In-depth Technology Innovation Assessment for Solid Wall Insulation

A Final Report to

Department of Energy and Climate Change

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Front cover photo:

Aerogel solid wall insulation system, as used in Victorian Terrace project (BRE)

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ES.1 Introduction

The Department of Energy and Climate Change (DECC) commissioned GHK Consulting (GHK), working in association with the Building Research Establishment (BRE), in January 2011 to undertake an in-depth technology innovation assessment for solid wall insulation (SWI). The main aims of the study were to identify how innovation in SWI can:

- Help meet climate change targets;
- Help overcome technological, cost and attitudinal barriers to deployment;
- Help to bring UK business benefits.

The consultants were asked to:

- Critically examine the case for intervention to encourage UK-based innovation in SWI, based on an assessment of existing and planned policy interventions; and
- Provide recommendations, underpinned by a robust evidence base, to inform DECC's future policy decisions and (potential) future programme design to support innovation in the SWI sector.

Overall, this study aimed to determine whether there is a need for more specific support for R,D&D (research, development and demonstration) of solid wall insulation.

The report is based on findings from a literature review and from detailed industry consultations with more than 17 leading firms across the SWI supply chain (from insulation manufacturers to SWI installers) as well as key stakeholders such as the Technology Strategy Board (TSB), Energy Technologies Institute (ETI) and Energy Savings Trust (EST).

The main study research was carried out during the first half of 2011. The results were used to inform DECC's Energy Innovation strategy and also informed discussions concerning the planned Green Deal and the Energy Company Obligation (ECO). Due to updates in modelling assumptions since the publication of the Energy Bill Impact Assessment, as well as new industry feedback in response to DECC's consultations on the Green Deal, GHK was asked by DECC in early 2012 to update the unpublished 2011 report to reflect new supply chain evidence and modelling assumptions as well as any changes in the industry's economic performance since the original study had been undertaken.

ES.2 Background to the problem

Energy use in the domestic building stock of 26.5 million properties consumes around 30% of total UK energy consumption. This usage has risen by 23% over the last 35 years and now generates around 40 million tonnes of carbon emissions per year[1].

DECC estimates that there are 7.8 million solid walled houses in the UK, of which 98% are estimated to have little or no insulation[2]. Of these, DECC estimates that there is potential to install SWI in around 6.9 million houses[3].

Solid walls and other 'problematic' walls conduct heat more quickly than cavity walls – increasing energy bills and carbon emissions. Installation of SWI in these properties would reduce energy consumption and cut carbon emissions; SWI also has an important role in helping move the entire UK housing stock to higher levels of energy performance.

Introducing an insulating layer to a wall reduces heat transfer by conduction, convection and/or radiation, thereby reducing energy bills. The savings that typical households can make from SWI varies considerably. DECC has recently estimated that between £190 and

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1 BRE, Domestic Energy Fact File, 2008 [available at www.bre.co.uk/filelibrary/pdf/rpts/Fact_File_2008.pdf]

2 Based on a DECC estimate that 122,000 properties had installed SWI, equating to 2% of solid walled properties. DECC, Estimates of Home Insulation Levels in Great Britain: January 2012 (www.decc.gov.uk/assets/decc/11/stats/energy/energy-efficiency/4537-statistical-release-estimates-of-home-insulation-.pdf)

3 Final stage Impact Assessment for the Green Deal and ECO, DECC, June 2012

£306 could be saved per year depending on solid wall type[4]; older estimates by the EST put typical household savings at between £445 and 475 per year[5]. The reason for DECC's lower figures is because these take account of the real performance of the SWI once installed. SWI can also help to weatherproof the external walls of older houses; improve the 'look' of a dwelling and so help to regenerate run-down neighbourhoods; and help to reduce noise transmitted through internal party walls.

ES.3 Overview of the technological solutions

Solid walls can be insulated from the inside or the outside using a diverse array of products and system types, applicable to both the domestic and non-domestic sectors. There are many advantages from each approach and systems are specified and tailored according to building type, client requirements and price.

There is a wide variety of insulation technologies on the market. These form the basis of SWI systems. Mineral wool is the oldest type of insulation product used; glass wool and expanded polystyrene (EPS) are also common. Over the past 20 years, Polyurethane (PUR), Polyisocyanurate (PIR) and phenolic foams have also come on to the market. The latest insulation innovation is aerogel which originated in applications within space technologies and the oil and gas industry.

To achieve certification under an industry/end-user recognised system, such as that offered by the British Board of Agrément (BBA)[6], products are typically required to demonstrate a 30 year lifeAll products accredited under BRE Global or British Board of Agrément (BBA) certification are required to have a 30 year life. Products certified for the Carbon Emissions Reduction Target (CERT) programme also have a 30 to 40 year life.

The supply of insulation is a mature market comprising a variety of insulation types. The market is differentiated by cost , with low cost products (e.g. mineral wool, glass wools and EPS) and mid cost products (e.g. PUR, PIR and phenolic foams) representing the majority of supply. New high performance, high cost products such as aerogels are currently only used strategically.

ES.4 Innovations in the supply and installation of SWI

The introduction of aerogel insulation to the UK market, albeit still at an early commercial stage and with apparent installation problems which need to be resolved[7], has prompted more established manufacturers marketing other kinds of insulation to improve their products[8]. Consequently, all insulation manufacturers are now aiming for performance levels comparable with those of aerogels.

However, with the new build market having stagnated in recent years, firms have been unwilling to invest large amounts of money unless they can see an assured demand for such premium products; conversely, companies are more willingto invest in R&D and alter or introduce new production lines if a clear retrofit programme, including the numbers of likely properties and interventions, is identified for the period up to 2020 and beyond.

Many innovations are being made in the supply chain at the point of processing of the raw materials that are used to make the insulation. Research into more efficient thermal properties is a key focus with the objective of achieving either reduced thickness of the insulation or other properties, such as improved rigidity, robustness as well as added value through lower embodied energy or lower transporting costs. Part of this innovation drive is a response to rapidly increasing raw materials and transports costs as well as energy price increases.

[4] See Annex A of Final stage Impact Assessment for the Green Deal and ECO, DECC (June 2012)

[5] See http://www.energysavingtrust.org.uk/In-your-home/Roofs-floors-walls-and-windows/Solid-wall-insulation

[6] BBA is one of a number of certification bodies that can accredit SWI

[7] Feedback from the experiences of the TSB "Retrofit for the Future" programme

[8] Consultation with insulation manufacturers

Another area of investment in innovation is the need to reduce potentially negative environmental impacts from products. Areas which manufacturers are now researching include: embodied carbon; use of greener materials to make insulation products (e.g. recycled plastic, cork); reduction of chemicals at the point of installation (e.g. reductions in formaldahyde off-gassing from products); and site waste products are retrieved for recycling into insulation (e.g. PIR, EPS) or other products, hence diverting them form landfill.

Investment in innovations within the SWI system suppliers (those that integrate insulation from major manufacturers into their products, mostly for external wall usage) is being directed at: novel dry lining systems (which borrow the concept from internal wall lining methods to reduce wet render and the costs of installation); mechanical fixings to enable systems to be installed on a wider array of building types; as well as specialist coatings (e.g. superhydrophobic nanotechnology which mimics a lotus leaf and is designed to channel water away from walls).

Another important area for innovation is in reducing the costs of installation. These costs can escalate rapidly on site due to surveying and design requirements and additional work such as roof/window extensions, moving utility wires and pipes, moving aerials and satellite dishes, etc. Sophisticated measurement equipment is now starting to be used to help quickly and accurately determine requirements for internal wall insulation. Such a tool can also enable insulation to be cut off-site ready for rapid installation which will also reduce site waste and resulting disposal costs.

All these innovations have a potential impact on price and are going some way towards helping the industry to reduce SWI system prices – which in turn will make their products more appealing to consumers. Investment in innovations is also improving performance (and hence reducing required thickness), product, reduced transport costs, sustainability and the ease of installation (i.e. the ‘hassle’ factor for customers).

RD&D (Research, Development and Deployment) activity across the UK SWI industry is critical to the development of technologies and installation approaches that are appropriate for the UK’s diverse housing stock and climate. This investment also enables suppliers to ensure their products take account of UK-specific building regulations and planning demands. It is one reason why SWI systems developed to suit the conditions of one country may not be immediately transferable into the UK market without demonstration and monitoring of performance.

ES.5 SWI supply side

The UK has an established and diverse SWI supply side that comprises world leading materials suppliers, insulation manufacturers and systems suppliers as well as innovative SMEs.

Turnover across the SWI supply chain in 2010 is estimated at £186m, with associated employment of approximately 2,300 people, of which three quarters are installers[9]. In line with the wider construction sector, there is evidence of recessionary impacts since 2007 in the sector, including declines in turnover (by 15-30% in several large firms), reduced profit margins and reduced employment[10].

The UK SWI industry has become increasingly international. There has been a certain amount of consolidation in the UK and increased foreign ownership over the last ten years, especially by German companies. There is also vertical integration between insulation manufacturers and UK system suppliers which will help to reduce costs through synergies, such as preferential usage of certain insulation types.

The UK sector is now characterised by a mixture of R&D being carried out in the UK while some of the larger foreign companies retain their R&D headquarters outside the UK. However, some of these firms also retain a modest R&D presence in the UK, often aligned

[9] Estimates based on industry analysis by GHK for this study

[10] Estimates based on industry analysis by GHK for this study

with their UK manufacturing sites. Firms appear to be investing modestly in on-going R&D and innovations across the SWI supply chain. A number of SWI manufacturers are working with the UK university sector on new innovations and product development although the scale of this interaction appears somewhat small-scale and project focused.

Currently there are market-ready SWI products that can meet Building Regulations for retrofit but which lack a market. To date, demand for SWI products has been driven primarily by government mandates on energy companies such as CERT to install insulation measures. However, even this demand has been insufficient to produce a step change in the annual numbers of properties retrofitted with SWI. One of the main reasons for this has been the cheaper option of installing loft and cavity wall insulations (CWI) since energy companies get more points per pound spent than SWI (although SWI scores more points per installation as it can achieve greater carbon reductions). Loft and CWI is therefore a more cost-effective option for energy companies at the moment.

This brake on deployment of SWI has reduced the potential for learning within the industry (which could help to reduce system supply and installation costs) and opportunities for demonstrating and selling more innovative products (which is another mechanism for reducing the costs to the consumer). It also limits investment in innovation and reduces the ability of suppliers to afford product certification – a critical ingredient which helps provide confidence, safety and market opportunities for firms that have it (e.g. acceptance into Ofgem's CERT matrix of suppliers).

In recent years (but before the recession) the new build market has provided a growing demand for SWI which has helped the industry to diversify. A key driver for this is the increasing stringency of Building Regulations for new build which is driving growth in solid walled properties, akin to approaches used in Germany.

It is important to acknowledge the role of the Community Energy Saving Programme (CESP), an associate programme to CERT, which was designed to encourage a whole house approach and focus on 'hard to treat' properties. This has boosted the SWI market as it has a more sophisticated carbon scoring system than CERT which determines the level of final payments, encouraging energy companies to focus on a handful of eligible measures including SWI, heating controls and boiler replacement which provide higher carbon scores. The most recent insulation estimates by DECC demonstrate that CESP is making an impact with a 28 per cent increase in installations in the year to April 2012[11]. While CESP is driven primarily by energy companies, there are joint investments between them and local authorities. Our consultations highlighted a perception that local authority budget cuts might impact in the short term on planned investments. However, CESP obligations have to be delivered by December 2012; and the latest CESP installation figures (i.e. in early 2012) do appear to show a greater emphasis on SWI which is boosting the market.

