



**Verified Carbon
Standard**

HOUSING DECARBONISATION IN THE UNITED KINGDOM



arctica partners

Document Prepared by Arctica Partners

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1 PROJECT DETAILS

1.1 Summary Description of the Project

The United Kingdom (UK) has more than 28.6 million dwellings and has built around 178,000 new dwellings per year since 2000.¹ Direct emissions from the housing stock comes from the combustion of fossil fuels, and indirect emissions occurs because of the electricity used, for heat, hot water, and cooking. Direct emissions from the housing stock were 67.76 MtCO₂e in 2019, 14% of the UK total and more than any sector other than surface transport². Around 74% of the UK's heating and hot water demand in dwellings was met by natural gas, and 10% by petroleum. The rest was mostly a small amount of wood (or other biomass) and coal.³

The UK has the oldest housing stock in Europe.⁴ Over 52% of dwellings were built before 1965, nearly 20% were built before 1919.⁵ This means that the UK needs to do more than many other countries to eliminate emissions from its housing stock. Direct emissions from the housing stock have not changed significantly from 2015 to 2019.⁶ In part that reflects that progress in installing energy efficiency measures slowed dramatically after 2012, following changes to the supporting policies.

This project covers emission reduction improvements made to dwellings, that is, energy efficiency measures directed at reducing the consumption of energy within a dwelling. Examples include, but are not limited to, insulating, air sealing and improving the central heating system in existing dwellings. 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.

¹ [Office for National Statistics \(2021\) House building, UK: permanent dwellings.](#)

² [Department for Business, Energy and Industrial Strategy \(2021\) 2020 UK Greenhouse Gas Emissions, Provisional Figures.](#)

³ [Department for Business, Energy and Industrial Strategy \(2020\) Energy Consumption in the UK \(ECUK\), End uses data tables, Table U2.](#)

⁴ [BRE Trust \(2020\) The Housing Stock of the United Kingdom.](#)

⁵ [Department for Levelling Up, Housing and Communities \(2021\) English Housing Survey 2020 to 2021: headline report.](#)

⁶ [National Atmospheric Emissions Inventory \(2020\) Breakdown of UK GHG emissions by source and greenhouse gas.](#)

This Project Document was prepared to allow Arctica Partners as project proponent (referred to as “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) all located in the UK⁷.

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 throughout the UK. 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 located in the UK 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 insulating, air sealing and improving the central heating system in existing dwellings To stimulate and enable investment partners to commit funding towards the decarbonisation of housing stock
3. 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.

Over the 7 years of the first crediting period, the project will generate an estimated annual average reduction of 82 tons of carbon dioxide equivalent (tCO₂e) and 574 tons over the 7 years of the first crediting period.

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 document provides a procedure to implement the VM0008 Methodology and determine net carbon dioxide (CO₂) emission reductions associated with energy efficiency activities for dwellings.

⁷Being a dwelling, as defined in UK legislation, currently the Finance Act 2013, c. 29, part 3, the Landlord and Tenant 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

Grouped Project: This project is a Grouped project. Individual dwellings included in this project are known as “project activity instances”. This Project Document includes information regarding the first 28 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 this document.

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

Category A – A combination of energy efficiency measures directed at the enhancement of the building envelope (i.e., air infiltration, insulation), and improving the efficiency of the central heating and/or cooling system and reducing fossil fuel consumption of appliances (i.e., replacement of ventilation units and lamps).

Category B – A combination of energy efficiency measures directed at the enhancement of the building envelope (i.e., air infiltration, insulation), and improving the efficiency of the central heating and/or cooling system only.

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

1.3 Project Eligibility

The project meets all the criteria set out in the VCS Program criteria for GHG emission reductions as supported by the VM0008 Methodology approved under the VCS Program. The project will reduce carbon dioxide emissions by facilitating decarbonisation measures directed at reducing the fossil fuel consumption within a dwelling. Examples include, but are not limited to, enhancement of the building envelope and improving the efficiency of the central heating system in existing dwellings which are permanent reductions. The project activity does not include carbon footprint assessments or carbon neutrality claims. The project is eligible under the scope of the VCS Program.

1.4 Project Design

This Project Document includes information regarding the first 28 project activity instances planned and developed to a sufficient level of detail to enable their assessment at validation (“Initial PAIs”).

The geographic areas included in the project are the physical boundaries of the United Kingdom, those being 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. Dwellings included in the project are subject to the same baseline scenario and rationale for the demonstration of additionality.

Additional individual dwellings will be added throughout the crediting period. These additional project activity instances will meet the eligibility criteria identified in this section 1.4 of this document and will be validated at the time of verification against the eligibility criteria. Additional project activity instances will have a start date (i.e., the date upon which the project activity instance begins reducing or removing GHG emissions) that is the same as or later than the project start date.

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 dwelling⁸ will meet the following eligibility conditions:

Table 1. Detailed description of the application of the eligibility criteria

No	Eligibility Condition	Project Compliance
1	The dwelling is located within the physical boundaries of the United Kingdom	<p>The physical address is checked to ensure the dwelling is located within the physical boundaries of the United Kingdom</p> <p>Documentation:</p> <p>a. the physical address and geodetic coordinates of the dwelling as provided by the dwelling owner</p> <p>Documentation is maintained in the project activity files</p>

The Initial PAIs included in the project activity meet this criterion as follows:

- The physical address of each dwelling was provided by the dwelling owner

⁸ Being a dwelling, as defined in UK legislation, currently the Finance Act 2013, c. 29, part 3, the Landlord and Tenant 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

- The address of each dwelling was checked to ascertain whether it is located within the physical boundaries of the United Kingdom
- The dwellings are all located in the United Kingdom

No	Eligibility Condition	Project Compliance
2	The dwelling is a single-family dwelling ⁹	The address of the dwelling is checked against the relevant Local Authority's register of "houses in multiple occupation" Documentation: a. Reports for each project activity instance are generated by the project proponent Documentation is maintained in the project activity files

The Initial PAIs included in the project activity meet this criterion as follows:

- The address of each dwelling was checked against the relevant Local Authority's register of "houses in multiple occupation"
- 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 ¹⁰ as evidenced by the owner or operator being a regulated provider of social housing or public entity; or

⁹ Not a "house in multiple occupation" as currently defined in the Housing Act 2004, c. 34, section 254

¹⁰ Housing and Regeneration Act 2008, c. 17, section 68

		<p>Household income up to £40,212 as defined by the Living Wage Commission¹¹ and as declared by the dwelling owner; or</p> <p>The dwelling is in a neighbourhood identified as 'deprived' as defined by the Department for Levelling Up, Housing and Communities¹²</p> <p>Same income group (middle-income):</p> <p>Household income above £40,212 and up to £70,004 as defined by the Living Wage Commission¹³ and Department for Education¹⁴ and as declared by the dwelling owner; or</p> <p>The dwelling is not in a neighbourhood identified as 'deprived' as defined by the Department for Levelling Up, Housing and Communities¹⁵</p> <p>Documentation:</p> <ol style="list-style-type: none"> a. The owner or operator is a regulated provider of social housing or public entity or b. Declaration by the dwelling owner or c. The physical address and geodetic coordinates of the dwelling as provided by the dwelling owner
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¹¹ 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.

¹² 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.

¹³ 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.

¹⁴ [Upper earnings threshold](#) for a household to [receive financial support for full-time education](#) for 2020/21.

¹⁵ 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.

		<p>d. Reports for each project activity instance are generated by the project proponent</p> <p>Documentation is maintained in the project activity files</p>
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The Initial PAIs included in the project activity meet these criteria as follows:

- The owner of the dwellings was checked against the Regulator of Social Housing’s register of regulated providers of social housing¹⁶
- The owner is a regulated provider of social housing
- The status of the dwellings is social housing stock under the Housing and Regeneration Act 2008
- The dwellings are all in the same income group (low-income)

No	Eligibility Condition	Project Compliance
6	Project ownership is accorded to the project proponent by a contractual agreement with the holder of the statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions	<p>Project ownership is accorded to the project proponent by the dwelling owner</p> <p>Documentation:</p> <p>a. An agreement with the dwelling owner which vests project ownership in the project proponent</p> <p>Documentation is maintained in the project activity files</p>

The Initial PAIs included in the project activity meet this criterion as follows:

- An agreement with the dwelling owner dwelling owner which vests project ownership in the project proponent¹⁷

¹⁶ Registered Providers of Social Housing, Regulator of Social Housing, February 2022.

¹⁷ Schedule 1(3) and (10)

In addition to meeting the eligibility conditions, dwellings and decarbonisation measures will meet the applicability conditions set out in the methodology. See section 3.2 (Application of the methodology) for a detailed description of these criteria and their application to the Initial PAIs included in this Project Description.

1.5 Project Proponent

Organization name	Arctica Partners
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 with a social purpose organisation to maximise the essential work of decarbonising the UK's 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 across the UK.

1.6 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	housing@arcticapartners.com
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This project operates in partnership with HACT. As the charity and innovation agency of the social housing sector, HACT has supported the transformation and development of housing providers 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.

1.7 Ownership

Project ownership is accorded to the project proponent by the dwelling owner. The project proponent is not expected to be the owner of the dwellings, unless there is documentation that legally proves the opposite.

1.8 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. The project crediting period start date is expected to be July 1, 2022.

1.9 Project Crediting Period

The project crediting period start date is expected to be 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.

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	X
Large project	

Ex-ante calculation (estimate) of emission reductions for the initial instances of project activity:

Year	Estimated GHG emission reductions or removals (tCO ₂ e)
2022	41
2023	82
2024	82
2025	82
2026	82
2027	82
2028	82
2029	41
Total estimated ERs	574
Total number of crediting years	Seven (1 st crediting period), twice renewable for a total of 21 years
Average annual ERs	82

1.11 Description of the Project Activity

Emission reductions are achieved within the categories of project activity defined in section 4.2 in the VM0008 Methodology. The categories are **Category A**, and **Category B**.

Eligible decarbonisation measures are those directed at reducing the fossil fuel and electricity consumption within a dwelling, for example:

Adding insulation that increases the resistance to conductive heat loss and reduces air infiltration either singularly or in aggregate within the building envelope, e.g., loft insulation; cavity wall insulation; external wall insulation; draught-proofing; replacing existing window glazing and/or floor insulation (**Category A** and **Category B**)

Improving the efficiency of, or replacing, the central heating components, e.g., cylinder insulation; thermostat, boiler, or heat pump controls; upgrading boiler with a condensing equivalent; and/or replacing gas boiler with a heat pump (**Category A**, and **Category B**)

Reducing fossil fuel and electricity consumption of the appliance plug load, e.g., replacement of ventilation units and lamps (**Category A**)

This list is not exhaustive.

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

Achieving emission reductions within Individual dwellings

Decarbonisation measures directed at reducing the fossil fuel and electricity consumption reduce the rate of conductive heat loss in the winter or heat gain in the summer, reduce air infiltration and consequently reduce convective heat loss or heat gain and reduce the rate of fossil fuel consumption within the dwelling. Reduced fossil fuel use resulting from decarbonisation measures generates emission reductions.

The steps required to achieve emission reductions are outlined below:

Identification of Dwellings

The project proponent identifies dwellings eligible to participate in the project activity in accordance with the eligibility criteria specified in section 1.4 (Eligibility Criteria) of this document.

Assigning Carbon Ownership

An agreement is signed by the dwelling owner which vests project ownership in the project proponent.

Energy Assessment

An accredited energy assessor conducts an energy assessment of the dwelling using the Standard Assessment Procedure (SAP) which is the UK Government's National Calculation Methodology for assessing the energy performance of dwellings and is the energy assessment system used for assessing dwellings in the project activity. The energy assessment records dwelling characteristics including size of the dwelling, fuel type, heating systems and controls and current heat load and electricity demand. All relevant data fields required to determine emission reductions are compiled by an accredited energy assessor.

Baseline Determination

The baseline scenario is calculated using data stored in the centralised data repository in accordance with the approach outlined in the VM0008 Methodology and defined in section 3.4 (Baseline Scenario) and section 4.1 (Emission Reductions and Removals) of this document.

Installation of Measures

Installation of the decarbonisation measures is carried out by persons of appropriate skill and experience in accordance with nationally recognised best practice standards, building regulations and any other applicable regulations that relate to the installation of the measure.

Calculating Additionality

Additionality is calculated using data stored in the centralised data repository in accordance with the approach outlined in the VM0008 Methodology and defined in section 3.5 (Additionality) of this document and section 4.4 (Emission Reductions and Removals) of this document. The project proponent compares the percent savings in **energy load** with the performance standard for all dwellings included within the project activity.

Calculating Emission Reductions

Emission reductions are calculated using data stored in the centralised data repository in accordance with the approach outlined in the VM0008 Methodology and defined in section 4.4 (Emission Reductions and Removals) of this document.

Monitoring

The project proponent oversees appropriate monitoring procedures. All necessary data are detailed in section 5 (Monitoring) of this document.

Adding Dwellings to the Grouped Project

Only dwellings that meet the eligibility criteria specified in section 1.4 (Eligibility Criteria) of this document are added to the project.

1.12 Project Location

The project activity location is within the physical boundaries of the United Kingdom those being 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.

1.13 Conditions Prior to Project Initiation

The conditions for dwellings in the project boundary are described below. These dwellings are some of the worst in Europe for thermal and energy efficiency, fossil fuel consumption and GHG emissions intensity, which results in high energy use and burden.¹⁸ They account for around 30

¹⁸ The decarbonisation of heat. Regen. 2020.

per cent of energy use and around 14 per cent of GHG emissions in the United Kingdom.¹⁹ When adjusting for annual temperature variation, emissions from these dwellings rose by 1% in 2017.²⁰ Currently, the amount of decarbonisation occurring is significantly less than the amount needed.²¹

The independent Climate Change Committee has said the decarbonisation of dwellings is the greatest challenge the UK faces to become a net zero carbon economy.²² More than the expansion of renewable electricity generation, or the electric transport revolution, the delivery of low carbon dwellings must overcome several consumer, technological, infrastructure and market barriers. In part, the scale of the challenge reflects the importance of heat utility in homes. Easy access to affordable heat has a profound impact in terms of health, comfort, well-being, and productivity, for people in their homes.

Emission reductions from the UK's 28.6 million dwellings has stalled.²³ Only 10% of UK dwellings currently use electricity as their main heating source.²⁴ This puts the UK towards the bottom of the league table of European countries in terms of the proportion of heat sourced from renewable sources.²⁵ The predominant source of heating is natural gas which is a fossil fuel and a significant source of carbon emissions. At the point of consumption, burning natural gas in a domestic boiler releases around 222 grams of CO_{2e} for every kWh of fuel energy input (the full supply chain and lifecycle emissions of natural gas are even higher).²⁶

By January 2023, over half of households in the UK will be in fuel poverty – spending over 10 per cent of net income on energy..²⁷ To date the government's focus has been aimed at encouraging improvement in the energy cost of dwellings.²⁸ By placing focus on reducing the cost of input fuel rather than reducing emissions, a consequence is that dwelling owners have been encouraged towards the use of cheaper but higher carbon fuels such as natural gas. Many of the steps taken to reduce energy costs and address fuel poverty have revolved around continued investment in gas network expansion.²⁹

¹⁹ Residential emissions were 19% of carbon emissions in 2019. BEIS. 2020. [UK Greenhouse Gas Emissions](#) provisional figures; 29% of energy use in 2019, 29.9% when temperature corrected. BEIS. 2020. [Consumption Data tables](#).

²⁰ [Home insulation and the net zero target](#). House of Lords Library. 2020.

²¹ [UK housing: Fit for the future?](#) Climate Change Committee. 2019.

²² [UK housing: Fit for the future?](#) Climate Change Committee. 2019.

²³ [Energy Efficiency of Existing Homes](#). House of Commons Environmental Audit Committee. 2021.

²⁴ [The decarbonisation of heat](#). Regen. 2020.

²⁵ [The decarbonisation of heat](#). Regen. 2020.

²⁶ [CO₂ emission factor prescribed](#) by Part L of the Building Regulations.

²⁷ [Fuel Poverty: Updated Estimates for the UK](#). Child Poverty Action Group. 2022.

²⁸ [Energy Efficiency of Existing Homes](#). House of Commons Environmental Audit Committee. 2021.

²⁹ [The decarbonisation of heat](#). Regen. 2020.

