

Research Proposal

RESEARCH PROJECT DESIGN

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Abstract

Wales has committed to achieving net zero greenhouse gas emissions by 2050, with the construction industry playing a key role in decarbonising domestic housing. The existing Welsh housing stock is dominated older with traditionally built dwellings and poor thermal performance.

This research project proposes to investigate, how emerging construction technologies systems can be integrated into domestic housing in Wales, to accelerate progress toward nett zero. Which the primary focus of this research proposal is to evaluate the viability of implementing Nett Zero methods of construction within social housing developments across Pembrokeshire, Wales.

The study will examine low-carbon building services technologies, including air-source and ground-source heat pumps, mechanical ventilation with heat recovery, and on-site renewable energy systems such as solar PV panels and battery storage, from a construction and installation perspective.

The research will respond to the findings within the Welsh construction industry, considering skills availability, supply chain constraints, cost implications, and the requirements of development for the Retrofit Programme and Nett Zero Requirements. Using selected case studies, project aims, interviews and surveys to identify differences methods of construction strategies for delivering low-carbon domestic housing.

Introduction

Background of Study:

“The Welsh government has committed to be to achieving net zero greenhouse gas emissions by 2050, recognising climate change as a national emergency and aligning with UK-wide and international decarbonisation targets”. (Net Zero Wales 2021)

Wales is actively progressing with retro fitting domestic housing to obtain nett zero carbon emissions by 2050. By delivery of highly efficient retrofitted homes, form the existing housing stock. Which is in need of addressing as Wales has an older housing stock which is long lasting.

“The Welsh Government policy strongly promotes a fabric-first approach to housing decarbonisation, particularly within domestic retrofit programmes. This approach prioritises upgrading the building envelope through enhanced insulation, improved airtightness, and better thermal performance before introducing low-carbon heating systems and renewable energy technologies. Addressing heat loss at source ensures that subsequent technologies operate more efficiently and cost-effectively. Fabric-first measures not only improve long-term building performance and durability, but also contribute to lower energy consumption, reduced carbon emissions, and improved thermal comfort for occupants. Crucially, by limiting energy demand, this approach plays an important role in tackling fuel poverty, ensuring that decarbonisation efforts deliver both environmental and social benefits”. (Optimised Retrofit Programme - Welsh Government (2023))

By the method of program implemented by the Welsh government you can also, by integrating retro fit systems such as PV panels, mechanical ventilation heat recovery system (MVHR), ASHP and ground heat pumps, will ensure energy-efficient and resilient buildings for domestic housing. In which these strategies will support renewable energy generation, enhances indoor air quality through controlled ventilation, and strengthens risk management by protecting long-term asset performance. Which these measures contribute to an improved building performance, occupant wellbeing, environmental and financial costs.

In my opinion, the Welsh Government’s implementation of these legislative measures enables domestic housing in Pembrokeshire to better align with net zero standards.

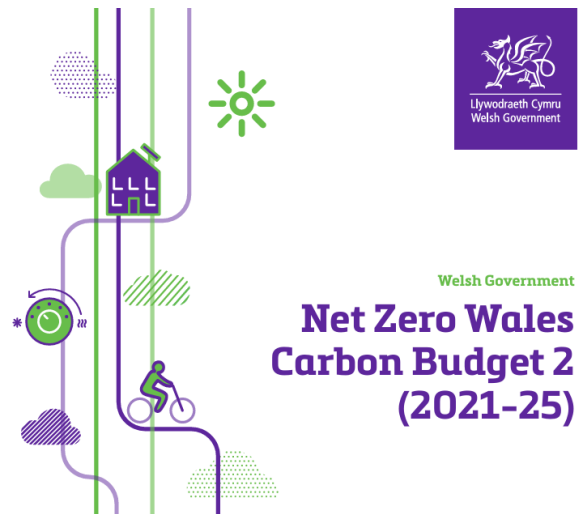


Figure 1 Welsh Government (2021)

Through targeted retrofit programmes, homes can become more energy efficient, reducing carbon emissions while improving overall housing quality.

In which also allows occupants to experience clear financial benefits, particularly through lower energy bills and reduced household outgoings. By combining improved building performance with practical support for residents, these strategies not only contribute to environmental sustainability but also enhance affordability and comfort.

Research Question

Proposed Question - How can emerging technologies be integrated into domestic housing in Wales to accelerate progress toward net zero by 2050?