Furthermore, the Green Deal will be supplemented by the new ECO from October 2012. The ECO will draw on the strengths of the existing energy company obligation and avoid some of the limitations (e.g. the approvals process currently required under CESP will be simplified). In order to help build longer term confidence in the SWI supply side (which will provide more certainty in investment decisions in RD&D and manufacturing), Government has the opportunity to provide a clear steer through the ECO as to the level of SWI deployment which it considers feasible to 2022 and beyond.

Existing innovation support programmes (e.g. the TSB's Retrofit for the Future and EST's solid wall field trial) have primarily focused on validating the performance of existing technologies. The EST field trials in particular have focused on the generation of robust and long term monitoring of SWI performance that will help generate confidence in consumers and make it easier to sell SWI. However, the industry should also invest in innovation for the longer term, to be able to deliver step changes in performance at much reduced prices and to overcome many of the installation challenges that might limit deployment rates.

[11] DECC, Estimates of home insulation levels for April 2012, Published June 2012. Available at http://www.decc.gov.uk/assets/decc/11/stats/energy/energy-efficiency/5457-stats-release-estimates-home-ins-apr2012.pdf

Significant increases in Building Regulations (i.e. U-value requirements) over the next ten years and beyond will also put pressure on suppliers to ensure that products and systems can comply while remaining fit for purpose and safe to use.

The large potential market size for SWI in the UK, which is currently considerably smaller than Germany or Poland[12],provides the potential for scale up and economies of scale, especially in maturing supply and distribution channels, which could also help reduce costs. Growth in demand for SWI will arise from new build opportunities as the UK economy sees more sustained growth as well as the introduction of the Green Deal and ECO. Greater investments from local authorities in their housing stocks will also help sustain the retrofit side of the SWI industry. Several system suppliers and installation companies also expect there to be a greater 'mix and match' approach to SWI in the future, combining external wall insulation (EWI) and internal wall insulation (IWI) techniques which could help the affordability of SWI.

However, significantly reduced prices, more cost-effective delivery and increased knowledge amongst domestic consumers of the potential energy and carbon savings benefits from SWI will be critical ingredients to creating growth in the sector. Certainly the current price of SWI systems appears too high to deliver a large pay-back to consumers. This is an important reason for the Green Deal being introduced for the "able to pay" market – to offset a large proportion of the upfront cost (the ECO picking up other types of housing). There remains a need for greater evidence to identify and validate the true benefits of SWI in terms of financial and carbon savings and to communicate these to the customer base. EST SWI field trials will help in this regard.

ES.6 Technology projections and stock analysis

Three future deployment projections were developed for SWI and their impacts analysed for the 2013-2022 period across the UK housing stock. The impact of policy initiatives such as changes to the Building Regulations and the proposed Green Deal and the ECO were explored together with how innovations within the SWI industry (including any potential support from government) might impact on the projections.

Our analysis shows how increasingly demanding U-value requirements would usually require a greater thickness of insulation. However, the improvements in lambda values anticipated by the industry (10-50%) through innovation will facilitate the achievement of thinner insulation product thicknesses which helps suppliers maintain market share. This also makes for more efficient fixing methods, and opportunities in confined spaces.

Another important finding is that for both EWI and IWI, but particularly with EWI, innovations in fixtures and fittings are not necessarily going to lead to significant cost reductions in overall installation costs because of the fixed extra costs. It is also suggested that the higher costs of supplying increased thickness of SWI will be cancelled out by innovations in performance across the sector over time (i.e. better lambda values).

For the Business as Usual (BAU) scenario, only 205,000 solid walls will be insulated by 2022. Under a Green Deal (including ECO) scenario, in which there is significant financial support to help stimulate demand, the three SWI deployment scenarios range from 825,000 installations by 2022 (Low scenario), 955,000 (Central) and 1.24 million (High).

The DECC Central scenario is considered feasible, where the industry meets its current installation capacity capability together with organic growth. Deployment following the DECC Central trajectory, where total SWI installations are gradually ramped up to 125,000 units per year by 2022 would represent a six -fold increase on the current installation rate.

The cumulative carbon savings from following a BAU scenario remain low at 0.17 $MtCO_2$ compared with 3.7, 4.1 and 5.2 $MtCO_2$ for the DECC Low, Central and High Green Deal

[12] National Insulation Association size estimates: http://nationalinsulationassociation.org.uk/downloads/NEA%20Con%20-%20Copy.ppt

scenarios. Since the stock model used in this study focuses solely on SWI installations, the carbon savings will be considerably greater if other measures are installed at the same time.

Regarding the value of non-traded carbon savings from the four scenarios by 2022, under a central pricing scenario, the value ranges from £11m (BAU), to £231m, £260m and £510m respectively for the three Green Deal (including ECO) scenarios.

The impacts of market uptake on carbon savings in the domestic sector were also modelled from 2020 to 2050. Building on the four scenarios, we modelled exponential growth in installations for the DECC Low, Central and High scenarios, to reach 4.6m, 5.3m and 6.9m installations respectively by 2050. Under the BAU scenario total installations would just fall short of 800,000 installations by 2050.

The model suggests that by 2050, cumulative carbon savings of between 78, 89 and 117 $MtCO_2$ respectively will be achieved for the three DECC scenarios compared to just 0.67 $MtCO_2$ for the BAU scenario. The value of these non-traded carbon savings ranges, under a central pricing scenario, ranges from £142m (BAU) through to £10.8 billion, £12.4 billion and £16.2 billion for the three Green Deal (including ECO) scenarios.

Key conclusions from a number of recent EU and Member State studies that have modelled large scale retrofit programmes are that significant reductions in domestic emissions can be achieved by making large public investments in deployment incentives. However, these costs can be offset not only through emissions abatement but also through recurring and substantial annual energy savings and positive employment impacts.

ES.7 Market opportunities and economic impacts from SWI deployment to 2020

There is a general consensus amongst the sector that the SWI market will increase significantly over the next five to ten years, particularly when the Green Deal andthe ECO are introduced. However, the need for greater cost effectiveness of SWI systems is widely accepted and industry efforts are focused on delivering innovation in materials and simplified installation processes. System supply cost reductions for EWI of between 25-50% are being sought to 2020. The importance of collaborating between manufacturers, system suppliers and installers to decrease overall system costs is apparent.

The recent entry of several foreign SWI system suppliers into the UK market is an indication of the UK offering long term business opportunities. Increased competition could also put downward pressure on supply costs. It might also lead to consolidation from larger firms wishing to buy into established client bases and long UK track records.

The need to explore more innovative forms of SWI system in the medium to long term will be an essential ingredient in driving prices down. Innovation could come from a number of areas, including the incorporation of novel forms of insulation with significantly improved performance compared to current types. Significant price reductions of 20-30% or more could be possible from widespread adoption in the industry of external dry lining systems which could eliminate the need for wet trades when installing EWI. The integration of phase change materials into insulation could also help to increase the value proposition of SWI, particularly if it is able to save energy by improving the thermal mass of the building – the savings may be currently marginal but improved materials, coupled with much hotter summers and significantly increased fuel costs in the next 10 to 20 years might drive demand. Furthermore, these supply side innovations could be combined with improvements and efficiencies in the way that SWI is installed to help reduce costs even further. Clearly there is a lot for the industry to contemplate and plan for if it is also to 'step up to the plate' and help make mass deployment of SWI a reality over the next decade.

A ramp up in EWI installations, following the DECC Central scenario to 88,500 per year by 2022[13], yields supply side turnover of £259m and total direct employment in supply and installation of around 4,300 – nearly double today's estimated EWI sector workforce. Whilst

[13] Note that EWI is modelled as 70% of total SWI installations, or a total of 125,000 installations for 2022

there could be short term bottlenecks in supply and installation, particularly if deployment rates increase rapidly, the supply of labour is likely to catch up with the demand for work in the long term, helped in part by new training schemes established by the Insulated Render and Cladding Association (INCA) for apprentices and those wishing to train up for doing EWI work. DECC has also invested £2m (plus £500,000 from Construction Skills) to help upskill people so that the ramp up to significantly higher installation rates can happen over 3 years.

ES.8 Support interventions

The study's terms of reference called for the development of a set of interventions that can be potentially supported to tackle the observed barriers to innovation within the SWI industry. Insulation manufacturers and system suppliers made a number of diverse suggestions for potential 'innovation support programmes' that the Government might help to fund.

It is noteworthy that very few companies consulted had an immediate RD&D 'wish list' that they felt was critical to the future success of the sector. This reinforces the view that the SWI supply side is relatively mature with established and refined products being sold. This is not a nascent low carbon sector dominated by a raft of pre-commercial technologies – rather it is relatively mature and consolidated. It is also eager to see greater demand and more market certainty which will go a long way towards stimulating investment in more efficient manufacturing processes, as well as reducing system costs through greater volume production.

Key interventions

We have focused on two interventions which we believe address key constraints in the sector:

- The first constraint is the high cost of EWI systems for the demand side. This is a result of EWI being mainly based on wet render which is costly to apply using skilled labour. We have investigated the potential economic and environmental benefits for a programme to support the development and demonstration of new dry lining systems (DLS) to significantly reduce the costs of EWI. We have considered an initial amount of £4 million for public funding;
- The second constraint is the value proposition of IWI systems. Improved functionality from incorporating phase change materials (PCMs) into IWI systems in domestic buildings, which would theoretically help smooth temperatures in homes as well as reduce energy usage, has the potential to create a faster payback for IWI. However, there is currently a significant price differential between current IWI insulation and a novel PCM impregnated product. The modelling of PCMs integrated into insulation across the domestic housing stock is vital in helping confirm the energy savings that these novel materials can bring about. Further demonstration of the benefits of PCMs in real household environments with monitoring and evaluation is also required as to date they have generally only been demonstrated in commercial settings. The total for public funding for this package of support would be around £1 million.

We carried out market sounding of both these innovation interventions, which would be at least 50% match funded by industry, and firms confirmed their interest in bidding into such a support programme.

Both the interventions investigated in detail would help overcome information market failures. The DLS intervention for EWI would enable access to capital and accelerated commercialisation of products; the PCMs insulation intervention would stimulate the tooling up of major companies that could then deliver a potential step change in volume supply of product, enabling price reductions in installation down to more cost-effective levels.

A number of economic impacts are apparent for both interventions, although further research is necessary to determine more exact numbers. For example DLS may be more suited to some house types than others – although indicative figures suggest system cost savings of between 20-30% or more across different property types. For PCMs, the current cost premium of IWI products with PCMs might quickly be reduced after a few years.

The DLS intervention provides impressive resource savings, primarily due to the elimination of three layers of wet render that is normally applied to outside walls coupled with increasing the use of DLS to achieve 10% market penetration by 2022 (five years after being introduced). If such an intervention was successful, in 2022, overall savings of £2 million were available for the BAU scenario rising to £10 million under the DECC Central (Green Deal and ECO) scenario.

For PCMs, the resource savings would derive from energy savings and carbon reductions, both of which are too difficult to model in this study. Indeed, this is a prime reason for public funding to support a significant parametric study together with the development of a more robust model and experimental testing which can clarify these savings.

Other interventions

We believe the SWI sector would also benefit from:

- Investigating the need to support the development of innovative insulation materials that can help take SWI performance to a higher level post 2020 as well as offer most cost effective products. The UK has R&D capabilities in aerogels and related insulation technologies which could be stimulated through government funding support. However, it was not possible in this study to comprehensively map the innovator landscape in this field to build a stronger case for intervention;
- Continuation of a research programme similar to the Energy Savings Trust's solid wall trials, but covering more property types and new systems, in order to build up a larger database of performance by house type;
- Continued support to demonstrate more innovative SWI technologies (alongside other building fabric interventions) via a programme akin to the Retrofit for the Future programme.

