



Programme Area: Buildings

Project: Building Supply Chain for Mass Refurbishment of Houses

Title: Executive summary of the detailed supply chain workshop report

Abstract:

Please note this report was produced in 2011/2012 and its contents may be out of date.

Context:

This project looked at designing a supply chain solution to improve the energy efficiency of the vast majority of the 26 million UK homes which will still be in use by 2050. It looked to identify ways in which the refurbishment and retrofitting of existing residential properties can be accelerated by industrialising the processes of design, supply and implementation, while stimulating demand from householders by exploiting additional opportunities that come with extensive building refurbishment. The project developed a top-to-bottom process, using a method of analysing the most cost-effective package of measures suitable for a particular property, through to how these will be installed with the minimum disruption to the householder. This includes identifying the skills required of the people on the ground as well as the optimum material distribution networks to supply them with exactly what is required and when.

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ETI Executive Summary

Programme:	Buildings
Project Name:	Optimising Thermal Efficiency of Existing Housing
Deliverable:	BU1001 / D4.4 – Detailed Supply Chain Workshop

Introduction

UK Residential buildings account for ~27% of the UK energy production, ~26% of CO₂ emissions and 23% of GHG emissions. 82% of the energy consumed in the UK residential buildings is for space heating and hot water. If the demand on the UK energy system from housing can be reduced then this will have a significant impact on CO₂ emissions and reduce the level of low CO₂ energy generation required.

The number of domestic dwellings in the UK is expected to rise to 32 million by 2050 from 26 million currently, of which 21 million are expected to remain in 2050. The refurbishment of existing dwellings is therefore a significant factor in achieving the 2050 target CO₂ reduction target.

This project is focussed on the refurbishment of the existing UK housing stock to improve its thermal efficiency and to investigate ways the refurbishment process can be accelerated at a national level.

The key outputs from the project are:

- A model capable of running “what if” scenarios for a range of UK house types showing the retrofit technologies required to optimise CO₂ reduction, minimise cost and maximise comfort/value to the customer
- A model capable of running scenarios at the local, regional and national level to identify the CO₂ impact and cost of various mass retrofit plans
- Defined delivery mechanisms (policies, supply chain requirements etc) for retrofitting the domestic housing stock at a sufficiently high rate to impact national climate change targets

The project is divided into 6 work packages to better enable it to address the outputs required above:

Work Package 1: Understanding thermal performance of the housing stock at an individual dwelling level.

Work Package 2: Impact of thermal efficiency measures on the UK housing stock.

Work Package 3: Developing retrofit solutions to improve thermal performance of our national housing stock.

Work package 4: Developing a sustainable supply chain to deliver whole house retrofit on a national scale.

Work Package 5: Understanding customer value & maximise the take up of retrofit.

Work Package 6: Developing the policy and regulatory framework to manage, support and encourage whole house retrofit.

Work Package 4 is specifically focussed on the delivery mechanisms aspect of the project, in particular the supply chain element and how to effectively deliver the optimum retrofit interventions identified through collaborative work across the other work packages.

There are 8 deliverables within Work Package 4, these are:

D4.0 Current Supply Chain Map: A visual representation of the material and installation capability for the current retrofit supply chain.

D4.1 Draft Supply Chain Design: A draft Value Stream Map of potential Retrofit Supply Chains covering material, distribution, customer engagement, survey, installation and customer service.

D4.2 Draft Supply Chain Scenarios: Evaluation of refurbishment and supply options as the inputs to a change management plan which will achieve the mass delivery of the whole home refurbishment programme.

D4.3 Refurbishment Supply Chain Implications: Market review to establish existing players' current and potential capability and willingness to deliver the mass retrofit. Summary of requirements for incentives or legislative change to enable transition at a sufficient pace as an input into WPs 5 & 6.

D4.4 Detailed Supply Chain Workshop: The design of an end to end supply chain model and specification

D4.5 Change Management Roadmap: Bringing together the technical (WP3) and customer (WP5) requirements to quantify the gap between current and required capability. This deliverable will develop a costed, resourced and scheduled plan.

D4.6 Market Readiness Report: A final report detailing the expected robustness of proposed solutions which could enable delivery of over a million refurbishments a year for 20 years. Identification of the risks to achieving substantial industrialization of the majority of the UK's construction

D4.7 Training & Competence Report: A report on skills and competence gaps and what is required to up-skill a new supply chain

Basis of Designs

The prior deliverables in Work Package 4 (available from the ETI Member Portal) have summarised the existing UK retrofit supply chain (D4.0) and developed a framework for an adaptable and scalable supply chain to meet customers' requirements for whole house retrofit to deliver improved thermal efficiency.

This report presents detailed plans for the delivery of mass scale whole house retrofit, covering the survey and installation process, the cost of retrofitting the most common property types in the UK and how the cost is built up.

Detailed Supply Chain Design

In prior work package 4 reports, an analysis and review of the retrofit supply chain was carried out and alternative supply chain models were reviewed. This led to the development of a 'least wasteful supply chain model' as show below. This seeks to overcome the inefficiencies of the current silo'd trade based supply chain.