Aims/Objectives of the Study

OBJECTIVE 1 - ANALYZE THE CURRENT CARBON EMISSION PROFILE OF DOMESTIC HOUSING IN WALES

Justification:

A defining feature of the current carbon emission profile of domestic housing in Wales is its heavy reliance on fossil fuel-based heating systems. Most homes are heated by natural gas boilers, while a significant proportion of rural properties, particularly in areas such as Pembrokeshire, are off the gas grid and rely on oil or LPG, both of which are highly carbon intensive. Emissions are further exacerbated by the age and condition of the housing stock, as Wales has a high proportion of older properties with solid walls, limited insulation, and low EPC ratings. These factors will increase heat loss and drive higher energy consumption per dwelling. (2025 - Office for National Statistics)(Heat strategy for Wales)

METHODOLOGY FOR ACHIEVING THE OBJECTIVE

Delivery Constraints:

- To examine the challenges facing Wales, with particular emphasis on infrastructure limitations in rural areas, and to assess how factors such as limited grid capacity, access constraints, housing typology and skills shortages hinder the effective installation of retrofit technologies, including insulation upgrades, low-carbon heating systems and renewable energy solutions.
- To conduct interviews with construction companies to identify practical methods, and solutions for delivering retrofit technologies effectively within rural areas of

- Wales. Which will consider the surrounding infrastructure, access to sites and skills constraints.
- This investigation examines data on Wales's current carbon footprint arising from domestic housing, drawing on findings (Update on "Better Homes, Better Wales, Better World" report by Lisa Dobbins, Head of Housing Decarbonisation) To evaluates Wales's current progress and stage of delivery, and analyses of behavioural changes associated with the increased introduction of retrofit technologies to obtain the achievement of national net-zero targets.

An evaluation of the cost-effectiveness of implementing retrofit technologies:

- What legislation and funding opportunities exist to support councils in delivering retrofit technologies within domestic homes. Compare with private owners which availability to retro fit technologies on installing.
- What financial savings do homeowners achieve through the installation of retrofit technologies?
- How do homeowners experience day-to-day living after the introduction of retrofit technologies in their homes, surveys will be gathered to analyse date.

Outcome:

Conducting this research will enable an analysis of the differences between domestic properties with and without retrofit technologies, and how these differences influence Wales's progress towards achieving Net Zero. The study will also identify the associated cost implications for Wales and examine how homeowners adapt to and manage these technologies in their day-to-day lives.

**OBJECTIVE 2 - EXAMINE EMERGING LOW CARBON TECHNOLOGIES
SUITABLE FOR WELSH HOMES**

Explanation:

To evaluate domestic retrofit technologies such as insulation upgrades, heat pumps, solar PV, and smart energy systems. These technologies are essential in reducing operational carbon emissions from existing housing stock and supporting Net Zero targets by improving energy efficiency, lowering fuel demand, and enhancing long-term sustainability. (Wcpp.org.uk. (2023). *Domestic Retrofit: Driving Green Growth and Social Equity - Wales Centre for Public Policy.*)

METHODOLOGY FOR ACHIEVING THE OBJECTIVE

Challenges:

- Retrofitting existing housing presents several challenges due to the need to comply with a complex regulatory framework in Wales. In which these are Welsh Building Regulations Approved Documents, planning and conservation legislation, PAS 2035 requirements for retrofit delivery, Building Safety and Fire Regulations, and the Welsh Housing Quality Standard (WHQS). These regulations increase compliance demands, project complexity, and delivery costs while ensuring safety, quality, and Decarbonisation objectives are met. Which will need to follow to installed certain types of retro fit technologies. I will carry out interviews across Councils to figure out which is the most common technologies used in Wales. Then analyze this data, to figure out the best route.

(GOV.WALES. (n.d.). *Building regulations: approved documents*)

(Whittaker, G., Baker, P. and Knight, E. (2025) GOV.WALES. (2026).

(What Retrofit Contractors Must Know About PAS 2030, PAS 2035 and TrustMark.)

(*Evaluation of Welsh Housing Quality Standard 2023 and Optimised Retrofit Programme* | GOV.WALES.)

Outcome:

- As a result of these regulatory requirements with retrofit projects in Wales are delivered to higher standards of safety, quality, and energy performance, supporting long-term decarbonisation goals.
- Analysing data collected from local authorities across Wales will provide access to reliable, large-scale evidence on retrofit delivery, costs, and performance outcomes. Local councils play a central role in implementing Welsh Government programmes such as the Optimised Retrofit Programme and monitoring compliance with the Welsh Housing Quality Standard 2023 (Thefis.org. (2026))
- However, increased compliance, and cost pressures can slow delivery of the projects and limit practicability for homeowners. Which will need to be streamlined processes, skilled supply chains, and continued government support.

