Programme Area: Buildings

Project: Building Supply Chain for Mass Refurbishment of Houses

Title: Executive summary of the draft supply chain scenarios 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Please note this report was produced in 2011/2012 and its contents may be out of date.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.

ETI Executive Summary

Programme: Buildings

Project Name: Optimising Thermal Efficiency of Existing Housing

Deliverable: BU1001 / WP4.2 – Draft Supply Chain Scenarios

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 is intended to further develop refurbishment supply chain options for the delivery of mass retrofit to the residential housing sector. Prior work across work packages 3, 4 and 5 has identified 3 key stages of retrofit:

1) Survey: a complex and potentially time consuming activity, but essential if a robust and predictable retrofit process is to be achieved. The long term goal is to achieve a survey process which can be accomplished within 4 hours.
2) Installation: Prior work on the project has highlighted that an installation time of 1 to 2 weeks is required to achieve mass appeal for whole house retrofit across target customer segments.
3) Through life: Supporting the customer post retrofit is important to delivering long term customer satisfaction

This deliverable focuses on the delivery mechanism and process requirements for these 3 stages of retrofit. The approach taken by the consortium was to use input from the technical intervention (D3.3), draft supply chain design (D4.1) and Customer requirements work packages (D5.2) to develop target retrofit systems with different options for delivery. A workshop programme was used to create process designs for the Survey / Installation / Through Life phases of retrofit. A Failure Mode and Effect Analysis (FMEA) was carried out on the Survey and Installation processes, with the results being used to prioritise improvement / development activities. The approach taken is presented graphically below in figure 1.