The work described in this report has built on this model to include estimates of the likely regional demand and supply chain capacity needed to deliver manpower and materials to satisfy projected demand for retrofit.

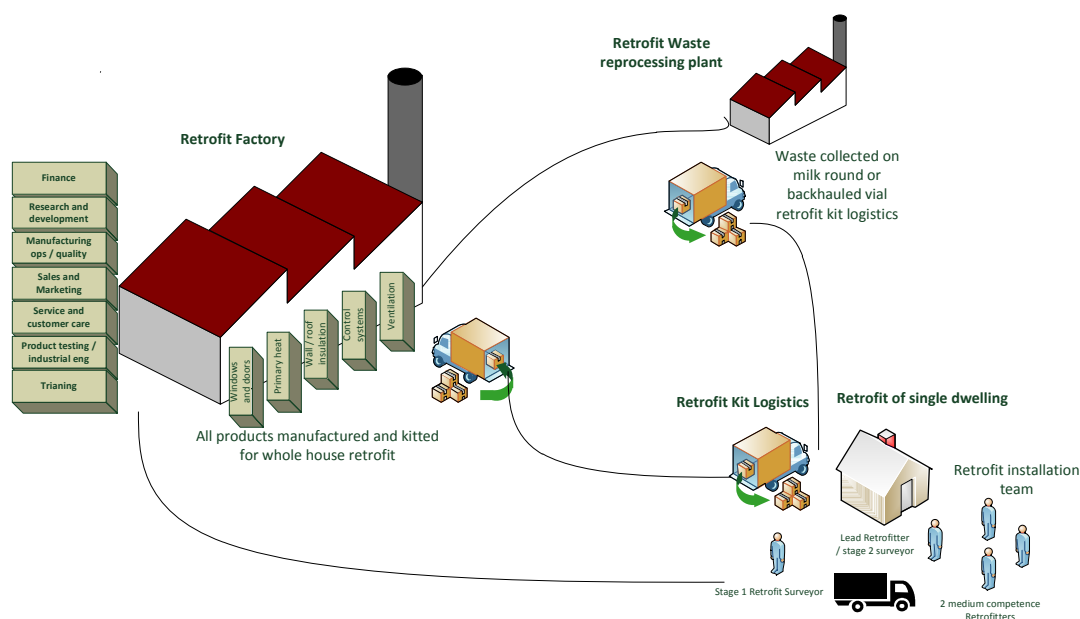


Figure 1: Least Wasteful Supply Chain Configuration

The supply chain proposed is characterised by a multi-skilled (poly-competent) team of 4 retrofitters who are the customer interface for retrofit. This is the team that will carry out retrofit in each of the properties identified. Work Package 5 identified that customers for retrofit prefer a consistent team of people to engage with through the retrofit process from survey to completion. The 4 man team delivers this. The 'lead retrofitter' doubles as a 2nd stage surveyor. Details of the survey process are provided below. If the demand for grows substantially then there may be a case for developing and implementing regional

manufacturing and kitting / consolidation centres, however as figure 2 below shows this lead to an increase in complexity in the supply chain.

