Wales Centre for Public Policy
Canolfan Polisi Cyhoeddus Cymru

Domestic retrofit: Driving green growth and social equity

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Summary

- Domestic retrofit refers to upgrading existing homes to improve energy efficiency, cut carbon emissions, and enhance comfort, health, and resilience for individuals. In Wales, where the housing stock is diverse and often inefficient, there is no one-size-fits-all solution: building-specific and well-timed interventions are essential.
- Domestic retrofit can deliver multiple benefits. It lowers household energy bills, reduces fuel poverty, creates skilled jobs, cuts emissions and improves public health. These gains benefit both households and Cardiff Council, supporting wider climate, economic, and social objectives. Progress, however, is constrained by high upfront costs, tenure differences, skills shortages, supply chain limitations, and governance and behavioural barriers.
- Overcoming these challenges requires targeted, large-scale investment to de-risk the market, consolidate demand, create economies of scale, and drive innovation and upskilling. Local authorities are well placed to play a convening role by establishing trusted delivery models, such as 'one-stop-shops', and coordinating area-based programmes that enable shared solutions like clean heat networks.
- Financing is a critical enabler. Local authorities can help create a more coherent and equitable funding landscape by blending multiple funding sources, tailoring support to household circumstances, and avoiding gaps for those at the margins of fuel poverty. Mechanisms such as PACE financing and partnerships with institutions like the Development Bank of Wales demonstrate how capital can be unlocked, risks reduced, and private sector investment attracted.
- Lessons from the five case studies analysed in this report (Kirklees Warm Zone, Warm Wales Retrofit Programme, Green Homes Wales, Ty Gwyrddfai, and the US Better Buildings Neighborhood Program) show that trusted local delivery, blended funding, flexible finance, and investment in skills and supply chains are central to success. Together, they illustrate how retrofit can drive green growth while tackling social inequality and supporting a just transition.
- Aligning local retrofit strategies with Welsh Government policy is important. Recommendations for achieving this include adopting Optimised Retrofit Programme (ORP) standards across tenures and using the ORP as the delivery model; integrating with Local Area Energy Plans and heat zoning; prioritising fuel-poor households; applying WHQS 2023 standards; embedding skills development; blending funding sources; aligning governance and data; and ensuring strong consumer protection.

Introduction

The Welsh Government has set a legally binding target for Wales to achieve net zero by 2050, with the public sector expected to lead the transition. Cardiff Council's One Planet Cardiff Strategy reflects this ambition, aiming for the city to become carbon neutral by 2030. Domestic buildings are central to this goal, accounting for 24% of the city's emissions (Department for Energy Security and Net Zero, 2025). Yet very few homes currently meet net zero standards, and the cost of decarbonising Cardiff's housing stock is estimated at £10–12 billion (HIA, 2024).

The transition to net zero presents a wider opportunity to rethink how the economy functions, particularly the balance between economic growth, environmental protection, and social equity. This project explores how investment in retrofit can serve as a mechanism to deliver multiple benefits: cutting emissions, improving housing quality, reducing fuel poverty, and supporting long-term economic resilience.

Despite the urgency of the climate crisis, with 19 of Wales's 22 local authorities having declared an emergency, emissions from buildings are not falling quickly enough. Retrofitting faces persistent challenges, including high upfront costs, disruption, a shortage of skilled contractors, and complex grant and planning processes (HIA, 2024). These issues are compounded by Wales's older and more difficult-to-decarbonise housing stock. Nearly two-thirds of Welsh homes are rated Energy Performance Certificate (EPC) 'D' or below, and 85% rely on gas heating (Notman et al., 2024). In October 2024, 41% of households in Wales were estimated to be in or at risk of fuel poverty, reinforcing the need for a strategy that addresses both emissions and affordability (Welsh Government, 2025a).

In response, Cardiff Council is developing a domestic retrofit strategy across all tenures – social, private rental, and owner-occupied – aligned with Welsh Government objectives and grounded in a green growth approach. This report reviews existing evidence and best practice to address three key questions:

- How can investment in large-scale, targeted domestic retrofit support and stimulate the development of a wider domestic retrofit market?
- How have such programmes been implemented elsewhere, and what lessons can be drawn for Cardiff?
- To what extent does this programme align with Welsh Government objectives, and could a local authority-led initiative complement national efforts?

What is domestic retrofit?

Domestic retrofit refers to the process of upgrading existing homes to improve energy efficiency, reduce carbon emissions, and enhance comfort, health, and resilience. In practice, domestic retrofit in the UK focuses on three main areas:

- **Insulating homes**: using techniques such as roof, cavity wall, floor, and external insulation, along with high-performance glazing.
- **Switching from gas to electricity**: replacing gas boilers with low-carbon systems such as heat pumps, often combined with on-site renewable energy generation (e.g. solar panels) and battery storage.
- **Reducing energy use**: through smart technologies such as heat recovery systems, digital controls, and energy-efficient appliances that minimise waste (UK Green Budget Council, n.d.).

Domestic retrofit may also involve climate adaptation measures, such as installing external shutters, cooling systems, and improved ventilation to increase a home's resilience to overheating and extreme weather (UK Green Budget Council, n.d.; Hodgkin and Rutter, 2024). Given the diversity of Wales's housing stock, there is no single solution. Tailored, building-specific approaches are essential, and the timing of interventions can be critical (Green et al., 2020; Fawcett, 2014).

Benefits and barriers to domestic retrofit

Domestic retrofit delivers a wide range of well-documented benefits that advance climate, economic, and social goals, in line with the Well-being of Future Generations (Wales) Act 2015. At the UK level, it is estimated that upgrading all homes to EPC band C could deliver around £40 billion in benefits to the UK economy by 2030, and up to £100 billion more over the following decade. These include approximately £24 billion in consumer bill savings, £9 billion in societal benefits, and around £4 billion in energy system savings (Citizens Advice, 2025). Although EPCs face well-known criticisms – including their reliance on energy costs, limited consideration of health and wellbeing, and weak links to real-world performance – they remain the primary benchmark in the absence of a stronger alternative (National Retrofit Hub, 2024).

At the local level, modelling suggests that a £170 million investment in domestic retrofit in Cardiff (£150 million for fuel-poor households and £20 million from the able-to-pay sector) could deliver up to £957 million in co-benefits over 20 years, equivalent to a payback period of 29 months. Scaling this to a £280 million investment (£250 million for fuel-poor homes and £30 million from the able-to-pay sector) could yield £1.6 billion in co-benefits, with a shorter payback period of 25 months (Bankers without Boundaries, n.d.). These projections are

based on a set of specific assumptions that are not always fully transparent, which may limit replicability, but they highlight the scale of potential returns (Bankers without Boundaries, unpublished). The benefits would accrue to both Cardiff Council and local households, spanning public health improvements, job creation, lower energy bills, and emissions reductions. Table 1 summarises these projected co-benefits.

Table 1: Estimated co-benefits of domestic retrofit in Cardiff

Category	£170m investment	£280m investment
Health		
NHS savings/year	£21m	£35m
Reduction in winter deaths/year	6%	11%
Total Damp/mould reduction in homes	3%	6%
Total Improved asthma outcomes (child and adult)	108	215
Total Economic burden of asthma avoided	£0.06m	£0.13m
Economic		
Total number of jobs created	2,720	4,480
Increase in Cardiff GDP over 10 years	0.15%	0.25%
Total potential financial benefit from increased employee productivity gain/year	£33m	£67m
Socio-economic		
Average decrease in yearly energy bills for all homes	4.85%	9.69%
Total increase in household disposable income	0.10%	0.21%
Total stamp duty revenue increased	£7.43m	£14.92m
Total property value increase	0.34%	0.69%
Environmental		
Total domestic CO2 emissions reduction	5.98%	11.96%
Total CO2 emissions reduction	1.43%	2.87%

Source: Summarised from Bankers without Boundaries (n.d.).

These benefits are particularly significant for lower-income households. A UK-wide domestic retrofit programme could reduce household energy bills by an average of £779 per year (UK Green Building Council, n.d.). Retrofitting also reduces household exposure to volatile gas prices and helps lower dependence on fossil fuels. Upgrading homes to EPC band C, for example, is projected to reduce household gas demand by up to 20% (UK Green Building Council, n.d.).

The health-related benefits of domestic retrofit are also substantial, largely through improved indoor environments and reduced pressure on the NHS. The UK Green Building Council (n.d.) estimates that retrofit could prevent 6,000 avoidable deaths each year in the UK by increasing thermal comfort. In addition, a £10 billion investment to improve all 'poor' housing

in England – defined, using a standardised approach across UK nations, as dwellings with one or more Category 1 hazards under the Housing Health and Safety Rating System (HHSRS) and focused on health outcomes (Nicol et al., 2019) – was estimated to save the NHS £1.4 billion annually, with the investment paying for itself in just over seven years (CCC, 2019). Warmer, drier homes are also associated with reduced respiratory illness and better mental health outcomes (Marmot Review Team, 2011).

Retrofit also delivers strong economic benefits, particularly through the creation of locally rooted jobs that are not easily outsourced (Webb et al., 2020; Emden, 2022). As a labour-intensive sector, it supports a wide range of roles, including construction, surveying, coordination, and monitoring (UK Green Building Council, n.d.). For instance, the estimated £7 billion annual investment required in England to meet retrofit targets (CCC, 2020) could support more than 400,000 direct and 500,000 indirect jobs by 2030, and over 1.2 million total jobs by 2050 – equivalent to around 5% of the 2020 workforce (Emden, 2022; Construction Leadership Council, 2021). Based on an average of 16 jobs created per £1 million invested, up to 4,480 jobs could be created in Cardiff over seven years (BwB, n.d.).

However, there are significant challenges to delivering domestic retrofit, as summarised in Figure 1. Upfront costs remain one of the most substantial barriers, particularly within the private rented and owner-occupied sectors (Webb et al., 2020; Mininni, 2024). Decarbonising the UK's housing stock is expected to cost £250 billion between 2020 and 2050, or around £9 billion annually (CCC, 2020), with the average cost per home estimated at just under £15,000 for energy efficiency upgrades and low-carbon heating (Citizens Advice, 2025). As relatively few homes in Cardiff currently meet net zero standards, the total cost of decarbonising the city's housing stock to achieve these standards is estimated at £10–12 billion (HIA, 2024). These costs remain prohibitive for many households, especially without accessible finance mechanisms.

National programmes have often relied on top-down delivery models that struggle to engage local actors or respond to area-specific needs, such as housing typologies, deprivation, and local supply chain capacity (Wade et al., 2020). Most existing support focuses on single measures, limiting opportunities for whole-house, fabric-first approaches (Wise et al., 2025).