OBJECTIVE 3 - COMPARE WALES'S APPROACH WITH LEADING INTERNATIONAL EXAMPLES.

Rational:

Comparing Wales's approach to housing retrofit and decarbonisation with leading international examples provides a robust rationale for identifying best practice, policy effectiveness, and transferable lessons. Countries such as Germany, Denmark, and the Netherlands have demonstrated successful large-scale retrofit delivery through long-term funding models, strong regulatory alignment, and skilled supply chains. By benchmarking Wales's policies against these international leaders, strengths and limitations can be critically assessed, enabling evidence-based recommendations to improve efficiency, reduce costs, and accelerate progress toward Net Zero targets while ensuring social and economic benefits are maximised.

(Trustmark.org.uk. (2024). *What can we learn from European countries and their home retrofitting practices & frameworks?* [online])

METHODOLOGY FOR ACHIEVING THE OBJECTIVE

Comparison:

- To compare the different retrofitting technologies by leading countries in their transition toward Net Zero.
- To assess the emerging retrofit technologies currently being implemented internationally.
- To evaluate how these countries are benefiting from the adoption of these technologies, including reductions in carbon emissions, energy costs, and improvements in building performance.
- Conduct interviews with professionals who have worked abroad to gather their perspectives and insights on working with emerging technologies within the construction and retrofit sector.

Result:

By comparing these international retrofit approaches, it will identify best-practice technologies and emerging solutions that accelerate progress towards Net Zero.

The professional interviews are to provide practical insights into real-world delivery, skills development, and lessons for Wales to learn moving forward.

ADDITIONAL RESEARCH OBJECTIVES:

- Assess the capacity of the Welsh supply chain and workforce to support emerging technologies
- Assess the potential carbon reduction impact of integrating selected technologies

Literature Review

REVIEW OF CURRENT RESEARCH AND LITERATURE

The current methods of domestic heating in Wales are characterised by the following pattern: “Based on the 2021 Census and recent Welsh Government reports, mainly homes in Wales continue to rely on non-renewable energy sources for central heating. Approximately 97-98% of households use fossil-fuel-based systems, with mains gas remaining dominant at around 71-72%. A further 7.8% of homes rely on oil, alongside smaller proportions using bottled gas and solid fuels. In contrast, renewable heating technologies remain limited, with only around 1.1% of Welsh households utilising renewable energy for central heating as of 2021.” (Title Energy Use in Wales Third Edition. (n.d.) In which Wales is trying to introduce retro fitting technologies to reduce these figures and create a pathway to Nett Zero.

Government Legislations:

- Energy Generation Wales Doc 2017:

The Energy Generation in Wales (2017) report explains how Wales intended to transition from fossil-fuel-dominated electricity production toward a renewable-led system. By setting clear targets, promoting local ownership, and tracking renewable deployment, it provides a strategic and legislative stepping stone toward achieving Net Zero by 2050.

(Energy Generation in Wales. (2017). Available at:

<https://www.gov.wales/sites/default/files/publications/2019-06/energy-generation-2017-report.pdf>.)

- Future Wales: The National Plan 2040:

This is the Welsh Government’s 20-year national development framework guiding spatial planning and development across Wales. Which it sets out priorities for housing, transport, and infrastructure. With a strong emphasis on decarbonisation, climate resilience, and sustainable placemaking. Which has a development plan status and

requires regional and local plans to align with its policies. In which to support Wales's long-term transition towards Net Zero and improved wellbeing for communities. (GOV.WALES. (n.d.). *Future Wales: the national plan 2040*. [online] Available at: <https://www.gov.wales/future-wales-national-plan-2040>.)

- Net Zero Skills Wales:

A Welsh Government programme designed to develop a skilled workforce capable of supporting the transition to a net-zero economy. Which is the Net Zero Skills Action Plan, which outlines 36 actions across seven priority areas, focusing on emissions sectors such as energy, transport, construction, and buildings. The programme promotes upskilling and reskilling through education, apprenticeships, and employer support. With the transition that creates economic opportunities while meeting Wales's Net Zero target. (GOV.WALES. (2024). *Net zero skills Wales* | GOV.WALES. [online] Available at: <https://www.gov.wales/net-zero-skills-wales>.)