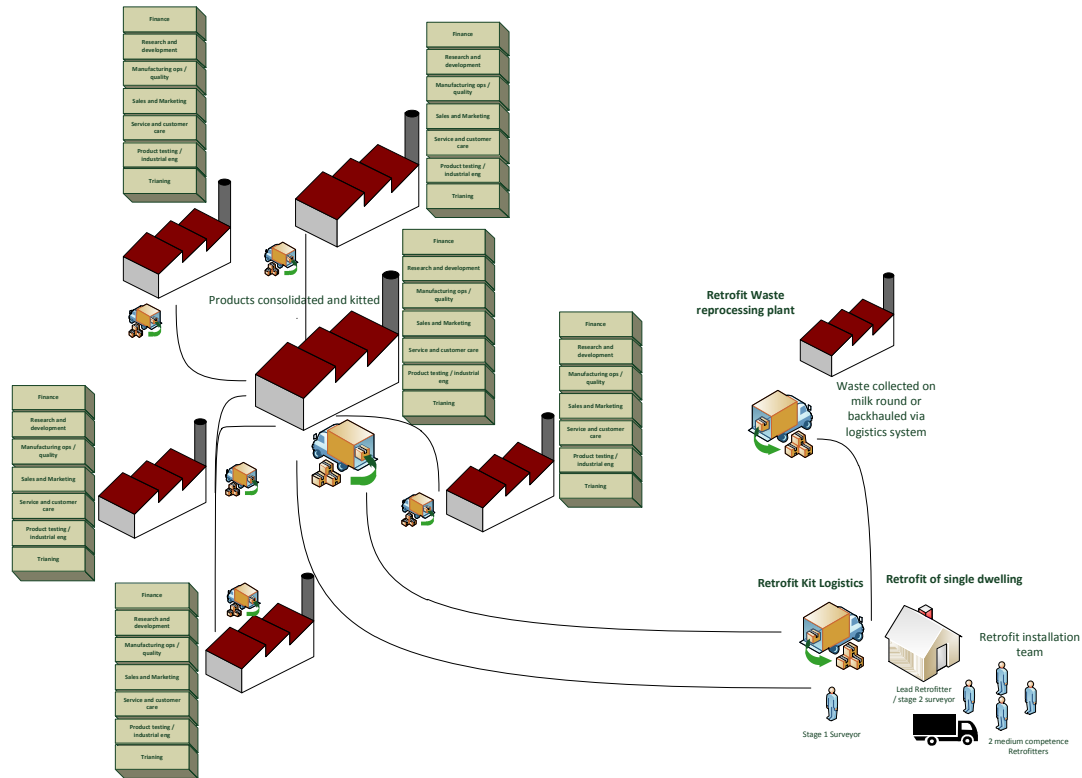


Figure 2: Manufacture with Kitting Plan / Consolidation Centre

The report describes a number of stages of analysis which have been carried out to quantify the potential demand and approach to be adopted to deliver retrofit in the UK. This is based around a target of 400,000 retrofits per any in the UK by 2020. The retrofit to be delivered would be based on the two standardise retrofit packages proposed by deliverables D3.4a, namely RetroFix and RetroPlus.

Various stages of analysis were carried out to answer the following questions:

Q1: What is the estimated demand for retrofit by consumer segment, building on the consumer segmentation work in work package 5?

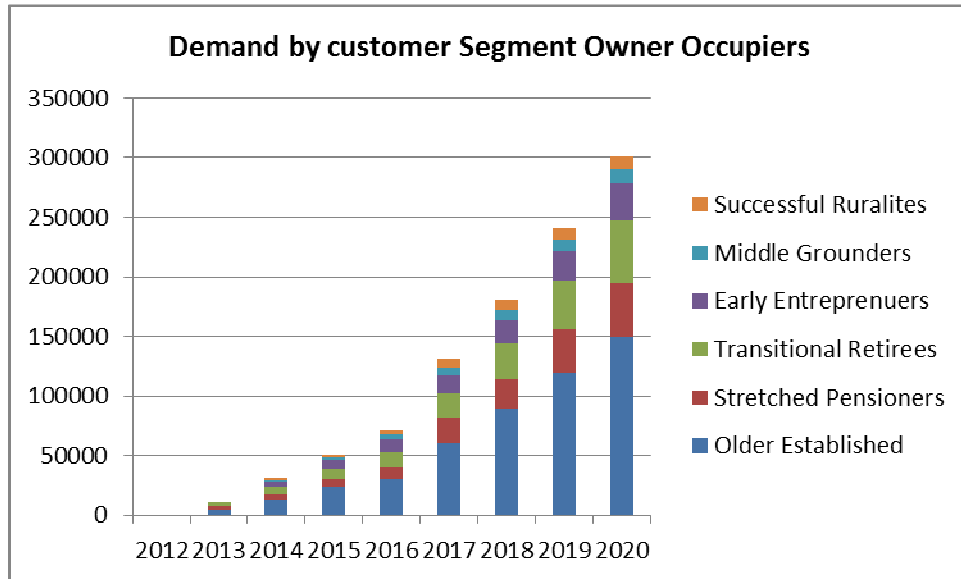


Figure 3: Projected Additional UK Demand for Retrofit by Customer Segment

Q2: What is the split of housing archetypes by region?

