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Introduction to Transform-ER



Retrofitting the UK housing stock is critical to meet net zero targets and improve the comfort and health of occupants.

However, multiple challenges and barriers exist including but not limited to: a lower than required retrofitting rate, insufficient retrofitting scope, and systemic construction sector challenges, which may jeopardise achieving this objective. To fulfil the UK's goal of decarbonising its housing stock, substantial changes must be implemented.

[Transform-ER](#) ([Transform.Engage.Retrofit](#)) is a game-changing, consortium-led project funded by Innovate UK that's tackling the retrofit industry's biggest barriers to achieving scale, from rising costs and underperformance issues to poor collaboration.

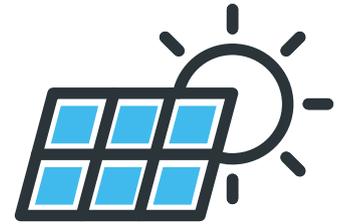
13 industry leaders (see below) are collaborating to create a cohesive, industrialised sector that uses a standardised end-to-end process to deliver high-performance, cost-effective home improvement solutions. The aim is to enable a retrofit sector that can deliver one million home upgrades every year by 2030.

The consortium will use the Demand-Develop-Deploy structure established during the [Construction Innovation Hub](#) to concurrently create new deployment and contract approaches, streamline accreditation processes, prototype products and kits-of-parts, develop digital pipeline tools and a scalable finance mechanism, foster culture change and form a Retrofit Rulebook.

The result? A new industrialised retrofit system and marketplace that upgrades homes and improves lives - open to existing and new delivery partners - tested and ready to launch in 2025, alongside a wealth of learning to be shared widely with the industry.



Executive summary



The UK's housing stock is in a critical state, characterised by poor energy efficiency and unacceptable living conditions. To achieve a notional benchmark of EPC C rating in all homes by 2035, national retrofitting rates must increase sixteen-fold.

Reducing carbon emissions from the housing stock is essential to meet national net zero carbon targets. However, with current methods, supply chain capabilities, and the present appetite of building owners, the UK will fail to meet these targets. A paradigm shift is therefore required to accelerate the change in industry.

Based upon housing survey data from all UK nations, it can be estimated that roughly 50% of the UK housing stock is still rated at EPC band D or lower. UK homes with the lowest EPC ratings are disproportionately represented across fuel poor homes, and improving the energy efficiency of homes is the most effective way of tackling fuel poverty in the long term.

Government funding schemes have started the process of retrofitting the UK housing stock, achieving around 4.1 million energy efficiency measures, saving over 60 MtCO₂ of lifetime carbon, but only since ECO4 was introduced in April 2022 has whole-house retrofit been adopted as a strategy.

To illustrate the market potential, this report estimates that for non-cavity wall dwellings in the UK, industry needs to produce and install an estimated 810 million m² of internal/external insulation products for this one segment of the retrofitting market alone.

Retrofit is currently achieving around £1bn worth of delivery per year. The Transform-ER consortium believe that the whole market potential could be valued in the order of £20-60bn per year.

Evidence shows that current methods are simply unable to achieve the volumes required and thus the need for retrofit at increased scale is undeniable.

Clear guidance is required on how to achieve retrofit at scale, together with credible demonstration that new delivery models are feasible in the real world. To better envision the future of retrofit, we need to understand the key barriers to scalability.



Transform-ER believes that the whole retrofit market potential could be valued in the order of £20-60bn per year.

Barriers include:

- an underdeveloped supply chain in the UK
- stakeholders' low risk appetite
- limited retrofitting capability and capacity
- workforce and skills shortages
- lack of industry standardisation, and;
- the absence of proven delivery models, including financing.

The Transform-ER consortium and its key work streams aim to overcome these barriers by learning the lessons of the Transforming Construction Challenge (TCC), that is, to accelerate the shift in construction in the UK towards manufacturing and digital processes.

This is underpinned by adopting the DEMAND-DEVELOP-DEPLOY framework defined in the Construction Innovation Hub's Product Platform Rulebook, the hub being the largest project funded within the TCC.

Through adopting the core principles of the TCC, moving towards a Manufacturing-Led approach (including platforms/product platforms, systems engineering, and developing interoperable kits-of-parts), mass customisation can be achieved. This unlocks customised and personalised designs at a cost near mass production.

Further to mass customisation, the benefits of adopting this approach include increased productivity, greater quality control and assurance, and applying digital technologies to further streamline the retrofit process. A Manufacturing-Led approach unlocks finance options through guarantees of functional performance and factory levels of quality.

As we approach the final six months of Transform-ER's Innovate UK funded phase, the lessons learnt from the project will be written up and captured in the project's [Retrofit Rulebook](#). This will provide clear guidance to other industry actors seeking to understand how to reach retrofit at scale.

The UK's big retrofit barriers



An underdeveloped supply chain



Stakeholders' low risk appetite



Limited retrofitting capability and capacity



Workforce and skills shortages



Lack of industry standardisation



Absence of proven delivery models, including financing

Background

Retrofitting to reduce the energy demand

According to The Climate Change Committee (CCC) [6th Carbon budget](#) [1], meeting the UK's net zero 2050 target involves the full decarbonisation of buildings' direct operational emissions (i.e. heating and electricity etc.), while the emissions from manufacturing and construction of buildings will have their own residual emissions budget.

The operational carbon of buildings can be reduced through three simultaneous strategies, as presented in Figure 1.

Retrofitting to upgrade the current UK housing stock

Old buildings often rely on inefficient heating systems and are either poorly insulated or not insulated at all [3], leading to high energy consumption, carbon emissions and health issues for occupants' due to exposure to extreme temperatures (hot and cold), and excess moisture leading to mould.

The ageing nature of the UK's housing stock results in many households suffering from fuel poverty, where high energy bills relative to income prevent adequate heating of their homes. Retrofitting can lower energy bills through improved efficiency, but it needs to be financially viable and accessible for all income levels and tenures, guaranteeing equity.

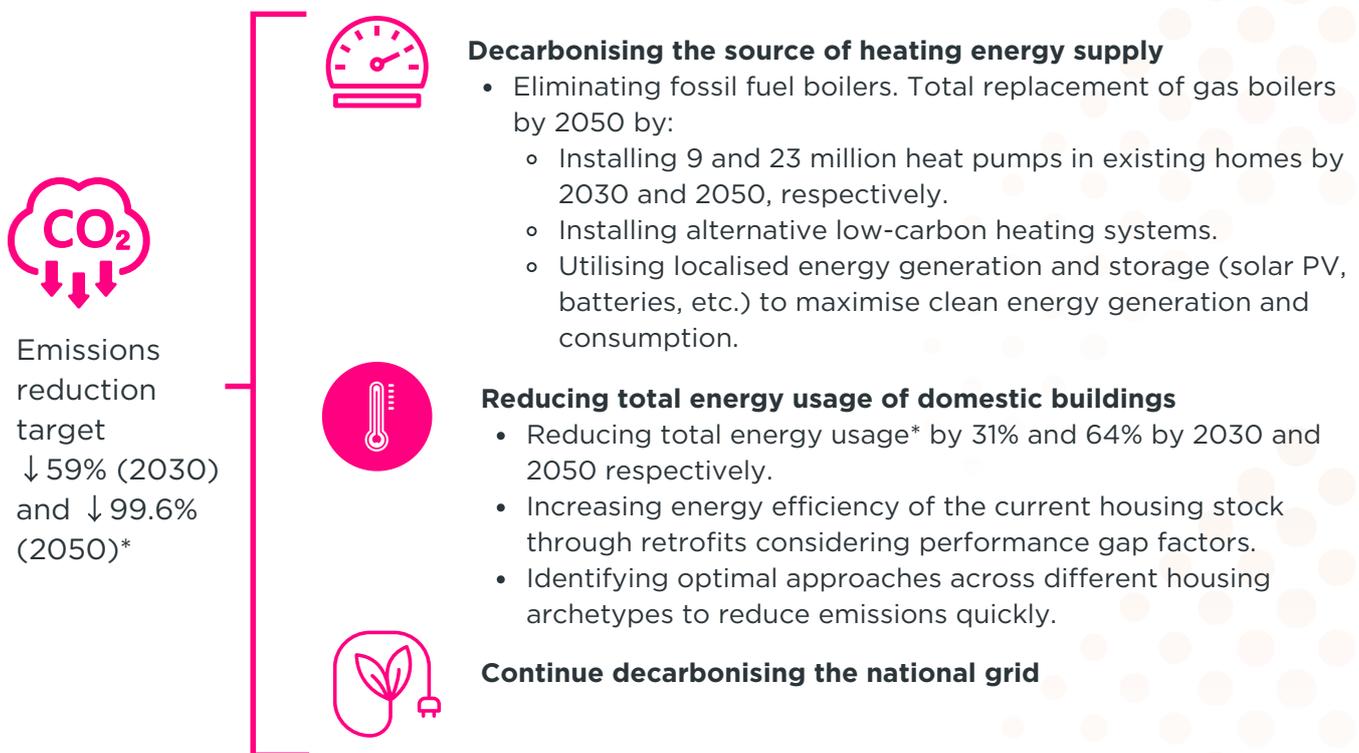


Figure 1: Targets to meet the CO₂e reduction targets according to UKGBC 2021 [2]

* Compared to 2018 levels.