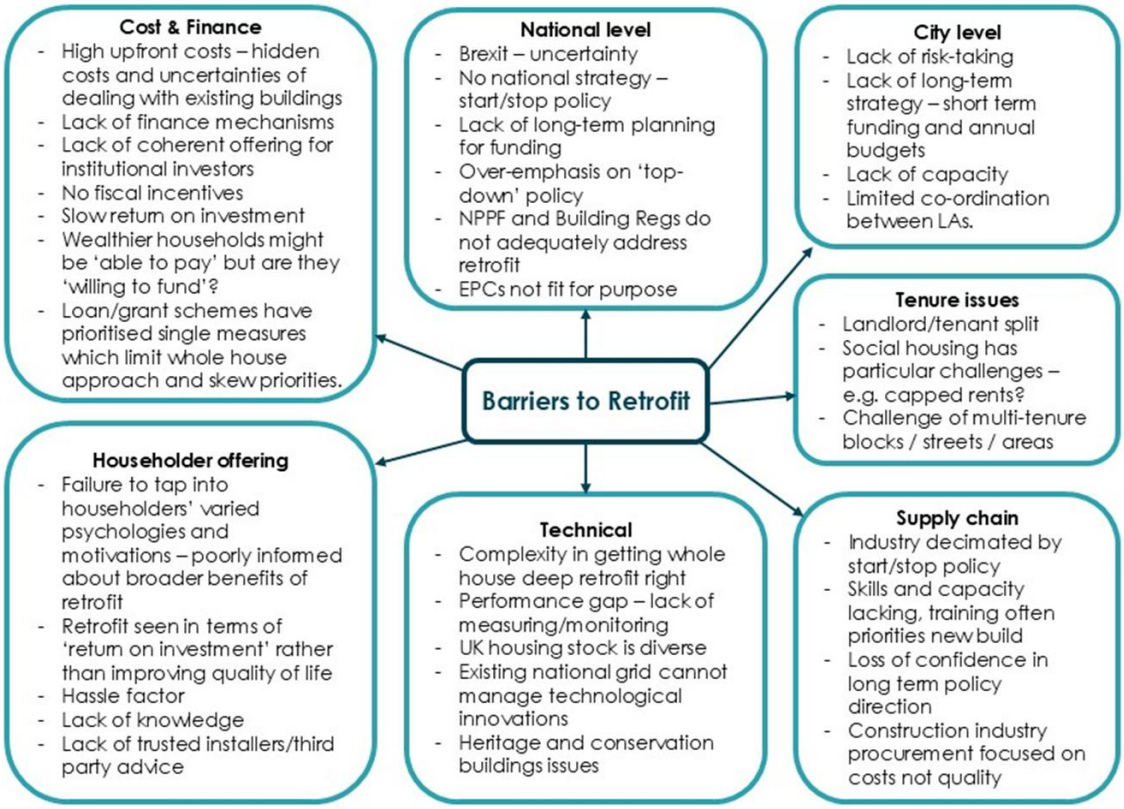
Tenure also influences feasibility. Rent caps can restrict investment in social housing, while coordination across mixed-tenure buildings remains complex. Among wealthier households, the key barrier may be willingness, rather than ability, to pay (UK Green Building Council, 2020). In the private rented sector, the 'split incentive' problem – where landlords fund upgrades but tenants benefit from lower bills and improved comfort – reduces motivation for investment, contributing to lower energy efficiency in rental homes compared to owner-occupied properties (Mininni, 2024). Census 2021 data show that 24.3% of Cardiff's population live in private rented or rent-free accommodation (Cardiff Council, 2022), highlighting the scale of residents potentially affected by this issue.

Skills shortages and supply chain limitations also present ongoing challenges (Notman et al., 2023). The retrofit sector remains underdeveloped, with many parts of the supply chain unprepared for large-scale delivery (Connected Places Catapult, 2023; UK Green Building Council, 2020; Webb et al., 2020). Current training provision is not aligned with demand for Publicly Available Specification (PAS) 2035-compliant retrofit, and bottlenecks persist in workforce entry, upskilling pathways, and long-term planning (Connected Places Catapult, 2023). Creating locally trained jobs is not guaranteed due to mismatches between workforce location and retrofit demand, alongside broader recruitment and training challenges across the construction industry (Emden, 2022). Wales's older housing stock adds further technical and logistical complexity, discussed below (Robinson et al., 2023).

Policy and governance constraints further hinder progress. National policy has been inconsistent, with fragmented regulation and funding undermining long-term planning and market confidence (Webb et al., 2020; Energy Security and Net Zero Committee, 2025). The abrupt withdrawal of schemes such as the Green Homes Grant Voucher Scheme in England damaged public trust and discouraged both household participation and supply chain investment (Public Accounts Committee, 2021). The UK Government's Green Deal, launched in 2013 to deliver domestic retrofits at scale, is widely considered a failure (Rosenow and Eyre, 2016). Initially expected to reach 14 million homes, it achieved only 14,000 by March 2016 before effectively ending. The scheme lacked guaranteed energy savings, excluded costlier measures, and was burdened by excessive complexity and bureaucracy. It offered limited financial incentives, failed to attract private investment, and resulted in high costs to the taxpayer (Rosenow and Eyre, 2016).

Meanwhile, local authorities often lack the capacity, funding certainty, and powers needed to coordinate retrofit across tenures and sectors (UK Green Building Council, 2020). Behavioural barriers also persist: public awareness remains low, and retrofit is often viewed as costly, disruptive, and overly complex. Many households assess retrofit purely through a financial lens, overlooking wider benefits such as comfort, health, and wellbeing (UK Green Building Council, 2020; Webb et al., 2020).

Figure 1: Summary of Barriers to delivering Domestic Retrofit



Source: UK Green Building Council (2020).

Policy engagement in domestic retrofit

Domestic retrofitting is a central component of both climate and social policy, providing a means for the UK and Welsh Governments to meet their legally binding net zero targets while tackling the growing crisis of fuel poverty (Wade and Visscher, 2021). However, progress remains slow: only 5% of UK homes currently use low-carbon heating, and most remain poorly insulated (Energy Systems Catapult, 2025). The Climate Change Committee (CCC) has repeatedly warned that the decarbonisation of buildings is significantly off track, with current policies and funding falling short. The CCC estimates that £250 billion will be needed to fully decarbonise homes, equivalent to £9 billion annually from the late 2020s to 2050 (CCC, 2020). Without policy reform and sustained long-term investment in domestic retrofit, both climate targets and fuel poverty objectives risk being missed.

Policy engagement with domestic retrofitting is closely linked to fuel poverty. As of April 2022, following the energy price cap increase, the Welsh Government estimated that up to

45% of households in Wales – around 641,000 homes – were living in fuel poverty.[1] [2] This represented a steep rise from 12% in 2018. Among lower-income households, 98% (217,700) were estimated to be in fuel poverty, with 41% (91,700) in severe fuel poverty following the April 2022 price cap increase (Welsh Government, 2022). These statistics may understate the true scale of the problem, particularly in rural or off-grid areas where energy options are limited, costly, and carbon intensive. Moreover, public perceptions of fuel poverty may exceed what official data capture (Energy Security and Net Zero Committee, 2025).

The nature of Wales's housing stock further complicates domestic retrofitting. Wales has the oldest housing stock in the UK, with over a quarter of homes built before 1919 and only 13% constructed within the last 30 years (Lannon and Green, 2019; Robinson et al., 2023). Most homes are detached or semi-detached, and just 11% are flats, compared with 21% in England (Welsh Government, 2018a). With demolition and new housebuilding rates remaining low, over 90% of existing homes are expected to still be in use by 2050 (Lannon and Green, 2019). This makes large-scale retrofit essential but technically and logistically complex. Nevertheless, recent research suggests that between a quarter and a third of Welsh homes could be suitable for heat pump installation without the need for prior fabric retrofit (Regan et al., 2023).

While most powers relating to energy supply decarbonisation and wider market regulation remain reserved to the UK Government, the Welsh Government holds significant devolved powers over housing, planning, building regulations, and retrofit policy, giving it scope to strongly influence this agenda (Notman et al., 2024). Guided by the goals of the Well-being of Future Generations (Wales) Act 2015 and the just transition framework, the Welsh Government's Heat Strategy for Wales recognises the central role of home retrofit in reducing building-related emissions (Welsh Government, 2024a). The strategy outlines the key policy drivers and existing support for domestic retrofit by housing tenure, as summarised in Table 2.

Table 2: Summary of policy drivers and support by housing tenure in Wales

Housing segment	Policy drivers	Existing support
Social housing (223,000 homes, ~17%)	Wales Housing Quality Standard: fabric-first approach; aims for EPC and EIR band A.	- **Optimised Retrofit Programme:** whole-house decarbonisation support for social landlords, covering building fabric, low- and zero-carbon technologies, and digital modelling.

[1] Defined as households needing to spend more than 10% of their income to keep their homes warm.

[2] While not directly comparable, due to difference in methodology, around 25% of households in Wales – approximately 340,000 – were estimated to be living in fuel poverty in October 2024 (Welsh Government, 2025a).

	- Compliance mandatory for social landlords.	
Private: rental (231,000 homes, ~17%)	- Domestic Minimum Energy Efficiency Standards: landlords must meet a minimum of EPC E to let a property.	- **Leasing Scheme Wales:** improves standards and affordability in the private rented sector. - **Empty Homes Grant**: up to £25,000 to bring properties back into use, including energy-efficiency measures. - **Boiler Upgrade Scheme**: grant for England and Wales to support the installation of heat pumps or biomass boilers. - **Energy Company Obligation**: GB-wide retrofit funding for fuel-poor households. - **Warm Homes Programme / Nest**: Welsh Government initiative targeting fuel poverty and decarbonisation through advice and home upgrades.
Private: owner-occupied (895,000 homes, ~66%)	- National Milestone (Well-being of Future Generations Act): All homes to achieve adequate, cost-effective energy performance by 2050.	

Source: Summarised from Welsh Government (2024a).

Launched in August 2020, the Welsh Government's Optimised Retrofit Programme (ORP) supports social housing providers to deliver whole-house retrofits using a fabric-first, technology-neutral approach. By April 2024, it had allocated £254 million to help decarbonise Wales's 1.4 million social homes and support compliance with the Wales Housing Quality Standard 2023, which requires social housing to achieve an average EPC rating of C by 2030. While data from the Welsh Housing Conditions Survey (2017–18) suggest that social housing is the most energy-efficient tenure in Wales (Welsh Government, 2018a), in Cardiff 69% of council homes still fall below the WHQS interim target of SAP 75 (Cardiff Council, 2025a).

Now in its third phase, the ORP provides funding, tools, and a learning framework to meet these goals, while also generating co-benefits such as lower energy bills, improved health outcomes, and local job creation (Welsh Government, 2025b). However, the ORP remains limited to the social housing sector. Although there is increasing focus on innovation and supply chain development, the Senedd's Climate Change, Environment and Infrastructure Committee has questioned why it has not yet been extended to the private rented and owner-occupied sectors, identifying this as a persistent policy gap (Climate Change, Environment and Infrastructure Committee, 2023).

Alongside delivering the ORP, all Welsh local authorities have been funded by Welsh Government since 2021 to develop Local Area Energy Plans (LAEPs). Coordinated regionally, these plans aim to improve data efficiency, integrate local and regional planning, and support the transition to net zero. They provide baseline assessments of energy use and emissions, model future demand and supply under low-carbon scenarios, and identify indicative delivery partners (Energy Systems Catapult, n.d.).

The Cardiff LAEP sets a vision for a net zero energy system by 2050 (Cardiff Council, 2024). It includes targets to install energy efficiency and insulation measures in 91,000 homes and 160,000 heat pumps across residential and commercial properties. Three priority areas within the city are identified:

- **Highmead**: a high proportion of social housing and low affordability, offering strong social and economic benefits from investment in energy efficiency and easier delivery via social landlords;
- **Wood Street substation:** the area with the greatest need for additional electrical capacity, where retrofitting would reduce load on the substation and enable large-scale heat pump deployment; and
- **Cardiff East Grid Primary:** the area with the highest retrofit need across all categories, with around 10,000 homes rated below EPC D (Cardiff Council, 2024).

These retrofit targets are reflected in the One Planet Cardiff strategy (One Planet Cardiff, 2021). Although the strategy recognises that the Council's direct delivery role is largely confined to its own housing stock and a small number of grant-funded private sector schemes, it is working with the Cardiff Capital Region to build an evidence base on barriers, opportunities, and funding routes to support a coordinated regional approach. The Council positions itself as a strategic hub, promoting retrofit, connecting households with delivery partners, and monitoring progress (One Planet Cardiff, 2021).