1 Introduction

Installing solid wall insulation (SWI) in existing buildings has the potential to reduce carbon emissions from the UK built environment and thus contribute to progress towards decarbonisation targets. As at January 2012, there are estimated to be 7.8 million solid walled houses in the UK, of which over 98% are estimated to have little or no insulation[14]. The fact that 80% of energy costs arise during the service life of buildings[15] provides a compelling market driver for the commercialisation of innovative insulation technologies for the retrofit market. Installation of SWI in solid walled properties would reduce energy usage and also cut carbon emissions.

There are, however, barriers to increasing consumer demand for SWI so that potential carbon savings are be realised. These barriers include the cost, the impact of external wall insulation on building aesthetics, and the 'hassle' factors associated with the installation of insulation. Innovation – of technologies, of systems and business models – will have an important role in reducing and removing those barriers. Prospects for market growth, and thus energy savings, will increase as insulation becomes more affordable, easier to fit and less obtrusive once installed.

In that context, the Department of Energy and Climate Change (DECC) commissioned GHK Consulting (GHK), working in association with the Building Research Establishment (BRE), to undertake an in-depth technology innovation assessment for SWI. The main aims of the study were to identify how innovation[16] in SWI can:

- Help meet climate change targets;
- Help overcome technological, cost and attitudinal barriers to deployment;
- Help to bring UK business benefits.

The consultants were asked to:

- Critically examine the case for intervention to encourage UK-based innovation in SWI, based on an assessment of existing and planned policy interventions; and
- Provide recommendations, underpinned by a robust evidence base, to inform DECC's future policy decisions and (potential) future programme design to support innovation in the SWI sector.

This Final Report provides the results of the study. It contains findings from a literature review and from detailed industry consultations with more than 17 leading companies from across the SWI supply chain (from insulation manufacturers to SWI installers). It highlights the areas where important innovations are occurring and where further research, development and demonstration (RD&D) would help secure outcomes that would support policy objectives.

The report concludes by outlining potential innovation support interventions which the UK Government could help to fund, and for which initial cost-benefit analyses have been undertaken.

1.1 The role of government in SWI innovation

Innovation is the successful exploitation of new ideas. It includes the discovery of new and better ways of identifying, developing and reducing the costs of new and improved technologies.

[14] Based on a DECC estimate that 122,000 properties had installed SWI, equating to 2% of solid walled properties. DECC, Estimates of Home Insulation Levels in Great Britain: January 2012 (www.decc.gov.uk/assets/decc/11/stats/energy/energy-efficiency/4537-statistical-release-estimates-of-home-insulation-.pdf)

[15] Source: National Platform for the Built Environment http://www.nationalplatform.org.uk/uksra/consumption.jsp

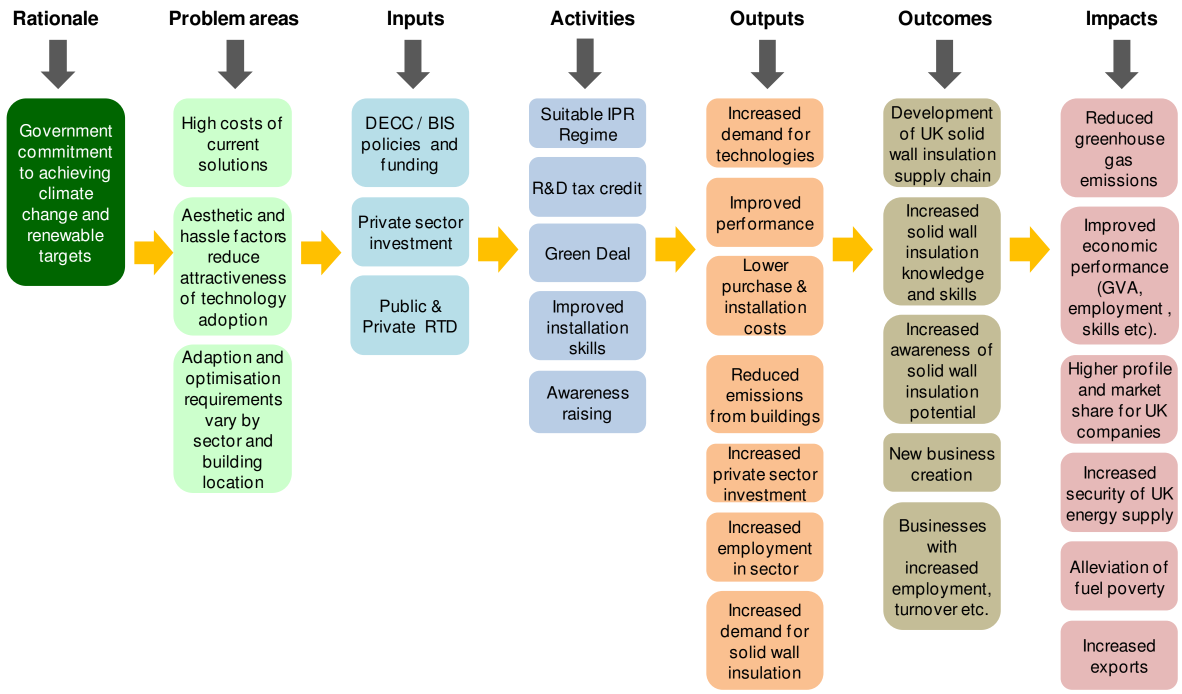
[16] The broadest definition of innovation was used for this study, i.e. covering solid wall insulations products, processes, and adaptation to different buildings/installation techniques, etc.

Innovation in the SWI sector will help it to develop more cost effective technologies and systems. This will not only help the sector's products to comply with more stringent building regulations in the future; it will also enable the industry to offer cheaper and better alternatives to current systems, including making SWI easier and quicker to install.

There is a supporting role for government in innovation. This includes support to the delivery of public goods (such as basic research), and tackling the market failures which hinder investment by the private sector in promising ideas, including information failures (uncertainty over future demand, over technology cost and performance), limited access to finance and positive externalities. The UK Government is already working in partnership with organisations such as the Research Councils, Technology Strategy Board (TSB), Energy Technologies Institute (ETI), Energy Saving Trust (EST) and Carbon Trust, to support technology innovation to address the challenge of climate change.

The intervention logic for government action to support greater innovations within the SWI sector, as well as supporting the market adoption of SWI through incentives for end users, is important in framing this in-depth assessment and has helped to direct our research, consultation with stakeholders, and analysis of potential policy options. An intervention logic model for supporting the promotion of SWI is shown in Figure 1.1.

Figure 1.1 Intervention logic for supporting the promotion of solid wall insulation



Source: GHK

Specific R&D support programmes already in place for the built environment include the TSB's £17 million Retrofit for the Future programme[17]; the ETI's £3 million Building programme which is looking at what is necessary to deliver a step-change in retrofit[18]; and the EST's SWI field trial which has investigated the performance of solid walls, and solid wall insulation directly. All these programmes are either directly or within their overall objectives considering the role of SWI in reducing energy use across the UK building stock. These innovation support programmes are generating performance data and experience in

[17] www.innovateuk.org/competitions/retrofit-for-the-future.ashx

[18] http://www.energytechnologies.co.uk/Home/Technology-Programmes/Buildings/Optimising_Thermal_Efficiency_Project.aspx

retrofitting SWI, as well as helping to determine the most cost effective technical SWI solutions for building stock across the UK.

This study aims to determine whether there is a need for additional and/or more specific support for R&D and demonstration of solid wall insulation.

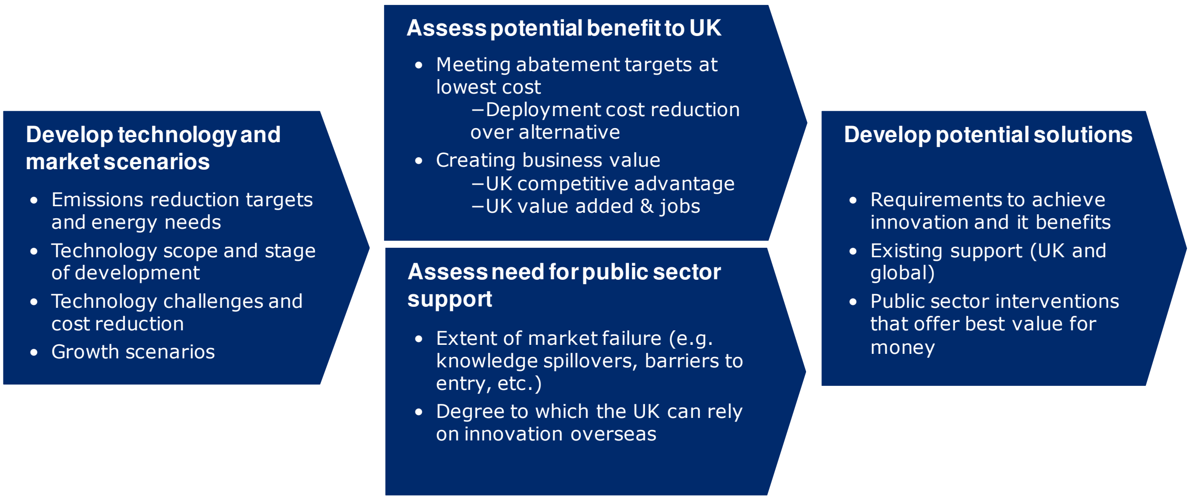
1.2 Assessment methodology

DECC's requirements were grouped into a work package which established two counterfactuals - (i) a world with the Green Deal (including the ECO)[19] and (ii) one without it - and examined future technology scenarios to understand what interventions might achieve both in the absence of the Green Deal (including the ECO) and with it coming into effect in 2012. This included examining impacts on carbon emissions and the economy compared with the baseline.

To undertake these tasks required a clear statement of current technologies and related trends in the market. This was developed using a literature review and in-depth interviews with the SWI supply side industry. Consultations were also used to elicit feedback on potential support for the sector which has been taken into account in the scoping of potential support measures.

The final phase of the study was to assess the need for public sector support for these support measures. A summary of the Technology Innovation Needs Assessment used by Government to establish a case for UK support of low carbon technologies and the potential nature of UK action is shown in Figure 1.2. This provides a high level framework for assessing the need for public sector support and the types of solution that be developed. Following this framework means that different low carbon technologies are all assessed according to the same criteria to ensure comparability of results.

Figure 1.2 Technology Innovation Needs Assessment



Source: DECC

[19] The Green Deal and the associated policy framework are explained in Annex 1.

1.3 Structure of this report

The remainder of this report is structured as follows:

- Section 2 provides an in-depth review of insulation technologies that underpin the current SWI market and the innovations occurring across the supply chain, from insulation manufacturers and system suppliers to the installer base;
- Section 3 provides a detailed market review of the SWI sector including key drivers and current constraints;
- Section 4 defines our technology scenarios and methodology for the domestic building stock analysis together with results from the modelling which includes carbon savings through to 2020 and 2050;
- Section 5 examines opinions of the sector about future market opportunities to 2020 and provides a snapshot of how the SWI industry might look by 2020 given different sales forcasts;
- Section 6 sets out the rationale and details of several support interventions, including a preliminary cost benefit analysis of an external dry lining system support programme and a programme to provide insights into the benefits of incorporating phase change materials into insulation products for domestic houses.

Annexes provide supporting information, specifically, in:

- Annex 1, a summary of the policy context in the UK and similar policies elsewhere in the EU including an overview of several studies that have modelled the employment and economic impacts of large scale retrofit programmes;
- Annex 2, a review of the main RD&D programmes in the UK relevant to innovation in solid wall insulation;
- Annex 3, an examination of the trade in insulation products between the UK and the rest of the EU;
- Annex 4, technology projections conducted for the study;
- Annex 5, a list of study consultees.

2 Technology review

This chapter provides an in-depth review of insulation technologies available in the market today and the innovations occurring across the supply chain both within the insulation suppliers and the installer base. It starts with a description of 'the problem' – the energy performance of solid walls and other walls that are not amenable to use of standard cavity wall insulation.

