HOUSING DECARBONISATION IN THE UNITED KINGDOM

Document Prepared by:
PNZ Carbon (formerly Artica Partners)

Project title	Housing Decarbonisation in the United Kingdom
Project ID	2649
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***VCS Standard* Version**	4.7
Prepared by	PNZ Carbon Limited (formerly Arctica Partners Limited)

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PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

The Powering Net Zero (PNZ) Group is facilitating the UK's transition to net zero by funding the affordable decarbonisation of British homes from the commercial demand for transparent, localised carbon credits.

Homes are the single largest contributor to carbon emissions from the built environment, accounting for almost a quarter of the UK's total carbon emissions and representing the largest barrier to reaching net zero by 2050.[1] The independent Committee on Climate Change has identified decarbonising the UK's 29 million homes as the greatest priority to becoming a net zero economy.[2] However, it has also been estimated that £500bn is needed to upgrade UK homes by 2050, a scale too large for the Government to achieve with public spending alone.[3]

The investment needed to tackle this means unlocking private sector investment will be critical to decarbonising the housing stock. For this reason, high-quality carbon credits will be an essential solution in the net zero transition. PNZ Carbon helps to address this, providing a route for investment in housing decarbonisation by verifying the emission reductions and social value of projects and originating verified carbon credits backed by those reductions.

In 2022, we launched a pilot of our service, Retrofit Credits, in association with the Housing Associations' Charitable Trust (HACT). Twenty-two social housing providers from across the UK benefited from the first crediting cycle, and the credits originated and represented 5,000 annualised tonnes of emission reductions. During 2023, we have significantly scaled our project, and we are currently involved in funding over 100,000 decarbonisation projects across the UK, including homes in rural and urban communities and from all regions and countries. We currently work with over 200 commercial market participants, including social housing providers, local authorities and installers with projects across the social housing, owner-occupied and private rental sectors.

During this monitoring period, 39,927 individual Project Activity Instances (PAIs) were decarbonised between January 1, 2023, and December 31, 2023, resulting in 30,756 tCO2e emission reductions, which is equivalent to an annualised 46,488 tCO2e.

The total number of PAIs decarbonised (39,927) includes all PAIs completed to date in the project, inclusive of all works completed in both monitoring periods.

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[1] The Cost of Poor Housing in England. Building Research Establishment. 2021.

[2] UK housing: Fit for the future?. Committee on Climate Change (CCC). 2019.

[3] Greening Our Existing Homes National retrofit strategy. Construction Leadership Council. 2021.

Decarbonisation measures installed during the monitoring period were energy efficiency measures, including insulation, air sealing, improving the efficiency of the central heating system, and reducing the grid-connected electricity consumption of appliances in existing PAIs.

1.2 Audit History

The table below illustrates the project's audit history to date, including the period covered by this Project Document.

Audit type	Period	Program	Validation/verification body name	Number of years
Validation	Date of issue: 13-06-2022	VCS	Earthood Services Private Limited	N/A
Verification	01-07-2022 – 31-12-2022	VCS	Earthood Services Private Limited	6 months
Verification	01-01-2023 – 31-12-2023	VCS	SustainCERT S.A	One year
Total	01-07-2022 – 31-12-2023	VCS	Earthood Services Private Limited / SustainCERT S.A	One year and 6 months

1.3 Sectoral Scope and Project Type

The project is a non-AFOLU project:

Sectoral scope	VCS Sectoral Scope 3: Energy Demand
Project activity type	Energy efficiency results from the installation of energy efficiency measures in PAIs.

Grouped Project: This project is a Grouped project where the proponent acts as a central administrator to expedite the pace of housing decarbonisation. This project targets a range of individual dwellings (referred to as "project activity instances" or "PAIs" in this document)[4]. Emission reduction improvements made to PAIs are called "decarbonisation measures" throughout this document.

[4] In the registered PDD, being a PAI, as defined in UK legislation, currently the Finance Act 2013, c. 29, part 3, the Landlord and Tennant Act 1985, c.70, section 38, the Finance Act 2003, c.14, schedule 6B or schedule 4ZA, and not a "house in multiple occupation" as currently defined in the Housing Act 2004, c. 34, section 254.

During the monitoring period, the project proponent collected, monitored, and aggregated data necessary to demonstrate the crediting baseline and additionality and to quantify emission reductions.

This Monitoring Report includes information regarding 39,927 individual PAIs in the project activity between January 1, 2023, and December 31, 2023. Additional individual PAIs will be added throughout the crediting period. These PAIs will meet the eligibility criteria identified in section 1.4 (Eligibility Criteria) of the Project Description.

Project activity conducted according to the VM0008 Methodology includes the following *categories:*

Category A – Weatherization measures are directed at the enhancement of the Building Envelope, improving the efficiency of the central heating/cooling system, and reducing the energy consumption of Appliances.

Category B – Weatherization measures directed at enhancement of the Building Envelope and/or improving the efficiency of the central heating/cooling system.

Project activity is not currently conducted according to Category C or D of the VM0008 Methodology.

1.4 Project Proponent

The contact details for the Project Director can be found in the table below:

Organization name	PNZ Carbon Limited
Contact person	Director of Operations
Title	Director
Address	1 King William St, London, EC4N 7AF
Telephone	0333 577 5954
Email	enquiries@pnzcarbon.co.uk

PNZ Carbon is an investor for impact working to maximise the essential work of decarbonising the housing stock. The housing sector urgently needs to improve its housing stock's thermal efficiency and increase its proportion using heat from renewable sources. This comes at a major cost, and the project's objective is to expedite the pace and scale of housing decarbonisation by offering a credible and transparent way to invest in housing decarbonisation activities.

Recognising the importance of decarbonisation to residents' lives, the project uses the UK Social Value Bank to demonstrate the positive impact of housing decarbonisation on health, well-being, and fuel poverty.

1.5 Other Entities Involved in the Project

The project proponent works closely with a Project Partner to deliver its service. Details can be found in the table below:

Organization name	Housing Associations Charitable Trust (HACT)
Role in the project	Project Partner
Contact person	Head of Retrofit Credits
Title	Director
Address	7-14 Great Dover Street, London, SE1 4YR
Telephone	+44 7 388 919 644
Email	retrofitcredits@hact.org.uk

HACT is a project partner. As the charity and innovation agency for the social housing sector, HACT has supported its transformation and development for over 60 years.

HACT pioneered the measurement of social value in housing, launching the UK Social Value Bank with Simetrica-Jacobs in 2014. Updated in 2022 to understand the well-being and exchequer impacts, it remains the largest set of methodologically consistent social values globally. It is the only social value tool that measures the positive impact of housing decarbonisation.

1.6 Project Start Date

Project start date	01-07-2022
Justification	The project crediting period start date is the date upon which the project activity instances began reducing GHG emissions. PAIs generate emission reductions beginning on the date of the completed installation of the decarbonisation measures. The first PAIs with completed installations of plant, technologies, and

	processes that generate GHG emission reductions were completed on July 1, 2022.

1.7 Project Crediting Period

Crediting period	☐ **Seven years, twice renewable** ☐ Ten years, fixed ☐ Other (state the selected crediting period and justify how it conforms with the VCS Program requirements)
Start and end date of first or fixed crediting period	01-07-2022 to 30-06-2029

1.8 Project Location

The project activity location is within the areas that qualify as part of the Same Building Stock as defined in the VM0008 Methodology. Initial project activity instances occur within this geographic area:

Project Latitude: 49°51′N to 59°48’N

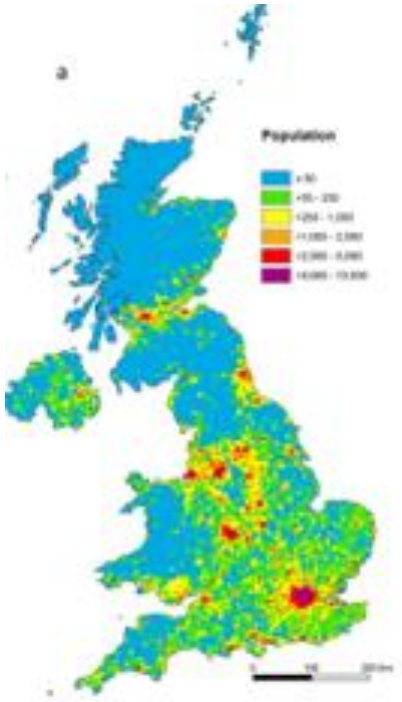
Project Longitude: 6°27′W to 1°46′E

New PAI instances, as reported for this monitoring period, are all within the above defined geographic area.

All PAIs added to the project activity will be subject to the same baseline scenario and rationale for demonstrating additionality. The geodetic coordinates of each PAI in the project activity will be recorded, and each PAI in the project will be assigned a unique Project Activity Instance (PAI) identification number.

There are about 28.6 million PAIs in the physical boundary of the current project location. Figure 1 below illustrates the spatial distribution of PAIs based on population.

Figure 1: Distribution of PAIs within the UK based on population (2016)[5].



1.9 Title and Reference of Methodology

Details of the methodology utilised by the project proponent can be found in the table below:

Type (methodology, tool or module).	Reference ID, if applicable	Title	Version
Methodology	VM0008	Weatherization of Single Family and Multi-Family Buildings	1.1

1.10 Double Counting and Participation under Other GHG Programs

The project has not applied for registration under any other GHG programme. Owners of the statutory, property or contractual right in the plant, equipment or process that generates GHG reductions, as defined in VCS Standard v4.7, section 3.7.1, confirm they will not seek to have the

[5] Vieno et al., 2016

emission reductions created by the PAIs registered with this project credited under any other GHG scheme or programme.

1.10.1 No Double Issuance

Is the project receiving or seeking credit for reductions and removals from a project activity under another GHG program?

☐ Yes ☒ **No**

1.10.2 Registration in Other GHG Programs

Was the project registered or seeking registration under any other GHG programs?

☐ Yes ☒ **No**

1.11 Double Claiming, Other Forms of Credit, and Scope 3 Emissions

1.11.1 No Double Claiming with Emissions Trading Programs or Binding Emission Limits

Are project reductions and removals or project activities also included in an emissions trading program or binding emission limit? See the *VCS Program Definitions* for definitions of emissions trading program and binding emission limit.

☐ Yes ☒ **No**

1.11.2 No Double Claiming with Other Forms of Environmental Credit

Has the project activity sought, received, or is planning to receive credit from another GHG-related environmental credit system? See the *VCS Program Definitions* for definition of GHG-related environmental credit system.

☐ Yes ☒ **No**

1.11.3 Supply Chain (Scope 3) Emissions

Do the project activities affect the emissions footprint of any product(s) (goods or services) that are part of a supply chain?

☐ Yes ☒ **No**

If yes:

Is the project proponent(s) or authorized representative a buyer or seller of the product(s) (goods or services) that are part of a supply chain?

☐ Yes ☐ No

If yes:

Has the project proponent(s) or authorized representative posted a public statement on their website saying, "Carbon credits may be issued through the Verified Carbon Standard project [project ID] for the greenhouse gas emission reductions or removals associated with [project proponent or authorized representative organization name(s)] [name of product(s) whose emissions footprint is changed by the project activities]."

☐ Yes ☐ No

1.12 Sustainable Development Contributions

The project promotes the decarbonisation of PAIs, which has a profound impact on comfort, well-being, and productivity. Decarbonisation measures can also create jobs and boost existing firms (especially SMEs and their supply chains) in construction. Economy-wide, there is considerable potential to develop and extend the labour force with a full range of skills.

The project contributes to several Sustainable Development priorities, including the fight against fuel poverty (reported to be responsible for an estimated annual 17,000 excess deaths) and directly supports SDG 13: Take urgent action to combat climate change and its impacts.

Please see **Appendix 2** for additional information about Sustainable Development Contributions.

Table 1: Sustainable Development Contributions

Row number	SDG target	SDG indicator	Net impact on SDG indicator	Current project contributions	Contributions over project lifetime
1)	1.5	1.5.1 Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population.	Implemented activities to decrease	Facilitated the retrofit of the homes of 27,341 low-income households which reduced the impact of fuel poverty during then monitoring period. Premature mortality related to fuel poverty is said to be responsible for 17,000 excess deaths per year. [6]	Facilitated the retrofit of homes of 27,341 low-income households. This figure is the cumulative contribution over the lifetime of the project, as well as the current project contribution, as works from the initial monitoring period and re-enrolled for future monitoring periods.

[6] 17,000 people in the UK died last winter due to cold housing. E3G, 2019.

2)	3.0	Ensure healthy lives and promote well-being for all at all ages.	Implemented activities to increase	Delivered £19,248,714 of social value – the monetary value of the health and wellbeing improvements that residents gained through improvements to the thermal and energy efficiency of their home during the monitoring period.[7]	Delivered health and wellbeing improvements valued at £19,248,714. (Cumulative project contribution over lifetime: £20,116,350)
3)	7.1	Energy intensity measured in terms of primary energy.	Implemented activities to decrease	Facilitated the retrofit of 39,927 homes which prevented the consumption of 146,927,376 kWh of energy during the monitoring period. [8]	Prevent the consumption of 146,927,376 kWh of energy. (Cumulative project contribution over lifetime: 153,626,711 kWh)

[7] The project proponent calculates social value by utilising the UK Social Value Bank, as operated by project partner HACT. The UK Social Value bank allows the measurement of social and environmental impact through improvements to wellbeing and savings made to the state.

[8] PNZC calculates this reduction via assessment of the energy efficiency improvements in individual properties after completion of PAIs.

4)	9.4	9.4.1 CO2 emission per unit of value added.	Implemented activities to decrease	Delivered £19,248,714 of social value – the monetary value of the health and wellbeing improvements that residents gained through improvements to the thermal and energy efficiency of their home during the monitoring period – with a CO2e emission per unit of value added of 0.00160 tCO2e per £1 of social value during the monitoring period. [9]	CO2e emission per unit of value added of 0.00160 tCO2e per £1 of social value.
5)	11.5	1.5.1 Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population.	Implemented activities to decrease.	Facilitated the retrofit of the homes of 27,341 low-income households which reduced the impact of fuel poverty during the monitoring period. Premature mortality related to fuel poverty is said to be responsible for 17,000 excess deaths per year.	Facilitated the retrofit of the home of 27,341 low-income households. This figure is the cumulative contribution over the lifetime of the project, as well as the current project contribution, as works from the initial monitoring period and re-enrolled for future monitoring periods.

[9] CO2e emission per unit of value added is calculated by dividing the emission reductions achieved during the monitoring period by the total social value generated during the monitoring period, as validated via the UK Social Value Bank. The Social Value achieved was validated via the UK Social Value Bank, based on changes in property SAP scores. The Social Value calculation utilised by the UK Social Value Bank comprises Wellbeing Value and Exchequer Value, together forming the Total Value. For a detailed overview of Social Value, please refer to the Project Design Document (PDD).

6)	13	13.3 Improve education, awareness-raising and human and institutional capacity on climate change	Implemented measures to increase.	Facilitated 39,927 PAIs across the project.	Raising awareness of the positives of carbon finance and supporting the installation of further decarbonisation measures across all our delivery partners. Our partners include over 140 social housing providers, local government authorities, and over 100 installers with projects across the social housing, owner-occupied and private rental sectors. Onboarding these partners to the project has supported completion of 39,927 PAIs.

1.13 Commercially Sensitive Information

No information has been excluded from this document because it is commercially sensitive. However, highly sensitive, highly confidential data may be collected from PAI owners in the project, including the physical address and energy consumption of individual project activity instances. Such information is protected under UK data protection laws and must remain confidential.

2 SAFEGUARDS AND STAKEHOLDER ENGAGEMENT

2.1 Stakeholder Engagement and Consultation

2.1.1 Stakeholder Identification

Stakeholder Identification	Stakeholder make up has not changed since validation, the initial and ongoing stakeholder identification process is described below. The Project Proponent consulted with local community stakeholders to inform the project's initial design and maximise participation from stakeholders. A literature review and initial outreach with interested parties occurred between March and October 2021. From this work, the following categories of local community stakeholder were identified: • Dwelling owners • Residents • Fuel poverty charities

- Decarbonisation measure installers
- Carbon credit buyers
- Data vendors

1) Government and local authorities

Engagement with potential local stakeholders occurred in November 2021, centred around two major housing conferences and engagement with local community stakeholders for the initial dwellings enrolled in the project at registration.

A focus group of identified local stakeholders held a series of follow-up virtual meetings between November 2021 and January 2022.

During the project's design stage, the project proponent gathered useful feedback from local stakeholders. No adverse impacts on local stakeholders were identified.

The Project Proponent has established a mechanism for ongoing communication with local stakeholders by promoting an email address to which local stakeholders have been invited to provide feedback (enquiries@pnzcarbon.co.uk).

The project proponent has partnered with HACT, the charity of the social housing sector, which specialises in helping organisations active in the housing sector to evaluate, monitor and improve their services. HACT has supported the transformation and development of housing provision in the UK for over 60 years.

HACT reviewed the project documents and conducted interviews with representatives of the categories of local stakeholders identified above to understand the impact of this project.

On an ongoing basis, HACT is involved in monitoring the extent to which the project continues to be aligned with stakeholder expectations and will suggest amendments where the project could be improved, drawing on examples of good practice from within and beyond the social housing sector.

	HACT has appointed a Relationship Lead for this project and has established a mechanism for ongoing communication with local stakeholders by promoting an email address to which local stakeholders have been invited to provide feedback (retrofitcredits@hact.org.uk). The project proponent and HACT regularly discuss the project with local community stakeholders across the UK, for example, during public webinars where they seek feedback about the project. A focus group of interested stakeholders has also been established.
Legal or customary tenure/access rights	No adverse impacts on local stakeholders were identified. This project facilitates much-needed funding to enable the affordable retrofit of existing homes, in many cases avoiding the alternative—demolishing and rebuilding existing homes—which could negatively impact local communities and generate significant amounts of embodied carbon. By facilitating retrofit over demolition, we are facilitating a better outcome from the perspective of local communities and residents.
Stakeholder diversity and changes over time	In 2022, twenty-two social housing organisations from across the UK participated in the first monitoring period. During 2023, we have significantly scaled our project, and we are currently involved in funding over 100,000 retrofit projects across the UK, including homes in rural and urban communities and from all regions and countries. Our delivery partners now include over 140 social housing providers, local government authorities, and over 100 installers with projects across the social housing, owner-occupied and private rental sectors.
Expected changes in well-being	In 2014, HACT and Simetrica[10] produced in the UK Social Value Bank, which applies a Wellbeing Valuation approach

[10] HACT, registered as the Housing Associations Charitable Trust, and Simetrica-Jacobs, the international experts in social value analysis, research, and econometrics, have established reputations for producing ground-breaking social impact measurement research and the development of accompanying practical tools for the housing sector. This includes the 2014 study Measuring the Social Impact of Community Investment: a Guide to Using the Wellbeing

to value the impact of housing providers' activities on their residents. It contains values for investment outcomes in domains such as employment and training, health, housing maintenance, money management, local neighbourhoods and crime, physical activity and, importantly, PAI energy efficiency. Updated in 2022 to understand wellbeing and exchequer impacts, the UK Social Value Bank remains the largest set of methodologically consistent social value in the world and is the only social value tool that measures the positive impact of housing decarbonisation. This project uses the UK Social Value Bank to assess the impact of project activity on health and wellbeing.

Wellbeing Valuation judges the success of a project by how it affects people's wellbeing. Rather than asking people about how much something has improved their life, which can introduce psychological complexities and extensive data collection, Wellbeing Valuation analyses existing datasets of national surveys, which instead reveal effects on wellbeing in a robust way. Analysis can isolate the impact of a specific aspect of life on wellbeing. This can be valued by finding from the data the equivalent amount of money needed to increase someone's well-being by the same amount. Wellbeing Valuation is recognised in HM Treasury's Green Book – the UK Government's core guide to policy evaluation[11] – as a method for placing values on things that do not have a market value through being bought and sold. Well-being valuation is also in the Treasury supplementary green book guidance on well-being appraisal.

During this monitoring period, the project delivered £19,248,714 of social value – the monetary value of the health and wellbeing improvements that residents gained through improvements to the thermal and energy efficiency of their home during the monitoring period.

Valuation Approach and accompanying Value Calculator, and the 2015 studies The Health Impacts of Housing Associations' Community Investment Activities and The Wellbeing Value of Tackling Homelessness.

[11] The Green Book: Central Government Guidance on Appraisal and Evaluation. HM Treasury. 2020.

Location of stakeholders	Project stakeholders are located within the project activity location. This is within areas which qualify as part of the Same Building Stock as defined in the VM0008 Methodology (see 1.7 'Project Location). The project encourages the decarbonisation of domestic PAIs within the project activity location, with stakeholders across social housing providers, local government authorities, installers of decarbonisation measures, and residents and local communities benefiting from the retrofit measures.
Location of resources	In 2022, twenty-two social housing organisations from across the UK participated in the first monitoring period. During 2023, we have significantly scaled our project, and we are currently involved in funding over 100,000 retrofit projects across the UK, including homes in rural and urban communities and from all regions and countries. Our delivery partners now include over 140 social housing providers, local government authorities, and over 100 installers with projects across the social housing, owner-occupied and private rental sectors.

2.1.2 Stakeholder Consultation and Ongoing Communication

Ongoing consultation	Consultation began in March 2021, and to date, over 500 organisations and more than 3,700 individuals have been engaged around the project and its design. The consultation has continued throughout the monitoring period. The project proponent engages regularly with decarbonisation measure installers, including regular meetings and site visits to educate them about the project. Project partner HACT regularly engages with social housing providers and local government authorities through bilateral engagement at public events, webinars, and sector-specific initiatives.
Date(s) of stakeholder consultation	Examples of attendance at Exhibitions, Webinars and Events include:

	• Northern Housing Summit (17-Jan-2023) • National Housing Maintenance (23-23-Jan-2023) • Housing Social Value (21-Feb-2023) • Housing Data and Digital Conference (21-Mar-2023) • Housing 2023 (27-29-June-2023) • Councils Housing Conference (18-Sept-2023) • Health and Housing Conference (17-Oct-2023) • Housing Forum National Conference (24-Oct-2023) • Homes UK (22 and 23-Nov-2023) Further Stakeholder Engagement activity is planned for future monitoring periods, including speaking and engagement slots at Councils Building Homes, Footprint 2024, Communities & Housing Investment Consortium (CHIC) and the annual event held by the UK's Real Estate Investment & Infrastructure (UKREiiF).
Communication of monitored results	The project proponent and project partner hold monthly Steering Group meetings with formal agendas that provide opportunities for feedback and discussion from all forms of stakeholder consultation. Results from specific instances of engagement are presented within the Steering Group and then more widely circulated amongst specific stakeholder groups, including via published posts on social media sites (e.g. LinkedIn) and the project website.
Consultation records	The results of all types of stakeholder consultation are discussed in monthly Steering Group meetings, with formalised and written updates provided to stakeholder groups as and when required.
Stakeholder input	Stakeholder input has been important to the development of the project and the project proponent engaged extensively with external stakeholders to gather valuable

	input on its design and implantation. All contributions were carefully reviewed and considered, with stakeholder input helping to shape the project's approach to wider stakeholder engagement, but no material changes were made to the project design. Input was discussed internally, during monthly Steering Group meetings and helped to verify the end goals of the project and confirm that the project design was sufficient to support its end goals. The project is unique in scope and approach, addressing a specific gap in the market to help support the retrofitting of domestic homes. As such, the original project design, which was proven to be successful during the initial monitoring period for the project, effectively meets its goals and renders any significant changes unnecessary at present.

2.1.3 Free, Prior, and Informed Consent

Consent	Social housing providers and local government authorities own or control the set of plant, technologies, measures or processes that could reduce GHG emissions and create social value ("Project Activity"). The housing providers and local authorities appoint PNZ Carbon to help raise finance to enable the deployment of their Project Activity to PAIs in the United Kingdom more widely and earlier than would otherwise be possible. To achieve this, the housing providers and local authorities seek to have the GHG emission reductions resulting from their Project Activity Instances issued as Verified Carbon Units ("VCUs") with the Verra Registry. The VCUs, when issued, are issued to PNZ Carbon as the Project Proponent, and HACT assesses and verifies the social value created by the Project Activity, working in partnership with PNZ Carbon. HACT then ascribes a monetary value to the social impact of each VCU with a view to marketing and selling the VCUs as Retrofit Credits to purchasers ("VCU Buyers"). Verra will only issue VCUs to an organisation with overall control and responsibility for a project registered under the

	Verified Carbon Standard and where that organisation holds all and any rights to the GHG emission reductions (as principal and not as agent). Accordingly: • Social housing providers and local government authorities enter into a contract under which they acknowledge and agree that PNZ Carbon as project proponent is the organisation that has overall control and responsibility for the Project registered under the Verified Carbon Standard and grant to PNZ Carbon an exclusive licence to all and any rights to the GHG emission reductions resulting from the Project Activity Instances during the Crediting Period to enable PNZ Carbon, as principal, to take those GHG emission reductions to the Registry and have them issued as VCUs. The Project Proponent does not own the plant, technologies, measures, or processes, nor the homes in which they are installed. Ownership of those remains with the housing providers and local authorities.
Outcome of FPIC	The FPIC process was followed thoroughly to ensure full consultation with Indigenous Peoples (IPs), Local Communities (LCs), and customary rights holders, as appropriate for the project. As a result of this process, all relevant parties were fully informed and engaged in understanding the scope and impact of the project. There has been no encroachment on land, and no individuals or communities have been relocated without their explicit consent. Additionally, the project has ensured that there has been no forced physical or economic displacement of people as it provides support for retrofitting of existing homes. The project supports the improvement of the energy efficiency of existing dwellings, without encroaching on negatively impacting individuals or communities.

