HOUSING DECARBONISATION IN THE UNITED KINGDOM

Document Prepared by Arctica Partners (now PNZ Carbon)

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1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

In July 2022, with funding from the Energy Redress Scheme, Arctica Partners (now PNZ Carbon) and Housing Associations Charitable Trust launched a pilot of this project, called Retrofit Credits. Twenty-two social housing organisations were part of this grouped project during the first crediting cycle, ranging from a small housing co-operative in Bristol to a G15 housing association in London. We have a partnership of housing associations in Hertfordshire, a rural-based association in Yorkshire and three local authorities. The diversity in our pilot has enabled us to test the approach with different housing providers.

6,717 individual dwellings were retrofitted during this monitoring period between July 1, 2022, and December 31, 2022, resulting in 1,481 tCO2e of emission reductions.

Retrofit measures installed during the monitoring period included 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 dwellings.

This, though, was just one part of the pilot. The other part was to identify buyers of the credits who met the conditions of the ethical framework that participating social landlords developed with us during the pilot. All the credits generated through the monitoring period were pre-sold to a range of organisations, businesses and corporates from across the UK economy.

But this is only the beginning. We are working with over 140 housing providers and local authorities to help them finance their retrofit ambitions. We already have over 100,000 homes enrolled in the service from providers across the UK.

We are developing an approach to securitisation, enabling the income generated from credits over future years to be available up front. And we are working with local authorities on a place-based approach with local businesses to help offset carbon and deliver improvements in local housing.

The project uses the “Methodology for Weatherization of Single and Multi-family Buildings” VM0008 Version 1.1 (VM0008 Methodology). Emission reduction improvements made to dwellings are referred to as “decarbonisation measures” throughout this document.

This Project Document was prepared to allow Arctica Partners as project developer (referred to as “PNZ Carbon” or “Project Proponent” throughout this document), to facilitate the funding of decarbonisation measures for dwellings throughout the UK, to quantify the resulting emission reductions and to originate Verified Carbon Units in conformance with the VM0008

Methodology. This project targets a range of individual dwellings (referred to as "project activity instances" in this document)[1].

This project is defined as a "Grouped Project" where the Project Proponent acts as a central administrator towards the objective of expediting the pace of housing decarbonisation. During the monitoring period, the Project Proponent collected, monitored, and aggregated data necessary to demonstrate the crediting baseline, additionality and to quantify emission reductions. The Project Proponent oversaw the verification of the resulting Verified Carbon Units.

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Audit Type	Period	Program	VVB Name	Number of years
Validation	Date of issue: 13-06-2022	Verified Carbon Standard (VCS)	Earthood Services Private Limited	N/A
Verification	01-07-2022 – 31-12-2022	Verified Carbon Standard (VCS)	Earthood Services Private Limited	6 months
Total	01-07-2022 – 31-12-2022	Verified Carbon Standard (VCS)	Earthood Services Private Limited	6 months

1.2 Sectoral Scope and Project Type

Energy Efficiency Project: This project has been developed under the VCS Sectoral Scope 3: Energy Demand. The project is an Energy Efficiency project that results from the installation of energy efficiency measures in dwellings. This Project Description provides a procedure to implement the VM0008 Methodology and determine net carbon dioxide (CO2) emission reductions associated with energy efficiency activities for dwellings.

Grouped Project: This project is a Grouped project. Individual dwellings included in this project are known as "project activity instances". This Monitoring Report includes information regarding the first 6,717 individual dwellings included in the project activity between July 1, 2022, and December 31, 2022. Additional individual dwellings will be added throughout the crediting period. These dwellings will meet the eligibility criteria identified in section 1.4 (Eligibility Criteria) of the Project Description.

[1] In the registered PDD, being a dwelling, 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 activity conducted according to the VM0008 Methodology includes the following categories:

Category A — Weatherization measures directed at 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.

1.3 Project Proponent

Organization name	Arctica Partners (now renamed PNZ Carbon)
Contact person	Project Director
Title	Director
Address	1 King William St, London EC4N 7AF
Telephone	+44 7 388 919 644
Email	housing@arcticapartners.com

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

Recognising the importance of retrofit to residents' lives, the project uses the UK Social Value Bank to demonstrate the positive impact that housing retrofit has on health, wellbeing, and fuel poverty.

1.4 Other Entities Involved in the Project

Organization name	Housing Associations Charitable Trust
Role in the Project	Project Partner
Contact person	Project Director
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 of the social housing sector, HACT has supported the transformation and development of the social housing sector 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 wellbeing and exchequer impacts, it remains the largest set of methodologically consistent social values in the world and is the only social value tool that measures the positive impact of housing decarbonisation.

1.5 Project Start Date

Project crediting period start date is the date upon which the project activity instances begin reducing GHG emissions. Dwellings generate emission reductions beginning on the date of the completed installation of the decarbonisation measures. At the time of Validation, the project crediting period start date was expected to be July 1, 2022. The first project activity instances with completed installation of plant, technologies, measures or processes that generate GHG emission reductions were completed on July 1, 2022. This 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 4.4, section 3.7.1.

1.6 Project Crediting Period

The project crediting period start date is July 1, 2022. Dwellings generate emission reductions beginning on the date of the completed installation of the decarbonisation measures. The project crediting period continues for seven years to June 30, 2029 (1st crediting period), twice renewable for a total of 21 years.

1.7 Project Location

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

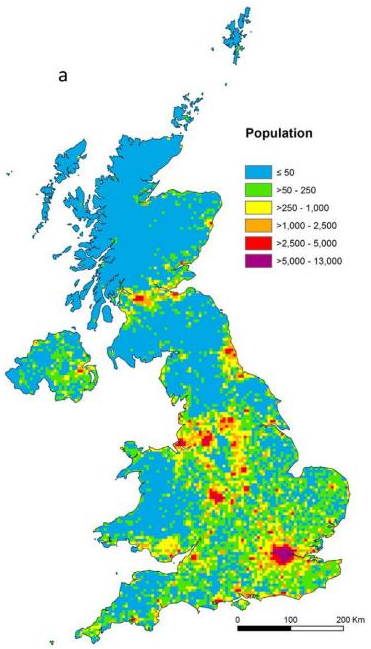
Project Latitude: 49°51′N to 59°48’N

Project Longitude: 6°27′W to 1°46′E

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

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

Figure 1. Distribution of dwellings within the UK based on population (2016)[2]



[2] Vieno et al., 2016

1.8 Title and Reference of Methodology

The project uses the approved Methodology *"Methodology for Decarbonisation of Single and Multi-Family Buildings"* VM0008 Version 1.1.

1.9 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 emission reductions, as defined in VCS Standard 4.4, section 3.7.1., confirm they will not seek to have the emission reductions created by the dwellings registered with this project credited under any other GHG scheme or programme.

1.10 Other Forms of Credit and Supply Chain (Scope 3) Emissions

1.10.1 Emissions Trading Programs and Other Binding Limits

Emissions from fossil fuel and grid-connected electricity consumption within the building envelope of dwellings in the United Kingdom are not subject to reduction targets pursuant to the UK emissions trading scheme.

1.10.2 Other Forms of Environmental Credit

The project is being developed solely under the Verified Carbon Standard for environmental crediting. The project also has considerable positive social, economic, and cultural impact on stakeholders and the project may also seek accreditation under the Verra Sustainable Development Verified Impact Standard.

1.10.3 Scope 3 Inventory Emissions

The project does not affect emissions associated with a good or service.

1.11 Sustainable Development Contributions

The decarbonisation of dwellings 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 Sustainable Development Goals (SDGs):

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

fossil fuel and grid-connected electricity consumption and GHG emissions intensity, which results in high energy use and burden.[3]

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.[4] Children living in cold housing conditions are more than twice as likely to suffer from breathing problems, including asthma and bronchitis.[5] The Committee on Climate Change has identified that improving the thermal and energy efficiency of dwellings could reduce the cost to the National Health Service in England by £1.4 – 2.0 billion per year.[6]

Around 13% of households in England and 12% of households in Wales are classified as fuel poor, which is where a household cannot afford adequate warmth.[7] Premature mortality related to fuel poverty is said to be responsible for 17,000 excess deaths per year.[8] 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 dwellings 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.[9]

The decarbonisation of dwellings 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[10].

By enabling the deployment of housing decarbonisation more widely, cost-effectively, and earlier than the present, this project directly supports the SDGs.

[3] The decarbonisation of heat. Regen. 2020.

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

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

[6] UK housing: Fit for the future? Climate Change Committee. 2019.

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

[8] E3G and National Energy Action. February 2019.