UK retrofitting rate

The International Energy Agency (IEA) has set a global average retrofit rate (RR) target, currently estimated to be below 1% per year, with a goal of upgrading at least 2.5% of existing homes to net zero annually by 2030 [4].

In countries with older building stock, such as the UK, this target may be higher [5]. The IEA emphasises the need to retrofit up to 50% of existing buildings to net zero levels by 2040 and 85% by 2050.

However, the current retrofitting rate (RR) is significantly below these targets, and without substantial changes, the sector will not meet these goals.

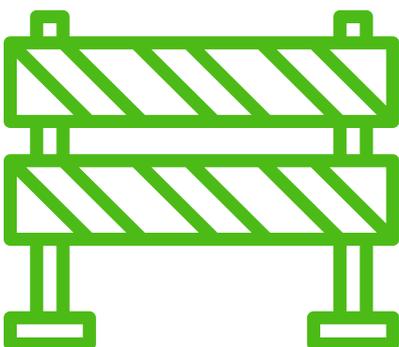
Therefore, a paradigm shift is essential to accelerate progress.

Barriers to retrofit

When it comes to retrofit, several key barriers exist [6], [7]. These include:

1. Systemic construction sector challenges: Shortage of skilled workers, inefficiencies, and supply chain issues [8], [9].

2. Public awareness and engagement: Low awareness of retrofit benefits and the financial assistance available, together with a misunderstanding of the impact home heating has on the environment [10], [11].



3. High costs and funding gaps: High upfront costs and long payback periods, with an estimated £250 billion needed for net zero standards. Significant funding gaps, both government subsidies and private finance, especially in low income and social housing households, limit appetite for retrofit [1], [6], [7], [12].

4. Policy and coordination issues: Need for cohesive, long-term strategy and better coordination. Ideally, one standardised national funding scheme would be rolled out at scale across the UK, with consolidated retrofitting goals.

5. Consumers perceptions: Low awareness, interest, and concerns about workmanship, property damage, and lifestyle disruptions. Elderly homeowners are particularly deterred.

6. A fragmented and underdeveloped supply chain: Unique property characteristics add complexity and cost. Predominance of small enterprises leads to unequal implementation.

7. Practical installation issues: Technical challenges, disruptions, and high costs. Issues like asbestos and space constraints complicate installations. Lack of clear roles and responsibilities despite PAS 2030 and 2035 [13].

8. Performance: Gap between estimated and actual performance due to poor installation, unsuitable products, and insufficient guidance to occupants on how to use technology.

9. Influence and awareness: Few successful examples and many failed pilots coupled with poor publicity and lack of credible pioneers hinder wider uptake of energy efficiency measures.

Why do we need transformation?

A new approach is required to increase the retrofitting rate and address the barriers to reaching retrofit at scale.

Accelerating retrofitting is crucial, but it must be done with high quality to prevent future costs and damage. Improvements should be carefully planned to meet clear targets with minimal disruption, particularly in occupied homes.

Successful and innovative implementation requires novel approaches, collaborative actions, scalable financing mechanisms, and Manufacturing-Led methods.

What does transformation look like?

Transform-ER is a novel consortium funded by Innovate UK to tackle the multiple barriers to retrofitting homes.

13 industry-leading partners have teamed up to catalyse the transformative change that is required to enable the rapid deployment of high-quality, cost-effective and performance-guaranteed retrofit solutions, which are financed under a shared savings model.

The Transform-ER approach will enable systemic change to tackle multiple intertwined challenges.

Transform-ER aims to accelerate several market mechanisms simultaneously by launching a new system and marketplace for retrofit, open to both existing and new delivery partners. It will achieve this by:

- **Developing new digital tools and approaches** to assess portfolios, categorise archetypes, aggregate demand, quantify property retrofit performance risks, and enable standardisation.
- **Enabling the adoption of industrialised solutions and interoperability rules** to facilitate the integration and implementation of products from different manufacturers as a kit-of-parts.



Accelerating retrofitting is crucial but it must be done with high quality to prevent future costs and damage.

- **Creating a Community Interest Company (CIC)** to provide a fair and structured ‘profit for purpose’ market vehicle. This vehicle will unlock new income streams for retrofits, which can be financed through a shared savings model, and deliver a standardised contract structure for deployment. Performance insurance will be central to this, guaranteeing outcomes for both residents and investors, allowing private finance to scale social housing retrofits.
- **Streamlining accreditation routes and prototyping products and kits-of-parts**, while defining interoperability standards to cost-effectively meet demand.
- **Forming a Retrofit Rulebook** to document project activities as case studies and provide clear guidance for other industry players and those looking to join the retrofit movement.

Unlocking finance

This section was written with Transform-ER partner Tallarna.

Importance of finance

Finance is consistently cited as one of the biggest barriers to action for large-scale retrofit. Transform-ER aims to unlock the substantial funding required to achieve net zero.

While public and consumer budgets are limited, private finance is abundant, with global investment in clean energy projects surpassing \$2 trillion in 2024. The challenge is aligning retrofit projects with funders’ investment criteria and risk appetite.

Social housing focus

Transform-ER prioritises social housing for two main reasons:

- 1. Equity:** Energy upgrades benefit those least able to afford them.
- 2. Scale:** Social housing provides the aggregation needed to attract both private sector investment and new market entrants who can address systemic challenges.

Why is traditional finance not enough for social housing retrofit?

The social housing sector faces a £104 billion bill to achieve net zero, with only £9.5 billion covered by grants. This funding gap presents several critical challenges:

- 1. Outstanding debt:** Landlords’ debt levels are substantial, representing 46% of their total balance sheet asset value [14]. S&P Global estimates the social housing sector will have £116 billion of outstanding debt by 31st March 2025 [15]. This high level of debt restricts landlords’ ability to borrow additional funds for retrofit projects.
- 2. Loan covenants:** When landlords take on debt, they must adhere to specific loan covenants, such as the [EBITDA MRI Interest Cover Ratio](#). This ratio indicates the surplus generated by a landlord compared to the interest payable on their balance sheet. Spending on retrofit and other major works counts against this ratio.

Currently, the social housing sector’s average EBITDA MRI Interest Cover Ratio has fallen below 100% for the first time since the 2008 financial crisis. This makes it challenging for landlords to spend money on projects - even when the funds are from grants - without breaching their loan covenants.

3. Traditional finance terms: Most debt is securitised against residents' homes and has a 5-10-year loan term. This is shorter than the cash flows generated by retrofits.

This means the payback period for retrofits exceeds the debt repayment period. Additionally, given landlords' existing debt level, securitising even more debt against residents' homes is too high a risk when the penalty default is repossession.

The sector has approximately £7.4 billion of debt capacity and £2.8 billion of refinancing capacity for net zero and other major works [14]. Debt capacity refers to how much of landlords' internal budgets can be spent given their loan covenants. Refinancing capacity is the amount of finance that can be raised by renegotiating existing debt.

In light of these challenges, the social housing sector collectively faces a funding shortfall of approximately £80 billion for achieving net zero.

Financial transformation for retrofit

To scale retrofits, social housing must access long-term, off-balance sheet private finance.

Project finance, supported by insurance and structuring, offers a solution. Here, finance is raised against the predicted value delivered by projects instead of against residents' homes. At the same time, insurance can guarantee projects' technical performance and resulting financial outcomes for up to 30 years. This matches the payback period of retrofit cash flows and enables funders to support projects through a long-term, off-balance sheet structure.

How does finance work within a Manufacturing-Led approach?

Transform-ER's approach leverages new retrofit product innovations to attract private finance. As technologies progress, costs lower, and data and evidence can be gathered to guarantee performance and associated outcomes, innovations and products can be insured, facilitating large-scale projects.