2.1.4 Grievance Redress Procedure

Grievances received	Resolution and outcome
N/A	Project developers have a crucial role to play within the communities they serve. This role is built on the foundations of listening and responding to the community's needs, giving residents a voice, and treating them with respect and dignity. As a project that impacts the lives of residents and local communities, we believe in the transformative power of working together, open communication, and collaborative decision-making. During this monitoring period, we have worked with HACT to analyse resident feedback, which is the cornerstone of our service delivery efforts. This feedback has helped us identify what the Retrofit Credits service does well, and more importantly, areas where we can improve. We have also spoken to teams leading on engagement and service delivery, ensuring that every voice is heard and valued. Our journey included meeting with social housing providers, local government authorities and residents in dwellings across the UK to understand what strong engagement should look like. Together with our lived experiences and the research we conducted, we are pleased to take the next steps to strengthen our engagement with residents through our resident engagement strategy. Through conversations, cooperation, and a shared vision for positive change, we can unlock the potential of our diverse and vibrant local communities.

2.1.5 Public Comments

Summary of comments received	Actions taken
No comments received.	N/A

2.2 Risks to Stakeholders and the Environment

2.2.1 Management Experience

PNZ Carbon is facilitating the UK's transition to net zero by 2050 by funding the affordable decarbonisation of British homes through the commercial demand for transparent, localised carbon credits. We are the only project developer in the world to originate carbon credits for the decarbonisation of housing stock and the only developer with projects in local UK communities.

The UK is facing one of our generation's most critical environmental, social and economically significant challenges, and the PNZ Carbon management team has considerable depth and breadth to develop and deliver the innovative solutions needed to finance housing decarbonisation.

2.2.2 Risk assessment

	Risk identified	Mitigation or preventative measure(s) taken
Natural and human-induced risks to stakeholders' wellbeing	Decarbonisation works are not delivered to the required standards, increasing the risk of natural and human-induced risks to stakeholders' wellbeing.	The project proponent undertook an Environmental Impact Assessment to inform the initial design of the project. Decarbonisation measures installed as part of this project are those directed at reducing the rate of conductive heat loss in the winter or heat gain in the summer, reducing air infiltration and consequently reducing convective heat loss or heat gain and reducing the rate of fossil

		fuel and grid-connected electricity consumption within the dwelling. Reduced fossil fuel and grid-connected electricity consumption from decarbonisation measures generates emission reductions. The project methodology mandates that a home's condition is suitable for retrofit activities, aligning with nationally recognised best practice standards. It further requires that retrofit activities not breach health and safety, environmental, or other pertinent regulations. Renovation of a dwelling's thermal elements and replacing heat-producing systems are regulated activities that must adhere to the Building Regulations. These regulations are the cornerstone of health and safety, environmental, and energy conservation obligations. Compliance is verified through a Building Regulations Compliance Certificate, confirmation of work by a person registered with a competent person scheme, a certificate under Publicly Available Specification 2030 (PAS) or an equivalent standard, or a declaration by a regulated social housing provider or local authority. PNZ Carbon and HACT work with over 200 delivery partners, including social housing

		providers, local government authorities and installers across the UK, in rural and urban communities and from all regions and countries. Housing providers in the UK are regulated by several bodies to ensure they meet specific standards and provide suitable housing for those in need. The central regulatory bodies include: • Regulator of Social Housing (RSH): England's primary regulatory body for social housing providers. The RSH regulates registered social housing providers to ensure their housing stock meets minimum standards. Responsibility for the quality of retrofit activity ultimately falls to the registered provider. The RSH monitors compliance with the Regulatory Standards through various tools, including the Housing Health and Safety Rating System (HHSRS). • Scottish Housing Regulator (SHR): The SHR regulates social housing providers in Scotland. Like the RSH, it monitors and assesses the performance of registered social landlords to ensure their housing stock meets minimum standards. • Welsh Government: The Welsh government regulates social housing providers in Wales. It sets policies and standards for

		social housing, oversees the performance of registered social landlords, and ensures compliance with similar minimum standards. Installers in the UK are regulated by several bodies to ensure their work meets specific standards, including: • Competent Persons Schemes: The UK government introduced these schemes to allow individuals and enterprises to certify that their work complies with the Building Regulations. A Competent Person must be registered with a scheme approved by the Department for Levelling Up, Housing and Communities. Contractors on the Competent Persons Register are regularly assessed to the standards of their sector and to ensure their work meets the requirements of the building regulations. • PAS (Publicly Available Specification, e.g., PAS 2035): PAS documents are minimum standards developed through a consensus process involving industry experts, government bodies, and other stakeholders. PAS sets out minimum standards and requirements for installing energy efficiency measures in existing buildings. It includes requirements regarding

		installation processes, process management, and service provision and criteria relating to installation methods, equipment, tools, product or system and material suitability, the commissioning of installed measures, and the training, skills, and competence of the people undertaking such installation. These bodies conduct assessments, inspections, and audits to ensure that retrofit works are effectively delivered and provide safe and suitable housing for households. They have the power to intervene registrants fail to meet the required standards or if there are concerns about their performance. The project activity is not expected to have any adverse environmental impacts.
Risks to stakeholder participation	Potential stakeholders' lack of understanding of the Voluntary Carbon Market and the value offered by high-integrity carbon credits could limit engagement.	Regular engagement with stakeholders, from both the project proponent and HACT, to ensure the project is understood. Materials produced, alongside supporting website content, to explain the project and act as reference material for stakeholders.
Working conditions	Decarbonisation works are not delivered to the required standards, increasing the risk of substandard working conditions.	See the description of mitigation or preventative measure(s) taken under section 2.3.1 below.

Safety of women and girls	No risk identified.	See the description of mitigation or preventative measure(s) taken under section 2.3.1 below.
Safety of minority and marginalized groups, including children	No risk identified.	See the description of mitigation or preventative measure(s) taken under section 2.3.1 below.
Pollutants (air, noise, discharges to water, generation of waste, and release of hazardous materials and chemical pesticides and fertilizers)	Decarbonisation works are not delivered to the required standards, increasing the risk of pollutants affecting local areas.	The project proponent undertook an Environmental Impact Assessment to inform the initial design of the project. Decarbonisation measures installed as part of this project are those directed at reducing the rate of conductive heat loss in the winter or heat gain in the summer, reducing air infiltration and consequently reducing convective heat loss or heat gain and reducing the rate of fossil fuel and grid-connected electricity consumption within the dwelling. Reduced fossil fuel and grid-connected electricity consumption from decarbonisation measures generates emission reductions. The project methodology mandates that a home's condition is suitable for retrofit activities, aligning with nationally recognised best practice standards. It further requires that retrofit activities not breach health and safety, environmental, or other pertinent regulations. Renovation of a dwelling's thermal elements and replacing heat-producing systems

		are regulated activities that must adhere to the Building Regulations. These regulations are the cornerstone of health and safety, environmental, and energy conservation obligations. Compliance is verified through a Building Regulations Compliance Certificate, confirmation of work by a person registered with a competent person scheme, a certificate under Publicly Available Specification 2030 (PAS) or an equivalent standard, or a declaration by a regulated social housing provider or local authority. PNZ Carbon and HACT work with over 200 delivery partners, including social housing providers, local government authorities and installers across the UK, in rural and urban communities and from all regions and countries. Housing providers in the UK are regulated by several bodies to ensure they meet specific standards and provide suitable housing for those in need. The central regulatory bodies include: • Regulator of Social Housing (RSH): England's primary regulatory body for social housing providers. The RSH regulates registered social housing providers to ensure their housing stock meets minimum standards. Responsibility for the quality of

		retrofit activity ultimately falls to the registered provider. The RSH monitors compliance with the Regulatory Standards through various tools, including the Housing Health and Safety Rating System (HHSRS). • Scottish Housing Regulator (SHR): The SHR regulates social housing providers in Scotland. Like the RSH, it monitors and assesses the performance of registered social landlords to ensure their housing stock meets minimum standards. • Welsh Government: The Welsh government regulates social housing providers in Wales. It sets policies and standards for social housing, oversees the performance of registered social landlords, and ensures compliance with similar minimum standards. Installers in the UK are regulated by several bodies to ensure their work meets specific standards, including: • Competent Persons Schemes: The UK government introduced these schemes to allow individuals and enterprises to certify that their work complies with the Building Regulations. A Competent Person must be registered with a scheme approved by the Department for

		Levelling Up, Housing and Communities. Contractors on the Competent Persons Register are regularly assessed to the standards of their sector and to ensure their work meets the requirements of the building regulations. • PAS (Publicly Available Specification, e.g., PAS 2035): PAS documents are minimum standards developed through a consensus process involving industry experts, government bodies, and other stakeholders. PAS sets out minimum standards and requirements for installing energy efficiency measures in existing buildings. It includes requirements regarding installation processes, process management, and service provision and criteria relating to installation methods, equipment, tools, product or system and material suitability, the commissioning of installed measures, and the training, skills, and competence of the people undertaking such installation. These bodies conduct assessments, inspections, and audits to ensure that retrofit works are effectively delivered and provide safe and suitable housing for households. They have the power to intervene registrants fail to meet the required standards or if there are

		concerns about their performance. The project activity is not expected to have any adverse environmental impacts.

2.3 Respect for Human Rights and Equity

Labor and Work

Risks Identified	Risk identified	Mitigation or preventative measure(s) taken
Sexual harassment	Failure to prevent sexual harassment.	See the description of mitigation or preventative measure(s) taken under section 2.3.1 below.
Gender equity in labor and work	Failure to prevent gender equality.	See the description of mitigation or preventative measure(s) taken under section 2.3.1 below.
Forced labor	Failure to prevent forced labour.	See the description of mitigation or preventative measure(s) taken under section 2.3.1 below.
Child labor	Failure to prevent child labour.	See the description of mitigation or preventative measure(s) taken under section 2.3.1 below.
Human trafficking	Failure to prevent human trafficking.	See the description of mitigation or preventative measure(s) taken under section 2.3.1 below.

2.3.1 Human Rights

Risks Identified	Mitigation or preventative measure(s) taken

Failure to recognise, respect and promote the protection of human rights	PNZ Carbon is committed to delivering high standards of corporate governance, and a key element of this is ensuring that we comply with our legal and regulatory responsibilities, including the Modern Slavery Act (2015). We have taken steps to understand the risks of modern slavery in our supply chains and organisation and to mitigate these risks. We support international efforts to eradicate modern slavery and human trafficking. We expect the same commitment from all organisations we do business with and will not knowingly support any business involved in slavery or human trafficking. Requirements under the Act. **PNZ Carbon must:** 1. Ensure that its supply chains are free from domestic servitude, forced or compulsory labour and human trafficking. 2. Demonstrate a proactive approach to assessing, mitigating and managing the risk of slavery in supply chains. 3. Publish an annual statement setting out the steps taken to ensure that slavery and human trafficking are not taking place within its supply chains. **All PNZ Carbon suppliers must ensure that their own employees and those of their suppliers:** 1. Are legally able to work 2. Have freely chosen employment (no forced or bonded labour) 3. Have a written contract 4. Have not had to pay fees or lodge documents to obtain work 5. Understand their statutory rights (i.e. sick pay and holiday pay) 6. Are paid following national law

7. Are working in a safe and hygienic environment
8. Are not expected to work excessively long hours and that working hours comply with national laws and guidelines

All PNZ Carbon suppliers should assess quotations and fees from any agency or supplier providing unusually low rates compared to industry standards.

Our supply chain

Procurement is mostly undertaken by the colleagues who are responsible for all origination-related works and services, along with buying items such as stationery, coffee and IT for the company.

Purchasing decisions must comply with the Modern Slavery Act (2015), and PNZ Carbon must monitor and report compliance with the Act under the Transparency in the Supply Chain Provision.

Repairs and maintenance are delivered through a series of trade-specific Measured Term Contracts. Due to the place-based nature of our business, many of our contractors are small, local firms, which allows us to build close relationships with suppliers, allowing us to promote our commitment with regards to social value and responsibility, living wage, sustainable procurement, a focus on supporting the local economy when possible and to work with our supply chain providers to zone out and, when possible, fully eliminate slavery and human trafficking. A clause requiring compliance with our Slavery and Human Trafficking Statement is now inserted in all new contracts which contractors sign.

We audit our supply chains on an ongoing basis and work with our suppliers to identify areas where slavery or human trafficking is a risk. We perform an annual contractor health check, and part of this process is verifying subcontractors' compliance. We raise contractor awareness of the Modern Slavery Act with any new contractors or suppliers, and this is included in the new contractor induction process.

Our staff

Recruiting permanent staff – PNZ Carbon operates comprehensive and transparent recruitment processes, which are subject to the oversight of the People and Development department and periodic external auditing. Our processes include Right to Work checks for all permanent and interim staff and pay at least the National Living Wage.

Where possible, we ensure that any agencies we use for temporary staff pay the National Living Wage. We also ensure that these partners apply good HR practices and processes, including Right to Work checks, and PNZ Carbon has access to these records and carries out regular audits to ensure they are up-to-date and accurate.

Policies and procedures

The PNZ Carbon Modern Slavery Policy mirrors this statement but includes an 'Impact Assessment' for internal purposes. The statement is reviewed annually by the Managing Director and presented to the Board for approval. Contract managers/procuring officers and their line managers are responsible for ensuring that new contracts comply with this policy and that suppliers under existing contracts (those awarded before the policy was introduced) and suppliers who are not under contract comply with it.

Policies are reviewed every five years or sooner. The current Policy was presented to the Board in May 2023.

Our Procurement Policy and Procedure is designed to ensure that buying decisions demonstrate proper consideration of quality, cost and purpose and that value for money, added value, and social value have been maximised.

Commitment from our Board of Directors

This statement is made under section 54(1) of the Modern Slavery Act 2015 and constitutes PNZ Carbon's slavery and human trafficking statement for the monitoring period ending 31 December 2023.

	This statement will be reviewed and updated annually and is approved by our Board. Our Board of Directors is committed to preventing slavery in our supply chains and has approved this statement accordingly.

2.3.2 Indigenous Peoples and Cultural Heritage

Risks Identified	Mitigation or preventative measure(s) taken
Disputes over rights to territories and resources	Social housing providers and local government authorities own or control the set of plant, technologies, measures or processes that could reduce GHG emissions and create social value ("Project Activity"). The housing providers and local authorities appoint PNZ Carbon to help raise finance to enable the deployment of their Project Activity to PAIs in the United Kingdom more widely and earlier than would otherwise be possible. To achieve this, the housing providers and local authorities seek to have the GHG emission reductions resulting from their Project Activity Instances issued as Verified Carbon Units ("VCUs") with the Verra Registry. The VCUs, when issued, are issued to PNZ Carbon as the Project Proponent, and HACT assesses and verifies the social value created by the Project Activity, working in partnership with PNZ Carbon. HACT then ascribes a monetary value to the social impact of each VCU with a view to marketing and selling the VCUs as Retrofit Credits to purchasers ("VCU Buyers"). Verra will only issue VCUs to an organisation that has overall control and responsibility for a project registered under the Verified Carbon Standard and where that organisation holds all and any rights to the GHG emission reductions (as principal and not as agent). Accordingly: • Social housing providers and local government authorities enter into a contract pursuant to which they acknowledge and agree that PNZ Carbon as project proponent is the organisation that has overall control and responsibility for the Project registered under the Verified Carbon Standard

	and grant to PNZ Carbon an exclusive licence to all and any rights to the GHG emission reductions resulting from the Project Activity Instances during the Crediting Period to enable PNZ Carbon, as principal, to take those GHG emission reductions to the Registry and have them issued as VCUs. The Project Proponent does not own the plant, technologies, measures, or processes, nor the homes in which they are installed. Ownership of those remains with the housing providers and local authorities.

2.3.3 Property Rights

Risks Identified	Mitigation or preventative measure(s) taken
Respect for property rights	Social housing providers and local government authorities own or control the set of plant, technologies, measures or processes that could reduce GHG emissions and create social value ("Project Activity"). The housing providers and local authorities appoint PNZ Carbon to help raise finance to enable the deployment of their Project Activity to PAIs in the United Kingdom more widely and earlier than would otherwise be possible. To achieve this, the housing providers and local authorities seek to have the GHG emission reductions resulting from their Project Activity Instances issued as Verified Carbon Units ("VCUs") with the Verra Registry. The VCUs, when issued, are issued to PNZ Carbon as the Project Proponent, and HACT assesses and verifies the social value created by the Project Activity, working in partnership with PNZ Carbon. HACT then ascribes a monetary value to the social impact of each VCU with a view to marketing and selling the VCUs as Retrofit Credits to purchasers ("VCU Buyers"). Verra will only issue VCUs to an organisation that has overall control and responsibility for a project registered under the Verified Carbon Standard and where that

	organisation holds all and any rights to the GHG emission reductions (as principal and not as agent). Accordingly: • Social housing providers and local government authorities enter into a contract pursuant to which they acknowledge and agree that PNZ Carbon as project proponent is the organisation that has overall control and responsibility for the Project registered under the Verified Carbon Standard and grant to PNZ Carbon an exclusive licence to all and any rights to the GHG emission reductions resulting from the Project Activity Instances during the Crediting Period to enable PNZ Carbon, as principal, to take those GHG emission reductions to the Registry and have them issued as VCUs. The Project Proponent does not own the plant, technologies, measures, or processes, nor the homes in which they are installed. Ownership of those remains with the housing providers and local authorities. Following the issuance and sale of VCUs, HACT, acting on behalf of PNZ Carbon, pays or arranges payment of the proceeds of sale to the housing provider or local authority less administration costs such as expenses payable for the Validation, Verification or issuance of the VCUs resulting from a Project Activity Instance.

2.3.4 Benefit Sharing

Summary of the benefit sharing plan	Social housing providers and local government authorities own or control the set of plant, technologies, measures or processes that could result in GHG emission reductions and create social value (“Project Activity”). The housing providers and local authorities appoint PNZ Carbon to help raise finance to enable the deployment of their Project Activity to PAIs in the United Kingdom more widely and earlier in time than would otherwise be possible.

To achieve this, the housing providers and local authorities seek to have the GHG emission reductions resulting from their Project Activity Instances issued as Verified Carbon Units ("VCUs") with the Verra Registry. The VCUs, when issued, are issued to PNZ Carbon as the Project Proponent, and HACT assesses and verifies the social value created by the Project Activity, working in partnership with PNZ Carbon. HACT then ascribes a monetary value to the social impact of each VCU with a view to marketing and selling the VCUs as Retrofit Credits to purchasers ("VCU Buyers").

Verra will only issue VCUs to an organisation that has overall control and responsibility for a project registered under the Verified Carbon Standard and where that organisation holds all and any rights to the GHG emission reductions (as principal and not as agent). Accordingly:

- Social housing providers and local government authorities enter into a contract pursuant to which they acknowledge and agree that PNZ Carbon as project proponent is the organisation that has overall control and responsibility for the Project registered under the Verified Carbon Standard and grant to PNZ Carbon an exclusive licence to all and any rights to the GHG emission reductions resulting from the Project Activity Instances during the Crediting Period to enable PNZ Carbon, as principal, to take those GHG emission reductions to the Registry and have them issued as VCUs.

The Project Proponent does not own the plant, technologies, measures, or processes, nor the homes in which they are installed. Ownership of those remains with the housing providers and local authorities.

Following the issuance and sale of VCUs, HACT, acting on behalf of PNZ Carbon, pays or arranges payment of the proceeds of sale to the housing provider or local authority less administration costs such as expenses payable for the Validation, Verification or issuance of the VCUs resulting from a Project Activity Instance.

Benefit sharing during the monitoring period	Sharing the proceeds of the sale of the VCUs with the housing provider or local authority enables them to overcome the financial barriers that currently prevent the widescale implementation of this important decarbonisation activity. The housing sector urgently needs to improve its housing stock's thermal efficiency and increase its proportion using heat from renewable sources. This comes at a major cost, and the project's objective is to expedite the pace and scale of housing decarbonisation by offering a credible and transparent way to invest in housing decarbonisation activities. The projects' benefits go far beyond carbon mitigation. The PAIs in the project boundary were built to relatively low thermal and energy efficiency standards and are cold and expensive to heat. These PAIs are some of the worst in Europe regarding thermal and energy efficiency. The health impacts of cold homes include increased risk of heart attack or stroke, respiratory illnesses, poor diet due to "heat or eat" choices, mental health issues, and worsening or slow recovery from existing conditions.[12] Children living in cold housing conditions are more than twice as likely to suffer from breathing problems, including asthma and bronchitis.[13] The decarbonisation of PAIs has a profound impact in terms of comfort, wellbeing, and productivity. By enabling the deployment of housing decarbonisation more widely, cost-effectively, and earlier than the present, this project facilitates benefit sharing with the residents of the retrofitted PAIs. This promotes healthy lives and well-being for those residents, as well as access to affordable, reliable, sustainable, and modern energy and a reduction of inequality. Housing decarbonisation reflects and reinforces existing socioeconomic disparities and can result in uneven or inequitable market dynamics, banking, financing patterns,

[12] Fuel Poverty. House of Commons Library. 2021.

[13] Assessing the Health Impact of Cold Homes. Centre for Sustainable Energy. 2017.

and resource deployment.[14] Outside of households that are eligible for government support schemes, the decarbonisation of homes is almost exclusively secured by higher-income households, creating disproportionate access to energy efficiency opportunities and exacerbating demographic inequity. Compared to the broader population, adopters of decarbonisation measures tend to live in higher-value homes and have higher incomes. One study examining diffusion patterns in the United Kingdom warned that increased adoption of micro-generation retrofit measures risked transferring wealth between lower-income and higher-income consumers.[14]

PNZ Carbon is using carbon finance to help address this by providing a route for private investment in decarbonising low- and moderate-income households. The pilot of our project, which commenced in 2022, demonstrated that carbon finance can play a significant role in helping to expedite the pace and scale of low-income housing retrofit by enabling commercial market participants, such as registered social housing providers and local government authorities, to overcome the financial barriers that currently prevent the widescale implementation of this important decarbonisation activity.

Over three million households in the United Kingdom are in fuel poverty – with rising energy prices and a cost-of-living crisis, this is only getting worse. Access to affordable heat profoundly impacts health, comfort, well-being, and productivity, with the Building Research Establishment finding that excess cold in homes costs the NHS £857m a year.[15]

Our high-quality housing decarbonisation projects are helping to tackle this by significantly reducing homes' heating demand, increasing their energy efficiency, and lowering bills. This creates warmer, healthier homes and delivers broader value for the Exchequer, with every £1

[14] B. K. Sovacool, M. Barnacle, A. Smith, M. C. Brisbois, Energy Policy, 2022, **124**, 112868.

[15] Building Research Establishment (2021) The Cost of Poor Housing in England. *Available online: link*

	spent on eradicating fuel poverty estimated to save the National Health Service 42p.[16] PNZ Carbon is helping to open energy efficiency to all for the first time, and in doing so is helping to democratise net zero.

2.4 Ecosystem Health

	Risk identified	Mitigation or preventative measure(s) taken during the monitoring period
Impacts on biodiversity and ecosystems	No risks identified.	No adverse impacts on biodiversity and ecosystems were identified. This project facilitates much-needed funding to enable the affordable retrofit of existing homes, in many cases avoiding the alternative—demolishing and rebuilding existing homes—which could negatively impact local biodiversity and ecosystems and generate significant amounts of embodied carbon. Ecosystem impacts from the installation of decarbonisation measures are not material and significantly less than the counterfactual of demolition and replacement with a more energy-efficient dwelling. By facilitating retrofit over demolition, this project is facilitating a better outcome from a biodiversity and ecosystem perspective.
Soil degradation and soil erosion	No risks identified.	No adverse impacts on soil degradation and soil erosion were

[16] UK Green Building Council (UKGBC) (2017) Regeneration and Retrofit. *Available online at: link*

		identified. This project facilitates much-needed funding to enable the affordable retrofit of existing homes, in many cases avoiding the alternative—demolishing and rebuilding existing homes—which could negatively impact local soil quality and generate significant amounts of embodied carbon. Disturbance of the soil ecosystem during the installation of decarbonisation measures is not material and significantly less than the counterfactual of demolition and replacement with a more energy-efficient dwelling. By facilitating retrofit over demolition, this project is facilitating a better outcome from a soil ecosystem perspective.
Water consumption and stress	No risks identified.	No adverse impacts on water consumption and stress were identified. This project facilitates much-needed funding to enable the affordable retrofit of existing homes, in many cases avoiding the alternative—demolishing and rebuilding existing homes—which could negatively impact local ecosystems and generate significant amounts of embodied carbon. Water consumption from the installation of decarbonisation measures is not material and significantly less than the counterfactual of demolition and replacement with a more energy-efficient dwelling. By facilitating retrofit over demolition, this project is facilitating a better outcome

		from a water consumption perspective.

2.4.1 Rare, Threatened, and Endangered species

Species or habitat	No adverse impacts on habitats for rare, threatened, or endangered species were identified. This project facilitates much-needed funding to enable the affordable retrofit of existing homes, in many cases avoiding the alternative—demolishing and rebuilding existing homes—which could negatively impact local ecosystems and generate significant amounts of embodied carbon. By facilitating retrofit over demolition, this project is facilitating a better outcome from the perspective of local ecosystems.
Areas needed for habitat connectivity	No adverse impacts on habitats needed for connectivity were identified. This project facilitates much-needed funding to enable the affordable retrofit of existing homes, in many cases avoiding the alternative—demolishing and rebuilding existing homes—which could negatively impact local ecosystems and generate significant amounts of embodied carbon. By facilitating retrofit over demolition, this project is facilitating a better outcome from the perspective of local ecosystems.