2.1 Solid walls and other 'problematic' walls conduct heat more quickly than cavity walls – increasing energy bills and carbon emissions

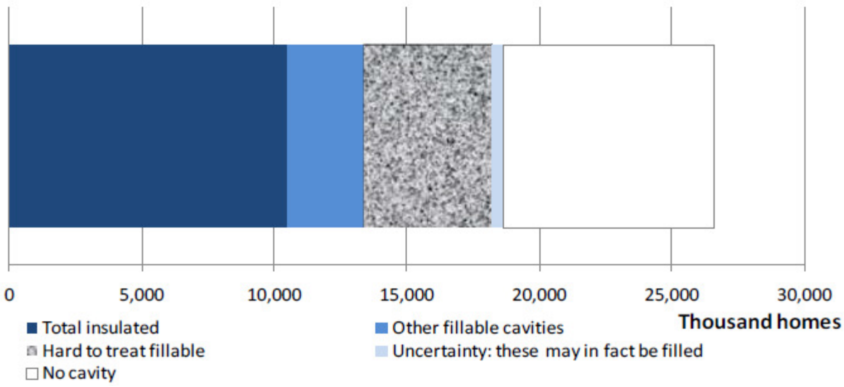
According to the Energy Saving Trust (EST), 45% of heat in an un-insulated solid wall house escapes through the walls, and twice as much heat can be lost through an un-insulated solid wall as through an un-insulated cavity wall[20]. Ambient conditions can also affect the thermal transmittance of a wall. For example, exposure to wind and, in particular, driving rain, will significantly increase U-values[21] as a damp wall will conduct heat out of a building much faster than a dry wall.

It is easy to talk in general terms about 'solid walls' – most studies do. However, this is to vastly simplify the realities of the huge diversity of 'problematic' walls that make up a significant part of the UK building stock. The paragraphs below explain the various types of wall that can be present when contractors consider retrofit solutions, specifically looking at:

- Solid walls;
- Hard-to-treat cavities; and
- Partial cavities.

Statistics released by DECC suggest that of the 26.5 million homes, 18.6 million have cavity walls of which 56% have now been insulated and 7.8 million had solid walls[22]. DECC estimate that there are 8.1 million un-insulated cavities. Of these 3.3 million are considered easy to treat, while 4.8 million are considered hard to treat (Figure 2.1).

Figure 2.1 The walls of around 56% of cavity walled UK homes are now insulated but solid and other hard to treat make up most of the remaining un-insulated stock



Source: DECC. Home insulation levels: New statistical release on home insulation levels, Dec 2010[23]

[20] See www.energysavingtrust.org.uk/Home-improvements-and-products/Home-insulation-glazing/Solid-wall-insulation

[21] U-value is a measure of how much heat loss is reduced through a given thickness of any specific material which includes conduction, convection and radiation.

[22] DECC, Special feature – Home insulation levels: New statistical release on home insulation levels, December 2010 *www.decc.gov.uk/assets/decc/statistics/publications/trends/articles_issue/1101-home-insulation-levels-trends-art.pdf*

[23] DECC, Special feature – Home insulation levels: New statistical release on home insulation levels, December 2010 *www.decc.gov.uk/assets/decc/statistics/publications/trends/articles_issue/1101-home-insulation-levels-trends-art.pdf*

2.1.2 Solid walls

Solid walls are defined by the National Insulation Association[24] as:

- Masonry walls of 225mm (9 inch) thickness and other non-traditional construction types such as single leaf masonry;
- Walls over 225mm thickness (e.g. thick stone walls);
- Concrete walls, metal or timber panels and some mixed wall types – for example, where the ground and first floors are constructed of different materials;
- Walls of high rise flats (at least 6 storeys high) – especially those built between 1953 and 1972.

Houses built before or around 1920 often have solid external walls rather than 'cavity walls'. Cavities were introduced to wall construction to provide a rain screen and to prevent saturation of the inner face of the brickwork, which causes more heat loss through the wall and a poor environment within the property.

2.1.3 Hard to treat cavities

BRE has estimated[25] that around 7% of the unfilled cavity wall stock cannot receive cavity wall insulation (CWI). These are classed as 'hard to treat' cavity walls[26]. One estimate[27] is that hard to treat cavity walls could represent 10% of the housing stock. The term 'hard to treat' also includes walls:

- where there is water penetration;
- where there is no damp proof coursing;
- where ties are missing or corroded;
- that are exposed to wind driven rain;
- that have flood risk cavities.

2.1.4 Partial cavities

Partial cavities occur where a wall appears to be a solid wall but inside there is an irregular cavity. This is the result of builders having used a fair faced brick or stone at the front, but then used and inferior product on the inner leaf, with a number of the front bricks/stones turned inwards to act as ties to the inner leaf. This can produce a cavity of 0-50mm, with a high degree of cold bridging. Such a wall could also be classed as 'hard to treat'.

Some companies are now targeting this market with the intention of using polyurethane (PU) foam to upgrade the wall. One drawback is that the upgraded wall is unlikely to get close to compliance with Building Regulations on its own since it is likely to have substantial amounts of cold bridging, or areas where the foam cannot penetrate. With cold bridging being a key area of focus in achieving effective reductions in dampness and mould, any measures would need to be supplemented with a further, if thinner, layer of insulation to achieve the desired result.

The DECC report prepared by Davis Langdon and Inbuilt[28] covers this topic in detail.

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[24] www.nationalinsulationassociation.org.uk

[25] In the English House Condition Survey which collects information on insulation measures in homes [Available at www.communities.gov.uk/housing/housingresearch/housingsurveys/englishhousecondition/]

[26] Note that "hard to treat" is technically not the same as "expensive to treat". CWI may be expensive either because remedial work is needed or there are access issues. This is important as the ECO covers hard to treat cavities, meaning a mixture of technically difficult and expensive cavities.

[27] Government ACE project report mentioned by one SWI manufacturer – but publication date of report unknown

[28] Study on hard to fill cavity walls in domestic dwellings in Great Britain, Inbuilt Ltd & Davis Langdon for DECC, October 2010 [Available at www.decc.gov.uk/assets/decc/What we do/Supporting consumers/saving_energy/analysis/788-hard-to-fill-cavity-walls-domestic.pdf]

2.2 Insulation improves the energy performance of solid external walls

The average Energy Performance Certificate rating for UK housing stock is 'D'[29]. The average EPC rating needs to be 'B' across the entire housing stock to achieve an 80% CO_2 emissions reduction for the housing stock. SWI has an important role in facilitating that transition.

Introducing an insulating layer to a wall reduces heat transfer by conduction, convection and/or radiation. Solid walls can be insulated from the inside or the outside. The savings that typical households can make from SWI varies considerably. DECC has recently estimated that between £190 and £306 could be saved per year depending on solid wall type[30]; older estimates by the EST put typical household savings at between £445 and 475 per year[31]. The reason for DECC's lower figures is because these take account of the real performance of the SWI once installed. SWI can also:

- help to weatherproof the external walls of older houses which are in a poor state of repair;
- improve the 'look' of a dwelling and so help to regenerate run-down neighbourhoods;
- help to reduce noise transmitted through internal party walls (particularly impact noises), although this depends on the type of insulation[32].

The theoretically optimal insulation solution is to introduce a vacuum. Products which do that do exist but they are expensive and their longevity has yet to be evaluated. The majority of insulation products on the market rely on a material that reduces conduction. It contains very high levels of air in a medium that prevents movement of that air by convection. Some insulation products are foil backed in order to ensure low emissivity of radiated heat to an unheated space.

The SWI used in the UK today is generally a composite system made up of three basic layers – an insulant, a fixing, and a protective decorative finish. The insulation can be applied to external or internal walls. Application of SWI can reduce the typical U-values of 2.05 W/m^2K to around 0.30 W/m^2K. Air tightness and thermal bridging are critical issues which impact on these indicative improvements and are challenges for each project.

The 2010 edition of Part L, Building Regulations, requires the improved U-value of solid walls to be 0.30. However, if the payback period is over 15 years, or the loss of floor area is over 5%, then lower provision is acceptable.

2.3 Insulation can be applied to the internal or external face of the wall

This sub-section describes the main types of solid wall insulation and how they are used. It considers:

- external wall insulation (EWI);
- internal wall insulation (IWI); and
- flexible thermal lining (also known as insulated wallpaper).

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[29] Energy Performance Certificates are produced for buildings following application of a 'Standard Assessment Procedure' (SAP). The SAP considers the rate of heat loss from the building concerned. For example, the thermal transmittance of a standard 225mm wall is $2.05W/m^2K$, meaning that for each degree of temperature the wall will transfer just over 2 Watts for each square metre of wall area. Therefore, maintaining the internal temperature at a fixed temperature requires heating to the value of 2 Watts for each m2 of wall area, per degree required. Thus the front wall of a mid terrace house, at a typical $10m^2$, would require 20.5 Watts of heat for each degree difference between the external and internal temperature. If the temperature outside was zero degrees Celsius and the required internal heat is 20 degrees Celsius then a heat source of over 400 Watts would need to be introduced to maintain the 20 degrees Celsius internal temperature. Other elements of heat loss also need to be factored in so as to calculate the total heat loss, for example heat loss through the building fabric, through air infiltration, roof, floors, and windows.

[30] See Annex A of Final stage Impact Assessment for the Green Deal and ECO, DECC (June 2012)

[31] See http://www.energysavingtrust.org.uk/In-your-home/Roofs-floors-walls-and-windows/Solid-wall-insulation

[32] SWI will not have much impact on external noise as this mostly comes through windows

Table 2.1 provides an overview of each of these types of insulation product.

Table 2.1 Main insulation types

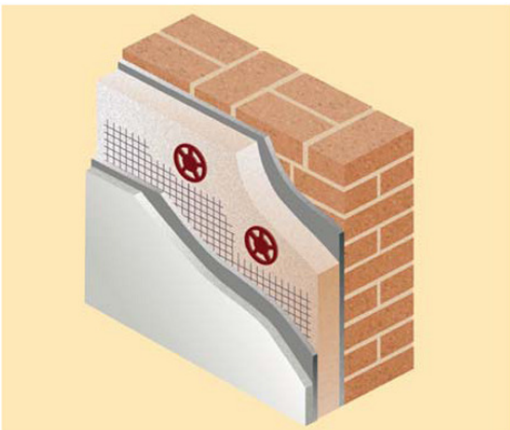
Category	Specific product types	Detailed description
External wall insulation	Wet rendered	An insulation layer (consisting of different types according to design and specification of system), plus a protective layer of render with a decorative finish (that may also be designed with increased functionality such as a self-cleaning surface).
	Dry cladding systems	Dry cladding fixed to the outside of a building.
Internal wall insulation	Spray-applied insulation	Spray polyurethane foam applied between previously erected timber or metal studwork, then covered with plasterboard, or plasterboard can be fixed to foam with dabs or a bonding plaster and finish can be applied directly to the foam.
	Internal rigid thermal board	Rigid thermal laminated board made of insulation-backed plasterboard.
	Built up internal systems	Built up systems use insulation held in place using a studwork frame.
Insulated wallpaper	Internal flexible lining	Supplied on rolls, typically one metre wide. The material is made from latex and has a fiberglass face that allows it to be decorated over. Its main aim is to reduce internal mould and condensation.

Source: Solid Wall Insulation Supply Chain Review (May 2009), report prepared for Energy Efficiency Partnership for Homes and EST; any modifications due to GHK based on market intelligence

2.3.2 Installation of external wall insulation

External wall insulation (EWI) is typically applied by attaching (either by adhesive or mechanical fixings or both) standard size insulation boards to walls and finishing with a reinforced render or cladding. In such cases, the insulation boards are typically 40-90mm thick. The total thickness of the insulation 'system' is therefore 50-150mm. Figure 2.2 provides a generalised view of an EWI system.