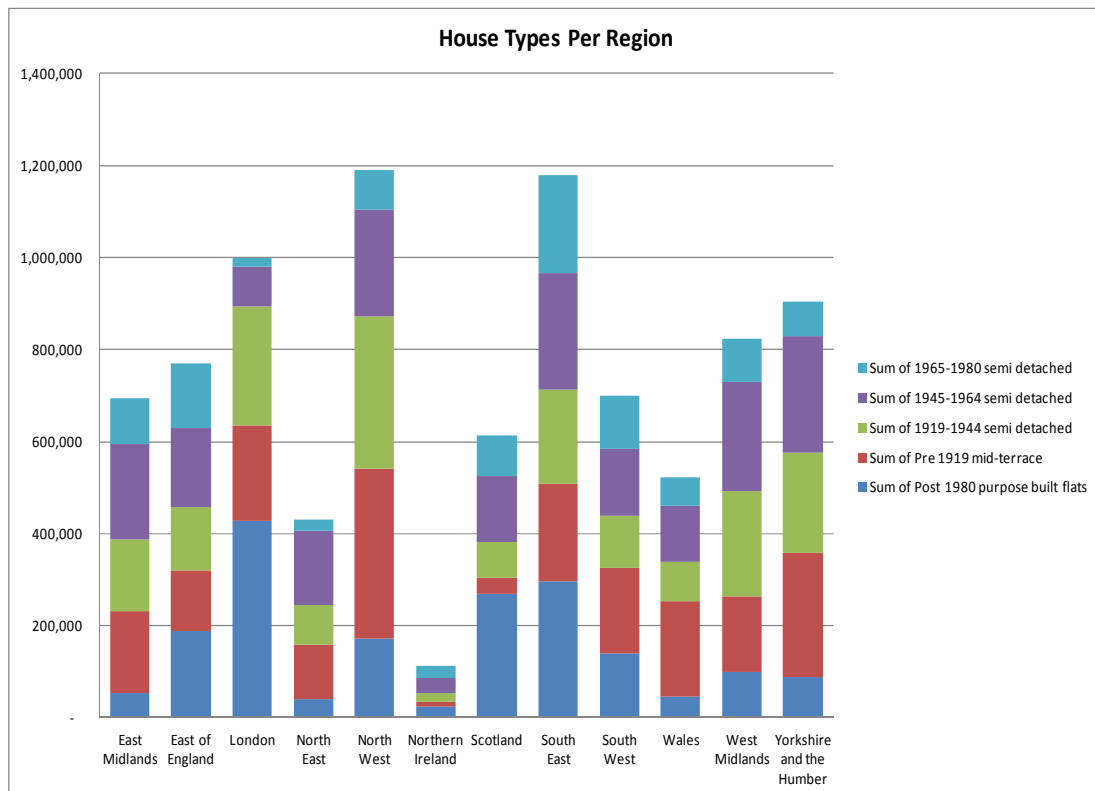


Figure 4: House Types by Region

Q3: What is the distribution of consumer type by region?

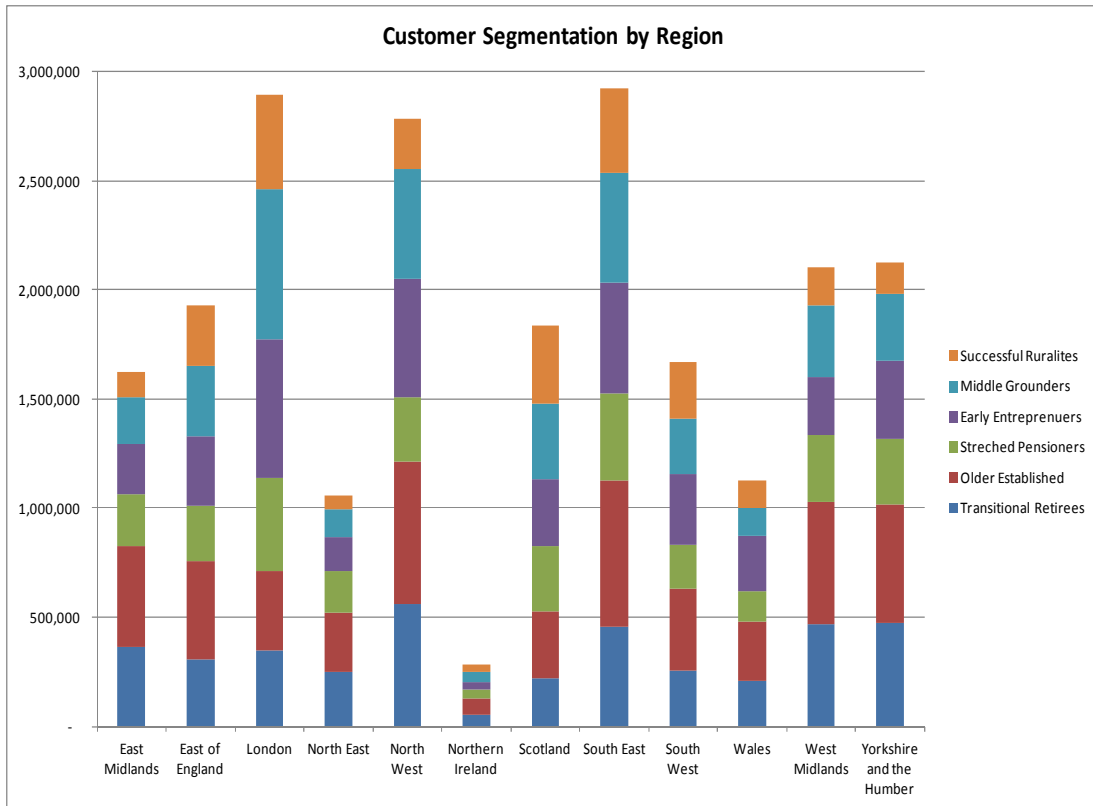


Figure 5: Consumer Segmentation by Region

Q4: What is the required delivery capacity for retrofit by region by year?

