Post Graduate Certificate Environment and Sustainability, Birkbeck College, University of London 2024/2025

A stop start policy approach remains the barrier to UK domestic retrofit

Introduction

In July 2022 the United Nations General Assembly adopted a resolution recognising the universal human right to a clean, healthy and sustainable environment. (Correia, 2022) and (Boyd, 2024). In the UK 3.5 million UK households failed the Decent Homes Standard (Ministry of Housing, Communities and Local Government, 2024). The UK has the oldest and worst housing stock in Europe. The UK's legally binding climate change targets will not be met without near-complete elimination of greenhouse gas emissions from UK buildings (Climate Change Committee, 2019).

Dauda and Ajayi (2022) differentiate retrofitting from repair, refurbishment or renovation. Living in the UK's old housing stock results in fuel poverty, health inequalities, regional and rural inequalities.

The Climate Change Committee estimates that £162 billion of additional investment is needed from 2020 to 2050 for installing low-carbon heating in existing UK homes (National Audit Office, 2024). Endless chopping and changing of UK retrofit policy has led to industry uncertainty (Green and Lannon 2024). The sector has been exposed to the highest rate of policy chopping and changing of any industry (New Statesman, 2024).

Britain was the worst hit country in Western Europe following the invasion of Ukraine due to overreliance on gas to generate 40% of electricity and heat 85% of the least energy efficient homes in Europe (Ralston, 2024).

Gayne (2024) reports the Government will build on the slate of retrofit policies introduced under Conservative predecessors rather than replace them including a focus on heat pumps in the Warm Homes Plan.

A formal national retrofit strategy is needed to oversee recruitment, training and upskilling of the required 500,000-workforce (Construction Industry Leadership Council, 2020).

What is retrofit ?

Dauda and Ajayi (2022) differentiate retrofitting from repair, refurbishment or renovation of existing buildings. Repair is fixing damaged structures to good working conditions. Refurbishment is restoring the structural integrity of damaged structures to their original state and is interchangeable with renovation. Retrofitting is the process of strengthening or improving the structural or energy performance of existing buildings.

The Construction Leadership Council (2021) defines retrofit is an integrated approach to transforming the energy and water needs and technical systems in our homes which require quality in design, installation and customer care. Any retrofit involves potential risks (Park, 2003). Planned measures need to ensure that the seismic characteristics of a structure improve do not shift a problem to other critical regions of a structure.

Energy home proofing solutions are failing. Many insulation materials are decreasing in thermal resistance. Foamed plastic products, such as polystyrene and polyurethane are degrading due to loss of blowing agents decreasing in thermal resistance by over 20%. (Department for Energy Security and Net Zero, 2025).

How accurate are EPCs?

Valid for 10 years, energy performance certificates (EPCs) rate a home from A (very efficient) to G (inefficient) (Energy Saving Trust, 2025). They are sometimes the only way that householders interact with the performance of their homes (National Retrofit Hub, 2024).

The cost of retrofitting a home is estimated at £10,000 (Santander, 2022). Retrofitting puts a price premium on homes with better EPC ratings, insulation, solar panels and heat pumps. 58% of consumers surveyed did not understand what an EPC is. The House of Commons Environmental Audit Committee (2021) called for the EPC system to be replaced with building renovation passports. The Government has confirmed that the EPC will remain an important tool for delivering the Warm Homes Plan.

Key impacts of the UK's old housing stock

Fuel poverty

Hjelmskog (2022) surmises we are witnessing a perfect storm of injustice for poor households. Martinez-Perez and Altamirano-Medina (2023) identify fuel poverty in the UK as a pervasive issue casting a long shadow over vulnerable households. Fuel poverty is where a household spends 10% of income keeping its home at a satisfactory heating level (National Energy Action, 2025). As of January 2025 the charity estimates that 6.1 million households are in fuel poverty.

The Office of National Statistics (2023) advises that the fuel poverty measurement metric in England changed in the 2021 Fuel Poverty Strategy, to the Low-Income Low Energy Efficiency (LILEE) indicator that a household is in fuel poverty if their home has a Fuel Poverty Energy Efficiency Rating (FPEER) of band D or below.

Health inequalities

Climate change is likely to have increasingly negative impacts on indoor environments in poor housing stock. (Vardoulakis *et al.,* 2015). There are complex links between building performance, outdoor conditions and structural (Mavrogianni and Ucci, 2024). Retrofitting to low-energy standards increases overheating risk unless passive prevention measures are included in the retrofit design (Ibrahim and Pelsmakers, 2018).

Regional inequalities

There was a substantial increase in estimated fuel poverty in Scotland between 2019 and 2022. The definition used in Scotland is sensitive to changes in fuel prices. Estimates for Wales and Northern Ireland have yet to be published for 2022. (House of Commons Library, Fuel Poverty, 2024).

Welsh housing stock is particularly old. One third of homes were built before 1919. Almost a quarter of households experience fuel poverty. Welsh housing consists of a range of different dwelling types, ages, physical forms and construction types. There is no single 'solution' for a housing stock that varies so significantly. (Green and Lannon, 2024).