Figure 2.2 Schematic of a typical EWI 'system' comprising different components



Source: EST CE309 Guidance Document: Sustainable Refurbishment (February 2010)

Advantages of EWI are that:

- With regard to performance:
  - It eliminates the majority of cold bridging;
  - There is no loss of internal floor space;
  - It increases the fire resistance of walls;
  - It increases moisture resistance.

- With regard to aesthetics:
  - There is the potential to improve external appearance of a building (e.g. with reference to 1960s/70s tower blocks).

- With regard to installation:
  - Insulated render and cladding systems can be applied, on average, in about three to five working days;
  - There is no need for occupants to move out during the refurbishment and installation generally causes less disturbance to the household than fitting internal insulation;
  - There is an established UK workforce, supplemented by installers from elsewhere in the European Union[33].

Disadvantages of EWI include:

- On performance:
  - It is necessary to apply EWI to all adjoining properties to achieve full benefits of eliminating cold bridging;
  - Insulated walls may trap moisture if not managed.

- On aesthetics:
  - It can lead to a loss of character of brick-faced properties if applied inappropriately;
  - There is the possibility of encroachment of the added wall onto the highway (if the house is located next to a road);
  - It may be costlier to make the EWI compatible with ‘heritage’ or ‘conservation’ properties[34].

- On installation:
  - Fitting requires medium to high skill levels, with qualified installer need to ensure professional work, especially the finishing around external services, pipework, windows, etc.;
  - Detailing is needed at roof and ground level to eliminate cold bridging;
  - Scaffolding costs are incurred;
  - Where render finishes are required installation can be affected by the weather.

2.3.3 Installation of internal wall insulation

Internal wall insulation (IWI), also referred to as dry-lining, involves applying a layer of 50-100 mm of insulation to the inside of external walls, then covering it with plasterboard that is fixed on with adhesive and sometimes with metal fasteners. The total thickness is 50-150mm. Installation can be a more involved process, for example, when mineral wool is placed between battens, boards or fixed to the wall in quilts. Spray foam can also be applied (see Figure 2.3).

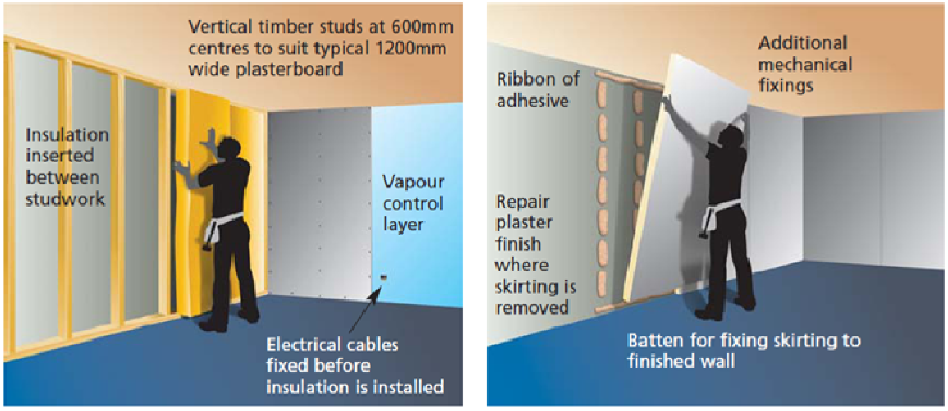
[33] Note that INCA is working with the European Association of Etics (EAE) on European wide Installation Guidance for solid wall properties. Every EU member state will have a section covering their main solid wall techniques

[34] If the building is listed then appropriate planning consents are required for the proposed EWI which may elevate installation costs.

Figure 2.3 There is more than one way to install internal wall insulation

Insulation between studwork

Pre laminated insulation on plasterboard



Source: EST CE309 Guidance Document: Sustainable Refurbishment (February 2010)

Source: Pre-laminated Aerogel in Calderdale. BRE Rethinking Refurbishment

The advantages of IWI mainly relate to installation, in that:

- No scaffolding is needed;
- The installation process is not affected by weather;
- The insulation can be pre-measured for speedy installation and less waste;
- The insulation can be pre-laminated to plasterboard;
- The insulation can be put onto walls as a flexible lining material;
- It can be installed through a qualified installer or by consumers on a do-it-yourself basis.

Disadvantages of IWI are that:

- On performance and building behaviour:
  - Moisture/condensation issues need to be addressed - internally insulated damp walls can freeze leading to cracking/loss of render;
  - It isolates the thermal mass of a building, so for some building types, and in a minority of cases, may lead to problems of overheating[35].

- On aesthetics and use of space:

[35] This potential problem would normally be picked up during an assessment of the building type. For example, building orientation and occupancy type (i.e. whether family or elderly occupied) are further considerations which can lead to overheating. These factors will determine the nature of the insulation and other measures that are specified and installed. See presentation by '*Adapting dwellings for heat waves*', Dr Stephen Porritt, Institute of Energy and Sustainable Development, July 2012. Available at www.goodhomes.org.uk/downloads/events/Porritt GHA slides 09-07-12[1].pdf

- It can result in loss of floor space.

- On installation and cost-effectiveness:
  - Thin solutions are very expensive;
  - There are additional costs in relocating services (electrical, plumbing);
  - Additional detailing is needed to deal with cold bridging;
  - Only part of the house can be done at one time due to access issues and disturbance to occupants (unless the house is vacant);
  - Internal decoration will always be required with IWI.

2.3.4 Summary of installation challenges

A broad conclusion from the above sections on the advantages and disadvantages of installing both forms of SWI (and a view confirmed by our consultations with SWI suppliers and installers) is that that there is no ‘one size fits all’ solution on EWI versus IWI. A ‘mix and match’ of combined approaches is likely to be preferable to achieve the optimal solutions for clients, both from a practical consideration and an economic perspective. For example, many properties will require different approaches to the front (i.e. installing IWI so the exterior appearance remains unchanged) compared to the sides and rear of properties where kitchens and bathrooms would prohibit IWI[36] and so EWI could be installed or even building cavity walls during building extension work.

The ‘combining’ of approaches requires skilled surveyors to understand, design and explain how the systems interact and calculate the overall energy performance of the combined system. This requires specialist skills and knowledge limited to a relatively small number of people. There is a lack of training provision to currently deliver these skills, and this limited pool of skilled people could potentially represent a barrier to future market growth, and increases the risk of installing inappropriate systems.

Of critical importance to achieving higher demand by consumers is whether the installation of SWI will not only make economic sense, but also whether it will fit with their own renovation plans. EST has recently been researching consumer “trigger points”[37] which suggests householders will continue to plan for incremental renovations to their houses over say a 3 year period. Trying to get sign off for a whole house ‘all in one go’ renovation is unlikely to fit well with current householder responses, particularly if it is not possible to draw down grant funding over a longer period that allows for incremental renovations.

A final consideration is that the retrofit of SWI (coupled with other forms of insulation) has implications for how the modified building reacts to extremes of temperature. For example, by increasing the level of insulation, there is potential for overheating on very hot summer days and a loss of thermal mass to control the heat capacity of properties in the winter. This creates an opportunity to incorporate additional functionality into the insulation (see section 6.5 where this is covered in more detail).

[36] Unless it could be installed when a new kitchen or bathroom is being fitted which would in turn require a broader understanding of the benefits of IWI by kitchen/bathroom fitters etc. so that they were able to advise the client in the first place

[37] Further information on ‘trigger points’ (i.e. opportunities for including improvements to the fabric of the house whilst undertaking key renovations) can be found in EST’s Sustainable Refurbishment Guidance Document (CE309), February 2010

2.4 There is a wide variety of insulation technologies on the market

2.4.1 Introduction

Table 2.2 shows the many different types of insulation now being used for solid walls and the associated suppliers. The box below explains the composition of selected types.

Table 2.2 Types of solid wall insulation and examples of manufacturers

Product	Examples of manufacturers supplying into product area[38]
Polyisocyanurate (PIR) foam rigid boards	Celotex, Ecotherm, Kingspan & Xtratherm
Polyurethane (PUR) foam rigid boards	BASF
Spray polyurethane (PUR) foam	BASF, Isothane
XPS (extruded polystyrene)	BASF Styrodur
EPS (expanded polystyrene)	Springvale, Jablite, BASF
Phenolic foams	British Gypsum Thermaline, Kingspan, Xtratherm
Mineral fibre insulated render system	Various suppliers
EPS based render system	Various suppliers
Silicone based render system	Two main types: BASFs polymer render and Weber's cementitious render, some featuring silicone as a self cleaning element
Vacuum Insulated Panels (VIPS)	Weber
Glass wool	Knauf, Isover
Mineral wool	Rockwool, Knauf
Recycled plastic quilt	B&Q HomeEco[39], Homebase (Ecohome)[40]
Aerogels	Aspen Aerogels
Sheep's wool	Second Nature
Cork and Wood Fibre	Various inc. Korktherm, Pavadentro, Westco
Flexible thermal liners	Mould Growth Consultants' Sempatap product

[38] This list is illustrative and not exhaustive

[39] B&Q product is made from 90% recycled plastic bottles see www.diy.com

[40] Marketed as a direct equivalent to glass fibre and produced from recycled plastic bottles. Claims of long term stability and durable for 50 years or more. See www.homebase.co.uk

GLOSSARY OF LEADING INSULATION TYPES

Glass mineral wool - made from sand and recycled glass, limestone and soda ash. The glass is spun to form fine fibres with a resin added to bind the fibres together to form a mat of non-combustible material. Supplied in rolls, a flexible slab or a rigid slab.

Rock mineral wool - mainly made from volcanic rock, typically basalt and/or dolomite, although increasingly made from blast furnace slag. Like glass wool, materials are melted and spun into fine fibres with a resin added to bind the fibres to form a mat of non-combustible material.

Polyisocyanurate (PIR) - made by blending together materials to form a rigid foam insulation product. Heat generated during the reaction enable gases to evaporate and become trapped within cells delivering premium thermal performance characteristics. It is supplied in a large number of thicknesses.

Extruded polystyrene (XPS) - made by mixing polystyrene pellets with various ingredients to liquify them after which a blowing agent is injected to form gas bubbles. The mixture is then forced through a shaping die. When cooled, it produces a rigid and moisture resistant closed-cell foam which is an ideal component of lightweight structural panels.

Rigid polyurethane (PUR) – made by reacting polyalcohols and isocyanates to form a rigid thermosetting polymer. Heat given off during the reaction evaporates a volatile liquid blowing agent contained in the mixture to produce a network of small bubbles in the material. Gas from the blowing agent remains in the cells and improves the thermal performance of the material.

Phenolic foams - supplied as rigid foam boards with the highest density of any rigid board product. Phenolic foam boards are lightweight, strong and very thin.

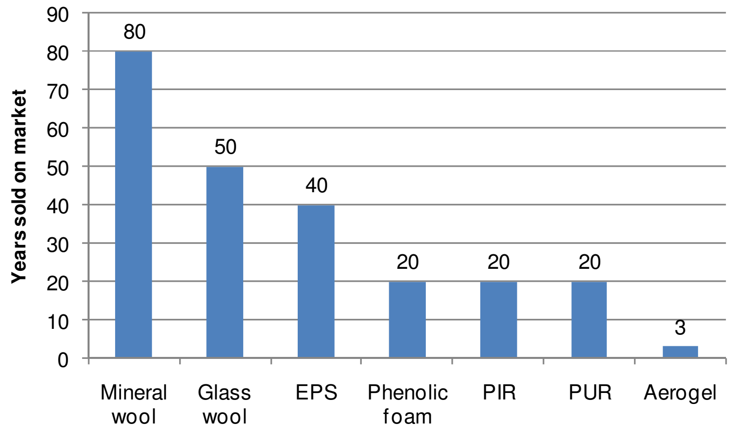
Aerogels – A silica nanofoam, typically injected into a polyester quilt providing class leading thermal properties.