It is also important to consider the state of building stock in the UK. Specific standards regarding insulation were only introduced in 1999. Due to the relatively slow turnover and replacement rate for older dwellings, the current stock is characterised by older dwellings which were poorly built to relatively low thermal and energy efficiency standards.^{30 31} Even with an expected uplift in the current rate of new home building, it is expected that most of the current housing stock will still be standing in 2050 and will by then make up 80% of the total stock.³² A massive investment programme is needed to retrofit efficiency measures to the fabric of existing dwellings. Low-carbon heat cannot be deployed cost-effectively unless buildings are properly insulated.³³

There is significant opportunity to increase decarbonisation in the UK and thereby improve the energy efficiency of the housing stock, reduce GHG emissions and reduce the financial burden of home heating for the population.

Regulatory surplus

Decarbonisation activity to improve the energy efficiency of dwellings housing is not mandated by enforced law, statute, or another regulatory framework in the UK. Furthermore, emissions reductions needed from the housing stock to meet the country's net zero ambitions do not have a clear policy plan, have significant funding gaps, and it is unclear how the government plans to deliver its targeted ambition.

The Climate Change Act (CCA) commits the UK government by law to reduce greenhouse gas emissions by 2050. The Act established the Committee on Climate Change to independently assess resulting Government policy. In its 2022 Progress Report to UK Parliament³⁴, the Committee on Climate Change concluded the government's climate change strategy will not deliver net zero and pointed to the poor insulation and dependence of the housing stock on fossil fuel for space and water heating as two of the main areas of material policy failure. In a statement accompanying the report, the Committee on Climate Change identified a "a shocking gap in policy for better insulated homes".

The UK Government had set out its plans to decarbonise the buildings sector in its Heat and Buildings Strategy³⁵. The Committee on Climate Change published an independent assessment of these policies in March 2022³⁶, which found that decarbonisation activity to improve the energy efficiency of the housing stock is not mandated by enforced law, statute, or another

³⁰ [Energy Efficiency of Existing Homes](#). House of Commons Environmental Audit Committee. 2021.

³¹ [The decarbonisation of heat](#). Regen. 2020.

³² [The decarbonisation of heat](#). Regen. 2020.

³³ [Energy Efficiency of Existing Homes](#). House of Commons Environmental Audit Committee. 2021.

³⁴ [Progress in reducing emissions 2022 Report to Parliament](#). Committee on Climate Change. 2022.

³⁵ [Heat and Buildings Strategy](#). HM Government. 2021

³⁶ [Independent Assessment: The UK's Heat and Buildings Strategy](#). Committee on Climate Change. 2022.

regulatory framework, concluding that “standards can only be effective if they are maintained, measured accurately and enforced.” The Government’s approach to housing decarbonisation is instead reliant on market-based incentives and mechanisms to drive delivery, notably for energy efficiency in owner-occupied homes and social housing.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

The project proponent affirms that no relevant laws or regulations are violated by the project activity. The project proponent undertakes to abide by all regulations while performing project activities.

1.15 Participation under Other GHG Programs

1.15.1 Projects Registered (or seeking registration) under Other GHG Program(s)

The project has not applied for registration under any other GHG programme. Dwelling owners 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.

1.15.2 Projects Rejected by Other GHG Programs

The project has not applied for registration under any other GHG programme and has not been rejected by any other GHG programme.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

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

1.16.2 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.

1.17 Sustainable Development Contributions

As called for by the VCS Standard v 4.3, this project contributes to sustainable development, as defined by, and tracked against the United Nations Sustainable Development Goals (SDGs).

These aim to end poverty, protect the planet, and ensure prosperity for all, by achieving 17 goals by 2030.³⁷

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 following SDG:

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

But the benefits also go far beyond carbon mitigation. The condition of dwellings in the project boundary is described in section 1.13 above. These dwellings were built to relatively low thermal and energy efficiency standards and are cold and expensive to heat.

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.³⁸ Children living in cold housing conditions are more than twice as likely to suffer from breathing problems, including asthma and bronchitis.³⁹ The Climate Change Committee 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.⁴⁰

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.⁴¹ Premature mortality related to fuel poverty is said to be responsible for 17,000 excess deaths per year.⁴² 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 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.⁴³

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

- SDG 1: End poverty in all its forms everywhere

³⁷ [Sustainable Development Goals](#). United Nations. 2021.

³⁸ [Fuel Poverty](#). House of Commons Library. 2021.

³⁹ [Assessing the Health Impact of Cold Homes](#). Centre for Sustainable Energy. 2017.

⁴⁰ [UK housing: Fit for the future?](#) Climate Change Committee. 2019.

⁴¹ [Heat Decarbonisation: Potential Impacts on Social Equity and Fuel Poverty](#). National Energy Action. 2017.

⁴² [E3G and National Energy Action](#). February 2019.

⁴³ [Heat Decarbonisation: Potential Impacts on Social Equity and Fuel Poverty](#). National Energy Action. 2017.

- SDG 3: Ensure healthy lives and promote well-being for all at all ages
- SDG 7: Ensure access to affordable, reliable, sustainable and modern energy
- SDG 10: Reduce inequality within and among countries
- SDG 11: Make cities inclusive, safe, resilient, and sustainable

Decarbonisation measures also have the potential to create jobs and boost existing firms (especially SMEs and their supply chains) in construction. Economy-wide, there is considerable potential to develop and extend the labour force with a full range of high value skills⁴⁴. By enabling the deployment of housing decarbonisation more widely, cost-effectively, and earlier than the present, this project also directly supports the following SDGs:

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

Measuring contribution to sustainable development

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

Social value refers to all the impacts that an intervention, policy, or project has on society and the value that these impacts have, both positive and negative. The social value of a project is the net value generated to society. As called for by VCS Standard v 4.3, a project must positively contribute to at least three SDGs. The social value generated by this project contributes to the eight SDGs identified above. This section is focussed on the approach taken by this project to quantify in a systematic way its contribution to sustainable development.

Wellbeing Valuation approach⁴⁵

⁴⁴ [Heat Decarbonisation: Potential Impacts on Social Equity and Fuel Poverty](#). National Energy Action. 2017.

⁴⁵ The use of values contained in the UK Social Value Bank, including the headline figures provided for illustration in this section and the values used in the project, are covered by licensing conditions, and appear with the consent of the copyright owner. These materials are made available for you to use (the "Authorised Use") for your review of this project under the VCS Program. Except for the Authorised Use, all commercial use of this document is prohibited.

In 2014, HACT and Simerica⁴⁶ produced the UK Social Value Bank, which applies a Wellbeing Valuation approach to value the impact of housing providers' activities on their residents. It contains values for investment outcomes in domains such as employment and training, health, housing maintenance, money management, local neighbourhood and crime, physical activity and, importantly, dwelling energy efficiency. Updated in 2022 to understand wellbeing and exchequer impacts, the UK Social Value Bank 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. This project uses the UK Social Value Bank to assess the impact of project activity on health and wellbeing.

Wellbeing Valuation judges the success of a project by how it affects people's wellbeing. Rather than asking people about how much something has improved their life, which can introduce psychological complexities and extensive data collection, Wellbeing Valuation analyses existing datasets of national surveys which instead reveal effects on wellbeing in a robust way. Analysis can isolate the impact of a specific aspect of life on wellbeing. This can be valued by finding from the data the equivalent amount of money needed to increase someone's wellbeing by the same amount. Wellbeing Valuation is recognised in HM Treasury's Green Book – the UK Government's core guide to policy evaluation⁴⁷ – as a method for placing values on things that do not have a market value through being bought and sold. Wellbeing valuation is also in the Treasury supplementary green book guidance on wellbeing appraisal.

In this project, the focus is the social value of improving the energy performance of a dwelling – that is the value that people gain in terms of enhanced life satisfaction through improvements to the dwelling's thermal and energy efficiency. Using Wellbeing Valuation, HACT and Simerica analysed data collected through the English Housing Survey (EHS) which is a continuous national survey commissioned by the Department for Levelling Up, Housing and Communities.⁴⁸ It collects information about people's housing circumstances and the condition of dwellings in England. It was first run in 2008-2009 and each year a sample of addresses is drawn at random from a list of private addresses held by the Royal Mail. The EHS collects information from over 13,000 households and is made up of two components:

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

⁴⁶ HACT, registered as the Housing Associations Charitable Trust, and Simerica-Jacobs, the international experts in social value analysis, research, and econometrics, have established reputations for producing ground-breaking social impact measurement research and the development of accompanying practical tools for the housing sector. This includes the 2014 study *Measuring the Social Impact of Community Investment: a Guide to Using the Wellbeing Valuation Approach and accompanying Value Calculator*, and the 2015 studies *The Health Impacts of Housing Associations' Community Investment Activities* and *The Wellbeing Value of Tackling Homelessness*

⁴⁷ [The Green Book: Central Government Guidance on Appraisal and Evaluation](#). HM Treasury. 2020.

⁴⁸ [The English Housing Survey](#). Department for Levelling Up, Housing and Communities. 2021.

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

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

HACT and Simetrica also used data collected through the British Household Panel Survey (BHPS) which has been completed each year by more than 10,000 of the same individuals since 1991 and so incorporates over 20 years of panel data.⁴⁹

To implement a Wellbeing Valuation approach, HACT and Simetrica constructed a Health model to assess the association between energy performance and general self-reported health using data from the EHS⁵⁰. They used data from the BHPS to construct a Life Satisfaction model to assess the association between health and life satisfaction⁵¹. By combining these two associations they isolated the average relationship that a particular energy performance would have with life satisfaction.⁵² By accessing data on income, they were able to estimate how higher levels of income are associated with life satisfaction and isolate the amount of money that has the equivalent association with an individual's life satisfaction as a specific improvement in energy performance.

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

Standard Assessment Procedure rating variables

The results obtained by HACT and Simetrica indicate that improving the energy performance of a dwelling has a significant association with the wellbeing of individuals living in the dwelling. This provides an indication that decarbonisation measures directed at reducing the fossil fuel

⁴⁹ [British Household Panel Survey](#). University of Essex. 2011.

⁵⁰ This is explained further in Appendix A1 of the 2014 study [Measuring the Social Impact of Community Investment: a Guide to Using the Wellbeing Valuation Approach](#) and as set out in previous work: Fujiwara, D., Kudrna, L., and Dolan, P. (2014). [Quantifying and Valuing the Wellbeing Impacts of Culture and Sport](#) (p. 45). London, UK: Department for Culture, Media and Sport

⁵¹ This is explained further in Appendix A1 of the 2014 study [Measuring the Social Impact of Community Investment: a Guide to Using the Wellbeing Valuation Approach](#)

⁵² Further details of the wellbeing valuation methodology can be found in the [Technical Manual](#)

consumption within a dwelling are associated with higher social value. To quantify the increase in value, HACT and Simetrica measured the amount of money that would induce the same increase in life satisfaction as an improvement in energy performance rating by one or multiple EPC bands.

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

EPC Band	SAP point range
A (most energy efficient)	92-100
B	81-91
C	69-80
D	55-68
E	39-54
F	21-38
G (least energy efficient)	1-20

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

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

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

- a) leads on average to an increase in people's life satisfaction
- b) the amount of money that would induce the same increase in life satisfaction is £1,000

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

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

Calculating the SAP rating for this project

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

Pre- and post-retrofit energy assessments are undertaken by accredited energy assessors certified by a public authority, or a private certification program recognised by a public authority. Energy assessments are conducted using the Standard Assessment Procedure (SAP) which is the Government-approved National Calculation Methodology for assessing the energy performance of 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 electricity consumption and may include physical inspection, diagnostic tests, use energy modelling software that implements the latest approved worksheet and conventions for SAP calculations as set out in the manual describing the Government's Standard Assessment Procedure, or apply building physics calculations.

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

Calculating the number of occupants for each project activity instance

The values drawn from the UK Social Value Bank are the value of an improvement in the SAP rating of a dwelling per person per year. To determine the average uplift in wellbeing for each

project activity instance in this project, it is necessary to multiply the values by the number of adult occupants of the dwelling over 16 years of age. For example, if the improvement in the SAP rating of a dwelling in this project is worth on average £2,000 per person per year and there are 3 adult occupants of the dwelling over 16 years of age then an annual total of £6,000 of social value has been measured.

Equation 1:

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

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

The manual describing the Government’s Standard Assessment Procedure sets out the following rules for determining the standardised number of occupants of a dwelling:⁵³

Equation 2:

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

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

For example, project activity instance 10011 has a Total Floor Area of 109 square meters. From the SAP rules for determining the number of occupants of a dwelling, the number of occupants benefitting from the uplift in wellbeing is 3.⁵⁴

Application to project activity instances

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

1. The baseline SAP rating for each dwelling added to the project is obtained from the pre-retrofit energy assessment (baseline SAP rating)

⁵³ 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

⁵⁴ As the Total Floor Area is greater than 13.9, equation 2(a) is used. The number of occupants = $1 + 1.76 \times [1 - \exp(-0.000349 \times (109 - 13.9)^2)] + 0.0013 \times (109 - 13.9)$

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

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

1. The baseline SAP rating is 66
2. Assume the SAP rating after project implementation is 90
3. The change in SAP rating would be 24 SAP rating points
4. The uplift in life satisfaction (Wellbeing Value) would be worth on average £2,445 per year
5. The number of occupants benefitting from the uplift in wellbeing is 3
6. The project activity instance's contribution to sustainable development is £7,335 per year
7. There would also be other impacts such as being able to heat the home in the winter, financial comfort and being relieved from burden of debt along with savings to the state (exchequer value).

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

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

Table 2. Summary table of estimated social value / contribution to sustainable development of initial project activity instances

Project Activity Instance	Wellbeing value	Number of occupants	Social value / Contribution to SDGs per yr.
10001	£3,001.00	2	£6,002.00
10002	£1,701.00	2	£3,402.00
10003	£2,268.00	2	£4,536.00
10004	£1,100.00	3	£3,300.00
10005	£2,008.00	2	£4,016.00
10006	£2,073.00	2	£4,146.00
10007	£3,717.00	2	£7,434.00
10008	£2,569.00	3	£7,707.00
10009	£1,949.00	2	£3,898.00
10010	£2,327.00	1	£2,327.00
10011	£2,445.00	3	£7,335.00
10012	£1,323.00	1	£1,323.00
10013	£1,949.00	2	£3,898.00
10014	£1,571.00	2	£3,142.00
10015	£2,008.00	3	£6,024.00
10016	£2,333.00	2	£4,666.00
10017	£2,699.00	3	£8,097.00

10018	£1,878.00	3	£5,634.00
10019	£3,173.00	2	£6,346.00
10020	£2,073.00	2	£4,146.00
10021	£2,079.00	2	£4,158.00
10022	£2,073.00	2	£4,146.00
10023	£2,225.00	2	£4,450.00
10024	£2,279.00	3	£6,837.00
10025	£1,335.00	3	£4,005.00
10026	£1,884.00	1	£1,884.00
10027	£1,766.00	2	£3,532.00
10028	£1,766.00	2	£3,532.00
Total	£129,923 in Social Value contribution / yr.		

1.18 Additional Information Relevant to the Project

Leakage Management

All leakage emissions are managed in accordance with leakage requirements identified in section 5 of the VM0008 Methodology and defined in section 4.3 (Leakage) of this document. 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 that are replaced as part of the project activity are required to be disposed of properly. Proof of proper disposal is demonstrated by a Building Regulations Compliance Certificate, or a Gas Safety Certificate, or a declaration by the dwelling owner that work was carried out by a person registered with a competent person scheme, a certificate under Publicly Available Specification (PAS) or an equivalent standard, or assessment by an accredited energy assessor or a declaration by a regulated provider of social housing or public entity.

Commercially Sensitive Information

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

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Further Information

Not applicable.

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. A literature review and initial outreach with interested parties took place between March and October 2021.

From this work the following categories of local stakeholder were identified:

- Dwelling owners
- Residents
- Fuel poverty charities
- Decarbonisation measure installers
- Carbon credit buyers
- Data vendors

- Government and local authorities

Engagement with potential local stakeholders took place in November 2021 around two major housing conferences with the aim of identifying local stakeholders who may be impacted by the project.

A set of follow-up virtual meetings took place between November 2021 and January 2022 with a focus group of identified local stakeholders.

During the design stage of the project, 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@arcticpartners.com). The project proponent has also partnered with 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.

HACT has reviewed the project documents and conducted interviews with representatives of the categories of local stakeholder identified above to understand the impact of this project. On an ongoing basis HACT will be monitoring the extent to which the project continues to be aligned with stakeholder expectations and will suggest amendments where the project could be improved, drawing on examples of good practice from within and beyond the social housing sector.