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

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

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 6,717 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[11]	Facilitated the retrofit of the homes of 6,717 low-income households.
2)	3.0	Ensure healthy lives and promote well-being for all at all ages	Implemented activities to increase	Delivered £867,636 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	Delivered health and wellbeing improvements valued at £867,636
3)	7.1	Energy intensity measured in terms of primary energy	Implemented activities to decrease	Facilitated the retrofit of 6,717 homes which prevented the consumption of 6,699,335 kWh of energy during the monitoring period	Prevented the consumption of 6,699,335 kWh of energy

[11] E3G and National Energy Action. February 2019.

4)	9.4	9.4.1 CO2 emission per unit of value added	Implemented activities to decrease	Delivered £867,636 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 0.00171 tCO2e per £1 of social value during the monitoring period	CO2e emission per unit of value added of 0.00171 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 6,717 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[12]	Facilitated the retrofit of the homes of 6,717 low-income households.
6)	13.0	Tonnes of greenhouse gas emissions avoided or removed	Implemented activities to decrease	Facilitated the retrofit of 6,717 homes which prevented the release of 1,481 tonnes of carbon into the atmosphere during the monitoring period	Prevented the release of 1,481 tonnes of carbon into the atmosphere

[12] E3G and National Energy Action. February 2019.

2 SAFEGUARDS

2.1 No Net Harm

No potential negative environmental and socio-economic impacts have been identified for the project.

2.2 Local Stakeholder Consultation

The project proponent has consulted with stakeholders to inform the design of the project and maximise participation from stakeholders.

The following categories of local stakeholder have been engaged during the monitoring period:

- Dwelling owners
- Residents
- Fuel poverty charities
- Decarbonisation measure installers
- Carbon credit buyers
- Data vendors
- Government and local authorities

During the monitoring period, the project proponent has 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 (*housing@arcticapartners.com*). The project proponent has also partnered with the Housing Associations' Charitable Trust (HACT), the charity of the social housing sector and specialists 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.

The project proponent and HACT have jointly held webinars and roundtable discussions with local stakeholders and have conducted discussions with representatives of the categories of local stakeholder identified above to understand the impact of this project. A focus group of interested stakeholders has been established and held an inaugural meeting in November 2022.

On an ongoing basis the project proponent and HACT monitor the extent to which the project continues to be aligned with stakeholder expectations and the project proponent will consider 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 its work on 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*).

During the monitoring period, the Project Proponent and HACT have engaged directly the owners of 1-2 million dwellings and has held discussions with over 60 organisations who support the project and are promoting the opportunity for housing owners and credit buyers to become involved with the project.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

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

The Project Proponent commenced a pilot of this project from 01-July-2022 to 31-December-2022. The pilot involved working with social housing providers and owners of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions, as defined in VCS Standard 4.4, section 3.7.1., where the installation of decarbonisation measures could improve the thermal efficiency of the home, reduce the carbon intensity of the heating source or reduce the grid-connected electricity consumption of appliances.

Initially the pilot targeted working with up to 3,500 dwellings from the social housing sector representing up to a dozen social housing providers. Interest in the project has been considerably greater than anticipated with more than 100,000 dwellings now enrolled in the project from more than 100 social housing providers, local authorities and owners of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions.

Although the decarbonisation of dwellings is the greatest challenge the United Kingdom faces to become a net zero carbon economy, it is severely underfunded and as a result, far from standard practice.[13] At least 65% of existing dwellings across the UK have not had any

[13] UK housing: Fit for the future? Climate Change Committee. 2019.

decarbonisation steps taken.[14] The pilot of this project has demonstrated that carbon finance can play a significant role in helping to expedite the pace and scale of housing retrofit by enabling dwelling owners (social housing providers, local authorities and owners of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions) to overcome the financial barriers that currently prevent the widescale implementation of this important decarbonisation activity.

During the Monitoring Period, the Project Activity has involved the installation of decarbonisation measures in 6,717 dwellings across the United Kingdom. Retrofit activity is currently planned or underway for a further 100,000 homes. These additional dwellings 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 at the time of verification against the eligibility criteria. All additional project activity instances 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.

Dwellings enrolled in the project are widely distributed, which is reflective of the challenges that are 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 dwellings that are particularly difficult and expensive to address.

Table 2: Distribution of enrolled homes

North East	7%
East of England	18%
North West	4%
South East	6%
East Midlands	5%
Yorkshire and the Humber	21%
Greater London	22%
South West	12%
Wales	2%
West Midlands	1%
Scotland	2%

[14] Energy Efficiency of Existing Homes. House of Commons Environmental Audit Committee. 2021.

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

Category A – Weatherization measures directed at enhancement of the Building Envelope, improving the efficiency of the central heating/cooling system, and reducing the fossil fuel and grid-connected electricity 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.

During the monitoring period the Project Proponent has sought to better understand the link between housing retrofit and social value. It is already known there is a link between a dwelling's energy efficiency and its residents' wellbeing. During the crediting period a more in-depth social value analysis will be conducted on a sample of homes to explore other ways that decarbonisation works, if delivered correctly, can improve the lives of residents.

During the monitoring period the Project Partner has developed an online platform and established workflow processes for full-scale implementation of the project, including processes to calculate emission reductions, social value and fuel cost savings and to increase the efficiency and timing of carbon finance being deployed to social housing providers, local authorities and owners of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions.

The Project Proponent acknowledges the support of the Energy Industry Voluntary Redress Scheme in funding the pilot of this project and HM Government's Department for Business, Energy and Industrial Strategy – Green Home Finance Accelerator in funding a securitisation project to align the timing of carbon finance with the deployed decarbonisation measures.

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 project proponent acts as a central administrator towards the objective of expediting the pace of housing decarbonisation. The project proponent collects, monitors, and aggregates data necessary to demonstrate the

crediting baseline, additionality and to quantify emission reductions. The project proponent is responsible for overseeing validation and registration of the project with the Verra Registry and managing the verification of the resulting Verified Carbon Units.

The main project objectives are:

1. To gradually group together individual dwellings inside a cluster, that achieve together a significant reduction in real emissions during the project crediting period
2. To stimulate and reward dwelling owners for their efforts to reduce emissions such as weatherization measures directed at enhancement of 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 dwellings
3. To stimulate and enable investment partners to commit funding towards the decarbonisation of housing stock
4. To overcome the inherent challenges of aggregating small scale decarbonisation activities, simplify third party auditing and control (monitoring) as well as undertaking centralised data collection activities paramount to the quantification of emission reductions.

Grouped Project: This project is a Grouped project. This Monitoring Report includes information regarding the 6,717 individual dwellings included in the project activity between July 1, 2022, and December 31, 2022.

Eligibility Criteria

As called for by the VCS Standard v 4.3, 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 with respect to additionality that are consistent with the initial instances for the specified project activity and geographic area.

The relevant eligibility criteria are applicable to all additional individual dwellings added throughout the crediting period. Applying these conditions, any dwelling[15] will meet the following eligibility conditions:

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

No	Eligibility Condition	Project Compliance

[15] In the registered PDD, being a dwelling, 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

1	The dwelling is located within the project boundary	The physical address is checked to ensure the dwelling is located within the project boundary Documentation: a. the physical address and geodetic coordinates of the dwelling 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 4.4, section 3.7.1. Documentation is maintained in the project activity files

The 6,717 PAIs included in the project activity during the monitoring period meet this criterion as follows:

- The physical address of each dwelling 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[16]
- The address of each dwelling was checked to ascertain whether it is located within the project boundary
- The dwellings are all located within the project boundary

No	Eligibility Condition	Project Compliance
2	The dwelling is a single-family dwelling[17]	The address of the dwelling is checked against the relevant Local Authority's register of "houses in multiple occupation" Documentation:

[16] Schedule 2(4)(a)

[17] 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 6,717 PAIs included in the project activity during the monitoring period meet this criterion as follows:

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

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

No	Eligibility Condition	Project Compliance
3 – 5	The dwelling is in the same income group (low-income) or same income group (middle-income)	Same income group (low-income): The status of the dwelling is social housing stock under the Housing and Regeneration Act 2008[18]; or Household income up to £40,212 as defined by the Living Wage Commission[19] 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 4.4, section 3.7.1. or The dwelling is in a neighbourhood identified as 'deprived' as defined by

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

[19] 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.

		the Department for Levelling Up, Housing and Communities[20] Same income group (middle-income): Household income above £40,212 and up to £70,004 as defined by the Living Wage Commission[21] and Department for Education[22] 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 4.4, section 3.7.1.; or The dwelling is not in a neighbourhood identified as 'deprived' as defined by the Department for Levelling Up, Housing and Communities[23] 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 4.4, section 3.7.1. or

[20] 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.