Source: Adapted from Wolseley Group: Build Centre wall insulation trade brochure[41]

2.4.2 Market experience with different products

Mineral wool is the oldest type of insulation product on the market today (Figure 2.4). It has been available for 80 years, glass wool for 50 years and EPS 40 years. These three types of insulation together continue to be a very important. Over the past 20 years, PUR, PIR and phenolic foams have come on to the market. The latest insulation innovation is aerogel which originated in applications within space technologies and the oil and gas industry.

Figure 2.4 Market experience of different insulation types varies widely



Source: BRE. NB: Approximate years sold; Aerogel - 3 years in the UK; VIPS - has isolated use

[41] Available at www.build-center.co.uk/files/downloads/insulation-drylining/Insulation-Walls-P41-64.pdf

2.4.3 Performance of different insulation types

The box below explains how insulation is conventionally assessed, and the derivation of standard measures of performance. Table 2.3 provides lambda values (alongside other parameters) for each current SWI technology to illustrate performance and shows which technologies can be used for different property types.

> The thermal conductivity - or lambda (λ) value - is a standardised measure of how easily heat flows through any specific material, which is independent of the material's thickness. The lower the number, the better the thermal performance, and it provides a quick way to compare the thermal performance of different insulants. Units are W/mK.
>
> The thermal resistance, R-value, is a measure of how much heat loss is reduced through a given thickness of any specific material. It is calculated from:
>
> $R = l / \lambda$ where l = thickness of material in metres
>
> For materials in series, their thermal resistances can simply be added together to give a thermal resistance for the whole. Units are m^2K/W.
>
> The U-value measure of how much heat loss is reduced through a given thickness of any specific material which includes conduction, convection and radiation. The U-value of a material (or several materials in series, e.g. brick and insulation in a wall) is calculated by taking the reciprocal of the R-value (i.e. 1/R-value) and adding convection and radiation heat losses. This is best done using a U-value calculator. Units are W/m^2K.
>
> *Source: EST guidance, CE71 Insulation materials chart (BRE)*

2.4.4 Operational lifetime

Established insulation products such as mineral/glass wool and EPS have been in use for many years. The lifetime of insulation over the very long term (i.e. 30 years or more) is uncertain and certification does not verify performance beyond 30 years. However, recent tests on EPS installed 40 years ago showed there was no loss of performance[42]. Quilted insulation products rely on being dry and not compressed. Where these conditions are met the performance is consistent.

Product certification usually requires products to have a 30 year life and Products certified for the CERT programme also have a 30 to 40 year life, primarily because certification is a prerequisite for Ofgem approval[43].

To illustrate the potential range in the market, vacuum insulated panel systems (VIPS) have an operational life of less than 20 years while Aspen Aerogels claims its product has a 50 year life span.

[42] Consultation with insulation manufacturer

[43] Consultation with SWI system supplier

Table 2.3 Solid wall insulation technology performance

Insulation type	Range of thermal conductivities (Lambda values) (W/mK)	Insulant thickness (mm) required to achieve U-value 0.30 W/m2/K	Environmental rating[44]	Internal	External
Vacuum Insulated Panels (VIPS)	0.008	30	-	✓	
Aerogels	0.013-0.014	40	-	✓	✓
Phenolic foams	0.020-0.025	70	-	✓	✓
PIR polyisocyanurate foam boards	0.022-0.023	80	A	✓	✓
Spray polyurethane foam	0.023-0.028	90	-	✓	
XPS (extruded polystyrene), with CO_2	0.025-0.037	95-140	-	✓	✓
EPS (expanded polystyrene)	0.030-0.045	115-165	A+	✓	✓
Glass wool [up to 48kg/m^3]	0.030-0.044	135-180	A+	✓	
Mineral wool [up to 160kg/m^3]	0.034-0.038	150-160	B to A+	✓	✓
Sheep's wool [25 kg/m^3]	0.034-0.054	150-215	A	✓	
Flexible thermal liner	0.040-0.063	n/a[¥]	-	✓	

[¥] Flexible thermal liners are thin layers designed to be applied directly to a solid wall. A 225mm solid wall with a 10mm liner will achieve a U-value of 1.5 W/m^2/K

Note: U-values calculated based on 225mm solid brick wall, internally applied insulation (with battens and/or air gap where appropriate) and 125mm plasterboard. Fixings and air movement accounted for in calculated figures. All thicknesses rounded to nearest 5mm. Source: BRE Global Ltd, Green Guide to Specification - part of BREEAM (BRE Environmental Assessment Method), an accredited environmental rating scheme for buildings

2.4.5 Carbon reduction potential

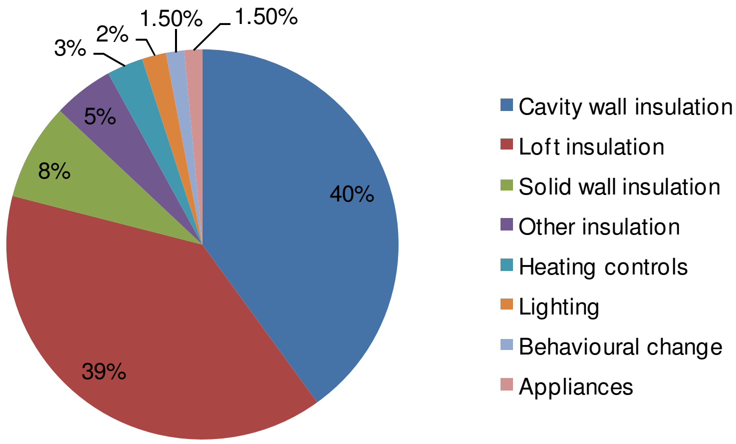
The carbon savings from SWI are potentially significant as there are 7.8 million solid wall properties in the UK[45]. However, to date, the demand for SWI has been much smaller than that for loft and CWI. An analysis of the methods used to cut 20 million tonnes of carbon from the UK's 'footprint' in 2008/9 (through activities which EST helps to monitor) shows that SWI accounted for only 8% of savings, compared with a combined 79% from cavity wall and loft insulation (Figure 2.5)[46].

[44] BRE Global's *Green Guide to Specification* provides a measure of overall environmental impacts for products using a ranking system of A+ through to E, where A+ represents the best environmental performance / least environmental impact, and E the worst environmental performance / most environmental impact. Evaluations are based on issues associated with extraction, manufacture, transport and disposal – sometimes referred to as 'embodied impacts'. Comparison between materials is on the basis of similar thermal resistance, rather than mass or volume. Products not yet rated are indicated – these are likely to be rated over time. More details available at www.bre.co.uk/greenguide

[45] DECC, Estimates of Home Insulation Levels in Great Britain: January 2012

[46] EST, Helping People Save Energy, June 2010 *www.energysavingtrust.org.uk/Media/About-Us/Helping-People-Save-Energy*

Figure 2.5 Cavity wall insulation and loft insulation together provided most of the carbon savings achieved in the housing stock in 2008/9



Aggregate: 20m tonnes of carbon. Source: EST, Helping People Save Energy, June 2010

2.4.6 Embodied carbon from insulation types

Another consideration in choosing an insulation type is embodied carbon. More sustainable forms of insulation, such as natural wool, hemp and straw, are now starting to be used in buildings. Table 2.4 illustrates the wide range of values associated with different forms of insulation. It shows that, in general, as insulation thickness reduces, embodied carbon rises considerably - although phenolic foam does not fit this trends, performing better than PUR and EPS relative to thickness.

Table 2.4 Embodied carbon in different forms of insulation (data from typical pre-1911 mid terrace property)

Insulation type	Thickness	Embodied carbon in kg	CO_2 payback in months
Thermafleece	150	50	0.4
Glass wool	120	63	0.5
Mineral wool	120	97	0.8
Phenolic Foam	60	173	1.5
PUR spray foam	90	205	2.3
EPS	90	216	1.9
Spacetherm (aerogel)	40	763	6.7

Excludes transportation CO_2. Embodied carbon data from www.greenspec.co.uk & manufacturers data

2.5 Current trends in technology development

2.5.1 Innovation factors across insulation types

Most insulation manufacturers continually seek improvements to the performance of their products. For some this also includes investing in new "premium" product development where a step change in performance is being sought. The recent introduction of aerogels into the UK market has certainly acted as a catalyst in this respect because of the high potential insulation performance of aerogel.aiming for performance levels comparable with those of aerogels. However, with the new build market stagnating, manufacturers have been unwilling to invest large amounts of money unless they can see an assured demand for premium products; conversely, companies will invest if a clear market is identified for the period up to 2020.

Currently the insulation market is differentiated by cost, comprising:

- Low cost products - such as mineral wool, glass wools and EPS. These are easily installed though extra thickness is required to achieve Building Regulations;
- Mid cost products – such as phenolic foams, PIR and PUR. These are also easy to install, but are more expensive than mineral wool, glass wool and EPS;
- High cost products – specifically, aerogels. Aerogels command a premium price as they are a new product to the construction industry, therefore they are currently used strategically where thin solutions are needed (e.g. where room size would be compromised), and complement the more traditional insulation types.

The technologies exist to improve some of the mid-range products towards aerogel performance levels, but prices will need to be remain at levels that are not that much higher than current mid range products in order to ensure market take up.

The following section provides insights into the innovation opportunities across the different technologies over the next 5-10 years.

Aerogels

The introduction of aerogel insulation to the UK market has prompted manufacturers marketing other kinds of insulation to improve their products.

With a class leading lambda value of 0.013W/mK, the Part L1B target U-value of 0.30Wm^{2}K for solid walls can be achieved with 40mm of aerogel insulation, with a plasterboard finish. This means a loss of floor area of just 50mm along the external wall. The product can also be fixed directly to a wall, with no need for an air gap or battening. The product is hydrophobic, repelling water so it will not become saturated; it is also breathable - an important factor in dealing with heritage properties. Whilst the product is fragile, it can be used externally under render or in the case of heritage properties, under stucco.

Although aerogels have been around for 80 years, they have only recently been introduced into construction, having previously been reserved for space exploration and insulation of deep sea gas pipelines. The only aerogel solid wall insulation product on the UK market is made in the United States by Aspen Aerogels (Aspen). At around £100 per square metre it is not cheap. Strong demand caused the price of Aspen's Spaceloft® aerogel to increase by 30% in 2010/11. This was primarily a result of the TSB's Retrofit for the Future programme creating a surge in interest for the product across the 80 or so exemplars. This demand drew in most of the available production at the time, at least for Europe and probably wider, hence the premiums increased for a scarce product.

In October 2010, BASF Venture Capital led an investment round in Aspen[47]. The investment enabled a doubling of the capacity of the production plant in Boston, USA, with the additional output coming online from March 2011. It was anticipated the investment would also help to achieve economies of scale and a reduced price per square metre. Aspen is currently

[47] Aspen Aerogels press release (8 October 2010) – see http://press.aerogel.com/index.php?s=25881&item=66360

identifying potential sites for a new factory in Europe which, if the investment goes ahead, could be up and running by March 2013[48].

There are a number of SMEs developing alternative aerogels in the UK, as well as in mainland Europe, though scaling up of the production of these materials to match that of Aspen would be very costly.

The high embodied carbon of this product (see Table 2.4) is an important consideration, and will need to be monitored to see that the economies of scale from increasing production capacity also result in less CO_2 required in the aerogel's manufacture.

PIR and Phenolic

Some of the main suppliers of PIR and phenolic foams are innovating in order to improve their products' lambda values to bring them towards aerogel products.

EPS/XPS

EPS is favoured by the building industry for its versatility and ease of use. It is robust and has been shown to retain its performance over 40 years. It is also useful in flood zones as it is not affected by saturation.