HACT has appointed a Relationship Lead for this project and has established a mechanism for ongoing communication with local stakeholders by promoting an email address to which local stakeholders have been invited to provide feedback (retrofitcredits@hact.org.uk). The project proponent and HACT regularly discuss the project with social stakeholders across the United Kingdom, for example, during a public webinar in August 2021 where they sought feedback about the project. A focus group of interested stakeholders has also been established and an inaugural roundtable will take place in November 2022.

2.3 Environmental Impact

Decarbonisation measures directed at reducing the fossil fuel consumption reduce the rate of conductive heat loss in the winter or heat gain in the summer, reduce air infiltration and consequently reduce convective heat loss or heat gain and reduce the rate of fossil fuel consumption within the dwelling. Reduced fossil fuel use resulting from decarbonisation measures generates emission reductions.

The project activity is not expected to have any adverse environmental impacts.

2.4 Public Comments

Following the procedures and guidelines established by the VCS Program this project was open for public comment from December 24th, 2021, for a 30-day public comment period. No adverse comments were received.

2.5 AFOLU-Specific Safeguards

Not applicable.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

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

3.2 Applicability of Methodology

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 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 the crediting period. Applying these conditions, any dwelling⁵⁵ or decarbonisation measure will meet the following eligibility conditions:

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

No	Applicability Condition	Project Compliance
1	<p>The condition of the dwelling is adequate for project activities according to nationally recognised best practice standards</p> <p>Project activities do not result in a violation of health and safety,</p>	<p>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,</p>

⁵⁵ Being a dwelling, as defined in UK legislation, currently the Finance Act 2013, c. 29, part 3, the Landlord and Tenant 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

	environmental, or other relevant regulations	<p>environmental and energy conservation obligations</p> <p>Building Regulations are designed to make sure dwellings are safe to use and inhabit and include requirements that address the applicability conditions</p> <p>Building Regulations are legal requirements that must be followed by those responsible for carrying out the work</p> <p>Compliance is demonstrated by a Building Regulations Compliance Certificate, or a declaration by the dwelling owner that work was carried out by a person registered with a competent person scheme, or a certificate under Publicly Available Specification (PAS)⁵⁶ or an equivalent standard, or a declaration by a regulated provider of social housing or public entity</p> <p>Documentation:</p> <ol style="list-style-type: none"> a. Building Regulations Compliance Certificate or b. Declaration by the dwelling owner 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
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⁵⁶ PAS sets out minimum standards and requirements for the installation of energy efficiency measures in existing buildings. PAS includes requirements in respect of installation processes, process management and service provision and includes criteria relating to installation methods, equipment, tools, product or system and material suitability, the commissioning of installed measures and the training, skills and competence of the people undertaking such installation

Documentation is maintained in the project activity files

The Initial PAIs included in the project activity meet these criteria as follows:

- The owner is a regulated provider of social housing
- 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 the regulated provider of social housing in the Contract for Provision of Verified Carbon Unit Services⁵⁷
- Project activities do not result in a violation of health and safety, environmental, or other relevant regulations as evidenced by a declaration by the regulated provider of social housing in the Contract for Provision of Verified Carbon Unit Services⁵⁸

No	Applicability Condition	Project Compliance
2	The replacement of appliances replaces functioning appliances	<p>Where the project activities include the replacement of appliances, a declaration by the dwelling owner</p> <p>Documentation:</p> <ul style="list-style-type: none"> a. Declaration by the dwelling owner b. Reports for each project activity instance are generated by the project proponent <p>Documentation is maintained in the project activity files</p>

The Initial PAIs included in the project activity meet this criterion as follows:

- Not applicable as the decarbonisation measures do not involve the replacement of appliances

⁵⁷ Schedule 1(4)(e)

⁵⁸ Schedule 1(4)(f)

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 ⁵⁹ , 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 dwelling owner ⁶⁰ Documentation: a. The status of the dwelling is social housing stock under the Housing and Regeneration Act 2008 ⁶¹ as evidenced by the owner or operator being a regulated provider of social housing or public entity b. Documentation or declaration by the dwelling owner c. Reports for each project activity instance are generated by the project proponent Documentation is maintained in the project activity files

The Initial PAIs included in the project activity meet this criterion as follows:

- The dwelling is occupied at the time of project activity as evidenced by a declaration by the dwelling owner in the Contract for Provision of Verified Carbon Unit Services⁶²

No	Applicability Condition	Project Compliance
4	The capacity of any replacement appliance or component of a central heating system satisfies the energy	Renovation of the thermal elements of a dwelling and replacement of heat producing systems are regulated

⁵⁹ For example, during installation of the decarbonisation measures

⁶⁰ 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

⁶¹ Housing and Regeneration Act 2008, c. 17, section 68

⁶² Schedule 1(4)(g)

	<p>load (the sum of the heat load and the electricity demand) within the dwelling</p>	<p>activities that must comply with the Building Regulations which are the primary source of health and safety, environmental and energy conservation obligations</p> <p>Building Regulations are designed to make sure dwellings are safe to use and inhabit and include requirements that address the applicability conditions</p> <p>Building Regulations are legal requirements that must be followed by those responsible for carrying out the work</p> <p>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</p> <p>Compliance is demonstrated by a Building Regulations Compliance Certificate, or a Gas Safety Certificate, or a declaration by the dwelling owner that work was carried out by a person registered with a competent person scheme, or a certificate under Publicly Available Specification (PAS)⁶³ or an equivalent standard, assessment by an accredited energy assessor or a declaration by a regulated provider of social housing or public entity</p> <p>Documentation:</p> <ol style="list-style-type: none"> a. Building Regulations Compliance Certificate or b. Gas Safety Certificate or c. Declaration by the dwelling owner that work was carried out by a
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⁶³ 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

		<p>person registered with a competent person scheme or</p> <p>d. Certificate under Publicly Available Specification (PAS) or an equivalent standard or</p> <p>e. Data compiled by an accredited energy assessor or</p> <p>f. Declaration a regulated provider of social housing or public entity</p> <p>g. Reports for each project activity instance are generated by the project proponent</p> <p>Documentation is maintained in the project activity files</p>
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The Initial PAIs included in the project activity meet these criteria as follows:

- The owner is a regulated provider of social housing
- 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 the regulated provider of social housing in the Contract for Provision of Verified Carbon Unit Services⁶⁴

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	<p>The type of heating system as identified by the pre-retrofit energy assessment, or as declared by the dwelling owner</p> <p>Documentation:</p> <p>a. Data from the pre-retrofit energy assessment or</p> <p>b. Declaration by the dwelling owner</p> <p>c. Reports for each project activity instance are generated by the project proponent</p>

⁶⁴ Schedule 1(4)(h)

		Documentation is maintained in the project activity files
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The Initial PAIs included in the project activity meet this criterion as follows:

- The heating systems supplying the dwellings do not serve multiple dwellings as evidenced by a declaration by the dwelling owner in the Contract for Provision of Verified Carbon Unit Services⁶⁵

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) and as declared by the dwelling owner Documentation: a. Declaration by the dwelling owner b. Reports for each project activity instance are generated by the project proponent Documentation is maintained in the project activity files

The Initial PAIs included in the project activity meet this criterion as follows:

- The project activity is not mandated, or required by law or regulation as evidenced by a declaration by the dwelling owner in the Contract for Provision of Verified Carbon Unit Services⁶⁶

No	Applicability Condition	Project Compliance
7	The dwelling meets or exceeds the performance benchmark as	Additionality is checked to ensure the dwelling meets or exceeds the performance benchmark

⁶⁵ Schedule 1(4)(j)

⁶⁶ Schedule 1(4)(k)

	calculated for the Same Building Stock	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 this document Documentation is maintained in the project activity files
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The Initial PAIs included in the project activity meet this criterion as follows:

- Additionality is calculated as set out in section 3.5 (Additionality) to ensure the dwelling meets or exceeds the performance benchmark
- 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 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.⁶⁷
- The pre-retrofit energy assessment determines the heat load and electricity demand (energy load) in the baseline. The post-retrofit energy assessment determines the heat load and electricity demand (energy load) following the implementation of project activity.
- To be additional, dwellings must satisfy the following condition:

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

- 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

⁶⁷ Additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 under the Pre- and post-retrofit energy assessment approach

- This Project Document includes information regarding the Initial PAIs planned and developed to a sufficient level of detail to enable their assessment at validation.
- At the time of validation only the pre-retrofit energy load can be obtained from first instance data for the Initial PAIs. For the purposes of validation, the post-retrofit energy load and change in energy load has been projected based on planned project activities. The actual change in energy load for the Initial PAIs will be calculated using first instance data as at the date of the completed installation of the decarbonisation measures.
- The projected change in energy load for the dwellings exceeds the performance benchmark as calculated for the Same Building Stock

No	Applicability Condition	Project Compliance
8	The decarbonisation measures fall into one of categories A or B	<p>The decarbonisation measures identified as installed by the Building Regulations Compliance Certificate, or Gas Safety Certificate, or declaration by the dwelling owner of work carried out by a person registered with a competent person scheme, or certificate under Publicly Available Specification (PAS)⁶⁸ or an equivalent standard, or declaration by a regulated provider of social housing or public entity or assessment by an accredited energy assessor</p> <p>Documentation:</p> <ol style="list-style-type: none"> a. Building Regulations Compliance Certificate or b. Gas Safety Certificate or c. Declaration by the dwelling owner of work carried out by a person

⁶⁸ 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

		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 f. Data compiled by an accredited energy assessor Reports for each project activity instance are generated by the project proponent Documentation is maintained in the project activity files
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The Initial PAIs included in the project activity meet this criterion as follows:

- The owner is a regulated provider of social housing
- This Project Document includes information regarding the Initial PAIs planned and developed to a sufficient level of detail to enable their assessment at validation. The decarbonisation measures to be installed are projected based on information from the dwelling owner
- The decarbonisation measures all fall into category B
- The decarbonisation measures installed will be evidenced by a declaration by the regulated provider of social housing in the Contract for Provision of Verified Carbon Unit Services⁶⁹

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

⁶⁹ Schedule 1(5)

		<p>a certificate under Publicly Available Specification (PAS)⁷⁰ or an equivalent standard, declaration by the dwelling owner or public entity or assessment by an accredited energy assessor</p> <p>Documentation:</p> <ol style="list-style-type: none"> a. Certificate under Publicly Available Specification (PAS) or an equivalent standard or b. Declaration by the dwelling owner c. Data compiled by an accredited energy assessor d. Reports for each project activity instance are generated by the project proponent <p>Documentation is maintained in the project activity files</p>
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The Initial PAIs included in the project activity meet this criterion as follows:

- 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 the pre-retrofit energy assessment

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)

⁷⁰ 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

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	<p>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. Initial project activity instances occur within this geographic area</p> <p>Eligibility criteria for future project activity instances are set out in Section 1.4 (Eligibility Criteria). 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</p> <p>Documentation:</p> <ol style="list-style-type: none"> a. the physical address and geodetic coordinates of the dwelling as provided by the dwelling owner <p>Documentation is maintained in the project activity files</p>

The Initial PAIs included in the project activity meet this criterion as set out in Section 1.4 (Eligibility Criteria).

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>i</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	Sampling is conducted in accordance with the methodology. When the adjusted consumption or the pre-and post-retrofit audit approach utilised, the methodology prescribes the size of the sample group of dwellings is established by multiplying 0.6 by the

<p>root of the total number of dwellings in the project but need not exceed 100 Dwellings.</p> <p>In any sampling approach, the following conditions must be met:</p> <ol style="list-style-type: none"> 1) The sample is statistically valid, and may be one of the following: <ol style="list-style-type: none"> a. Simple random sample b. Systematic sampling c. Stratified sampling within the Same Building Stock d. Cluster sampling. 2) The sample is representative of the population. 3) The data must come from an approved source, i.e., a certified energy auditor, or a nationally recognised data source. 4) Actions that may bias the sample will be avoided. Sampling will include 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 	<p>square root of the total number of dwellings</p>
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The calculation of the performance benchmark for Category A and Category B and the approaches to calculating emission reductions and related monitoring parameters meet this criterion as set out in Section 3.5 (Additionality), Section 4 (Quantification of GHG emission reductions and removals) and Section 5 (Monitoring).

In addition to meeting the applicability conditions, dwellings and decarbonisation measures will meet the eligibility conditions set out in section 1.4 (Eligibility Criteria) for a detailed description of these criteria and their application to the Initial PAIs included in this Project Description.

3.3 Project Boundary

The geographic areas included in the project are the physical boundaries of the United Kingdom, those being 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. All dwellings added to the project activity will be subject to the same baseline scenario and rationale for the demonstration of additionality.

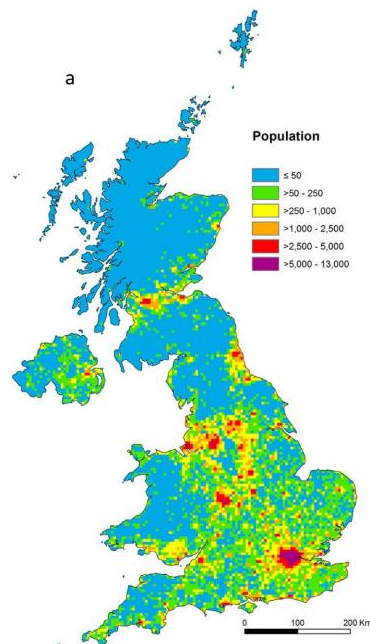
Coordinates for the physical boundary are:

Latitude: 49° 51'N to 59° 48'N

Longitude: 6° 27'W to 1° 46'E

There are currently about 28.6 million dwellings. Figure 1 below illustrates the spatial distribution of dwellings within the UK based on population.

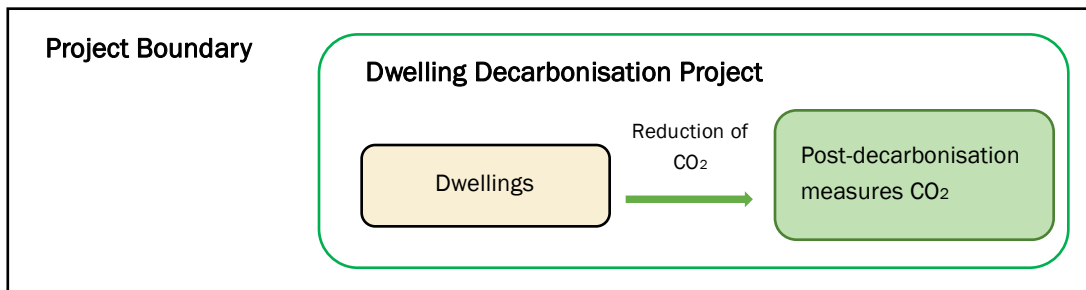
Figure 1. Distribution of dwellings within the UK based on population (2016)⁷¹



The flow diagram provided below, Figure 2, illustrates the systems and emissions sources and GHGs included within the project boundary.

Figure 2. Project boundary flow diagram

⁷¹ Vieno et al., 2016



The project boundary is the building envelope of dwellings and the associated heating and cooling equipment. Table 4 below identifies and assesses the GHG sources in the baseline and project scenario.