[21] 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.

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

[23] 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.

		c. The physical address and geodetic coordinates of the dwelling 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 4.4, 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 6,717 PAIs included in the project activity during the monitoring period meet these criteria as follows:

1) Social housing:

   a) Declaration that the dwelling 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[24];

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

2) Non-social housing:

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

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

No	Eligibility Condition	Project Compliance

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

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 4.4, section 3.7.1. Documentation: a. An agreement with 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 4.4, section 3.7.1., which vests project ownership in the project proponent Documentation is maintained in the project activity files

The 6,717 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 [25]

Applicability of Methodology

As called for by the VCS Standard v 4.4, regulations applicable to grouped projects and consistent with the VM0008 Methodology, this grouped project provides applicability criteria for project activity instances.

These criteria are intended to ensure that project activity meets the applicability conditions set out in the methodology. The applicability criteria are applicable to all project activity throughout

[25] Section 2.1(c)

the crediting period. Applying these conditions, any dwelling[26] 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 dwelling is adequate for project activities according to nationally recognised best practice standards Project activities do not result in a violation of health and safety, environmental, or other relevant regulations	Renovation of the thermal elements of a dwelling 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 dwellings 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 4.4, 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)[27]

[26] In the registered PDD, being a dwelling, 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

[27] 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

		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 defined in VCS Standard 4.4, 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 6,717 PAIs included in the project activity during the monitoring period meet these criteria as follows:

1) Social housing:

a) The condition of the dwellings 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[28]; and

b) Project activities do not result in a violation of 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[29].

2) Non-social housing:

a) The condition of the dwellings 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 emission reductions, in the Contract for Provision of Verified Carbon Unit Services[30], 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[31], 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 4.4, section 3.7.1. Documentation:

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

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

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

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

		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 4.4, 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 6,717 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 generates GHG emission reductions in the Contract for Provision of Verified Carbon Unit Services[32].

No	Applicability Condition	Project Compliance
3	The dwelling is occupied at the time of project activity. Vacancy is permitted on an intermittent basis for up to three months[33], or if the dwelling is occupied seasonally on an annual basis	Utility bills or mortgage statements relating to the dwelling 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 4.4, section 3.7.1.[34]

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

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

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

		Documentation: a. The status of the dwelling is social housing stock under the Housing and Regeneration Act 2008[35] 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 Standard 4.4, 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 6,717 PAIs included in the project activity during the monitoring period meet these criteria as follows:

1) Social housing:

   a) The dwelling 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[36].

2) Non-social housing:

   a) The dwelling 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[37].

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

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

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

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 dwelling	Renovation of the thermal elements of a dwelling 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 dwellings 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 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 4.4, 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)[38] or an equivalent standard, assessment

[38] 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

		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 emission reductions, as defined in VCS Standard 4.4, 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 6,717 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 dwelling 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[39].

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 dwelling as evidenced by a Building Regulations Compliance Certificate, Gas Safety 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[40], 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 dwellings, all residential dwellings 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 4.4, 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 4.4, section 3.7.1. c. Reports for each project activity instance are

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

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

		generated by the project proponent Documentation is maintained in the project activity files

The 6,717 PAIs included in the project activity during the monitoring period meet this criterion as follows:

a) The heating systems supplying the dwellings do not serve multiple dwellings 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[41].

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 4.4, 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 4.4, section 3.7.1. b. Reports for each project activity instance are generated by the project proponent

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

		Documentation is maintained in the project activity files

The 6,717 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[42].

No	Applicability Condition	Project Compliance
7	The dwelling meets or exceeds the performance benchmark as calculated for the Same Building Stock	Additionality is checked to ensure the dwelling 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 6,717 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 dwelling meets or exceeds the performance benchmark

b) To demonstrate additionality, a pre-retrofit energy assessment takes place for each dwelling prior to implementation of the project activity. Then a post-retrofit energy assessment takes place after the decarbonisation measures are completed. Pre- and

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

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 dwellings.[43]

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, dwellings must satisfy the following condition:

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

e) Where:

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

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

f) The change in energy load for the 6,717 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 the 6,717 PAIs included in the project activity during the monitoring period. A total of 297 dwellings 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

[43] 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

		VCS Standard 4.4, 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)[44] or an equivalent standard, or a declaration by a regulated provider of social housing or public entity or assessment by an accredited energy assessor 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 4.4, 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

[44] 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

		generated by the project proponent Documentation is maintained in the project activity files

The 6,717 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[45].

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[46], 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 dwelling prior to project activity The fuel sources that were already a source of emissions in the dwelling prior to project activity are identified by a certificate under Publicly Available Specification (PAS)[47] or an equivalent

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

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

[47] 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

		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 4.4, section 3.7.1., or assessment by an accredited energy assessor Documentation: a. Certificate under Publicly Available Specification (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 4.4, 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 6,717 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 dwelling 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[48], or data compiled by an accredited energy assessor.

[48] 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
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)

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	Initially the geographic areas included in the project are the physical boundaries of United Kingdom, those being areas which qualify as part of the Same Building Stock as defined in the VM0008 Methodology. The 6,717 PAIs included in the project activity during the monitoring period occur within the project boundary. Eligibility criteria for future project activity instances are set out in Section 1.4 (Eligibility Criteria) of the Project Description. These criteria are intended to ensure that new project activity instances have characteristics with respect to additionality that are consistent with the initial instances for the specified project activity and geographic area. Documentation: a. the physical address and geodetic coordinates of the dwelling 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 4.4, section 3.7.1. Documentation is maintained in the project activity files

The 6,717 PAIs included in the project activity during the monitoring period meet this criterion as follows:

a) The physical address of each dwelling 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[49]

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

No	Applicability Condition	Project Compliance
12	When sampling, the minimum number of dwellings to be sampled is the square root of the total number of dwellings *i* included in the project. Statistically sound sampling approaches are used. When the control group approach is utilised, the size of the control group is the square root of the total number of dwellings in the project but need not exceed 100 Dwellings. 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	Sampling is conducted in accordance with the methodology. The pre-and post-retrofit audit approach is utilized *to* measure emission reductions, for which the methodology prescribes the size of the quality assurance sample group of dwellings is established by multiplying 0.6 by the square root of the total number of dwellings (6,717) which equals a sample group of 50.

[49] Schedule 2(4)(a)

	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 dwellings that are dispersed geographically. For each defined Building Stock included in the project activity, sampling will occur. Criteria include region, dwelling type, and income	

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 dwellings within the Same Building Stock
Source of data	National data published by the Department for Business, Energy and Industrial Strategy (BEIS) as part of the National Energy

	Efficiency Data Framework (NEED).[50] The dataset used is the Property level natural gas and electricity consumption dataset[51]
Value applied	Low-income single-family dwelling Performance Standard: x= 5.0152 Middle-income individual dwelling 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 dwellings within the Same Building Stock. A sample of dwellings may be used. Percent savings are calculated by comparing year 1 to year 2 and year 2 to year 3, etc. [52] 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) 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
Frequency	Once per project crediting period, the level of the Performance Standard metric available at project validation is used for each verification event for the duration of all project crediting periods
Purpose of Data	Calculation of performance standard
Comments	N/A

Methodology reference	Table 3
Data / Parameter	Performance Standard (σ)
Data unit	N/A
Description	Standard Deviation of the annual percent savings

[50] 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

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

[52] 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

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 dwellings is non-Gaussian (as evidenced by the Property level natural gas and electricity consumption data published by BEIS[53]) and accordingly the standard deviation is not applicable
Frequency	N/A
Purpose of Data	N/A
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 dwellings. Currently either: a) CO_2 emission factor prescribed by Part L of the Building Regulations as detailed in the Standard Assessment Procedure (SAP) Manual[54] at Table 12: Fuel prices, emission factors and primary energy

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

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

	factor. SAP is the UK Government's National Calculation Methodology for assessing the energy performance of dwellings and is the energy assessment system used for dwellings 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[55] 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 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
Frequency	Once per project crediting period
Purpose of Data	Calculation of emission reductions
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[56]
Value applied	Natural Gas: 0.0375GJ/m^3

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

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

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
Frequency	Once per project crediting period
Purpose of Data	Calculation of emission reductions
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 dwellings. 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[57] 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 dwellings and is the energy assessment system used for dwellings 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[58] 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