Manufacturing-Led retrofit can catalyse the development of product and process innovation and therefore build the assurances and guarantees required to unlock greater levels of private finance.

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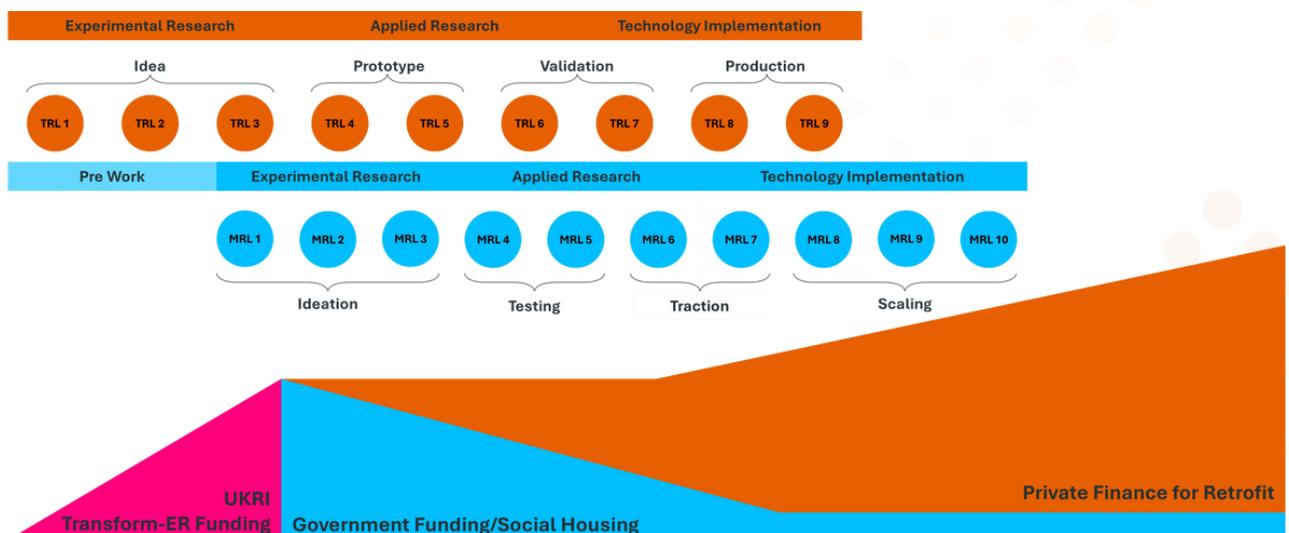


Figure 2: How Manufacturing Readiness Level (MRL) and Technology Readiness Level (TRL) can be linked with government and private finance.

Reaching retrofit at scale

Transform-ER believes that retrofit can learn from the lessons of the Transforming Construction Challenge (TCC). The Research and Development (R&D) included the adoption of platforms, systems engineering, and interoperable kits-of-parts. These are all inherently linked concepts, aiming to deliver a Manufacturing-Led approach for new build government pipeline. These fundamental concepts established in the TCC can also be applied to reach retrofit at scale. A brief description of these is given below.

Platform

A term that is widely used but with consistent elements including: a set of low variety core assets (i.e. components, processes, knowledge, people and relationships); a complementary set of peripheral components that exhibit high variety; stable interfaces that act as a bridge between the stable core and variable peripherals; and a set of rules or standards governing how components can be integrated [16].

Systems engineering

Systems engineering is defined as a methodical, multi-disciplinary approach for the design, realisation, technical management, operations, and retirement of a system. A “system” is the combination of elements that function together to produce the capability required to meet a need [17].

Interoperability

The ability to work together with other systems or pieces of equipment. e.g. “We have developed a set of rules to ensure the interoperability of all our products.” [18].

Product Platform

A kit-of-parts, associated production processes, and the knowledge, people and relationships required to deliver all or part of construction projects using a platform approach. A product platform provides a stable core which is configured and combined with complementary components (via defined interfaces) to suit a particular project. A product platform also includes the processes tools and equipment required for assembly [16].

Kit-of-parts

A collection of repeatable, standardised building components that are pre-engineered and designed to create a variety of assemblies which define part or all of a finished building [16].



How can these principles be applied to retrofit?

By encouraging collaboration and innovation within the retrofit market, manufacturers of retrofit products for specific PAS 2030/2035 energy efficiency measures can develop standardised, repeatable and de-risked standard details for interfaces.

By embedding common repeatable elements such as kits-of-parts, processes, knowledge and relationships, retrofit manufacturers can adopt a platform approach – to gain the benefits of repeatability, while developing variable product families and product variants with a level of flexibility to meet the needs and requirements of different projects and programmes. Adopting a platform approach for retrofit enables the move towards mass customisation and interoperable kits-of-parts.

Case Studies

Below are some examples of where platforms and Manufacturing-Led approaches have successfully brought tangible benefits as part of the Transforming Construction Challenge for Government new build projects.

The Seismic Platform

- 75% improvement in speed and efficiency
- 70% reduction in carbon
- 47% improvement in value across the project programme.

The Manufacturing benefits for the Seismic Platform are outlined further in the [Capability for Modern Construction Case Study](#). [19]

The AIMCH project

[The Advanced Industrialised Methods for the Construction of Homes \(AIMCH\)](#) project included the Modern Methods of Construction at scale on real housing sites, versus traditional methods. Partners estimated a productivity increase ranging from 30% to 50% for different processes, as well as gaining the benefits of cost reduction, quality assurance, increased health and safety, and 50% reduction in build time [20].

Energiesprong Germany

External to the TCC, but showcasing how a Manufacturing-Led approach to retrofit can be adopted to increase pace and scale of deployment, examples of achieving whole house retrofit using offsite constructed products can be found via Energiesprong Germany, including:

- 40 apartment buildings and a total of 338 residential units in [Dusseldorf](#) upgraded to the highest German energy rating, including prefabricated wooden façade elements [21].
- Partners estimated a productivity increase ranging from 30% to 50% for different processes, as well as gaining the benefits of cost reduction, quality assurance, increased health and safety, and 50% reduction in build time.



Adopting a platform approach for retrofit enables the move towards mass customisation and interoperable kits-of-parts

Define the need methodology

In seeking to develop a viable at scale retrofit platform, the Transform-ER consortium has analysed the market opportunity for industrialised retrofit. Informed primarily by UK housing stock data and by the Transform-ER consortium, the methodology has been structured around five main steps:

1. Gather sources of data
2. Data analysis
3. Quantify the retrofit demand
4. Harmonise requirements
5. Conclusions, recommendations and next steps

Step 1 - Gather sources of data

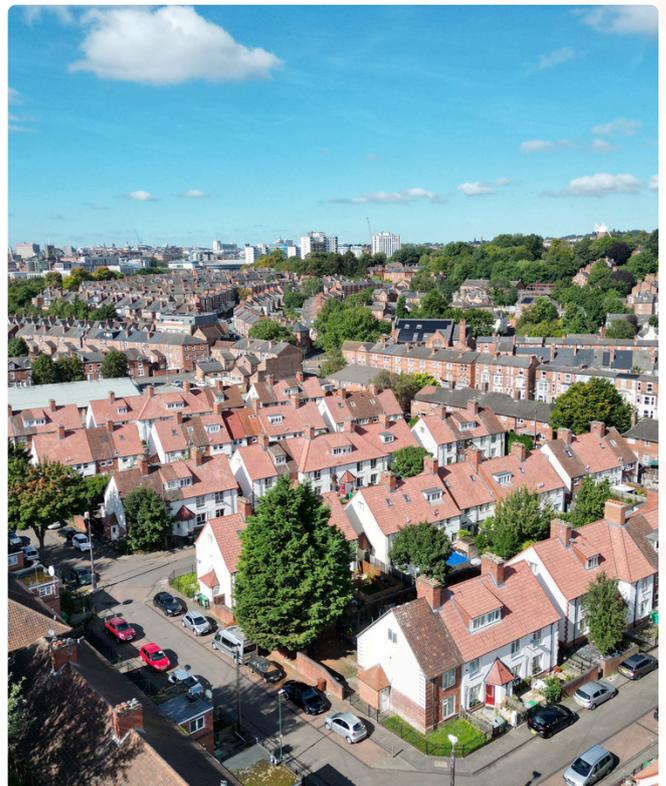
To define the scale of UK dwellings to be retrofitted in the short, medium, and long term, and the extent to which a platform /Manufacturing-Led approach could be applied, several sources were used to analyse the pipeline demand for new retrofit projects to meet net zero 2050 targets. These included:

- Northern Ireland House Condition Survey [22]
- Welsh Housing Conditions Survey [23]
- Building Research Establishment - The Housing Stock of the United Kingdom [3]
- Low Energy Transformation Initiative - Climate Emergency Retrofit Guide [24]
- Scottish House Condition Survey [25]
- The English Housing Survey [26]

- Statistics from Ministry of Housing, Communities & Local Government, MHCLG* [27]
- Department for Energy Security and Net Zero Household Energy Efficiency Statistics, headline release September 2024 [28].