Table 4. Relevant GHG sources included in the baseline and project scenario

Source		Gas	Included?	Justification/Explanation
Baseline	Emissions from fuel combustion by heating systems	CO ₂	Included	Source of GHG emissions. Fuel combustion other than to satisfy the heat load is negligible and not separately accounted for
		CH ₄	Excluded	Negligible
		N ₂ O	Excluded	Negligible
		Other	Excluded	Negligible
	Emissions from grid electricity consumption by heating/cooling systems or other electric appliances	CO ₂	Included	Source of GHG emissions. Only GHG emissions from grid connected electricity generation are accounted for
		CH ₄	Excluded	Negligible
		N ₂ O	Excluded	Negligible
		Other	Excluded	Negligible
	Emissions from wood combustion for heat	CO ₂	Excluded	Excluded for simplification
		CH ₄	Excluded	Negligible
		N ₂ O	Excluded	Negligible
		Other	Excluded	Negligible
Project	Emissions from fuel combustion by	CO ₂	Included	Source of GHG emissions. Fuel combustion other than to satisfy the heat load is negligible and not separately accounted for

Source	Gas	Included?	Justification/Explanation
heating systems	CH ₄	Excluded	Negligible
	N ₂ O	Excluded	Negligible
	Other	Excluded	Negligible
Emissions from grid electricity consumption by heating/cooling systems or other electric appliances	CO ₂	Included	Source of GHG emissions. Only GHG emissions from grid connected electricity generation are accounted for
	CH ₄	Excluded	Negligible
	N ₂ O	Excluded	Negligible
	Other	Excluded	Negligible
Emissions from wood combustion for heat	CO ₂	Excluded	Excluded for simplification
	CH ₄	Excluded	Negligible
	N ₂ O	Excluded	Negligible
	Other	Excluded	Negligible
Emissions from improper disposal of boilers	CO ₂	Included	When the boiler is not disposed of according to applicable laws and regulations there could be leakage from continued operation. The leakage emissions are calculated and excluded from emission reductions as described in (Section 1.18 and Section 4.3).
	CH ₄	Excluded	Negligible
	N ₂ O	Excluded	Negligible
	Other	Excluded	Negligible

The United Kingdom of Great Britain and Northern Ireland, commonly known as the United Kingdom (UK) or Britain, is a sovereign country in Western Europe. Lying off the north-western coast of the European mainland, the UK includes the island of Great Britain, the north-eastern part of the island of Ireland and many smaller islands. With an area of 242,500 square kilometers, the UK is the 78th-largest sovereign state in the world. It is also the 21st-most populous country, with an estimated 65.5 million inhabitants in 2016.

Figure 3. Geographical boundary of the country where the initial project activity is implemented



The Initial PAIs are all located in England and will be retrofitted to install a combination of energy efficiency measures directed at the enhancement of the building envelope (i.e., air infiltration, insulation), and improving the efficiency of the central heating and/or cooling system and reducing fossil fuel and electricity consumption of appliances (i.e., replacement of ventilation units and lamps). These project activity instances fall into **Category B**.

The dwellings are all characterised by having low thermal and energy efficiency standards. Decarbonisation measures directed at reducing the fossil fuel and electricity consumption reduce the rate of conductive heat loss in the winter or heat gain in the summer, reduce air infiltration and consequently reduce convective heat loss or heat gain and reduce the rate of fossil fuel consumption within the dwelling. Reduced fossil fuel use resulting from decarbonisation measures generates emission reductions.

3.4 Baseline Scenario

The baseline scenario represents the conditions most likely to occur in the absence of the project. In accordance with the VM0008 Methodology, the baseline scenario is defined as the fossil fuel consumed to satisfy the heat load and electricity demand during the most recent twelve-month period for which data are available prior to project implementation. The baseline fossil fuel and electricity consumption are calculated for each type of Same Building Stock from vendor reported natural gas and electricity meter-point readings published by the Department for Business, Energy and Industrial Strategy (BEIS) as part of the National Energy Efficiency

Data Framework (NEED).⁷² The independent data has been collected and arranged in a systematic or methodical way by the project proponent.

Same Building Stock: Low-income single-family dwellings – Fossil fuel consumption

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.^{73 74 75} The sample size was 11,066,210 low-income single-family dwellings within the United Kingdom.

The baseline is calculated using actual natural gas consumption data for approximately 78% of the total population of low-income single-family dwellings within the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology⁷⁶.

Table 5. Baseline fossil fuel consumption calculations for Low-income single-family dwellings

Household income	Number in sample	Mean
Less than £15,000	2,547,420	9,800 kWh
£15,000 to £19,999	1,615,740	11,000 kWh
£20,000 to £29,999	3,774,130	12,000 kWh
£30,000 to £39,999	3,128,920	13,200 kWh

⁷² 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

⁷³ Additional Consumption Tables: England, Wales and Scotland, 2019. Department for Business, Energy and Industrial Strategy (BEIS). December 2021.

⁷⁴ 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 Table A11 of the Household natural gas and electricity consumption data published by BEIS under the NEED framework

⁷⁶ 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

Baseline fossil fuel consumption for Low-income single-family dwellings is calculated using a weighted mean calculation which results in natural gas consumption of 11,500 kWh annually.⁷⁷

Same Building Stock: Low-income single-family dwellings – Grid electricity consumption

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.^{78 79 80} The sample size was 13,480,630 low-income single-family dwellings within the United Kingdom.

The baseline is calculated using actual grid electricity consumption data for approximately 92% of the total population of low-income single-family dwellings within the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology.⁸¹

Table 6. Baseline electricity consumption calculations for Low-income single-family dwellings

Household income	Number in sample	Mean
Less than £15,000	3,304,520	2,700 kWh
£15,000 to £19,999	1,963,250	3,100 kWh
£20,000 to £29,999	4,490,300	3,400 kWh
£30,000 to £39,999	3,722,560	3,600 kWh

⁷⁷ Consumption is rounded down to the nearest 100 kWh

⁷⁸ Additional Consumption Tables: England, Wales and Scotland, 2019. Department for Business, Energy and Industrial Strategy (BEIS). December 2021.

⁷⁹ 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

⁸⁰ Table A12 of the Household natural gas and electricity consumption data published by BEIS under the NEED framework

⁸¹ 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

Baseline electricity consumption for Low-income single-family dwellings is calculated using a weighted mean calculation which results in electricity consumption of 3,000 kWh annually.⁸²

Same Building Stock: Middle-income single-family dwellings – Fossil fuel consumption

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.^{83 84 85} The sample size was 4,879,760 middle-income single-family dwellings within the United Kingdom.

The baseline is calculated using actual natural gas consumption data for approximately 78% of the total population of middle-income single-family dwellings within the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology.⁸⁶

Table 7. Baseline fossil fuel consumption calculations for Middle-income single-family dwellings

Household income	Number in sample	Mean
£40,000 to £49,999	2,367,880	13,900 kWh
£50,000 to £59,999	1,476,750	14,700 kWh
£60,000 to £69,999	1,035,130	15,700 kWh

⁸² Consumption is rounded down to the nearest 100 kWh

⁸³ Additional Consumption Tables: England, Wales and Scotland, 2019. Department for Business, Energy and Industrial Strategy (BEIS). December 2021.

⁸⁴ 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

⁸⁵ Table A11 of the Household natural gas and electricity consumption data published by BEIS under the NEED framework

⁸⁶ 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

Baseline fossil fuel consumption for Middle-income single-family dwellings is calculated using a weighted mean calculation which results in natural gas consumption of 14,400 kWh annually.⁸⁷

Same Building Stock: Middle-income single-family dwellings – Grid electricity consumption

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.^{88 89 90} The sample size was 5,851,540 middle-income single-family dwellings within the United Kingdom.

The baseline is calculated using actual electricity consumption data for approximately 92% of the total population of middle-income single-family dwellings within the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology.⁹¹

Table 8. Baseline electricity consumption calculations for Middle-income single-family dwellings

Household income	Number in sample	Mean
£40,000 to £49,999	2,817,440	3,800 kWh
£50,000 to £59,999	1,775,840	4,000 kWh
£60,000 to £69,999	1,258,260	4,200 kWh

⁸⁷ Consumption is rounded down to the nearest 100 kWh

⁸⁸ Additional Consumption Tables: England, Wales and Scotland, 2019. Department for Business, Energy and Industrial Strategy (BEIS). December 2021.

⁸⁹ 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

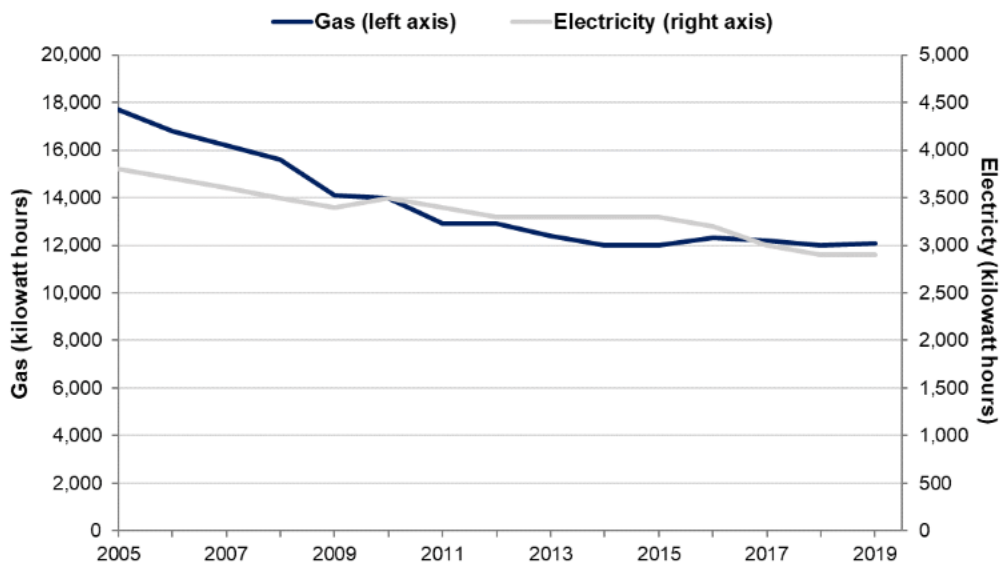
⁹⁰ Table A12 of the Household natural gas and electricity consumption data published by BEIS under the NEED framework

⁹¹ 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

Baseline electricity consumption for Low-income single-family dwellings is calculated using a weighted mean calculation which results in electricity consumption of 3,900 kWh annually.⁹²

Fossil fuel consumption remains static in the initial baseline scenario. This is since historical consumption reports for the five years prior to the baseline indicate that fuel consumption either remains the same or increases (see Figure 4). For example, had the baseline scenario been calculated with data for 2014, the natural gas consumption for low-income single-family dwellings would have also been 11,500 kWh annually and the consumption for middle-income single-family dwellings would have also been 14,400 kWh annually. Changes in electricity demand over time are addressed using an Electricity Correction Factor applied during the calculation of emission reductions.

Figure 4. Trends in median annual domestic natural gas and electricity consumption, England and Wales, 2005 – 2019 ⁹³



Every three years, historical fossil fuel and electricity consumption will be analysed to confirm the continuation of this trend or make the necessary modifications to the baseline if the trend changes.

3.5 Additionality

⁹² Consumption is rounded down to the nearest 100 kWh

⁹³ National Energy Efficiency Data-Framework (NEED): Summary of Analysis, Great Britain. BEIS. 2021.

Although 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 common practice.⁹⁴ At least 65% of existing dwellings across the UK have not had any decarbonisation steps taken.⁹⁵ Financial additionality from the carbon markets would be impactful for signaling the value of low carbon dwellings and an important step to incentivise dwelling owners to improve building thermal and energy efficiencies. The contribution of carbon markets may not be sufficient to overcome all the cost barriers faced by dwelling owners but would help to rebalance cost-benefit analyses and may prove critical for mass retrofit programmes on the cusp of viability.⁹⁶

Additionality is demonstrated using the performance method for dwellings in accordance with the VM0008 Methodology. The performance method uses a performance standard to demark a decrease in fossil fuel and electricity consumption that is unlikely to occur naturally, i.e., in the absence of the project activity.

The performance standard under the VM0008 Methodology is defined as follows:

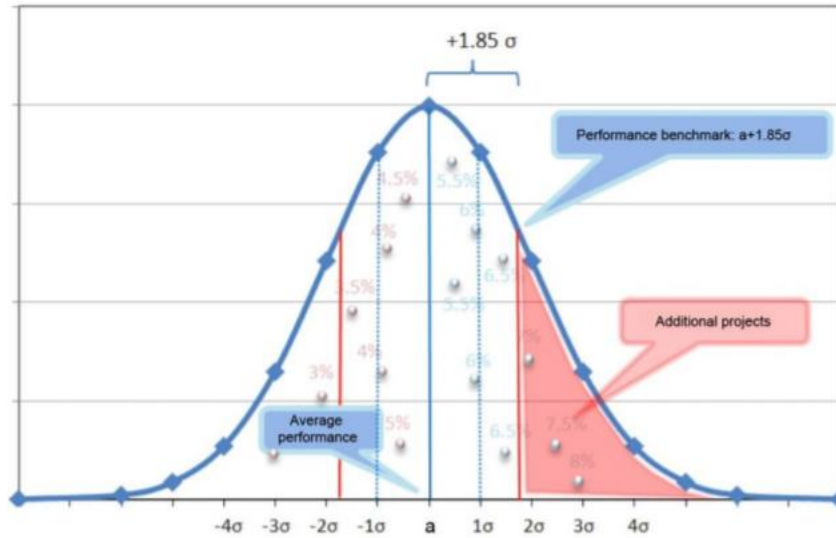
Category A and Category B –The performance benchmark is a value above average performance that represents a percent savings in fossil fuel and electricity consumption that dwellings are not likely to reach with 90% certainty in the absence of the project. The average performance is the annual average percent savings in weather normalised fossil fuel and electricity consumption in dwellings from the Same Building Stock over at least the three most recent twelve-month periods for which data are available.

Although Category B comprises measures to enhance the building envelope and improve the efficiency of the central heating and/or cooling system only, the same performance benchmark can be used if the percent savings is calculated for the entire fossil fuel and electricity consumption of the dwelling and not just for the consumption of heating and/or cooling energy. This way, savings achieved under the project are comparable to overall trends. By broadening the base, savings from the project are diluted. They would be higher if calculated for the savings in heating and/or cooling energy alone.

⁹⁴ [UK housing: Fit for the future?](#) Climate Change Committee. 2019.

⁹⁵ [Energy Efficiency of Existing Homes](#). House of Commons Environmental Audit Committee. 2021.

⁹⁶ [The decarbonisation of heat](#). Regen. 2020.



VM0008 Methodology requires the performance benchmark to be calculated using the standard deviation (sigma) of the percent savings in the Same Building Stock where the underlying data follows a normal distribution. For data not following a normal distribution (non-Gaussian), the Methodology requires the performance benchmark to be equal to the 90th percentile value within the numerically ordered sample.

The performance benchmark is calculated for each type of Same Building Stock from vendor reported natural gas and electricity meter-point readings published by the Department for Business, Energy and Industrial Strategy (BEIS) as part of the National Energy Efficiency Data Framework (NEED)⁹⁷. The independent data has been collected and arranged in a systematic or methodical way by the project proponent.

The distribution of fossil fuel and electricity consumption by dwellings in the UK is non-Gaussian (as evidenced from the Property level natural gas and electricity consumption data published by BEIS as part of the NEED Framework).⁹⁸ In accordance with the VM0008 Methodology, the performance standard is therefore calculated using the percentile method for both low-income and middle-income dwellings:

- The Performance Standard is equal to the 90th percentile value within the numerically ordered sample. To calculate the 90th percentile the sample data point values ($v_1, v_2 \dots v_N$) must be ordered from least to greatest. The 90th percentile value is equal to the value of the data point with the rank at which 90% of the data falls below

⁹⁷ 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

⁹⁸ Anonymised NEED data: 4 million row sample. Department for Business, Energy and Industrial Strategy (BEIS). June 2021.

Equation 3:

a.
$$n = \left\lceil \frac{NP_{90}}{100} + 0.05 \right\rceil$$

 b. x = the value of the data point at rank n calculated in (a).

Where:

 x = Performance Standard

 n = Rank of the ordered data point falling at the 90th percentile

 N = Total number of data points included in the sample

 P_{90} = 90th percentile

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 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 dwellings⁹⁹.

The pre-retrofit energy assessment determines the heat load and electricity demand (energy load) in the baseline for each dwelling added to the project. The post-retrofit energy assessment determines the heat load and electricity demand (energy load) following the implementation of project activity.

To be additional, dwellings must satisfy the following condition:

Equation 4:

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

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

⁹⁹ Additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 under the Pre- and post-retrofit energy assessment approach

Calculation: The Performance Standard is calculated from vendor reported natural gas and electricity meter-point readings that are collated and published by the Department for Business, Energy and Industrial Strategy (BEIS) as part of the National Energy Efficiency Data Framework (NEED).¹⁰⁰ The independent data has been collected and arranged in a systematic or methodical way by the project proponent using a data engineering software platform. The independent data collected and arranged by the project proponent is the Property level natural gas and electricity consumption data published by BEIS as part of the NEED Framework.^{101 102} This data comprises a stratified random sample of approximately 15% of dwellings (3.6 million meter-points). Sampling was undertaken by staff of BEIS and overseen by the Office of National Statistics. The full range of available data for nine twelve-month periods is used in the calculation.