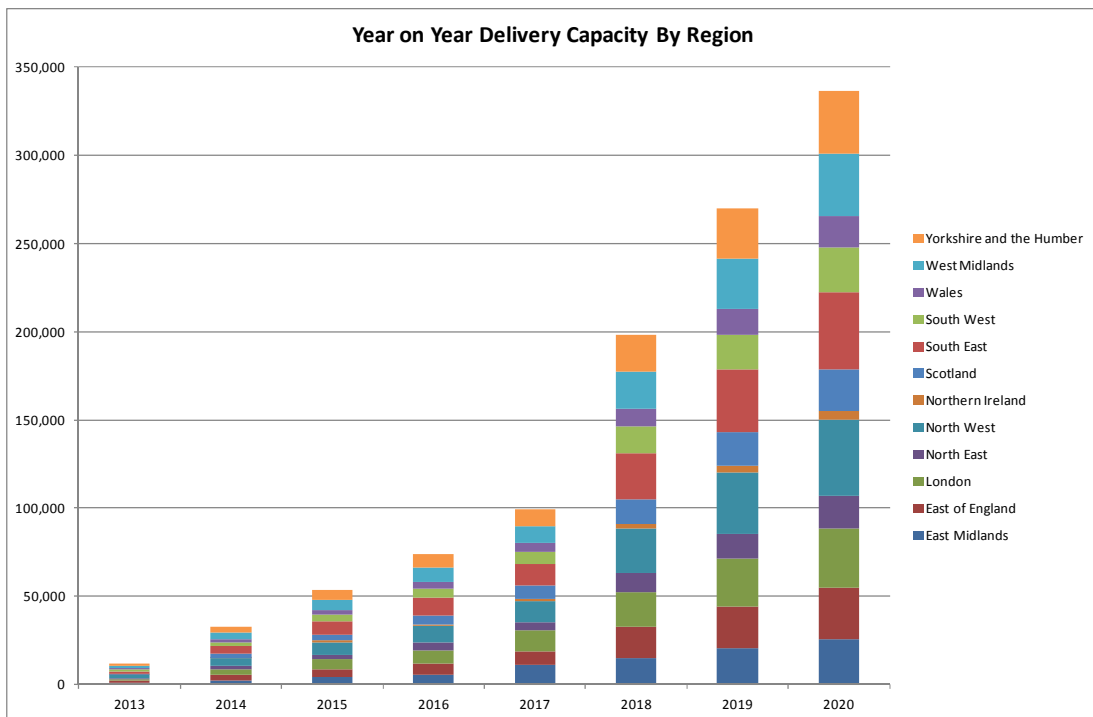


Figure 6: Delivery Capacity Plan by Year by Region

A number of factors were considered

- The willingness of the customer segment to adopt retrofit
- Demand estimates by customer segment
- Matching house types to occupant customer segment

It is possible to make estimates of the number of installation teams and quantities of materials needed on a region by region basis. Since consumers and building archetypes vary by region there is not a direct relationship from region to region on needs.

A key success factor in retrofit is generating demand. Major factors that are considered by consumers when considering retrofit are cost and disruption, information on these topics needs to be shared with potential customers together with the benefits of retrofit in terms of reduced energy use, increased comfort and reduced CO2 emissions.

Key recommendations arising from the analysis of the supply chain design may be summarised as follows:

- Keep the supply chain simple to keep costs down and minimise waste in all its forms
- Focus on the most likely customers to take up retrofit
- Build capability and keep control of quality

The Survey Process

An accurate survey which provides confidence in the estimates of activities to be carried out is key to successful roll out of retrofit. Previous work within Work Package 4 has proposed that a two stage process for surveying properties is developed. This deliverable builds on prior work to employ lean process design techniques to develop the survey process further in terms of managing disruption, minimising risk, maximising quality and reducing the time to complete. This has been accomplished through a series of workshops to analyse the requirements and process steps. This has included a detailed analysis of the skills and costs associated with all aspects of the survey process.

The diagram below illustrates how the survey process fits into the client engagement process. The points in yellow relate to engagement steps. White process stages relate to sales and integration.

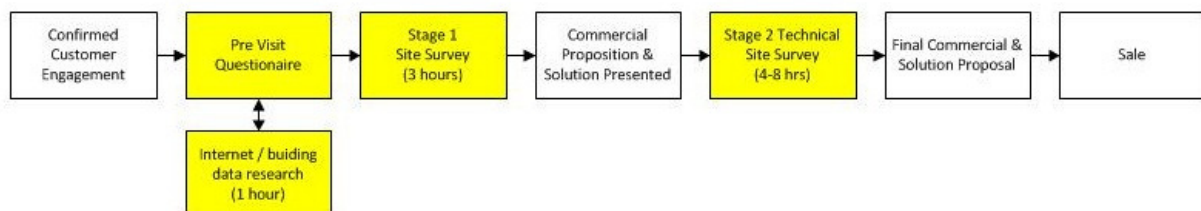


Figure 6: Customer Sales Process

The key findings from the work on the survey process are:

- The survey process requires two distinct stages. One to establish a solution and sales proposition to the client, and a second to confirm the solution viability and capture details for product manufacture / order.
- The stage one survey can be conducted within a total of 4 hours through a combination of on and off site research, client questionnaire and interview. The surveyor needs to be capable of conducting an energy assessment, possess a basic understanding of construction and building defects knowledge and be confident to engage in sales and marketing with the client. The estimated cost for a stage one survey is £140 per property.
- The stage two survey can be conducted in a maximum of 8 man hours dependant on house type and intervention solution. The surveyor will need to possess a significant range of technical capabilities, product knowledge and an understanding of the likely legal constraints whole house retrofit may incur. The surveyor could also be the Team Leader of the installation team which will de-risk the installation process and facilitate cost certainty. Due to the level of skills required and increase duration the cost of a stage two survey is estimated at between £50 - £400 dependant on property and solution type. To reduce the stage 2 survey to the target 4 hours, assistance may be required from the stage 1 surveyor or an additional install team member (should there be space in the installation schedule) to perform non-technical tasks.

The Implementation Process and Costs

The fundamental aspect of mass retrofit is the process by which retrofit is carried out within the target the properties, the implementation process. The project has studied the process of delivery of whole house retrofit measures using a poly-competent team. This has involved a detailed analysis of the programmes of work needed for each house type and the likely costs involved in setting up and running the team as a business. Costs have been reviewed in detail, including overhead costs that are likely for the proposed delivery organisation, material costs including distribution, stock holding and “last mile” costs. Proposals for areas of future cost reduction are made.

As identified previously the project has proposed a 4 man poly-competent team of retrofitters to carry out the retrofit work identified. This team requires a range of skills to be present to make it work, with different levels of competency required in different members of the team. The requisite skills are detailed below:

Low Competency	<ul style="list-style-type: none"> • General Labouring • Installing Insulation board • Installing Loft Insulation
Medium Competency	<ul style="list-style-type: none"> • Plastering • Rendering • Carpentry

	<ul style="list-style-type: none"> • Decoration • Tiling • Basic Plumbing • Basic Electrics • Basic roofing • Scaffolding/Access
High Competency	<ul style="list-style-type: none"> • Electrics to Part P • Gas Safe Engineer

Table 1: Competency Levels Required for Mass Retrofit Teams

The project has defined the activities, skills and competence levels required from each member of the poly-competent team (see section 6.2 of the report), appropriate accreditation levels are also defined.

The research undertaken on the poly-competent team approach suggests that there are significant time savings to be gained versus the traditional approach; this is due to:

- Sequencing of works to avoid loss of production from over laps in trade.
- Lower overhead for a small self directed team

The advantages of the new delivery process will be in its ability to scale organically to meet market demand and offer progression for the workforce through a sustainable employment model, this should relate to a lower overhead as it is less linked to specific trades work than the traditional model, having a workforce that can apply itself to a number of measures should also equate greater productivity.

In addition to focusing on productivity of the delivery team, the project has also reviewed the materials and techniques used for retrofit, costs of retrofit are made up of 3 main elements, as illustrated below for a 1950's semi-detached property

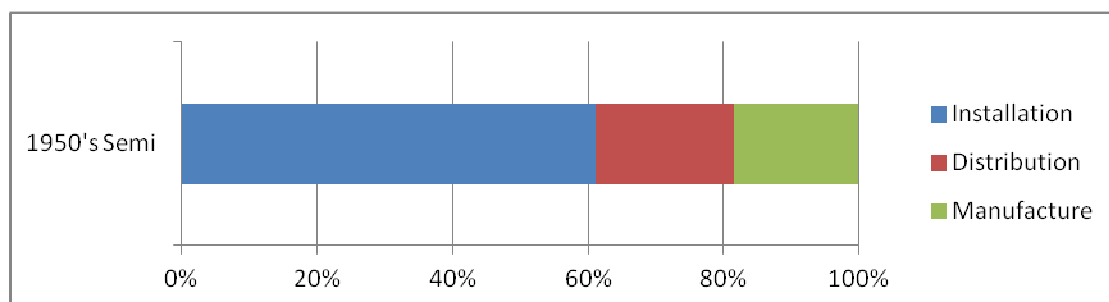


Figure 7: Distribution of Retrofit Costs for a 1945 – 1964 Semi

Through analysis it has been identified that there is considerable scope to reduce labour time through materials that minimise on site activity, with the example of external wall insulation (EWI) which is currently a three stage process of applying insulation, base coat

and then top render coat. If this could be reduced to a single dry fix operation labour time could be reduced by more than 50%. In addition current costs for EWI are tied up in the purchase of systems which have expensive warranty arrangements attached, if there is no longer a client requirement for a warranty backed system cost could be reduced by procuring components separately.

The key to a lower cost delivery model will be a long term market delivering at scale, with a delivery vehicle that is not tied to a particular technical solution but one that is poly-competent to meet varying demand for a range of solutions.

By reducing loss of productivity through better sequencing, certainty of works and process efficiency we can significantly reduce costs throughout the supply chain.