Fuel poverty levels in Northern Ireland have fluctuated from 27% in 2001, to 44% in 2009 and 24% in 2021, the most recent year for which official statistics are available.) A higher proportion of rural properties are off the gas using oil, coal or liquid petroleum gas for heating. Being off the gas grid is associated with a higher incidence of fuel poverty (Rural Services Network, 2022)

Barriers impeding sustainability in structural retrofitting of existing buildings

Dauda and Ajayi (2022) identify four groups of barriers that impede sustainability in structural retrofitting of existing buildings: Cultural barriers, economic barriers, technical knowledge and skills factors and regulatory barriers involving legislation and policies around retrofitting old buildings. There is no wide margin in terms of which barrier has the most damning impact.

These overlap with the UK Green Building Council (2021) seven barriers: Cost and finance, technical issues, national level, city level, tenure issues, householder offering, technical issues and supply chain.

Stop/start government policy failures

The House of Commons Research Briefing (2024) reiterates that the UK government has set a legally binding 'net zero target' to reduce the UK's net emissions by 100% by 2050 compared with 1990 levels. In 2022, emissions from residential buildings accounted for 20% of greenhouse gas emissions in the UK.

There is no coherent national retrofit strategy in place in the UK. Endless chopping and changing of retrofit policy plus lack of investment has led to industry uncertainty (Green and Lannon 2024). The New Statesman (2024) reported that the sector has been exposed to the highest rate of policy chopping and changing of any industry. Between 2012 and 2022, Westminster and the devolved governments introduced 30 retrofit schemes. Failure of policy was highlighted by the Committee on Climate Change (2022) reporting that as the UK's second largest source of emissions after surface transport, buildings had shown no sustained reduction in emissions in the last decade reflecting low levels of annual home energy efficiency improvements. Uptake of energy efficiency improvements in homes stalled far below its peak in 2012 when retrofit support schemes were scaled down.

Panakaduwa, Coats and Munir (2024) refer to 'the lost decade of insulation'. The Green Deal was a mass-scale retrofit drive in 2013 aimed at retrofitting over 14 million houses. It delivered 14,000. The National Audit Office (2024) reiterates the Climate Change Committee estimate of £162 billion of additional investment needed from 2020 to 2050 for installing low-carbon heating in existing UK homes. Over one million UK properties must undergo retrofit each year to meet the target of retrofitting more than 27 million homes by 2050 and achieve net zero emissions (Connected Places Catapult, 2024).

Energy costs from the energy crisis impacted everyone.

Ralston (2024) reports that following the invasion of Ukraine, Britain was the worst hit country in Western Europe due to overreliance on gas to generate 40% of electricity and heat 85% of the least energy efficient homes in Europe.

Between 1 January to 31 March 2025 the energy price cap is set at £1,738 per year for a typical household who use electricity and gas and pay by Direct Debit. This is an increase of 1.2% compared to the cap set between 1 October to 31 December 2024 (£1,717). The price cap is based on typical household energy use (Ofgem, 2025). Published figures from the University of Salford's Energy House show there are 6.1 million UK households in fuel poverty. (National Energy Action, 2025).

Costs of decarbonising housing association homes

National Housing Federation and Savills (2021) made what Savills termed 'early estimates' that decarbonising the existing 2.7 million housing association homes will be at least £36bn to cover the costs of bringing 39% of homes up to EPC C, installing heat pumps and other clean heat technologies.

A total of 3.49 million homes need to be retrofitted to EPC C by 2030 (Local Government Association, 2021). This means 1,017 homes retrofitted a day saving £698 million from energy bills by 2030. The ambition is to install 5.5 million heat pumps to 2030 in fuel poor and /or council-owned homes and new council homes.UK Finance (2023) estimates the cost of bringing the entire UK housing stock to a minimum EPC rating of C will is £249.5 billion.

The Committee on Climate Change (2024) reported that annual heat pump installations in homes were just over 60,000 in 2023, only a 4% increase compared to the previous year. An increase has been seen in recent months following the increase to the grant available to install heat pumps via the Boiler Upgrade Scheme. The total installation rate seen in 2023 will need to increase substantially by the end of the decade, to ensure that approximately 10% of current homes are heated by a heat pump, compared to around 1% today.

Bush and Webb (2020) conclude local authorities, and third sector organisations are increasingly recognised for their role in the coordination and promotion of wide scale, but locally tailored, building retrofit (Bush and Webb, 2020). A successful city initiative is the Greater Manchester Retrofit Task Force three-year programme was launched in 2021 to tackle the climate crisis through innovative finance solutions and build the supply and demand for the skills and jobs needed to grow the supply chain. Energy Efficient Scotland (EES) is the Scottish Government's flagship programme for the national-scale retro fitting of buildings over the next 15–20 years. The success of EES is reliant on partnerships between local authorities, arms-length external organisations, charities, and social enterprises (Wade, Bush and Webb, 2020).

Technical knowledge barriers involving education and skills factors

The UK construction industry came late to retrofit for energy efficiency (Rickaby, 2023). Retrofit standards and best practice have been pioneered by small membership organisations such as the Association for Environment Conscious Building (AECB) CarbonLite™ Standards. The Royal Institute of British Architects, the UK Green Building Council and the Chartered Institution of Building Service Engineers (CIBSE) endorse the Low Energy Transformation Initiative (2021) industry guidance. The British Standards Institution (BSI) has developed the BSI Retrofit Standards Framework based on three main components, the Publicly Available Specifications PAS 2035, PAS 2030 and PAS 2038 (Rickaby, 2023).