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

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

	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: 0.059 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
Frequency	Once per project crediting period
Purpose of Data	Calculation of emission reductions
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 dwelling added to the project activity when the data parameter is followed by "*i*". Dwelling 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 ex-ante emission reductions. The "value applied" will change as dwellings 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 dwelling *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 dwelling 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 dwellings[59]. 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 dwelling prior to implementation of the project activity The energy load pre-retrofit may be calculated after the energy efficiency measures are installed
Value applied	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[60]
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology[61]
Purpose of data	Calculation of performance standard
Calculation method	The SAP methodology considers a range of factors that contribute to energy efficiency including materials used for construction of a dwelling, thermal insulation of the building fabric, air leakage characteristics of the dwelling, efficiency and control of the heating system(s) and the fuel used to provide space and water heating. Energy assessments cover both fossil

[59] 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

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

[61] 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

	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[62]
Comments	N/A

Methodology reference	Table 7
Data / Parameter	$EL_{post,I}$
Data unit	BTU/m^2
Description	Post-retrofit energy load of dwelling *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 dwelling 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 dwellings[63] 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 dwelling following the implementation of project activity
Value applied	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[64]

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

[63] 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

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

QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology[65]
Purpose of data	Calculation of performance standard
Calculation method	The SAP methodology considers a range of factors that contribute to energy efficiency including materials used for construction of a dwelling, thermal insulation of the building fabric, air leakage characteristics of the dwelling, 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[66]
Comments	N/A

Methodology reference	Table 9
Data / Parameter	$Elec_{b,I}$
Data unit	kWh/yr.
Description	Grid-connected electricity consumed in the year prior to project implementation in dwelling *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)[67] 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 dwellings in the Same Building Stock for a period of one-year pre-retrofit

[65] 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

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

[67] 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 meaning the dataset meets the highest standards of trustworthiness, quality, and public value

Frequency of monitoring/recording	Once prior to implementation of the project activity. Once a dwelling has an established baseline, it remains constant for the crediting period
Value applied	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[68]
Purpose of data	Calculation of emission reductions for adjusted consumption approach
Calculation method	The minimum sample size is established by multiplying by 0.6 the square root of the total number of dwellings, *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 dwellings** 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 on June 24, 2021, as part of the NEED Framework.[69] [70] [71] The sample size was 13,480,630 dwellings, representing approximately 92% of the total population of low-income single-family dwellings in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology[72] **Same Building Stock: Middle-income single-family dwellings** The independent data collected and arranged in a systematic or methodical way by the project proponent is the Household

[68] 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

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

[70] 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

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

[72] 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 dwellings, *i*, included in the project. This sample size would support a total number of dwellings far greater than the total number of dwellings in the geographic scope of this project

	electricity consumption data published by BEIS on June 24, 2021, as part of the NEED Framework.[73] [74] [75] The sample size was 5,851,540 dwellings, representing approximately 92% of the total population of middle-income single-family dwellings in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology[76]
Comments	N/A

Methodology reference	Table 9
Data / Parameter	$Elec_{p,y,l}$
Data unit	kWh/yr.
Description	Grid-connected electricity consumed by the project in year *y* for Dwelling *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 dwellings in the Same Building Stock for a period of one-year post-retrofit
Frequency of monitoring/recording	Annually for each year *y*
Value applied	Not applicable during this monitoring period
Monitoring equipment	Documentation is maintained in the project activity files

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

[74] 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

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

[76] 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 dwellings, *i*, included in the project. This sample size would support a total number of dwellings far greater than the total number of dwellings in the geographic scope of this project

QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology[77]
Purpose of data	Calculation of emission reductions for adjusted consumption approach
Calculation method	The minimum sample size is established by multiplying by 0.6 the square root of the total number of dwellings, *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 dwelling per year
Description	Fuel type *j* consumed in the year prior to project implementation ($F_{b,j,j}$) for dwelling *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) [78] 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 dwellings 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 dwelling has an established baseline, it remains constant for the crediting period
Value applied	Not applicable during this monitoring period

[77] 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

[78] 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 meaning the dataset meets the highest standards of trustworthiness, quality, and public value

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 [79]
Purpose of data	Calculation of emission reductions for adjusted consumption approach
Calculation method	The minimum sample size is established by multiplying by 0.6 the square root of the total number of dwellings, *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 dwellings** 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 on June 24, 2021, as part of the NEED Framework.[80] [81] [82] The sample size was 11,066,210 dwellings, representing approximately 78% of the total population of low-income single-family dwellings in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology [83] **Same Building Stock: Middle-income single-family dwellings** 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 on June 24, 2021, as part

[79] 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

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

[81] 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

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

[83] 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 dwellings, *i*, included in the project. This sample size would support a total number of dwellings far greater than the total number of dwellings in the geographic scope of this project

	of the NEED Framework.[84] [85] [86] The sample size was 4,879,760 dwellings, representing approximately 78% of the total population of middle-income single-family dwellings in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology [87]
Comments	N/A

Methodology reference	Table 9
Data / Parameter	$F_{p,y,j,j}$
Data unit	Mass or volume per dwelling per year
Description	Fuel type *j* consumed by the project in year *y* ($F_{p,y,j,j}$) for dwelling *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 dwellings in the Same Building Stock for a period of one-year post-retrofit
Frequency of monitoring/recording	Annually for each year *y*
Value applied	Not applicable during this monitoring period
Monitoring equipment	Documentation is maintained in the project activity files

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

[85] 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

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

[87] 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 dwellings, *i*, included in the project. This sample size would support a total number of dwellings far greater than the total number of dwellings in the geographic scope of this project

QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology [88]
Purpose of data	Calculation of emission reductions for adjusted consumption approach
Calculation method	The minimum sample size is established by multiplying by 0.6 the square root of the total number of dwellings, *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)[89] or the Final energy demand data published by the Department for Business, Energy and Industrial Strategy (BEIS)[90]. 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

[88] 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

[89] 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 meaning the dataset meets the highest standards of trustworthiness, quality, and public value

[90] In the registered PDD, published by the Department for Business, Energy and Industrial Strategy (BEIS) 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 applied	Not applicable during this monitoring period
Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of emission reductions for the adjusted consumption approach
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: **Same Building Stock: Low-income single-family dwellings** 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 on June 24, 2021, as part of the NEED Framework.[91] [92] [93] The sample size was 13,480,630 dwellings, representing approximately 92% of

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

[92] 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

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

	the total population of low-income single-family dwellings in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology [94] **Same Building Stock: Middle-income single-family dwellings** 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 on June 24, 2021, as part of the NEED Framework.[95] [96] [97] The sample size was 5,851,540 dwellings, representing approximately 92% of the total population of middle-income single-family dwellings in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology [98]
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
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) as part of the 'Energy Trends'[99] quarterly bulletin containing statistics on

[94] 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 dwellings, *i*, included in the project. This sample size would support a total number of dwellings far greater than the total number of dwellings in the geographic scope of this project

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

[96] 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

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

[98] 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 dwellings, *i*, included in the project. This sample size would support a total number of dwellings far greater than the total number of dwellings in the geographic scope of this project

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

	weather patterns, including temperature, heating degree days, wind speeds, sun hours and rainfall[100]
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 applied	Not applicable during this monitoring period
Monitoring equipment	Data retrieved from the Department for Business, Energy and Industrial Strategy (BEIS)
QA/QC procedures to be applied	Source data is 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 meaning the dataset meets the highest standards of trustworthiness, quality, and public value
Purpose of data	Calculation of emission reductions for the adjusted consumption approach
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[101]
Comments	HDD values are calculated on a rolling twelve-month period to accommodate periodicity of adding dwellings 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

[100] 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

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

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) as part of the 'Energy Trends'[102] quarterly bulletin containing statistics on weather patterns, including temperature, heating degree days, wind speeds, sun hours and rainfall[103]
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 applied	Not applicable during this monitoring period
Monitoring equipment	Data retrieved from the Department for Business, Energy and Industrial Strategy (BEIS)
QA/QC procedures to be applied	Source data is 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 meaning the dataset meets the highest standards of trustworthiness, quality, and public value
Purpose of data	Calculation of emission reductions for the adjusted consumption approach
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

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

[103] 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

	counted twice. Data on temperatures recorded are provided by the Meteorological Office [104]
Comments	HDD values are calculated on a rolling twelve-month period to accommodate periodicity of adding dwellings 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 dwelling 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 dwellings[105] The post-retrofit energy assessment determines the number of fuel types
Frequency of monitoring/recording	Annually
Value applied	Not applicable during this monitoring period
Monitoring equipment	Data retrieved from the project database
QA/QC procedures to be applied	N/A

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

[105] 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

Purpose of data	Calculation of emission reductions for the adjusted consumption approach
Calculation method	The SAP methodology considers a range of factors that contribute to energy efficiency including materials used for construction of a dwelling, thermal insulation of the building fabric, air leakage characteristics of the dwelling, 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[106]
Comments	N/A