	Risks identified	**Mitigation or preventative measure(s) taken**
Habitats for rare, threatened, and endangered species	No risks identified.	No adverse impacts on habitats for rare, threatened, or endangered species were identified. This project facilitates much-needed funding to enable the affordable retrofit of existing homes, in many cases avoiding the alternative—demolishing and rebuilding existing homes—which could negatively impact local ecosystems and generate significant amounts of embodied carbon. By facilitating

		retrofit over demolition, this project is facilitating a better outcome from the perspective of local ecosystems.
Areas for habitat connectivity		No adverse impacts on habitats needed for connectivity were identified. This project facilitates much-needed funding to enable the affordable retrofit of existing homes, in many cases avoiding the alternative—demolishing and rebuilding existing homes—which could negatively impact local ecosystems and generate significant amounts of embodied carbon. By facilitating retrofit over demolition, this project is facilitating a better outcome from the perspective of local ecosystems.

2.4.2 Introduction of species

Species introduced	Classification	Justification for use	Adverse effects and mitigation
N/A	N/A	N/A	N/A

	Risks identified	Mitigation or preventative measure(s) taken
Invasive species	No risks identified.	No adverse impacts on local ecosystems from introducing invasive species were identified. This project facilitates much-needed funding to enable the affordable retrofit of existing homes, in many cases avoiding the alternative—abandonment of existing homes that are too

		expensive to heat—which could negatively impact local ecosystems by enabling invasive plants to overrun the abandoned homes. By facilitating retrofit over abandonment, this project is facilitating a better outcome from the perspective of local ecosystems.

2.4.3 Ecosystem conversion

	Risks identified	Mitigation or preventative measure(s) taken
Ecosystem conversion	No risks identified.	No adverse impacts on local ecosystems were identified. This project facilitates much-needed funding to enable the affordable retrofit of existing homes, in many cases avoiding the alternative—demolishing and rebuilding existing homes—which could negatively impact local ecosystems and generate significant amounts of embodied carbon. By facilitating retrofit over demolition, this project is facilitating a better outcome from the perspective of local ecosystems.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

The Powering Net Zero (PNZ) Group is facilitating the UK's transition to net zero by funding the affordable decarbonisation of British homes from the commercial demand for transparent, localised carbon credits.

The Project Activity is fully operational. PAIs are included in the Project Activity on a rolling basis as this is a Grouped Project. All PAIs included in this monitoring report for the Verification Period have satisfied the criteria for inclusion in the project.

Homes are the single largest contributor to carbon emissions from the built environment, accounting for almost a quarter of the UK's total carbon emissions and representing the largest barrier to reaching net zero by 2050.[17] The independent Committee on Climate Change has identified decarbonising the UK's 29 million homes as the greatest priority to becoming a net zero economy.[18] However, it has also been estimated that £500bn is needed to upgrade UK homes by 2050, the scale of which is too large for the Government to achieve with public spending alone.[19]

Concerted action is needed now to scale and finance the net zero transition. The investment needed to tackle this means unlocking private sector investment will be critical to decarbonising the housing stock. For this reason, high-quality carbon credits will be an essential solution in the net zero transition.

With previous Government attempts to stimulate the decarbonisation market ending in failure, unlocking private sector investment will be critical to achieving decarbonisation at the scale and pace needed to meet the UK's net zero targets. PNZ Carbon helps to address this, providing a route for investment in housing decarbonisation by verifying the emission reductions and social value of housing decarbonisation projects and originating carbon credits backed by those reductions.

In 2022, we launched a pilot of our service, Retrofit Credits, in association with the Housing Associations' Charitable Trust (HACT). Twenty-two social housing providers from across the UK benefited from the first crediting cycle; 6,717 PAIs were decarbonised during the first monitoring period between July 1, 2022, and December 31, 2022, resulting in approximately 5,000 annualised tonnes of emission reductions. The pilot of the project, which focused on works completed in 2022, demonstrated that carbon finance can play a significant role in helping to expedite the pace and scale of housing decarbonisation by enabling commercial market participants (social housing providers, local authorities and installers) to overcome the financial barriers that currently prevent the widescale implementation of this important decarbonisation activity.

In 2023, we significantly scaled our project, and we are currently involved in funding over 100,000 PAIs across the UK, including homes in rural and urban communities and from all regions and countries. We are currently working with over 200 commercial market participants,

[17] The Cost of Poor Housing in England. Building Research Establishment. 2021.

[18] UK housing: Fit for the future?. Committee on Climate Change (CCC). 2019.

[19] Greening Our Existing Homes National retrofit strategy. Construction Leadership Council. 2021.

including social housing providers, local authorities, and installers, on projects across the social housing, owner-occupied, and private rental sectors.

The decarbonisation of 39,927 PAIs was achieved during this monitoring period between January 1, 2023, and December 31, 2023, resulting in 30,756 tCO2e emission reductions, equivalent to an annualised 46,488 tCO2e. Additional PAIs will be added to the project throughout the crediting period, where they meet the eligibility criteria identified in the Project Description and will be validated against the eligibility criteria at the time of verification. All additional project activity instances will have a start date (i.e., the date upon which the project activity instance begins reducing or removing GHG emissions) that is the same as or later than the project start date.

Decarbonisation measures installed during the monitoring period were energy efficiency measures, including insulating, air sealing, improving the efficiency of the central heating system and reducing the grid-connected electricity consumption of appliances in existing PAIs.

Carbon offsetting has often been distrusted as a tool for achieving net zero targets despite playing a vital role in global decarbonisation efforts. PNZ Carbon has pioneered a local circular economy model that has helped resolve this. We work with local buyers to fund local emissions reduction projects, which deliver benefits in their communities so they can see the genuine benefits in real-time. Crucially, this measurable and localised approach drives greater transparency and integrity.

Whilst other carbon credit projects view each tonne of carbon reduction as interchangeable, our projects focus on decarbonisation's positive impact on people's lives. We measure not just tonnes of carbon reduction but the social value that warmer, more energy-efficient homes deliver for people and communities, ensuring that the benefits of green policies are widely shared. Our credits have an attached social impact value, based on the UK Social Value Bank, which enables buyers of our credits to model, monitor, and measure their social impact through improvements in resident health and wellbeing and savings made to the Exchequer.

PAIs enrolled in the project are widely distributed, which reflects the challenges faced across the UK in funding the decarbonisation of the housing stock. The project has seen strong engagement from housing providers in rural locations with PAIs that are particularly difficult and expensive to address.

Table 2a: Distribution of enrolled homes

Northeast	7.62%
East of England	21.33%
Northwest	15.42%

Southeast	13.55%
East Midlands	8.53%
Yorkshire and the Humber	13.72%
Greater London	12.75%
Southwest	2.29%
Wales	0.51%
West Midlands	1.74%
Scotland	2.53%

The UK exhibits a disproportionate pace of decarbonisation, displaying a clear North-South divide, with Southern regions decarbonising at a rate much higher than that of the North.

Domestic carbon emissions from the least energy-efficient homes in the Northeast, the Northwest, Yorkshire, and the Humber have remained high since 2010. The Northeast shows the slowest progress in decarbonising its housing stock, with zero change in the percentage of high-emission homes from 2010 to 2023. The neighbouring Yorkshire and the Humber region showed just a 0.4% decrease.

During 2023, our project has supported the decarbonisation of homes across the UK, but with a focus on the north of England as part of an initiative to bridge the regional gap, with almost 50% of our PAIs located in the north of England.

Project activity completed during the Monitoring Period included the following categories following the VM0008 Methodology:

Category A — Weatherization measures directed at enhancing the Building Envelope, improving the efficiency of the central heating/cooling system, and reducing Appliances' fossil fuel and grid-connected electricity consumption.

Category B — Weatherization measures directed at enhancement of the Building Envelope and/or improving the efficiency of the central heating/cooling system.

Of the 39,927 PAIs decarbonised during the monitoring period, the following Category A and Category B breakdown can be provided.

Table 2b: Breakdown of PAI Categories

	Category A	Category B	Total
Low-Income	926	26,415	27,341
Middle-Income	2,601	9,985	12,586
Total	3,527	36,400	39,927

The proponent continues to work with HACT better to understand the link between housing decarbonisation and social value. The health impacts of cold homes include increased risk of heart attack or stroke, respiratory illnesses, poor diet due to "heat or eat" choices, mental health issues, and worsening or slow recovery from existing conditions.[20] Children living in cold housing conditions are more than twice as likely to suffer from breathing problems, including asthma and bronchitis.[21] Access to affordable heat profoundly impacts health, comfort, well-being, and productivity, with the Building Research Establishment finding that excess cold in homes cost the NHS £857m a year.[22]

In the latest estimates, around 13% of households in England, 14% of households in Wales and 20% in Scotland are classified as fuel poor[23], which is where a household cannot afford adequate warmth. Premature mortality related to fuel poverty is said to be responsible for 17,000 excess deaths per year.[24] Low thermal and energy efficiency standards are a key factor in fuel poverty and the installation of decarbonisation measures directed at reducing the fossil fuel and grid-connected electricity consumption in PAIs is one of the key ways of alleviating fuel poverty and is an effective form of preventative healthcare for both physical and mental ill health.[25]

The decarbonisation of PAIs has a profound impact in terms of comfort, wellbeing, and productivity. Decarbonisation measures also have the potential to create jobs and boost existing firms (especially SMEs and their supply chains) in construction. Economy-wide, there is considerable potential to develop and extend the labour force with a full range of high-value skills[26].

[20] Fuel Poverty. House of Commons Library. 2021.

[21] Assessing the Health Impact of Cold Homes. Centre for Sustainable Energy. 2017.

[22] The Cost of Poor Housing in England, Building Research Establishment, 2021.

[23] Fuel Poverty In The UK, House of Commons Library, 2024

[24] E3G and National Energy Action, February 2019

[25] Heat Decarbonisation: Potential Impacts on Social Equity and Fuel Poverty. National Energy Action. 2017.

[26] Heat Decarbonisation: Potential Impacts on Social Equity and Fuel Poverty. National Energy Action. 2017.

This project is helping to tackle these problems by significantly reducing the heating demand of homes, increasing their energy efficiency and lowering bills. This creates warmer, healthier homes and delivers broader value for the Exchequer, with every £1 spent on eradicating fuel poverty estimated to save the NHS 42p.[27]

In the registered PPD, the estimated ex-ante average GHG emission reductions and removals per PAI was 2.928 tCO2e per year. The first Monitoring Report included information regarding the first 6,717 PAIs included in the project activity during the first six-month monitoring period. The annualised GHG emission reductions per PAI for the first monitoring period was 0.7306 tCO2e.

This Monitoring Report includes information regarding the 39,927 PAIs in the project activity during the second twelve-month monitoring period. The annualised GHG emission reductions per PAI for the second monitoring period were 1.164 tCO2e.

This increase demonstrates that our project is unlocking more intensive decarbonisation work. The project has observed an increase in the proportion of multi-measure projects compared to single-measure projects, and the pace and scale of decarbonisation have improved as a result.

The average GHG emission reductions and removals per PAI are expected to continue to increase as this project begins to scale its innovative delivery model and funding mechanism to make what can often be unattractive decarbonisation business cases fundable.

There has not been any change in the project monitoring plan during this monitoring period.

3.2 Deviations

3.2.1 Methodology Deviations

There is no methodology deviation.

3.2.2 Project Description Deviations

There is no project description deviation.

3.3 Grouped Projects

This project is defined as a “Grouped Project” where the proponent acts as a central administrator towards expediting the pace of housing decarbonisation. The project proponent collects, monitors, and aggregates data necessary to demonstrate the crediting baseline and additionality and to quantify emission reductions. The project proponent is responsible for overseeing the validation and registration of the project with the Verra Registry and managing the verification of the resulting Verified Carbon Units.

[27] Regeneration and Retrofit. UK Green Building Council (UKGBC). 2017.

The main project objectives are:

1. To gradually group individual PAIs inside a cluster that significantly reduces real emissions during the project crediting period.
2. To stimulate and reward PAI owners for their efforts to reduce emissions, such as decarbonisation measures directed at enhancing the building envelope, improving the efficiency of the central heating/cooling system, and reducing the fossil fuel and grid-connected electricity consumption of appliances in PAIs.
3. To stimulate and enable investment partners to commit funding towards decarbonising housing stock.
4. To overcome the inherent challenges of aggregating small-scale decarbonisation activities, simplify third-party auditing and control (monitoring) as well as undertake centralised data collection activities paramount to the quantification of emission reductions.

The first monitoring report included information for 6,717 individual PAIs included in the initial project activity between July 1, 2022, and December 31, 2022. This Monitoring Report, covering the second monitoring period, includes information regarding 39,927 individual PAIs included in the project activity between January 1, 2023, and December 31, 2023, incorporating the individual PAIs included in the project activity during the first and second monitoring periods. 33,211 new PAIs were added during the monitoring period. A total PAI count of 39,927 is included, with 1 PAI removed from the PAIs onboarded during the first monitoring period.

Eligibility Criteria

As called for by the VCS Standard v4.7, regulations applicable to grouped projects and consistent with the VM0008 Methodology, this grouped project provides eligibility criteria for future project activity instances. These criteria are intended to ensure that new project activity instances are subject to the baseline scenario determined in the project description for the specified project activity and geographic area and have characteristics for additionality that are consistent with the initial instances for the specified project activity and geographic area.

The relevant eligibility criteria apply to all additional individual PAIs added throughout the crediting period. Applying these conditions, any PAI[28] will meet the following eligibility conditions:

Table 3: Detailed description of the application of the eligibility criteria

[28] In the registered PDD, being a PAI, as defined in UK legislation, currently the Finance Act 2013, c. 29, part 3, the Landlord and Tennant Act 1985, c.70, section 38, the Finance Act 2003, c.14, schedule 6B or schedule 4ZA and not a "house in multiple occupation" as currently defined in the Housing Act 2004, c. 34, section 254.

No	Eligibility Condition	Project Compliance
1	The PAI is located within the project boundary	The physical address is checked to ensure the PAI is located within the project boundary Documentation: a. the physical address and geodetic coordinates of the PAI as provided by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS Standard v4.7, section 3.7.1. Documentation is maintained in the project activity files

The 39,927 PAIs included in the project activity during the monitoring period meet this criterion as follows:

a) The physical address of each PAI was provided by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as evidenced by a declaration in the Contract for Provision of Verified Carbon Unit Services;[29]

b) The address of each PAI was checked to ascertain whether it is located within the project boundary;

c) The PAIs are all located within the project boundary.

No	Eligibility Condition	Project Compliance
2	The PAI is a single-family PAI[30]	The address of the PAI is checked against the relevant Local Authority's register of "houses in multiple occupation" Documentation:

[29] Schedule 2(4)(a).

[30] In the registered PDD, not a "house in multiple occupation" as currently defined in the Housing Act 2004, c. 34, section 254.

		a. Reports for each project activity instance are generated by the project proponent Documentation is maintained in the project activity files

The 39,927 PAIs included in the project activity during the monitoring period meet this criterion as follows:

a) The address of each PAI was checked against the Local Authority's register of "houses in multiple occupation";

b) None of the PAIs is a "house in multiple occupation" as defined in the Housing Act 2004.

No	Eligibility Condition	Project Compliance
3 – 5	The PAI is in the same income group (low-income) or same income group (middle-income)	Same income group (low-income): The status of the PAI is social housing stock under the Housing and Regeneration Act 2008[31]; or Household income up to £40,212 as defined by the Living Wage Commission[32] as declared by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS Standard v4.7, section 3.7.1. or The PAI is in a neighbourhood identified as 'deprived' as defined by the Department for Levelling Up, Housing and Communities[33] Same income group (middle-income):

[31] Housing and Regeneration Act 2008, c. 17, section 68.

[32] In the registered PDD, UK Living Wage for a household with two adults and two children aged 3-4 and 5-11 for 2020/21. See, N Cominetti, Calculating the Real Living Wage for London and the Rest of the UK: 2020-21, Resolution Foundation, November 2021.

[33] In the registered PDD, located within the most deprived four deciles nationally using the published Indices of Deprivation 2019 for England, Ministry of Housing, Communities and Local Government; for Wales, Welsh Government or for Scotland, Scottish Government.

		Household income above £40,212 and up to £70,004 as defined by the Living Wage Commission[34] and Department for Education[35] and as declared by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS Standard v4.7, section 3.7.1.; or The PAI Is not In a neighbourhood identified as 'deprived' as defined by the Department for Levelling Up, Housing and Communities[36] Documentation: a. The owner or operator is a regulated provider of social housing or public entity or b. Declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS Standard v4.7, section 3.7.1. or c. The physical address and geodetic coordinates of the PAI as provided by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions,

[34] In the registered PDD, UK Living Wage for a household with two adults and two children aged 3-4 and 5-11 for 2020/21. See, N Cominetti, Calculating the Real Living Wage for London and the Rest of the UK: 2020-21, Resolution Foundation, November 2021.

[35] In the registered PDD, upper earnings threshold for a household to receive financial support for full-time education for 2020/21.

[36] In the registered PDD, Not located within the most deprived four deciles nationally using the published Indices of Deprivation 2019 for England, Ministry of Housing, Communities and Local Government; for Wales, Welsh Government or for Scotland, Scottish Government.

		as defined in VCS Standard v4.7, section 3.7.1. d. Reports for each project activity instance are generated by the project proponent Documentation is maintained in the project activity files

The 39,927 PAIs included in the project activity during the monitoring period meet these criteria as follows:

1) Social housing:

   a) Declaration that the PAI is social housing stock under the Housing and Regeneration Act 2008 from the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions in the Contract for Provision of Verified Carbon Unit Services;[37]

   b) The PAI is assigned to the low-income group.

2) Non-social housing:

   a) The neighbourhood of the PAI was checked against the definition of 'deprived' as defined by the Department for Levelling Up, Housing and Communities;

   b) The PAI is assigned to an income group (low-income or middle-income) accordingly.

No	Eligibility Condition	Project Compliance
6	Project ownership is accorded to the project proponent by a contractual agreement with the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions	Project ownership is accorded to the project proponent by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS Standard v4.7, section 3.7.1. Documentation: a. An agreement with the holder of the statutory, property or contractual right in the plant,

[37] Schedule 2(4)(c) of Social Housing Provider Contracts.

		equipment or process that generates GHG emission reductions, as defined in VCS Standard v4.7, section 3.7.1., which vests project ownership in the project proponent Documentation is maintained in the project activity files

The 39,927 PAIs included in the project activity during the monitoring period meet this criterion as follows:

a) An agreement with the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, which vests project ownership in the project proponent as evidenced in the Contract for Provision of Verified Carbon Unit Services.[38]

Applicability of Methodology

As called by the VCS Standard v4.7, regulations applicable to grouped projects and consistent with the VM0008 Methodology, this grouped project provides applicability criteria for project activity instances.

These criteria ensure that project activity meets the applicability conditions set out in the methodology. The applicability criteria apply to all project activities throughout the crediting period. Applying these conditions, any PAI[39] or decarbonisation measure will meet the following eligibility conditions:

Table 4: Detailed description of the application of the applicability criteria

No	Applicability Condition	Project Compliance
1	The condition of the PAI is adequate for project activities according to nationally recognised best practice standards	Renovation of the thermal elements of a PAI and replacement of heat-producing systems are regulated activities that must comply with the Building Regulations, which are the

[38] Section 2.1(c).

[39] In the registered PDD, being a PAI, as defined in UK legislation, currently the Finance Act 2013, c. 29, part 3, the Landlord and Tennant Act 1985, c.70, section 38, the Finance Act 2003, c.14, schedule 6B or schedule 4ZA and not a "house in multiple occupation" as currently defined in the Housing Act 2004, c. 34, section 254.

	Project activities do not result in a violation of health and safety, environmental, or other relevant regulations	primary source of health and safety, environmental and energy conservation obligations Building Regulations are designed to make sure PAIs are safe to use and inhabit and include requirements that address the applicability conditions Building Regulations are legal requirements that must be followed by those responsible for carrying out the work Compliance is demonstrated by a Building Regulations Compliance Certificate, or a declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS Standard v4.7, section 3.7.1., that work was carried out by a person registered with a competent person scheme or that work was carried out by a person registered with a competent person scheme, or a certificate under Publicly Available Specification (PAS)[40] or an equivalent standard, or a declaration by a regulated provider of social housing or public entity Documentation: a. Building Regulations Compliance Certificate or b. Declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as

[40] In the registered PDD, PAS sets out minimum standards and requirements for the installation of energy efficiency measures in existing buildings. PAS includes requirements in respect of installation processes, process management and service provision and includes criteria relating to installation methods, equipment, tools, product or system and material suitability, the commissioning of installed measures and the training, skills and competence of the people undertaking such installation.

		defined in VCS Standard v4.7, section 3.7.1., that work was carried out by a person registered with a competent person scheme or c. Certificate under Publicly Available Specification (PAS) or an equivalent standard or d. Declaration by a regulated provider of social housing or public entity e. Reports for each project activity instance are generated by the project proponent Documentation is maintained in the project activity files

The 39,927 PAIs included in the project activity during the monitoring period meet these criteria as follows:

1) Social housing:

a) The condition of the PAIs is and will remain adequate for decarbonisation activities according to nationally recognised best practice standards as evidenced by a declaration by a regulated provider of social housing or a public entity in the Contract for Provision of Verified Carbon Unit Services;[41]

b) Project activities do not violate health and safety, environmental, or other relevant regulations as evidenced by a declaration by a regulated provider of social housing or a public entity in the Contract for Provision of Verified Carbon Unit Services.[42]

2) Non-social housing:

a) The condition of the PAIs is and will remain adequate for decarbonisation activities according to nationally recognised best practice standards as evidenced by a Building Regulations Compliance Certificate, a declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG

[41] Schedule 2(4)(d) of Social Housing Provider Contracts.

[42] Schedule 2(4)(e) of Social Housing Provider Contracts.

emission reductions, in the Contract for Provision of Verified Carbon Unit Services[43], or a Certificate under Publicly Available Specification (PAS) or an equivalent standard.

b) Project activities do not result in a violation of health and safety, environmental, or other relevant regulations as evidenced by a Building Regulations Compliance Certificate, a declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, in the Contract for Provision of Verified Carbon Unit Services[44], or a Certificate under Publicly Available Specification (PAS) or an equivalent standard.

No	Applicability Condition	Project Compliance
2	The replacement of appliances replaces functioning appliances	Where the project activities include the replacement of appliances, a declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions as defined in VCS Standard v4.7, section 3.7.1. Documentation: a. Declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions as defined in VCS Standard v4.7, section 3.7.1. b. Reports for each project activity instance are generated by the project proponent Documentation is maintained in the project activity files

[43] Schedule 2(4)(c) of Non-Social Housing Provider Contracts.

[44] Schedule 2(4)(d) of Non-Social Housing Provider Contracts.

The 39,927 PAIs included in the project activity during the monitoring period meet this criterion as follows:

a) The replacement of appliances replaces functioning appliances as evidenced by a declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generated GHG emission reduction in the Contract for Provision of Verified Carbon Unit Services.[45]

No	Applicability Condition	Project Compliance
3	The PAI is occupied at the time of project activity. Vacancy is permitted on an intermittent basis for up to three months[46], or if the PAI is occupied seasonally on an annual basis	Utility bills or mortgage statements relating to the PAI or other indicators such as mortgage deeds, the existence of a lease or license (such as a tenancy agreement), or a declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS Standard v4.7, section 3.7.1.[47] Documentation: a. The status of the PAI is social housing stock under the Housing and Regeneration Act 2008[48] or b. Documentation or declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS

[45] Schedule 2(4)(f) of Social Housing Provider Contracts and Schedule 2(4)(e) of Non-Social Housing Provider Contracts.

[46] In the registered PDD, for example, during installation of the decarbonisation measures.

[47] In the registered PDD, for example, a declaration that the PAI is not subject to an 'empty homes premium' levied by a local authority in England, Wales or Scotland.

[48] Housing and Regeneration Act 2008, c. 17, section 68.

		Standard v4.7, section 3.7.1. c. Reports for each project activity instance are generated by the project proponent Documentation is maintained in the project activity files

The 39,927 PAIs included in the project activity during the monitoring period meet these criteria as follows:

1) Social housing:

   a) The PAI is social housing stock under the Housing and Regeneration Act 2008 as evidenced by a declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions in the Contract for Provision of Verified Carbon Unit Services.[49]

2) Non-social housing:

   a) The PAI is occupied at the time of project activity as evidenced by a declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions in the Contract for Provision of Verified Carbon Unit Services.[50]

No	Applicability Condition	Project Compliance
4	The capacity of any replacement appliance or component of a central heating system satisfies the energy load (the sum of the heat load and the electricity demand) within the PAI	Renovation of the thermal elements of a PAI and replacement of heat producing systems are regulated activities that must comply with the Building Regulations which are the primary source of health and safety, environmental and energy conservation obligations Building Regulations are designed to make sure PAIs are safe to use and

[49] Schedule 2(4)(g) of Social Housing Provider Contracts.