There are six PAS 2035 defined roles: Retrofit Advisor (point of contact for client for tenant); Retrofit Assessor (Domestic Energy Assessor tests home energy efficiency); Retrofit Coordinator (Technical Project Manager oversees management of retrofit project); Retrofit Designer (architect or engineer); Retrofit Installer (tradespeople and utilities engineers installing specific measures) and Retrofit Evaluator (independent surveyor function). (Connected Places Catapult, 2023).

There are dangers of cutting corners with short training packages. The Retrofit Academy delivers training modules for retrofit professionals nationwide. The free Retrofit 101 course for anyone wanting to learn about whole-house domestic retrofit takes six hours to complete. The Level 2 Award Understanding Domestic Retrofit course costing £395 + VAT takes 30 hours to complete.

Grosvenor (2023) identifies an estimated 100,000 people currently work on historic buildings and the need for 105,000 new each year until 2050 to focus solely on upgrading buildings built before 1919**.** The Crown Estate, National Trust, Grosvenor, Historic England and the Peabody Trust published *Heritage and Carbon Addressing the skills gap* (2023) that calls for a joined-up long-term energy efficiency strategy that specifically considers historic buildings.

Cultural barriers characterised by human behaviour and interest

Progress in housing energy retrofit in the UK is critically weak (Panakaduwa, Coats and Munir 2024). Poor demand for housing retrofit from the homeowners is a major problem. There is scarce uptake or adoption of energy retrofit measures within the private rented sector (Mininni, G.M. *et al*., 2024). The researchers interviewed landlords in Brighton and Hove. Mistrust towards authorities and uneasiness in accessing grants constrain landlords' decision-making.

Current and notable policies that tackle the urgent need for retrofit in the UK

Sedon, P. (2024) reported the energy secretary unveiling consultation plans at the Labour party Conference for social homes in England to achieve an energy performance certificate (EPC) rating of at least C by 2030. Gayne (2024) reports the Government will build on the slate of retrofit policies introduced under its Conservative predecessors rather than replacing them. The Department for Energy Security and Net Zero (2024) launched the Warm Homes Plan package of measures in November 2024 promising that 300,000 homes will benefit from upgrades in 2025.

The Climate Change Committee (2024) reported to Parliament that there were just over 60,000 annual heat pump installations in homes in 2023 - only a 4% increase compared to the previous year. Approximately 10% of current homes are heated by a heat pump, compared to around 1% today.

This Government's package of measures places heavy reliance on the successful uptake of heat pumps amongst private homeowners in England and Wales who will get a £7,500 heat pump grant through the Boiler Upgrade Scheme.

The National Audit Office (2024) reports that some stakeholders they interviewed did not want to commit to installing heat pump technology because of uncertainty over whether their area will be on a heat network or hydrogen heating will become available.

The National Audit Office (2024) notes that the Department of Energy Security and Net Zero does not have a single measure of the number of heat pumps installed. Achieving the target of 600,000 annual installations by 2028 requires an elevenfold increase from 2022 to 2028.

A comparative analysis of possible solutions

UK Government initiatives announced in autumn 2024 have yet to be embedded. A reformed Clean Heat Market Mechanism will be launched on 1 April 2025. (Department for Energy Security and Net Zero, 2024). Warm Homes Plan details are expected in spring 2025. The Department for Energy Security and Net Zero closed the *Energy Company Obligation 4 and the Great British Insulation Scheme Consultation on mid-scheme changes* on 12 December 2024.

UK Green Building Council calls for the Government to set out a 10-year strategic programme with an initial five years of funding committed to give local authorities and councils devolved powers, responsibility and resources to play a major role in the delivery of a nationwide home upgrade programme.

What is missing is a national retrofit strategy as outlined by the Construction Industry Leadership Council (2020). A Retrofit Delivery Agency would work with the Government and industry to identify key risks and build in mitigations (Construction Industry Leadership Council, 2020).

Deploying digital techniques to generate a building renovation plan or ‘passport’ for each residential unit or group of units to an agreed standard would provide an evidence-based pathway to decarbonisation through fabric and water efficiency and zero carbon heating technologies.

The Construction Industry Leadership Council (2020) calls for consumer financial incentives including one off council tax rebates on properties that undergo energy efficiency retrofit; stamp duty rebates if a property is above a given energy efficiency standard and an increased rate for properties that perform less well; reduced VAT on ‘retrofit-led renovation’ to stimulate demand for retrofit; wider market availability of green mortgages such as those provided by the Skipton Green Lending (2025).

Good communication is the cornerstone of a successful retrofit programme (Morgan, Maddock and Musselwhite 2024). Tenants should be provided with accessible information in various formats, given at different time points throughout the process with post-retrofit support.

Alabid, Bennadji and Seddiki (2022) suggest that Innovation centres, local governments and authorities should introduce events, workshops and training programs on sustainable building retrofits that bring stakeholders together including policy makers and end-users to be part of the decision-making process.

Shwashreh,Taki and Kagioglou (2024) conclude there is transformative potential of comprehensive retrofit measures and the paramount importance of resident engagement taking a multifaceted approach that intertwines energy efficiency upgrades, indoor comfort, and resident satisfaction.

Conclusion

Lives and buildings are crumbling in the UK in the absence of a national retrofit strategy that acknowledges the UK’s unique legacy. There is no single ‘solution’ for a housing stock that varies so significantly.

The UK’s legally binding climate change targets will not be met without near-complete elimination of greenhouse gas emissions from UK buildings (Climate Change Committee, 2019). The UK Green Building Council (2021) identifies seven manageable barriers to retrofit. The Construction Leadership Council has a strategy consultation document to be revisited. The Crown Estate, National Trust, Grosvenor, Historic England and the Peabody Trust have extensive reach.