Methodology reference	Table 9
Data / Parameter	*I*
Data unit	N/A
Description	Number of dwellings 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 applied	Not applicable during this monitoring period
Monitoring equipment	Data retrieved from the project database
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of emission reductions for the adjusted consumption approach

[106] In the registered PDD, the Government's Standard Assessment Procedure for Energy Rating of Dwellings, 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 dwelling per year
Description	Quality assurance sample group of fuel consumption within the dwelling
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 dwellings 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 applied	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[107]
Purpose of data	Monitoring of emission reductions for adjusted consumption approach
Calculation method	The minimum quality assurance sample size is established by multiplying by 0.6 the square root of the total number of dwellings, *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 dwellings of the Same Building Stock. If

[107] 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 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, 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 dwelling
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 dwellings 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 applied	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[108]
Purpose of data	Monitoring of emission reductions for adjusted consumption approach
Calculation method	The minimum quality assurance sample size is established by multiplying by 0.6 the square root of the total number of dwellings, *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 dwellings 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

[108] 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

	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 10
Data / Parameter	$Elec_{b,I}$
Data unit	kWh/yr.
Description	Grid-connected electricity consumed in the year prior to project implementation in dwelling *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)[109] 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 dwellings 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 dwelling has an established baseline, it remains constant for the crediting period
Value applied	Low-income single-family dwelling baseline consumption: 3,000 kWh annually Middle-income individual dwelling baseline consumption: 3,900 kWh annually Consumption for each dwelling is calculated by applying the mean consumption determined from a sample of dwellings of the Same Building Stock (the sample may be normalized for size) to all dwellings included in the project activity. To ensure accurate and conservative emission reduction calculations, in the cases where a dwelling 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[110]
Purpose of data	Calculation of emission reductions for the pre- and post-retrofit energy assessment approach
Calculation method	The minimum sample size is established by multiplying by 0.6 the square root of the total number of dwellings, *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

[109] 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 meaning the dataset meets the highest standards of trustworthiness, quality, and public value

[110] 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

	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 dwellings** 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 on June 24, 2021, as part of the NEED Framework.[111] [112] [113] The sample size was 13,480,630 dwellings, representing approximately 92% of the total population of low-income single-family dwellings in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology[114] **Same Building Stock: Middle-income single-family dwellings** 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 on June 24, 2021, as part of the NEED Framework.[115] [116] [117] The sample size was 5,851,540 dwellings, representing approximately 92% of the total population of middle-income single-family dwellings in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology[118]
Comments	N/A

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

[112] 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

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

[114] 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 dwellings, *i*, included in the project. This sample size would support a total number of dwellings far greater than the total number of dwellings in the geographic scope of this project

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

[116] 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

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

[118] 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 dwellings, *i*, included in the project. This sample size would support a total number of dwellings far greater than the total number of dwellings in the geographic scope of this project

Methodology reference	Table 10
Data / Parameter	$E_{dem,pre,i}$
Data unit	kW
Description	Pre-retrofit grid-connected electricity demand for dwelling *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 dwelling 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 dwellings[119] The pre-retrofit energy assessment determines the grid-connected electricity demand in the baseline
Frequency of monitoring/recording	Once per dwelling 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 applied	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[120]
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology[121]
Purpose of data	Calculation of emission reductions for the pre- and post-retrofit energy assessment approach
Calculation method	The SAP methodology considers a range of factors that contribute to energy efficiency including materials used for construction of a dwelling, thermal insulation of the building fabric, air leakage characteristics of the dwelling, efficiency and

[119] 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

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

[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 pre- and post-retrofit energy assessment approach

	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	$E_{dem,post,i}$
Data unit	kW
Description	Post-retrofit grid-connected electricity demand for dwelling *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 dwelling 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 dwellings[122] The post-retrofit energy assessment determines the grid-connected electricity demand following the implementation of project activity
Frequency of monitoring/recording	Once per dwelling following the implementation of project activity
Value applied	Determined individually for each project activity instance or for a sample of dwellings in the Same Building Stock in accordance with the VM0008 Methodology

[122] 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[123]
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology[124]
Purpose of data	Calculation of emission reductions for the pre- and post-retrofit energy assessment approach
Calculation method	The SAP methodology considers a range of factors that contribute to energy efficiency including materials used for construction of a dwelling, thermal insulation of the building fabric, air leakage characteristics of the dwelling, 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 dwelling per year
Description	Fuel type *j* consumed in the year prior to project implementation for dwelling *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)[125] using the last

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

[124] 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

[125] 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 meaning the dataset meets the highest standards of trustworthiness, quality, and public value

	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 dwellings 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 dwelling has an established baseline, it remains constant for the crediting period
Value applied	Low-income single-family dwelling baseline consumption: 1,104 m^3 annually Middle-income individual dwelling baseline consumption: 1,382 m^3 annually Consumption for each dwelling is calculated by applying the mean consumption determined from a sample of dwellings of the Same Building Stock (the sample may be normalized for size) to all dwellings included in the project activity. To ensure accurate and conservative emission reduction calculations, in the cases where a dwelling 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[126]
Purpose of data	Calculation of emission reductions for the pre- and post-retrofit energy assessment approach
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 dwellings, *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

[126] 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

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 dwellings

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 on June 24, 2021, as part of the NEED Framework.[127] [128] [129] The sample size was 11,066,210 dwellings, representing approximately 78% of the total population of low-income single-family dwellings in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology[130]

Same Building Stock: Middle-income single-family dwellings

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 on June 24, 2021, as part of the NEED Framework.[131] [132] [133] The sample size was 4,879,760 dwellings, representing approximately 78% of the total population of middle-income single-family dwellings in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology[134]

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

[128] 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

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

[130] 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 dwellings, *i*, included in the project. This sample size would support a total number of dwellings far greater than the total number of dwellings in the geographic scope of this project

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

[132] 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

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

[134] 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 dwellings, *i*, included in the project. This sample size would support a total number of dwellings far greater than the total number of dwellings in the geographic scope of this project

Comments	N/A

Methodology reference	Table 10
Data / Parameter	$H_{load,pre,i}$
Data unit	kWh/m²/HDD or GJoules/m²/HDD
Description	Heat load pre-retrofit for dwelling *i* based on size of the dwelling 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 dwelling 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 dwellings[135] The pre-retrofit energy assessment determines the heat load in the baseline
Frequency of monitoring/recording	Once per dwelling prior to implementation of the project activity. The heat load pre-retrofit may be calculated after the energy efficiency measures are installed
Value applied	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[136]
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology[137]
Purpose of data	Calculation of emission reductions for the pre- and post-retrofit energy assessment approach

[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 Dwellings, 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

Calculation method	The SAP methodology considers a range of factors that contribute to energy efficiency including materials used for construction of a dwelling, thermal insulation of the building fabric, air leakage characteristics of the dwelling, 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 dwellings in the Same Building Stock

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 dwelling *i* based on size of the dwelling 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 dwelling 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 dwellings[138] The post-retrofit energy assessment determines the heat load following the implementation of project activity

[138] 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

Frequency of monitoring/recording	Once per dwelling following the implementation of project activity
Value applied	Determined individually for each project activity instance or for a sample of dwellings 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[139]
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology[140]
Purpose of data	Calculation of emission reductions for the pre- and post-retrofit energy assessment approach
Calculation method	The SAP methodology considers a range of factors that contribute to energy efficiency including materials used for construction of a dwelling, thermal insulation of the building fabric, air leakage characteristics of the dwelling, 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 dwellings in the Same Building Stock

Methodology reference	Table 10
Data / Parameter	ECF_y

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

[140] 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

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)[141] or the Final energy demand data published by the Department for Business, Energy and Industrial Strategy (BEIS)[142]. 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 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 applied	Low-income single-family dwelling baseline consumption: 0.9824 Middle-income individual dwelling baseline consumption: 0.9859
Monitoring equipment	N/A

[141] 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 meaning the dataset meets the highest standards of trustworthiness, quality, and public value

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

QA/QC procedures to be applied	N/A
Purpose of data	Calculation of emission reductions for the pre- and post-retrofit energy assessment approach
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: **Same Building Stock: Low-income single-family dwellings** 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 on June 24, 2021, as part of the NEED Framework.[143] [144] [145] The sample size was 13,480,630 dwellings, representing approximately 92% of the total population of low-income single-family dwellings in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology[146] **Same Building Stock: Middle-income single-family dwellings** 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 on June 24,