[50] Schedule 2(4)(f) of Non-Social Housing Provider Contracts.

		inhabit and include requirements that address the applicability conditions Building Regulations are legal requirements that must be followed by those responsible for carrying out the work The installation of gas boilers must also be undertaken in accordance with the Gas Safety Regulations which are an additional source of health and safety, environmental and energy conservation obligations Compliance is demonstrated by a Building Regulations Compliance Certificate, or a Gas Safety Certificate, or a declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS Standard v4.7, section 3.7.1., that work was carried out by a person registered with a competent person scheme, or a certificate under Publicly Available Specification (PAS)[51] or an equivalent standard, assessment by an accredited energy assessor or a declaration by a regulated provider of social housing or public entity Documentation: a. Building Regulations Compliance Certificate or b. Gas Safety Certificate or c. Declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG

[51] In the registered PDD, PAS sets out minimum standards and requirements for the installation of energy efficiency measures in existing buildings. PAS includes requirements in respect of installation processes, process management and service provision and includes criteria relating to installation methods, equipment, tools, product or system and material suitability, the commissioning of installed measures and the training, skills and competence of the people undertaking such installation.

		emission reductions, as defined in VCS Standard v4.7, section 3.7.1., that work was carried out by a person registered with a competent person scheme or d. Certificate under Publicly Available Specification (PAS) or an equivalent standard or e. Data compiled by an accredited energy assessor or f. Declaration a regulated provider of social housing or public entity g. Reports for each project activity instance are generated by the project proponent Documentation is maintained in the project activity files

The 39,927 PAIs included in the project activity during the monitoring period meet these criteria as follows:

1) Social housing:

   a) The capacity of any replacement appliance or component of a central heating system satisfies the energy load (the sum of the heat load and the electricity demand) within the PAI as evidenced by a declaration by a regulated provider of social housing or a public entity in the Contract for Provision of Verified Carbon Unit Services.[52]

2) Non-social housing:

   a) The capacity of any replacement appliance or component of a central heating system satisfies the energy load (the sum of the heat load and the electricity demand) within the PAI as evidenced by a Building Regulations Compliance Certificate, Gas Safety Certificate, source data that is used during the creation of accreditation certificates, a declaration by the holder of the statutory, property or contractual right in the plant,

[52] Schedule 2(4)(h) of Social Housing Provider Contracts.

equipment or process that generates GHG emission reductions in the Contract for Provision of Verified Carbon Unit Services[53], or a Certificate under Publicly Available Specification (PAS) or an equivalent standard.

No	Applicability Condition	Project Compliance
5	In the case of heating systems that serve multiple PAIs, all residential PAIs connected to the system are included in the project	The type of heating system as identified by the pre-retrofit energy assessment, or as declared by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS Standard v4.7, section 3.7.1. Documentation: a. Data from the pre-retrofit energy assessment or b. Declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS Standard v4.7, section 3.7.1. c. Reports for each project activity instance are generated by the project proponent Documentation is maintained in the project activity files

The 39,927 PAIs included in the project activity during the monitoring period meet this criterion as follows:

a) The heating systems supplying the PAIs do not serve multiple PAIs as evidenced by a declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions in the Contract for

[53] Schedule 2(4)(g) of Non-Social Housing Provider Contracts.

Provision of Verified Carbon Unit Services.[54]

b)

No	Applicability Condition	Project Compliance
6	The project activity is not mandated, or required by law or regulation	Analysis of the applicable legal framework is outlined in section 1.13 (Conditions Prior to Project Initiation) of the Project Description and as declared by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS Standard v4.7, section 3.7.1. Documentation: a. Declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS Standard v4.7, section 3.7.1. b. Reports for each project activity instance are generated by the project proponent Documentation is maintained in the project activity files

The 39,927 PAIs included in the project activity during the monitoring period meet this criterion as follows:

a) The project activity is not mandated or required by law or regulation as evidenced by a declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions in the Contract for Provision of Verified Carbon Unit Services.[55]

[54] Schedule 2(4)(i) of Social Housing Provider Contracts and Schedule 2(4)(h) of Non-Social Housing Provider Contracts.

[55] Schedule 2(4)(j) of Social Housing Provider Contracts and Schedule 2(4)(i) of Non-Social Housing Provider Contracts.

No	Applicability Condition	Project Compliance
7	The PAI meets or exceeds the performance benchmark as calculated for the Same Building Stock	Additionality is checked to ensure the PAI meets or exceeds the performance benchmark Documentation: a. Reports required for demonstrating additionality are generated from the centralised data repository by the project proponent in accordance with the approach outlined in section 3.5 (Additionality) of the Project Description Documentation is maintained in the project activity files

The 39,927 PAIs included in the project activity during the monitoring period meet this criterion as follows:

a) Additionality is calculated as set out in section 3.5 (Additionality) of the Project Description to ensure the PAI meets or exceeds the performance benchmark

b) To demonstrate additionality, a pre-retrofit energy assessment takes place for each PAI prior to implementation of the project activity. Then a post-retrofit energy assessment takes place after the decarbonisation measures are completed. Pre- and post-retrofit energy assessments are undertaken by accredited energy assessors certified by a public authority, or a private certification program recognised by a public authority. Energy assessments are conducted using the Standard Assessment Procedure (SAP) which is the Government-approved National Calculation Methodology for assessing the energy performance of PAIs.[56]

c) The pre-retrofit energy assessment determines the heat load and grid-connected electricity demand (energy load) in the baseline. The post-retrofit energy assessment determines the heat load and grid-connected electricity demand (energy load) following the implementation of project activity.

d) To be additional, PAIs must satisfy the following condition:

[56] In the registered PDD, additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 of the Project Description under the Pre- and post-retrofit energy assessment approach.

$$\frac{EL_{Pre,i} - EL_{Post,i}}{EL_{Pre,i}} \times 100 \geq x$$

e) Where:

$EL_{Pre,i}$ = Pre-retrofit energy load of PAI *i*

$EL_{Post,i}$ = Post-retrofit energy load of PAI *i* after installation of the decarbonisation measures

f) The change in energy load for the 39,927 PAIs included in the project activity during the monitoring period has been calculated using first instance data as at the date of the completed installation of the decarbonisation measures.

g) The change in energy load exceeds the performance benchmark for 39,927 PAIs included in the project activity during the monitoring period. A total of 517 PAIs were rejected from inclusion in this grouped project as the change in energy load resulting from the installation of the decarbonisation measures did not exceed the performance benchmark.

No	Applicability Condition	Project Compliance
8	The decarbonisation measures fall into one of categories A or B	The decarbonisation measures identified as installed by the Building Regulations Compliance Certificate, or Gas Safety Certificate, or a declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS Standard v4.7, section 3.7.1., that work was carried out by a person registered with a competent person scheme, or a certificate under Publicly Available Specification (PAS)[57] or an equivalent standard, or a declaration by a regulated provider of social housing or public entity or assessment by an accredited energy assessor

[57] In the registered PDD, PAS sets out minimum standards and requirements for the installation of energy efficiency measures in existing buildings. PAS includes requirements in respect of installation processes, process management and service provision and includes criteria relating to installation methods, equipment, tools, product or system and material suitability, the commissioning of installed measures and the training, skills and competence of the people undertaking such installation.

		Documentation: a. Building Regulations Compliance Certificate or b. Gas Safety Certificate or c. Declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS Standard v4.7, section 3.7.1., that work was carried out by a person registered with a competent person scheme or d. Certificate under Publicly Available Specification (PAS) or an equivalent standard or e. Declaration a regulated provider of social housing or public entity or f. Data compiled by an accredited energy assessor g. Reports for each project activity instance are generated by the project proponent Documentation is maintained in the project activity files

The 39,927 PAIs included in the project activity during the monitoring period meet these criteria as follows:

1) Social housing:

a) The decarbonisation measures fall into one of categories A or B as evidenced by a declaration by a regulated provider of social housing or the public entity in the Contract for Provision of Verified Carbon Unit Services.[58]

2) Non-social housing:

a) The decarbonisation measures fall into one of categories A or B as evidenced by a Building Regulations Compliance Certificate, a declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions in the Contract for Provision of Verified Carbon Unit Services[59], or a Certificate under Publicly Available Specification (PAS) or an equivalent standard.

No	Applicability Condition	Project Compliance
9	The decarbonisation measures do not involve fuel switching	The decarbonisation measures use and apply electricity or another fuel source that was already a source of emissions in the PAI prior to project activity The fuel sources that were already a source of emissions in the PAI prior to project activity are identified by a certificate under Publicly Available Specification (PAS)[60] or an equivalent standard, declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS Standard v4.7, section 3.7.1., or assessment by an accredited energy assessor Documentation: a. Certificate under Publicly Available Specification

[58] Schedule 2(4)(k) of Social Housing Provider Contracts.

[59] Schedule 2(4)(j) of Non-Social Housing Provider Contracts.

[60] In the registered PDD, PAS sets out minimum standards and requirements for the installation of energy efficiency measures in existing buildings. PAS includes requirements in respect of installation processes, process management and service provision and includes criteria relating to installation methods, equipment, tools, product or system and material suitability, the commissioning of installed measures and the training, skills and competence of the people undertaking such installation.

		(PAS) or an equivalent standard or b. Declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS Standard v4.7, section 3.7.1. or c. Data compiled by an accredited energy assessor d. Reports for each project activity instance are generated by the project proponent Documentation is maintained in the project activity files

The 39,927 PAIs included in the project activity during the monitoring period meet this criterion as follows:

a) The decarbonisation measures use and apply electricity or another fuel source that was already a source of emissions in the PAI prior to project activity as evidenced by a Certificate under Publicly Available Specification (PAS) or an equivalent standard, a declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions in the Contract for Provision of Verified Carbon Unit Services[61], or data compiled by an accredited energy assessor.

No	Applicability Condition	Project Compliance
10	In the case of "replacement" of a mobile home, the word "retrofit" shall be read to mean replacement throughout the methodology	Not applicable. Project activity is not initially conducted according to Category D of the VM0008 Methodology (replacement of mobile homes)

[61] Schedule 2(4)(l) of Social Housing Provider Contracts and Schedule 2(4)(k) of Non-Social Housing Provider Contracts.

No	Applicability Condition	Project Compliance
11	The methodology may be applied in any geographic region, provided appropriate data exist to establish the level of the performance benchmark for the Same Building Stock of a Project's geographic region	The geographic areas included in the project are initially the physical boundaries of the United Kingdom, areas that qualify as part of the Same Building Stock as defined in the VM0008 Methodology. During the monitoring period, the 39,927 PAIs included in the project *activity* occurred within the project boundary. The Project Description sets the eligibility criteria for future project activity instances in Section 1.4 (Eligibility Criteria). These criteria are intended to ensure that new project activity instances have characteristics for additionality that are consistent with the initial instances for the specified project activity and geographic area. Documentation: a. the PAI's physical address and geodetic coordinates as provided by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS Standard v4.7, section 3.7.1. Documentation is maintained in the project activity files

The 39,927 PAIs included in the project activity during the monitoring period meet this criterion as follows:

a) The physical address of each PAI was provided by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission

reductions, as evidenced by a declaration in the Contract for Provision of Verified Carbon Unit Services;[62]

b) The address of each PAI was checked to ascertain whether it is located within the project boundary.

No	Applicability Condition	Project Compliance
12	When sampling, the minimum number of PAIs to be sampled is the square root of the total number of PAIs *i* included in the project. Statistically sound sampling approaches are used. When the control group approach is utilised, the control group size is the square root of the total number of PAIs in the project but need not exceed 100 PAIs. In any sampling approach, the following conditions must be met: 1) The sample is statistically valid and may be one of the following: a. Simple random sample b. Systematic sampling c. Stratified sampling within the Same Building Stock d. Cluster sampling. 2) The sample is representative of the population. 3) The data must come from an approved source, i.e., a certified energy auditor or a nationally recognised data source. 4) Actions that may bias the sample will be avoided. Sampling will include PAIs that are dispersed geographically. Sampling will occur for each defined Building Stock included	Sampling is conducted in accordance with the methodology. The pre-and post-retrofit audit approach is utilised to measure emission reductions, for which the methodology prescribes the size of the quality assurance sample group of PAIs is established by multiplying 0.6 by the square root of the total number of PAIs 39,927, which equals a sample group of 158. The quality assurance process was run across a sample group comprising 2,215 PAIs to enable multiple quality assurance tests (approximately 14 times).

[62] Schedule 2(4)(a).

	in the project activity. Criteria include region, PAI type, and income	

3.4 Baseline Reassessment

Did the project undergo baseline reassessment during the monitoring period?

☐ Yes ☒ **No**

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Methodology Reference	Table 3
Data / Parameter	Performance Standard (*a*)
Data unit	Percent
Description	Average performance, defined as the annual average percent savings in weather normalised fossil fuel and grid-connected electricity consumption in PAIs within the Same Building Stock
Source of data	National data published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED).[63] The dataset used is the Property level natural gas and electricity consumption dataset[64]
Value applied	Low-income single-family PAI Performance Standard: *x*= 5.0152 Middle-income individual PAI Performance Standard: *x*= 4.4992
Justification of choice of data or description of measurement methods and procedures applied	Calculated from national statistics for at least the three most recent twelve-month periods for which data are available from PAIs within the Same Building Stock. A sample of PAIs may be

[63] In the registered PDD, Published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic.

[64] In the registered PDD, Anonymised NEED data: 4 million row sample. Department for Business, Energy and Industrial Strategy (BEIS), now Department for Energy Security and Net Zero (DESNZ). June 2021.

	used. Percent savings are calculated by comparing year 1 to year 2 and year 2 to year 3, etc.[65] Calculation conducted in accordance with the VM0008 Methodology as set out in section 3.5 (Additionality) of the Project Description Source data is published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic meaning the dataset meets the highest standards of trustworthiness, quality, and public value
Purpose of data	Calculation of project emissions
Comments	N/A

Methodology Reference	Table 3
Data / Parameter	Performance Standard (σ)
Data unit	N/A
Description	Standard Deviation of the annual percent savings
Source of data	N/A
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	VM0008 Methodology requires the performance benchmark to be calculated using the standard deviation (sigma) of the percent savings in the Same Building Stock only where the underlying data follows a normal distribution (Gaussian) For data not following a normal distribution, the Methodology requires the performance benchmark to be equal to the 90th percentile value within the numerically ordered sample As set out in section 3.5 (Additionality) of the Project Description, the distribution of fossil fuel and grid-connected electricity consumption by PAIs is non-Gaussian (as evidenced by the Property level natural gas and electricity consumption data

[65] In the registered PDD, Year 1, year 2 and year 3 may have gaps of time in between the years. For example: Year 1 data may cover 2011, year 2 data may cover 2015, and year 3 may cover 2019.

	published by BEIS (now DESNZ)[66]), and accordingly the standard deviation is not applicable
Purpose of data	Calculation of project emissions
Comments	N/A

Methodology Reference	Table 5
Data / Parameter	$Elec_{CO2}$
Data unit	tCO_{2e} / kWh
Description	Grid emission factor for the regional grid-connected electricity source
Source of data	National data used to assess the energy and environmental performance of PAIs. Currently either: a) CO_2 emission factor prescribed by Part L of the Building Regulations as detailed in the Standard Assessment Procedure (SAP) Manual[67] at Table 12: Fuel prices, emission factors and primary energy factor. SAP is the UK Government's National Calculation Methodology for assessing the energy performance of PAIs and is the energy assessment system used for PAIs in the project b) CO_2 emission factor prescribed for company reporting by UK-based organisations as detailed in the UK Government GHG Conversion Factors for Company Reporting dataset[68] at table 'UK electricity'. These emission factors are prescribed for use by organisations in the UK to report on emissions
Value applied	Electricity: 0.000212 tCO_{2e} / kWh from the Conversion Factors for Company Reporting dataset In accordance with the VM0008 Methodology, the project may use the CO_2 emission factor per unit of grid-connected electricity available at project validation for each verification event
Justification of choice of data or description of	GHG emission values of the specified fuel types are well established and remain constant per unit fuel volume. These

[66] In the registered PDD, Anonymised NEED data: 4 million row sample. Department for Business, Energy and Industrial Strategy (BEIS) now the Department for Energy Security and Net Zero (DESNZ). June 2021.

[67] In the registered PDD, the Government's Standard Assessment Procedure for Energy Rating of PAIs, SAP 2012 version 9.92, dated October 2013. Published on behalf of the Department for Energy and Climate Change by BRE Group.

[68] In the registered PDD, the Government's Greenhouse Gas Reporting: Conversion Factors 2021, published by the Department for Business, Energy and Industrial Strategy (BEIS) now the Department for Energy Security and Net Zero (DESNZ), dated 2 June 2021.

measurement methods and procedures applied	values are acceptable under the VM0008 Methodology as established emission factors of various fuel types
Purpose of data	Calculation of project emissions
Comments	N/A

Methodology Reference	Table 5
Data / Parameter	Cal_j
Data unit	GJ/mass or GJ/volume
Description	Calorific value of fuel type *j*
Source of data	National data from National Grid, the operator of the national gas network in Great Britain[69]
Value applied	Natural Gas: 0.0375GJ/m^3
Justification of choice of data or description of measurement methods and procedures applied	Calorific value of fuel types is well established and remain constant per unit volume of fuel. These values are acceptable under the VM0008 Methodology as established calorific values of various fuel types
Purpose of data	Calculation of project emissions
Comments	In accordance with the VM0008 Methodology, the project uses the Calorific value available at project validation for each verification event

Methodology Reference	Table 5
Data / Parameter	F_{CO2j}
Data unit	tCO_{2e} / GJ
Description	CO_2 emission factor for fuel type j
Source of data	National data used to assess the energy and environmental performance of PAIs. At validation either: a) CO_2 emission factor prescribed by Part L of the Building Regulations as detailed in the Standard Assessment Procedure (SAP) Manual[70] at Table 12: Fuel prices, emission factors and primary energy factor. SAP is the UK Government's National Calculation Methodology for assessing the energy

[69] In the registered PDD, the Calorific Value dataset is provided by National Grid.

[70] In the registered PDD, the Government's Standard Assessment Procedure for Energy Rating of PAIs, SAP 2012 version 9.92, dated October 2013. Published on behalf of the Department for Energy and Climate Change by BRE Group.

	performance of PAIs and is the energy assessment system used for PAIs in the project activity b) CO_2 emission factor prescribed for company reporting by UK-based organisations as detailed in the UK Government GHG Conversion Factors for Company Reporting dataset[71] at table 'Fuels'. These emission factors are prescribed for use by organisations in the UK to report on emissions
Value applied	Anthracite: 0.110 tCO_{2e} / GJ from the Standard Assessment Procedure (SAP) Manual Bottled gas: 0.067 tCO_{2e} / GJ from the Standard Assessment Procedure (SAP) Manual Community mains gas: 0.060 tCO_{2e} / GJ from the Standard Assessment Procedure (SAP) Manual Dual fuel (mineral and wood): 0.063 tCO_{2e} / GJ from the Standard Assessment Procedure (SAP) Manual House coal: 0.110 tCO_{2e} / GJ from the Standard Assessment Procedure (SAP) Manual LPG: 0.067 tCO_{2e} / GJ from the Standard Assessment Procedure (SAP) Manual Mains gas: 0.060 tCO_{2e} / GJ from the Standard Assessment Procedure (SAP) Manual Oil: 0.083 tCO_{2e} / GJ from the Standard Assessment Procedure (SAP) Manual Smokeless coal: 0.120 tCO_{2e} / GJ from the Standard Assessment Procedure (SAP) Manual Wood logs: 0.0052 tCO_{2e} / GJ from the Standard Assessment Procedure (SAP) Manual Wood pellets: 0.011 tCO_{2e} / GJ from the Standard Assessment Procedure (SAP) Manual
Justification of choice of data or description of measurement methods and procedures applied	GHG emission values of the specified fuel types are well established and remain constant per unit volume of fuel. These values are acceptable under the VM0008 Methodology as established emission factors of various fuel types
Purpose of data	Calculation of project emissions

[71] In the registered PDD, the Government's Greenhouse Gas Reporting: Conversion Factors 2021, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), dated 2 June 2021.

Comments	In accordance with the VM0008 Methodology, the project uses the CO_2 emission factor per unit of energy of fuel available at project validation for each verification event

4.2 Data and Parameters Monitored

The following parameters are monitored for each PAI added to the project activity when the data parameter is followed by "*i*". PAI specific values are extrapolated from the sample when the Methodology allows. Unless otherwise noted, the "value applied" is based on preliminary data and used to illustrate the calculation of the ex-ante emission reductions. The "value applied" will change s PAIs are added to the project activity.

Methodology Reference	Table 7
Data / Parameter	$EL_{pre,i}$
Data unit	BTU/m^2
Description	Pre-retrofit energy load of PAI *i*
Source of data	Pre-retrofit energy assessment
Description of measurement methods and procedures to be applied	A pre-retrofit energy assessment takes place for each PAI prior to implementation of the project activity. Pre-retrofit energy assessments are undertaken by accredited energy assessors certified by a public authority, or a private certification program recognised by a public authority. Energy assessments are conducted using the Standard Assessment Procedure (SAP) which is the Government-approved National Calculation Methodology for assessing the energy performance of PAIs[72]. All relevant data fields required to determine emission reductions are compiled by an accredited energy assessor The pre-retrofit energy assessment determines the heat load and grid-connected electricity demand (energy load) in the baseline
Frequency of monitoring/recording	Once per PAI prior to implementation of the project activity The energy load pre-retrofit may be calculated after the energy efficiency measures are installed
Value monitored	Determined individually for each project activity instance

[72] In the registered PDD, additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 of the Project Description under the pre- and post-retrofit energy assessment approach.

Monitoring equipment	Energy modelling software that implements the latest approved worksheet and conventions for SAP calculations as set out in the SAP Manual[73]
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology[74]
Purpose of the data	Calculation of baseline emissions
Calculation method	The SAP methodology considers a range of factors that contribute to energy efficiency including materials used for construction of a PAI, thermal insulation of the building fabric, air leakage characteristics of the PAI, efficiency and control of the heating system(s) and the fuel used to provide space and water heating. Energy assessments cover both fossil fuel and grid-connected electricity consumption and may include physical inspection, diagnostic tests, use energy modelling software that implements the latest approved worksheet and conventions for SAP calculations as set out in the SAP Manual[75]
Comments	N/A

Methodology Reference	Table 7
Data / Parameter	$EL_{post,I}$
Data unit	BTU/m^2
Description	Post-retrofit energy load of PAI *i*
Source of data	Post-retrofit energy assessment
Description of measurement methods and procedures to be applied	A post-retrofit energy assessment takes place for each PAI after the decarbonisation measures are completed. Post-retrofit energy assessments are undertaken by accredited energy assessors certified by a public authority, or a private certification program recognised by a public authority. Energy assessments are conducted using the Standard Assessment Procedure

[73] In the registered PDD, the Government's Standard Assessment Procedure for Energy Rating of PAIs, SAP 2012 version 9.92, dated October 2013. Published on behalf of the Department for Energy and Climate Change by BRE Group.

[74] In the registered PDD, additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 of the Project Description under the pre- and post-retrofit energy assessment approach.

[75] In the registered PDD, the Government's Standard Assessment Procedure for Energy Rating of PAIs, SAP 2012 version 9.92, dated October 2013. Published on behalf of the Department for Energy and Climate Change by BRE Group.

	(SAP) which is the Government-approved National Calculation Methodology for assessing the energy performance of PAIs[76] The post-retrofit energy assessment determines the heat load and grid-connected electricity demand (energy load) following the implementation of project activity
Frequency of monitoring/recording	Once per PAI following the implementation of project activity
Value monitored	Determined individually for each project activity instance
Monitoring equipment	Energy modelling software that implements the latest approved worksheet and conventions for SAP calculations as set out in the SAP Manual[77]
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology[78]
Purpose of the data	Calculation of project emissions
Calculation method	The SAP methodology considers a range of factors that contribute to energy efficiency including materials used for construction of a PAI, thermal insulation of the building fabric, air leakage characteristics of the PAI, efficiency and control of the heating system(s) and the fuel used to provide space and water heating. Energy assessments cover both fossil fuel and grid-connected electricity consumption and may include physical inspection, diagnostic tests, use energy modelling software that implements the latest approved worksheet and conventions for SAP calculations as set out in the SAP Manual[79]
Comments	N/A

Methodology Reference	Table 9
Data / Parameter	$Elec_{b,I}$

[76] In the registered PDD, additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 of the Project Description under the pre- and post-retrofit energy assessment approach.

[77] In the registered PDD, the Government's Standard Assessment Procedure for Energy Rating of PAIs, SAP 2012 version 9.92, dated October 2013. Published on behalf of the Department for Energy and Climate Change by BRE Group.

[78] In the registered PDD, additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 of the Project Description under the pre- and post-retrofit energy assessment approach.

[79] In the registered PDD, the Government's Standard Assessment Procedure for Energy Rating of PAIs, SAP 2012 version 9.92, dated October 2013. Published on behalf of the Department for Energy and Climate Change by BRE Group.

Data unit	kWh/yr.
Description	Grid-connected electricity consumed in the year prior to project implementation in PAI *i* (baseline consumption)
Source of data	The factor is determined from national Household electricity consumption data published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ)[80] using the last consecutive twelve months of consumption data available prior to implementation of the project activity
Description of measurement methods and procedures to be applied	Calculated as the mean consumption based on actual grid-connected electricity consumption data for a sample of PAIs in the Same Building Stock for a period of one-year pre-retrofit
Frequency of monitoring/recording	Once prior to implementation of the project activity. Once a PAI has an established baseline, it remains constant for the crediting period
Value monitored	Not applicable during this monitoring period
Monitoring equipment	Documentation is maintained in the project activity files
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology[81]
Purpose of the data	Calculation of baseline emissions
Calculation method	The minimum sample size is established by multiplying by 0.6 the square root of the total number of PAIs, *i*, included in the adjusted consumption approach for the project Baseline grid-connected electricity consumption for the Same Building Stock is calculated using a weighted mean calculation as set out in section 3.4 of the Project Description for the baseline scenario. The baseline consumption is calculated as follows: **Same Building Stock: Low-income single-family PAIs**

[80] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic meaning the dataset meets the highest standards of trustworthiness, quality, and public value.