A parallel exercise is focusing on the role of local authorities and grassroot movements in fostering local and devolved solutions. Bush and Webb (2020) conclude local authorities and third sector organisations are increasingly recognised for their role in the coordination and promotion of wide scale, but locally tailored, building retrofit. Energy Efficient Scotland is an example of one such programme. With the new Government shaping initiatives and opening public consultations, there is the opportunity to consolidate on what works.

The retrofit sector must never again be exposed to the highest rate of policy chopping and changing of any industry.

-END-

BIBLIOGRAPHY

UK Green Building Council (2019) *Accelerator Cities Pathfinder* . Available at: https://ukgbc.org/resources/accelerator-cities-pathfinder/ (Accessed: 02 December 2024).

Alabid, J., Bennadji, A. and Seddiki, M. (2022) 'A review on the energy retrofit policies and improvements of the UK existing buildings, challenges and benefits', *Renewable and Sustainable Energy Reviews,* Volume 159. doi: https://doi.org/10.1016/j.rser.2022.112161

Association for Environment Conscious Building *AECB Retrofit Standard.* Available at: https://aecb.net/https-aecb-net-aecb-carbonlite-retrofit/ (Accessed: 08 January 2025).

Boyd, D.R. (2024) *The Right to a Healthy Environment A User's Guide*. Available at: https://www.ohchr.org/sites/default/files/documents/issues/environment/srenvironment/activities/2024-04-22-stm-earth-day-sr-env.pdf (Accessed: 01 January 2025).

Built Environment – Smarter Transformation (2024) *Retrofit Scotland relaunches to scale neighbourhood retrofit delivery*. Available at: https://www.be-st.build/news/retrofit-scotland-relaunches-to-scale-neighbourhood-retrofit-delivery/ (Accessed: 07 January 2025).

Business News (2024). '£45m Retrofit Partnership is 'The Shape of Things to Come' for Social Housing'*, Business News Wales,* 27 December. Available at: https://businessnewswales.com/cardiff-based-city-energy-network-45m-retrofit-partnership-with-birmingham-city-council/ (Accessed: 10 January 2025).

Centre for Sustainable Energy (2025) What is retrofit? Available at: https://www.cse.org.uk/news/what-is-retrofit/ (Accessed: 02 January 2025).

Chartered Institution of Building Service Engineers (2021), *LETI Retrofit guide published with CIBSE backing.* Available at: https://www.cibse.org/policy-insight/ key-policy-areas/net-zero/leti-retrofit-guide-published-with-cibse-backing (Accessed: 27 December 2024).

Correia, J.E. (2022) *The UN just declared a new human right.* Available at: https://www.weforum.org/stories/2022/08/ (Accessed: 02 December 2024).

Committee on Climate Change (2024) *Progress in reducing emissions 2024 Report to Parliament.* Available at: https://www.theccc.org.uk/wp-content/uploads/2024/07/ Progress-in-reducing-emissions-2024-Report-to-Parliament-Web.pdf (Accessed: 02 December 2024).

Committee on Climate Change (2022) *Progress in reducing emissions 2022 Report to Parliament.* pp.162. Available at: https://www.theccc.org.uk/wp-content/uploads/2022/06/Progress-in-reducing-emissions-2022-Report-to-Parliament.pdf (Accessed: 02 December 2024).

Committee on Climate Change (2019) *UK housing: Fit for the future?* Available at: https://www.theccc.org.uk/ wp-content/uploads/2019/02/UK-housing-Fit-for-the-future-CCC-2019.pdf (Accessed: 02 December 2024).

Connected Places Catapult (2024) *Housing retrofit challenges and future opportunities explained.* Available at: https://cp.catapult.org.uk/article/housing-retrofit-challenges-and-future-opportunities-explained/#:~:text=Making%20homes%20more%20energy%20efficient,housing%20sector%20to%20promote%20retrofit.&text=Over%20one%20million%20UK%20properties,Regulatory%20frameworks (Accessed: 09 January 2025).

Connected Places Catapult (2023) *Workforce 2050: Campaigns for Change Retrofit Skills Gap & Supply Chain Analysis.* Available at: https://cp-catapult.s3.amazonaws.com/ uploads/2024/03/Workforce-2050-Campaigns-for-Change.pdf (Accessed: 09 January 2025).

Construction Leadership Council (2021) *Greening Our Existing Homes National retrofit strategy A consultative document.* Available at: https://www.constructionleadershipcouncil.co.uk/wp-content/uploads/2020/12/CLC-National-Retrofit-Strategy-final-for-consultation.pdf (Accessed: 09 January 2025).

Department for Communities (2025) *Fuel Poverty and the Just Transition.* Available at: https://www.communities-ni.gov.uk/articles/fuel-poverty-and-just-transition (Accessed: 08 December 2025).

Dauda, J.A and Ajayi, S.O.(2022) 'Understanding the impediments to sustainable structural retrofit of existing buildings in the UK', *Journal of Building Engineering,* Volume 60. doi: https://doi.org/10.1016/j.jobe.2022.105168

Department for Education and Prime Minister's Office (24 September 2024) *Prime Minister overhauls apprenticeships to support opportunity* (media release). Available at: https://www.gov.uk/government/news/prime-minister-overhauls-apprenticeships-to-support-opportunity (Accessed: 09 January 2025).