* Was Department for Levelling Up, Housing and Communities (DLUHC).

Photo (right): neighbourhood of homes retrofitted in Nottingham, UK with a fabric-first approach. Credit - Energiesprong UK



Step 2 - Data analysis of existing housing stock

Some of the key statistics to highlight from the data referenced in Step 1 include:

1. Most common dwelling in the UK

- According to the housing surveys, terraced housing is the most common at 8.5 million, semi-detached is the second most common at 7.2 million homes.

2. Energy Performance Certificate - EPC

- Given the ambitions of the new Labour government on EPC ratings [29], based on housing survey data from all UK nations, it can be estimated that roughly 50% of the UK housing stock is still rated at band D and lower.

3. Fuel type in the UK

- 23 million (85%) homes are gas fuelled.

4. Social housing in the UK

- 4.9 million homes are socially rented.

Figure 3 and Figure 4 visualise the interaction of UK housing stock by age, type, fuel and then by insulation type, using the sources stated in Step 1.

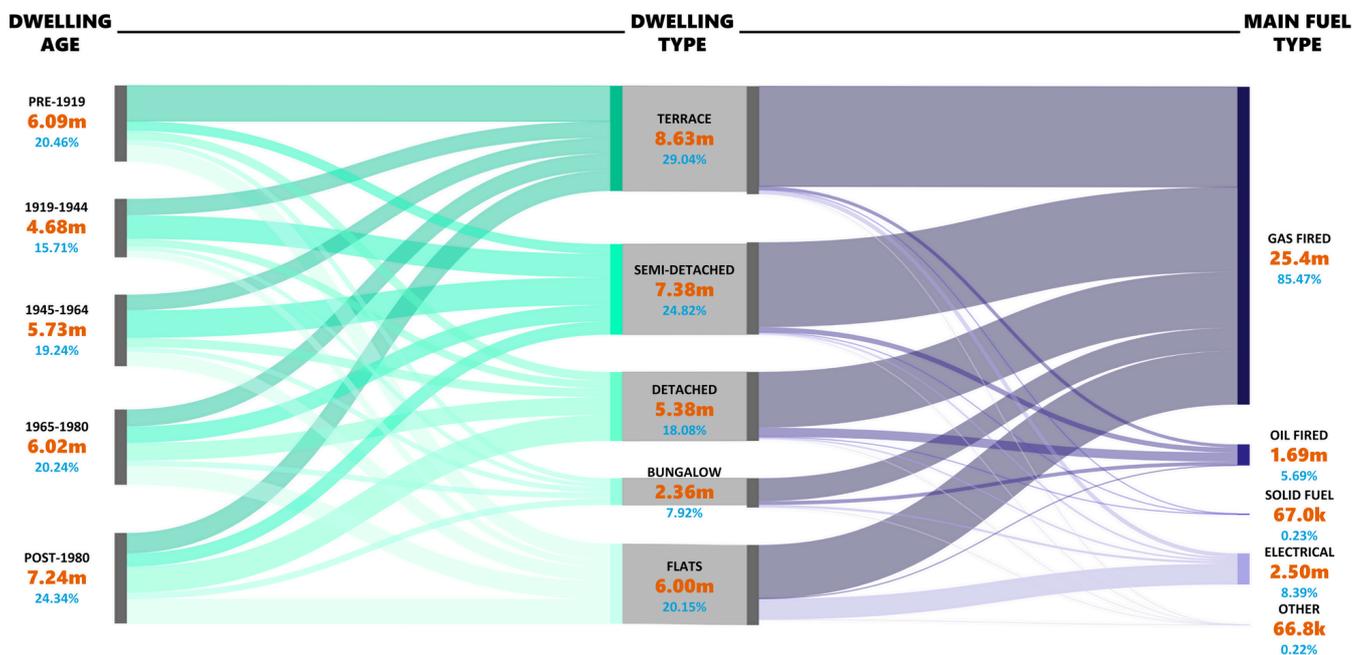
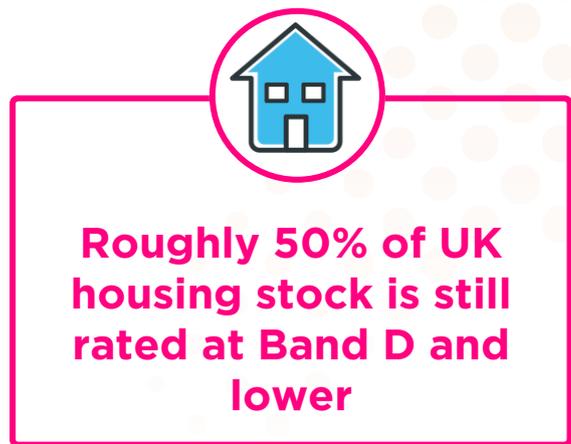


Figure 3: Diagram illustrating the distribution of housing across age, dwelling type and fuel type.

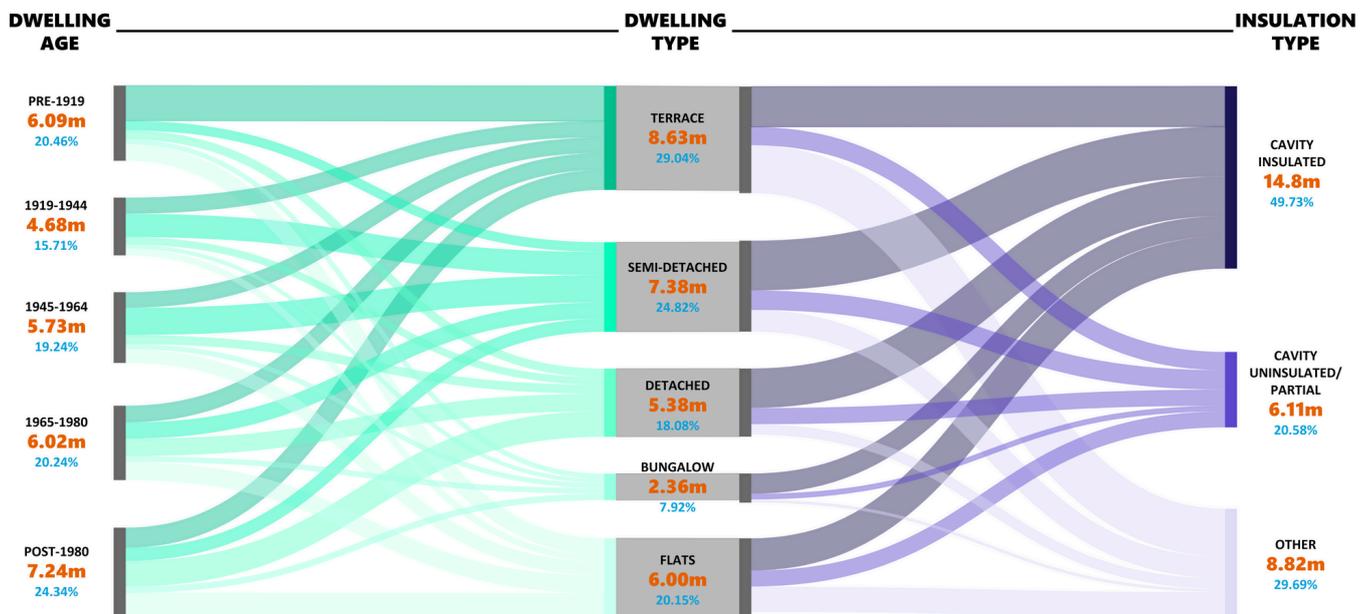


Figure 4: Diagram illustrating the distribution of housing across age, dwelling type and insulation type.

Step 3 - Quantify the retrofit demand

A full economic analysis is required to build an accurate picture of the market value for retrofitting the UK’s housing stock, and the contribution it may have to the UK’s GDP. High level calculations conducted by the MTC suggest the market value could range from £20bn to £60bn per annum.