[81] In the registered PDD, additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 of the Project Description under the adjusted consumption approach and under the control group approach.

	The independent data collected and arranged in a systematic or methodical way by the project proponent is the Household electricity consumption data published by BEIS (now DESNZ) on June 24, 2021, as part of the NEED Framework.[82] [83] [84] The sample size was 13,480,630 PAIs, representing approximately 92% of the total population of low-income single-family PAIs in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology[85] **Same Building Stock: Middle-income single-family PAIs** The independent data collected and arranged in a systematic or methodical way by the project proponent is the Household electricity consumption data published by BEIS (now DESNZ) on June 24, 2021, as part of the NEED Framework.[86] [87] [88] The sample size was 5,851,540 PAIs, representing approximately 92% of the total population of middle-income single-family PAIs in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology[89]
Comments	N/A

Methodology Reference	Table 9
Data / Parameter	$Elec_{p,y,l}$
Data unit	kWh/yr.

[82] In the registered PDD, Additional Consumption Tables: England, Wales and Scotland, 2019.

[83] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic.

[84] In the registered PDD, Table A12 of the Household natural gas and grid-connected electricity consumption data published by BEIS (now DESNZ) under the NEED framework.

[85] In the registered PDD, the sample size of the sample group is established by multiplying 0.6 by the square root of the total number of PAIs, *i*, included in the project. This sample size would support a total number of PAIs far greater than the total number of PAIs in the geographic scope of this project.

[86] In the registered PDD, Additional Consumption Tables: England, Wales and Scotland, 2019. Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ). December 2021.

[87] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic.

[88] In the registered PDD, Table A12 of the Household natural gas and grid-connected electricity consumption data published by BEIS (now DESNZ) under the NEED framework.

[89] In the registered PDD, the sample size of the sample group is established by multiplying 0.6 by the square root of the total number of PAIs, *i*, included in the project. This sample size would support a total number of PAIs far greater than the total number of PAIs in the geographic scope of this project.

Description	Grid-connected electricity consumed by the project in year *y* for PAI *l*
Source of data	Sample group under the adjusted consumption approach
Description of measurement methods and procedures to be applied	Calculated as the mean consumption based on fuel bills, reported fuel consumption, or data from a smart metering or thermostatic control device for a sample of PAIs in the Same Building Stock for a period of one-year post-retrofit
Frequency of monitoring/recording	Annually for each year *y*
Value monitored	Not applicable during this monitoring period
Monitoring equipment	Documentation is maintained in the project activity files
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology[90]
Purpose of the data	Calculation of project emissions
Calculation method	The minimum sample size is established by multiplying by 0.6 the square root of the total number of PAIs, *i*, included in the adjusted consumption approach for the project To calculate the mean consumption of the sample group, fuel bills, reported fuel consumption, or data from a smart metering or thermostatic control device covering a one-year period
Comments	N/A

Methodology Reference	Table 9
Data / Parameter	$F_{b,l,j}$
Data unit	Mass or volume per PAI per year
Description	Fuel type *j* consumed in the year prior to project implementation ($F_{b,j,j}$) for PAI *l* (baseline consumption)
Source of data	The factor is determined from Household gas consumption data published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ)[91] using the last consecutive twelve months of

[90] In the registered PDD, additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 of the Project Description under the pre- and post-retrofit energy assessment approach.

[91] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED)

	consumption data available prior to implementation of the project activity
Description of measurement methods and procedures to be applied	Calculated as the mean consumption based on actual natural gas consumption data for a sample of PAIs in the Same Building Stock for a period of one-year pre-retrofit
Frequency of monitoring/recording	Once prior to implementation of the project activity. Once a PAI has an established baseline, it remains constant for the crediting period
Value monitored	Not applicable during this monitoring period
Monitoring equipment	Documentation is maintained in the project activity files
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology [92]
Purpose of the data	Calculation of baseline emissions
Calculation method	The minimum sample size is established by multiplying by 0.6 the square root of the total number of PAIs, *i*, included in the adjusted consumption approach for the project Baseline fuel consumption for the Same Building Stock is calculated using a weighted mean calculation as set out in section 3.4 of the Project Document for the baseline scenario. The baseline consumption is calculated as follows: **Same Building Stock: Low-income single-family PAIs** The independent data collected and arranged in a systematic or methodical way by the project proponent is the Household gas consumption data published by BEIS (now DESNZ) on June 24, 2021, as part of the NEED Framework.[93] [94] [95] The sample size

and designated as an official national statistic meaning the dataset meets the highest standards of trustworthiness, quality, and public value.

[92] In the registered PDD, additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 of the Project Description under the adjusted consumption approach and under the control group approach.

[93] In the registered PDD, Additional Consumption Tables: England, Wales and Scotland, 2019. Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ). December 2021.

[94] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic.

[95] In the registered PDD, Table A11 of the Household natural gas and grid-connected electricity consumption data published by BEIS (now DESNZ) under the NEED framework.

	was 11,066,210 PAIs, representing approximately 78% of the total population of low-income single-family PAIs in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology [96] **Same Building Stock: Middle-income single-family PAIs** The independent data collected and arranged in a systematic or methodical way by the project proponent is the Household gas consumption data published by BEIS (now DESNZ) on June 24, 2021, as part of the NEED Framework.[97] [98] [99] The sample size was 4,879,760 PAIs, representing approximately 78% of the total population of middle-income single-family PAIs in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology[100]
Comments	N/A

Methodology Reference	Table 9
Data / Parameter	$F_{p,y,j,j}$
Data unit	Mass or volume per PAI per year
Description	Fuel type *j* consumed by the project in year *y* ($F_{p,y,j,j}$) for PAI *i* (project consumption)
Source of data	Sample group under the adjusted consumption approach
Description of measurement methods and procedures to be applied	Calculated as the mean consumption based on fuel bills, reported fuel consumption, or data from a smart metering or thermostatic control device for a sample of PAIs in the Same Building Stock for a period of one-year post-retrofit

[96] In the registered PDD, the sample size of the sample group is established by multiplying 0.6 by the square root of the total number of PAIs, *i*, included in the project. This sample size would support a total number of PAIs far greater than the total number of PAIs in the geographic scope of this project.

[97] In the registered PDD, Additional Consumption Tables: England, Wales and Scotland, 2019. Department for Business, Energy and Industrial Strategy (BEIS). December 2021.

[98] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS) as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic.

[99] In the registered PDD, Table A11 of the Household natural gas and grid-connected electricity consumption data published by BEIS under the NEED framework.

[100] In the registered PDD, the sample size of the sample group is established by multiplying 0.6 by the square root of the total number of PAIs, *i*, included in the project. This sample size would support a total number of PAIs far greater than the total number of PAIs in the geographic scope of this project.

Frequency of monitoring/recording	Annually for each year *y*
Value monitored	Not applicable during this monitoring period
Monitoring equipment	Documentation is maintained in the project activity files
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology [101]
Purpose of the data	Calculation of project emissions
Calculation method	The minimum sample size is established by multiplying by 0.6 the square root of the total number of PAIs, *i*, included in the adjusted consumption approach for the project To calculate the mean consumption of the sample group, fuel bills, reported fuel consumption, or data from a smart metering or thermostatic control device covering a one-year period
Comments	N/A

Methodology Reference	Table 9
Data / Parameter	ECF_y
Data unit	N/A
Description	Grid-connected electricity correction factor for year *y*. The ECF is only to be applied in the equation if it is negative
Source of data	The factor is determined from local, regional or national electricity household consumption data from a public authority, a public utility or regulatory agency, or a recognised energy research organisation such as the Household electricity consumption data published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ)[102] or the Final energy demand data published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy

[101] In the registered PDD, additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 of the Project Description under the adjusted consumption approach and under the control group approach.

[102] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic meaning the dataset meets the highest standards of trustworthiness, quality, and public value.

	Security and Net Zero (DESNZ)[103]. Historical data from a public authority may be used to determine the ECF. Projected trends in changes in the rate of grid-connected electricity demand reported by a public authority may also be used as the ECF
Description of measurement methods and procedures to be applied	The ECF represents the trend in grid-connected electricity demand based on average grid-connected electricity consumption within the state over a period of at least ten years. The ECF is stated as a multiplier. For example, 0.98 represents an electricity consumption growth rate of -2%. The ECF is used to update the baseline grid-connected electricity consumption based on decreases in grid-connected electricity demand over time. The ECF is only applied when it is less than 1 to maintain conservativeness in the emission reduction calculation. This factor is applied to the calculation of the emission reduction calculation after project implementation because grid-connected electricity consumption in the baseline may not remain the same
Frequency of monitoring/recording	Annually for each year *y*
Value monitored	Not applicable during this monitoring period
Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of the data	Calculation of project emissions
Calculation method	The ECF represents the trend in grid-connected electricity demand based on average grid-connected electricity consumption within the state over a period of at least ten years. For each of the ten years, baseline household grid-connected electricity consumption data is calculated, for example as follows when using the Household energy consumption dataset from BEIS (now DESNZ): **Same Building Stock: Low-income single-family PAIs** The independent data collected and arranged in a systematic or methodical way by the project proponent is the Household electricity consumption data published by BEIS (now DESNZ) on

[103] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the Energy demand, greenhouse gas emissions and electricity generation trends data; Annex F.

	June 29, 2023, as part of the NEED Framework.[104] [105] [106] The sample size was 12,229,450 PAIs, representing approximately 83% of the total population of low-income single-family PAIs in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology [107] **Same Building Stock: Middle-income single-family PAIs** The independent data collected and arranged in a systematic or methodical way by the project proponent is the Household electricity consumption data published by BEIS (now DESNZ) on June 24, 2021, as part of the NEED Framework.[108] [109] [110] The sample size was 6,478,350 PAIs, representing approximately 98% of the total population of middle-income single-family PAIs in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology [111]
Comments	N/A

Methodology Reference	Table 9
Data / Parameter	HDD_y
Data unit	Degree days
Description	Heating degree days for year *y* after project activity

[104] In the registered PDD, Additional Consumption Tables: England, Wales and Scotland, 2019. Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ). December 2021.

[105] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic.

[106] In the registered PDD, Table A12 of the Household natural gas and grid-connected electricity consumption data published by BEIS under the NEED framework.

[107] In the registered PDD, the sample size of the sample group is established by multiplying 0.6 by the square root of the total number of PAIs, *i*, included in the project. This sample size would support a total number of PAIs far greater than the total number of PAIs in the geographic scope of this project.

[108] In the registered PDD, Additional Consumption Tables: England, Wales and Scotland, 2019. Department for Business, Energy and Industrial Strategy (BEIS). December 2021.

[109] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic.

[110] In the registered PDD, Table A12 of the Household natural gas and grid-connected electricity consumption data published by BEIS under the NEED framework.

[111] In the registered PDD, the sample size of the sample group is established by multiplying 0.6 by the square root of the total number of PAIs, *i*, included in the project. This sample size would support a total number of PAIs far greater than the total number of PAIs in the geographic scope of this project.

Source of data	Data from a reputable regional or national meteorological organisation such as National data published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the 'Energy Trends'[112] quarterly bulletin containing statistics on weather patterns, including temperature, heating degree days, wind speeds, sun hours and rainfall[113]
Description of measurement methods and procedures to be applied	The HDDCF is used to update the baseline fossil fuel and grid-connected electricity consumption annually based on changes in temperature. This factor accounts for changes in heating degree days and associated changes in heating loads
Frequency of monitoring/recording	Once after project activity for each monitoring period
Value monitored	Not applicable during this monitoring period
Monitoring equipment	Data retrieved from the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ)
QA/QC procedures to be applied	Source data is published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic meaning the dataset meets the highest standards of trustworthiness, quality, and public value
Purpose of the data	Calculation of project emissions
Calculation method	Degree days are calculated from the maximum and minimum daily temperature as recorded at 17 meteorological stations, selected as representative of fuel consumption in Britain with 2 in Scotland, 2 in Wales and 13 in England, 4 of which are counted twice. Data on temperatures recorded are provided by the Meteorological Office[114]

[112] In the registered PDD, Energy Trends: UK Weather, Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ). Published: 24 February 2022. Table ET7: Average temperatures and heating degree days and deviations from the long-term mean.

[113] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic.

[114] In the registered PDD, Digest of UK weather statistics (DUKES): weather, Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ). Published: 24 February 2022. Data on annual trends in temperatures and heating degree days produced as part of DUKES.

Comments	HDD values are calculated on a rolling twelve-month period to accommodate periodicity of adding PAIs to the Project Activity Any given instance may have a unique HDDCF value specific to the baseline year and Monitoring Period

Methodology Reference	Table 9
Data / Parameter	HDD_b
Data unit	Degree days
Description	Heating degree days for one year before project activity
Source of data	Data from a reputable regional or national meteorological organisation such as National data published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the 'Energy Trends'[115] quarterly bulletin containing statistics on weather patterns, including temperature, heating degree days, wind speeds, sun hours and rainfall[116]
Description of measurement methods and procedures to be applied	The HDDCF is used to update the baseline fossil fuel and grid-connected electricity consumption annually based on changes in temperature. This factor accounts for changes in heating degree days and associated changes in heating loads
Frequency of monitoring/recording	Once prior to each project activity instance
Value monitored	Not applicable during this monitoring period
Monitoring equipment	Data retrieved from the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ)
QA/QC procedures to be applied	Source data is published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic meaning the dataset meets the highest standards of trustworthiness, quality, and public value

[115] In the registered PDD, Energy Trends: UK Weather, Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ). Published: 24 February 2022. Table ET7: Average temperatures and heating degree days and deviations from the long-term mean.

[116] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic.

Purpose of the data	Calculation of baseline emissions
Calculation method	Degree days are calculated from the maximum and minimum daily temperature as recorded at 17 meteorological stations, selected as representative of fuel consumption in Britain with 2 in Scotland, 2 in Wales and 13 in England, 4 of which are counted twice. Data on temperatures recorded are provided by the Meteorological Office[117]
Comments	HDD values are calculated on a rolling twelve-month period to accommodate periodicity of adding PAIs to the Project Activity Any given instance may have a unique HDDCF value specific to the baseline year and Monitoring Period

Methodology Reference	Table 9
Data / Parameter	*J*
Data unit	N/A
Description	Number of fuel types
Source of data	Post-retrofit energy assessment
Description of measurement methods and procedures to be applied	A post-retrofit energy assessment takes place for each PAI after implementation of the project activity. Post-retrofit energy assessments are undertaken by accredited energy assessors certified by a public authority, or a private certification program recognised by a public authority. Energy assessments are conducted using the Standard Assessment Procedure (SAP) which is the Government-approved National Calculation Methodology for assessing the energy performance of PAIs[118] The post-retrofit energy assessment determines the number of fuel types
Frequency of monitoring/recording	Annually
Value monitored	Not applicable during this monitoring period
Monitoring equipment	Data retrieved from the project database

[117] In the registered PDD, Digest of UK weather statistics (DUKES): weather, Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ). Published: 24 February 2022. Data on annual trends in temperatures and heating degree days produced as part of DUKES.

[118] In the registered PDD, additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 of the Project Description under the pre- and post-retrofit energy assessment approach.

QA/QC procedures to be applied	N/A
Purpose of the data	Calculation of project emissions
Calculation method	The SAP methodology considers a range of factors that contribute to energy efficiency including materials used for construction of a PAI, thermal insulation of the building fabric, air leakage characteristics of the PAI, efficiency and control of the heating system(s) and the fuel used to provide space and water heating. Energy assessments cover both fossil fuel and grid-connected electricity consumption and may include physical inspection, diagnostic tests, use energy modelling software that implements the latest approved worksheet and conventions for SAP calculations as set out in the SAP Manual[119]
Comments	N/A

Methodology Reference	Table 9
Data / Parameter	*I*
Data unit	N/A
Description	Number of PAIs included in the adjusted consumption approach for the project
Source of data	Project database
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	Annually
Value monitored	Not applicable during this monitoring period
Monitoring equipment	Data retrieved from the project database
QA/QC procedures to be applied	N/A
Purpose of the data	Calculation of project emissions

[119] In the registered PDD, the Government's Standard Assessment Procedure for Energy Rating of PAIs, SAP 2012 version 9.92, dated October 2013. Published on behalf of the Department for Energy and Climate Change by BRE Group.

Calculation method	N/A
Comments	N/A

Methodology Reference	Table 9
Data / Parameter	N/A
Data unit	Mass or volume per PAI per year
Description	Quality assurance sample group of fuel consumption within the PAI
Source of data	Quality assurance monitoring sample group under the adjusted consumption approach
Description of measurement methods and procedures to be applied	Fuel bills, reported fuel consumption, or data from a smart metering or thermostatic control device for a sample of PAIs in the Same Building Stock are collected for a period of one-year pre-retrofit and one-year post-retrofit
Frequency of monitoring/recording	Annually for two years
Value monitored	Not applicable during this monitoring period
Monitoring equipment	Documentation is maintained in the project activity files
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology[120]
Purpose of the data	Calculation of project emissions
Calculation method	The minimum quality assurance sample size is established by multiplying by 0.6 the square root of the total number of PAIs, *i*, included in the adjusted consumption approach for the project. The mean of the emission reductions calculated according to the adjusted consumption approach is compared to the mean of the emission reductions calculated for the quality assurance sample of PAIs of the Same Building Stock. If the discrepancy between the two mean values is found to be significant, the project proponent will assess the need to adjust the baseline for the purpose of calculating emission reductions accurately.

[120] In the registered PDD, additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 of the Project Description under the adjusted consumption approach and under the control group approach.

	When the data come from two different processes, such as the emission reductions calculated according to the adjusted consumption approach and the measurements from the sample group, significant discrepancy is defined based on an independent 2-sample t-test for equality of two means. If the t-value of the statistic obtained from a t-value table or calculation is greater than the corresponding value of the t-distribution for a 95% confidence level and degrees of freedom given by 2n-2, then the null hypothesis of equal means is rejected, and the observed discrepancy is concluded to be significant. A t-test is a standard statistical tool and readily available. One of the t-tests set forth below is applied. The test is determined by the type of samples, samples sizes and assumptions made on the underlying population variances. 1. An independent 2-sample t-test for samples of equal sizes and equal variances is used when the number of observations (data points) in both samples is equal and it can reasonably be assumed that the population variance of both samples is the same. 2. An independent 2-sample t-test for unequal sample sizes and equal variances is used when the number of observations (data points) in both samples is not equal and it can reasonably be assumed that the population variance of both samples is the same. 3. An independent 2-sample t-test for unequal sample sizes and unequal variances is used when the two data samples are of unequal size, and it can be reasonably assumed that the population variance is different. This test is referred to as Welch's t-test.
Comments	N/A

Methodology Reference	Table 9
Data / Parameter	*N/A*
Data unit	kWh/yr.

Description	Quality assurance sample group of grid-connected electricity consumption within the PAI
Source of data	Quality assurance monitoring sample group under the adjusted consumption approach
Description of measurement methods and procedures to be applied	Fuel bills, reported fuel consumption, or data from a smart metering or thermostatic control device for a sample of PAIs in the Same Building Stock are collected for a period of one-year pre-retrofit and one-year post-retrofit
Frequency of monitoring/recording	Annually for two years
Value monitored	Not applicable during this monitoring period
Monitoring equipment	Documentation is maintained in the project activity files
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology[121]
Purpose of the data	Calculation of project emissions
Calculation method	The minimum quality assurance sample size is established by multiplying by 0.6 the square root of the total number of PAIs, *i*, included in the adjusted consumption approach for the project. The mean of the emission reductions calculated according to the adjusted consumption approach is compared to the mean of the emission reductions calculated for the quality assurance sample of PAIs of the Same Building Stock. If the discrepancy between the two mean values is found to be significant, the project proponent will assess the need to adjust the baseline for the purpose of calculating emission reductions accurately. When the data come from two different processes, such as the emission reductions calculated according to the adjusted consumption approach and the measurements from the sample group, significant discrepancy is defined based on an independent 2-sample t-test for equality of two means. If the t-value of the statistic obtained from a t-value table or calculation is greater than the corresponding value of the t-distribution for a 95% confidence level and degrees of freedom given by 2n-2,

[121] In the registered PDD, additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 of the Project Description under the adjusted consumption approach and under the control group approach.

	then the null hypothesis of equal means is rejected, and the observed discrepancy is concluded to be significant. A t-test is a standard statistical tool and readily available. One of the t-tests set forth below is applied. The test is determined by the type of samples, samples sizes and assumptions made on the underlying population variances. 1. An independent 2-sample t-test for samples of equal sizes and equal variances is used when the number of observations (data points) in both samples is equal and it can reasonably be assumed that the population variance of both samples is the same. 2. An independent 2-sample t-test for unequal sample sizes and equal variances is used when the number of observations (data points) in both samples is not equal and it can reasonably be assumed that the population variance of both samples is the same. 3. An independent 2-sample t-test for unequal sample sizes and unequal variances is used when the two data samples are of unequal size, and it can be reasonably assumed that the population variance is different. This test is referred to as Welch's t-test.
Comments	N/A

Methodology Reference	Table 10
Data / Parameter	$Elec_{b,I}$
Data unit	kWh/yr.
Description	Grid-connected electricity consumed in the year prior to project implementation in PAI *i* (baseline consumption)
Source of data	The factor is determined from Household electricity consumption data published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ)[122] using the last consecutive

[122] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic meaning the dataset meets the highest standards of trustworthiness, quality, and public value.

	twelve months of consumption data available prior to implementation of the project activity
Description of measurement methods and procedures to be applied	Calculated as the mean consumption based on actual grid-connected electricity consumption data for a sample of PAIs in the Same Building Stock for a period of one-year pre-retrofit
Frequency of monitoring/recording	Once prior to implementation of the project activity. Once a PAI has an established baseline, it remains constant for the crediting period
Value monitored	Low-income single-family PAI baseline consumption: 3,000 kWh annually Middle-income individual PAI baseline consumption: 3,900 kWh annually Consumption for each PAI is calculated by applying the mean consumption determined from a sample of PAIs of the Same Building Stock (the sample may be normalized for size) to all PAIs included in the project activity. To ensure accurate and conservative emission reduction calculations, in the cases where a PAI in the project activity has a unique energy load reported in the pre-retrofit energy assessment, the unique energy load is incorporated into the calculation of the baseline consumption
Monitoring equipment	Documentation is maintained in the project activity files
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology[123]
Purpose of the data	Calculation of baseline emissions
Calculation method	The minimum sample size is established by multiplying by 0.6 the square root of the total number of PAIs, *i*, included in the adjusted consumption approach for the project Baseline grid-connected electricity consumption for the Same Building Stock is calculated using a weighted mean calculation as set out in section 3.4 of the Project Description for the baseline scenario. The baseline consumption is calculated as follows: **Same Building Stock: Low-income single-family PAIs** The independent data collected and arranged in a systematic or methodical way by the project proponent is the Household

[123] In the registered PDD, additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 of the Project Description under the adjusted consumption approach and under the control group approach.

	electricity consumption data published by BEIS (now DESNZ) on June 24, 2021, as part of the NEED Framework.[124] [125] [126] The sample size was 13,480,630 PAIs, representing approximately 92% of the total population of low-income single-family PAIs in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology[127] **Same Building Stock: Middle-income single-family PAIs** The independent data collected and arranged in a systematic or methodical way by the project proponent is the Household electricity consumption data published by BEIS (now DESNZ) on June 24, 2021, as part of the NEED Framework.[128] [129] [130] The sample size was 5,851,540 PAIs, representing approximately 92% of the total population of middle-income single-family PAIs in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology[131]
Comments	N/A

Methodology Reference	Table 10
Data / Parameter	$E_{dem,pre,i}$
Data unit	kW

[124] In the registered PDD, Additional Consumption Tables: England, Wales and Scotland, 2019. Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ). December 2021.

[125] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic.

[126] In the registered PDD, Table A12 of the Household natural gas and grid-connected electricity consumption data published by BEIS (now DESNZ) under the NEED framework.

[127] In the registered PDD, the sample size of the sample group is established by multiplying 0.6 by the square root of the total number of PAIs, *i*, included in the project. This sample size would support a total number of PAIs far greater than the total number of PAIs in the geographic scope of this project.

[128] In the registered PDD, Additional Consumption Tables: England, Wales and Scotland, 2019. Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ). December 2021.

[129] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic.

[130] In the registered PDD, Table A12 of the Household natural gas and grid-connected electricity consumption data published by BEIS (now DESNZ) under the NEED framework.

[131] In the registered PDD, the sample size of the sample group is established by multiplying 0.6 by the square root of the total number of PAIs, *i*, included in the project. This sample size would support a total number of PAIs far greater than the total number of PAIs in the geographic scope of this project.

Description	Pre-retrofit grid-connected electricity demand for PAI *i*
Source of data	Pre-retrofit energy assessment
Description of measurement methods and procedures to be applied	A pre-retrofit energy assessment takes place for each PAI prior to implementation of the project activity. Pre-retrofit energy assessments are undertaken by accredited energy assessors certified by a public authority, or a private certification program recognised by a public authority. Energy assessments are conducted using the Standard Assessment Procedure (SAP) which is the Government-approved National Calculation Methodology for assessing the energy performance of PAIs[132] The pre-retrofit energy assessment determines the grid-connected electricity demand in the baseline
Frequency of monitoring/recording	Once per PAI prior to implementation of the project activity. The grid-connected electricity demand pre-retrofit may be calculated after the energy efficiency measures are installed
Value monitored	Determined individually for each project activity instance
Monitoring equipment	Energy modelling software that implements the latest approved worksheet and conventions for SAP calculations as set out in the SAP Manual[133]
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology[134]
Purpose of the data	Calculation of baseline emissions
Calculation method	The SAP methodology considers a range of factors that contribute to energy efficiency including materials used for construction of a PAI, thermal insulation of the building fabric, air leakage characteristics of the PAI, efficiency and control of the heating system(s) and the fuel used to provide space and water heating. Energy assessments cover both fossil fuel and grid-connected electricity consumption and may include physical inspection, diagnostic tests, use energy modelling software that implements the latest approved worksheet and conventions for SAP calculations as set out in the manual describing the

[132] In the registered PDD, additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 of the Project Description under the pre- and post-retrofit energy assessment approach.