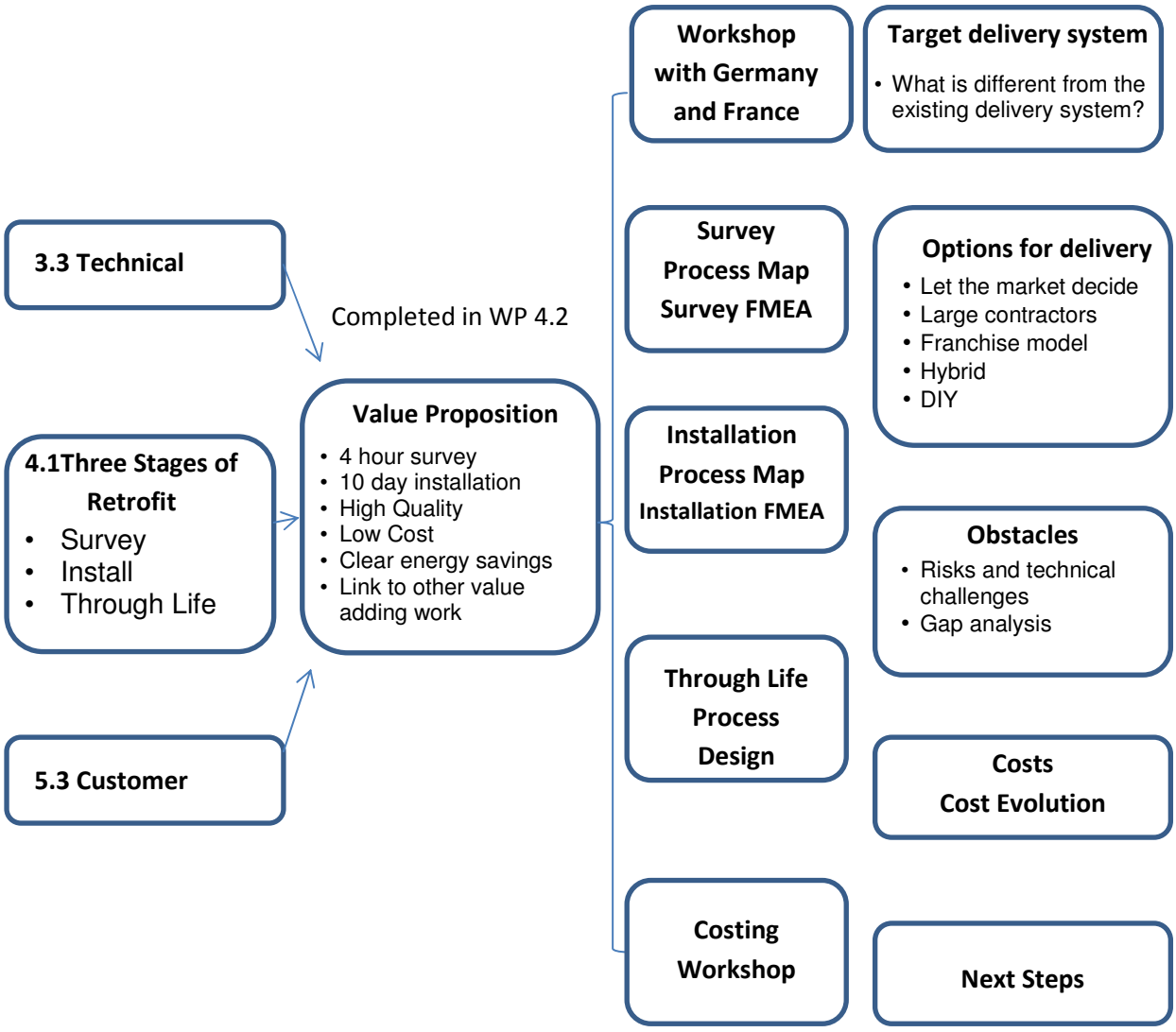

Figure 1: Approach to Work Package 4.2

Outputs from the workshops were used to evaluate potential supply chain structures best suited to deliver whole house retrofit. The supply chain options considered were:

1) Leave it to the market: Rely on the existing vertically integrated and dispersed supply chains (as described in D4.0). This model exists in France and Germany and is analysed in D4.1.
2) Large corporate delivery: Retrofit is delivered by large companies using a mix of sub-contracted and direct labour teams, an example of this would be the Decent Homes Programme.

3) Scalable unit model: The combination of a single point of contact as achieved with the large corporate model, but relying on discrete scalable delivery units operating at a local level.

4) Hybrid model: Variations and / or combinations of the above.

5) DIY: Interventions project managed and / or executed by individual householders.

The ability of each of the supply chain options to deliver mass retrofit was considered against a number of criteria:

1) Functionality: Thermal performance and aesthetics

2) Flexibility: The ability to react to customer needs for details of timing, finish, combining other works into the retrofit package

3) Dependability: The quality of service delivered by the retrofit company to include quality of installation and finish, punctuality and meeting time and other commitments made to the customer

4) Speed: The time taken at any stage of the process: E.g. From initial contact to survey; from survey to installation, or the time taken for the installation itself.

5) Cost: The overall cost of the retrofit to include all activities from survey through to installation and through life support.

6) Disruption: From the customers' perspective, how much the customers day to day activities are affected by the retrofit. This can be a trade-off between numbers of retrofitters in the home and the overall time taken for the retrofit.

7) Trust: The emotional connection made between the customer and the retrofit business and the level of commitment and delivery of assurances given prior to the retrofit installation.

Further to this a gap analysis of the preferred supply chain options (scalable unit model) was conducted which six primary impediments to creating a workable supply chain model. The elements were grouped into survey, skills, training & accreditation, legislation & regulation, programming and products & processes.

Finally a range of retrofit solutions have been costed using current materials and installation processes. Retrofit options were grouped into potential 'bundles' classified as Bronze / Silver / Gold to allow their collective benefits to be quantified via the Thermal Efficiency model developed as part of Work Package 1.

Results summary

The results of the assessment of each of the supply chain models against the 7 evaluation criteria detailed above is summarised in table 1.

Model / Criteria	Leave it to the Market	Large Corporate	Scalable unit	Hybrid	DIY
Functionality	✓✓	✓✓✓	✓✓✓	✓✓✓	✓
Flexibility	✓	✓✓	✓✓✓	✓✓✓	✓✓
Dependability	✓	✓✓	✓✓✓	✓✓	✓✓
Speed	✓	✓✓	✓✓✓	✓✓	✓✓✓
Cost	✓	✓	✓✓✓	✓	✓
Disruption	✓	✓✓	✓✓✓	✓✓	✓
Trust	✓	✓✓	✓✓✓	✓✓	✓✓
Qualititative assessment of the relative capabilities of alternative delivery models. ***Only at 3 ticks is the model considered fully capable for mass retrofit delivery***					
✓ *contingent upon enabling innovations for data, tools and work execution*					

Table 1: Supply Chain Assessment

The **scalable unit** is the preferred option as this is most likely to deliver the required customer value and a whole house systems engineered product. Retrofit would be delivered by small specialist teams with the appropriate competence and highly effective supply chain.