Other sources, such as building.co.uk, states “over the next 10 years, the retrofit market for Britain’s domestic housing stock will exceed £500 billion, with another £500bn again for non-domestic: hospitals, schools, commercial buildings” [30], while RICS outlines the investment required “Decarbonising homes requires retrofits, and the committee estimates that an investment of about £250bn will be needed – the equivalent of about £9bn each year from the late 2020s to 2050.” [31]

Data on the current rate of whole-house retrofits (WHR) is difficult to source, and as such assumptions must be made to infer current retrofitting rates. According to the Department for Energy Security & Net Zero (DESNZ) [28] between April 2022 and August 2024, 202,100 WHR were completed under ECO4*, this represents an average delivery of 86,614 WHR per year since the beginning of ECO 4. This is just 6% of the 1.4 million per year retrofitting rate required to meet UKGBC’s target for all homes to achieve a minimum EPC of C [32].

“
The UK must increase the national retrofitting rate by a factor of 16

*Limitations with available data means that we must assume all homes completed under the ECO4 scheme equate to WHR, the true number may be less due a number of ECO homes having previously been upgraded with other government scheme, and not counting as WHR.



Figure 5 Remaining insulation potential in Great Britain, end December 2023 (based on: DESNZ, 2024).

To stimulate the adoption of Manufacturing-Led approaches, it is fundamental to have a better understanding of the production targets per measure or system to better forecast pipelines.

DESNZ provides an estimation of the average insulation level within the UK’s housing stock, with Figure 5 illustrating the magnitude of remaining insulation potential within the UK’s housing stock [33].

The key takeaways from this are that in the UK there are:

- 3.8 million easy-to-treat cavity walled homes
- 5.6 million easy-to-treat lofts.

Situations in which a wall might be ‘hard-to-treat’ are given in Table 1 below.

Table 1: Situations in which the wall might be hard-to-treat according to the EHS [39].

Cavity wall insulation	Solid wall insulation	Loft insulation
<ul style="list-style-type: none"> • More than three storeys • Narrow cavities (<50mm) • Concrete, metal or timber frame • Predominant tiles or cladding • Wall finish is in state of disrepair • Exposed positions • Stone wall (uneven cavity) 	<ul style="list-style-type: none"> • Non-cavity wall with external features • Predominant render wall finish • Predominant clad or stone (non-masonry finish) • Dwelling is a flat 	<ul style="list-style-type: none"> • Pre-existence of boarded loft • Habitable room • Shallow pitch • Flat roof

This Define the Need report provides an estimate of the current market potential for England based on the use of publicly available data and highlights the opportunity for novel approaches when forecasting the pipeline.

On cavity walls

- 2.7 million homes have easy to treat uninsulated cavity walls, making 295 Million metres squared (Mm²).
- 2.3 million homes have hard-to-treat uninsulated cavity walls, resulting in 191 Mm².
- At least 1.4 million semi-detached and detached homes are suitable for standard fillable insulation resulting in 197 Mm².

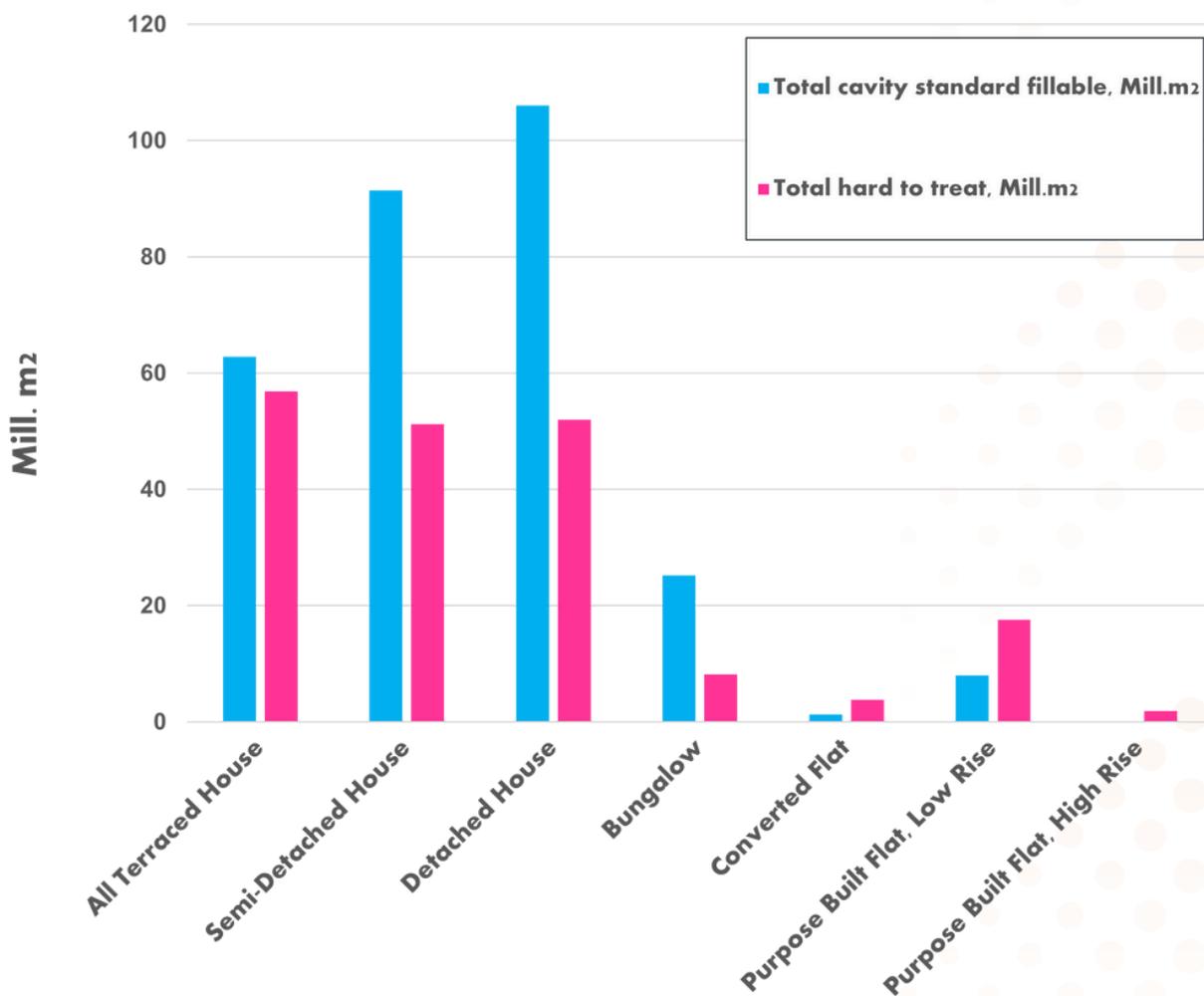
On non-cavity walls

- Almost 1.2 million homes have easy-to-treat uninsulated non-cavity walls, making 180 Mm².
- 5.3 million homes have hard-to-treat uninsulated non-cavities, making 630 Mm².

On loft insulation

- At least 1.3 million homes may need to insulate or upgrade their lofts.
- 237 Mm² are estimated to be non-problematic and 77 Mm² are harder to insulate.

(a)



(b)