Department for Energy Security and Net Zero (2024) *Energy Company Obligation 4 and the Great British Insulation Scheme Consultation on mid-scheme changes.* Available at: https://assets.publishing.service.gov.uk/media/6734835937aabe56c4161036/eco4-and-gbis-mid-scheme-consultation.pdf (Accessed: 12 January 2025).

Department for Energy Security and Net Zero (2023) *Net Zero Government Initiative UK Roadmap to Net Zero Government Emissions*. Available at: https://assets.publishing.service.gov.uk/media/6569cb331104cf000dfa7352/net-zero-government-emissions-roadmap.pdf (Accessed: 02 December 2024).

Department for Energy Security and Net Zero (2024), *Warm Homes Plan Help to save households money and deliver cleaner heat to homes.* Available from: https://www.gov.uk/government/news/help-to-save-households-money-and-deliver-cleaner-heat-to-homes. (Accessed: 02 December 2024).

Department for Energy Security and Net Zero (2025) *Deterioration of retrofit insulation performance.* Available at: https://assets.publishing.service.gov.uk/media/677ff1c0d721a08c00665619/drip-report.pdf (Accessed: 10 January 2025).

Department of Levelling Up, Housing and Communities (2024) *Adapting historic homes for energy efficiency: a review of the barriers.* Available at: https://www.gov.uk/government/publications/adapting-historic-homes-for-energy-efficiency-a-review-of-the-barriers/adapting-historic-homes-for-energy-efficiency-a-review-of-the-barriers#introduction (Accessed: 04 January 2025).

End Fuel Poverty Coalition (2024) *Warm Homes Plan "downpayment", but no additional energy help in Budget*. Press Release. 30 October. Available at: https://www.endfuelpoverty.org.uk/warm-homes-plan-downpayment-but-no-additional-energy-help-in-budget/ (Accessed: 04 January 2025).

End Fuel Poverty Coalition (2025) *4,950 excess winter deaths caused by cold homes last winter.* Available at: https://www.endfuelpoverty.org.uk/4950-excess-winter-deaths-caused-by-cold-homes-last-winter/ (Accessed: 08 January 2025).

Energy News (2024) 'Ed Miliband promises energy efficient homes for all', *Planning, Building & Construction Today,* 26 September. Available at: https://www.pbctoday.co.uk/news/energy-

news/ed-miliband-promises-energy-efficient-homes-for-all/144072/ (Accessed: 06 January 2025).

Energy Saving Trust (2025) *Energy performance certificates explained*. Available at: https://energysavingtrust.org.uk/advice/guide-to-energy-performance-certificates-epcs/ (Accessed: 08 December 2024).

Energy Saving Trust (2022) *How to spot an energy scam.* Available at: https://energysavingtrust.org.uk/how-to-spot-an-energy-scam/#:~:text=Energy%20efficiency%20and%20home%20improvement,on%20common%20energy%20efficiency%20scams.(Accessed: 08 December 2024).

Engelbrecht, G. (2025) '£30 million funding secured for North East housing retrofit project', *The Northern Echo*, 07 January. Available at: https://www.thenorthernecho.co.uk/news/24835484.30-million-funding-secured-north-east-housing-retrofit-project/ (Accessed: 08 January 2025).

Fulford, E.(2024) **'**How are barriers to retrofitting heritage homes being addressed?', 01 May. Available at: https://www.housing.org.uk/news-and-blogs/blogs/ewan-fulford/how-are-barriers-to-retrofitting-heritage-homes-being-addressed/ (Accessed: 02 January 2025).

Gayne, D (2024) 'Last government's retrofit programmes to stay as minister says no time for hiatus'*, Inside Housing,* 09 September. Available at: https://www.housingtoday.co.uk/news/last-governments-retrofit-programmes-to-stay-as-minister-says-no-time-for-hiatus/5131473.article#:~:text=The%20Department%20for%20Energy%20Security,in%20government%2C%E2%80%9D%20she%20said (Accessed: 06 January 2025).

Green, E. and Lannon, S.(2024) *Homes of today for tomorrow Decarbonising Welsh Housing between 2020 and 2050*, Available at*:* https://orca.cardiff.ac.uk/id/eprint/115442/3/Homes%20of%20Today%20for%20Tomorrow%20stage%201%20report.pdf (Accessed: 08 December 2024).

Grosvenor (2023) *Heritage and Carbon Addressing the skills gap.* Available at: https://www.grosvenor.com/getattachment/ 7042425-b1cc-4c45-b338-5193a1c93d32/Heritage-and-Carbon_Final_Digital_DPS.pdf (Accessed: 02 January 2025).

Hasanthika, C. *et al.,* (2015) 'Effectiveness of financial support interventions to reduce adverse health outcomes among households in fuel poverty in the United Kingdom', *Environment International,* Volume 85, pp. 299-313. doi: https://doi.org/10.1016/j.envint.2015.09.010

Heat Pump Association (2024) *Projecting The Future Domestic Heat Pump Workforce*. Available at: https://www.heatpumps.org.uk/wp-content/uploads/2024/11/HPA-Projecting-the-Future-Domestic-Heat-Pump-Workforce-Background-and-Methodology.pdf (Accessed: 31 December 2024).