[133] In the registered PDD, the Government's Standard Assessment Procedure for Energy Rating of PAIs, SAP 2012 version 9.92, dated October 2013. Published on behalf of the Department for Energy and Climate Change by BRE Group.

[134] In the registered PDD, additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 of the Project Description under the pre- and post-retrofit energy assessment approach.

	Government's Standard Assessment Procedure, or apply building physics calculations
Comments	N/A

Methodology Reference	Table 10
Data / Parameter	$E_{dem,post,i}$
Data unit	kW
Description	Post-retrofit grid-connected electricity demand for PAI *i*
Source of data	Post-retrofit energy assessment
Description of measurement methods and procedures to be applied	A post-retrofit energy assessment takes place for each PAI after the decarbonisation measures are completed. Post-retrofit energy assessments are undertaken by accredited energy assessors certified by a public authority, or a private certification program recognised by a public authority. Energy assessments are conducted using the Standard Assessment Procedure (SAP) which is the Government-approved National Calculation Methodology for assessing the energy performance of PAIs[135] The post-retrofit energy assessment determines the grid-connected electricity demand following the implementation of project activity
Frequency of monitoring/recording	Once per PAI following the implementation of project activity
Value monitored	Determined individually for each project activity instance or for a sample of PAIs in the Same Building Stock in accordance with the VM0008 Methodology
Monitoring equipment	Energy modelling software that implements the latest approved worksheet and conventions for SAP calculations as set out in the SAP Manual[136]
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology[137]

[135] In the registered PDD, additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 of the Project Description under the pre- and post-retrofit energy assessment approach.

[136] In the registered PDD, the Government's Standard Assessment Procedure for Energy Rating of PAIs, SAP 2012 version 9.92, dated October 2013. Published on behalf of the Department for Energy and Climate Change by BRE Group.

[137] In the registered PDD, additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 of the Project Description under the pre- and post-retrofit energy assessment approach.

Purpose of the data	Calculation of project emissions
Calculation method	The SAP methodology considers a range of factors that contribute to energy efficiency including materials used for construction of a PAI, thermal insulation of the building fabric, air leakage characteristics of the PAI, efficiency and control of the heating system(s) and the fuel used to provide space and water heating. Energy assessments cover both fossil fuel and grid-connected electricity consumption and may include physical inspection, diagnostic tests, use energy modelling software that implements the latest approved worksheet and conventions for SAP calculations as set out in the manual describing the Government's Standard Assessment Procedure, or apply building physics calculations
Comments	N/A

Methodology Reference	Table 10
Data / Parameter	$F_{b,l,j}$
Data unit	Mass or volume per PAI per year
Description	Fuel type *j* consumed in the year prior to project implementation for PAI *i* (baseline consumption)
Source of data	The factor is determined from national Household gas consumption data published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ)[138] using the last consecutive twelve months of consumption data available prior to implementation of the project activity
Description of measurement methods and procedures to be applied	Calculated as the mean consumption based on actual natural gas consumption data for a sample of PAIs in the Same Building Stock for a period of one-year pre-retrofit
Frequency of monitoring/recording	Once prior to implementation of the project activity. Once a PAI has an established baseline, it remains constant for the crediting period
Value monitored	Low-income single-family PAI baseline consumption:

[138] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic meaning the dataset meets the highest standards of trustworthiness, quality, and public value.

	1,104 m^3 annually Middle-income individual PAI baseline consumption: 1,382 m^3 annually Consumption for each PAI is calculated by applying the mean consumption determined from a sample of PAIs of the Same Building Stock (the sample may be normalized for size) to all PAIs included in the project activity. To ensure accurate and conservative emission reduction calculations, in the cases where a PAI in the project activity has a unique energy load reported in the pre-retrofit energy assessment, the unique energy load is incorporated into the calculation of the baseline consumption
Monitoring equipment	Documentation is maintained in the project activity files
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology[139]
Purpose of the data	Calculation of baseline emissions
Calculation method	One Kilowatt hour is equal to 0.0036 Gigajoules. The minimum sample size is established by multiplying by 0.6 the square root of the total number of PAIs, *i*, included in the adjusted consumption approach for the project Baseline fuel consumption for the Same Building Stock is calculated using a weighted mean calculation as set out in section 3.4 of the Project Description for the baseline scenario. The baseline consumption is calculated as follows: **Same Building Stock: Low-income single-family PAIs** The independent data collected and arranged in a systematic or methodical way by the project proponent is the Household gas consumption data published by BEIS (now DESNZ) on June 24, 2021, as part of the NEED Framework.[140] [141] [142] The sample size was 11,066,210 PAIs, representing approximately 78% of the

[139] In the registered PDD, additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 of the Project Description under the adjusted consumption approach and under the control group approach.

[140] In the registered PDD, Additional Consumption Tables: England, Wales and Scotland, 2019. Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ). December 2021.

[141] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic.

[142] In the registered PDD, Table A11 of the Household natural gas and grid-connected electricity consumption data published by BEIS (now DESNZ) under the NEED framework.

	total population of low-income single-family PAIs in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology[143] **Same Building Stock: Middle-income single-family PAIs** The independent data collected and arranged in a systematic or methodical way by the project proponent is the Household gas consumption data published by BEIS (now DESNZ) on June 24, 2021, as part of the NEED Framework.[144] [145] [146] The sample size was 4,879,760 PAIs, representing approximately 78% of the total population of middle-income single-family PAIs in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology[147]
Comments	N/A

Methodology Reference	Table 10
Data / Parameter	$H_{load,pre,i}$
Data unit	kWh/m^2/HDD or GJoules/m^2/HDD
Description	Heat load pre-retrofit for PAI *i* based on size of the PAI and historical HDD for the region
Source of data	Pre-retrofit energy assessment
Description of measurement methods and procedures to be applied	A pre-retrofit energy assessment takes place for each PAI prior to implementation of the project activity. Pre-retrofit energy assessments are undertaken by accredited energy assessors certified by a public authority, or a private certification program recognised by a public authority. Energy assessments are conducted using the Standard Assessment Procedure

[143] In the registered PDD, the sample size of the sample group is established by multiplying 0.6 by the square root of the total number of PAIs, *i*, included in the project. This sample size would support a total number of PAIs far greater than the total number of PAIs in the geographic scope of this project.

[144] In the registered PDD, Additional Consumption Tables: England, Wales and Scotland, 2019. Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ). December 2021.

[145] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic.

[146] In the registered PDD, Table A11 of the Household natural gas and grid-connected electricity consumption data published by BEIS (now DESNZ) under the NEED framework.

[147] In the registered PDD, the sample size of the sample group is established by multiplying 0.6 by the square root of the total number of PAIs, *i*, included in the project. This sample size would support a total number of PAIs far greater than the total number of PAIs in the geographic scope of this project.

	(SAP) which is the Government-approved National Calculation Methodology for assessing the energy performance of PAIs[148] The pre-retrofit energy assessment determines the heat load in the baseline
Frequency of monitoring/recording	Once per PAI prior to implementation of the project activity. The heat load pre-retrofit may be calculated after the energy efficiency measures are installed
Value monitored	Determined individually for each project activity instance
Monitoring equipment	Energy modelling software that implements the latest approved worksheet and conventions for SAP calculations as set out in the SAP Manual[149]
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology[150]
Purpose of the data	Calculation of baseline emissions
Calculation method	The SAP methodology considers a range of factors that contribute to energy efficiency including materials used for construction of a PAI, thermal insulation of the building fabric, air leakage characteristics of the PAI, efficiency and control of the heating system(s) and the fuel used to provide space and water heating. Energy assessments cover both fossil fuel and grid-connected electricity consumption and may include physical inspection, diagnostic tests, use energy modelling software that implements the latest approved worksheet and conventions for SAP calculations as set out in the manual describing the Government's Standard Assessment Procedure, or apply building physics calculations.
Comments	Note that the size (M_2) and historical heating degree days do not change from $H_{load,pre,i}$ to $H_{load,post,i}$ and therefore cancel out. Therefore, the HLF is calculated as the total difference in GJoules pre and GJoules post. Additionally, using the same principle, the heat load is reported in kWh or GJ for all PAIs in the Same Building Stock

[148] In the registered PDD, additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 of the Project Description under the pre- and post-retrofit energy assessment approach.

[149] In the registered PDD, the Government's Standard Assessment Procedure for Energy Rating of PAIs, SAP 2012 version 9.92, dated October 2013. Published on behalf of the Department for Energy and Climate Change by BRE Group.

[150] In the registered PDD, additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 of the Project Description under the pre- and post-retrofit energy assessment approach.

Methodology Reference	Table 10
Data / Parameter	$H_{load,post,i}$
Data unit	kWh/m²/HDD or GJoules/m²/HDD
Description	Heat load post-retrofit for PAI *i* based on size of the PAI and historical HDD for the region
Source of data	Post-retrofit energy assessment
Description of measurement methods and procedures to be applied	A post-retrofit energy assessment takes place for each PAI after the decarbonisation measures are completed. Post-retrofit energy assessments are undertaken by accredited energy assessors certified by a public authority, or a private certification program recognised by a public authority. Energy assessments are conducted using the Standard Assessment Procedure (SAP) which is the Government-approved National Calculation Methodology for assessing the energy performance of PAIs[151] The post-retrofit energy assessment determines the heat load following the implementation of project act*ivity*
Frequency of monitoring/recording	Once per PAI following the implementation of project activity
Value monitored	Determined individually for each project activity instance or for a sample of PAIs in the Same Building Stock in accordance with the VM0008 Methodology
Monitoring equipment	Energy modelling software that implements the latest approved worksheet and conventions for SAP calculations as set out in the SAP Manual[152]
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology[153]
Purpose of the data	Calculation of project emissions
Calculation method	The SAP methodology considers a range of factors that contribute to energy efficiency including materials used for

[151] In the registered PDD, additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 of the Project Description under the pre- and post-retrofit energy assessment approach.

[152] In the registered PDD, the Government's Standard Assessment Procedure for Energy Rating of PAIs, SAP 2012 version 9.92, dated October 2013. Published on behalf of the Department for Energy and Climate Change by BRE Group.

[153] In the registered PDD, additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 of the Project Description under the pre- and post-retrofit energy assessment approach.

	construction of a PAI, thermal insulation of the building fabric, air leakage characteristics of the PAI, efficiency and control of the heating system(s) and the fuel used to provide space and water heating. Energy assessments cover both fossil fuel and grid-connected electricity consumption and may include physical inspection, diagnostic tests, use energy modelling software that implements the latest approved worksheet and conventions for SAP calculations as set out in the manual describing the Government's Standard Assessment Procedure, or apply building physics calculations
Comments	Note that the size (M_2) and historical heating degree days do not change from $H_{load,pre,i}$ to $H_{load,post,i}$ and therefore cancel out. Therefore, the HLF is calculated as the total difference in GJoules pre and GJoules post. Additionally, using the same principle, the heat load is reported in kWh or GJ for all PAIs in the Same Building Stock

Methodology Reference	Table 10
Data / Parameter	ECF_y
Data unit	N/A
Description	Grid-connected electricity correction factor for year *y*. The ECF is only to be applied in the equation if it is negative
Source of data	The factor is determined from local, regional or national grid-connected electricity household consumption data from a public authority, a public utility or regulatory agency, or a recognised energy research organisation such as the Household energy consumption data published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ)[154] or the Final energy demand data published by the Department for Business, Energy and Industrial Strategy (BEIS)[155]. Historical data from a public authority may be used to determine the ECF. Projected trends in changes in the rate of grid-connected electricity demand reported by a public authority may also be used as the ECF

[154] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department of Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic meaning the dataset meets the highest standards of trustworthiness, quality, and public value.

[155] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department of Energy Security and Net Zero (DESNZ), as part of the Energy demand, greenhouse gas emissions and electricity generation trends data; Annex F.

Description of measurement methods and procedures to be applied	The ECF represents the trend in grid-connected electricity demand based on average grid-connected electricity consumption within the state over a period of at least ten years. The ECF is stated as a multiplier. For example, 0.98 represents an electricity consumption growth rate of -2%. The ECF is used to update the baseline grid-connected electricity consumption based on decreases in grid-connected electricity demand over time. The ECF is only applied when it is less than 1 to maintain conservativeness in the emission reduction calculation. This factor is applied to the calculation of the emission reductions after project implementation because grid-connected electricity consumption in the baseline may not remain the same
Frequency of monitoring/recording	Annually for each year *y*
Value monitored	Low-income single-family PAIs: 0.9825 Middle-income individual PAIs: 0.9835
Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of the data	Calculation of project emissions
Calculation method	The ECF represents the trend in grid-connected electricity demand based on average grid-connected electricity consumption within the state over a period of at least ten years. For each of the ten years, baseline household grid-connected electricity consumption data is calculated, for example as follows when using the Household energy consumption dataset from BEIS (now DESNZ): **Same Building Stock: Low-income single-family PAIs** The independent data collected and arranged systematically or methodically by the project proponent is the Household electricity consumption data published by BEIS (now DESNZ) on June 29,

	2023, as part of the NEED Framework.[156] [157] [158] The sample size was 12,229,450 PAIs, representing approximately 83% of the total population of low-income single-family PAIs in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology [159] **Same Building Stock: Middle-income single-family PAIs** The independent data collected and arranged systematically or methodically by the project proponent is the Household electricity consumption data published by BEIS (now DESNZ) on June 24, 2021, as part of the NEED Framework.[160] [161] [162] The sample size was 6,478,350 PAIs, representing approximately 98% of the total population of middle-income single-family PAIs in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology [163]
Comments	N/A

Methodology Reference	Table 10
Data / Parameter	HDD_y
Data unit	Degree days
Description	Heating degree days for year *y* after project activity

[156] In the registered PDD, Additional Consumption Tables: England, Wales and Scotland, 2019. Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ). December 2021.

[157] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic.

[158] In the registered PDD, Table A12 of the Household natural gas and grid-connected electricity consumption data published by BEIS (now DESNZ) under the NEED framework.

[159] In the registered PDD, the sample size of the sample group is established by multiplying 0.6 by the square root of the total number of PAIs, *i*, included in the project. This sample size would support a total number of PAIs far greater than the total number of PAIs in the geographic scope of this project.

[160] In the registered PDD, Additional Consumption Tables: England, Wales and Scotland, 2019. Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ). December 2021.

[161] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic.

[162] In the registered PDD, Table A12 of the Household natural gas and grid-connected electricity consumption data published by BEIS (now DESNZ) under the NEED framework.

[163] In the registered PDD, the sample size of the sample group is established by multiplying 0.6 by the square root of the total number of PAIs, *i*, included in the project. This sample size would support a total number of PAIs far greater than the total number of PAIs in the geographic scope of this project.

Source of data	Data from a reputable regional or national meteorological organisation such as National data published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the 'Energy Trends'[164] quarterly bulletin containing statistics on weather patterns, including temperature, heating degree days, wind speeds, sun hours and rainfall[165] This monitoring period uses data retrieved from the Meteorological Office from its observation site at Nottingham Watnall (WMO ID 03354).
Description of measurement methods and procedures to be applied	The HDDCF is used to update the baseline fossil fuel and grid-connected electricity consumption annually based on changes in temperature. This factor accounts for changes in heating degree days and associated changes in heating loads
Frequency of monitoring/recording	Once after project activity for each monitoring period
Value monitored	Calculated once for each project activity instance for each monitoring period
Monitoring equipment	Data retrieved from the Meteorological Office from its observation site at Nottingham Watnall (WMO ID 03354). The site hosts a suite of instruments including surface metrological observations and laser ceilometer. The station is located 177m above mean sea level in Nottinghamshire, east UK. Since 1941 meteorological observations have been recorded on a 24hr basis, linking the station to the synoptic network of the Met Office Meteorological Service.
QA/QC procedures to be applied	Data retrieved from the Meteorological Office from its observation site at Nottingham Watnall (WMO ID 03354). The site hosts a suite of instruments including surface metrological observations and laser ceilometer. The station is located 177m above mean sea level in Nottinghamshire, east UK. Since 1941 meteorological observations have been recorded on a 24hr basis, linking the station to the synoptic network of the Met Office Meteorological Service.

[164] In the registered PDD, Energy Trends: UK Weather, Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ). Published: 24 February 2022. Table ET7: Average temperatures and heating degree days and deviations from the long-term mean.

[165] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic.

Purpose of the data	Calculation of project emissions
Calculation method	Degree days are calculated from the maximum and minimum daily temperature as recorded by the Meterological Office from its observation site at Nottingham Watnall (WMO ID 03354).
Comments	HDD values are calculated on a rolling twelve-month period to accommodate periodicity of adding PAIs to the Project Activity Any given instance may have a unique HDDCF value specific to the baseline year and Monitoring Period

Methodology Reference	Table 10
Data / Parameter	HDD_b
Data unit	Degree days
Description	Heating degree days for one year before project activity
Source of data	Data from a reputable regional or national meteorological organisation such as National data published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the 'Energy Trends'[166] quarterly bulletin containing statistics on weather patterns, including temperature, heating degree days, wind speeds, sun hours and rainfall[167] This monitoring period uses data retrieved from the Meteorological Office from its observation site at Nottingham Watnall (WMO ID 03354).
Description of measurement methods and procedures to be applied	The HDDCF is used to update the baseline fossil fuel and grid-connected electricity consumption annually based on changes in temperature. This factor accounts for changes in heating degree days and associated changes in heating loads
Frequency of monitoring/recording	Once prior to each project activity instance
Value monitored	Calculated for each rolling twelve-month period before project activity

[166] In the registered PDD, Energy Trends: UK Weather, Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ). Published: 24 February 2022. Table ET7: Average temperatures and heating degree days and deviations from the long-term mean.

[167] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and designated as an official national statistic.

Monitoring equipment	Data retrieved from the Meteorological Office from its observation site at Nottingham Watnall (WMO ID 03354). The site hosts a suite of instruments including surface metrological observations and laser ceilometer. The station is located 177m above mean sea level in Nottinghamshire, east UK. Since 1941 meteorological observations have been recorded on a 24hr basis, linking the station to the synoptic network of the Met Office Meteorological Service.
QA/QC procedures to be applied	Data retrieved from the Meteorological Office from its observation site at Nottingham Watnall (WMO ID 03354). The site hosts a suite of instruments including surface metrological observations and laser ceilometer. The station is located 177m above mean sea level in Nottinghamshire, east UK. Since 1941 meteorological observations have been recorded on a 24hr basis, linking the station to the synoptic network of the Met Office Meteorological Service.
Purpose of the data	Calculation of baseline emissions
Calculation method	Degree days are calculated from the maximum and minimum daily temperature as recorded by the Meterological Office from its observation site at Nottingham Watnall (WMO ID 03354).
Comments	HDD values are calculated on a rolling twelve-month period to accommodate periodicity of adding PAIs to the Project Activity Any given instance will have a unique HDDCF value specific to the baseline year and Monitoring Period

Methodology Reference	Table 10
Data / Parameter	*J*
Data unit	N/A
Description	Number of fuel types
Source of data	Post-retrofit energy assessment
Description of measurement methods and procedures to be applied	A post-retrofit energy assessment takes place for each PAI after implementation of the project activity. Post-retrofit energy assessments are undertaken by accredited energy assessors certified by a public authority, or a private certification program recognised by a public authority. Energy assessments are conducted using the Standard Assessment Procedure

	(SAP) which is the Government-approved National Calculation Methodology for assessing the energy performance of PAIs[168] The post-retrofit energy assessment determines the number of fuel types
Frequency of monitoring/recording	Annually
Value monitored	Eleven fuel types: 1) Bottled LPG 2) Anthracite 3) Wood logs 4) Wooden pellets 5) Dual fuel 6) Smokeless coal 7) Community natural gas 8) Mains natural gas 9) LPG 10) Oil 11) House coal
Monitoring equipment	Data retrieved from the project database
QA/QC procedures to be applied	N/A
Purpose of the data	Calculation of project emissions
Calculation method	The SAP methodology considers a range of factors that contribute to energy efficiency including materials used for construction of a PAI, thermal insulation of the building fabric, air leakage characteristics of the PAI, efficiency and control of the heating system(s) and the fuel used to provide space and water heating. Energy assessments cover both fossil fuel and grid-connected electricity consumption and may include physical inspection, diagnostic tests, use energy modelling software that implements the latest approved worksheet and conventions for SAP calculations as set out in the manual describing the Government's Standard Assessment Procedure, or apply building physics calculations
Comments	N/A

[168] In the registered PDD, additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 of the Project Description under the pre- and post-retrofit energy assessment approach.

Methodology Reference	Table 10
Data / Parameter	*I*
Data unit	N/A
Description	Number of PAIs included in the pre- and post-retrofit energy assessment approach for the project
Source of data	Project database
Description of measurement methods and procedures to be applied	*N/A*
Frequency of monitoring/recording	Annually
Value monitored	39,927 PAIs
Monitoring equipment	Data retrieved from the project database
QA/QC procedures to be applied	N/A
Purpose of the data	Calculation of project emissions
Calculation method	N/A
Comments	N/A

Methodology Reference	Table 10
Data / Parameter	S
Data unit	N/A
Description	Number of PAIs included in the sample group
Source of data	Project database
Description of measurement methods and procedures to be applied	*N/A*
Frequency of monitoring/recording	Once for each year *y*

Value monitored	Sampling is conducted in accordance with the methodology. The pre-and post-retrofit audit approach is utilised to measure emission reductions, for which the methodology prescribes the size of the quality assurance sample group of PAIs is established by multiplying 0.6 by the square root of the total number of PAIs 39,927, which equals a sample group of 158. The quality assurance process was run across a sample group comprising 2,215 PAIs to enable multiple quality assurance tests (approximately 14 times)
Monitoring equipment	Data retrieved from the project database
QA/QC procedures to be applied	N/A
Purpose of the data	Calculation of project emissions
Calculation method	The sample size for the quality assurance sample is established by multiplying by 0.6 the square root of the total number of PAIs, *i*, included in the Project Where: *i = 39,927* The sample size for the quality assurance sample is 158
Comments	N/A

Methodology Reference	Table 11
Data / Parameter	$Elec_{SG,y,b}$
Data unit	kWh/yr.
Description	Mean grid-connected electricity consumed by sample group PAIs in Building Stock b in year y
Source of data	Sample group of PAIs to be decarbonised
Description of measurement methods and procedures to be applied	Fuel bills, reported fuel consumption, or data from a smart metering or thermostatic control device for a sample group of PAIs
Frequency of monitoring/recording	Monitored monthly, calculated annually
Value monitored	Not applicable during this monitoring period
Monitoring equipment	Documentation is maintained in the project activity files

QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology
Purpose of the data	Calculation of baseline emissions
Calculation method	Sample groups are defined individually for PAIs from the Same Building Stock which are to be decarbonised. The minimum number of PAIs to be sampled will be the square root of the total number of PAIs *i*, included in the control group approach in the project. The sample will be statistically valid, and may be one of the following: a. Simple random sample b. Systematic sampling c. Stratified sampling within the Same Building Stock d. Cluster sampling. The sample will be representative of the population. Actions that may bias the sample will be avoided. Sampling will include PAIs that are dispersed geographically. For each defined Building Stock included in the project activity, sampling will occur. Criteria include region, PAI type, and income.
Comments	N/A

Methodology Reference	Table 11
Data / Parameter	$Elec_{CG,y,b}$
Data unit	kWh/yr.
Description	Mean grid-connected electricity consumed by control group PAIs in Building Stock *b* in year *y*
Source of data	Control group of PAIs not decarbonised
Description of measurement methods and procedures to be applied	Fuel bills, reported fuel consumption, or data from a smart metering or thermostatic control device for a control group of PAIs
Frequency of monitoring/recording	Monitored monthly, calculated annually
Value monitored	Not applicable during this monitoring period
Monitoring equipment	Documentation is maintained in the project activity files

QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology
Purpose of the data	Calculation of project emissions
Calculation method	Control groups are created which contain PAIs from the Same Building Stock with no record of any decarbonisation measure installed in the year before, after or during the installation year. The control group sample may include different PAIs each year so long as the control group contains only PAIs with no record of any decarbonisation measure installed in the year before, after or during the installation year. The size of the control group is the square root of the total number of PAIs in the Project but need not exceed 100 PAIs.
Comments	N/A

Methodology Reference	Table 11
Data / Parameter	$F_{SG,y,j,b}$
Data unit	Mass or volume, per PAI per year
Description	Mean fuel type j consumed by sample group PAIs in Building Stock b in year y
Source of data	Sample group of PAIs to be decarbonised
Description of measurement methods and procedures to be applied	Fuel bills, reported fuel consumption, or data from a smart metering or thermostatic control device for a sample of PAIs in the Same Building Stock
Frequency of monitoring/recording	Monitored monthly, calculated annually
Value monitored	Not applicable during this monitoring period
Monitoring equipment	Documentation is maintained in the project activity files
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology
Purpose of the data	Calculation of baseline emissions
Calculation method	Sample groups are defined individually for PAIs from the Same Building Stock which are to be decarbonised. The minimum number of PAIs to be sampled will be the square root of the total number of PAIs *i*, included in the control group approach in the

	project. The sample will be statistically valid, and may be one of the following: a. Simple random sample b. Systematic sampling c. Stratified sampling within the Same Building Stock d. Cluster sampling. The sample will be representative of the population. Actions that may bias the sample will be avoided. Sampling will include PAIs that are dispersed geographically. For each defined Building Stock included in the project activity, sampling will occur. Criteria include region, PAI type, and income
Comments	N/A