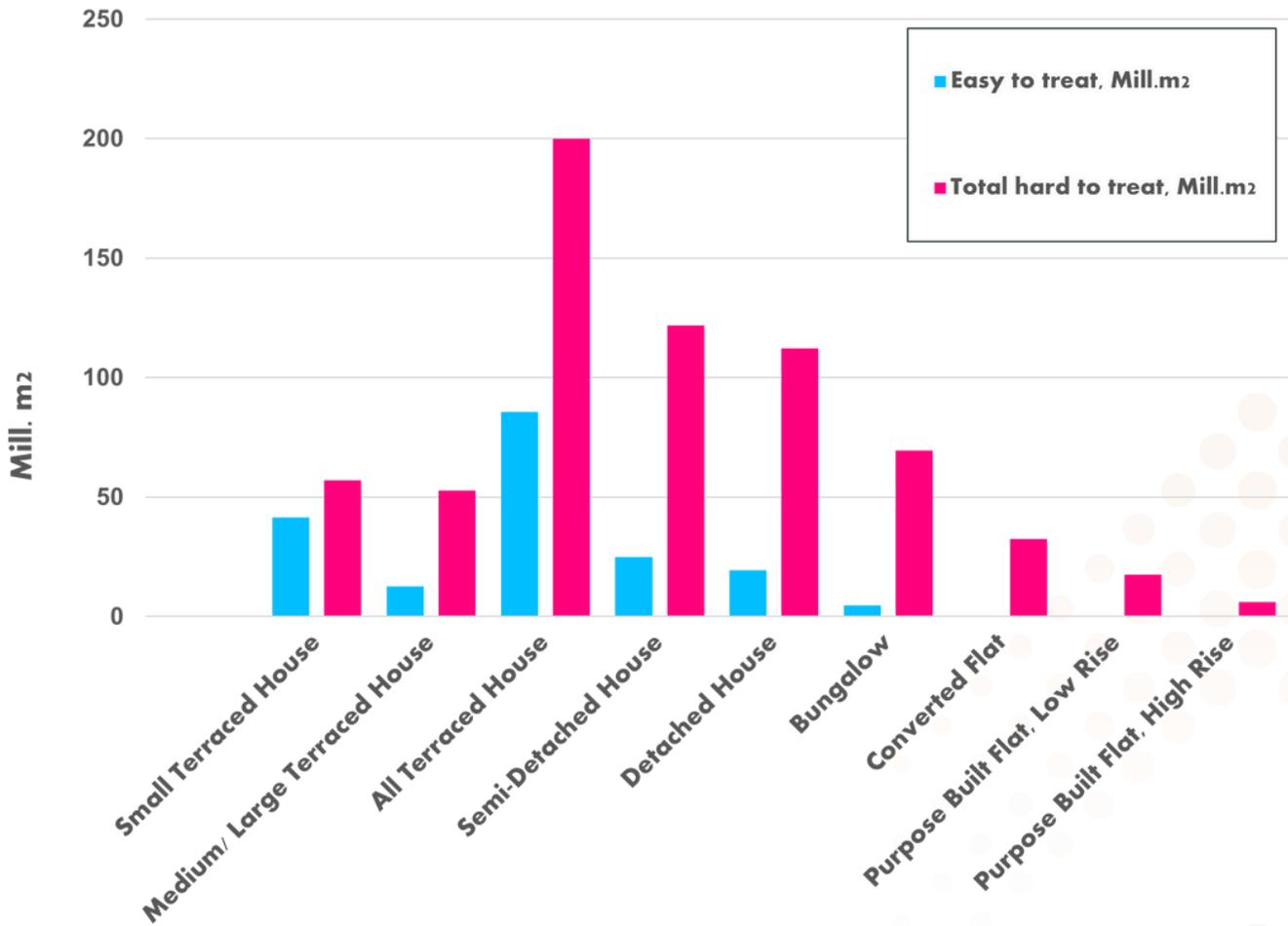


Figure 6: Estimated surface area in m² of remaining insulation potential by dwelling type and difficulty. (a) Uninsulated cavity walls, and (b) uninsulated non-cavity walls.

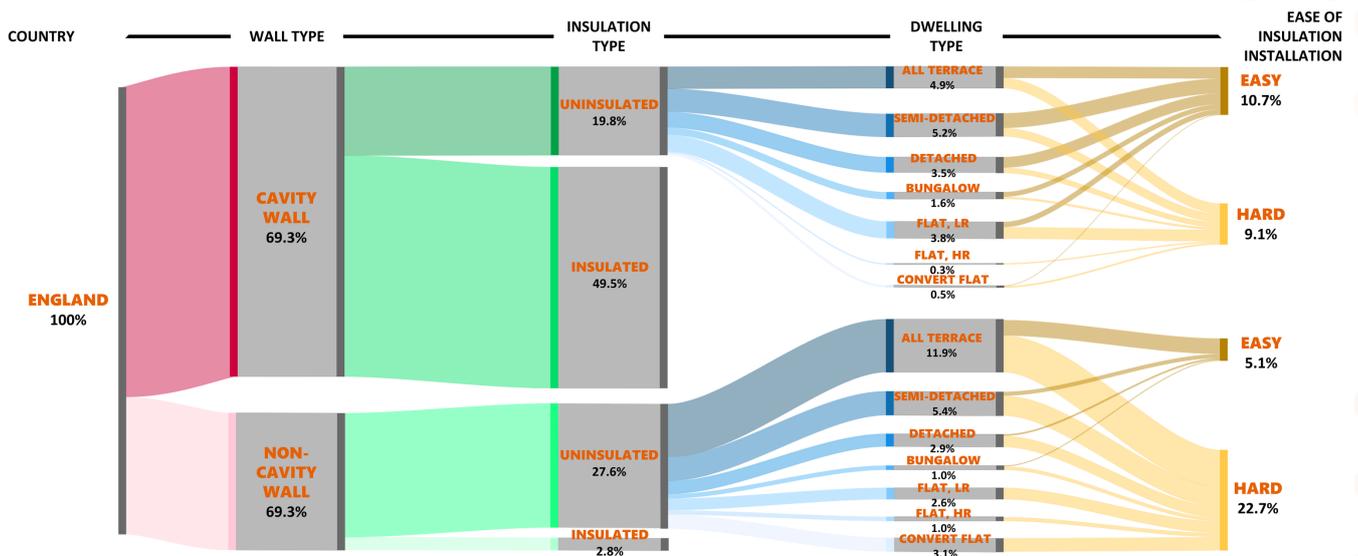


Figure 7: Estimation of insulation remaining potential for English housing stock by wall type, insulation, type of dwelling and difficulty of retrofitting. Values represent the percentage of total homes in England. (Data source: (DLUHC, 2022; DLUHC, 2023))

Step 4 – Harmonise requirements

To achieve a platform or Manufacturing-Led approach for the built environment, there are fundamental steps that need to take place first, as identified within the [DEMAND](#) phase of the CIH Rulebook framework.

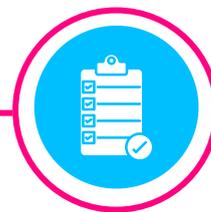
Standardising processes while allowing for customer variability enables mass customisation through the development of interoperable kits-of-parts. As well as aggregation of demand to gain visibility of pipeline. Another key step is the harmonisation of requirements.

For the Construction Innovation Hub, a core focus was to Harmonise, Digitise, Rationalise (HDR) requirements across schools, hospitals and other department buildings. This approach was adopted from The Construction Playbook, which guides government new build projects.

What does HDR mean for the retrofit market?

The core aim of HDR within the hub was to enable standardised offsite solutions, based on standardised government client requirements. Harmonising requirements ensures industry has consistent, common information.

Digitising enables data to be used effectively, and a digital thread of information can flow from requirements into construction of the built asset. Rationalising requirements removes wasted time and effort, through providing commonality of information of the pipeline demand.



“Harmonising, digitising and rationalising demand will enable standardised, repeatable design, components and interfaces and drive the adoption of Modern Methods of Construction (MMC) including digital and offsite manufacturing technologies.” [34]

“Contracting authorities should seek opportunities to collaborate in order to develop and adopt shared requirements and common standards. This should be done to enable standardised and interoperable components from a variety of suppliers to be used across a range of public works. This will create a more resilient pipeline and drive efficiencies, innovation and productivity in the sector.” [35]

Simplifying the pipeline of demand for retrofit means finding commonality of requirements and standards across the range of archetypes in the UK, as opposed to new build hospitals, schools and other government buildings. One example of a national effort to research HDR for retrofit, includes the pilot version of the [UK Net Zero Carbon Buildings Standard](#).

Figure 8 shows all categories identified as critical for Transform-ER’s performance requirements. These have been collated from consortium partners and with input from the [Construction Innovation Hub Define the Need report](#).