Applying the eligibility criteria set out in section 1.4, any dwelling included in the demonstration of additionality will meet the following conditions:

1. Dwellings in the same state is dwellings which are in the physical boundaries of the United Kingdom. Geographic areas with initial project activity instances that are subject to the same rationale for the demonstration of additionality are the UK
2. Dwellings in the same category (single-family) is individual residential properties/households
3. Dwellings in the same income group (low-income) is dwellings located in a neighbourhood identified as 'deprived' as defined by the Department for Levelling Up, Housing and Communities ¹⁰³
4. Dwellings in the same income group (middle-income) is dwellings not located in a neighbourhood identified as 'deprived' as defined by the Department for Levelling Up, Housing and Communities ¹⁰⁴

Same Building Stock: Low-income single-family dwellings

Additionality is calculated using actual natural gas and electricity consumption data for 1.48 million low-income single-family dwellings within the UK, representing approximately 10.43% of the total population of low-income single-family dwellings within the UK which exceeds the

¹⁰⁰ 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 Anonymised NEED data: 4 million row sample. Department for Business, Energy and Industrial Strategy (BEIS). June 2021.

¹⁰² 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

¹⁰³ 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.

¹⁰⁴ 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.

minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology.¹⁰⁵

Same Building Stock: Middle-income single-family dwellings

Additionality is calculated using actual natural gas and electricity consumption data for 2.19 million middle-income single-family dwellings within the UK, representing approximately 35.59% of the total population of middle-income single-family dwellings within the UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology.¹⁰⁶

The independent data has been collected and arranged in a systematic or methodical way by the project proponent as follows:

1. Records are excluded from the analysis if any of the following conditions hold:
 - a) The dwelling was built from 2000 onwards. This is because post-1999 properties have specific installation standards regarding loft and wall insulation. These dwellings are not included in this project as they are not insufficiently thermally efficient. Including these dwellings would dilute the percent change in fossil fuel and electricity consumption in dwellings that are in the Same Building Stock. As such excluding these dwellings is more conservative
 - b) Fossil fuel or electricity consumption data is missing for one of the included twelve-month periods
 - c) Fossil fuel or electricity consumption data is not within a plausible range. For natural gas the plausible range is 2,500 – 50,000 kWh. For electricity, the range is 500 – 25,000 kWh ¹⁰⁷
2. The percent savings in fossil fuel and electricity consumption data are calculated for each dwelling in the dataset as follows:
 - a. The total fossil fuel and electricity consumption of each dwelling is calculated for each twelve-month period by adding the natural gas (kWh) and electricity (kWh) consumption

¹⁰⁵ 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

¹⁰⁶ 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

¹⁰⁷ Quality control measure introduced by the Department for Business, Energy and Industrial Strategy (BEIS) as part of the National Energy Efficiency Data Framework (NEED) and its designation as an official national statistic

- b. The percent savings in total fossil fuel and electricity consumption of each dwelling is calculated for each set of twelve-month periods (the difference between year t and year t+1, year t+1 and year t+2, etc.) by:
 - i. Subtracting the total fossil fuel and electricity consumption in year t+1 from the total fossil fuel and electricity consumption in year t
 - ii. Dividing the result by the total fossil fuel and electricity consumption in year t
- c. The average percent savings in total fossil fuel and electricity consumption for each dwelling is calculated for each dwelling by:
 - i. Adding the result from (b)(ii) above for each year included in the analysis
 - ii. Dividing the result by the number of years included in the analysis
 - iii. Converting the result to the percent savings

The average percent savings in total fossil fuel and electricity consumption for each dwelling is numerically ordered from least to greatest in accordance with equation 3. The 90th percentile value is equal to the value of the data point with the rank at which 90% of the data falls below. The Performance Standard is equal to the 90th percentile value.

Same Building Stock: Low-income single-family dwellings

The Performance Standard is equal to the 5.0152%. All low-income dwellings that achieve a percent savings in fossil fuel and electricity consumption must achieve a percent savings value of 5.0152% or greater to be considered additional. Additionality is assessed for each dwelling included in the project activity.

Same Building Stock: Middle-income single-family dwellings

The Performance Standard is equal to the 4.4992%. All middle-income dwellings that achieve a percent savings in fossil fuel and electricity consumption must achieve a percent savings value of 4.4992% or greater to be considered additional. Additionality is assessed for each dwelling included in the project activity.

In accordance with the VM0008 Methodology, the project uses the level of the Performance Standard metric available at project validation for each verification event for the duration of all project crediting periods.

3.6 Methodology Deviations

There is no methodology deviation.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

Baseline emissions are defined as emissions from fossil fuel consumed during the most recent twelve-month period for which data are available prior to project implementation. Refer to section 3.4 (Baseline Scenario) of this document for explanation of how baseline emissions are determined. Once established, the baseline for a dwelling remains static throughout the crediting period.

4.2 Project Emissions

Project activity emissions are defined as emissions from fossil fuel consumed over a twelve-month 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 this document for explanation of how project emissions are determined.

4.3 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 United Kingdom and condensate must be disposed of appropriately. Leakage from condensate or the possible continued operation of improperly disposed of boilers is accounted for by the regulatory framework in the UK.

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 dwelling owner that work was carried out by a person registered with a competent person scheme, a certificate under Publicly Available Specification (PAS) or an equivalent standard, or assessment by an accredited energy assessor or a declaration by a regulated provider of social housing or public entity.

4.4 Net GHG Emission Reductions and Removals

This section presents 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. Equations required to calculate emission reductions under each approach and monitoring parameters applicable to each approach are listed in this section.

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.

Refer to section 5 (Monitoring) of this document for additional detail on the monitoring plans and parameters.

Category A – Calculation of the emission reductions and monitoring is based on either:

1. The Adjusted consumption approach
2. The Pre- and post-retrofit energy assessment approach, or
3. The Control group approach

Category B – Calculation of the emission reductions and monitoring is based on either:

1. The Adjusted consumption approach
2. The Pre- and post-retrofit energy assessment approach, or
3. The Control group approach

This Project Document includes information regarding the Initial PAIs planned and developed to a sufficient level of detail to enable their assessment at validation. Emission reductions will be calculated for the Initial PAIs using the Pre- and post-retrofit energy assessment approach.

The baseline calculations in this section are calculated using first instance data for the Initial PAIs. For the purposes of validation, the emission reductions calculations have been projected based on planned project activity. The actual emission reductions for the Initial PAIs will be calculated using first instance data as at the date of the completed installation of the decarbonisation measures. The tables in this section rely on data that are not first instance specific and may differ from the actual emission reductions.

1. Adjusted consumption approach

In this approach, emissions in the baseline and the project activity scenario are not calculated separately but are calculated directly as the VM0008 Methodology allows. Measured energy consumption pre-retrofit, the baseline consumption, is adjusted for each crediting year to take account of changes in heating degree days using a Heating Degree Day Correction Factor (“HDDCF”) and changes in electricity demand over time using an Electricity Correction Factor (“ECF”). A sample of dwellings of the Same Building Stock may be used to measure energy consumption pre-retrofit.

Project consumption of fossil fuel and electricity is subtracted from the adjusted baseline consumption per dwelling. The resulting fossil fuel and electricity savings are multiplied by an emission factor for the fuel or electricity used in the baseline. The fuel consumption of a control group of non-decarbonised dwellings is monitored as a quality assurance measure.

Quality assurance monitoring in the VM0008 Methodology allows for correcting the adjusted baseline where a significant discrepancy occurs between emission reductions calculated according to the adjusted consumption approach and emission reductions calculated for a sample of dwellings of the Same Building Stock.

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 control group approach for the sample of dwellings, 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.

The reduction in consumption is calculated as follows:

Equation 5:

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

Where:

$EL_{Pre,i}$ = Pre-retrofit consumption of dwelling i

$EL_{Post,i}$ = Post-retrofit 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 6:

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

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 electricity consumption based on decreases in 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 in the adjusted consumption approach are calculated as follows:

Equation 7:

$$ER_y = \sum_{i=1}^I (Elec_{b,i} \times ECF_y \times HDDCF_y - Elec_{p,y,i}) \times Elec_{CO_2} + \sum_{i,j=1}^{I,J} (F_{b,i,j} \times HDDCF_y - F_{p,y,i,j}) \times Cal_j \times F_{CO_2,j} - L_y$$

Where:

ER_y = Emission Reduction in year y in metric tons ("t") CO₂e/yr.

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

$Elec_{p,y,i}$ = Electricity consumed by the project in year y for dwelling i in kWh (project consumption)

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

$HDDCF_y$ = Heating Degree Days Correction Factor¹⁰⁸ 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 in the appropriate mass, or volume unit (baseline consumption)

$F_{p,y,i,j}$ = Fuel type j consumed by the project in year y for dwelling i in the appropriate mass, or volume unit (project consumption)

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

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

L_y = Leakage in year y as calculated using equation 8

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 manner¹⁰⁹

Leakage, L_y , is assessed for project activity as described in section 4.3 (Leakage) of this document and is calculated as follows:

Equation 8:

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

Where:

¹⁰⁸ In accordance with the VM0008 Methodology, HDDCF replaces the Cooling Degree Day Correction Factor (CDDCF) in the equation because electricity is typically the central heating source post-retrofit

¹⁰⁹ 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

$L_{CO_2,y}$ = Leakage from improper disposal of, or continued operation of replaced boilers, in year y

The parameters to be monitored in the adjusted consumption approach are listed in section 5.

This Project Document includes information regarding the Initial PAIs planned and developed to a sufficient level of detail to enable their assessment at validation. None of the Initial PAIs will use the adjusted consumption approach.

2. Pre- and post-retrofit energy assessment approach

In this approach, emissions in the baseline and 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 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 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 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 electricity demand (energy load) in the baseline for each dwelling added to the project. The resulting fossil fuel and electricity consumption is multiplied by the emission factor of the fuel type to provide the baseline emissions for each dwelling.¹¹⁰ The post-retrofit energy assessment determines the

¹¹⁰ The fossil fuel and 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

heat load and electricity demand (energy load) following the implementation of project activity. The change in heat load and electricity demand provides the Heat Load Reduction Factor (“HLF”) and Electricity Demand Reduction Factor (“EDF”) which are calculated individually for every decarbonisation measure to ensure accurate and conservative emission reduction calculations.

To calculate emission reductions, the total change in fossil fuel and electricity consumption is multiplied by the emission factor of the fuel type to provide the emission reductions for each dwelling. Emission reductions are adjusted for leakage emissions. For years after the project year, emission reductions are adjusted for changes in heating degree days and changes in electricity demand over time.

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 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.¹¹¹

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.

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 for the purpose of calculating emission reductions accurately.

unique energy load reported in the pre-retrofit energy assessment, the unique energy load is incorporated into the calculation of the baseline

¹¹¹ 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, $EL_{pre,j}$ 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

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, significant discrepancy is defined based on an independent 2-sample t-test for equality of two means. If the t-value of the above 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.

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

Equation 9:

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

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

Equation 10:

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

Where:

HLF = Heat load reduction factor (no unit)

$H_{load,post,s}$ = Heat load post-retrofit for 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 electricity consumption based on decreases in electricity demand over time. The ECF is only be 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”) CO₂e/yr.

$Elec_{b,i,j}$ = 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 Factor¹¹² for year y

$Elecc_{CO_2}$ = 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)

$F_{CO_2,j}$ = 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 manner¹¹³

Leakage, L_y , is assessed for project activity as described in section 4.3 (Leakage) of this document and is calculated as follows:

Equation 14:

$$L_y = L_{CO_2,y}$$

Where:

$L_{CO_2,y}$ = Leakage from improper disposal of, or continued operation of replaced boilers, in year y

The parameters to be monitored in the pre-and post-retrofit energy assessment approach are listed in Section 9.

¹¹² In accordance with the VM0008 Methodology, HDDCF replaces CDDCF in the equation because electricity is typically the central heating source post-retrofit

¹¹³ 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

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

At the time of validation only the heat load and electricity demand in the baseline can be calculated using first instance data for the Initial PAIs. For the purposes of validation, the post-retrofit heat load and electricity demand have been projected based on planned project activities. The actual emission reductions for the Initial PAIs will be calculated using first instance data as at the date of the completed installation of the decarbonisation measures.

Calculating ex-ante emission reductions with first instance and projected data values for the Initial PAIs, where:

$$ECF_y = 1 \text{ (for the baseline year)}$$

$$HDDCF_y = 1 \text{ (for the baseline year)}$$

$$Elec_{CO_2} = 0.00021233$$

$$FCO_{12j} = 0.00021600$$

$$L_y = 0$$

$$I = 28$$

$$J = 1$$

$$j = \text{Natural gas}$$

$$y = 1$$

Table 9. Summary table of estimated ex-ante emission reductions from Category B in the project year

Project Activity Instance	Baseline emissions (tCO ₂ e/yr.) <i>*Unrounded</i>	Estimated project emissions (tCO ₂ e/yr.) <i>*Rounded up</i>	Estimated leakage emissions (tCO ₂ e/yr.) <i>*Rounded up</i>	Estimated net GHG emission reductions (tCO ₂ e/yr.) <i>*Rounded down</i>
Total	93	11	0	82

Calculating the quality assurance sample with first instance and projected data values for the Initial 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:

$$i = 28$$

The sample size for the quality assurance sample is 4. Using a random number generator, the constituents of the quality assurance sample are dwellings: 10012, 10001, 10010 and 10025.

The difference in consumption between the control group and the intervention group, as calculated under the control group approach for the project year is 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 difference 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.

Table 10. Summary table of estimated quality assurance sample

Project Activity Instance	Calculated reduction in energy load determined for the common decarbonisation measures by the post-retrofit energy assessment (%)	Calculated reduction in consumption for the common decarbonisation measures and Same Building Stock under the control group approach (%)
10012	1.56	3.11
10001	27.99	25.17
10010	1.51	3.11
10025	16.87	25.17
Mean	11.98	14.14

The t-value of the above statistic obtained from a t-value calculation is -0.23761 and the critical two-tail value is 2.446912. Since the absolute value of the test statistic is not greater than the critical two-tail value, the two populations' means are not statistically different. Also, the two-tailed p-value of the test is 0.820091, which is larger than 0.05 and confirms that the two populations' means are not statistically different.

Table 11. Ex-ante calculation (estimate) of emission reductions for the initial instances of project activity

Year	Estimated number of cumulative dwellings	Estimated baseline emissions (tCO _{2e})	Estimated project emissions (tCO _{2e})	Estimated leakage emissions (tCO _{2e})	Estimated net GHG emission reductions or removals (tCO _{2e})
2022	14	46.5	5.5	0	41
2023	28	93	11	0	82
2024	28	93	11	0	82
2025	28	93	11	0	82
2026	28	93	11	0	82
2027	28	93	11	0	82
2028	28	93	11	0	82
2029	14	46.5	5.5	0	41
Total	28	651	77	0	574

3. The Control group approach

In this approach, emissions in the baseline and the project activity scenario are not calculated separately but are calculated directly as the VM0008 Methodology allows. Intervention and control groups are defined individually for each type of decarbonisation measure installed as part of the project. The intervention groups contain dwellings from the Same Building Stock which have received the decarbonisation measure, and no other measure in the year before, during or a year after the installation year.

The intervention groups cannot be analysed in isolation since a change in consumption could be due to other factors, such as a change in energy prices. Therefore, 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 project does not prevent or deny decarbonisation to any dwelling for the purpose of maintaining the control group. Therefore, 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.

To calculate emission reductions, the difference in the energy consumption between the control group and the intervention group for a given decarbonisation measure each year constitutes the fossil fuel and/or electricity savings for all dwellings that have received the same type of decarbonisation measure and are being credited as part of the project for that year.¹¹⁴ ¹¹⁵ The difference in energy consumption is multiplied by the emission factor of the fuel type(s) to provide the emission reductions for each dwelling. Emission reductions are adjusted for leakage emissions.

Emission reductions in the control group approach are calculated as follows:

Equation 15: Emission reductions:

$$ER_y = \sum_{b=1}^B \left\{ (Elec_{CG,y,b} - Elec_{SG,y,b}) \times Elec_{CO2} \right\} + \sum_{j=1}^J \left\{ (F_{CG,y,j,b} - F_{SG,y,j,b}) \times Cal_j \times F_{CO2j} \right\} \times I_b - L_{yb}$$

Where:

ER_y = Emission Reduction in year y in metric tons (“t”) CO₂e/yr.