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

[144] 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

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

[146] 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 dwellings, *I*, included in the project. This sample size would support a total number of dwellings far greater than the total number of dwellings in the geographic scope of this project

	2021, as part of the NEED Framework.[147] [148] [149] The sample size was 5,851,540 dwellings, representing approximately 92% of the total population of middle-income single-family dwellings in the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology[150]
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
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) as part of the 'Energy Trends'[151] quarterly bulletin containing statistics on weather patterns, including temperature, heating degree days, wind speeds, sun hours and rainfall[152]
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

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

[148] 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

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

[150] 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 dwellings, *i*, included in the project. This sample size would support a total number of dwellings far greater than the total number of dwellings in the geographic scope of this project

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

[152] 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

Frequency of monitoring/recording	Once after project activity for each monitoring period
Value applied	Calculated once for each project activity instance for each monitoring period
Monitoring equipment	Data retrieved from the Department for Business, Energy and Industrial Strategy (BEIS)
QA/QC procedures to be applied	Source data is 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 meaning the dataset meets the highest standards of trustworthiness, quality, and public value
Purpose of data	Calculation of emission reductions for the pre- and post-retrofit energy assessment approach
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[153]
Comments	HDD values are calculated on a rolling twelve-month period to accommodate periodicity of adding dwellings 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) as part of the

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

	'Energy Trends'[154] quarterly bulletin containing statistics on weather patterns, including temperature, heating degree days, wind speeds, sun hours and rainfall[155]
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 applied	Calculated for each rolling twelve-month period before project activity
Monitoring equipment	Data retrieved from the Department for Business, Energy and Industrial Strategy (BEIS)
QA/QC procedures to be applied	Source data is 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 meaning the dataset meets the highest standards of trustworthiness, quality, and public value
Purpose of data	Calculation of emission reductions for the pre- and post-retrofit energy assessment approach
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[156]
Comments	HDD values are calculated on a rolling twelve-month period to accommodate periodicity of adding dwellings to the Project Activity

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

[155] 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

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

	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 dwelling 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 dwellings[157] The post-retrofit energy assessment determines the number of fuel types
Frequency of monitoring/recording	Annually
Value applied	Ten fuel types: 1) Bottled LPG 2) Anthracite 3) Wood logs 4) Dual fuel 5) Smokeless coal 6) Community natural gas 7) Mains natural gas 8) LPG 9) Oil 10) House coal
Monitoring equipment	Data retrieved from the project database

[157] 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 data	Calculation of emission reductions and removals for the pre- and post-retrofit energy assessment approach
Calculation method	The SAP methodology considers a range of factors that contribute to energy efficiency including materials used for construction of a dwelling, thermal insulation of the building fabric, air leakage characteristics of the dwelling, 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	*I*
Data unit	N/A
Description	Number of dwellings 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 applied	6,717 Dwellings
Monitoring equipment	Data retrieved from the project database
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of emission reductions and removals for the pre- and post-retrofit energy assessment approach

Calculation method	N/A
Comments	N/A

Methodology reference	Table 10
Data / Parameter	S
Data unit	N/A
Description	Number of dwellings 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 applied	The sample size for the quality assurance sample for the Initial PAIs is 50
Monitoring equipment	Data retrieved from the project database
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of emission reductions and removals for the pre- and post-retrofit energy assessment approach
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 dwellings, *i*, included in the Project Where: *i = 6,717* The sample size for the quality assurance sample is 50
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 dwellings in Building Stock *b* in year *y*
Source of data	Sample group of dwellings 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 dwellings
Frequency of monitoring/recording	Monitored monthly, calculated annually
Value applied	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 data	Calculation of emission reductions for the control group approach
Calculation method	Sample groups are defined individually for dwellings from the Same Building Stock which are to be decarbonised. The minimum number of dwellings to be sampled will be the square root of the total number of Dwellings *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 dwellings that are dispersed geographically. For each defined Building Stock included in the project activity, sampling will occur. Criteria include region, dwelling 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 dwellings in Building Stock *b* in year *y*
Source of data	Control group of dwellings 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 dwellings
Frequency of monitoring/recording	Monitored monthly, calculated annually
Value applied	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 data	Calculation of emission reductions for the control group approach
Calculation method	Control groups are created which contain dwellings 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 dwellings each year so long as the control group contains only dwellings 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 dwellings in the Project but need not exceed 100 dwellings.
Comments	N/A

Methodology reference	Table 11

Data / Parameter	$F_{SG,y,j,b}$
Data unit	Mass or volume, per dwelling per year
Description	Mean fuel type *j* consumed by sample group dwellings in Building Stock *b* in year *y*
Source of data	Sample group of dwellings 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 dwellings in the Same Building Stock
Frequency of monitoring/recording	Monitored monthly, calculated annually
Value applied	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 data	Calculation of emission reductions for the control group approach
Calculation method	Sample groups are defined individually for dwellings from the Same Building Stock which are to be decarbonised. The minimum number of dwellings to be sampled will be the square root of the total number of Dwellings *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 dwellings that are dispersed geographically. For each defined Building Stock included in the project activity, sampling will occur. Criteria include region, dwelling 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 dwellings in Same Building Stock *b* in year *y*
Source of data	Control group of dwellings 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 dwellings in the Same Building Stock
Frequency of monitoring/recording	Monitored monthly, calculated annually
Value applied	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 data	Calculation of emission reductions for the control group approach
Calculation method	Control groups are created which contain dwellings 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 dwellings each year so long as the control group contains only dwellings 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 dwellings in the Project but need not exceed 100 dwellings.
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 dwelling 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 dwellings[158] The post-retrofit energy assessment determines the number of fuel types
Frequency of monitoring/recording	Annually
Value applied	Not applicable during this monitoring period
Monitoring equipment	Data retrieved from the project database
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of emission reductions and removals for the control group approach
Calculation method	The SAP methodology considers a range of factors that contribute to energy efficiency including materials used for construction of a dwelling, thermal insulation of the building fabric, air leakage characteristics of the dwelling, 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

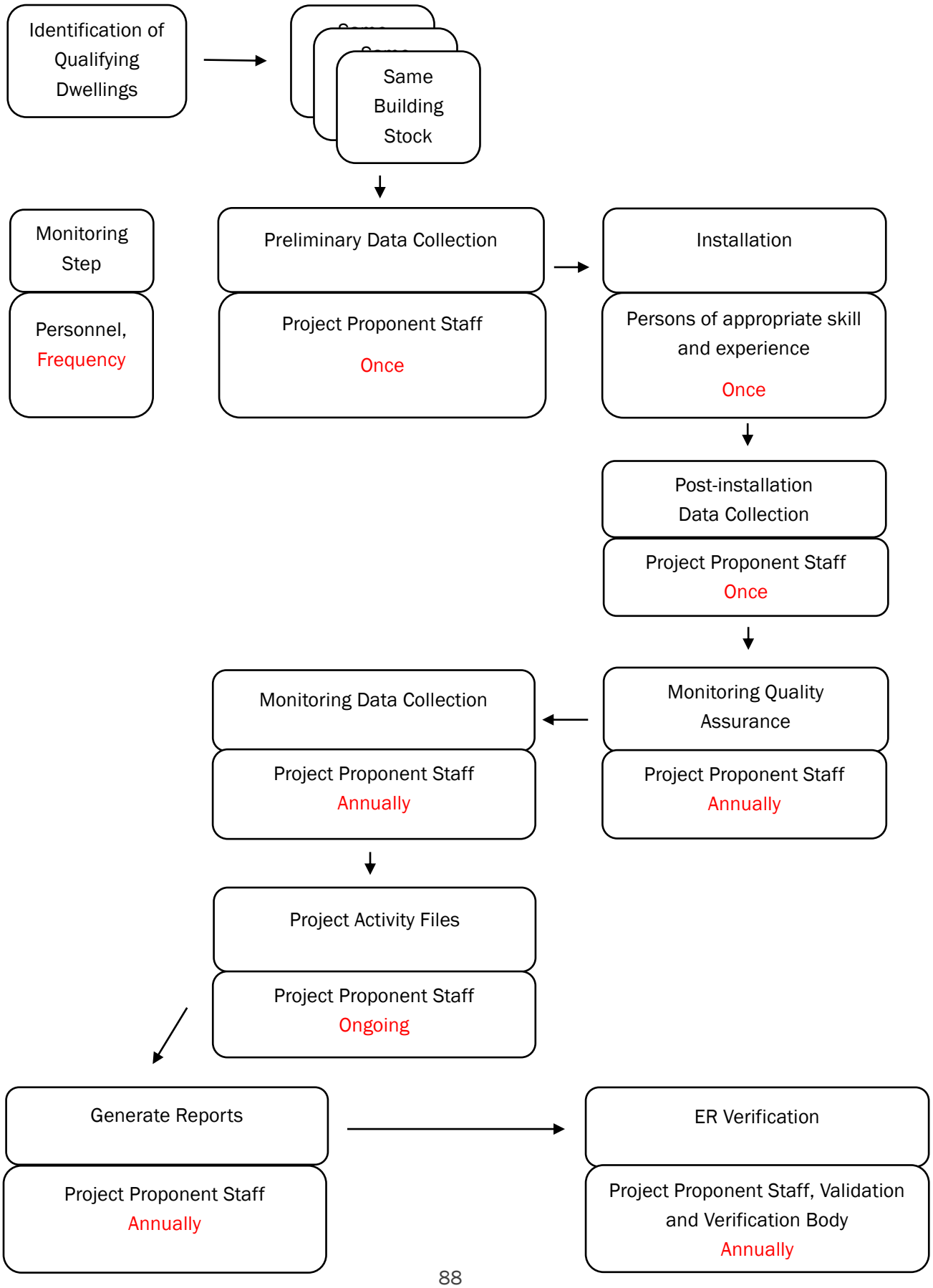
[158] In the registered PDD, additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 of the Project Description under the pre- and post-retrofit energy assessment approach