Costs of Retrofit

As described above, an analysis of the costs of retrofit was carried out, drawing heavily on the work from Work Packages 1 and 2, in particular deliverables D1.5 and D2.2. The retrofit measures and associated costs are shown below. The base line house chosen is 1930's 2 storey semi-detached house with solid walls, single glazed windows and minimal loft insulation.

Item	Labour	Materials	Prelims	Overhead	Profit	Total
100mm External Wall Insulation	£2,287.60	£5,863.40	£626.51	£486.77	£265.51	**£9,602.64**
Internal Wall Insulation	£1,922.63	£7,991.98	£610.13	£592.09	£322.96	**£11,680.33**
Door Front	£104.80	£418.00	£149.82*	£31.22	£17.03	**£615.91**
Door Rear	£102.20	£392.00		£29.51	£16.10	**£582.21**
Windows	£1,083.92	£3,774.17	£330.11	£290.12	£158.25	**£5,723.28**
Loft Insulation	£150.75	£74.25	£141.00	£13.44	£7.33	**£265.07**
Boiler	£383.89	£1,075.31	£291.73	£87.14	£47.53	**£1,719.08**
Floor Insulation	1885.95	725.85	£393.87	£155.97	£85.08	**£3,076.94**

*both doors replaced together

Table 2: Measure by Measure Retrofit Costs

The impact on household energy consumption of each of the measures is plotted below in figure 2.