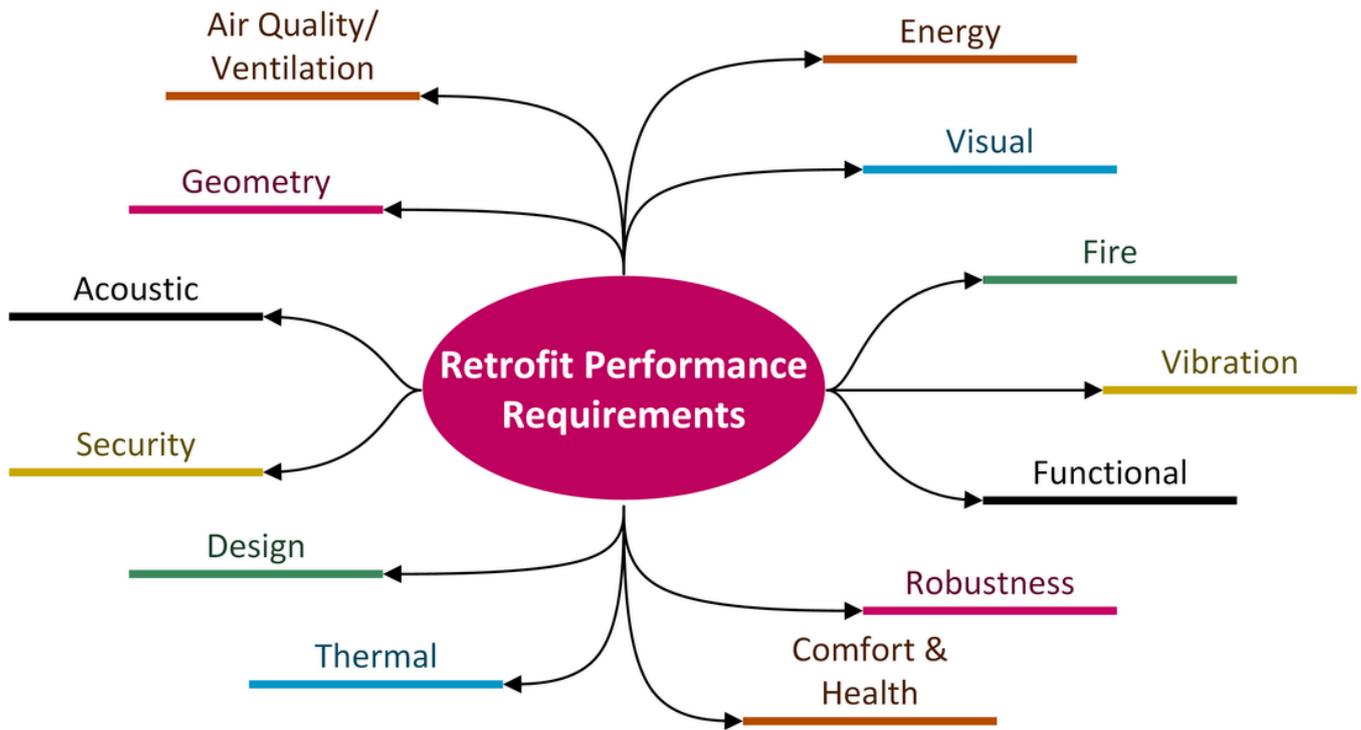


Figure 8: Context diagram illustrating the categories considered within the hypothesis specification.

Step 5 - Conclusions, recommendations and next steps

Step 5 considers:

- **Conclusions** – from analysing the housing stock of the UK
- **Recommendations** – the medium- to long-term recommendations to reach retrofit at scale
- **Next steps** – the short-term Transform-ER goals.

Conclusions

The findings within this report show that, to meet net zero 2050 targets set out in UK legislation and to reduce emissions from the UK's housing stock, a step change is required in how we approach retrofit and accelerate the retrofiting rate.

As has been found in the Transforming Construction Challenge for new build government pipeline, a move towards a platform approach to gain benefits of Manufacturing-Led retrofit should be adopted. This enables mass customisation through developing interoperable kits-of-parts.

The Transform-ER consortium believes adopting a Manufacturing-Led approach can ramp up the delivery of retrofit at scale, through proving the Transform-ER delivery model.

A growing number of organisations have published reports highlighting the need to decarbonise the UK housing stock through effective retrofit at scale.



There is still vast potential to decarbonise the remaining housing stock by adopting the right business and finance model and development of the supply chain

The UK now needs to shift from knowing and reporting about the problem into actions to tackle the problem, through rapidly establishing delivery models and accelerating the deployment of retrofits at a large portfolio level.

Through use of the housing surveys of the nations of the UK, the housing stock data can be used to sort by tenure, dwelling form, EPC rating and other sorting methods to build a greater understanding of the retrofit pipeline, at a national level.

Limitations of this data have been identified, from EPC accuracy to unknowns on the characterisation of insulation, and a further need for granularity of data for manufacturers, architects and other stakeholders involved in retrofitting. Accurate data for the housing stock of the UK is required to fully understand the pipeline of archetypes. Use of technology may need to be adopted to increase the reliability of data capture on survey information.

Retrofit delivery to date has been financed by a number of different government funding schemes, all with different aims and outcomes, most of which have not set whole house retrofit as the strategic target, often with piecemeal measures installed i.e. a shallow retrofit. There is still vast potential to decarbonise the remaining housing stock, if the right business and finance model is adopted at a national level, and the annual retrofitting rate is accelerated through development of the UK supply chain capability and capacity, to deliver one million retrofits per annum.

Recommendations

Initiating a standardised UK approach to retrofit by consolidating pockets of pilot and small scale retrofit projects into portfolios of properties. In line with the growing number of organisations outlining the need for retrofit at scale, such as the National Retrofit Hub [36], the Sustainable Development Foundation [37] and the Institution of Engineering and Technology [38], address the barriers to retrofit through:

- Unlocking finance
- Consistent government policy
- Developing UK supply chain capability and capacity
- Addressing the national skills and workforce shortage
- Increasing user uptake and demand
- Developing new delivery models
- Driving innovation of retrofit products and solutions.

Streamlining retrofit. By adopting the Demand – Develop – Deploy structure recommended by the CIH product platform rulebook, the overall process of retrofit can be streamlined, as will be developed further in the Transform-ER project’s next phases and written up in the Retrofit Rulebook.

Several key opportunities exist for streamlining retrofit, categorised into Demand, Develop, and Deploy:

Demand – aggregation of retrofit pipeline.

- Quantification of the retrofit demand to clearly define a pipeline of potential work, minimising effort by using an archetype approach.
- Archetype definition: To help identify pipelines of properties with common physical characteristics. An archetype in this report refers to the typical example of a property subject to energy rehabilitation measures. The archetype is defined by a series of characteristics, and all homes that share these characteristics can, by extension, be added to the pipeline and be subject to renovation with known expected outcomes. The more characteristics defined, the greater the definition of the archetype, leading to greater similarity with the homes added to the archetype but a smaller number of such homes. An archetype should consider as a minimum ‘dwelling type’ and ‘age’. ‘Archetype definition’ may be one of the first steps in the DEMAND phase of the Retrofit Rulebook.

- Aggregating portfolios of properties using digital tools, such as:
 - Digital platform
 - Product database
 - Portfolios and properties database
 - Digital condition surveys.
- Harmonise, Rationalise, and Digitise technical retrofit requirements.



Initiate a standardised UK approach to retrofit by consolidating pockets of pilot and small scale retrofit projects into portfolios of properties.

Develop – design standardised retrofit products and kits-of-parts.

- Product specification and development of product databases, in line with UK standards, to support the ramp-up of product development and ensure structured product information.
- ‘Design for X’ toolsets to develop products, e.g. U-value calculators to optimise products for thermal performance.
- Establishing routes to certification:
 - An expediated route to certification, enabling manufacturers/designers to innovate and follow best practice engineering principles for retrofit.

- Fostering greater collaboration between manufacturers and designers to develop standardised kits-of-parts.
- Work with industry to develop standardised kits-of-parts:
 - Standardised rulesets
 - A standardised approach to interfaces.
- Improve UK capability for Manufacturing-Led retrofit.
- Improve site delivery logistics and processes to deliver retrofit projects efficiently and to a high quality.
- Identify skills and competency gaps and opportunities for existing construction workforce to upskill into future retrofit specialists.



Fostering greater collaboration between manufacturers and designers to develop standardised kits-of-parts.

Deploy - defining processes to commercialise products and repeatedly install retrofits effectively.

- Financing model - expand the range of financial options to move away from purely grant focused schemes and bring in external finance.
- More collaborative contracting and procurement aiming to form alliances between suppliers and customers to:
 - Ensure a shared vision
 - Produce mutually beneficial outcomes
 - Mitigate risks through transparent planning
 - Identify further opportunities
 - React together to future market changes through mutual innovation.
- Bridge the skills gap and limited labour force to support onsite installation through:
 - Standardising the process to simplify skillsets required, to build individual competency and UK Manufacturing capability. Examples include:
 - Application of Design for Manufacture and Assembly (DfMA) principles
 - Error proofing of complex operations.
 - Standardising and simplifying the skill sets for a future multi-skilled offsite and onsite workforce.
- Define the retrofit strategy and the retrofitting target using feedback data, for example:
 - Use of sensors to gather data to inform energy targets
 - Energy modelling using data from sensors, to identify achievable outcomes.

Next steps

The Transform-ER consortium has identified the following steps as key to achieving national retrofit at scale:

Develop retrofit kits-of-parts

Manufacturer-Led design and development of retrofit products and kits-of-parts, optimised for offsite construction and ease of onsite deployment.