Hjelmskog, A. (2022) *How to combine action on housing retrofit with tackling health inequalities (and other injustices),* Briefing Paper. Available at: https://housingevidence.ac.uk/wp-content/uploads/2024/02/220615-How-to-combine-action-on-housing-retrofit-with-tackling-health-inequalities_final_web-ready.pdf (Accessed: 08 January 2025).

House of Commons Environmental Audit Committee (2021). *Energy Efficiency of Existing Homes Fourth Report of Session 2019–21.* Available at:

https://committees.parliament.uk/publications/5171/documents/52521/default/ (Accessed: 06 January 2025)

House of Commons Library (2024) *Fuel Poverty.* Policy. Available at: https://researchbriefings.filesparliament.uk/documents/CBP-8730/CBP-8730.pdf. (Accessed: 27 December 2024).

House of Commons Library Research Briefing (2024) *Housing and net zero.* Available at: https://researchbriefings.files.parliament.uk/documents/CBP-8830/CBP-8830.pdf (Accessed: 12 December 2024).

Ibrahim, A. and Pelsmakers, S. (2018) 'Low energy housing retrofit in North England: Overheating risks and possible mitigation strategies', *Building Services Engineering Research & Technology,* Volume 39, Issue 2. pp. 161–72. doi: https://doi.org/10.1177/0143624418754386

Local Government Association (2021) *Delivering local net zero.* Available at: https://www.local.gov.uk/publications/delivering-local-net-zero (Accessed: 09 December 2025=4).

Low Carbon Exchange (2025) *Successful Retrofit Project Delivery for Social Housing Providers & Local Authorities: Essential Tips.* Available at: https://lowcarbonexchange.com/successful-retrofit-project-delivery/#:~:text=Engaging%20contractors%20early%20in%20the,realistic%20timelines%2C%20and%20clarify%20expectations. (Accessed: 09 January 2025).

Low Energy Transformation Initiative (2021) *LETI Climate Emergency Retrofit Guide How existing homes can be adapted to meet UK climate targets* Available at: https://www.leti.uk/_files/ ugd/252d09_c71428bafc3d42fbac34f9ad0cd6262b.pdf (Accessed 09 December 2024).

Martinez-Perez, R. and Altamirano-Medina, H. (2023) 'Retrofitting proposal for a dwelling in London considering unintentional health consequences and Energy Efficiency Measures', *CIBSE Technical Symposium.* Glasgow, Scotland, 20-21 April. Available at: https://discovery.ucl.ac.uk/id/eprint/10183915/ (Accessed:19 December 2024)

Max Fordham LLP (2022), *Net Zero Carbon Guide.* Available at: https://www.netzerocarbonguide.co.uk/guide/early-decisions/retrofit-or-new-build/summary Accessed: 02 January 2025).

Mininni, G.M. *et al*., (2024) 'Landlords' accounts of retrofit: A relational approach in the private rented sector in England', *Energy Research and Social Science*, Volume 118. doi: https://doi.org/10.1016/j.erss.2024.103742

Ministry of Housing, Communities and Local Government and Department for Energy Security and Net Zero (2024) *Open consultation Reforms to the Energy Performance of Buildings regime*. Available at: https://www.gov.uk/government/consultations/reforms-to-the-energy-performance-of-buildings-regime/reforms-to-the-energy-performance-of-buildings-regime (Accessed: 10 January 2025).

Ministry of Housing, Communities and Local Government (2024) *English Housing Survey 2022 to 2023: housing quality and condition.* Available at: https://www.gov.uk/government/statistics/english-housing-survey-2022-to-2023-housing-quality-and-condition/english-housing-survey-2022-to-2023-housing-quality-and-

condition#:~:text=In%202022%2D23%2C%203.5%20million%20households%20(14%25)%20were,%2Ddecent%2C%20Annex%20Table%201.1.(Accessed: 08 December 2024).

Morgan. D.J., Maddock, C.A. and Musselwhite, C.B.A.(2024) 'These are tenants not guinea pigs: Barriers and facilitators of retrofit in Wales, United Kingdom', *Energy Research & Social Science,* Volume 111. Available at: file:///C:/Users/sueg0/OneDrive/Documents/Birkbeck/Modules/Environment%20and%20Policy%20(2024_25)/Assessment/Retrofitting%20the%20UK's%20leaky%20old%20housing%20stock/Wales/These%20are%20tenants%20not%20guinea%20pigs%20Wales.pdf (Accessed: 07 December 2024).

National Housing Federation and Savills (2021) *Decarbonising housing associations' homes to cost £36bn, according to National Housing Federation.* Available at: https://www.savills.co.uk/insight-and-opinion/savills-news/320272-0/decarbonising-housing-associations--homes-to-cost-%C2%A336bn--according-to-national-housing-federation (Accessed: 09 December 2024).

National Audit Office (2024) *Decarbonising home heating.* Available at: https://www.nao.org.uk/wp-content/uploads/2024/03/Decarbonising-home-heating-HC-581.pdf (Accessed: 04 January 2025).

National Audit Office (2023) *How fuel poverty is measured in the UK*: Available at: https://www.ons.gov.uk/peoplepopulationandcommunity/housing/articles/howfuelpovertyismeasuredintheuk/march2023#:~:text=In%20England%2C%20the%20measurement%20of,of%20band%20D%20or%20below (Accessed: 11 January 2025).

National Energy Action (2025) *Energy Crisis.* Available at: https://www.nea.org.uk/energy-crisis/ (Accessed: 07 December 2024).