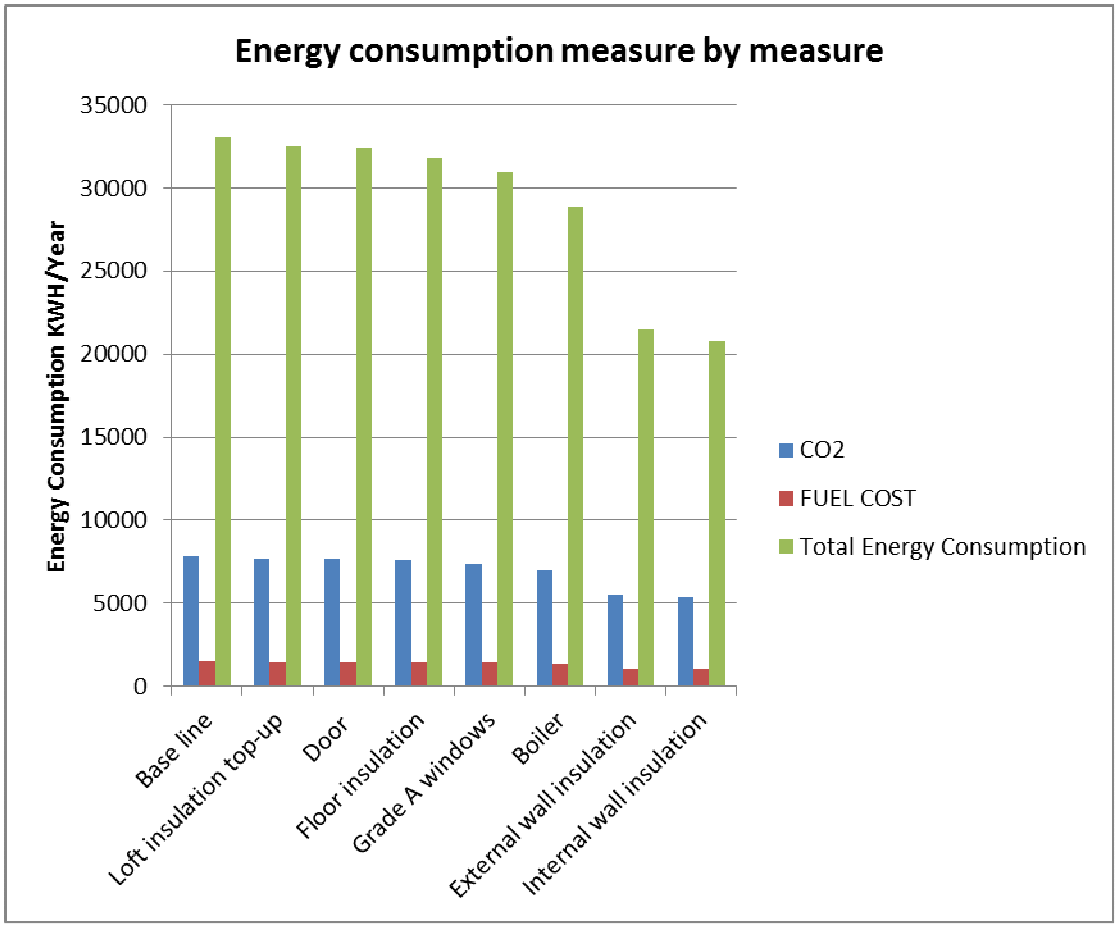

Figure 2: Evaluation of Effectiveness of Each Retrofit Measure

This illustrates that the most effective retrofit measures are internal / external wall insulation followed by an A rated boiler.

‘Bundles of retrofit measures were created based on the above individual interventions, they are as follows. Separate tables are presented for internal and external wall insulation:

External Wall Insulation Solution	Labour	Materials	Prelims	Overhead	Profit	Total
Bronze (EWI plus Loft insulation)	£2,438.35	£5,937.65	633.66	460.68	284.11	**£9,754.45**
Silver (Bronze plus Doors &Boiler)	£3,029.24	£7,822.96	659.05	633.12	364.33	**£12,508.70**
Gold (silver plus floors & windows)	£5,999.11	£12,322.98	740.58	1048.45	603.33	**£20,714.45**

Table 3: Packaged Measures – External Wall Insulation

Internal Wall Insulation Solution	Labour	Materials	Prelims	Overhead	Profit	Total
Bronze (IWI plus Loft insulation)	£2,073.38	£8,066.23	612.58	591.37	340.31	**£11,683.86**
Silver (Bronze plus Doors & Boiler)	£2,664.27	£9,951.54	636.98	728.9	419.45	**£14,401.14**
Gold (silver plus floors & windows)	£5,634.14	£14,451.56	1067.38	1163.42	669.5	**£22,986.00**

Table 4: Packaged Measures – Internal Wall Insulation

Using the Thermal Efficiency model the effectiveness of each of the retrofit measures was assessed.

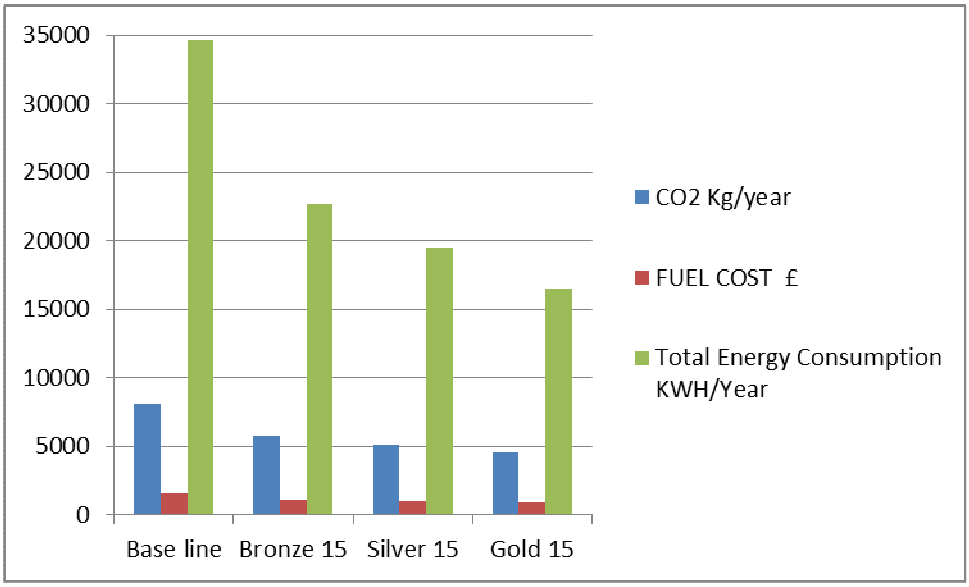

Figure 3: Effectiveness of Retrofit Measures

It can be seen that energy bills for the base line house are £1459 per year, whereas with the bronze package they are £1142, with silver £1018 and gold £897.