Authorship of the Retrofit Rulebook

The Retrofit Rulebook has two core aims:

1. Define an approach for developing interoperability rules and standards for retrofit products and systems for industry to follow. Provide practical examples of interoperability rules and standards from the Transform-ER project, which shall be written up as case studies, for a set number of interfaces, archetypes, and products and systems from the consortium's industrial partners.
2. Apply the Demand - Develop - Deploy structure from the Construction Innovation Hub [16] to define guidance on delivering retrofit at scale, using the knowledge and lessons learned gained during the project. This shall capture key insights gained from the expertise within the consortium's partners, through overcoming core barriers of reaching retrofit at scale, and writing this into the Retrofit Rulebook, for the benefit of wider industry.

Develop the Transform-ER retrofit delivery vehicle

The Transform-ER digital platform: To streamline the aggregation of demand for retrofit across the UK, assess portfolios of properties, provide solution matching of products and solutions to different archetypes.

The digital platform shall streamline the early stages of the retrofit process in line with PAS 2030 and PAS 2035 and provide a product database for standardised retrofit kits-of-parts.

Identify a new route to certification and testing: To fast-track the process of approving retrofit products and systems, ensuring they meet a level of quality and performance standards, aiming to aid the ramp up of approved and quality assured retrofit products available on the market.

This aims to meet the clear market need in developing an expedited product development pathway through which products and systems can be tested and certified to ensure safe and high-quality retrofit products enter the market.

Create a Community Interest Company: Development and launch of the operational model for Transform-ER, to begin deploying retrofits at scale. A wide range of stakeholders is required to finance, develop, aggregate demand, and install products and systems to upgrade and decarbonise the UK housing stock. Design of the contracting and delivery model is a fundamental step in transforming the industry towards repeatability and economies of scale.

Calls to action

Transform-ER has a far-reaching spectrum of stakeholders invested in its success. The following key stakeholders have been identified (as shown in Figure 9 overleaf) as critical to achieving our mission, with clear calls to action for each:

We need a future owner of the Retrofit Rulebook

As we move beyond the R&D phase, we need an owner of the Retrofit Rulebook to update the guidance as the Transform-ER delivery model ramps up delivery of retrofit at scale.

The Retrofit Rulebook will set out clear guidance for industry organisations wishing to adopt the Transform-ER approach and deliver high-performance, cost-effective home energy upgrades at scale.

This will likely be, at least in part, managed by the new retrofit delivery vehicle but support from other industry bodies would be beneficial. [Get in touch](#) if you are interested in supporting this work.

We need clients to sign up to the new retrofit delivery vehicle

Define the Need helps clarify what a manufacturing / platform approach is for achieving retrofit at scale, and the benefits of this in working with a new delivery model such as Transform-ER. Transform-ER's retrofit delivery vehicle will be launched in 2025 - [sign up for updates](#).

We need new entrants to the retrofit market

From manufacturers and installers to retrofit assessors and architects, we need new organisations to join the retrofit revolution.

Define the Need illustrates the size of the retrofit challenge, why transformation is required, how transformation can be achieved through a Manufacturing-Led approach and delivery model designed for scale, and insights into some of the market potential.

Our work on streamlining accreditation and certification pathways is designed to support you in this journey - [sign up for updates](#).

We need support from relevant government departments with a long-term strategy and funding support

Define the Need demonstrates how retrofit at scale can be delivered by new delivery models such as Transform-ER as part of a procurement framework, and why this is so essential to the health and environmental wellbeing of the country. Read our [5 key points for policymakers](#).

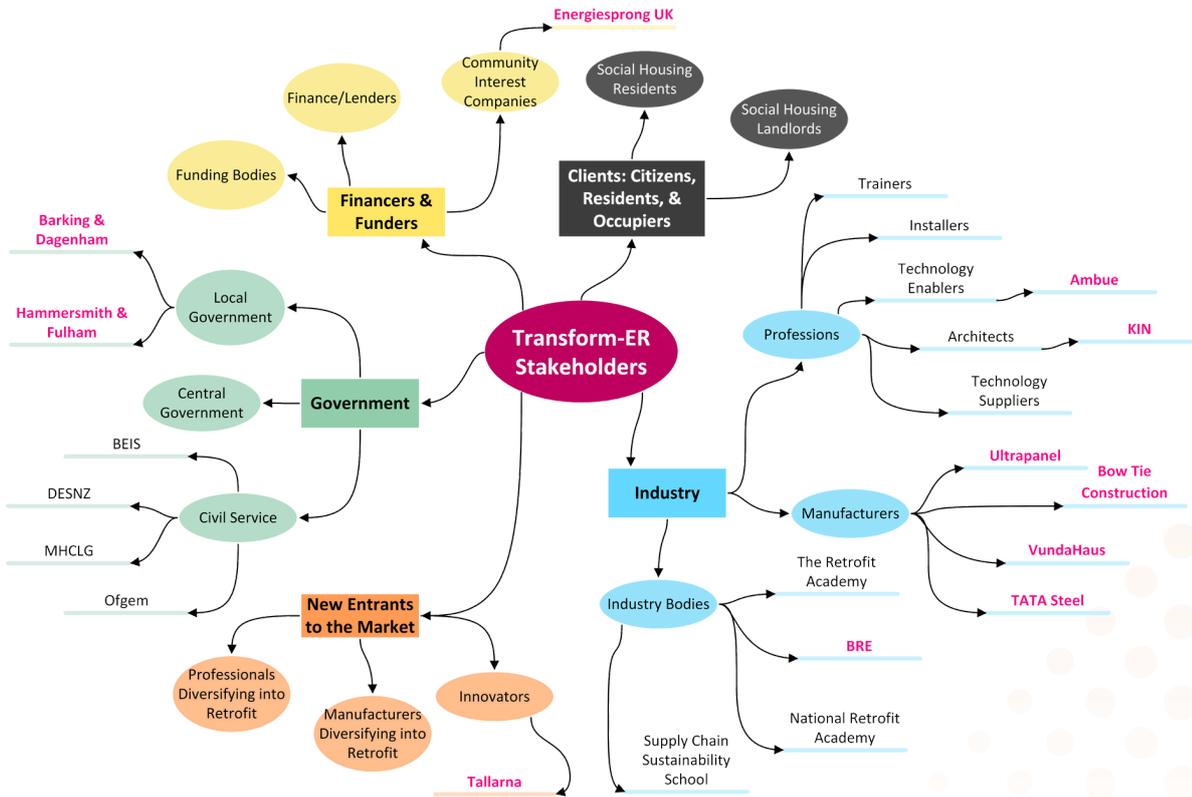


Figure 9: Transform-ER stakeholders.



The manufacturers in the Transform-ER consortium are developing kits-of-parts solutions to support the delivery of high-performing retrofit at scale. From top left clockwise: Bow Tie Construction, Tata Steel (roof), VundaHaus, Ultrapanel.

5 key points for policymakers

1. It's critical that we tackle the UK's big retrofit challenge

We must dramatically increase our retrofitting rate to meet the Government's net zero targets - it is currently 6% of what is needed. This will also help address our housing stock's critical state, characterised by poor energy efficiency and unacceptable living conditions.

2. There's a huge market opportunity

Roughly 50% of the UK's housing is still rated at Band D or lower. The Manufacturing Technology Centre (the MTC) estimates that retrofitting these homes represents an estimated market potential of between £20bn and £60bn annually for the UK economy.

3. We need systemic change for systemic barriers

Transform-ER is taking a systemic approach to tackle retrofit's barriers to scale - including high costs and funding gaps, an underdeveloped supply chain, workforce and skills shortages, lack of industry standardisation and absence of proven delivery models including financing.

4. We can unlock better retrofit for everyone

Transform-ER is developing a new retrofit delivery model for financeable, high-quality and cost-effective solutions and a radically new resident engagement programme:

- The industry benefits from a standardised end-to-end process with improved procurement and contracting processes.
- Residents benefit from increased agency and desirable, comfortable homes with guaranteed performance where damp, mould and overheating risks are mitigated.

5. Adopting a Manufacturing-Led approach is essential

The consortium advises that a Manufacturing-Led approach to industrialise the retrofit sector can facilitate large-scale implementation through increased productivity and efficiency. This includes aggregating demand and applying technology to develop standardised kits-of-parts to enable common solutions to be applied to different archetypes.



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Define the Need

TRANSFORM-ER



Written by the MTC on behalf of the
Transform-ER consortium

A summary of why we need to transform
the retrofit market and how

To view the full Define the Need report, please visit:
<https://bit.ly/definetheneedreport>

To find out more about the Transform-ER project and keep up-to-date with
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