As part of the One Planet Cardiff strategy, the Cardiff Heat Network will be Wales's first large-scale low-carbon district heating system (Cardiff Council, 2025b). Using waste heat from Viridor's Energy Recovery Facility in Cardiff Bay, the network will supply buildings including the Senedd, Wales Millennium Centre, Cardiff and Vale College, and several council facilities. While initially serving a defined set of public and residential buildings, modelling in the Cardiff LAEP identifies opportunities for future expansion, where the heat network could provide an alternative to heat pumps in suitable areas (Cardiff Council, 2024).

Investment to stimulate domestic retrofit

Misaligned investment incentives, policy incoherence and instability, and a centralised financial model with limited local levers remain key concerns inhibiting investment in domestic retrofit (Bergmann and Foxon, 2020; Climate Assembly UK, 2020 Emden, 2022). These persistent barriers have contributed to a fragmented and immature domestic retrofit market in the UK (Brocklehurst et al., 2021).

Targeted, large-scale investment in domestic retrofit can address these barriers and stimulate a viable and self-sustaining retrofit market. A growing body of evidence highlights several key mechanisms to achieve this. Investment can de-risk market entry through subsidies, guarantees, and demonstration projects (Boskovic and Cullen, 2025; Energy Security and Net Zero Committee, 2025), create economies of scale by aggregating demand and standardising delivery (New Economics Foundation, 2025; BEIS, 2021), and drive innovation and workforce upskilling by enabling firms to develop new technologies and expand training (Boskovic and Cullen, 2025; PwC, 2022). Investment can also build market confidence and public acceptance through visible, trusted programmes (Energy Security and Net Zero Committee, 2025) and support a just and inclusive transition by targeting low-income and fuel-poor households (Robins and Tickell, 2020). Table 3 summarises these mechanisms and their supporting evidence.

Table 3: Mechanisms through which large-scale, targeted investment can stimulate the domestic retrofit market

Mechanism	Description	Evidence source
De-risking initial market entry	Subsidies, guarantees, and demonstration projects reduce financial risk for households and firms. This encourages new market entrants, builds confidence, and stimulates early-stage adoption in a sector often characterised by low trust.	Boskovic and Cullen (2025); Energy Security and Net Zero Committee (2025)
Creating economies of scale	Aggregating retrofit demand lowers per-unit costs through bulk procurement, standardised delivery, and operational efficiencies. This supports scalable, mass-market retrofit models.	New Economics Foundation (2025); BEIS (2021)

Driving innovation and upskilling	Predictable investment enables firms to develop new technologies and expand training for the retrofit workforce. This strengthens supply chains and improves long-term sector capacity.	Boskovic and Cullen (2025); PwC (2022)
Building market confidence and cultural acceptance	High-visibility programmes increase public trust in retrofit outcomes. Successful projects provide social proof and encourage consumer willingness to invest independently.	Energy Security and Net Zero Committee (2025)
Supporting a just and inclusive market transition	Public investment in low-income or fuel-poor households ensures that early market development is inclusive and equitable. This broadens the customer base and builds social legitimacy for future policy.	Robins and Tickell (2020)

Local-level investment

Evidence indicates that investment in the domestic retrofit market is most effective when designed and delivered locally and aligned with local contexts and capabilities (Brocklehurst et al., 2021; Gillich et al., 2018; Wade and Visscher, 2021). Local authorities are particularly well placed to enable retrofit because of their understanding of local housing stock, demographics, workforce skills, supply chain constraints, and patterns of fuel poverty (Energy Security and Net Zero Committee, 2025). Their proximity to residents and integration within local governance structures also grant them democratic legitimacy, enhancing their ability to build trust, co-design programmes, and engage households. This is particularly important in the retrofit sector, where behavioural change and consumer confidence are central to uptake (Brocklehurst et al., 2021).

Catalysing local government action can also unlock new partnerships and investment flows. By mobilising the full value chain of local climate finance, local authorities can help create functioning markets for retrofit (Cities Climate Finance Leadership Alliance, 2016). Schemes led or commissioned by local authorities tend to offer stronger protections for households than individual applications. Larger-scale delivery enables greater oversight, clearer lines of accountability, and more rigorous quality assurance, reducing the risk of substandard installation and improving consumer outcomes (Energy Security and Net Zero Committee, 2025).

The role of local authorities in market enablement

Local authority investment can stimulate the domestic retrofit market by reducing investment risk, aggregating demand, and creating stable pipelines that attract private finance and support supply chain development (Brocklehurst et al., 2021; Construction Leadership Council, 2021; Energiesprong UK, 2022). A central concept in this process is 'crowding in' investment, where targeted public finance de-risks private sector participation, strengthens market confidence, and leverages additional capital (Frontier Economics, 2022). Crowding in occurs when the public sector addresses market failures – such as high upfront costs, uncertain returns, or lack of coordination – that deter private actors from investing. By tackling these barriers, local authorities can generate the critical mass of demand needed to encourage innovation and attract new suppliers into the retrofit sector (Institution of Engineering and Technology, 2020).

Within the context of reduced local capacity, increased centralisation, and austerity-related budget constraints in the UK, the Retrofit Playbook outlines a spectrum of actions that local and combined authorities can adopt to stimulate and support the domestic retrofit market (UK Green Building Council, 2020). These roles vary according to institutional capacity, political will, and access to funding. They include:

- **Facilitation:** convening coalitions of local stakeholders to co-develop and deliver retrofit strategies and programmes;
- **Marketing and communication:** raising awareness of retrofit benefits, whole-house planning, and the importance of using accredited installers and suppliers;
- **Coordination:** acting as a central hub to align planning, finance, skills, and supply chain activity (for example, supporting local 'one-stop-shops' or piloting financing mechanisms);
- **Being a 'trusted' partner:** lending credibility to third-party programmes and expanding their reach through established community relationships;
- **Supporting local skills and supply chain development:** collaborating with training providers and local businesses to build retrofit delivery capacity, including accreditation via Trustmark and the Microgeneration Certification Scheme; and
- **Direct delivery:** commissioning retrofit in social or council-owned housing to create early demand signals and strengthen supply chain readiness (UK Green Building Council, 2020).

These roles are not mutually exclusive, and their implementation depends on local capacity, resources, and priorities. While not all authorities can fulfil every function, most can play a role in market enablement. Crucially, local action must align with national policy, devolved financing mechanisms, and long-term coordination frameworks (UK Green Building Council, 2020).

Collaboration between local authorities, cities, and social landlords has proven particularly effective for scaling retrofit. By aggregating retrofit demand across jurisdictions and housing portfolios, such partnerships help expand supply chains, attract new providers, and strengthen the evidence base for the long-term value of large-scale retrofit programmes in meeting national climate goals (UK Green Building Council, 2020).

Facilitating retrofit through 'one-stop-shops'

'One-stop-shops' are emerging as a key solution to the fragmented nature of the domestic retrofit market. By providing households with a single, trusted point of contact, they integrate technical advice, financial planning, contractor coordination, and quality assurance, guiding households through the retrofit process from start to finish (Brown, 2018; Panakaduwa et al., 2025).

Evidence shows that these models are most effective when delivered locally, where trust and familiarity are stronger (Panakaduwa et al., 2025). Place-based approaches enable programmes to build on existing networks, community relationships, and neighbourhood champions, all of which support higher take-up – as demonstrated in the Netherlands (Ebrahimigharehbaghi et al., 2022). For local authorities, one-stop-shops also offer a mechanism to scale delivery, stimulate local supply chains, and strengthen consumer confidence (Local Government Association, 2023).

To operate effectively, local one-stop-shops should combine five core services: proactive homeowner engagement through targeted marketing and segmentation; tailored financial planning delivered as a single package or in stages; project coordination to reduce hassle and uncertainty for households; affordable, long-term financing options, particularly for fuel-poor households; and guaranteed results with post-completion monitoring to ensure quality and energy savings (Local Government Association, 2023).

One-stop-shop models vary in the extent of responsibility they assume for renovation outcomes (Panakaduwa et al., 2025). The INNOVATE project identifies three main types: advisory services, coordination models, and fully integrated providers offering performance guarantees (INNOVATE, 2020). Councils are advised to conduct an option appraisal to determine which model best aligns with their objectives, capacity, and resources (Local Government Association, 2023).

Coordinating local delivery of clean heat

Building on their enabling role in the domestic retrofit market, local authorities are well placed to coordinate the delivery of low-carbon heating, an essential component of whole-home retrofit and of reducing fuel poverty and health inequalities, as outlined in the Warm Homes: Local Grant Scheme (Energy Saving Trust, 2025). Emerging evidence supports a shift from individual, household-led action to street-by-street or neighbourhood-scale deployment,

particularly where communal infrastructure such as heat networks or shared ground loops is most viable (Marsden et al., 2024; Energy Systems Catapult, 2024).

Local energy and heat planning enables local authorities to identify suitable technologies for different housing types, anticipate uptake, and collaborate with electricity and gas networks to unlock timely, cost-effective investment. This helps reduce grid constraints, enables targeted flexibility services, and supports the repurposing of gas infrastructure where appropriate. It also provides clearer signals to local supply chains, encouraging investment, green job creation, and training opportunities (Marsden et al., 2024; Sissons, 2024).

Coordinated planning also addresses equity challenges. Over-reliance on individual action risks excluding households with limited capital or access to support schemes, particularly in the private rented sector (Whincup et al., 2025). Community energy schemes offer an alternative model. For instance, Ynni Lleol Bethesda in Gwynedd enables households to match their electricity use with local hydro generation, reducing bills by 10–30% while retaining value within the community (Energy Local, n.d.). Such approaches demonstrate how area-based delivery can simultaneously improve affordability and strengthen local economic resilience.

To support this transition, evidence increasingly favours the creation of dedicated local heat bodies – multi-disciplinary teams embedded within or closely aligned to local authorities. These bodies would be responsible for:

- Zoning and local heat planning, identifying where and when different technologies are most appropriate;
- Coordinated scheme delivery, particularly for social housing and dense urban areas;
- Stakeholder engagement, including utilities, contractors, and residents; and
- Aligning local action with national targets, supported by guidance and incentives from a central heat transition unit (Marsden et al., 2024).

Funding mechanisms for local authorities

Domestic retrofitting presents significant opportunities to improve well being, reduce service costs, and stimulate local economic growth. However, the current funding landscape poses substantial barriers to scaling activity (Owens, 2024). This is a particular challenge for local authorities: in 2020, 97% and 94% of English councils reported that the amount and accessibility of funding, respectively, were barriers to tackling climate change (Local Government Association, 2022). For most councils, the scale of investment required means they cannot fund retrofit programmes from core budgets and must therefore explore alternative models, including blending funding from multiple sources (Energy Security and Net Zero Committee, 2025). Proposed delivery models for financing decarbonisation highlight that this challenge cannot be met by any single organisation (Brown et al., 2021; UK Green Building Council, 2020).

In Wales, it was estimated in 2020 that delivering a national retrofit programme by 2030 would require £14.75 billion of investment, comprising:

- £5.5 billion for social housing;
- £4.8 billion for homes in fuel poverty; and
- £4.4 billion for owner-occupied and private rented ('able to pay') homes (Brown et al., 2021).[3]

Emerging sources of green investment for local authorities include the Public Works Loan Board, the UK Municipal Bond Agency, green lenders, crowdfunding or Community Municipal Bonds, Salix Finance, and the National Wealth Fund (formerly the UK Infrastructure Bank). When considering debt funding, councils are advised to assess factors such as the cost of borrowing, borrowing capacity, security, and due diligence requirements (Local Government Association, 2022). In Wales, analysis suggests that retrofitting social housing owned by local authorities may be more feasible through municipal or community bonds, while retrofit investment funds may be more appropriate for larger registered social landlords (Brown et al., 2021).