$Elec_{SG,y,b}$ = Mean electricity consumed by sample group dwellings of the Same Building Stock b in year y

$Elec_{CG,y,b}$ = Mean electricity consumed by control group dwellings of the Same Building Stock b in year y

$Elec_{CO2}$ = Grid emission factor in tCO₂e /kWh

$F_{SG,y,j,b}$ = Mean fuel type j consumed by sample group dwellings of the Same Building Stock b in year y

$F_{CG,y,j,b}$ = Mean fuel type j consumed by control group dwellings of the Same Building Stock b in year y

¹¹⁴ Electricity consumption is only included in the analysis when electricity is the central heating source pre-retrofit

¹¹⁵ Since the fossil fuel consumed by decarbonised dwellings is directly compared to the fossil fuel consumed by non-decarbonised dwellings within the Same Building Stock and the same year, there is no need to apply heating degree day correction factors

$F_{CO_2,j}$ = The CO₂ 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

I_b = Number of dwellings in Same Building Stock b

$L_{y,b}$ = Leakage in Same Building Stock b in year y

L_y = Leakage in year y as calculated using Equation 16

J = Number of fuel types

j = Fuel type

B = Number of Same Building Stock types

b = Same Building Stock b

To ensure conservativeness in the emission reduction calculation approach, a 95% confidence interval is applied to the energy consumption within the Control group and the Intervention group.

Leakage, L_y , is assessed for project activity as described in section 4.3 (Leakage) of this document and is calculated as follows:

Equation 16:

$$L_y = L_{CO_2,y}$$

Where:

$L_{CO_2,y}$ = Leakage from improper disposal of, or continued operation of replaced boilers, in year y

The parameters to be monitored in the control group approach are listed in section 5.

This Project Document includes information regarding the Initial PAIs planned and developed to a sufficient level of detail to enable their assessment at validation. None of the Initial PAIs uses the control group approach. For the purposes of validation of the quality assurance monitoring for the pre- and post-retrofit energy assessment approach, the difference in energy consumption between intervention and control groups has been calculated with first instance data values for the first crediting year.

Construction of the intervention and control groups and determination of the difference in the energy consumption between the groups is undertaken by a public authority.^{116 117} Applying the definition set out in section 1.4, dwellings in the same income group (low-income) are dwellings with household income up to £40,212 and dwellings in the same income group (middle-income) are dwellings with household income above £40,212 and up to £70,004. Electricity consumption is not included in the analysis for the purposes of validation as electricity is typically not the central heating source pre-retrofit.

Calculating emission reductions with first instance data values for **Loft Insulation** for **Low-income dwellings** for crediting year 2022:

1. Find Combined Mean from the following data

$$N_1 = 670, \bar{X}_1 = 200, \sigma_1 = 0$$

$$N_2 = 620, \bar{X}_2 = 500, \sigma_2 = 0$$

$$N_3 = 430, \bar{X}_3 = 400, \sigma_3 = 0$$

Solution:

Combined Mean :

$$\bar{x}_{12} = \frac{N_1 \cdot \bar{x}_1 + N_2 \cdot \bar{x}_2 + N_3 \cdot \bar{x}_3}{N_1 + N_2 + N_3}$$

$$\bar{x}_{12} = \frac{670 \times 200 + 620 \times 500 + 430 \times 400}{670 + 620 + 430}$$

$$\bar{x}_{12} = \frac{134000 + 310000 + 172000}{1720}$$

$$\bar{x}_{12} = \frac{616000}{1720}$$

$$\bar{x}_{12} = 358.1395$$

2. Calculate emission reductions from the following data

Where:

$$I = 1$$

$$J = 1$$

j = Natural gas

$$F_{CG,y,j,b,m} - F_{SG,y,j,b,m} = 358 \text{ kWh}$$

¹¹⁶ The Impact of measures data tables published by the Department for Business, Energy and Industrial Strategy on June 24, 2021, as part of the NEED Framework

¹¹⁷ Published by a government agency and designated as an official national statistic

$$L_y = 0$$

$$y = 2022$$

$$F_{CO_2j} = 0.000216 \text{ tCO}_{2e} / \text{kWh}$$

$$ER_y = \sum_{i,j=1}^{I,J} (F_{CG,y,j,b,m} - F_{SG,y,j,b,m} \times F_{CO_2,j}) - L_y$$

$$ER_{2022} = 0.077328 \text{ tCO}_{2e}$$

Calculating ex-ante emission reductions with first instance data values for **Cavity Wall Insulation** for **Low-income dwellings** for crediting year 2022:

1. Find Combined Mean from the following data

$$N_1 = 1260, \bar{X}_1 = 800, \sigma_1 = 0$$

$$N_2 = 1280, \bar{X}_2 = 900, \sigma_2 = 0$$

$$N_3 = 1040, \bar{X}_3 = 1300, \sigma_3 = 0$$

Solution:

Combined Mean :

$$\bar{x}_{12} = \frac{N_1 \cdot \bar{x}_1 + N_2 \cdot \bar{x}_2 + N_3 \cdot \bar{x}_3}{N_1 + N_2 + N_3}$$

$$\bar{x}_{12} = \frac{1260 \times 800 + 1280 \times 900 + 1040 \times 1300}{1260 + 1280 + 1040}$$

$$\bar{x}_{12} = \frac{1008000 + 1152000 + 1352000}{3580}$$

$$\bar{x}_{12} = \frac{3512000}{3580}$$

$$\bar{x}_{12} = 981.0056$$

2. Calculate emission reductions from the following data

Where:

$$I = 1$$

$$J = 1$$

j = Natural gas

$$F_{CG,y,j,b,m} - F_{SG,y,j,b,m} = 981 \text{ kWh}$$

$$L_y = 0$$

$$y = 2022$$

$$F_{CO_2,j} = 0.000216 \text{ tCO}_{2e} / \text{kWh}$$

$$ER_y = \sum_{i,j=1}^{I,J} (F_{CG,y,j,b,m} - F_{SG,y,j,b,m} \times F_{CO_2,j}) - L_y$$

$$ER_{2022} = 0.211896 \text{ tCO}_{2e}$$

Calculating ex-ante emission reductions with first instance data values for **Solid Wall Insulation** for **Low-income dwellings** for crediting year 2022:

1. Find Combined Mean from the following data

$$N_1 = 470, \bar{X}_1 = 2300, \sigma_1 = 0$$

$$N_2 = 220, \bar{X}_2 = 3200, \sigma_2 = 0$$

$$N_3 = 100, \bar{X}_3 = 2200, \sigma_3 = 0$$

Solution:

Combined Mean :

$$\bar{x}_{12} = \frac{N_1 \cdot \bar{x}_1 + N_2 \cdot \bar{x}_2 + N_3 \cdot \bar{x}_3}{N_1 + N_2 + N_3}$$

$$\bar{x}_{12} = \frac{470 \times 2300 + 220 \times 3200 + 100 \times 2200}{470 + 220 + 100}$$

$$\bar{x}_{12} = \frac{1081000 + 704000 + 220000}{790}$$

$$\bar{x}_{12} = \frac{2005000}{790}$$

$$\bar{x}_{12} = 2537.9747$$

2. Calculate emission reductions from the following data

Where:

$$I = 1$$

$$J = 1$$

j = Natural gas

$$F_{CG,y,j,b,m} - F_{SG,y,j,b,m} = 2,537 \text{ kWh}$$

$$L_y = 0$$

$$y = 2022$$

$$F_{CO_2j} = 0.000216 \text{ tCO}_{2e} / \text{kWh}$$

$$ER_y = \sum_{i,j=1}^{I,J} (F_{CG,y,j,b,m} - F_{SG,y,j,b,m} \times F_{CO_2,j}) - L_y$$

$$ER_{2022} = 0.547992 \text{ tCO}_{2e}$$

Calculating ex-ante emission reductions with first instance data values for **Condensing Boiler** for **Low-income dwellings** for crediting year 2022:

1. Find Combined Mean from the following data

$$N_1 = 47790, \bar{X}_1 = 600, \sigma_1 = 0$$

$$N_2 = 52110, \bar{X}_2 = 800, \sigma_2 = 0$$

$$N_3 = 45340, \bar{X}_3 = 800, \sigma_3 = 0$$

Solution:

Combined Mean :

$$\bar{x}_{12} = \frac{N_1 \cdot \bar{x}_1 + N_2 \cdot \bar{x}_2 + N_3 \cdot \bar{x}_3}{N_1 + N_2 + N_3}$$

$$\bar{x}_{12} = \frac{47790 \times 600 + 52110 \times 800 + 45340 \times 800}{47790 + 52110 + 45340}$$

$$\bar{x}_{12} = \frac{28674000 + 41688000 + 36272000}{145240}$$

$$\bar{x}_{12} = \frac{106634000}{145240}$$

$$\bar{x}_{12} = 734.1917$$

2. Calculate emission reductions from the following data

Where:

$$I = 1$$

$$J = 1$$

j = Natural gas

$$F_{CG,y,j,b,m} - F_{SG,y,j,b,m} = 734 \text{ kWh}$$

$$L_y = 0$$

$$y = 2022$$

$$F_{CO2,j} = 0.000216 \text{ tCO}_{2e} / \text{ kWh}$$

$$ER_y = \sum_{i,j=1}^{I,J} (F_{CG,y,j,b,m} - F_{SG,y,j,b,m} \times F_{CO2,j}) - L_y$$

$$ER_{2022} = 0.158544 \text{ tCO}_{2e}$$

Calculating ex-ante emission reductions with first instance data values for **Loft Insulation** for **Middle-income dwellings** for crediting year 2022:

1. Find Combined Mean from the following data

$$N_1 = 300, \bar{X}_1 = 600, \sigma_1 = 0$$

$$N_2 = 150, \bar{X}_2 = 900, \sigma_2 = 0$$

$$N_3 = 260, \bar{X}_3 = 900, \sigma_3 = 0$$

Solution:

Combined Mean :

$$\bar{x}_{12} = \frac{N_1 \cdot \bar{x}_1 + N_2 \cdot \bar{x}_2 + N_3 \cdot \bar{x}_3}{N_1 + N_2 + N_3}$$

$$\bar{x}_{12} = \frac{300 \times 600 + 150 \times 900 + 260 \times 900}{300 + 150 + 260}$$

$$\bar{x}_{12} = \frac{180000 + 135000 + 234000}{710}$$

$$\bar{x}_{12} = \frac{549000}{710}$$

$$\bar{x}_{12} = 773.2394$$

2. Calculate emission reductions from the following data

Where:

$$I = 1$$

$$J = 1$$

j = Natural gas

$$F_{CG,y,j,b,m} - F_{SG,y,j,b,m} = 773 \text{ kWh}$$

$$L_y = 0$$

$$y = 2022$$

$$F_{CO_2,j} = 0.000216 \text{ tCO}_2\text{e} / \text{kWh}$$

$$ER_y = \sum_{i,j=1}^{I,J} (F_{CG,y,j,b,m} - F_{SG,y,j,b,m} \times F_{CO_2,j}) - L_y$$

$$ER_{2022} = 0.166968 \text{ tCO}_2\text{e}$$

Calculating ex-ante emission reductions with first instance data values for **Cavity Wall Insulation** for **Middle-income dwellings** for crediting year 2022:

1. Find Combined Mean from the following data

$$N_1 = 920, \bar{X}_1 = 1600, \sigma_1 = 0$$

$$N_2 = 600, \bar{X}_2 = 1500, \sigma_2 = 0$$

$$N_3 = 1540, \bar{X}_3 = 1700, \sigma_3 = 0$$

Solution:

Combined Mean :

$$\bar{x}_{12} = \frac{N_1 \cdot \bar{x}_1 + N_2 \cdot \bar{x}_2 + N_3 \cdot \bar{x}_3}{N_1 + N_2 + N_3}$$

$$\bar{x}_{12} = \frac{920 \times 1600 + 600 \times 1500 + 1540 \times 1700}{920 + 600 + 1540}$$

$$\bar{x}_{12} = \frac{1472000 + 900000 + 2618000}{3060}$$

$$\bar{x}_{12} = \frac{4990000}{3060}$$

$$\bar{x}_{12} = 1630.719$$

2. Calculate emission reductions from the following data

Where:

$$I = 1$$

$$J = 1$$

j = Natural gas

$$F_{CG,y,j,b,m} - F_{SG,y,j,b,m} = 1,630 \text{ kWh}$$

$$L_y = 0$$

$$y = 2022$$

$$F_{CO_2j} = 0.000216 \text{ tCO}_{2e} / \text{kWh}$$

$$ER_y = \sum_{i,j=1}^{I,J} (F_{CG,y,j,b,m} - F_{SG,y,j,b,m} \times F_{CO_2,j}) - L_y$$

$$ER_{2022} = 0.35208 \text{ tCO}_{2e}$$

Calculating ex-ante emission reductions with first instance data values for **Solid Wall Insulation** for **Middle-income dwellings** for crediting year 2022:

1. Find Combined Mean from the following data

$$N_1 = 80, \bar{X}_1 = 2700, \sigma_1 = 0$$

$$N_2 = 30, \bar{X}_2 = 2300, \sigma_2 = 0$$

$$N_3 = 70, \bar{X}_3 = 4300, \sigma_3 = 0$$

Solution:

Combined Mean :

$$\bar{x}_{12} = \frac{N_1 \cdot \bar{x}_1 + N_2 \cdot \bar{x}_2 + N_3 \cdot \bar{x}_3}{N_1 + N_2 + N_3}$$

$$\bar{x}_{12} = \frac{80 \times 2700 + 30 \times 2300 + 70 \times 4300}{80 + 30 + 70}$$

$$\bar{x}_{12} = \frac{216000 + 69000 + 301000}{180}$$

$$\bar{x}_{12} = \frac{586000}{180}$$

$$\bar{x}_{12} = 3255.5556$$

2. Calculate emission reductions from the following data

Where:

$$I = 1$$

$$J = 1$$

j = Natural gas

$$F_{CG,y,j,b,m} - F_{SG,y,j,b,m} = 3,255 \text{ kWh}$$

$$L_y = 0$$

$$y = 2022$$

$$F_{CO_2,j} = 0.000216 \text{ tCO}_2\text{e} / \text{kWh}$$

$$ER_y = \sum_{i,j=1}^{I,J} (F_{CG,y,j,b,m} - F_{SG,y,j,b,m} \times F_{CO_2,j}) - L_y$$

$$ER_{2022} = 0.70308 \text{ tCO}_2\text{e}$$

Calculating ex-ante emission reductions with first instance data values for **Condensing Boiler** for **Middle-income dwellings** for crediting year 2022:

1. Find Combined Mean from the following data

$$N_1 = 35270, \bar{X}_1 = 800, \sigma_1 = 0$$

$$N_2 = 22790, \bar{X}_2 = 800, \sigma_2 = 0$$

$$N_3 = 51980, \bar{X}_3 = 700, \sigma_3 = 0$$

Solution:

Combined Mean :

$$\bar{x}_{12} = \frac{N_1 \cdot \bar{x}_1 + N_2 \cdot \bar{x}_2 + N_3 \cdot \bar{x}_3}{N_1 + N_2 + N_3}$$

$$\bar{x}_{12} = \frac{35270 \times 800 + 22790 \times 800 + 51980 \times 700}{35270 + 22790 + 51980}$$

$$\bar{x}_{12} = \frac{28216000 + 18232000 + 36386000}{110040}$$

$$\bar{x}_{12} = \frac{82834000}{110040}$$

$$\bar{x}_{12} = 752.7626$$

2. Calculate emission reductions from the following data

Where:

$$I = 1$$

$$J = 1$$

j = Natural gas

$$F_{CG,y,j,b,m} - F_{SG,y,j,b,m} = 752 \text{ kWh}$$

$$L_y = 0$$

$y = 2022$

$F_{CO2,j} = 0.000216 \text{ tCO}_{2e} / \text{kWh}$

$$ER_y = \sum_{i,j=1}^{I,J} (F_{CG,y,j,b,m} - F_{SG,y,j,b,m} \times F_{CO2,j}) - L_y$$

$ER_{2022} = 0.162432 \text{ tCO}_{2e}$

Table 12. Ex-ante consumption reductions and emission reductions for first instance data values for crediting year 2022

Building Stock Type	Loft Insulation		Cavity Wall Insulation		Solid Wall Insulation		Condensing Boiler	
	Savings (kWh)	Savings (tCO _{2e})	Savings (kWh)	Savings (tCO _{2e})	Savings (kWh)	Savings (tCO _{2e})	Savings (kWh)	Savings (tCO _{2e})
Low-Income	358	0.0773	981	0.2118	2,537	0.5479	734	0.1585
Middle-Income	773	0.1669	1,630	0.3520	3,255	0.7030	752	0.1624

5 MONITORING

5.1 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 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). ¹¹⁸ The dataset used is the Property level natural gas and electricity consumption dataset ¹¹⁹
Value applied	<p>Low-income single-family dwelling Performance Standard: x= 5.0152</p> <p>Middle-income individual dwelling Performance Standard: x= 4.4992</p>
Justification of choice of data or description of measurement methods and procedures applied	<p>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 ¹²⁰</p> <p>Calculation conducted in accordance with the VM0008 Methodology as set out in section 3.5 (Additionality) of this document</p> <p>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</p>

¹¹⁸ 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

¹¹⁹ Anonymised NEED data: 4 million row sample. Department for Business, Energy and Industrial Strategy (BEIS). June 2021.