National Engineering Policy Centre (2024*), Healthy, safe and sustainable buildings: Maximising benefits in building retrofit.* Available at: https://nepc.raeng.org.uk/healthy-buildings (Accessed:19 December 2024).

National Housing Federation and Local Government Association (2022) *Hard to Decarbonise Social Homes.* Available at: https://www.housing.org.uk/globalassets/files/climate-and-sustainability --energy-crisis/hard-to-decarbonise-homes-2022.pdf (Accessed: 02 January 2024).

National Retrofit Hub (2023) *Enabling the delivery of housing retrofit at scale.* Available at: https://nationalretrofithub.org.uk/ (Accessed: 09 January 2025).

National Retrofit Hub (2024) *The Future of Energy Performance Certificates: A Roadmap for Change.* Available at: https://nationalretrofithub.org.uk/wp-content/uploads/2024/11/NRH-The-Future-of-EPCs.pdf?vgo_ee=Zn%2BiIKnm16zgsYKAj2yQ714SmRGlT%2BDqsnMuphHFBjwfjLEgB1hvkdU%3D%3AExE6BZA5kJBwZuoQV1EjJ5l05oY%2BBkMH (Accessed: 12 January 2025).

Nesta (2024) *Insulation impact: How much do UK houses really need?* Available at: https://media.nesta.org.uk/documents/Insulation_impact__how_much_do_UK_houses_really_need___1.pdf (Accessed: 02 January 2024).

New Statesman Spotlight on policy (2024) 'Retrofit revolution: how do we decarbonise the UK's homes? The UK has the worst insulated and leakiest housing in Europe – experts discuss how we can fix it', *New Statesman,* 15 May. Available at:

https://www.newstatesman.com/spotlight/economic-growth/regional-development/housing/2024/05/retrofitting-homes-housing-decarbonisation-energy-bills-net-zero-climate-change (Accessed: 08 December 2024)

Ofgem (2025) *Energy price cap.* Available at: https://www.ofgem.gov.uk/energy-price-cap (Accessed: 12 January 2025).

Office of National Statistics (2023) *How fuel poverty is measured in the UK: March 2023.* Available at: https://www.ons.gov.uk/peoplepopulationandcommunity/housing/articles/howfuelpovertyismeasuredintheuk/march2023#:~:text=In%20England%2C%20the%20measurement%20of,of%20band%20D%20or%20below (Accessed: 09 December, 2024).

Panakaduwa, C., Coats, S. and Munir, M. (2024) 'Evaluation of Government Actions Discouraging Housing Energy Retrofit in the UK: A critical Review'. *20th International Conference on the European Energy Market (EEM).* Istanbul, Turkey, 10 -12 June. pp.1-6. doi: 10.1109/EEM60825.2024.10608933.

Park, R. (2003). Structural Integrity Assessment - Examples and Case Studies Retrofit Methods', in Milne, I., Ritchie, O.R. and Karihaloo, B. (eds.) *Comprehensive Structural Integrity.* Volume 3. Elsevier Science Ltd.

Passivhaus Trust, *EnerPHit The new Passivhaus refurbishment standard from the Passivhaus Institute* (2011) Available at: https://www.passivhaustrust.org.uk/ (Accessed: 08 January 2025).

Peñasco, C.(2024) 'From policy to practice: The role of national policy instruments and social barriers in UK energy efficiency adoption in households', *Energy Policy*, Volume 194. doi: https://doi.org/10.1016/j.enpol.2024.114308

Putnam, T. and Brown, D. (2021) 'Grassroots retrofit: Community governance and residential energy transitions in the United Kingdom', *Energy Research & Social Science* Volume 78. Available at: https://doi.org/10.1016/j.erss.2021.102102

Ralston, J. (2024) 'How has the UK's energy security, prices and system been changed in the two years since Russia invaded Ukraine*?*, *Energy & Climate Intelligence Unit*, 22 February. Available at: https://eciu.net/insights/2024/two-years-of-russias-war-on-ukraine-the-gas-crisis-price-rises-and-energy-security#:~:text=In%20the%20first%20year%2C%20the,%2D22%20%2C%20before%20the%20invasion (Accessed: 04 January 2025).

Rickaby, P. (2023) *The importance of standards for safe energy retrofit* A BSI white paper**.** Available at: https://www.bsigroup.com/siteassets/pdf/en/insights-and-media (Accessed: 03 January 2025).

Robert, A. and Kummert, M. (2012) 'Designing net-zero energy buildings for the future climate, not for the past', Building and Environment, Volume 55. doi: https://doi.org/10.1016/j.buildenv.2011.12.014

Royal Institute of British Architects (2021) *The six principles for retrofitting a house to meet net zero targets.* Available at: https://www.architecture.com/knowledge-and-resources/knowledge-landing-page/the-six-principles-for-retrofitting-a-house-to-meet-net-zero-targets?srsltid=AfmBOoqMwnuwdTZG0e9k4DY_kzF0D2WniTmLsN7CFYfqv2e11WUWDGG9 (Accessed: 27 December 2024).

Rural Services Network (2022) *Rural cost of living.* Available at: https://rsnonline.org.uk/images/publications/rural-cost-of-living.pdf (Accessed: 11 January 2025).

Santander (2022) *Buying into the Green Homes Revolution.* Available at: https://www.santander.co.uk/assets/s3fs-public/documents/buying_into_the_green_homes_revolution_report_oct_2022_noef.pdf (Accessed: 07 December 2024).