Given the diversity of housing conditions, tenure types, and household incomes, a one-size-fits-all approach will not work. Multiple funding sources will need to be leveraged, combining grants, loans, and self-funding (Brown et al., 2021). As shown in Figure 2, households with the lowest incomes and highest fuel costs should be fully grant-funded, while most will rely

[3] These estimates are based on different housing sectors aiming for different EPC targets.

on loans, and higher-income households can self-fund some lower-cost measures. Avoiding a financing ‘cliff edge’ for those just above the fuel-poverty threshold and improving coordination to prevent fragmented funding are critical.

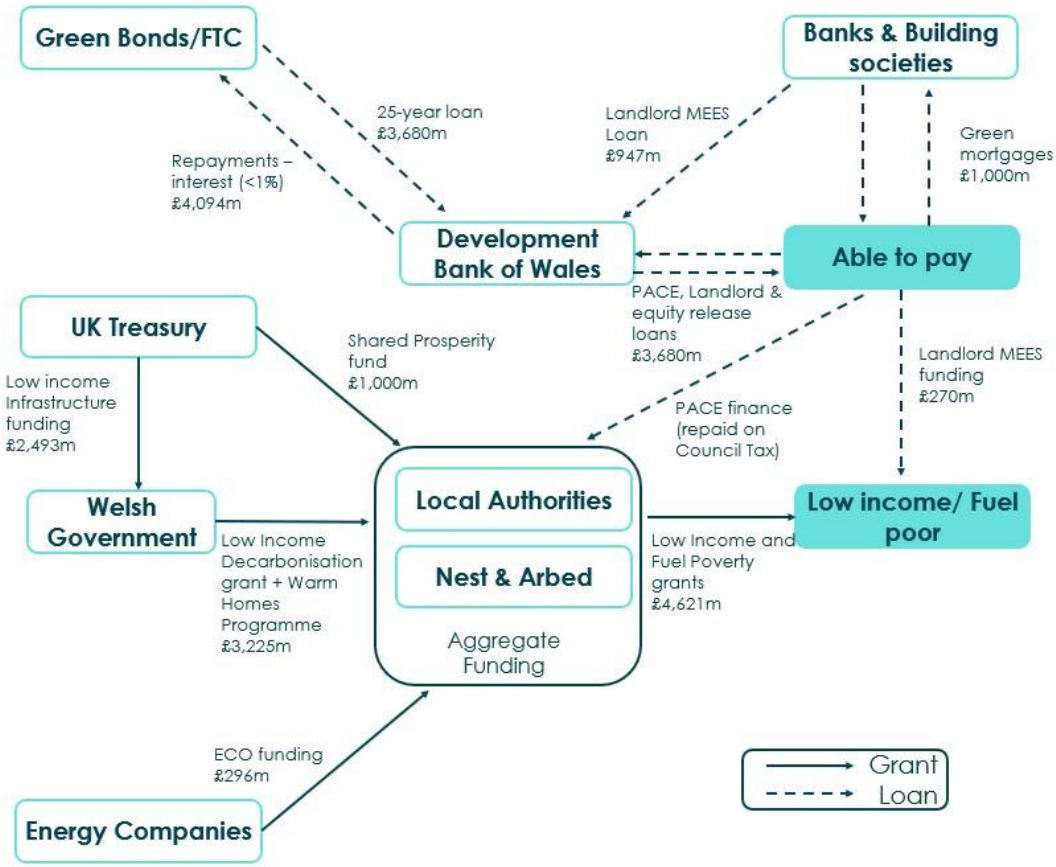
Figure 2: Affordability matric for fuel costs and retrofit funding

Source: Brown et al. (2021).

In the ‘able to pay’ sector, Figure 3 outlines a delivery model where local authorities coordinate area-based retrofit programmes, expand NEST and Arbed schemes, and actively seek funding from the Shared Prosperity Fund (Brown et al., 2021). One key mechanism is Property Assessed Clean Energy (PACE) financing, which attaches retrofit debt to the property via the council tax bill. This helps overcome split incentives between landlords and tenants, or between current and prospective owners. Widely used in California, where it has supported $4 billion in clean energy investment and achieved 27–28% average energy-use reductions, PACE is now being trialled in Europe through the EuroPACE project (Brown et al., 2021).

The same model also proposes that local authorities partner with the Development Bank of Wales to pilot equity-release models and low-interest loans for landlords, potentially funded through the Financial Transactions Capital allocation, which could be expanded to cover both private and social housing retrofits (Brown et al., 2021). Acting as an early or first mover, the Development Bank could de-risk investments, crowd in private finance, and provide specialist project assessment capabilities beyond those of mainstream lenders, signalling to the market that such investments are credible (Bergmann and Foxon, 2020).

Figure 3: Proposed delivery model for financing decarbonisation in the 'able to pay' sector in Wales



Source: Brown et al. (2021).

Overall, securing the scale of investment required for domestic retrofitting will demand that local authorities act as both conveners and innovators, blending funding from multiple sources to suit household needs and housing conditions. Mechanisms such as PACE and partnerships with institutions like the Development Bank of Wales demonstrate how tailored approaches can unlock capital, reduce risks, and attract private sector participation. By coordinating funding streams, closing gaps for those on the margins of fuel poverty, and building long-term investor confidence, local authorities can help create a more coherent, equitable, and scalable retrofit funding landscape.

Case studies

Overview

The five case studies presented below offer valuable insights into the growing body of work on domestic retrofit across Wales, the wider UK and beyond. They highlight a range of approaches, challenges, and solutions being developed to improve the energy performance of existing homes, reduce carbon emissions, and promote a just transition to more sustainable living. The case studies were drawn from desk research and an information event held at the Pierhead Building in June 2025. They were selected to illustrate a variety of approaches to funding, supply chain development, household participation, marketing, and programme rollout. Collectively, they demonstrate how different contexts shape delivery models and outcomes. Together, they capture lessons learned and examples of best practice, while also shedding light on the opportunities and complexities involved in delivering retrofit at scale. Table 4 summarises the key characteristics and takeaways from each case study.

Table 4: Summary of case studies

Case study	Summary	Key characteristics and takeaways
Kirklees Warm Zone (2007–2010)	As one of the UK's largest domestic retrofit programmes, the Kirklees Warm Zone scheme aimed to tackle fuel poverty, increase the uptake of state benefit support among residents, and create local employment opportunities.	• Funded through a combination of local authority and energy supplier funding. • Primarily targeted private sector homes. • 51,255 (29%) homes insulated through the scheme. • Measures carried out included cavity wall and loft insultation, low energy light bulbs and heating system improvements. • High levels of participation achieved through trust building, clear communication and community engagement. • Systematic delivery of measures through a 'Zip-Up Method'.
Warm Wales Retrofit Programme (Arbed 1) (2009–2011)	A Welsh Government domestic retrofit programme designed to reduce fuel poverty, cut carbon emissions, create employment and training opportunities, and strengthen local supply chains.	• Funded through a combination of Welsh Government, UK Government, Local Authority, Social Landlord and Energy Supplier funding. • A mixture of social landlord, local authority, and privately-owned homes targeted. • 1,147 homes retrofitted through the Warm Wales Programme. • Measures carried out included external wall insulation, solar PV installation, fuel switching, and solar thermal and air source heat pump installation.

Green Homes Wales (2024–Present)	A Welsh Government initiative focused on accelerating residential decarbonisation, lowering household energy bills, reducing carbon emissions, and improving overall home comfort.	• A domestic retrofit program targeted at private homeowners. • Retrofit measures are funded through interest-free loans of £1,000–£25,000. • Interest-free loans are provided with flexible repayment options (up to 10 years). • Measures carried out included smart homes energy systems, external wall insulation and air source heat pumps.
Ty Gwyrddfai (2024–Present)	A pioneering decarbonisation hub and 'Living Lab' established to transform the local housing stock through large-scale retrofit, build resilient local supply chains, and generate sustainable employment opportunities.	• Funded through the UK Shared Prosperity Fund. • Provides accredited decarbonisation courses. • Addresses green skills shortages. • Supports business to diversify into retrofit markets. • Low-carbon technologies testing through a 'Living Lab'. • Co-location of supply chain stakeholders created an integrated base for retrofit supply and delivery.
US Better Buildings Neighborhood Program (2010–2013)	A large-scale retrofit programme implemented across the United States, encompassing 41 state and local initiatives.	• Federally funded programme. • Combined national objectives with local design. • Utilised a mixture of rebates and loans to overcome cost barriers. • Participation encouraged through traditional media marketing and community-based social marketing.

Case study 1: Kirklees Warm Zone

Background

The Kirklees Warm Zone (KWZ) scheme remains one of the UK's largest domestic energy efficiency and retrofit programmes. In 2006, it was estimated that between 35,000 and 45,000 homes in Kirklees (20–26%) were affected by fuel poverty, with the borough ranked among the 25% most deprived local authorities in England (Liddell et al., 2011). Running from 2007 to 2010, the scheme aimed to reduce carbon emissions and alleviate fuel poverty across Kirklees, a borough in West Yorkshire with over 420,000 residents and a high proportion of older, energy-inefficient housing (Webber et al., 2015) (Table 5).

Table 5: A comparison between Kirklees and Cardiff housing landscapes

	Kirklees	Cardiff
Population	>420,000	362,310
# of wards	23	28
# of households	176,000	147,333
% of social housing	15%	17%
% of housing stock built before 1919	27%	24%
# (%) of households in fuel poverty	35,000–45,000 (20–26%)	36,833 (25%)*

* This is an estimate for Cardiff based on Wales-wide figures (Welsh Government, 2025a); all other figures are Cardiff-specific.

Source: Webber et al. (2015); Office for National Statistics (ONS) (2022; 2023a; 2023b); The Health Foundation (2024); Cardiff Council (2025c)

The KWZ scheme sought to address multiple social and environmental challenges, with four core objectives:

- To tackle fuel poverty;
- To deliver a low-carbon Kirklees;
- To increase residents' uptake of state benefit support; and
- To create local employment opportunities (Kirklees Council, 2010, cited in Liddell et al., 2011).

To achieve these aims, the scheme offered cavity wall and loft insulation, low-energy light bulbs, and heating system upgrades free of charge to eligible households. In addition, replacement boilers and central heating systems were offered at competitive prices, alongside interest-free loans for renewable technologies (Liddell et al., 2011). The KWZ scheme received an initial investment of £20.9 million (Butterworth et al., 2011). Of this, £11.7 million came from Kirklees Council, funded through the sale of its stake in Leeds Bradford International Airport in 2007 (Edrich et al., 2011, cited in Long et al., 2015), with the remainder provided by Scottish Power (Butterworth et al., 2011).

Delivery approach

The KWZ scheme was designed to deliver large-scale, area-based energy efficiency improvements across all housing tenures within the borough. It primarily targeted private sector homes, as council housing already performed well, with an average Standard Assessment Procedure (SAP) rating of 73 (Liddell et al., 2011). Nevertheless, all households were included to ensure equitable access. Council tenants received carbon monoxide detectors, low-energy light bulbs, and personalised energy advice (Liddell et al., 2011), ensuring no residents were excluded from wider benefits.