¹²⁰ 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

	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
Source of data	N/A
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	<p>VM0008 Methodology requires the performance benchmark to be calculated using the standard deviation (σ) of the percent savings in the Same Building Stock only where the underlying data follows a normal distribution (Gaussian)</p> <p>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</p> <p>As set out in section 3.5 (Additionality) of this document, the distribution of fossil fuel and electricity consumption by dwellings in the UK is non-Gaussian (as evidenced by the Property level natural gas and electricity consumption data published by BEIS¹²¹) and accordingly the standard deviation is not applicable</p>
Frequency	N/A
Purpose of Data	N/A
Comments	N/A

¹²¹ Anonymised NEED data: 4 million row sample. Department for Business, Energy and Industrial Strategy (BEIS). June 2021.

Methodology reference	Table 5
Data / Parameter	Elecc _{CO2}
Data unit	tCO _{2e} / kWh
Description	Grid emission factor for the regional electricity source
Source of data	<p>National data used to assess the energy and environmental performance of dwellings. Currently at validation either:</p> <ul style="list-style-type: none"> a) CO₂ emission factor prescribed by Part L of the Building Regulations as detailed in the Standard Assessment Procedure (SAP) Manual¹²² 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 b) CO₂ emission factor prescribed for company reporting by UK-based organisations as detailed in the UK Government GHG Conversion Factors for Company Reporting dataset¹²³ at table 'UK electricity'. These emission factors are prescribed for use by organisations in the UK to report on emissions
Value applied	<p>0.000212 tCO_{2e} / kWh from the Conversion Factors for Company Reporting dataset</p> <p>In accordance with the VM0008 Methodology, the project may use the CO₂ emission factor per unit of electricity available at project validation for each verification event</p>
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

¹²² 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

¹²³ The Government's [Greenhouse Gas Reporting: Conversion Factors 2021](#), published by the Department for Business, Energy and Industrial Strategy (BEIS), dated 2 June 2021.

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 ¹²⁴
Value applied	Natural Gas: 0.0375GJ/m ³
Justification of choice of data or description of measurement methods and procedures applied	Calorific value of fuel types is well established and remain constant per unit volume of fuel. These values are acceptable under the VM0008 Methodology as established calorific values of various fuel types
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_{CO_2j}
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. Currently at validation either: <ul style="list-style-type: none"> a) CO₂ emission factor prescribed by Part L of the Building Regulations as detailed in the Standard Assessment Procedure (SAP) Manual¹²⁵ at Table 12: Fuel prices, emission factors and primary energy factor. SAP is the UK Government's National

¹²⁴ The [Calorific Value dataset](#) is provided by National Grid

¹²⁵ 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

	<p>Calculation Methodology for assessing the energy performance of dwellings and is the energy assessment system used for dwellings in the project activity</p> <p>b) CO₂ emission factor prescribed for company reporting by UK-based organisations as detailed in the UK Government GHG Conversion Factors for Company Reporting dataset¹²⁶ at table ‘Fuels’. These emission factors are prescribed for use by organisations in the UK to report on emissions</p>
Value applied	Natural Gas: 0.058333 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

5.2 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

¹²⁶ The Government’s [Greenhouse Gas Reporting: Conversion Factors 2021](#), published by the Department for Business, Energy and Industrial Strategy (BEIS), dated 2 June 2021.

Description	Pre-retrofit energy load of dwelling <i>i</i>
Source of data	Pre-retrofit energy assessment
Description of measurement methods and procedures to be applied	<p>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 dwellings¹²⁷. All relevant data fields required to determine emission reductions are compiled by an accredited energy assessor</p> <p>The pre-retrofit energy assessment determines the heat load and electricity demand (energy load) in the baseline</p>
Frequency of monitoring/recording	<p>Once per dwelling prior to implementation of the project activity</p> <p>The energy load pre-retrofit may be calculated after the energy efficiency measures are installed</p>
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 ¹²⁸
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology ¹²⁹
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 electricity consumption and may include physical inspection, diagnostic tests, use energy modelling software that

¹²⁷ Additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 under the pre- and post-retrofit energy assessment approach

¹²⁸ 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

¹²⁹ Additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 under the pre- and post-retrofit energy assessment approach

	implements the latest approved worksheet and conventions for SAP calculations as set out in the SAP Manual ¹³⁰
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>i</i>
Source of data	Post-retrofit energy assessment
Description of measurement methods and procedures to be applied	<p>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 dwellings¹³¹</p> <p>The post-retrofit energy assessment determines the heat load and electricity demand (energy load) following the implementation of project activity</p>
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 ¹³²

¹³⁰ 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

¹³¹ Additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 under the pre- and post-retrofit energy assessment approach

¹³² 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 ¹³³
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 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 ¹³⁴
Comments	N/A

Methodology reference	Table 9
Data / Parameter	$Elec_{b,i}$
Data unit	kWh/yr.
Description	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) ¹³⁵ 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 electricity consumption data for a sample of dwellings in the Same Building Stock for a period of one-year pre-retrofit

¹³³ Additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 under the pre- and post-retrofit energy assessment approach

¹³⁴ 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

¹³⁵ 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	<p>Low-income single-family dwelling baseline consumption: 3,000 kWh annually</p> <p>Middle-income individual dwelling baseline consumption: 3,900 kWh annually</p> <p>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</p>
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 ¹³⁶
Purpose of data	Calculation of emission reductions for adjusted consumption approach
Calculation method	<p>The minimum sample size is established by multiplying by 0.6 the square root of the total number of dwellings, <i>i</i>, included in the adjusted consumption approach for the project</p> <p>Baseline electricity consumption for the Same Building Stock is calculated using a weighted mean calculation as set out in section 3.4 for the baseline scenario. The baseline consumption is calculated as follows:</p> <p>Same Building Stock: Low-income single-family dwellings</p> <p>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,</p>

¹³⁶ Additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 under the adjusted consumption approach and under the control group approach

	<p>2021, as part of the NEED Framework.^{137 138 139} 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 Methodology¹⁴⁰</p> <p>Same Building Stock: Middle-income single-family dwellings</p> <p>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.^{141 142 143} 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 Methodology¹⁴⁴</p>
Comments	N/A

Methodology reference	Table 9
Data / Parameter	$Elec_{p,y,l}$
Data unit	kWh/yr.
Description	Electricity consumed by the project in year y for Dwelling l
Source of data	Sample group under the adjusted consumption approach

¹³⁷ [Additional Consumption Tables: England, Wales and Scotland, 2019](#)

¹³⁸ 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

¹³⁹ Table A12 of the Household natural gas and electricity consumption data published by BEIS under the NEED framework

¹⁴⁰ 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

¹⁴¹ [Additional Consumption Tables: England, Wales and Scotland, 2019](#). Department for Business, Energy and Industrial Strategy (BEIS). December 2021.

¹⁴² 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

¹⁴³ Table A12 of the Household natural gas and electricity consumption data published by BEIS under the NEED framework

¹⁴⁴ 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

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	Determined individually for each dwelling
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 ¹⁴⁵
Purpose of data	Calculation of emission reductions for adjusted consumption approach
Calculation method	<p>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</p> <p>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</p>
Comments	N/A

Methodology reference	Table 9
Data / Parameter	$F_{b,i,j}$
Data unit	Mass or volume per dwelling per year
Description	Fuel type j consumed in the year prior to project implementation ($F_{b,i,j}$) for dwelling i (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) ¹⁴⁶ using the last consecutive twelve months of

¹⁴⁵ Additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 under the adjusted consumption approach and under the control group approach

¹⁴⁶ 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

	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	<p>Low-income single-family dwelling baseline consumption: 1,104 GJ annually</p> <p>Middle-income individual dwelling baseline consumption: 1,382 GJ annually</p> <p>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</p>
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 ¹⁴⁷
Purpose of data	Calculation of emission reductions for adjusted consumption approach
Calculation method	<p>The minimum sample size is established by multiplying by 0.6 the square root of the total number of dwellings, <i>i</i>, included in the adjusted consumption approach for the project</p> <p>Baseline fuel consumption for the Same Building Stock is calculated using a weighted mean calculation as set out in section 3.4 for the baseline scenario. The baseline consumption is calculated as follows:</p> <p>Same Building Stock: Low-income single-family dwellings</p>

¹⁴⁷ Additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 under the adjusted consumption approach and under the control group approach

	<p>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.^{148 149 150} 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 ¹⁵¹</p> <p>Same Building Stock: Middle-income single-family dwellings</p> <p>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.^{152 153 154} 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 ¹⁵⁵</p>
Comments	N/A
Methodology reference	Table 9
Data / Parameter	$F_{p,y,j,j}$

¹⁴⁸ Additional Consumption Tables: England, Wales and Scotland, 2019. Department for Business, Energy and Industrial Strategy (BEIS). December 2021.

¹⁴⁹ 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

¹⁵⁰ Table A11 of the Household natural gas and electricity consumption data published by BEIS under the NEED framework

¹⁵¹ 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

¹⁵² Additional Consumption Tables: England, Wales and Scotland, 2019. Department for Business, Energy and Industrial Strategy (BEIS). December 2021.

¹⁵³ 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

¹⁵⁴ Table A11 of the Household natural gas and electricity consumption data published by BEIS under the NEED framework

¹⁵⁵ 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

Data unit	Mass or volume per dwelling per year
Description	Fuel type j consumed by the project in year y ($F_{p,y,j}$) 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	Determined individually for each dwelling
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 ¹⁵⁶
Purpose of data	Calculation of emission reductions for adjusted consumption approach
Calculation method	<p>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</p> <p>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</p>
Comments	N/A

Methodology reference	Table 9
Data / Parameter	ECF _y
Data unit	N/A

¹⁵⁶ Additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 under the adjusted consumption approach and under the control group approach

Description	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) ¹⁵⁷ or the Final energy demand data published by the Department for Business, Energy and Industrial Strategy (BEIS) ¹⁵⁸ . Historical data from a public authority may be used to determine the ECF. Projected trends in changes in the rate of 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 electricity demand based on average 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 electricity consumption based on decreases in 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 electricity consumption in the baseline may not remain the same
Frequency of monitoring/recording	Annually for each year y
Value applied	Currently at validation: Low-income single-family dwelling baseline consumption: 0.9824 Middle-income individual dwelling baseline consumption: 0.9859
Monitoring equipment	N/A

¹⁵⁷ 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

¹⁵⁸ 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 adjusted consumption approach
Calculation method	<p>The ECF represents the trend in electricity demand based on average electricity consumption within the state over a period of at least ten years. For each of the ten years, baseline household electricity consumption data is calculated, for example as follows when using the Household energy consumption dataset from BEIS:</p> <p>Same Building Stock: Low-income single-family dwellings</p> <p>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.^{159 160 161} 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 Methodology¹⁶²</p> <p>Same Building Stock: Middle-income single-family dwellings</p> <p>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.^{163 164 165} The sample size was 5,851,540 dwellings, representing approximately 92% of the total population of middle-income single-family dwellings in the</p>

¹⁵⁹ [Additional Consumption Tables: England, Wales and Scotland, 2019](#). Department for Business, Energy and Industrial Strategy (BEIS). December 2021.

¹⁶⁰ 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

¹⁶¹ Table A12 of the Household natural gas and electricity consumption data published by BEIS under the NEED framework

¹⁶² The sample size of the sample group is established by multiplying 0.6 by the square root of the total number of dwellings, j , 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

¹⁶³ [Additional Consumption Tables: England, Wales and Scotland, 2019](#). Department for Business, Energy and Industrial Strategy (BEIS). December 2021.

¹⁶⁴ 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

¹⁶⁵ Table A12 of the Household natural gas and electricity consumption data published by BEIS under the NEED framework

	UK which exceeds the minimum sample size for quality assurance purposes prescribed in the VM0008 Methodology ¹⁶⁶
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' ¹⁶⁷ quarterly bulletin containing statistics on weather patterns, including temperature, heating degree days, wind speeds, sun hours and rainfall ¹⁶⁸
Description of measurement methods and procedures to be applied	The HDDCF is used to update the baseline fossil fuel and 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	Annually for each year y
Value applied	Calculated for each rolling twelve-month period after project activity
Monitoring equipment	Data retrieved from the Department for Business, Energy and Industrial Strategy (BEIS)

¹⁶⁶ 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

¹⁶⁷ 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](#)

¹⁶⁸ 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

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 ¹⁶⁹
Comments	<p>HDD values are calculated on a rolling twelve-month period to accommodate periodicity of adding dwellings to the Project Activity</p> <p>Any given instance may have a unique HDDCF value specific to the baseline year and project year</p>

Methodology reference	Table 9
Data / Parameter	HDD _b
Data unit	Degree days
Description	Heating degree days for one year before project activity
Source of data	Data from a reputable regional or national meteorological organisation such as National data published by the Department for Business, Energy and Industrial Strategy (BEIS) as part of the 'Energy Trends' ¹⁷⁰ quarterly bulletin containing statistics on weather patterns, including temperature, heating degree days, wind speeds, sun hours and rainfall ¹⁷¹

¹⁶⁹ 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](#)

¹⁷⁰ 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](#)

¹⁷¹ 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

Description of measurement methods and procedures to be applied	The HDDCF is used to update the baseline fossil fuel and 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 project activity for each rolling twelve-month period
Value applied	2141.3 Degree days
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 ¹⁷²
Comments	<p>HDD values are calculated on a rolling twelve-month period to accommodate periodicity of adding dwellings to the Project Activity</p> <p>Any given instance will have a unique HDDCF value specific to the baseline year and project year</p>

Methodology reference	Table 9
Data / Parameter	<i>J</i>
Data unit	N/A
Description	Number of fuel types

¹⁷² 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](#)

Source of data	Post-retrofit energy assessment
Description of measurement methods and procedures to be applied	<p>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 dwellings¹⁷³</p> <p>The post-retrofit energy assessment determines the number of fuel types</p>
Frequency of monitoring/recording	Annually
Value applied	N/A
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
Calculation method	<p>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 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 Manual¹⁷⁴</p>
Comments	N/A
Methodology reference	Table 9

¹⁷³ Additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 under the pre- and post-retrofit energy assessment approach

¹⁷⁴ 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

Data / Parameter	/
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	N/A
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
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	Quality assurance monitoring in the VM0008 Methodology allows for correcting the baseline where a significant discrepancy occurs between emission reductions calculated according to the adjusted consumption approach and emission reductions calculated for a sample of dwellings of the Same Building Stock; Calculated for each year y after project activity
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 ¹⁷⁵
Purpose of data	Monitoring of emission reductions for adjusted consumption approach
Calculation method	<p>The minimum quality assurance sample size is established by multiplying by 0.6 the square root of the total number of dwellings, <i>i</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.</p> <p>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.</p>

¹⁷⁵ Additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 under the adjusted consumption approach and under the control group approach

	<p>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.</p> <ol style="list-style-type: none"> 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 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	Quality assurance monitoring in the VM0008 Methodology allows for correcting the adjusted baseline where a significant discrepancy occurs between emission reductions calculated according to the adjusted consumption approach and emission reductions calculated for a sample of dwellings of the Same Building Stock; Calculated for each year y after project activity
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 ¹⁷⁶
Purpose of data	Monitoring of emission reductions for adjusted consumption approach
Calculation method	<p>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.</p> <p>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.</p> <p>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.</p>

¹⁷⁶ Additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 under the adjusted consumption approach and under the control group approach

	<ol style="list-style-type: none"> 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	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) ¹⁷⁷ 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 electricity consumption data for a sample of dwellings in the Same Building Stock for a period of one-year pre-retrofit

¹⁷⁷ 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	<p>Low-income single-family dwelling baseline consumption: 3,000 kWh annually</p> <p>Middle-income individual dwelling baseline consumption: 3,900 kWh annually</p> <p>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</p>
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 ¹⁷⁸
Purpose of data	Calculation of emission reductions for the pre- and post-retrofit energy assessment approach
Calculation method	<p>The minimum sample size is established by multiplying by 0.6 the square root of the total number of dwellings, <i>i</i>, included in the adjusted consumption approach for the project</p> <p>Baseline electricity consumption for the Same Building Stock is calculated using a weighted mean calculation as set out in section 3.4 for the baseline scenario. The baseline consumption is calculated as follows:</p> <p>Same Building Stock: Low-income single-family dwellings</p> <p>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,</p>

¹⁷⁸ Additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 under the adjusted consumption approach and under the control group approach

	<p>2021, as part of the NEED Framework.^{179 180 181} 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 Methodology¹⁸²</p> <p>Same Building Stock: Middle-income single-family dwellings</p> <p>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.^{183 184 185} 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 Methodology¹⁸⁶</p>
Comments	N/A

Methodology reference	Table 10
Data / Parameter	$E_{dem,pre,i}$
Data unit	kW
Description	Pre-retrofit electricity demand for dwelling i
Source of data	Pre-retrofit energy assessment

¹⁷⁹ [Additional Consumption Tables: England, Wales and Scotland, 2019](#). Department for Business, Energy and Industrial Strategy (BEIS). December 2021.