Methodology reference	Table 11
Data / Parameter	I_b
Data unit	N/A
Description	Number of dwellings 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 applied	Not applicable during this monitoring period
Monitoring equipment	Data retrieved from the project database
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of emission reductions and removals for the control group approach
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.

Figure 2 Line diagram outlining the key monitoring steps, as well as the key personnel responsible for obtaining the relevant data or generating the reports necessary for verification


Identification of Qualifying Dwellings
Same Building Stock
Monitoring Step
Personnel, Frequency
Preliminary Data Collection
Project Proponent Staff
Once
Installation
Persons of appropriate skill and experience
Once
Post-installation Data Collection
Project Proponent Staff
Once
Monitoring Quality Assurance
Project Proponent Staff
Annually
Monitoring Data Collection
Project Proponent Staff
Annually
Project Activity Files
Project Proponent Staff
Ongoing
Generate Reports
Project Proponent Staff
Annually
ER Verification
Project Proponent Staff, Validation and Verification Body
Annually

Monitoring is conducted primarily by project proponent staff, or by designated personnel who participate in decarbonisation project activity. Dwelling-specific data is collected in accordance with this Project Description.

These data include 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 dwelling 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. These data are maintained in a centralised data repository. All necessary calculations and generated reports, based on data maintained in the centralised data repository, are produced by project proponent staff, or by designated personnel who participate in decarbonisation project activity.

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 dwellings within the United Kingdom; actual grid-connected electricity consumption data for approximately 92% of the total population of low-income single-family dwellings within the UK; actual natural gas consumption data for approximately 78% of the total population of middle-income single-family dwellings within the UK; and actual grid-connected electricity consumption data for approximately 92% of the total population of middle-income single-family dwellings 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 dwellings in the UK. Sampling was undertaken by staff of the Department for Business, Energy and Industrial Strategy (BEIS) 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 dwellings, $(\sqrt{i})$, where i is the total number of dwellings, of the Same Building Stock b, decarbonised as part of the project activity, but need not exceed 100 dwellings.

- Quality Assurance monitoring in the VM0008 Methodology allows for correcting the HLF and EDF for all dwellings 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 dwellings 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, i.e., a certified energy auditor, or a nationally recognized data source.

  4) Actions that may bias the sample are avoided. Sampling shall include Dwellings 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 monitoring of the size of the quality assurance sample groups and control groups.

Identification of Qualifying Dwellings

Project proponent staff, or designated personnel who participate in decarbonisation project activity, select eligible dwellings to include in the project activity. The project instances meet the criteria set out 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 for each project activity instance the documentation 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 activity, obtain for each project activity instance the documentation 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.

Monitoring Quality Assurance

Project proponent staff, or designated personnel who participate in decarbonisation project activity, obtain for each year, or for the duration of the verification period, confirmation of the official designation of the relevant source data. Where a dataset ceased to be designated, the project proponent would undertake a statistical evaluation to determine if the approach to calculation of 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 for 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 defined as emissions from fossil fuel and grid-connected electricity consumed during the most recent twelve-month period for which data are available prior to project implementation. Consumption for each dwelling is calculated by applying the mean consumption determined from a sample of dwellings of the Same Building Stock (the sample may be normalized for size) to all dwellings included in the project activity. To ensure accurate and conservative emission reduction calculations, in the cases where a dwelling 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 twice the mean consumption determined for the Same Building Stock. In such a case, the energy load is incorporated into the calculation of the baseline consumption.

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

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5.2 Project Emissions

Project activity emissions are defined as emissions from fossil fuel and grid-connected electricity consumed over a period once the project activity has occurred. In accordance with the VM0008 Methodology, emissions from the process of installation of the decarbonisation measures are negligible and need not be included. 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 are calculated directly as the VM0008 Methodology allows. Emission reductions are based on the data generated by a pre- and post-retrofit energy assessment of the dwelling. A pre-retrofit energy assessment takes place prior to implementation of the project activity. Then a post-retrofit energy assessment takes place after the decarbonisation measures are completed for a sample of the dwellings.

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 dwellings. The SAP methodology considers a range of factors that contribute to energy efficiency including materials used for construction of a dwelling, thermal insulation of the building fabric, air leakage characteristics of the dwelling, 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. 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 for each dwelling added to the project.[159] The post-retrofit energy assessment determines the heat load and grid-connected electricity demand (energy load) following the implementation of 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 emission reductions created by the project.

To calculate emission reductions, the HLF and EDF are multiplied by the baseline consumption of fuel and grid-connected electricity. The result is then be 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 adjusted 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)

[159] 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 dwellings and extended to each dwelling in the project activity. To ensure accurate and conservative emission reduction calculations, in the cases where the dwelling has a unique energy load reported in the pre-retrofit energy assessment, the unique energy load is incorporated into the calculation of the baseline

$H_{load,post,s}$ = Heat load post-retrofit for dwelling s, kWh/m²

$H_{load,pre,s}$ = Heat load pre-retrofit for dwelling s, kWh/m²

EDF = Electricity demand reduction factor (no unit)

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

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

S = Number of dwellings

s = sample dwelling 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 dwelling *i*

$EL_{Post,i}$ = Post-retrofit energy load / consumption of dwelling *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 dwelling *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[160] 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 dwelling *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 dwellings

i = Dwelling

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[161]

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

[161] 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

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*

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 6,717 PAIs included in the project activity.

Calculating ex-ante emission reductions for the 6,717 PAIs, where:

ER_y = 1,481.795 tCO_2e

$Elec_{b,I,j}$ = 4,094,400 kWh

EDF = Calculated per dwelling

ECF_y = 1

$HDDCF_y$ = Calculated per dwelling

$Elec_{CO2}$ = 0.000212

$F_{b,i,j}$ = 7,877,806 m^3

HLF = Calculated per dwelling

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

Cal_j = 0.0375GJ/m^3

L_y = 0

I = Number of dwellings

i = Dwelling

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 dwellings 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 dwellings of the Same Building Stock and the actual reduction in consumption calculated from directly metered energy data.[162]

The minimum quality assurance sample size is established by multiplying by 0.6 the square root of the total number of dwellings, *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 6,717 PAIs:

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

Where:

i = 6,717

The sample size for the quality assurance sample is 50.

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

[162] 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 a one-year period pre-retrofit is compared with equivalent consumption data post-retrofit for a sample of dwellings 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 dwellings 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 dwellings in the sample group and the control group approach are included in the comparison. Under this approach, and for the purposes of equation 11, $EL_{Pre,i}$ is the energy load in the baseline for dwellings in the Same Building Stock as described in section 3.4. In accordance with 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 by the public authority 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

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 dwellings that are dispersed geographically (see sub-condition four below).