The scheme adopted a 'Zip-Up Method' to systematically deliver measures across the borough:

- Kirklees was divided into 23 wards, prioritised based on six weighted factors, including multiple deprivation index (MDI) scores, insulation coverage, and socio-economic indicators.
- Installation was completed one ward at a time, fully saturating each before moving on, alternating between the most and least deprived areas to balance workloads and community impact.
- Within each ward, work was organised into smaller 'patches', such as streets or neighbourhoods, to maximise logistical efficiency.
- Vulnerable households (for example, those with serious health conditions or aged over 60 with an income below £20,000) were granted fast-track access regardless of ward scheduling.

This targeted, phased method improved delivery efficiency by an estimated 30–50% compared to conventional approaches (Liddell et al., 2011). The scheme was coordinated by Kirklees Council, managed by Yorkshire Energy Services, and delivered by private sector contractors (Webber et al., 2015).

Participation

The KWZ scheme achieved notably high levels of household participation, with Kirklees ranking highest among all British authorities for the percentage of housing stock insulated

within the first two years of the Carbon Emissions Reduction Target (CERT) scheme (Butterworth et al., 2011). Initial public scepticism, stemming from distrust of free offers and concerns about unauthorised contractors, posed early challenges (Liddell et al., 2011). To address this, Kirklees Council implemented a robust engagement strategy centred on trust, transparency, and community outreach.

A comprehensive marketing campaign established credibility through billboards in targeted wards, local radio and TV advertising, and increased brand visibility. Uniformed staff wore distinctive red jackets and carried photographic ID to reinforce authenticity (Liddell et al., 2011). This increased visibility encouraged residents to move from intending to participate to adopting the scheme (Owen et al., 2014). Local police and community organisations were informed of schedules to prevent fraudulent activity (Liddell et al., 2011).

Door-to-door engagement was central to participation: every property was visited at least three times (Long et al., 2015). This personal approach was combined with a 'mop-up' phase where initially reluctant households were contacted again having been reassured by word-of-mouth recommendations and visible activity in neighbouring homes (Liddell et al., 2011; Long et al., 2015). This follow-up phase accounted for 17% of all assessments and 28% of installations (Long et al., 2015).

Key factors that motivated residents to participate included:

- The provision of free insultation measures, which was the primary driver for 98% of participants (Long et al., 2015; Webber et al., 2015); and
- A desire to reduce energy consumption and minimise environmental impact (82%) (Long et al., 2015).

For non-participants, a reluctance to partake in the scheme was mainly due to a desire to avoid disruption (40%), lack of time, or inaccessible lofts (Long et al., 2015). The scheme successfully minimised disruption by offering flexible installation schedules and, where needed, additional support such as loft clearance services (Webber et al., 2015). Consequently, participation occurred in three phases (Liddell et al., 2011):

- Early adopters;
- Those persuaded by word-of-mouth; and
- Late adopters responding to final invitations.

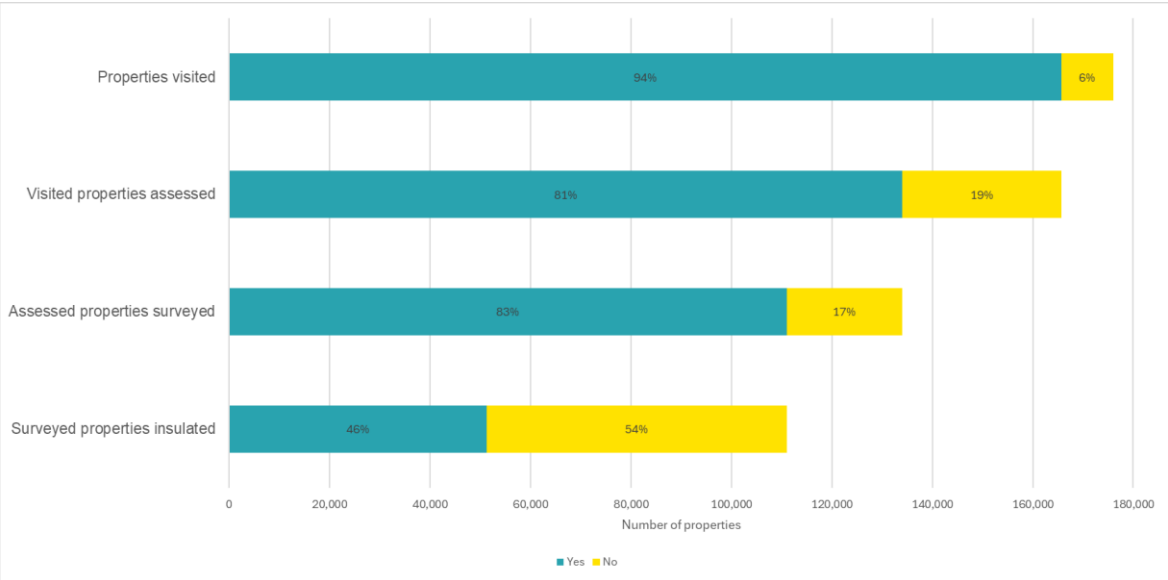
Most residents reported positive experiences, highlighting the convenience and efficiency of the scheme (Long et al., 2015). For those working on KWZ scheme, positive perceptions of the scheme were attributed partly to how they presented themselves, including wearing overshoes, and wearing company uniform (Owen et al., 2014).

Outcomes and impact

Scale of delivery

- Of the 176,000 properties in the Kirklees area, 165,686 (94%) were visited, 134,000 (76%) received initial doorstep assessments, and 111,000 (63%) underwent full surveys (Webber et al., 2015; Figure 4).
- 51,255 homes (29%) were insulated under the scheme (Butterworth et al., 2011; Long et al., 2015), with 64,000 individual measures installed, including 43,000 loft and 21,000 cavity wall insulations (Webber et al., 2015).

Figure 4: KWZ scale of delivery



Source: Developed from Webber et al. (2015).

Energy and environmental benefits

- The scheme achieved annual energy savings of approximately 106,000 MWh and CO_2 emissions reductions of more than 23,000 tonnes per year (Butterworth et al., 2011).
- Households that received insulation measures reduced their energy consumption by an average of 2,655 kWh per year, outperforming the national downward trend in household energy use (Webber et al., 2015).

Employment and skills development

- The scheme directly created 126 full-time equivalent (FTE) jobs during its three-year operation, with a further 117 jobs generated in the supply chain and related sectors, totalling 243 jobs (Butterworth et al., 2011).

- Jobs created ranged from installers and project managers to door-to-door energy assessors and administrative staff (Butterworth et al., 2011).
- Long-term employment opportunities were also observed, with many positions being sustained beyond the scheme's lifetime (Butterworth et al., 2011).

Social and behavioural outcomes

- Most residents reported lower energy bills, fewer draughts, and reduced damp as key improvements, enhancing overall comfort and housing quality (Long et al., 2015).
- 29% of participants reported changing their energy use behaviour after installation, such as actively monitoring energy consumption (Long et al., 2015).
- 28% of participants reported turning the thermostat down after installation (Long et al., 2015).

Financial and economic impact

- With an initial investment of £20.9 million, the average spend per treated home was £400 (Butterworth et al., 2011).
- Participating households reported an average annual reduction in fuel bills of £76 per home, contributing to a total annual saving of nearly £4 million and a payback period of just over five years (Butterworth et al., 2011).
- Advice on benefits resulted in an estimated £1.648 million of additional claims across 868 households, equating to an average per annum increase of £2,552 per household (Butterworth et al., 2011).
- The scheme's net social value was estimated at nearly £250 million (Butterworth et al., 2011):
    a. £156 million in household fuel bill savings.
    b. £4.9 million in estimated NHS savings through improved housing and associated health benefits.
    c. Increases in house value greater than the cost of the insulation measures.
    d. An £80 million boost to the local economy through job creation, supply chain activity, and household savings.

Delivery efficiency

- The KWZ's area-based, street-by-street delivery model achieved up to 50% greater operational efficiency compared with traditional approaches (Butterworth et al., 2011).
- Cost efficiencies were driven by reduced travel time between jobs, fewer missed appointments, continuous high workloads for teams, and bulk purchasing of materials (Butterworth et al., 2011).

Case study 2: Warm Wales Retrofit Programme (Arbed 1)

Background

The Arbed 1 scheme, launched in 2009 by the Welsh Government, aimed to deliver environmental, social, and economic benefits by improving the energy efficiency of existing homes in some of Wales's most deprived communities (Atkinson et al., 2015; Welsh Government, 2011a, cited in De Laurentis et al., 2017). Wales faces significant challenges in improving housing energy efficiency, with over a quarter of homes built before 1919 (Lannon and Green, 2019; Robinson et al., 2023), making it among the oldest and least thermally efficient in Europe (King, 2011, cited in Atkinson et al., 2015). At the time, an estimated 30% of Welsh households (about 386,000 homes) were fuel poor, up from 134,000 in 2004 (Patterson, 2016). Notably, 44% of these fuel-poor households were in social housing (Patterson, 2016).

The strategic objectives of Arbed 1 were:

- To reduce fuel poverty by increasing the energy efficiency of homes;
- To reduce carbon emissions from the domestic housing sector;
- To create employment and training opportunities within the Welsh energy efficiency and renewable energy sectors; and
- To stimulate local economic activity and promote the development of local supply chains in energy efficiency and renewables (Patterson, 2012; 2016; De Laurentis et al., 2017).

An additional aim was to build an evidence base to inform future large-scale retrofitting programmes (De Laurentis et al., 2017).

To achieve these outcomes, Arbed 1 sought large-scale installation of domestic energy efficiency and renewable energy measures to upgrade the housing stock, attract investment into Wales's low-carbon economy, and support carbon reduction (Patterson, 2012).

The Arbed 1 scheme received funding totalling £60 million, comprising:

- £30 million from Welsh Government's Strategic Capital Investment Fund (SCIF) and the UK Department of Energy and Climate Change (DECC);
- £10 million from energy suppliers through the Carbon Emission Reduction Target (CERT) and Community Energy Saving Programme (CESP); and
- £20 million from Local Authorities (LAs) and Registered Social Landlords (RSL), who brought forward existing budgets to maximise cost savings and leverage economies of scale (Patterson, 2012; 2016).

Delivery approach

The Arbed 1 Scheme was delivered through a coordinated, multi-agency approach led by the Welsh Government, working with Community Housing Cymru, the Welsh Local Government Association, and social housing providers (De Laurentis et al., 2017). The scheme adopted a 'whole house' retrofit approach, providing comprehensive energy efficiency improvements to individual homes across Wales, whilst also working at a neighbourhood scale through a street-by-street approach (Patterson, 2012). This approach sought to maximise impact by upgrading clusters of homes within Strategic Regeneration Areas characterised by low household incomes (Patterson, 2016). Mixed-tenure areas, where both public and private housing coexisted, were prioritised, targeting homes owned by registered social landlords, local authorities, and private homeowners (Patterson, 2012; 2016).

Warm Wales was commissioned by five registered social landlords and two local authorities to help deliver the scheme, providing contract management, technical advice, and stakeholder coordination with contractors, housing providers, and energy suppliers. Warm Wales also led community engagement, recruiting private households to participate in the scheme, facilitating job creation, and delivering energy efficiency education to residents (Patterson, 2012). Energy wardens were appointed to act as direct links to residents (Patterson, 2016).