¹⁸⁰ 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

¹⁸¹ Table A12 of the Household natural gas and electricity consumption data published by BEIS under the NEED framework

¹⁸² 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

¹⁸³ [Additional Consumption Tables: England, Wales and Scotland, 2019](#). Department for Business, Energy and Industrial Strategy (BEIS). December 2021.

¹⁸⁴ 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

¹⁸⁵ Table A12 of the Household natural gas and electricity consumption data published by BEIS under the NEED framework

¹⁸⁶ 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

Description of measurement methods and procedures to be applied	<p>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 dwellings¹⁸⁷</p> <p>The pre-retrofit energy assessment determines the electricity demand in the baseline</p>
Frequency of monitoring/recording	<p>Once per dwelling prior to implementation of the project activity. The electricity demand pre-retrofit may be calculated after the energy efficiency measures are installed</p>
Value applied	<p>Determined individually for each project activity instance</p>
Monitoring equipment	<p>Energy modelling software that implements the latest approved worksheet and conventions for SAP calculations as set out in the SAP Manual¹⁸⁸</p>
QA/QC procedures to be applied	<p>Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology¹⁸⁹</p>
Purpose of data	<p>Calculation of emission reductions for the pre- and post-retrofit energy assessment approach</p>
Calculation method	<p>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 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</p>

¹⁸⁷ Additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 under the pre- and post-retrofit energy assessment approach

¹⁸⁸ 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

¹⁸⁹ Additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 under the pre- and post-retrofit energy assessment approach

Comments	N/A
Methodology reference	Table 10
Data / Parameter	$E_{dem,post,i}$
Data unit	kW
Description	Post-retrofit electricity demand for dwelling i
Source of data	Post-retrofit energy assessment
Description of measurement methods and procedures to be applied	<p>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 dwellings¹⁹⁰</p> <p>The post-retrofit energy assessment determines the electricity demand following the implementation of project activity</p>
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 ¹⁹¹
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology ¹⁹²

¹⁹⁰ Additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 under the pre- and post-retrofit energy assessment approach

¹⁹¹ 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

¹⁹² Additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 under the pre- and post-retrofit energy assessment approach

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 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	$F_{b,i,j}$
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) ¹⁹³ 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	Low-income single-family dwelling baseline consumption:

¹⁹³ 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

	<p>1,104 GJ annually</p> <p>Middle-income individual dwelling baseline consumption: 1,382 GJ annually</p> <p>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</p>
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 ¹⁹⁴
Purpose of data	Calculation of emission reductions for the pre- and post-retrofit energy assessment approach
Calculation method	<p>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>i</i>, included in the adjusted consumption approach for the project</p> <p>Baseline fuel consumption for the Same Building Stock is calculated using a weighted mean calculation as set out in section 3.4 for the baseline scenario. The baseline consumption is calculated as follows:</p> <p>Same Building Stock: Low-income single-family dwellings</p> <p>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</p>

¹⁹⁴ Additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 under the adjusted consumption approach and under the control group approach

	<p>of the NEED Framework.^{195 196 197} 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 Methodology¹⁹⁸</p> <p>Same Building Stock: Middle-income single-family dwellings</p> <p>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.^{199 200 201} 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 Methodology²⁰²</p>
Comments	N/A

Methodology reference	Table 10
Data / Parameter	$H_{load,pre,i}$
Data unit	kWh/m ² /HDD or GJoules/m ² /HDD
Description	Heat load pre-retrofit for dwelling i based on size of the dwelling and historical HDD for the region

¹⁹⁵ Additional Consumption Tables: England, Wales and Scotland, 2019. Department for Business, Energy and Industrial Strategy (BEIS). December 2021.

¹⁹⁶ 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

¹⁹⁷ Table A11 of the Household natural gas and electricity consumption data published by BEIS under the NEED framework

¹⁹⁸ 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

¹⁹⁹ Additional Consumption Tables: England, Wales and Scotland, 2019. Department for Business, Energy and Industrial Strategy (BEIS). December 2021.

²⁰⁰ 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

²⁰¹ Table A11 of the Household natural gas and electricity consumption data published by BEIS under the NEED framework

²⁰² 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

Source of data	Pre-retrofit energy assessment
Description of measurement methods and procedures to be applied	<p>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 dwellings²⁰³</p> <p>The pre-retrofit energy assessment determines the heat load in the baseline</p>
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 ²⁰⁴
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology ²⁰⁵
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 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

²⁰³ Additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 under the pre- and post-retrofit energy assessment approach

²⁰⁴ 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

²⁰⁵ Additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 under the pre- and post-retrofit energy assessment approach

	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/m ² /HDD or GJoules/m ² /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	<p>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 dwellings²⁰⁶</p> <p>The post-retrofit energy assessment determines the heat load following the implementation of project activity</p>
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

²⁰⁶ Additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 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 ²⁰⁷
QA/QC procedures to be applied	Quality assurance monitoring is undertaken in accordance with the VM0008 Methodology ²⁰⁸
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 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
Data unit	N/A
Description	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

²⁰⁷ 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

²⁰⁸ Additional detail on the quality assurance monitoring and its implementation within this project is set out in section 4.4 under the pre- and post-retrofit energy assessment approach

	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) ²⁰⁹ or the Final energy demand data published by the Department for Business, Energy and Industrial Strategy (BEIS) ²¹⁰ . Historical data from a public authority may be used to determine the ECF. Projected trends in changes in the rate of 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 electricity demand based on average 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 electricity consumption based on decreases in 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 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
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 electricity demand based on average electricity consumption within the state over a period of at least ten years. For each of the ten years, baseline household

²⁰⁹ 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

²¹⁰ 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

<p>electricity consumption data is calculated, for example as follows when using the Household energy consumption dataset from BEIS:</p> <p>Same Building Stock: Low-income single-family dwellings</p> <p>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.^{211 212 213} 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 Methodology²¹⁴</p> <p>Same Building Stock: Middle-income single-family dwellings</p> <p>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.^{215 216 217} 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 Methodology²¹⁸</p>	<p>electricity consumption data is calculated, for example as follows when using the Household energy consumption dataset from BEIS:</p> <p>Same Building Stock: Low-income single-family dwellings</p> <p>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.^{211 212 213} 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 Methodology²¹⁴</p> <p>Same Building Stock: Middle-income single-family dwellings</p> <p>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.^{215 216 217} 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 Methodology²¹⁸</p>
<p>Comments</p>	<p>N/A</p>

²¹¹ Additional Consumption Tables: England, Wales and Scotland, 2019. Department for Business, Energy and Industrial Strategy (BEIS). December 2021.

²¹² 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

²¹³ Table A12 of the Household natural gas and electricity consumption data published by BEIS under the NEED framework

²¹⁴ 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

²¹⁵ Additional Consumption Tables: England, Wales and Scotland, 2019. Department for Business, Energy and Industrial Strategy (BEIS). December 2021.

²¹⁶ 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

²¹⁷ Table A12 of the Household natural gas and electricity consumption data published by BEIS under the NEED framework

²¹⁸ 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	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' ²¹⁹ quarterly bulletin containing statistics on weather patterns, including temperature, heating degree days, wind speeds, sun hours and rainfall ²²⁰
Description of measurement methods and procedures to be applied	The HDDCF is used to update the baseline fossil fuel and 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	Annually for each year y
Value applied	Calculated for each rolling twelve-month period after 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

²¹⁹ 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](#)

²²⁰ 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

	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 ²²¹
Comments	<p>HDD values are calculated on a rolling twelve-month period to accommodate periodicity of adding dwellings to the Project Activity</p> <p>Any given instance will have a unique HDDCF value specific to the baseline year and project year</p>

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 'Energy Trends' ²²² quarterly bulletin containing statistics on weather patterns, including temperature, heating degree days, wind speeds, sun hours and rainfall ²²³
Description of measurement methods and procedures to be applied	The HDDCF is used to update the baseline fossil fuel and 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 project activity for each rolling twelve-month period
Value applied	57.7 Degree days
Monitoring equipment	Data retrieved from the Department for Business, Energy and Industrial Strategy (BEIS)

²²¹ 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](#)

²²² 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](#)

²²³ 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

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 ²²⁴
Comments	<p>HDD values are calculated on a rolling twelve-month period to accommodate periodicity of adding dwellings to the Project Activity</p> <p>Any given instance will have a unique HDDCF value specific to the baseline year and project year</p>

Methodology reference	Table 10
Data / Parameter	<i>J</i>
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 ²²⁵

²²⁴ 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](#)

²²⁵ Additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 under the pre- and post-retrofit energy assessment approach

	The post-retrofit energy assessment determines the number of fuel types
Frequency of monitoring/recording	Annually
Value applied	One fuel type: Natural gas
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 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 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	/
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	28 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 4
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: $i = 28$ The sample size for the quality assurance sample is 4
Comments	N/A

Methodology reference	Table 11
Data / Parameter	$EleC_{SG,y,b}$
Data unit	kWh/yr.
Description	Mean 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	Calculated as the mean electricity consumption based on actual consumption data for a sample of dwellings in the Same Building Stock
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

	<ul style="list-style-type: none"> b. Systematic sampling c. Stratified sampling within the Same Building Stock d. Cluster sampling. <p>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.</p>
Comments	N/A

Methodology reference	Table 11
Data / Parameter	$Elecc_{CG,y,b}$
Data unit	kWh/yr.
Description	Mean electricity consumed by control group dwellings in Building Stock <i>b</i> in year <i>y</i>
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	Calculated as the mean electricity consumption based on actual consumption data for a control group of dwellings in the Same Building Stock
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

	<p>dwelling 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.</p>
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	Calculated as the mean fuel consumption based on actual consumption data for a sample of dwellings in the Same Building Stock
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	<p>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:</p>

	<ul style="list-style-type: none"> a. Simple random sample b. Systematic sampling c. Stratified sampling within the Same Building Stock d. Cluster sampling. <p>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.</p>
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	Calculated as the mean electricity consumption based on actual consumption data for a control group of dwellings in the Same Building Stock
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	<i>J</i>
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	<p>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 dwellings²²⁶</p> <p>The post-retrofit energy assessment determines the number of fuel types</p>
Frequency of monitoring/recording	Annually
Value applied	N/A
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

²²⁶ Additional detail on the SAP assessment and its implementation within this project is set out in section 4.4 under the pre- and post-retrofit energy assessment approach

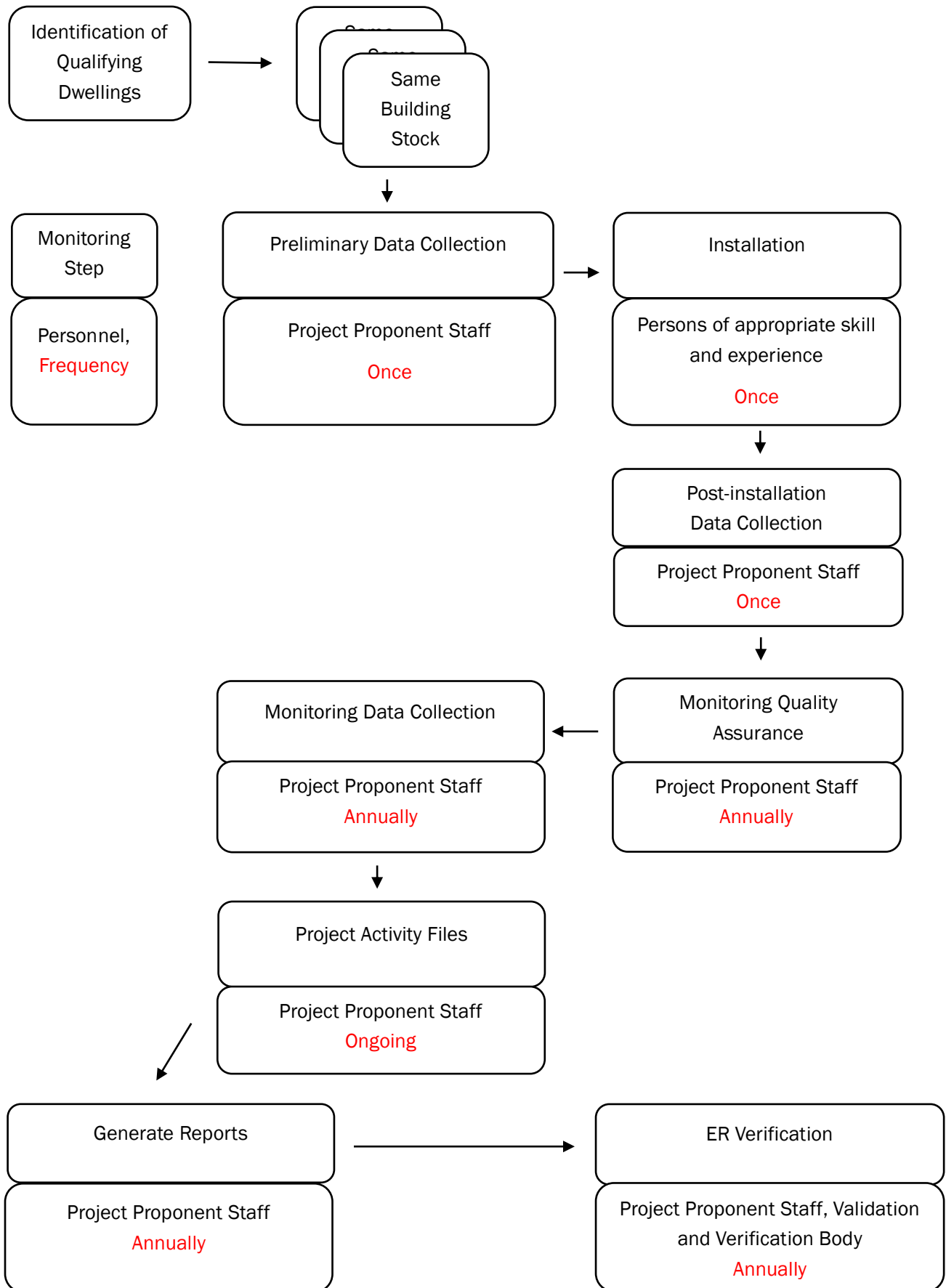
Calculation method	The SAP methodology considers a range of factors that contribute to energy efficiency including materials used for construction of a dwelling, thermal insulation of the building fabric, air leakage characteristics of the dwelling, efficiency and control of the heating system(s) and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

Methodology reference	Table 11
Data / Parameter	I_b
Data unit	N/A
Description	Number of 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	N/A
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

5.3 Monitoring Plan

Monitoring plans for the project activity follow the approach outlined in the VM0008 Methodology.

Figure 5 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



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 this document. 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 are collected in accordance with this 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) 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 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 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) comprises actual natural gas and 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) 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) will be 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
- Project proponent staff, or designated personnel who participate in decarbonisation project activity, will 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 will meet the criteria set out in section 1.4 (Eligibility Criteria) of this document. 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 this document. 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 this document. 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 this document using data stored in the centralised data repository.