Methodology Reference	Table 11
Data / Parameter	$F_{CG,y,j,b}$
Data unit	kWh/yr.
Description	Mean fuel type *j* consumed by control group PAIs in Same Building Stock *b* in year *y*
Source of data	Control group of PAIs not decarbonised
Description of measurement methods and procedures to be applied	Fuel bills, reported fuel consumption, or data from a smart metering or thermostatic control device for a control group of PAIs in the Same Building Stock
Frequency of monitoring/recording	Monitored monthly, calculated annually
Value monitored	Not applicable during this monitoring period
Monitoring equipment	Documentation is maintained in the project activity files
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology
Purpose of the data	Calculation of project emissions
Calculation method	Control groups are created which contain PAIs from the Same Building Stock with no record of any decarbonisation measure installed in the year before, after or during the installation year. The control group sample may include different PAIs each year so

	long as the control group contains only PAIs with no record of any decarbonisation measure installed in the year before, after or during the installation year. The size of the control group is the square root of the total number of PAIs in the Project but need not exceed 100 PAIs.
Comments	N/A

Methodology Reference	Table 11
Data / Parameter	*J*
Data unit	N/A
Description	Number of fuel types
Source of data	Pre-retrofit energy assessment
Description of measurement methods and procedures to be applied	A post-retrofit energy assessment takes place for each PAI prior to implementation of the project activity. Post-retrofit energy assessments are undertaken by accredited energy assessors certified by a public authority, or a private certification program recognised by a public authority. Energy assessments are conducted using the Standard Assessment Procedure (SAP) which is the Government-approved National Calculation Methodology for assessing the energy performance of PAIs[169] The post-retrofit energy assessment determines the number of fuel types
Frequency of monitoring/recording	Annually
Value monitored	Not applicable during this monitoring period
Monitoring equipment	Data retrieved from the project database
QA/QC procedures to be applied	N/A
Purpose of the data	Calculation of project emissions
Calculation method	The SAP methodology considers a range of factors that contribute to energy efficiency including materials used for construction of a PAI, thermal insulation of the building fabric, air leakage characteristics of the PAI, efficiency and control of the heating system(s) and the fuel used to provide space and water heating. Energy assessments cover both fossil fuel and grid-

[169] In the registered PDD, additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 of the Project Description under the pre- and post-retrofit energy assessment approach.

	connected electricity consumption and may include physical inspection, diagnostic tests, use energy modelling software that implements the latest approved worksheet and conventions for SAP calculations as set out in the manual describing the Government's Standard Assessment Procedure, or apply building physics calculations
Comments	N/A

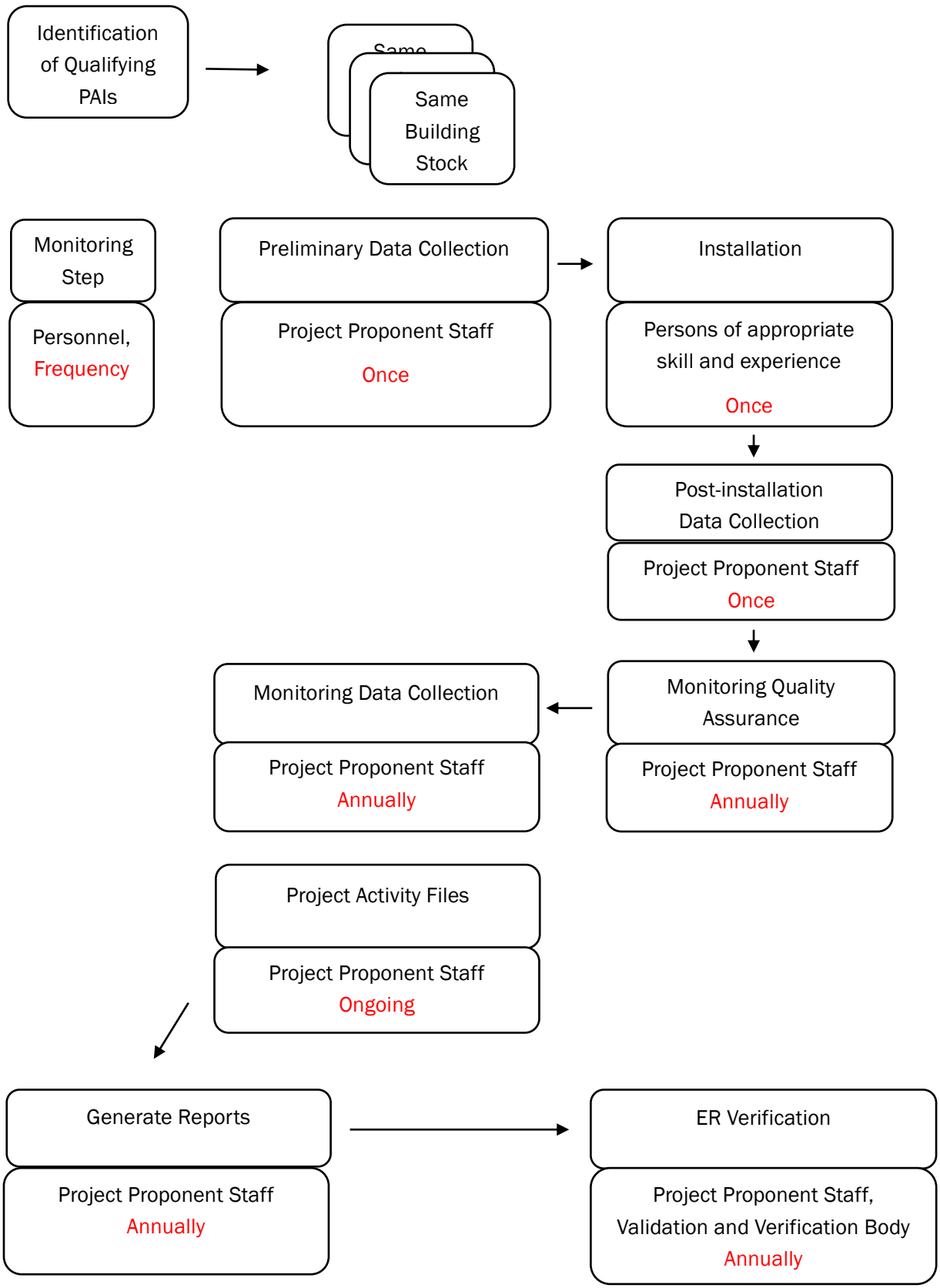
Methodology Reference	Table 11
Data / Parameter	I_b
Data unit	N/A
Description	Number of PAIs included in the control group approach for the project
Source of data	Project database
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	Annually
Value monitored	Not applicable during this monitoring period
Monitoring equipment	Data retrieved from the project database
QA/QC procedures to be applied	N/A
Purpose of the data	Calculation of project emissions
Calculation method	N/A
Comments	N/A

Methodology Reference	Table 11
Data / Parameter	I_b
Data unit	N/A
Description	Number of PAIs included in the control group approach for the project
Source of data	Project database

Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	Annually
Value monitored	Not applicable during this monitoring period
Monitoring equipment	Data retrieved from the project database
QA/QC procedures to be applied	N/A
Purpose of the data	Calculation of project emissions
Calculation method	N/A
Comments	N/A

4.3 Monitoring Plan

Monitoring plans for the project activity follow the approach outlined in the VM0008 Methodology. The Line Diagram on the following page provides an overview of the monitoring process and the key steps within it.



Monitoring is conducted primarily by project proponent staff or designated personnel participating in decarbonisation project activity. PAI-specific data is collected following this Project Description. PNZ Carbon employs 15 staff to undertake its day-to-day operations, with another 13 staff making regular contributions to the business from the PNZ Group and its wider partners.

Reviewed data includes the items specified for determining project eligibility in accordance with the criteria set out in section 1.4 (Eligibility Criteria) of the Project Description. Each PAI decarbonised within the project activity has a file that contains all relevant documentation and data. These files are maintained as part of the project activity files.

Data obtained from outside sources is collected in accordance with the Project Description and maintained in a centralised data repository. Based on this data, project proponent staff or designated personnel participating in decarbonisation project activity produce all necessary calculations and generate reports.

Sampling Procedure

Sampling meets the requirements of the VM0008 Methodology as follows:

- The source data used for calculating the baseline scenario as set out in section 3.4 (Baseline Scenario) of the Project Description comprises actual natural gas consumption data for approximately 78% of the total population of low-income single-family PAIs within the United Kingdom; actual grid-connected electricity consumption data for approximately 92% of the total population of low-income single-family PAIs within the UK; actual natural gas consumption data for approximately 78% of the total population of middle-income single-family PAIs within the UK; and actual grid-connected electricity consumption data for approximately 92% of the total population of middle-income single-family PAIs within the UK, all of which exceed the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology.

- The source data used for calculating additionality as set out in section 3.5 (Additionality) of the Project Description comprises actual natural gas and grid-connected electricity consumption data that comprises a stratified random sample of approximately 15% of PAIs in the UK. Sampling was undertaken by staff of the Department for Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), as part of the National Energy Efficiency Data Framework (NEED) and overseen by the Office of National Statistics.

- The source data used for calculating the reduction in consumption under the Control group approach as set out in section 4.4 (Emission Reductions and Removals) of the Project Description and used as the reduction in consumption for quality assurance purposes under the Adjusted consumption and Pre- and post-retrofit energy assessment approaches as set out in section 4.4 (Emission Reductions and Removals) of the Project Description is established by multiplying the square root of the total number of PAIs, ($\sqrt{i}$), where i is the

total number of PAIs, of the Same Building Stock *b*, decarbonised as part of the project activity, but need not exceed 100 PAIs.

- Quality Assurance monitoring in the VM0008 Methodology allows for correcting the HLF and EDF for all PAIs and decarbonisation measures where a significant discrepancy occurs between the calculated reduction in energy load as shown in the post-retrofit energy assessment for a sample of PAIs of the Same Building Stock and the actual reduction in consumption calculated from directly metered energy data.
- In compiling the Quality Assurance sample group, the following conditions Applicability Conditions from Section 4.2 of the VM0008 Methodology are applied:

  1) The sample is statistically valid, and may be one of the following:

     a) Simple random sample

     b) Systematic sampling

     c) Stratified sampling within the Same Building Stock

     d) Cluster sampling.

  2) The sample is representative of the population.

  3) The data comes from an approved source, such as a certified energy auditor or a nationally recognised data source.

  4) Actions that may bias the sample are avoided. Sampling shall include PAIs that are dispersed geographically and include each defined Building Stock included in the Project activity.

- Project proponent staff or designated personnel who participate in decarbonisation project activity oversee the monitoring of the size of the quality assurance sample groups and control groups.

Identification of Qualifying PAIs

Project proponent staff, or designated personnel who participate in decarbonisation project activity, select eligible PAIs to include in the project activity. The project instances meet the criteria in section 1.4 (Eligibility Criteria) of the Project Description. Documentation is maintained in the project activity files.

Preliminary Data Collection

Project proponent staff, or designated personnel who participate in decarbonisation project activity, obtain documentation for each project activity to evidence the requisite criteria set out in section 1.4 (Eligibility Criteria) of the Project Description. Documentation is maintained in the project activity files.

Post-installation Data Collection

Following installation of the decarbonisation measures, project proponent staff or designated personnel who participate in decarbonisation project activities obtain (where necessary) the

documentation to evidence the requisite criteria set out in section 1.4 (Eligibility Criteria) of the Project Description for each project activity instance. Documentation is maintained in the project activity files.

Monitoring Quality Assurance

Project proponent staff or designated personnel who participate in decarbonisation project activity obtain confirmation of the official designation of the relevant source data for each year or for the duration of the verification period. Where a dataset ceased to be designated, the project proponent undertakes a statistical evaluation to determine whether the approach to calculating emission reductions remained statistically valid.

Calculating Emission Reductions

Project proponent staff, or designated personnel who participate in decarbonisation project activity, generate the leakage and emission reductions reports for each year or the duration of the verification period, using data from the centralised data repository. Emission reduction calculations are made in accordance with section 4.4 (Emission Reductions and Removals) of the Project Document using data stored in the centralised data repository.

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

Baseline emissions are emissions from fossil fuel and grid-connected electricity consumed during the most recent twelve-month period for which data are available before project implementation. Consumption for each PAI is calculated by applying the mean consumption determined from a sample of PAIs of the Same Building Stock (the sample may be normalised for size) to all PAIs included in the project activity. To ensure accurate and conservative emission reduction calculations, in the cases where a PAI in the project activity has a unique energy load reported in the pre-retrofit energy assessment, the unique energy load is incorporated into the calculation of the baseline consumption. The energy load is considered unique where it is at least the mean consumption determined for the Same Building Stock. In such a case, the unique energy load is incorporated into the calculation of the baseline consumption.

Refer to Section 3.4 (Baseline Scenario) of the Project Document for an explanation of how baseline consumption and emissions are determined. Once established, the baseline for a PAI remains static throughout the crediting period.

5.2 Project Emissions

Project activity emissions are emissions from fossil fuel and grid-connected electricity consumed once the project activity has occurred. Following the VM0008 Methodology,

emissions from the installation of decarbonisation measures are not included because the embodied and operational carbon associated with this activity is significantly less than the counterfactual of demolition and replacement with a more energy-efficient dwelling. Refer to section 4.4 (Emission Reductions and Removals) of the Project Document for an explanation of how project emissions are determined.

This project is accredited to use three approaches to calculating emission reductions and related monitoring parameters. They are 1) the Adjusted consumption approach, 2) the Pre- and post-retrofit energy assessment approach and 3) the Control group approach.

During the Monitoring Period, the project used only the Pre- and post-retrofit energy assessment approach.

Pre- and post-retrofit energy assessment approach

In this approach, emissions in the project activity scenario are not calculated separately but directly as the VM0008 Methodology allows. Emission reductions are based on the data generated by a pre- and post-retrofit energy assessment of the PAI. A pre-retrofit energy assessment takes place before the implementation of the project activity. Then, a post-retrofit energy assessment will take place after the decarbonisation measures are completed for a sample of the PAIs.

Pre- and post-retrofit energy assessments are undertaken by accredited energy assessors certified by a public authority, or a private certification program recognised by a public authority. Energy assessments are conducted using the Standard Assessment Procedure (SAP), the government-approved National Calculation Methodology, to assess the energy performance of PAIs. The SAP methodology considers a range of factors that contribute to energy efficiency, including materials used for the construction of a PAI, thermal insulation of the building fabric, air leakage characteristics of the PAI, efficiency and control of the heating system(s) and the fuel used to provide space and water heating. Energy assessments cover fossil fuel and grid-connected electricity consumption and may include physical inspection, diagnostic tests, and the use of energy modelling software that implements the latest approved worksheet and conventions for SAP calculations as set out in the manual describing the Government's Standard Assessment Procedure or apply building physics calculations.

After data collection, an accredited energy assessor certified by a public authority compiles the data and reviews for any discrepancies and corrects for any outliers. This quality assurance phase is an additional step to ensure greater data integrity.

During this monitoring period, the project proponent introduced a new monitoring technology to validate the energy savings delivered by the decarbonisation activity in real-time. This proprietary solution collects sensor data, such as indoor humidity and temperature, fossil fuel and grid-connected electricity consumption data, data on the efficiency of the installed heating

system and external weather data on outdoor temperatures and humidity to deliver real life information based on thousands of data points. A machine learning algorithm then analyses this data to calculate the home's exact energy efficiency, enabling the measurement of real energy performance. It also allows for the benchmarking of decarbonisation projects.

The pre-retrofit energy assessment determines the heat load and grid-connected electricity demand (energy load) in the baseline for each PAI added to the project.[170] The post-retrofit energy assessment determines the heat load and grid-connected electricity demand (energy load) following the implementation of the project activity. The change in heat load and grid-connected electricity demand provides the Heat Load Reduction Factor ("HLF") and Electricity Demand Reduction Factor ("EDF"), which are used to calculate the project's emission reductions.

To calculate emission reductions, the HLF and EDF are multiplied by the baseline consumption of fuel and grid-connected electricity. The result is then multiplied by the emission factor of the fuel type. Emission reductions are adjusted for leakage emissions. For years after the project year, emission reductions are adjusted for changes in grid-connected electricity demand over time and for heating/cooling degree days during the project crediting period.

The Heat Load Reduction Factor ("HLF") is calculated as follows:

Equation 9:

$$HLF = 1 - \frac{\sum_{s=1}^{S} H_{load,post,s}}{\sum_{s=1}^{S} H_{load,pre,s}}$$

The Electricity Demand Reduction Factor ("EDF") is calculated as follows:

Equation 10:

$$EDF = 1 - \frac{\sum_{s=1}^{S} E_{dem,post,s}}{\sum_{s=1}^{S} E_{dem,pre,s}}$$

Where:

HLF = Heat load reduction factor (no unit)

$H_{load,post,s}$ = Heat load post-retrofit for PAI s, kWh/m^2

$H_{load,pre,s}$ = Heat load pre-retrofit for PAI s, kWh/m^2

EDF = Electricity demand reduction factor (no unit)

[170] The fossil fuel and grid-connected electricity consumption in the baseline are established from fuel bills, reported fuel consumption, or data from a smart metering or thermostatic control device for a sample of PAIs and extended to each PAI in the project activity. To ensure accurate and conservative emission reduction calculations, in the cases where the PAI has a unique energy load reported in the pre-retrofit energy assessment, the unique energy load is incorporated into the baseline calculation.

$E_{dem,post,s}$ = Electricity demand post-retrofit for PAI s, kW

$E_{dem,pre,s}$ = Electricity demand pre-retrofit for PAI s, kW

S = Number of PAIs

s = sample PAI undergoing post-retrofit audit

The reduction in energy load and reduction in consumption are calculated as follows:

Equation 11:

$$\frac{EL_{Pre,i} - EL_{Post,i}}{EL_{Pre,i}} \times 100$$

Where:

$EL_{Pre,i}$ = Pre-retrofit energy load / consumption of PAI *i*

$EL_{Post,i}$ = Post-retrofit energy load / consumption of PAI *i* after installation of the decarbonisation measures being compared as part of the control group monitoring

The Heating Degree Day Correction Factor is calculated as follows:

Equation 12:

$$HDDCF_y = \frac{HDD_y}{HDD_b}$$

Where:

HDD_y = Heating degree days for year *y* after project implementation

HDD_b = Heating degree days for one year before project implementation

The Electricity Correction Factor is used to update the baseline grid-connected electricity consumption based on decreases in grid-connected electricity demand over time. The ECF is only applied when it is less than 1 to maintain conservativeness in the emission reduction calculation.

Emission reductions created by the project are calculated as follows:

Equation 13:

$$ER_y = \sum_{i=1}^{I} Elec_{b,i} \times EDF \times ECF_y \times HDDCF_y \times Elec_{CO2} + \sum_{i,j=1}^{I,J} F_{b,i,j} \times HLF \times HDDCF_y \times Cal_j \times F_{CO2} - L_y$$

Where:

ER_y = Emission Reductions in year *y* in metric tons ("t") CO_2e

$Elec_{b,I,j}$ = Electricity consumed in the year prior to Project implementation for PAI *i* in kWh (baseline consumption)

EDF = Electricity demand reduction factor (no unit)

ECF_y = Electricity correction factor for year *y* to be applied to the baseline

$HDDCF_y$ = Heating Degree Days Correction Factor[171] for year *y*

$Elec_{CO2}$ = Grid emission factor in tCO_{2e} /kWh

$F_{b,i,j}$ = Fuel type *j* consumed in the year prior to project implementation for PAI *i* (baseline consumption)

HLF = Heat load reduction factor (no unit)

$F_{CO2,j}$ = The CO_2 emission factor per unit of energy of fuel type *j* expressed in tCO_{2e} / GJ

Cal_j = Calorific value of fuel type *j* in GJ/mass or volume

L_y = Leakage in year *y* as calculated using equation 14

I = Number of PAIs

i = PAI

J = Number of fuel types

j = Fuel type

y = Any consecutive twelve months during the project's crediting period, and is defined with an integer from 1 on in a consecutive manner[172]

Leakage, $L_{y,}$ is assessed for project activity as described in section 4.3 (Leakage) of the Project Document and is calculated as follows:

Equation 14:

$$L_y = L_{CO2,y}$$

Where:

$L_{CO2,y}$ = Leakage from improper disposal of, or continued operation of replaced boilers, in year *y*

[171] In accordance with the VM0008 Methodology, HDDCF replaces CDDCF in the equation because electricity is typically the central heating source post-retrofit.

[172] Where less than 12 months has elapsed since the project start date or less than 12 months remains until the end of the project crediting period, any consecutive period less than 12 months within the same calendar year.

The parameters monitored in the pre-and post-retrofit energy assessment approach are listed in Section 4.

At the time of verification, the heat load and grid-connected electricity demand in the baseline and project activity can be calculated using first-instance data for the 39,927 PAIs included in the project activity.

Calculating ex-ante emission reductions for the 39,927 PAIs, where:

ER_y = 30,756.544 tCO_2e

$Elec_{b,l,j}$ = 35,283,157

EDF = Calculated per PAI

ECF_y = 1

$HDDCF_y$ = Calculated per PAI

$Elec_{CO2}$ = 0.000212

$F_{b,i,j}$ = 57,882,483 m^3

HLF = Calculated per PAI

$F_{CO2,j}$ = Calculated per PAI

Cal_j = 0.0375GJ/m^3

L_y = 0

I = Number of PAIs

i = PAI

J = 10

j = Fuel type

y = 1

Quality Assurance

Quality assurance monitoring in the VM0008 Methodology allows for correcting the HLF and EDF for all PAIs and decarbonisation measures where a significant discrepancy occurs between the calculated reduction in energy load (the sum of the heat load and the grid-connected electricity demand), as shown in the post-retrofit energy assessment for a sample of PAIs of the Same Building Stock and the actual reduction in consumption calculated from directly metered energy data.[173]

[173] In the registered PDD, to calculate the reduction in consumption, fuel bills, reported fuel consumption, or data from a smart metering or thermostatic control device covering one year pre-retrofit is compared with equivalent consumption

The minimum quality assurance sample size is established by multiplying by 0.6 the square root of the total number of PAIs, *i*, included in the pre- and post-retrofit energy assessment approach for the project.

Calculating the quality assurance sample with first instance and projected data values for the 39,927 PAIs:

The sample size for the quality assurance sample is established by multiplying by 0.6 the square root of the total number of PAIs, *i*, included in the Project.

Where:

i = 39,927

The quality assurance sample group of PAIs is established by multiplying 0.6 by the square root of the total number of PAIs 39,927, which equals a sample group of 158. The quality assurance process was run across a sample group comprising 2,215 PAIs to enable multiple quality assurance tests (approximately 14 times).

In compiling the sample group, the following conditions Applicability Conditions from Section 4.2 of the VM0008 Methodology are applied:

1) The sample is statistically valid, and may be one of the following:
   a) Simple random sample
   b) Systematic sampling
   c) Stratified sampling within the Same Building Stock
   d) Cluster sampling.

   The sample group is a simple random sample.

2) The sample is representative of the population.

   The sample group is representative of the population. Sampling includes PAIs that are dispersed geographically (see sub-condition four below).

data post-retrofit for a sample of PAIs from the Same Building Stock. The difference in consumption between a control group and intervention group ("the control group approach"), as calculated by a public authority, such as those produced as part of the Impact of measures dataset published by the Department for Business, Energy and Industrial Strategy for the monitoring period may be used to calculate the reduction in consumption. Under this approach, the mean of the calculated reductions in energy load determined by the post-retrofit energy assessment for PAIs in the sample group is compared to the mean of the reduction in consumption calculated for the Same Building Stock under the control group approach. Only the decarbonisation measures in common between PAIs in the sample group and the control group approach are included in the comparison. Under this approach, and for equation 11, $EL_{Pre,i}$ is the energy load in the baseline for PAIs in the Same Building Stock as described in section 3.4. Following the VM0008 methodology, the difference in the energy consumption between the control and intervention groups is calculated using data from two 12-month periods (referred to as the pre-intervention year (y-1) and the post-intervention year (y+1)). The dataset to be used is the dataset published during the monitoring period. If the public authority publishes the dataset later than year y, the dataset published during an earlier monitoring period, up to three years prior, may be used.