The conclusion drawn by the project is that there are cost savings to be provided through the new delivery vehicle, and in order to realise the full potential it is necessary to achieve collaboration from project partners and the wider supply chain, in summary

- Greater transparency of the distribution of cost within the existing supply chain will allow for incremental cost reductions to be achieved, quick wins should be achievable through optimisation of existing process.
- Large reduction in cost (circa 30 to 50% is considered to be achievable) will require new process and new material innovations and reconfiguration of the supply chain
- The quality of measures is vital to long term performance and to the reputation and hence mass take up of retrofit. Standard methods and robust standard work and continual refinement will be needed to deliver this
- There is substantial investment in the establishment of a new delivery vehicle this will need to be supported by the long term visibility of a retrofit market, as the market grows there is likely to be a number of viable delivery options, however a vehicle which is able to "flex" to suit demand will be required at the outset.
- Increasing capability of delivery teams is vital to deliver great customer experiences and fuel demand for retrofit

Through Life Support

From the early stages of the project it has been apparent that there are three phases of the retrofit process:

- Pre-sale: the survey and business acquisition process
- Installation: execution of the retrofit activities
- Through life: the support and warranty activities offered to customers following completion of retrofit works.

Through life support of whole house retrofit measures is likely to be more affordable than when installed individually and offers customer peace of mind and hassle free maintenance with minimal disruption. It is proposed that the installation company takes responsibility for support giving ownership and providing a long term relationship with the client. Research work carried out within work package 5 suggests that it is unlikely that there will be a high take up of through life support of retrofit measures.

Potential services which could be offered as part of a through life support package include

- Review of energy use
- Inspection of potential problem areas, damp, mould, render cracking etc. This will include dealing with any warranty claims on behalf of the customer.
- Lifestyle changes, i.e. Children leaving home and re-tuning heating systems for best economy.
- Provision of other measures, Solar PV / hot water, water saving devices etc.

These services could be linked to regular, planned events such as the annual gas boiler service.

Retrofit Demand

Since there is no established retrofit market in the UK, the project has established a hypothesis based on who is most likely to take up retrofit, which house types they live in and where they are located. This has enabled the construction of a model for demand from 2012 until 2020 based on achieving an installation rate of 400,000 houses by 2020.

An estimate has been made of how demand could build over time and uses the work on customer attitudes from Work Package 5 to assess the likelihood of different customer segments taking up retrofit. The most open customer segments are shown to generate demand first with other segments following on over time as demand builds. (The assessment criteria for customer segment likelihood to retrofit is included in appendix 9 of deliverable D4.4) The trajectory results in an overall UK capacity for retrofit of 400,000 houses per annum by 2020. The graph of demand by customer segment is shown in figure 3. Based on work carried out in work packages 1, 2 and 3 estimates were made by the project as to the demand for retrofit by region over the period to 2020 (see figure 3), this leads to the development of the materials requirements projected out to 2020.