- Building a Low-Carbon Economy in Wales:

This legislation was published by the UK Climate Change Committee in 2017, sets out how Wales can reduce greenhouse gas emissions while supporting economic growth and wellbeing. The report recommends legally binding carbon budgets under the Environment (Wales) Act 2016 and highlights cost-effective decarbonisation pathways across energy, buildings, transport, industry, and land use.

It concludes that early investment in low-carbon technologies, energy efficiency, and skills can deliver economic benefits, improve public health, and support.

(Building a low-carbon economy in Wales. (n.d.). Available at:

<https://www.theccc.org.uk/wp-content/uploads/2017/12/CCC-Building-a-low-carbon-economy-in-Wales-Setting-Welsh-climate-targets.pdf>.)

- Royal Institution of Chartered Surveyors (RICS)

Within domestic housing, the Royal Institution of Chartered Surveyors (RICS) provides professional leadership on retrofit through its Residential Retrofit Standard (2024), setting clear requirements for surveyors advising homeowners. The standard promotes a whole-house, fabric-first approach, addresses risks such as damp and ventilation, and aligns with PAS 2035 to ensure safety, performance, and consumer protection. By standardising assessments and advice, RICS supports informed retrofit decisions that improve energy efficiency, comfort, and property value while contributing to Net Zero goals. (Rics.org. (2026). Available at: <https://www.rics.org/news-insights/reforming-energy-performance-across-england-and-wales>)

- The Optimised Retrofit Programme (ORP)

This is the Welsh Government's primary funding mechanism for decarbonising existing social housing in Wales. Launched in 2020, the programme provides capital grant funding to local authorities and registered social landlords to deliver whole-house, fabric-first retrofit measures, including insulation, low-carbon heating, renewable energy, and energy monitoring systems. ORP supports compliance with the Welsh Housing Quality Standard. Welsh Government (2023). *Optimised RetroFit Programme* | GOV.WALES. [online] www.gov.wales. Available at: <https://www.gov.wales/optimised-retrofit-programme>.

Case Studies:

The ORP PV and Battery Systems report (2025) "evaluates domestic solar and battery retrofits delivered through the Welsh Government's Optimised Retrofit Programme. The programme has invested over £200 million to retrofit more than 16,000 social homes, including over 2,760 solar PV installations. Monitoring data shows PV-only systems generate around 2,350 kWh per home annually, with households' self-consuming 65%, saving approximately £430 per year and 190 kg CO₂. Adding battery storage increases self-consumption to 95%, raises bill savings to about £650 annually, and reduces emissions by 293 kg CO₂ per home. The report concludes that PV and battery systems are highly effective measures for reducing costs, improving energy resilience, and supporting Wales's Net Zero housing strategy "(ORP Retrofit CASE STUDY -PV and battery systems. (2025). Available at: <https://www.gov.wales/sites/default/files/publications/2025-09/orp-pv-battery%20systems.pdf>.)

"The Vale of Glamorgan Council's Hybrid Heating Installation project demonstrates a practical approach to decarbonising social housing while addressing fuel poverty. The scheme delivered 57 hybrid heating systems, supported by 100 Airwit sensors and building passport assessments to monitor performance and inform future upgrades. Local contractors and in-house staff were upskilled to install air source heat pumps and intelligent energy systems, securing extended warranties and improving long-term reliability. Although initial tenant scepticism presented challenges, targeted communication and clear information improved engagement. Overall, the project highlights the importance of tenant involvement, skills development, and data-led retrofit delivery" (Housing, V. and Stopgate, D. (n.d.). *Vale of Glamorgan Council Optimised Retrofit Programme (ORP) -Year 1 Hybrid Heating Installations Project Present by*. [online] Available at: <https://www.gov.wales/sites/default/files/publications/2024-03/orp-case-study-hybrid-heating-installations.pdf> [Accessed 19 Apr. 2026].

Analysis of Gaps in the Existing Literature

- **Research within privately owned homes regarding emerging technologies:**

Privately owned and owner-occupied homes account for over 80% of dwellings in Wales, yet research addressing how emerging technologies can be involved hasn't been as research as domestic housing. (Senedd.wales. (2026).

- **Limited Long-Term Performance Evidence for Emerging Technologies:**

Most Welsh studies only encounter for case studies up to 1-3 years. (Crowe, E., Mills, E., Poeling, T., Curtin, C., Bjørnskov, D., Fischer, L. and Granderson, J. (2020). Which there is a lack of 10–20 years performance and lifecycle studies evaluating how emerging domestic technologies function under real Welsh climatic.