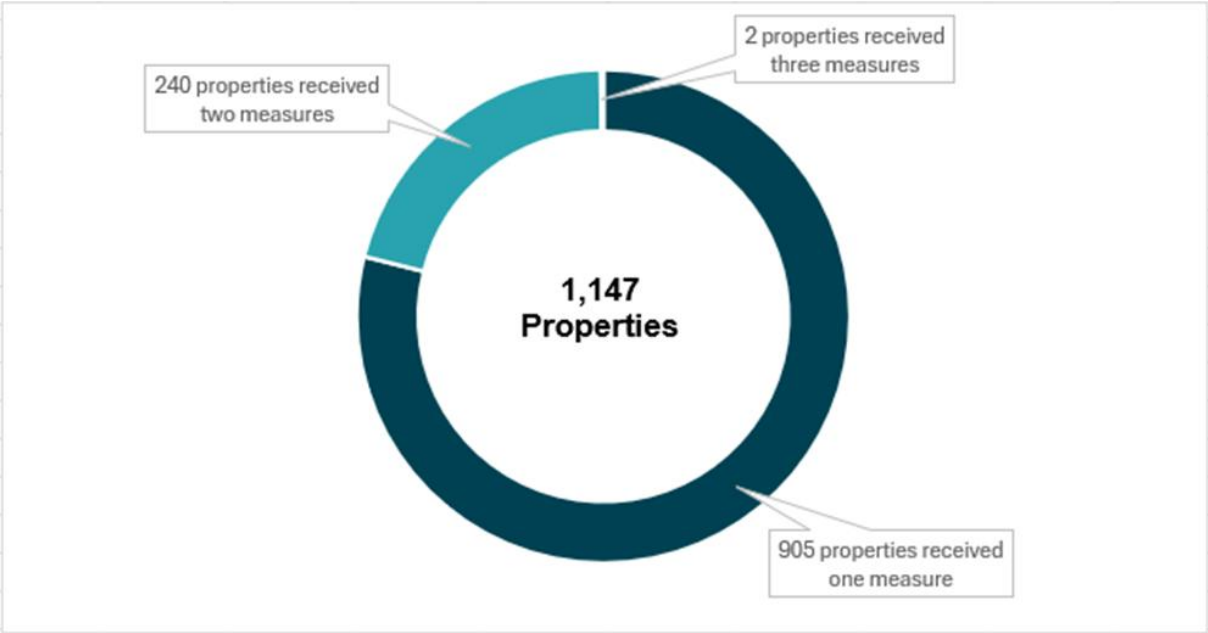
Outcomes and impact

Scale of delivery

The Arbed 1 scheme retrofitted more than 6,000 homes across 28 separate projects (Patterson, 2012; 2016). Most properties to receive energy efficiency improvements were within the social housing sector, with limited reach into private stock (De Laurentis et al., 2017). Over 7,500 measures were installed, including external wall insulation, solar PV systems, air source heat pumps, and replacement of coal or electric heating with high-efficiency gas boilers (Patterson, 2016; De Laurentis et al., 2017).

Within the Warm Wales programme specifically, 1,147 properties were retrofitted, of which 57% were owned by registered social landlords, 23% by local authorities, and 20% were owner occupied (Patterson, 2012). Recruitment of owner-occupied homes proved difficult due to programme time constraints and the need for greater assurances among homeowners (Patterson, 2012; 2016).

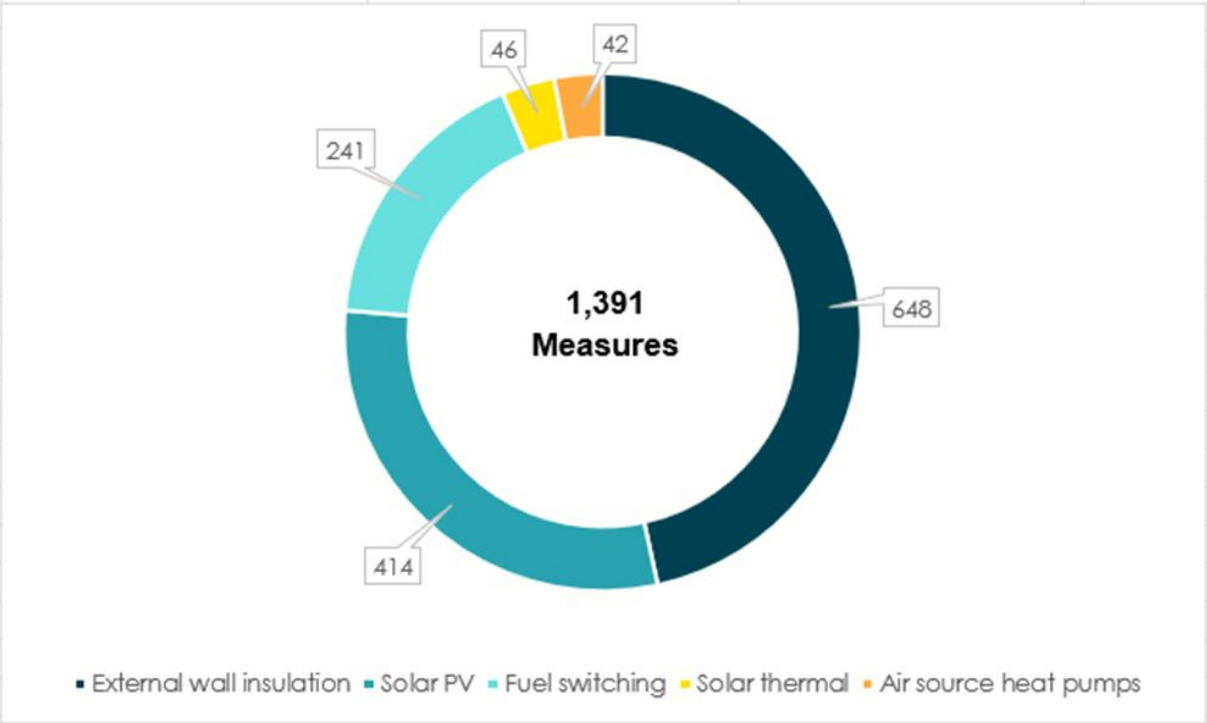
Figure 5: Scale of delivery – number of measures received per property



Source: Developed from Patterson (2012; 2016).

While the scheme aimed to deliver a 'whole house' retrofit approach, Warm Wales prioritised reaching more properties with fewer measures per home. Of the 1,147 properties treated, 905 (78.9%) received a single measure, 240 (20.9%) received two, and two (0.2%) received three measures (Patterson, 2012; 2016; Figure 5). In total, 1,391 measures were implemented across the 1,147 properties (Patterson, 2012; 2016). External wall insulation was most common, delivered to 648 properties; 414 properties received solar PV; 241 switched to more efficient heating systems; 46 received solar thermal; and 42 had air source heat pumps installed (Patterson, 2012; 2016; Figure 6).

Figure 6: Distribution of measures



Source: Developed from Patterson (2012; 2016).

Energy and environmental impact

Across the Warm Wales programme, the average SAP rating improved from 60 to 69, surpassing the Welsh Housing Quality Standard (WHQS) benchmark of 65 for many properties (Patterson, 2012; 2016). Total CO_2 savings were calculated at 3,025 tonnes per year, with about one-third of properties achieving savings of more than 40% compared with pre-retrofit emissions (Patterson, 2012; 2016).

Financial and economic impact

The cost of measures implemented through Warm Wales totalled £9,658,509 (Patterson, 2012; 2016). Average annual household energy costs fell by approximately £216, delivering combined potential savings of £285,000 per year across participating homes (Patterson, 2012; 2016). The estimated payback period for the £9.66 million investment was around 33 years, not accounting for wider social, health, and aesthetic benefits (Patterson, 2012; 2016).

Employment and skills impact

The scheme placed strong emphasis on employment and training to stimulate local economic activity and low-carbon supply chains. Of the 20 contractors and subcontractors engaged, 16 were based in South Wales, and four of seven product manufacturers were located in Wales, supporting local employment and manufacturing (Patterson, 2012; 2016). A total of 1,704 training weeks were provided, exceeding the target by 25%, including training in carpentry, plumbing, electrical work, and construction skills. These training opportunities

were delivered through initiatives such as ‘Job Match’ and ‘Beyond Bricks and Mortar’, as well as three- and four-year apprenticeships (Patterson, 2012; 2016). The scheme also employed 15 Community Energy Wardens to deliver community engagement, installation support, aftercare, and guidance on optimising new systems (Patterson, 2012; 2016).

Social and behavioural impact

The Warm Wales programme delivered notable social benefits alongside energy efficiency improvements. Stakeholder feedback indicated that the scheme made a positive difference to household comfort and community aesthetics. About 60% of residents reported feeling warmer in their homes after installation, and 35% agreed their home was more comfortable (Patterson, 2012). Half of participants noted that their homes and surrounding areas looked better following the works (Patterson, 2012).

The scheme also contributed to improved environmental awareness: one-third of respondents reported greater awareness of carbon emissions and the need to reduce them, while over half of residents said they had become more conscious of their household energy use after participating in the programme (Patterson, 2012).

Nevertheless, some negative experiences were recorded, including poor workmanship, delays, untidy work practices, and insufficient communication about scheduling (Patterson, 2012).

Case study 3: Green Homes Wales

Background

The Green Homes Wales (GHW) programme is a Welsh Government initiative designed to accelerate residential decarbonisation, lower household energy bills, and improve home comfort (Welsh Government, 2024b; GHW, 2025). Managed by the Development Bank of Wales (DBW), the scheme offers successful applicants a support package of interest-free loans and fully funded expert guidance from accredited Retrofit Coordinators (Welsh Government, 2024b; DBW, 2025; GHW, 2025). The scheme operates as both a finance mechanism and a market stimulator, supporting homeowners to make energy efficiency improvements to their homes by supporting them to identify, finance and implement ‘eligible measures’ (GHW, 2025). These measures include smart home energy systems, external wall insulation, and air source heat pumps (Welsh Government, 2024b). The programme also integrates with existing schemes such as the ‘Boiler Upgrade Scheme', ‘ECO4’, and Warm Homes Wales (Welsh Government, 2024b; GHW, 2025). However, unlike GHW, eligibility for these integrated schemes is typically based on pre-existing health conditions and income thresholds (GHW, 2025).

To qualify for GHW, homeowners must undergo an affordability assessment, including a credit check (DBW, 2025; GHW, 2025). In addition, the property must be located in Wales, serve as the applicant's primary residence, and be owner-occupied (GHW, 2025). New build properties, defined as those 'built in the last 6 months and that have not previously been occupied', are not eligible (GHW, 2025: 5). Listed buildings and homes owned by private landlords are also excluded (GHW, 2025).

Delivery approach

The scheme follows a structured four-stage delivery model (GHW, 2025):

- **Initial advice –** Applicants are first directed to existing advisory services such as Nest to understand what existing support and funding opportunities may already be available.
- **Home assessment application –** Prospective applicants are required to submit a home assessment application, which, if successful, enables them to access a non-repayable Retrofit Coordinator Grant. This covers the cost of a qualified, TrustMark-registered Retrofit Coordinator, who supports the applicant throughout the assessment, application, installation, and evaluation phases. Applicants can select from a pre-approved list of Retrofit Coordinators provided by the scheme.
- **Home assessment –** Once a Retrofit Coordinator has been approved, they will arrange for a home assessment to be carried out in order to develop a set of decarbonisation recommendations tailored to the occupant's needs (DBW, 2025). This stage consists of two phases:
    a. *Home assessment*: The first phase involves an on-site assessment of the applicant's home. These assessments take approximately two to three hours and require information on occupancy and energy usage. This process produces a range of outputs, including a floor plan, a condition report, an occupancy assessment, and an energy performance assessment (GHW, 2025).
    b. *Recommendations report*: Following the home assessment, the Retrofit Coordinator will produce a personalised Recommendations Report. This will outline a short- and medium-term plan for improving the property's energy efficiency based on individual circumstances. The recommendations are informed by a risk assessment, as well as engagement with the homeowner to establish their budget and desired outcomes from the improvements (GHW, 2025).
- **Review of recommendations and quotations –** Following the homeowner's review of the Recommendations Report and selection of their preferred measures, the Retrofit Coordinator will assist in engaging with installers to discuss the agreed scope of the

work and receive quotations. The Coordinator then supports the homeowner in reviewing these quotations.