Sawyer *et al.,* (2022) 'It's changed my life not to have the continual worry of being warm' – health and wellbeing impacts of a local fuel poverty programme: a mixed-methods evaluation', *BMC Public Health*. Available at: https://doi.org/10.1186/s12889-022-12994-4 (Accessed: 08 January 2025).

Sedon, P (2024). 'The energy secretary has announced plans to raise energy efficiency rules for social housing, in a bid to cut fuel bills for tenants and meet climate goals.' 24 September 2024. Available at: https://www.bbc.co.uk/news/articles/c1l4py0gz3jo#:~:text=Updated%2024%20September%202024,to%20come%20up%20to%20scratch. (Accessed: 08 December 2024).

Shwashreh, L., Taki, A. and Kagioglou (2024) 'Retrofit Strategies for Alleviating Fuel Poverty and Improving Subjective Well-Being in the UK's Social Housing', *Buildings.* doi: https://doi.org/10.3390/buildings14020316

Skipton Building Society (2025) *Green Lending.* Available at: https://www.skipton-intermediaries.co.uk/criteria/green-lending (Accessed:12 January 2025).

Smith, N., Davis, A. and Hirsch, D. (2010) *A minimum income standard for rural households.* Available at: https://www.rsnonline.org.uk/new-report-shows-devastating-triple-blow- pushes-rural-communities-in-a-cost-of-living-emergency#:~:text=New%20report%20shows%20devastating%20triple,living%20emergency%20-%20Rural%20Services%20Network.(Accessed: 08 December 2024).

The Crown Estate, National Trust, Grosvenor, Historic England and the Peabody Trust (2023) *Heritage and Carbon Addressing the skills gap.* Available at: file:///C:/Users/sueg0/OneDrive/Documents/Birkbeck/Modules/Environment%20and%20Policy%20(2024_25)/Assessment/Retrofitting%20the%20UK's%20leaky%20old%20housing%20stock/Commercial/Heritage-and-Carbon_Final_Digital_DPS.pdf (Accessed: 08 December 2024).

The Housing Finance Corporation (2025), *Retrofitting social housing: what you need to know.* Available at: https://www.thfcorp.com/insight/retrofitting-social-housing-what-you-need-to-know/ (Accessed: 09 December 2024).

The Retrofit Academy (2025) *The Driving Force in Retrofit Knowledge and Skills.* Available at: https://retrofitacademy.org/ (Accessed: 09 January 2025).

The Skipton Building Society for Intermediaries (2025), *The realities of retrofitting.* Available at: https://www.mortgagesolutions.co.uk/sponsored-content/skipton-intermediaries-co-uk/the-realities-of-retrofitting/ (Accessed: 08 January 2025).

TrustMark (2025) *PAS 2035:2019 / PAS 2035/2030:2023* Available at: https://www.trustmark.org.uk/business/information-guidance/pas-20352019-pas-203020352023 (Accessed: 09 January 2025).

Ucci, M. and Mavrogianni, A. (2024) ‘Health inequalities and indoor environments: research challenges’, *Buildings & Cities,* Volume 5 Issue:1 pp. 662–674. doi: https://doi.org/10.5334/bc.514

UK Finance (2025) *Warm Homes Plan at the Budget: Government needs to galvanise demand for retrofit.* Available at: https://www.ukfinance.org.uk/news-and-insight/blog/warm-homes-plan-budget-government-needs-galvanise-demand-retrofit (Accessed: 12 January 2025).

UK Green Building Council *Accelerator Cities Pathfinder* (2019) Available at: https://ukgbc.org/resources/ accelerator-cities-pathfinder/ (Accessed:11 January 2025).

UK Green Building Council *Retrofit Practical Guide.* Available at: https://ukgbc.org/wp-content/uploads/2024/07/Retrofit.pdf (Accessed: 02 December 2024).

UK Green Building Council (2024) *UKGBC responds to changes in retrofit schemes. Available at:* https://ukgbc.org/resources/ukgbc-responds-to-changes-to-retrofit-schemes/ (Accessed: 08 December 2024).

UK Research and Innovation (2025) *Innovate UK*. Available at: https://www.ukri.org/councils/innovate-uk/wp-content/uploads/2021/05/Construction-Leadership-Council-National-Retrofit-Strategy-Version-2.pdf (Accessed: 09 January 2025).

Vardoulakis, S. *et al.* (2015) ‘Impact of climate change on the domestic indoor environment and associated health risks in the UK’, *Environment International*, Volume 85, pp.299 -313. doi: https://doi.org/10.1016/j.envint.2015.09.010

Wade, F, Bush, R & Webb, J. (2020) ‘Emerging linked ecologies for a national scale retrofitting programme: The role of local authorities and delivery partners’, *Energy Policy* , Volume 137. doi: https://doi.org/10.1016/j.enpol.2019.111179

Webb, C (2023) *Government launches £500m local authority retrofit scheme.* Local Government Chronicle.18 December. Available at: https://www.lgcplus.com/services/housing/government-launches-500m-local-authority-retrofit-scheme-18-12-2023/ (Accessed: 08 December 2024).

Wise, F., Gillich, A. and Palmer, P. (2025) ‘Retrofit information challenges and potential solutions: Perspectives of households, retrofit professionals and local policy makers in the United Kingdom’, Energy Research & Social Science, Volume 119. doi: https://doi.org/10.1016/j.erss.2024.103866