In 1995, BASF invented an enhanced EPS technology for its grey EPS product Neopor® by integrating finely-dispersed graphite particles which absorb and reflect heat. It has since integrated the same graphite particles into its XPS Styrodur Neo® product, introduced to the market around two years ago, enabling it to be 20% more energy efficient than competing products[49] and also 20% thinner than standard EPS boards.

Thinner Insulation

There is no evidence to suggest that there is a product that will improve on the performance of aerogel in the next five years. There is the opportunity for other players to enter the aerogel market. The full potential of aerogel has not been exhausted and thinner products could be developed. However, their stability and lifespan would need to be ascertained, and a full certification process would take a number of years.

Therefore, it can be assumed that insulation projects on less hard to treat properties carried between now and 2020 will need to be planned on a minimum of 40mm plus finish, i.e. 50mm. For the period 2020 to 2050, innovation should bring products to market that are more suitable for properties subject to heritage or conservation related constraints (currently some 2.5 million dwellings).

This leaves a core of just over 5 million properties that are neither less hard to treat or of cultural importance. There is an argument for concentrating on these in the period to 2020. They will need a combination of EWI and IWI that is acceptable to both the owner and the planning authorities.

2.5.2 Other innovations in insulation relevant to the solid wall market

Vacuum Insulated Panel Systems (VIPS)

There are a number of innovators (i.e. developers, some architects and fans of PassivHaus technology) looking to use VIPS in refurbishment. The TSB Retrofit for the Future programme has featured VIPS in both wall insulation and solid doors to bring them up to and beyond the 2010 building Regulations. The current issue with VIPS is that they are a technology that has been transferred from the refrigeration industry, and as such are currently built to a lesser life expectancy (i.e. around 15 years) than the building industry is used to. The main drawback is that after around 15 years VIPS will start to lose their vacuum which reduces significantly the product's performance. Panel penetration by occupants is also a major issue so more protection is required which adds to the product cost. Current products are mostly produced in mainland Europe and the Far East.

48 Consultation with Aspen Aerogels

49 See article on this www.basf.com/group/pressrelease/P-11-103

The building industry is seeking VIPS with at least a 30 year life expectancy for them to be a viable proposition. Certainly as more robust VIPS are developed and costs are reduced they will form a potential solution for the next phase of a UK building retrofit programme, probably post 2020 when the 'harder to treat' properties require more innovative solutions (see section 2.7.2 below).

Dynamic insulation

The principle of dynamic insulation is to capture heat that would otherwise escape through the insulation, by channelling it through holes in the insulation and then to use this heat to pre heat incoming air into the ventilation system of the dwelling. This technique is ideally suited to new build where the layers of the wall can be built up to include air layers to convect the heat up through the structure into the ventilation system. To retrofit this onto existing buildings could be costly. One insulation manufacturer has developed a system in partnership with a spin-out from Aberdeen University,

Another system is the method of using the walls to provide a thermal constant, where by pipes are run though the walls structure and fluids are run through the wall to keep it at a constant temperature throughout the year. The fluid can be heated in exchangers in solar panels, built into the external leaf of walls, or into the roof, even under the roof tiles or slates, or incorporated into Structural Insulated Panel Systems (SIPS). While SIPS have been used extensively in new build in the UK over the past ten years, their application for retrofit has been limited. However, there are opportunities for incorporating SIPS technology into larger programmes for planned maintenance. Tooling up costs would mean that replication of standard sizes is required as bespoke solutions would be more costly.

2.6 Innovation activity across the SWI supply chain

This section details current practices across the SWI supply chain. It helps provides an insight into investments into different types of innovation that are used to improve product performance, reduce costs and improve installation techniques.

2.6.1 Insulation manufacturers

Research and development of insulation types is mostly done by large multinationals such as BASF, Saint-Gobain Isover, Du Pont, Rockwool, etc. The industry also has a number of SMEs bringing new products to market.

Many of the innovations are made at the point of development of the raw materials that are used to make the insulation. Research into more efficient thermal properties is a key focus with the objective of achieving either reduced thickness of the insulation or other properties, such as improved rigidity, robustness as well as added value through lower embodied energy or lower transporting costs.

Most manufacturing companies that were consulted as part of this study claim to be investing in manufacturing developments with a view to enhancing their product's performance. Some are also making improvements to reduce the energy required to manufacture product – so that they are intrinsically greener. Manufacturers are also investing in improved process controls and more advanced analytics as part of a process of continual improvement in their operations. This will help to reduce costs and improve product quality, including lambda values.

One of the obvious areas for manufacturers to consider investing in greater innovation is the need to reduce potentially negative environmental impacts of their products. Considerations include:

- Embodied carbon, including the use of renewable materials to make insulation products (e.g. recycled plastic, cork);
- Reduction of chemicals at the point of installation (for example, reductions in formaldahyde off-gassing from products);
- End of life disposal issues (e.g. recycling schemes for diverting insulation waste form landfill);

- Use of increased recycled insulation products into new products (e.g. PIR, EPS).

The need to consider the impacts of extreme summer temperatures and potential overheating impacts on well insulated buildings is also increasing the interest from manufacturers in the integration of phase change materials (PCMs) with insulation. Such a hybrid technology has the potential to help regulate building temperatures thereby reducing the need for air conditioning demand which could help reduce peak demand.

2.6.2 SWI system suppliers

Component design and supply

Most EWI manufacturing companies claim to be working with their suppliers (typically a few for each component) to reduce the costs of their systems. The presence of overseas suppliers in the market (e.g. for fixings) also provides downward cost pressures.

Combining aesthetics and improved functionality

The aesthetics of SWI products are important and help persuade customers to invest in the technology, especially if it helps to enhance a property. Retrofit of a number of properties can also help to improve the appearance of housing estates, creating intangible socio-economic benefits. Some suppliers specialise in different coloured coatings for improving façades; others are using nanotechnology to improve the functionality of facades. For example, a German speciality coatings supplier has developed a system incorporating titanium dioxide pigments. This breaks down dirt particles into smaller fragments which are then washed away by rainwater improving cleanliness. Another German SWI manufacturer has also developed a superhydrophobic nanotechnology coating which mimics a lotus leaf and is designed to channel water away from the wall.

Dry external finishes

The EWI market is dominated by wet renders. These renders are built up in a number of layers, which is labour-intensive work requiring plasterers working from scaffolding. The rendering process is vulnerable to weather conditions. The scaffolding accounts for much of the cost associated with installation of external systems. Use of a dry fix rain screen could insulate the fitting process from the weather. Insulated rain screens are used primarily on new build and commercial buildings, so the technology exists, but needs to be adapted to the domestic sector. Pre-cut panels with a dry finish could eliminate much of the work and cost, and could be installed from scissor lifts or cherry pickers.

Currently we believe there is only one commercial niche application of an external dry lining system (DLS) targeting domestic properties. The manufacturer supplies an external DLS for park homes[50]. The market potential for park homes in the UK is significant, as there are around 400,000 such homes (or 5% of the 8 million solid wall housing stock), most of which have no insulation and many of the occupants are living in fuel poverty.

The company originally developed a pre-manufactured and pre-painted vacuum insulation panel system (VIPS) using 9mm of aerogel and recycled plastic to form the outer and inner layer of the VIPS. The aerogel was regarded as a good product but expensive and quite difficult to use. The recycled plastic cladding was originally sourced from France but a supplier was found in the UK. As a completely dry EWI system it could be installed very quickly, and in wet weather, reducing installation times by over 50%.

The company has since developed a second generation external DLS for park homes which uses an alternative insulation material sourced from the UK and an external facing sheet pre-coated with a textured resin finish. It is more efficient than the previous product and is significantly cheaper and quicker to produce. All suppliers of the new system are UK based. Independent verification[51] of the installed systems at a park homes site in Cornwall showed

[50] Park homes are residential mobile homes which either resemble bungalows or else traditional static caravans

[51] Undertaken as part of a project for 10 park homes in Cornwall with Scottish and Southern Energy and Cornwall County Council, and the Gamston Mobile Park Home trial with National Energy Action (NEA)

that the system reduced total costs (i.e. system supply and installation) by 50% compared to a wet render system. The firm sees no reason why cost savings of 20-30% or more cannot be achieved for other types of property in the UK, particularly since the UK is felt to have the required expertise and capability to research this opportunity.

Besides this market, the company is seeking to develop similar products for use with other domestic and non-domestic solid wall buildings, as well as exploring export opportunities (see Case Study box 1 below), but recognises the need to demonstrate the cost savings and increased energy performance of these technologies to build market confidence.

Case Study 1: Innovative UK SME gains interest from multinational engineering group and Eastern European market

This supplier of an external dry lining system was approached by the Atkins Group to provide its product for a school classroom renovation project. A school is currently being sought to participate in a trial. Additional financial support would be useful to help fund all relevant surveys as well as before and after installation monitoring tests and occupancy evaluation. The company has also received enquiries from Eastern Europe (e.g. Estonia) to develop and install EWI on Soviet-era concrete flats which have no insulation. EU funds are available for schemes that can improve U-values by 20%.

Another UK SME has a market ready external DLS product for mainstream housing which is currently awaiting system certification. The company has been selling EWI and IWI for traditional house types for eight years so it knows the market well and believes there are large opportunities for exploiting this new technique. Table 2.5 compares the firm's new external DLS with its existing product - cost savings of at least 20% are estimated on a terraced house through material and labour savings. Similar cost savings are believed to be possible for semi-detached houses while savings for blocks of flats would depend on the area being covered and the complexity of job, but they could be higher[52].

Table 2.5 New external wall dry lining system can reduce costs by over 20%

	Existing EWI system	New Dry Fix EWI system
Market status	In market for 4 years	Patent pending & awaiting system certification
Insulation	Phenolic board – 50mm	Pre-laminated double reinforced phenolic weatherboard with choice of top coat (roller finish or brick slip) for additional waterproofing – 56mm
Meshes	Yes	-
Fixings	Adhesive or Mechanical	Mechanical
Joints	Taped	Taped
Wet render	Yes – 15mm	-
Cost of supply & fit $70m^2$ terraced house	£4,500	£3,500 22% cost reduction
Cost per m^2	£64.3	£45-50
Comment	Very labour intensive method Longer timescales to apply Lost hours with weather in UK	Weatherboard avoids material costs of render and expense of wet trades (plasterers) which typically cost £1000 per terraced house. Roller finish with texture coatings can achieve 30 year weatherproofing within 30 minutes

[52] Consultation with SWI supplier

	Can be applied by semi-skilled labour

Re-engineering SWI systems – but at what cost?

One supplier reported that it was aiming to simplify its EWI system for installers, working towards reducing installed supply costs by 25%-50%. According to one SWI expert, a standard EWI system with the cheapest finishes could be supplied and installed for £60/m^2 by re-engineering systems and using less demanding specifications to reduce costs by using, for example:

- Reduced quality fixings;
- Reduced reinforcing scrim; and
- Cheaper insulation without system certification[53].

Costs could be reduced by outsourcing lower quality components. However, this is likely to reduce the integrity of the system. There are also potential ramifications of unrealistic price cutting on the sector (see Evidence box 1).

Whilst certification does incur costs for firms, it does provide an independent assurance of the performance of the productthat can help demand in the sector.

Evidence 1: The problem of price cuts on sector reputation

Price pressure may result in the use of inferior components and products within the systems and consequently inferior specifications. There are examples from the USA, Canada and the UK of SWI failures such as ingress of rainwater behind the system and detachment of the render finishes. These are due mainly to the incorrect installation of the systems and use of *ad hoc* unproven systems and components.

Installation of SWI should only be carried out by experts with many years experience and fully trained in the correct selection and use of all the appropriate components and materials, using fully proven and independent third party certified systems. Failure to observe these principles can only lead to significant numbers of claims in the future for defective systems, loss of confidence in the industry and potential high risk of injury or loss of life due to detachment of finishes. In particular, special consideration should be given to the high risk associated with falling objects from high-rise buildings. The challenge is to cut costs without cutting product quality.