The payback period for each of the packages has been calculated using current costs:

Package	Energy Use KWH	Energy saving KWH	CO2 emissions KG/Year	CO2 savings KG/year	Energy bill	Energy saving	Cost of measure	Payback Years
Base	34,614	0	8,131	0	£1,543	0	0	0
Bronze	22,642	11,972	5,761	2,370	£ 1,135	£ 408	£ 9,754	23.9
Silver	19,466	15,148	5,132	7,619	£ 1,026	£ 517	£ 12,508	24.1
Gold	16,558	18,056	4,556	3,575	£ 927	£ 616	£ 20,714	33.6

Table 5: Cost Benefit – Current Costs

Using examples from other industries, the consortium has proposed that cost erosion of retrofit should be possible over a number of year. This would be achieved through a number of means including off-site fabrication, standardisation of work processes, value engineering of existing products and economies of scale. This could result in the following payback durations:

Package	Energy Bill	Energy Saving	Cost of measure	Payback Years
Base	£1,543	0	0	
Bronze	£1,135	£408	£5,947	14.75
Silver	£1,026	£517	£7,627	14.75
Gold	£927	£616	£12,630	20.5

Table 6: Cost Benefit – Eroded Costs

Key findings

Through the work completed for this stage of retrofit supply chain development major themes have emerged which will be explored in the next phase of work (work package 4.3)

- The current supply chain is split by silos around the existing trades:
  - Windows and doors
  - Loft / Roof insulation
  - Heating and plumbing
  - External insulation
  - Internal insulation
- Delivery of retrofit is centred on these trade silos resulting in duplication in the supply chain and retrofit installation businesses
- There is a piecemeal approach to retrofit design and installation again split by function resulting in a failure to achieve the performance and cost benefits of a systems engineered approach
- The skills and qualifications demanded to work legally and to satisfy warranty provisions with products used in retrofit are mostly general and not “right sized, and fit for the purpose” for a future mass retrofit market
- The existing supply chain is not configured for the retrofit market (which has yet to emerge) and there is no clear strategy for distribution and consolidation of products to effectively support and enable retrofit businesses.
- Routes to obtain funding and investment in domestic retrofit are unclear and the team has been unsuccessful in engaging with the financial community on this project. The green deal may include mechanisms but is unlikely to enable the whole house retrofit systems approach.
- The survey process requires in depth study to provide a robust system to remove risk from the retrofit process. This is likely to include a large element of continuous monitoring, feedback and improvement as the industry forms and matures.

- Current trade skills are inappropriate for retrofit being broad based with limited cover for cross trade working. The retrofit installation process also requires in depth study to understand the basic competences and optimise team working to achieve the best value balance of number of people on site and time taken for retrofit.
- Trade qualifications and legislation for working with gas, water and electricity are likely to limit the speed and effectiveness of the development of retrofit unless reviewed and brought into line with the competence approach suggested here.
- New products are required to simplify retrofit activities and increase the robustness of the end result. Pre fabrication and off site material preparation are also seen as a requirement to increase speed and quality of installation results.
- Significant cost erosion is required to allow whole house retrofit to be a financially attractive investment to home owners.

Further work

The scalable unit model will be developed further in Work Package 4.3 where the routes for funding, training and regulation to enable and stimulate will be explored.

References

D1.5 Refinement of Core Model

D2.2 Schedule of Costs for Improvement

D3.3a Technical Solutions Matrix

D3.4b Whole House Solutions Report

D4.0 Current Supply Chain Map

D4.1 Draft Supply Chain Design

D5.2 Consumer Value Methodology