- **Underdeveloped Understanding of tenants with merging Technology within domestic housing:**

Behavioural research into domestic decarbonisation exists, but emerging technologies introduce new layers of complexity within the household. Which the tenant has not got an understanding on how the technology works and would need a proper introduction. More research is needed on tenants' adaptation with emerging technology systems to allow them to receive the most benefits from the technology system, especially in vulnerable or fuel-poor households.

- **Planning and Permitted Development Constraints:**

Planning permission is frequently cited as a barrier to technologies, particularly in conservation areas and rural settings. Which there is insufficient evidence in how planning regulations with retro fitting approaches to domestic housing especially in a heritage rich Wales infrastructure places.

- **Weather and Climatic Constraints:**

Wales has a harsh climate, including high rainfall, elevated humidity and high wind exposure. Existing literature does not explore how emerging technologies will perform in Welsh weather conditions, particularly in coastal and upland areas.

- **Supply chain and demand:**

Emerging technologies rely not only on installers, manufacturers and distributions. In which literature rarely addresses Wales's limited domestic manufacturing base for

low-carbon housing technologies. There have been minimal studies on how local manufacturing, regional innovation hubs, or circular-economy approaches could strengthen supply-chain resilience and reduce delivery risks.

How Your Research Will Address These Gaps

- **Generating Performance Evidence:**

To monitor data analytics, domestic homes on how emerging technologies are being used within the house. Which will enable researchers to evaluate in-use performance rather than predicted outcomes. Which will:

- Bridge the performance gap between design and operation
- Improves understanding of degradation, maintenance, and user interaction
- Strengthens the empirical evidence base, particularly for rural and hard-to-treat dwellings

- **Environmental Impacts:**

To carry out life cycle assessment (LCA'S) with emerging technologies. Which will allow to show results on:

- Capture embodied carbon and supply-chain impacts
- Compare low-tech and high-tech retrofit pathways fairly
- Identify environmental trade-offs.

This will directly address the gap with a whole-life sustainability assessment.

- **Social:**

Conduct interviews with domestic homeowners in Pembrokeshire to explore their experiences of installed retrofit technologies. Use a structured survey to measure technology acceptance, usability, and satisfaction. Assess whether homeowners believe they are using the systems to their full potential and identify barriers to optimal performance.

- **Legislation restraints:**

This research will examine how current planning regulations and building standards affect the delivery of domestic retrofit technologies in Wales.

- Analyse existing planning policies, permitted development rights, and building regulations relevant to domestic retrofit technologies across Wales.
- Conduct interviews with local authority planning officers and policymakers to identify specific regulatory challenges and inconsistencies in interpretation or enforcement.
- Develop evidence-based policy recommendations aimed at streamlining approval processes for retrofit measures and supporting sustained investment and large-scale deployment of low-carbon housing retrofits.

- **Economic and Financial Viability:**

This research will evaluate the economic viability of domestic retrofit technologies by examining both upfront and long-term financial impacts, particularly in rural housing contexts. Which the study will:

- Conduct a cost-benefit analysis comparing retrofit interventions (e.g. insulation upgrades, low-carbon heating, and smart energy systems) against traditional maintenance or minimal-upgrade approaches in rural housing.
- Assess how transportation distances, installation complexity, and maintenance requirements influence the financial practicality of retrofit technologies in rural Wales.
- Explore available funding mechanisms, grants, and government incentives that could improve the affordability and long-term economic viability of domestic retrofit projects for homeowners and housing providers.

Research Design and Methodology

“Research is broadly categorized into qualitative and quantitative approaches, which differ in their goals, data types, and analysis methods. Qualitative research focuses on understanding human experiences and "why" things happen through words and meanings. In contrast, quantitative research measures "what" is happening and "how much" using numerical data and statistical testing” (Streefkerk, R. (2019). Qualitative vs. quantitative research)

Survey approach:

A survey-based approach will be considered the most suitable method for this research, as it enables the collection of views from a broad range of stakeholders while allowing the data to be efficiently processed and analysed within the available timeframe. A structured

questionnaire will therefore be used as the primary data collection instrument to obtain sufficient and reliable data to support the research objectives.

Questionnaire data collection:

The questionnaire will use mainly closed-ended questions to ensure consistency and allow efficient analysis. Respondents will rate statements using a scaled format to assess perceptions of retrofit technologies, including cost, performance, and usability. Both positive and negative statements will be included to reduce response bias, and only the general topic of domestic retrofitting will be stated to avoid influencing responses. (Naoum, 1998).