- **Funding application –** Once a quotation for the work has been agreed with the homeowner, the Retrofit Coordinator provides support in completing a funding application. Supplementary information is required as part of the funding application, including an information sheet for each of the measures being installed, quotations from installers and suppliers, details of the Retrofit Coordinator overseeing installation and evaluation, and evidence of the homeowner's income. Applicants can apply for interest-free loans ranging from £1,000 to £25,000, with a repayment period of up to 10 years, including a six-month repayment holiday following installation to allow the new energy efficiency measures to begin delivering results (DBW, 2025; GHW, 2025). Table 6 below illustrates the repayment commitments for different lending amounts over a 10-year repayment period. Loans are subject to availability and affordability checks to ensure applicants can manage repayments. Payments are made directly to the customer, who is then responsible for managing payments to the installers. Loan repayments are taken on the first of each month, and applicants can make overpayments without early repayment penalties. Successful loan applicants also gain access to grant funding, which can be applied for in addition to the loans to support specific energy efficiency measures. These grants cannot be accessed without a linked loan (GHW, 2025).

Table 6: GHW Loan Repayment Breakdown

Loan amount	Interest rate	Repayment term (years)*	Annual repayment amount	Monthly repayment amount
£25,000	0%	10	£2,500	£208.33
£20,000	0%	10	£2,000	£166.67
£15,000	0%	10	£1,500	£125.00
£10,000	0%	10	£1,000	£83.33
£5,000	0%	10	£500	£41.67
£2,500	0%	10	£250	£20.83
£1,000	0%	10	£100	£8.33

*Following expiry of the initial 6-month repayment holiday. Source: GHW (2025).

- **Installation –** Once homeowners have received their funding offer, work can commence. All works are carried out by accredited installers (PAS 2030 or MCS-certified), with project oversight from the Retrofit Coordinator to ensure installations are completed on time and within budget. Upon completion, either the homeowner or the Retrofit Coordinator, acting on their behalf, submits a confirmation of completion to GHW. This is then assessed before any grant funding is released.
- **Evaluation –** Post-installation evaluation ensures quality assurance, homeowner satisfaction, and compliance with PAS 2035 standards. This involves the Retrofit

Coordinator asking the homeowner a series of questions regarding their satisfaction with the work undertaken.

Outcomes and impact

With the GHW scheme launching in Quarter 4 of 2024, evidence of its outcomes and impacts has yet to be established. However, the anticipated benefits of the scheme include the following:

Reduced carbon emissions

Through the uptake of low-carbon technologies and insulation measures, domestic carbon emissions are lowered, reducing overall carbon footprints and supporting climate change objectives (DBW, 2025; GHW, 2025).

Reduced energy bills

Energy-saving measures reduce energy consumption, resulting in lower household bills (DBW, 2025; GHW, 2025).

Improved comfort

Greater thermal efficiency reduces winter heat loss and enhances comfort levels for occupants (GHW, 2025).

Development and strengthening of local supply chains

By stimulating demand for accredited retrofit services and products, the scheme will strengthen local supply chains and create opportunities for green jobs (Welsh Government, 2024b).

Increased property value

As energy-efficient homes are more attractive to potential buyers, such improvements may lead to an increase in property value (GHW, 2025).

Case study 4: Ty Gwyrddfai

Background

The Welsh Government has set ambitious targets for average Standard Assessment Procedure (SAP) ratings to reach 75 by 2030 and 92 by 2034 (Welsh Government, 2024c). However, in Gwynedd, North Wales, fewer than a quarter of homes achieve an EPC rating of C or above, and the county has the fourth-highest average energy bills across England and Wales (BIC Innovation, 2022). Older housing in Gwynedd costs, on average, £615 more per year to heat than new builds, contributing to fuel poverty in an area with an average salary of £27,000.

Against this backdrop, ADRA, a large housing association with more than 8,000 homes and responsibility for over 20,000 tenants, has committed to a decarbonisation strategy (Ty Gwyrddfai, 2025). Its approach recognises the need to:

- Improve the housing stock through large-scale retrofit;
- Build resilient local supply chains; and
- Create sustainable employment and training pathways, especially for young people and women (BIC Innovation, 2022; Ty Gwyrddfai, 2025).

The closure of the Northwood Hygiene Products factory in Penygroes in 2020, a 120,000 sq ft facility, created an opportunity to repurpose the site (BIC Innovation, 2022; 2025). Acquired by ADRA, it has been transformed into Ty Gwyrddfai (TG), a decarbonisation and 'Living Lab' developed in partnership with Bangor University and Grŵp Llandrillo Menai (GLLM) (BIC Innovation, 2022; 2025; Ty Gwyrddfai, 2025). The management of TG is overseen by the TG Management Board, which includes representatives from ADRA, Bangor University, and GLLM, with a signed Memorandum of Understanding between ADRA and Bangor University ensuring shared strategic direction (BIC Innovation, 2025).

Delivery approach

TG operates as a multi-purpose hub, bringing together training, applied research and industry collaboration under one roof. The delivery model is built around three core functions:

Training and skills development

TG focuses solely on the provision of construction training and skills development, reflecting the sector's importance within the local community and the opportunities it offers (Ty Gwyrddfai, 2025). In October 2023, ADRA secured £500,000 of grant funding from the UK Shared Prosperity Fund (SPF) for its Hyfforddiant Net Sero Project (Wavehill, 2025). Running from July 2024 to February 2025, the project aimed to address green skills shortages and support local supply chains to diversify into retrofit markets (Wavehill, 2025). Specifically, it sought to close knowledge gaps in decarbonisation and to demonstrate and promote low-carbon technologies among housing associations, tenants, and private homeowners (Wavehill, 2025). To achieve this, GLLM's Centre for Infrastructure, Skills and Technology (CIST) delivered accredited courses in low-carbon construction and retrofit at TG (Wavehill, 2025; BIC Innovation, 2025).

Training had already been taking place at TG before this project, beginning in winter 2023, but a formal marketing campaign promoting the upcoming Hyfforddiant Net Sero Project began in January 2024. The promotional campaign included mass email marketing and social media advertisements (Wavehill, 2025).

Innovation and product testing

In October 2023, ADRA received another grant from the UK Shared Prosperity Fund (SPF), in addition to the £500,000 award already mentioned, securing £400,000 to build a 'Living Lab' at TG, the first facility of its kind in Wales (BIC Innovation, 2025; Ty Gwyrddfai, 2025). Construction of the Living Lab was completed in October 2024 at a total cost of £414,709.34 (BIC Innovation, 2025), with an overspend of £14,709.34 covered by ADRA (BIC Innovation, 2025). The TG Living Lab cost a fraction of comparable facilities, such as the £16 million Salford Energy House (BIC Innovation, 2025). Of the £400,000 SPF grant, £360,000 (90%) was spent on construction costs (BIC Innovation, 2025). No staffing costs were incurred during the project, with ADRA providing project management free of charge (BIC Innovation, 2025). The lab's design was developed by Bangor University, which also leads research conducted there (Ty Gwyrddfai, 2025). Both ADRA and Bangor University have acknowledged that the development of the TG 'Living Lab' would not have been possible without grant funding (BIC Innovation, 2025).

The repurposed 'Living Lab' consists of two environmental chambers where innovative low-carbon construction materials and retrofit solutions can be tested under simulated climate conditions, including extreme heat, cold, wind, and humidity (BIC Innovation, 2025; Ty Gwyrddfai, 2025). The facility enables prototyping, testing, and validation of technologies before deployment, supporting commercialisation opportunities and providing a valuable knowledge base for the wider sector (BIC Innovation, 2025; Ty Gwyrddfai, 2025).

Industry collaboration

The hub is designed to strengthen the local retrofit supply chain by equipping small and medium-sized enterprises with the skills, confidence, and capacity to tender for decarbonisation projects (BIC Innovation, 2022; Ty Gwyrddfai, 2025). The co-location of ADRA's in-house contractor team (150+ staff) and a Travis Perkins trade counter creates an integrated base for retrofit delivery and materials supply (BIC Innovation, 2025).

Outcomes and impact

Due to the relative infancy of TG, evidence of its outcomes and impacts remains limited. Nonetheless, several initial and potential future outcomes can be identified:

Training and skills development

A total of 152 individuals and 84 businesses were trained in retrofit and low-carbon technologies through the Hyfforddiant Net Sero Project, with courses rated highly for quality and accessibility (Wavehill, 2025). This training supported service diversification and expansion into new markets (Wavehill, 2025). Improved employment prospects and higher skill levels among participants as a result of the training also contributed to better job performance and increased confidence in green skills. Benefits were also reported by GLLM as the training provider, who reported skill improvements among staff as a result of access to

specialised equipment and technology at TG (Wavehill, 2025). Following the Hyfforddiant Net Sero Project, TG continues to provide training to individuals and businesses (Ty Gwyrddfai, 2025).

Innovation and product testing

As construction of the TG 'Living Lab' not completed until October 2024, no research projects were concluded there until January 2025 (BIC Innovation, 2025). Evidence of research impact is therefore limited. However, with the support of Bangor University, findings from future projects conducted in the 'Living Lab' Lab are expected to contribute to national and international knowledge on low-carbon practices (BIC Innovation, 2025). It is also anticipated that this research will open opportunities to commercialise new technologies. Moreover, the facility is already attracting interest from other housing associations seeking to test retrofit systems before deployment (BIC Innovation, 2025).

Industry collaboration

TG has already begun to establish collaborative partnerships and joint projects across private, public, and third-sector organisations to achieve wide-scale decarbonisation in North Wales. Increased awareness of TG has also proven beneficial for manufacturers and suppliers (BIC Innovation, 2025).

Case study 5: US Better Buildings Neighborhood Program

Background

The Better Buildings Neighborhood Program (BBNP) was a large-scale US retrofit initiative launched in 2010 as part of the American Recovery and Reinvestment Act, an $840 billion stimulus package introduced following the 2008 recession (Recovery.gov, 2015, cited in Gillich et al., 2018). Unlike most US retrofit schemes, which are typically utility company-led and ratepayer-funded, BBNP was federally financed, with $508 million allocated competitively to 41 state and local programmes (referred to as 'grantees') that met eligibility criteria set by the Department of Energy (DOE) (Gillich et al., 2018).

The BBNP had three overarching objectives (DOE, 2009, cited in Gillich et al., 2018):

- Deliver high-quality retrofits achieving significant energy performance improvements:
- Embed sustainable delivery models that will continue to deliver beyond the federal funding period; and
- Transform energy markets so that energy efficiency and renewables become the default choice.

Running from September 2010 to August 2013, BBNP differed from traditional US retrofit schemes by combining nationally prescribed objectives with local flexibility. Given the programme's scale, Gillich et al. (2018) conducted a comparative analysis of the 41 grantees, identifying a set of best-practice principles that could inform the development of an 'optimal' retrofit programme.

Best practice principles

Gillich et al. (2018) argue that these best-practice principles are also applicable to current and future iterations of UK retrofit programmes, given the similarities between the US and UK, with both countries similarly driving domestic retrofit via regulatory and market-based mechanisms. Furthermore, the 'able-to-pay' sections of both country's retrofit markets are similar in demographic and face similar barriers.