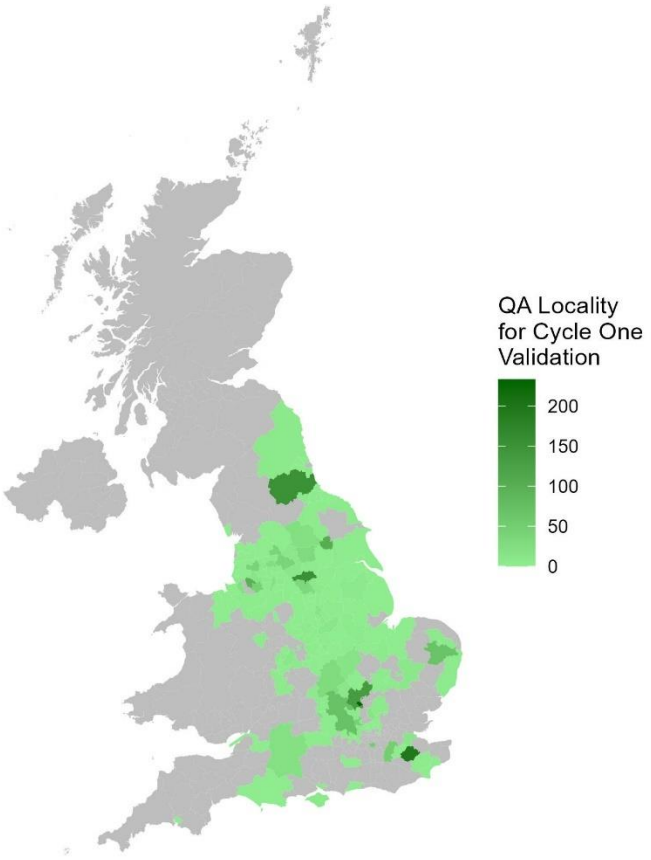
3) The data comes from an approved source, i.e., a certified energy auditor, or a nationally recognized data source.

   Pre- and post-retrofit energy assessments are undertaken by accredited energy assessors certified by a public authority, or a private certification program recognised by a public authority.

4) Actions that may bias the sample are avoided. Sampling shall include PAIs that are dispersed geographically and include each defined Building Stock included in the Project activity.

   The sample group is statistically valid. Sampling includes PAIs that are dispersed geographically:

Figure 3: Geographical distribution of the sample group PAIs



The mean of the calculated reductions in energy load determined by the post-retrofit energy assessment for PAIs in the sample group is compared to the mean of the directly metered energy data. If the discrepancy between the two mean values is found to be significant, the project proponent will assess the need to adjust the HLF and/or EDF.

When the data come from two different processes, such as the post-retrofit energy assessment for the calculated reduction in energy load and the control group approach for the actual reduction in consumption, a significant discrepancy is defined based on an independent 2-sample t-test for equality of two means. If the t-value is greater than the critical value of the t-distribution for a 95% confidence level and degrees of freedom given by 2n-2, then the null hypotheses of equal means I rejected, and the observed discrepancy is concluded to be significant.

For this verification period between January 1, 2023, and December 31, 2023, the mean of the calculated reductions in energy load determined by the post-retrofit energy assessment for PAIs in the sample group is compared to the mean of the actual reduction in consumption calculated from directly metered energy data for the Same Building Stock. The statistical analysis included a sample size of 2,215 PAIs. The sample size 2,215 was determined by taking all PAIs included in the project activity (39,927) and multiplying the number by 0.6, following the Methodology. The result was 158.39, which is rounded down to 158. A larger sample size was chosen to allow the test to be replicated (14 times).

Intermediate values are used in calculations:

- Two-tailed t Critical value = 1.9605
- t = 1.4019

Statistical significance

- The two-tailed P value equals 0.1610

A t-value greater than the t Critical value is not considered statistically significant. The difference between the two mean values is not statistically significant, so the HLF and EDF are accurate and suitable for calculating emission reductions during this verification period.

5.3 Leakage Emissions

An identified source of potential leakage is the improper disposal of boilers that have been replaced. Condensing boilers account for over 98% of the domestic boilers installed in the UK, and condensate must be disposed of appropriately. Leakage from condensate or the possible continued operation of improperly disposed boilers is accounted for by the regulatory framework.

Renovation of the thermal elements of a PAI and replacement of heat-producing systems are regulated activities that must comply with the Building Regulations, which are the primary source of health and safety, environmental and energy conservation obligations including for the disposal of boilers that have been replaced. Building Regulations are legal requirements that must be followed by those responsible for carrying out the work. The installation of gas boilers must also be undertaken in accordance with the Gas Safety Regulations which are an

additional source of health and safety, environmental and energy conservation obligations including for the disposal of boilers that have been replaced.

Compliance is demonstrated by a Building Regulations Compliance Certificate, or a Gas Safety Certificate, or a declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS Standard v4.7, section 3.7.1., a certificate under Publicly Available Specification (PAS) or an equivalent standard, an assessment by an accredited energy assessor or a declaration by a regulated provider of social housing or public entity.

All leakage emissions are managed in accordance with the leakage requirements identified in section 5 of the VM0008 Methodology and defined in section 4.3 (Leakage) of the Project Description. The VM0008 Methodology requires that leakage from improper disposal of, or continued operation of replaced boilers, be included as leakage if replacing the boiler is part of the project activity. To control the risk of leakage, all boilers replaced as part of the project activity must be disposed of properly.

The 39,927 PAIs included in the project activity during the monitoring period meet this criterion as follows;

a) All boilers replaced as part of the project activity are disposed of properly as evidenced by a declaration by the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS Standard v4.7, section 3.7.1 in the Contract for Provision of Verified Carbon Unit Services[174].

5.4 GHG Emission Reductions and Carbon Dioxide Removals

PAIs generate emission reductions beginning on the date of the completed installation of the decarbonisation measures. This date is demonstrated through a declaration from the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS Standard v4.7, section 3.7.1. This declaration is included in Schedule 5 of the Participant Contract.

To accommodate the periodicity of adding PAIs to the project, emission reductions are calculated per Heating Degree Day (HDD). Every PAI has a unique HDD$_b$ for one year before project implementation, and Net GHG emission reductions accrue based on the number of Heating Degree Days since the date of the completed installation of the decarbonisation measures.

The Net GHG emission reductions for PAIs with completed installation measures during the Monitoring Period is summarised in the table below. Evidence of the project's Baseline

[174] Schedule 2(4)(m) of Social Housing Provider Contracts and of Schedule 2(4)(n) of Non-Social Housing Provider Contracts.

Emissions, Project Emissions, Leakage and Net GHG Emission Reductions is provided as an Appendix to this report.

Table 6: Summary table of Net GHG Emission Reductions

Vintage period	Baseline emissions (tCO_2e)	Project emissions (tCO_2e)	Leakage emissions (tCO_2e)	Reduction VCUs (tCO_2e)	Removal VCUs (tCO_2e)	Total VCUs (tCO_2e) *Rounded down*
Year 1 (01-July-2022 – 31-December-2022)	-	-	0	1,481	0	1,481
Year 2 (01-January-2023 – 31-December-2023)	-	-	0	30,756	0	30,756
Total	-	-	0	32,237	0	32,237

Table 7: Summary table of estimated ex-ante GHG emission reductions and removals and the achieved emission reductions and removals for all monitoring periods

Vintage period	Ex-ante estimated reductions (tCO2e)	Achieved reductions (tCO2e)	Percent difference	Explanation for the difference
Year 1 (01-July-2022 – 31-December-2022)	2.928 per PAI	0.220	-92.471%	See explanation below
Year 2 (01-January-2023 – 31-December-2023)	2.928 per PAI	0.7703	-73.692%	See explanation below

In the registered PPD, the estimated ex-ante average GHG emission reductions and removals per PAI was 2.928 tCO2e per year.

This project is a Grouped project. The first Monitoring Report included information regarding the first 6,717 PAIs included in the project activity during the first six-month monitoring period. The ex-post average GHG emission reductions and removals per PAI was 0.220 tCO2e per year.

This Monitoring Report includes information regarding the 39,927 PAIs in the project activity during the second twelve-month monitoring period. The ex-post average GHG emission reductions and removals per PAI was 0.7703 tCO2e per year.

This increase demonstrates that our project is unlocking more intensive decarbonisation work. The project has observed an increase in the proportion of multi-measure projects compared to single-measure projects, and the pace and scale of decarbonisation have improved as a result.

The challenges of decarbonising homes in the UK are many, and they are complex. UK homes often have solid walls built from simple foundations and external spaces unsuitable for adding an external insulation later. Adding insulation to internal walls demands careful detailing to avoid bridging the damp course. It poses the risk that the external walls remain cold and saturated with condensation, affecting the external structure.

Decarbonising a home to be energy efficient also means aligning the interests of multiple stakeholders. It also requires scale and volume to reduce transaction cost, create economies of scale and attract private finance. The first two monitoring periods of this project have demonstrated that carbon finance can play an important role in helping the expedite the pace and scale of housing decarbonisation.

Most measures installed during the monitoring period were ‘fabric first’ improvements to the thermal efficiency of the building envelope – measures that are an important first step in improving energy efficiency because they provide a foundation for improving the heating system’s efficiency later. The average GHG emission reductions and removals per PAI are expected to continue to increase as this project begins to scale its innovative delivery model and funding mechanism to make what can often be unattractive decarbonisation business cases fundable.

APPENDIX 1: COMMERCIALLY SENSITIVE INFORMATION

Section	Information	Justification
N/A	N/A	N/A

APPENDIX 2: SUSTAINABLE DEVELOPMENT

Additional narrative on the Sustainable Development contributions of the project can be found below:

As called for by the VCS Standard v4.7, the project contributes to sustainable development, as defined by, and tracked against the United Nations Sustainable Development Goals (SDGs). These aim to end poverty, protect the planet, and ensure prosperity for all, by achieving 17 goals by 2030.[175]

The decarbonisation of PAIs plays a critical role in the transition to a low-carbon economy. By enabling the deployment of housing decarbonisation more widely, cost-effectively, and earlier than the present, this project directly supports the following SDG:

- **SDG 13:** Take urgent action to combat climate change and its impacts.

The projects benefits go far beyond carbon mitigation. The PAIs in the project boundary were built to relatively low thermal and energy efficiency standards and are cold and expensive to heat. These PAIs are some of the worst in Europe for thermal and energy efficiency.

The health impacts of cold homes include increased risk of heart attack or stroke, respiratory illnesses, poor diet due to "heat or eat" choices, mental health issues, and worsening or slow recovery from existing conditions.[176] Children living in cold housing conditions are more than twice as likely to suffer from breathing problems, including asthma and bronchitis.[177]

The decarbonisation of PAIs has a profound impact in terms of comfort, wellbeing, and productivity. By enabling the deployment of housing decarbonisation more widely, cost-effectively, and earlier than the present, this project also directly supports the following SGDs:

- **SDG 1:** End poverty in all of its forms everywhere.
- **SDG 3:** Ensure healthy lives and promote well-being for all at all ages.
- **SDG 7:** Ensure access to affordable, reliable, sustainable and modern energy.
- **SDG 10:** Reduce inequality within and among countries.
- **SDG 11:** Makes cities inclusive, safe, resilient, and sustainable.

Decarbonisation measures also have the potential to create jobs and boost existing firms (especially SMEs and their supply chains) in construction. Economy-wide, there is considerable potential to

[175] Sustainable Development Goals. United Nations. 2021.

[176] Fuel Poverty. House of Commons Library. 2021.

[177] Assessing the Health Impact of Cold Homes. Centre for Sustainable Energy. 2017.

develop and extend the labour force with a full range of high value skills[178]. By enabling the deployment of housing decarbonisation more widely, cost-effectively, and earlier than the present, this project also directly supports the following SDGs:

- **SDG 8:** Promote sustained, inclusive, and sustainable economic growth, full and productive employment and decent work for all.
- **SDG 9:** Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Measuring contribution to sustainable development

The SDGs can be understood as a set of metrics that are relevant to people's quality of life. Their incorporation into the VCS Standard gives reviewers a perspective from which to evaluate a project's design. The SDGs also help project proponents to understand how a project may affect the quality of life of stakeholders. In other words, the SDGs are a measurement of social value.

Social value refers to all the impacts that an intervention, policy, or project has on society and the value that these impacts have, both positive and negative. The social value of a project is the net value generated to society. As called by VCS Standard v4.7, a project must positively contribute to at least three SDGs. The social value generated by this project contributes to the eight SDGs identified above. This section is focussed on the approach taken by this project to quantify in a systematic way its contribution to sustainable development.

Wellbeing Valuation approach[179]

In 2014, HACT and Simetrica[180] produced in the UK Social Value Bank, which applies a Wellbeing Valuation approach to value the impact of housing providers' activities on their residents. It contains values for investment outcomes in domains such as employment and training, health, housing maintenance, money management, local neighbourhoods and crime, physical activity and, importantly, PAI energy efficiency. Updated in 2022 to understand wellbeing and exchequer impacts, the UK Social Value Bank remains the largest set of methodologically consistent social value in the world and is the

[178] Heat Decarbonisation: Potential Impacts on Social Equity and Fuel Poverty. National Energy Action. 2017.

[179] The use of values contained in the UK Social Value Bank, including the headline figures provided for illustration in this section and the values used in the project, are covered by licensing conditions, and appear with the consent of the copyright owner. These materials are made available for you to use (the "Authorised Use") for your review of this project under the VCS Program. Except for the Authorised Use, all commercial use of this document is prohibited.

[180] HACT, registered as the Housing Associations Charitable Trust, and Simetrica-Jacobs, the international experts in social value analysis, research, and econometrics, have established reputations for producing ground-breaking social impact measurement research and the development of accompanying practical tools for the housing sector. This includes the 2014 study Measuring the Social Impact of Community Investment: a Guide to Using the Wellbeing Valuation Approach and accompanying Value Calculator, and the 2015 studies The Health Impacts of Housing Associations' Community Investment Activities and The Wellbeing Value of Tackling Homelessness.

only social value tool that measures the positive impact of housing decarbonisation. This project uses the UK Social Value Bank to assess the impact of project activity on health and wellbeing.

Wellbeing Valuation judges the success of a project by how it affects people's wellbeing. Rather than asking people about how much something has improved their life, which can introduce psychological complexities and extensive data collection, Wellbeing Valuation analyses existing datasets of national surveys which instead reveal effects on wellbeing in a robust way. Analysis can isolate the impact of a specific aspect of life on wellbeing. This can be valued by finding from the data the equivalent amount of money needed to increase someone's wellbeing by the same amount. Wellbeing Valuation is recognised in HM Treasury's Green Book – the UK Government's core guide to policy evaluation[181] – as a method for placing values on things that do not have a market value through being bought and sold. Wellbeing valuation is also in the Treasury supplementary green book guidance on wellbeing appraisal.

In this project, the focus is the social value of improving the energy performance of a PAI – that is the value that people gain in terms of enhanced life satisfaction through improvements to the PAI's thermal and energy efficiency. Using Wellbeing Valuation, HACT and Simetrica analysed data collected through the English Housing Survey (EHS) which is a continuous national survey commissioned by the Department for Levelling Up, Housing and Communities.[182] It collects information about people's housing circumstances and the condition of PAIs in England. It was first run in 2008-2009 and each year a sample of addresses is drawn at random from a list of private addresses held by the Royal Mail. The EHS collects information from over 13,000 households and is made up of two components:

a) A household interview conducted with all householders in the sample

b) A physical inspection of a sub sample of the PAIs by qualified surveyors.

The household interview includes questions on general health and questions on their housing situation and their lives, such as their satisfaction with their home and their aspiration to buy a property, as well as a range of demographic factors. The physical inspection includes the collection of information about the energy efficiency of the PAI, specifically the Energy Performance Certificate (EPC) band which is measured using the Standard Assessment Procedure (SAP) which is the UK Government's National Calculation Methodology for assessing the energy performance of PAIs.

HACT and Simetrica also used data collected through the British Household Panel Survey (BHPS) which has been completed each year by more than 10,000 of the same individuals since 1991 and so incorporates over 20 years of panel data.[183]

To implement a Wellbeing Valuation approach, HACT and Simetrica constructed a Health model to assess the association between energy performance and general self-reported health using data from

[181] The Green Book: Central Government Guidance on Appraisal and Evaluation. HM Treasury. 2020.

[182] The English Housing Survey. Department for Levelling Up, Housing and Communities. 2021.

[183] British Household Panel Survey. University of Essex. 2011.

the EHS[184]. They used data from the BHPS to construct a Life Satisfaction model to assess the association between health and life satisfaction[185]. By combining these two associations they isolated the average relationship that a particular energy performance would have with life satisfaction.[186] By accessing data on income, they were able to estimate how higher levels of income are associated with life satisfaction and isolate the amount of money that has the equivalent association with an individual's life satisfaction as a specific improvement in energy performance.

In 2022, HACT and Simetrica-Jacobs supplemented the Wellbeing Valuation approach with the incorporation of new dimensions, including exchequer values. An exchequer value values the indirect, secondary impacts of an outcome in net fiscal terms to the government in the form of tax receipts, benefit payments and cost reductions.

Standard Assessment Procedure rating variables

The results obtained by HACT and Simetrica indicate that improving the energy performance of a PAI has a significant association with the wellbeing of individuals living in the PAI. This provides an indication that decarbonisation measures directed at reducing the fossil fuel and grid-connected electricity consumption within a PAI are associated with higher social value. To quantify the increase in value, HACT and Simetrica measured the amount of money that would induce the same increase in life satisfaction as an improvement in energy performance rating by one or multiple EPC bands.

Under the UK Government's national calculation methodology for assessing the energy performance of PAIs is divided into 7 bands ranging from A-G. Each band covers a set range of SAP points:

EPC Band	SAP point range
A (most energy efficient)	92-100
B	81-91
C	69-80
D	55-68
E	39-54

[184] This is explained further in Appendix A1 of the 2014 study Measuring the Social Impact of Community Investment: a Guide to Using the Wellbeing Valuation Approach and as set out in previous work: Fujiwara, D., Kudrna, L., and Dolan, P. (2014). Quantifying and Valuing the Wellbeing Impacts of Culture and Sport (p. 45). London, UK: Department for Culture, Media and Sport.

[185] This is explained further in Appendix A1 of the 2014 study Measuring the Social Impact of Community Investment: a Guide to Using the Wellbeing Valuation Approach.

[186] Further details of the wellbeing valuation methodology can be found in the Technical Manual.

F	21-38
G (least energy efficient)	1-20

HACT and Simetrica identified the uplift in life satisfaction caused by an improvement in energy performance rating by one EPC band is worth on average £1,735.

Having identified the average value per EPC band, HACT and Simetrica calculated the impact of improvements of less than a whole EPC band. To interpolate SAP points-based values they took each midpoint, worked out the number of points to the next midpoint, and then divided the value of a band move by that number of steps. The per point values that apply from mid-B to mid-A were extended all the way to the top of A, and similarly at the bottom end. This gave a set of values that can be applied per SAP point at different parts of the points range.

Applying these values, for example, shows that decarbonisation measures directed at reducing the fossil fuel and grid-connected electricity consumption within a PAI which result in an improvement in the SAP rating of the PAI by ten SAP points from 57 to 67:

a) leads on average to an increase in people's life satisfaction
b) the amount of money that would induce the same increase in life satisfaction is £1,000
c) the uplift in life satisfaction caused by this improvement in the SAP rating is worth on average £1,000 per year
d) an increase in energy efficiency also increases savings to the state and will likely impact on other wellbeing measures such as being able to heat the home in the winter, financial comfort and being relieved from burden of debt.

This is the annual Wellbeing Value for that project activity for adult occupants of the PAI over 16 years of age. These values represent the uplift in wellbeing the average individual experiences. The monetary value is the amount of cash that you would have to give someone to increase their wellbeing the equivalent amount if the project activity had not taken place. Wellbeing Valuation does not seek to value everyone's experience of the project activity but instead represents the experience of the average person.

Calculating the SAP rating for the project

Calculation of the change in SAP rating for project activity instances is based on the data generated by a pre- and post-retrofit energy assessment of the PAI. A pre-retrofit energy assessment takes place once before project implementation for every PAI and a post-retrofit energy assessment takes place as at the date of the completed installation of the decarbonisation measures.

Pre- and post-retrofit energy assessments are undertaken by accredited energy assessors certified by a public authority, or a private certification program recognised by a public

authority. Energy assessments are conducted using the Standard Assessment Procedure (SAP) which is the Government-approved National Calculation Methodology for assessing the energy performance of PAIs. The SAP methodology considers a range of factors that contribute to energy efficiency including materials used for construction of a PAI, thermal insulation of the building fabric, air leakage characteristics of the PAI, efficiency and control of the heating system(s) and the fuel used to provide space and water heating. Energy assessments cover both fossil fuel and grid-connected electricity consumption and may include physical inspection, diagnostic tests, use energy modelling software that implements the latest approved worksheet and conventions for SAP calculations as set out in the manual describing the Government's Standard Assessment Procedure, or apply building physics calculations.

The pre-retrofit energy assessment determines the SAP rating in the baseline. The pre-retrofit SAP rating is then compared to the post-retrofit SAP rating. This comparison provides the change in SAP points.

Calculating the number of occupants for each project activity instance

The values drawn from the UK Social Value Bank are the value of an improvement in the SAP rating of a PAI per person per year. To determine the average uplift in wellbeing for each project activity instance in this project, it is necessary to multiply the values by the number of adult occupants of the PAI over 16 years of age. For example, if the improvement in the SAP rating of a PAI in this project is worth on average £2,000 per person per year and there are 3 adult occupants of the PAI over 16 years of age then an annual total of £6,000 of social value has been measured.

Equation 1:

Social value = UK Social Value Bank value associated with project activity instance x Number of occupants of the PAI

For consistency with the Wellbeing Valuation approach, this project uses the standardised number of occupants from the UK Government's National Calculation Methodology for assessing the energy performance of PAIs. SAP calculations are independent of factors related to the individual characteristics of the household occupying the PAI, for example, household size and composition and individual heating patterns and temperatures. For household characteristics, SAP consists of a system of values as defined by rules that generate a set of input data for the SAP calculation.

The manual describing the Government's Standard Assessment Procedure sets out the following rules for determining the standardised number of occupants of a PAI:[187]

Equation 2:

[187] The Government's Standard Assessment Procedure for Energy Rating of PAIs, SAP 2012 version 9.92, dated October 2013. Published on behalf of the Department for Energy and Climate Change by BRE Group.

$$\text{if TFA} > 13.9: \ N = 1 + 1.76 \times \ [1\text{-exp}\ (-0.000349 \times (\text{TFA}-13.9)^2\ )] + 0.0013 \times (\text{TFA}-13.9)$$
$$\text{if TFA} \leq 13.9: \ N = 1$$

N is the assumed number of occupants, TFA is the total floor area of the dwelling.

For example, project activity instance 10011 has a Total Floor Area of 109 square meters. From the SAP rules for determining the number of occupants of a PAI, the number of occupants benefitting from the uplift in wellbeing is 3.[188].

Application to project activity instances

For each project activity instance, the project proponent measures the contribution to sustainable development using the Wellbeing Valuation approach as follows:

1. The baseline SAP rating for each PAI added to the project is obtained from the pre-retrofit energy assessment (baseline SAP rating)
2. The project SAP rating for each PAI added to the project is obtained from the post-retrofit energy assessment (project SAP rating). Calculation takes place as at the date of the completed installation of the decarbonisation measures
3. The baseline SAP rating is then compared to the project SAP rating. This comparison provides the change in SAP rating for the project activity instance
4. The uplift in life satisfaction (Wellbeing Value) is calculated using the UK Social Value Bank for the change in SAP rating
5. The standardised number of occupants is calculated using equation 2
6. The project activity instance's contribution to sustainable development is calculated using equation 1.

For example, the contribution to sustainable development of project activity instance 10011 is calculated as follows:

1. The baseline SAP rating is 66
2. Assume the SAP rating after project implementation is 90
3. The change in SAP rating would be 24 SAP rating points
4. The uplift in life satisfaction (Wellbeing Value) would be worth on average £2,445 per year
5. The number of occupants benefitting from the uplift in wellbeing is 3

[188] As the Total Floor Area is greater than 13.9, equation 2(a) is used. The number of occupants = 1 + 1.76 x [1-exp(-0.000349 x (109-13.9)^2)] + 0.0013 x (109-13.9).

6. The project activity instance's contribution to sustainable development is £7,335 per year

7. There would also be other impacts such as being able to heat the home in the winter, financial comfort and being relieved from burden of debt along with savings to the state (exchequer value).

This Project Document includes information regarding the Initial PAIs planned and developed to a sufficient level of detail to enable their assessment at validation.

At the time of validation only the baseline SAP rating can be obtained from first instance data for the Initial PAIs. For the purposes of validation, the post-retrofit SAP rating and change in SAP points has been projected based on planned project activities. The actual change in SAP points for the Initial PAIs will be calculated using first instance data as at the date of the completed installation of the decarbonisation measures.

Summary table of estimated social value / contribution to sustainable development of the initial 28 project activity instances:

Project Activity Instance	Wellbeing value	Number of occupants	Social value / Contribution to SDGs per yr.
10001	£3,001.00	2	£6,002.00
10002	£1,701.00	2	£3,402.00
10003	£2,268.00	2	£4,536.00
10004	£1,100.00	3	£3,300.00
10005	£2,008.00	2	£4,016.00
10006	£2,073.00	2	£4,146.00
10007	£3,717.00	2	£7,434.00
10008	£2,569.00	3	£7,707.00
10009	£1,949.00	2	£3,898.00
10010	£2,327.00	1	£2,327.00

10011	£2,445.00	3	£7,335.00
10012	£1,323.00	1	£1,323.00
10013	£1,949.00	2	£3,898.00
10014	£1,571.00	2	£3,142.00
10015	£2,008.00	3	£6,024.00
10016	£2,333.00	2	£4,666.00
10017	£2,699.00	3	£8,097.00
10018	£1,878.00	3	£5,634.00
10019	£3,173.00	2	£6,346.00
10020	£2,073.00	2	£4,146.00
10021	£2,079.00	2	£4,158.00
10022	£2,073.00	2	£4,146.00
10023	£2,225.00	2	£4,450.00
10024	£2,279.00	3	£6,837.00
10025	£1,335.00	3	£4,005.00
10026	£1,884.00	1	£1,884.00
10027	£1,766.00	2	£3,532.00
10028	£1,766.00	2	£3,532.00
Total	**£129,923 in Social Value contribution / yr.**		