The questionnaire will be completed by many participants to ensure clarity, relevance, and ease of completion. It will be distributed via email, with regular reminders sent to encourage responses. Once collected, the data will be analysed to identify recurring patterns, trends, and common themes relevant to the research objectives.

Data Analysis:

Thematic Coding from Data:

Thematic coding is a qualitative analysis method that organises complex data into meaningful patterns. Key segments of data are labelled with codes, which are then grouped into broader themes. This process helps reveal underlying meanings in participants' experiences, behaviours, and opinions, moving analysis beyond surface-level findings to support informed insights and decision-making. (Usercall.co. (2025). *How to Do Thematic Coding & Analysis - A Step-by-Step Guide.*)

Quantitative data - from closed-ended questionnaires will be analysed using SPSS, applying statistical tests such as *t-tests*, *ANOVA*, and *chi-square* to identify patterns and relationships (Field, 2018; Pallant, 2020).

Qualitative data - from interviews and open-ended responses. Will undertake the "why" and "how." In which it was captured, concepts, and descriptions rather than numbers or statistics. It is used to understand human behavior, emotions, and social patterns. (Fullstory (2021). *What Is Qualitative Data?*)

Interviews:

As a local authority employee, I will conduct interviews with the in-house decarbonisation team to identify forthcoming projects and the emerging retrofit technologies planned for installation. I will also review the annual business plan to analyse planned programmes,

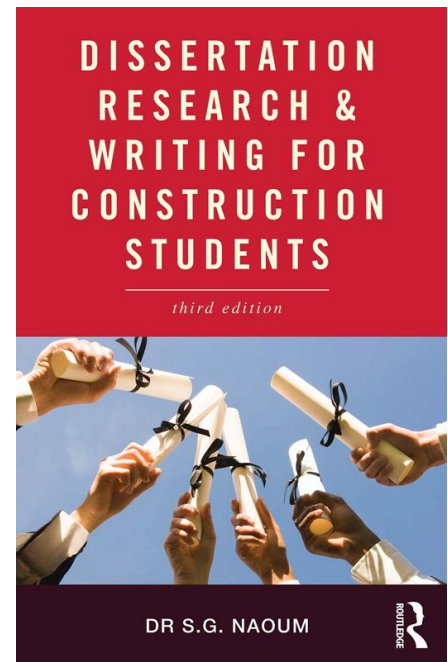


Figure 2 - Naoum, 1998

timelines, and investment priorities, supporting a clearer understanding of future retrofit delivery and strategic direction.

This will purposely contribute as purposive sampling, as this interview research is deliberately targeting key managers and team members involved with the retrofitting delivery, decision making, coordination techniques and insights within the local authority.

Ethical Considerations

Will undergo an assessment through “FINER is a framework for judging research questions: Feasible with available time and data; Interesting to researchers and stakeholders; Novel in adding new knowledge; Ethical in respecting participants and impacts; and Relevant to policy, practice, or scientific advancement, to guide clear, focused, and high-impact study design decisions across multiple disciplines.” (FINER Criteria for Developing Research Questions)

Research Bias:

I am going to reduce the risk of bias by using appropriate sampling methods such as the correct participants, designing neutral questions for participants and ensuring transparency by making the research findings accessible for review, allowing others to assess and validate the results. (Baldwin, J.R., Pingault, J.-B., Schoeler, T., Sallis, H.M. and Munafò, M.R. (2022).

Timeline

TASK	ESTIMATED DURATION
Literature Review	1 Month
Designing Surveys and Interviews	4 Weeks
Data Collection	2 Months
Data Analysis	1 Month
Creating Report	1 Month
Reviewing Data collected	4 Weeks
Total Duration (est)	8 Months

Outcome

The proposed research is expected to identify clear patterns in the integration of emerging retrofit technologies within domestic housing. Which will be demonstrating measurable reductions in household energy bills and property carbon emissions. It will show how retrofit programmes can be better coordinated and streamlined across Wales, enabling faster installation and improved delivery efficiency. The study anticipates that upgraded technologies will lead to improved housing performance and EPC ratings.

Key challenges are to include meeting increasing demand for technologies and limits within supply chains. The research will produce evidence-based policy and delivery recommendations to support scalable, rural-appropriate retrofit solutions and accelerate Wales's progress toward net zero by 2050.

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