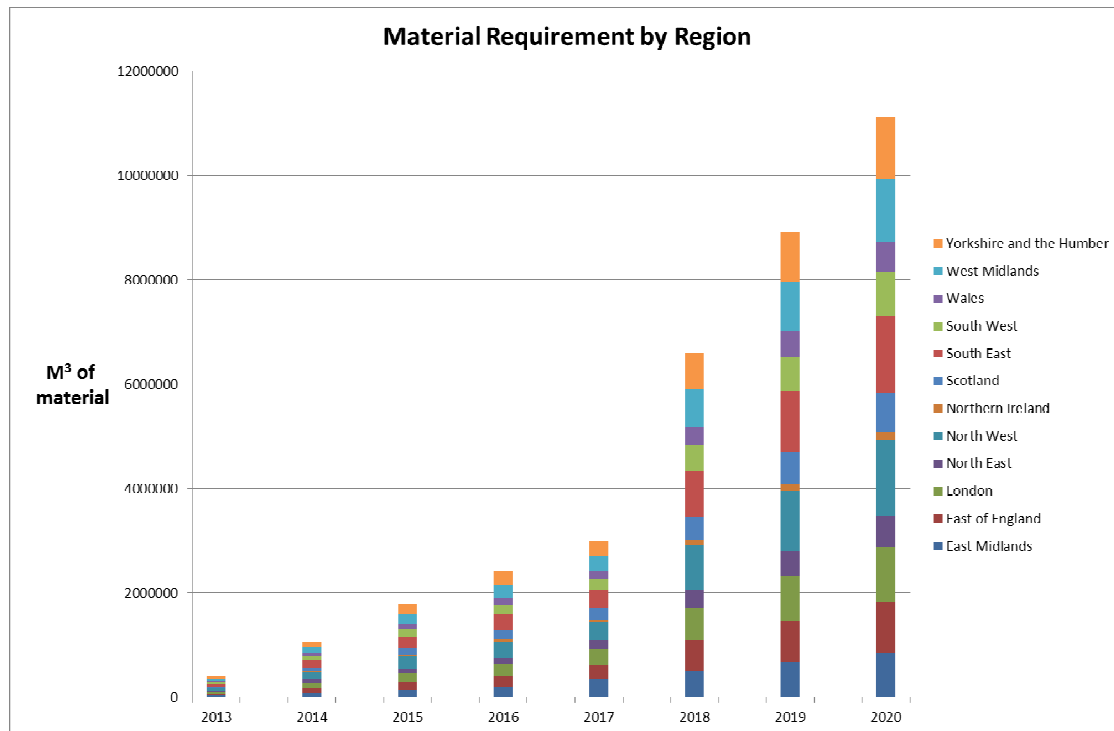


Figure 8: Material Capacity by Region

The above table shows regional material requirements over time to deliver the retrofit hypothesis developed here. The amount of material per intervention has been estimated and applied to the demand forecast for that house type. The material estimations per intervention can be found in Appendix 8 of deliverable D4.4. Within the deliverable these material requirements are evaluated in greater detail for external wall insulation, external wall insulation.

Results summary

The report proposes that the most effective way to build an industry is for delivery to be via small (4 people) highly effective teams and the team leader to be involved in the second stage survey to give ownership of the outcome of retrofit from an early stage.

An assessment has been made of the likely cost of retrofit for the property archetypes considered, and how demand could build over time and where demand is most likely to come from; retrofit costs of under £10,000 for most property types appears to be feasible but further work is needed to understand cost in material distribution. The report concludes that demand is likely build slowly and come from the older age groups who have some spare money and want to safeguard themselves from rising fuel process and to keep themselves comfortable into their retirement.

Material availability is unlikely to choke the take up of retrofit and current distribution networks exist to provide sufficient capacity to deliver product throughout the UK. The supply of products such as windows and doors, boilers and heating controls is likely to form part of

a retrofit rather than perhaps be individual purchases as householders adopt a “whole house approach” For products such as solid wall insulation there will need to be a growing capacity to fulfil demand and this is a largely new area for the owner occupier market.

A significant challenge is to develop a training and accreditation system that is straightforward and provides different entry points into retrofit and supporting qualifications to allow people from different trades / backgrounds to enter the market quickly while controlling competence and the delivered quality of retrofit measures.

Through discussions with existing players in retrofit it is clear that few people understand the true value in creating a new supply chain for retrofit despite the poor performance and reputation of the current industry. Some within the industry are keen to become beacons of excellence and see a profitable niche in retrofit. Realising the solutions presented in this report will mean confronting and destroying the current industry paradigm and creating new enterprises to deliver whole house retrofit brilliantly.

Key findings

Key findings from this piece of work are:

- A 4hour detailed survey with 2 people is possible (even for the most difficult house) and there is scope to reduce this further.
- It has been shown to be possible to retrofit the two levels of intervention, RetroFix and RetroPlus across the modelled house types in 10 elapsed days or less (depending on property size/ complexity and weather permitting) using a team of 4 poly-competent retrofitters.
- Increasing competencies will be vital to deliver retrofit brilliantly and at scale - new training systems are required to provide an up-skilling route for people wishing to enter the retrofit industry.
- New or simplified accreditation and warranty systems are needed for retrofit.
- Standard retrofit solutions will help generate efficiency gains and simplify the provision of materials.
- Progress has been made to understand how cost is built up within the supply chain but further work is needed to allow key players to share cost information.
- Retrofit cost of under £10,000 for most house types is feasible but challenging for most house types based on our understanding of how cost is built up within the supply chain. More specific cost data will be generated for common house archetypes; these will be presented in follow up reports for this work package.

Further work

This report presents a number of suggestions on the manpower, materials and regional coverage that will be needed to establish a credible industry; this will need to expand at a rate that will deliver the UK’s Carbon Reduction Commitment. It is important that the hypotheses developed here are tested and commented upon by industry experts and their

comments embodied in our thinking going forward. In addition, further work is needed to engage with key players in the supply of materials and products needed for retrofit to fully understand how cost is built up through the value stream, from raw ingredients to products embodied on site. Representatives of the existing supply chain have been reluctant to share cost information, details of how products are distributed and how cost is built up as this is seen as highly commercially sensitive.

The consortium have a goal of a 50% reduction in, future work with key supply chain players will seek to determine if this is achievable and if so then how a 50% reduction in cost of products delivered to site could be made possible. In addition it is planned to work with product developers and manufacturers to identify product innovations that result in less labour on site and are unaffected by prevailing weather conditions. Specifically to move away from wet finishes for solid wall insulation.

Subsequent reports will detail how the supply chain could adapt and reinvent to provide the needs of whole house retrofit and propose a road map with time scales for change. In addition gaps between current and future supply chain needs will be examined for materials, manpower, products and process requirements. This will include an assessment of the competences required at each stage of the supply chain, (materials manufacture, consolidation, fabrication, scheduling, distribution, property surveying, retrofit installation, quality control. And accreditation) and what training is required to support this.

References

D3.4a – Virtual Refurbishment Report

D4.0 – Current Supply Chain Map

D5.5 – Consumer Behaviour Synthesis Report