Programme design

Grantees commonly began by conducting a market assessment to establish homeowner demand, contractor capacity, and the local policy landscape. The latter examined how the retrofit programme would fit within and interact with existing policies. Partnerships were developed across marketing, finance, staffing, and infrastructure to build understanding of the local market. Grantees were given autonomy over their programme but were required to achieve energy savings of 15%. This allowed programmes to be locally designed while ensuring alignment of objectives. This autonomy included freedom to allocate funds across each of the principles discussed here. This contrasts with the UK's Green Deal, which restricted the use of funding to financial incentives (Gillich et al., 2018).

Marketing and outreach

Grantees typically used a combination of traditional media marketing and personal engagement. Community-based social marketing and the use of trusted messengers were generally seen as effective means of personal engagement. Outreach strategies evolved over time, incorporating multiple 'touch points' to move customers from programme awareness to the point of sale. Grantees were permitted to allocate part of their programme funding to drive demand through local marketing campaigns. Again, this contrasts with the Green Deal and other UK retrofit schemes, where funding was limited to financing the installation of measures, relying instead on demand driven by economic self-interest (Gillich et al., 2018).

Workforce engagement

Once the contractor market had been assessed (often through a market assessment, as discussed above), programmes were required to develop a strategy for engaging the local workforce. Gillich et al. (2018) found that grantees incentivised contractors to participate in the programme by offering opportunities to undertake greater volumes and larger-scale jobs, as well as through training provision. In particular, sales and marketing training were

regarded as valuable, as contractors were often asked to sell products beyond their usual expertise. Ongoing communication with contractors was found to benefit both parties, keeping contractors informed of programme changes while giving grantees greater insight into contractor operations and enabling strategic planning. The creation of an 'energy advisor' position, acting as an intermediary between homeowners and contractors, was viewed as an effective way of bridging information gaps between the two groups (Gillich et al., 2018).

Financial incentives

Upfront costs represent a significant barrier for most retrofit programmes. To overcome this, grantees offered a mix of rebates (often 25% of project cost) and loans. While subsidies are said to be commonly (mis)used to create short-term demand spikes, Gillich et al. (2018) found that rebates were calibrated to sustain steady demand rather than to stimulate temporary surges. Loan schemes, while slower to take hold, were designed to encourage longer-term market transformation and could be combined with rebates for maximum effect. Interestingly, Gillich et al. (2018) argue that requiring homeowners to pay for assessments helps filter out those less committed.

Data and evaluation

Grantees were required to collect and report performance data to the DOE for quality assurance, conduct interim evaluations, and adjust strategies (marketing, contractor engagement, and incentives) based on market response.

Outcomes and impact

A final impact evaluation of the BBNP concluded that the programme met five of its seven objectives (RIA, 2015, cited in Gillich et al., 2018), achieving:

- Over 100,000 residential and commercial properties upgraded;
- More than 10,000 jobs created during the delivery period;
- Average household energy cost savings of at least 15% per upgraded household;
- Mobilisation of nearly $1.4 billion in private-sector investment; and
- Market sustainability, with 84% of grantees maintaining programme elements beyond the funding period.

Alignment of local retrofit delivery with national policy

The implementation of a successful programme of large-scale domestic retrofit relies on coordination between national policy frameworks and local delivery capacity (Dyson, 2023). Welsh Government legislation and strategies set binding targets, quality standards, and expectations for decarbonising the built environment, with an emphasis on place-based delivery, quality assurance, and social equity. Local authorities provide essential on-the-ground delivery to meet these aims. Without alignment between policy at the national and local levels, delivery risks becoming fragmented and less cost-effective (Dyson, 2023). Table 7 summarises how a local domestic retrofit approach could align with Welsh Government policy.

The Well-being of Future Generations (Wales) Act 2015 links domestic retrofit to multiple well-being goals, including A Prosperous Wales, A Resilient Wales, and A Globally Responsible Wales, through improvements in energy efficiency, reductions in fuel poverty, and the promotion of low-carbon skills (Welsh Government, 2015). The Environment (Wales) Act 2016 (Welsh Government, 2016) and Climate Change (Wales) Regulations 2018/2021 legally require emissions reductions to net zero by 2050, with housing identified as a priority sector (Welsh Government, 2018b, 2021c).

Recent policy developments further strengthen the case for harmonisation:

- The Net Zero Wales Plan for Carbon Budget 2 (2021–2025) (Welsh Government, 2021a) calls for large-scale housing decarbonisation;
- The Heat Strategy for Wales (2024) promotes place-based delivery via LAEPs and heat zoning; and
- The Tackling Fuel Poverty Plan 2021–2035 (Welsh Government, 2021b) positions retrofit as a core intervention to end severe fuel poverty.

Table 7: Alignment of a local domestic retrofit approach with Welsh Government policy frameworks

Welsh Government framework	Key objectives / commitments	Potential alignment of local retrofit programme
Well-being of Future Generations (Wales) Act 2015	Improve social, economic, and cultural well-being; well-being goals such as A Prosperous Wales, A	Retrofit improves housing energy efficiency, reduces fuel poverty, and supports low-

	Resilient Wales, and A Globally Responsible Wales.	carbon jobs, delivering multiple well-being goals.
Environment (Wales) Act 2016	Legally binding emissions targets and carbon budgets.	Reduces housing sector emissions to support statutory targets.
Climate Change (Wales) Regulations 2018/2021	Net Zero by 2050; emission reductions across all sectors including housing	Local retrofit directly reduces built environment emission and supports Carbon Budget 2 targets.
Net Zero Wales Plan for Carbon Budget 2 (2021–2026)	Large-scale decarbonisation of housing; integration with other sectors	Local delivery accelerates progress towards Carbon Budget 2 targets through fabric-first and low-carbon heating measures.
Heat Strategy for Wales (2024)	Place-based delivery via Local Area Energy Plans and heat zoning; net zero heat by 2050.	Retrofit delivered in heat-pump ready, or network zones supports national spatial planning
Tackling Fuel Poverty Plan 2021–2035	End severe fuel poverty by 2035; reduce prevalence to <5% of households	Targets vulnerable households for retrofit, reducing energy costs

To align a local retrofit strategy with national policy, Cardiff Council could consider:

- **Adopting the ORP standards**: Require PAS 2035/2030 compliance and TrustMark lodgement for all projects. This ensures consistency and quality assurance across tenures, maintains eligibility for national funding, and reduces future co-funding risks by embedding recognised standards from the outset.
- **Using ORP as the delivery model:** Apply ORP's 'whole-home' approach across both social and private housing. This avoids splitting the supply chain between differing requirements, aligns decision making pathways across tenures, and ensures retrofit delivers wider benefits such as improved comfort, health, and affordability alongside carbon reduction.
- **Integrating with Local Area Energy Plans (LAEPs) and heat zoning:** Coordinate retrofit delivery with LAEPs and the Welsh Government's Heat Strategy for Wales. This

spatial alignment enables building upgrades to support future low-carbon heat networks, reduce grid constraints, and unlock investment in shared infrastructure such as ground loops and heat networks.

- **Targeting fuel poverty:** Retrofit should directly reinforce the Tackling Fuel Poverty Plan. By linking outreach to the Warm Homes/Nest programme and funding works outside its current scope, councils can ensure vulnerable households benefit from energy savings and improved health outcomes, not only those able to self-fund.
- **Meeting WHQS 2023 standards:** Apply WHQS energy performance metrics across all tenures. This establishes a consistent baseline for the private rental sector and supports statutory housing quality and net zero targets.
- **Embedding skills development:** Link procurement to local training, apprenticeships, and skills programmes in retrofit and low-carbon technologies. This strengthens the supply chain, supports local employment, and ensures delivery capacity grows in line with demand.
- **Blending funding sources:** Combine ORP, Warm Homes/Nest, and UK-wide schemes within a single local strategy. This maximises available resources while following Welsh standards, avoids duplication, fills gaps between schemes, and ensures households are supported seamlessly rather than navigating fragmented offers.
- **Aligning governance and data:** Use national data formats and feed outcomes into Welsh Government dashboards. This enhances accountability, enables consistent monitoring of progress against net zero and fuel poverty targets, and supports evidence-based policy development.
- **Protecting consumers:** Embed national warranty and redress mechanisms locally, for example through PAS and TrustMark requirements. This minimises the risk of poor-quality installations, builds public trust, and gives households confidence to invest in retrofit.

Conclusion

Domestic retrofit is central to achieving Cardiff Council's net zero target by 2035, as well as tackling fuel poverty and driving green growth. The evidence presented in this review shows that retrofit delivers wide-ranging economic, social, and environmental benefits. These include creating skilled local jobs, improving health outcomes, lowering energy bills and reducing emissions. However, progress remains slow, reflecting the scale of the retrofit challenge and the barriers of cost, capacity and coordination.

A key part of this challenge is that the retrofit market remains fragmented and immature. Targeted, large-scale investment can help stimulate both demand and supply by de-risking market entry, creating economies of scale and driving innovation. Local government has a pivotal role to play, as communities tend to trust local actors more, and local authorities are well placed to coordinate delivery. Examples include developing one-stop-shops to provide trusted advice to households and delivering coordinated, area-based programmes that enable shared solutions such as heat networks or grouped heat pump deployment.

Lessons from the case studies reinforce this case. The Kirklees Warm Zone case showed that trusted local delivery is essential: high uptake depended on trust-building, clear communication, and systematic methods such as the 'Zip-Up' approach. Warm Wales (Arbed 1) and the US Better Buildings Neighborhood Program demonstrated that blended funding, combining local, national, and utility sources, enables wider roll-out and supports delivery across tenures. Green Homes Wales highlighted that flexible, low- or no-interest finance is vital for overcoming upfront cost barriers for homeowners. Ty Gwyrddfai underlined the importance of investing in skills and supply chains, with hubs that co-locate training, business support, and testing capacity. Finally, the US Better Buildings Neighborhood Program illustrated how national objectives are most effective when tailored to the local context through community engagement and targeted marketing. Together, these lessons show that retrofit success depends not only on technology and funding, but also on trusted delivery, supply chain readiness, and the integration of national direction with local flexibility.

From this analysis, three clear implications for domestic retrofit policy emerge. First, there is a need for stronger alignment between national and local policy, alongside greater clarity and direction, to provide certainty for households, supply chains, and investors. Second, there is an ongoing challenge of linking finance to projects in ways that make retrofit an attractive investment option while remaining affordable and accessible across tenures. Third, the scale of the challenge demands long-term planning, cross-sector alignment, and consistent standards to ensure that retrofit delivers both climate and social objectives.

Building on the need for policy alignment, a local retrofit approach could embed ORP standards (PAS 2035/2030 compliance and TrustMark lodgement) across all projects to ensure quality and funding eligibility while reducing future co-funding risks. Applying the ORP

‘whole-home’ approach across social and private housing would meet multiple statutory objectives and align sectors along shared decision pathways, ensuring supply chains remain coherent. Integration with LAEPs and heat zoning would deliver spatial alignment with the Heat Strategy for Wales, unlocking shared infrastructure and reducing grid constraints.

Equity should be central to this approach. Targeting fuel-poor households would directly support the Tackling Fuel Poverty Plan (Welsh Government, 2021b). Applying WHQS 2023 standards across tenures would ensure consistency, while linking procurement to local training and apprenticeships would help address capacity and skills gaps. Blending funding streams from ORP, Warm Homes/Nest and UK-wide schemes, while following national governance, data and warranty requirements, could maximise resources, protect households and position local authorities as exemplars of coordinated, equitable and high-impact housing decarbonisation in Wales.

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