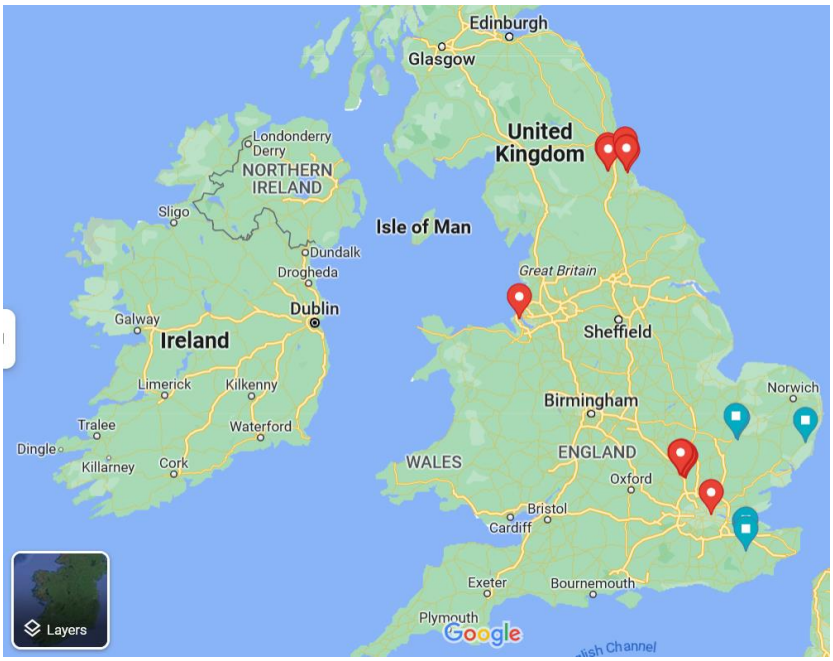
3) The data comes from an approved source, i.e., a certified energy auditor, or a nationally recognized data source.

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 Dwellings that are dispersed geographically and include each defined Building Stock included in the Project activity.

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

Figure 3. Geographical distribution of the sample group dwellings[163]



[163] Map data: Google LLC

Figure 4. Sub-geographical distribution of the sample group dwellings (south)[164]

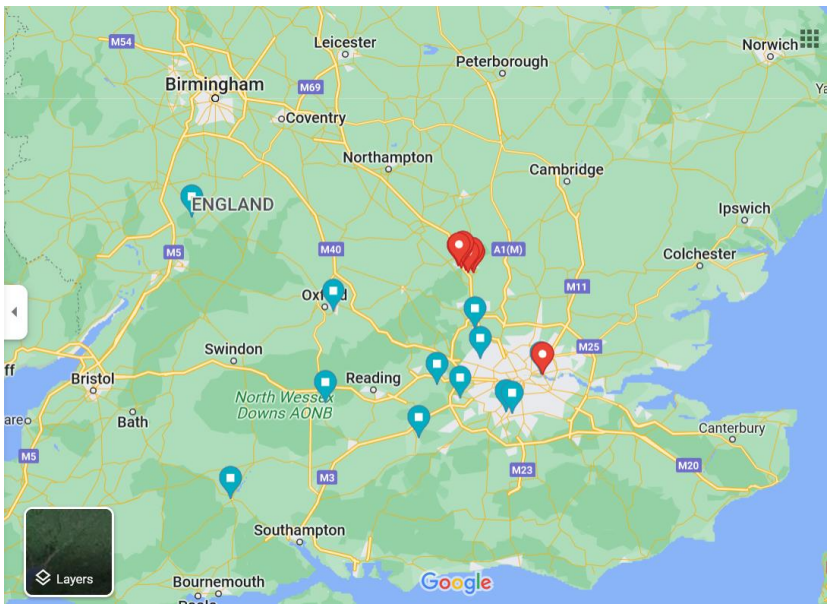
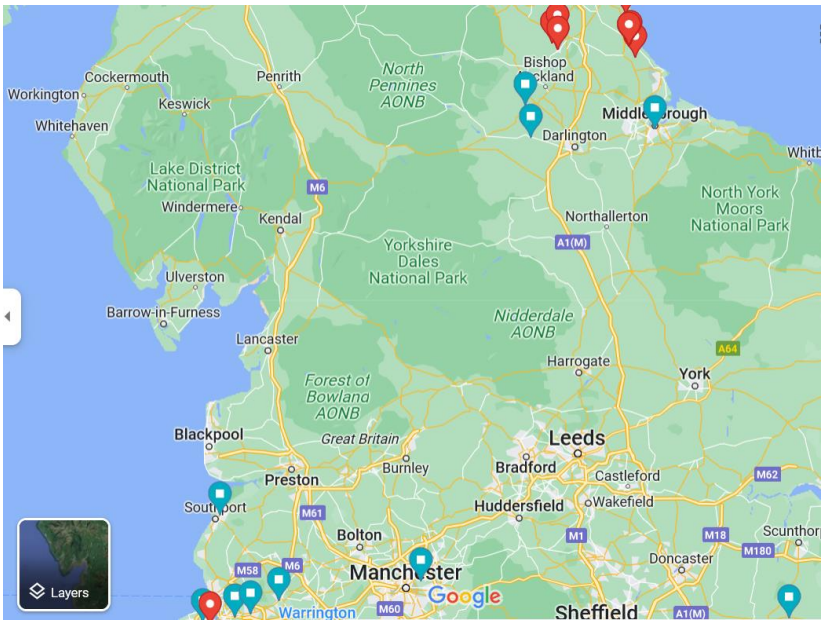


Figure 5. Sub-geographical distribution of the sample group dwellings (north)[165]



[164] Map data: Google LLC

[165] Map data: Google LLC

The mean of the calculated reductions in energy load determined by the post-retrofit energy assessment for dwellings 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 to calculate emission reductions accurately.

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 hypothesis of equal means is rejected, and the observed discrepancy is concluded to be significant.

For this verification period between 1 July 2022 and 31 December 31, 2022, the mean of the calculated reductions in energy load determined by the post-retrofit energy assessment for dwellings 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 50 PAIs. The sample size of 50 was determined by taking all dwellings included in the project activity (6,717) and multiplying the number by 0.6, in accordance with the Methodology. The result was 49.174, which is rounded up to 50.

Intermediate values used in calculations:

- Two-tailed t Critical value = 1.9912
- t = 1.4351

statistical significance:

- The two-tailed P value equals 0.1544

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

5.3 Leakage

The only potential sources of leakage are 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 dwelling 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 4.4, 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 6,717 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 4.4, section 3.7.1 in the Contract for Provision of Verified Carbon Unit Services[166].

5.4 Net GHG Emission Reductions and Removals

Dwellings 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 4.4, section 3.7.1. This declaration is included in Schedule 5 of the Participant Contract.

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

To accommodate the periodicity of adding dwellings 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 Emissions, Project Emissions, Leakage and Net GHG Emission Reductions is provided as appendices to this report.

Table 6. Summary table of Net GHG Emission Reductions

Year	Baseline emissions or removals (tCO_2e) *[167]	Project emissions or removals (tCO_2)	Leakage emissions (tCO_2)	Net GHG emission reductions or removals (tCO_2e) *Rounded down*
Year 1 2022 (01-July-2022 – 31-December-2022)	–	–	0	1,481
Total	–	–	0	1,481

Table 7. Summary table of estimated ex-ante GHG emission reductions and removals and the achieved emission reductions and removals for this monitoring period

Ex-ante emissions reductions/removals (tCO_2e)	Achieved emissions reductions/removals (tCO_2e)	Percent difference	Justification for the difference

[167] Pursuant to the applied methodology and registered PPD, emission reductions are calculated directly under each approach; in other words, baseline and project emissions are not calculated separately under the methodology. This results in a simplified and accurate estimation of project emissions normalised for weather and electricity correction factors. Leakage is calculated separately under each approach

2.928 per PAI	0.220 per PAI	-92.471%	See 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. Additional PAIs have been added since validation commenced and will continue to be added throughout the crediting period. This Monitoring Report includes information regarding the first 6,717 PAIs included in the project activity during the six-month monitoring period. The achieved ex-post GHG emission reductions and removals per PAI for this monitoring period was 0.220 tCO2e.

Achieved emissions reductions and removals were 92.471% less than estimated (before considering the monitoring period was half the length of the estimated monitoring period). The estimated GHG emission reductions/removals were based on 'deep retrofits', retrofitting a home to the highest levels of energy efficiency. The average cost of a deep retrofit is at least double the expected amount – averaging around £69,000[168]. As a result, the proportion of deep retrofits is less than expected, and consequently, the achieved emission reductions/removals are less than estimated.

The challenges of retrofitting 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 layer. 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.

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

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 increase as this project begins to scale its innovative delivery model and funding mechanism to make what can often be unattractive business cases fundable.

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[168] Source: 'Nottingham Carbon Neutral Housing: Cost vs Carbon Retrofit Roadmap'

APPENDIX 1: EMISSION REDUCTION WORKSHEET

Evidence of the Quantification of GHG Emission Reductions and Removals, Quality Assurance Monitoring and the Net GHG Emission Reductions and Removals is provided in the file: VCS2649_MR2022 – Emission Reduction Worksheet