Source: discussion with SWI expert

New insulations measures

The system package for EWI includes fixings, render, finishes and scaffolding as well as the insulation. The marginal cost of additional or higher specifications for insulation is a small part of the overall package value. However, changes in the amount of product required by the market may lead to cost reductions for certain materials.

2.6.3 Installation of EWI and adaptation to different buildings/installation techniques

Cooperation between system suppliers and installation contractors

The largest EWI system suppliers work closely with main contractors and installers on design specifications, for example by calculating U-values and system loads. They also facilitate demand by helping to get projects through the planning process. This creates a valuable market intelligence 'channel' that enables installer experiences and knowledge to be fed back to suppliers, which in turn can inform product development.

Bulk purchasing practices

The industry already regards itself as very competitive and having a focus on cutting costs out where possible. For example, buying in bulk is now widely practiced. One leading

[53] Note that under the Green Deal and ECO all SWI will require certification

installation contractor spotted an opportunity to become a wholesale supplier and this now represents a significant part of its turnover (see Case Study box 2).

Case Study 2: Installer diversifies to create win-win for sector

A leading SWI installer recognised that in London there was no supplier stocking the full range of SWI materials required for jobs. Consequently, firms involved in one-off SWI jobs found it virtually impossible to source products at competitive rates. As a large contractor, the firm has worked hard to bulk purchase equipment for itself. Needing a warehouse for its own operations, it decided that it could help supply the sector at the same time. As a supplier of EWI products, it has been selling products for over 2 years and continues to see business grow.

Making systems easier to install

Simplified systems, and particularly dry lining EWI systems, have the potential to reduce labour costs by reducing installation times and time lost during wet weather.

Innovation in surveys

WHISCERS (Whole House In Situ Carbon and Energy Reduction Solution) is being used in a TSB *Retrofit for the Future* project involving United House, one of the largest social housing contractors in the UK. Measurements of the property are taken by laser and the internal insulation is cut off-site, maximising the potential usage of the boards' surface area. The insulation is delivered ready to install with minimal impact. The house occupants remain in residence during the installation[54]. 3-D imaging of rooms provides precise measurements that can enable rooms to be fitted with IWI within half an hour.

Eliminating scaffolding

Most SWI work is done at the same time as planned maintenance work so scaffolding tends to be *in situ* already. Single jobs other than multi-storey buildings are rare.

2.6.4 Opportunities within the new build sector

The new build market has already helped some SWI system suppliers to diversify their market away from refurbishment. Indeed, SWI is now becoming increasingly important in the new build sector, including the commercial building market. This is because building footprints are getting larger due to Part L of the Building Regulations. For example, on new build sites, as U-value requirements become tighter over time, firms are now looking at wider foundations and wider cavities. An alternative is for them to use thin insulation systems on solid walls (as in other parts of the EU) instead of cavities to reduce wall thickness.

Current challenges are for EWI systems designers to work with manufacturers to keep board thicknesses as thin as possible to avoid extra wide insulation coatings. However, super insulating wall coatings such as aerogels are now starting to become integrated into solid wall systems which will make this end goal easier to achieve. Developments in new insulation materials and designs for SWI are therefore likely to have broader market potential in the future where builders are seeking to develop thin walled houses compliant with Building Regulations. Innovations could also reduce these new build costs.

2.6.5 Summary of innovations

Table 2.6 below provides an overview of the innovations which are occurring throughout the SWI supply chain and their potential impact on price; it also illustrates the other potential issues that investment in innovations will have such as on performance, sustainability and ease of installation.

These insights have been used to inform the learning rates in our SWI technology deployment scenarios in section 4.

[54] A video of installation under the RftF project using WHISCERS is available at rahttp://www.youtube.com/watch?v=-r-sFV-DNtI

Table 2.6 Innovations across the UK SWI supply chain and their potential impact on future prices and other issues

Part of supply chain	Innovation description	Focus of impact (product, system, whole house, company, sector)	Potential impact on future price reductions (High, Medium, Low)	Other potential impacts	Likely timescale
Universities & Research & Technology Organisations (RTOs)	Whole house demonstrators exploring innovative combinations of low carbon technologies including insulation and measures to overcome e.g. condensation, air tightness problems, etc.	System, Whole House, Company, Sector	Low – High	Awareness raising	On-going
Universities & RTOs	Collaborative R&D with companies to help bring new products to market	Product & System	Low – High	GVA, jobs	On-going
Universities & RTOs	Applied research into improved lambda values from novel insulation materials (e.g. polymers, nanotechnology, new environmentally friendly chemical formulations, etc.)	Product	Medium – High	Sustainability	On-going
Universities & RTOs	Innovations in mechanical fixings and other engineering characteristics	Product & System	Low - Medium	Safety, longevity, aesthetics	On-going
Universities & RTOs	Fire safety for new systems	System	Potential Negative impact (i.e. price rise)	Safety	On-going
Universities & RTOs	Research into recyclability of insulation and insulation system wastes on site and at end of life	Product & System	Low	Sustainability	On-going
Insulation manufacturers	On-going improvements to existing insulation product range	Product	No additional cost	Improved lambda values (of 5-20%)	On-going
Insulation manufacturers	New insulation products being developed for introduction over the period 2011 to 2013	Product	Medium (or no additional cost)	Improved lambda values (of 10-50%), aesthetics, ease of installation	Short Term
Insulation manufacturers	Commercially focused research into novel insulation approaches (e.g. dynamic flow systems)	Product	Low – Medium	Improved lambda values (up to 35%), air quality, reduced heating	Medium – Long Term

Part of supply chain	Innovation description	Focus of impact (product, system, whole house, company, sector)	Potential impact on future price reductions (High, Medium, Low)	Other potential impacts	Likely timescale
Insulation manufacturers	Research into phase change materials (i.e. heat storage micro capsules) and their incorporation into insulation materials and the building fabric	Product, System, Whole House, Company, Sector	Low – Medium (or negative impact, i.e. price rise but energy savings)	Enhanced energy savings, Shaving peak demand	Short – Medium Term
Insulation manufacturers	Manufacturing process improvements (e.g. energy reductions) and quality considerations (e.g. better analytics)	Product & Company	Low – Medium	Improved lambda values (of 10-100%), quality, longevity of product	On-going
Insulation manufacturers	Research into recyclability of insulation and insulation system wastes, both for on-site wastes and at the end of the building's life	Product & System	Low	Sustainability	Short – Medium Term
EWI system suppliers	Simplifying system, e.g. through dry lining methods, whilst maintaining U-values	System	High	Ease and speed of installation	Medium Term
EWI system suppliers	Research into new fixing technologies	Product & System	Low - Medium	Safety, longevity	Medium Term
EWI system suppliers	Collaborative research with insulation board manufacturers on new coatings and rain screens	System	Low or negative impact (i.e. price rise)	Improved lambda values, aesthetics	Short – Medium Term
IWI/EWI system suppliers	Improved use of autocad and manufacturing systems to tailor system supply so that it is delivered ready to fit (e.g. modular, pre-painted, etc.) as well as just-in-time production	System	Low – Medium	Sustainability, fitted during wet weather, faster installation	Short – Medium Term
IWI/EWI system suppliers	Improved distribution channels to improve access for the smallest contractors	Product & System	Low - High	Faster installation, greater client access, market consolidation?	Short – Medium Term
Installers	Feedback to IWI/EWI suppliers (and energy companies) on what works well and consumer insights to inform R&D efforts	System	Low - High	Ease and speed of installation, future product	On-going

Part of supply chain	Innovation description	Focus of impact (product, system, whole house, company, sector)	Potential impact on future price reductions (High, Medium, Low)	Other potential impacts	Likely timescale
				development	
Installers	Larger installers working to reduce material costs and labour as well as improve design/specification methods, working in close partnership with IWI/EWI system suppliers	System	Low - Medium	Potential market consolidation, market reputation	On-going
Installers	Potential to avoid using scaffolding (e.g. scissor lifts)	System	Low - Medium	Faster installation; bespoke SWI more commercially viable	Short – Medium Term
Installers	Bulk purchasing of materials	Product & System	Low - High	Affordability to "able to pay" market	Short term
Installers	More rapid diagnostic of walls and surveying (e.g. using WHISCERS laser measurement)	System & Whole house	Low – Medium	Ease and speed of installation, sustainability (reduced wastage)	Short term

Key: Impact on price: Low (<10%); Medium (10-25%); High (25%+). Timescales – Short Term (0 to 2 years); Medium Term (2-5 years); Long Term (5 years +)

Sources: research into the SWI market backed by survey responses from insulation manufacturers, system suppliers and installers, and GHK estimates

2.7 Future approaches to insulating hard to treat solid walls

2.7.1 Innovations required to insulate hard to treat solid walls, 2011 - 2020

In order to meet the 29% emissions reduction target for 2020, it will be necessary to put the 'hard to treat' market into two categories:

- dwellings that can be treated using existing technology; and,
- those that will need product advances to achieve a level of customer acceptance or to solve particular technical challenges.

A critical mass of properties suitable for intervention could be identified by prioritising properties that can be fitted with EWI (i.e. low on aesthetic quality, post-war system properties, etc.) and where rooms are of an adequate size to be suitable for IWI. A programme could then be drawn up using the materials that are available now and the improved products that are likely to be available for installation up to 2020.

There are a million 'non traditional' houses, many of which could benefit from EWI. The systems currently exist to treat these property types (e.g. Wimpey 'no fines'). Whilst there are no formal restrictions to the use of SWI, specific local authority planning departments may not currently allow such interventions as permissible developments. Another issue which needs to be considered includes 'oversailing' of properties onto public rights of way.

2.7.2 Innovations required to insulate hard to treat solid walls, 2020 – 2030

The more 'accessible' opportunities for SWI retrofitting outlined above should provide the mainstay for the sector over the next ten years. Over that period new innovations are likely to come to market that should enable some of the more challenging property types to be tackled. The learning from installation of SWI through to 2020 should also develop leaner supply chains, more efficient installation, and product innovations.

2.8 Cost inflators on SWI projects at the site

It is important to understand why innovation should be necessary in a sector which is well established, albeit struggling to reach its full deployment in the retrofit market. Part of the reason is that costs of SWI materials and systems typically account for 50% of the overall cost of a SWI installation and that costs start to rapidly increase on site depending on the nature of the contract. Existing SWI products and systems are relatively labour intensive (e.g. requiring multiple, on-site applications) and the application of EWI can also be affected by weather conditions. This affects the ability of installers to reduce labour inputs and costs and raises the importance of innovation to develop products and systems that are not only cheaper but also easier and quicker to install.

The complexity of the job - not the SWI technologies themselves - has a huge bearing on overall costs. One leading contractor noted that the price for installation could be anything from £60/m^2 to £100/m^2 depending on how complex the work ended up being. The costs of SWI installations can be inflated by:

- Surveying and design requirements, such as
  - The need to assess what fixings will be needed per building. EWI is typically designed specifically for the building, i.e. bespoke jobs;
  - The need to have accredited surveyors and this cost will need to be factored into the system cost;
  - Hard to treat cavities which require 3 to 4 times the detailed surveying compared to a standard solid wall in order to provide an accurate assessment of the wall structure.
- Fixings
  - Variability in fixture holding capability in different wall types/condition causes more and/or different fixings. Conducting proper pull-out tests may be one of the

steps the less scrupulous contractors may avoid. This is potentially a technology improvement area - the 100% reliable fixture for all wall types[55].

- Roof/window extensions
  - These modifications are very labour intensive and require matching tiles etc. This is a very hard supply chain issue in itself, and potentially one which a business might see an opportunity to fill through supplying small batches of custom roof tiles made to order. The development of insulated eaves carriers and gable details have been considered by industry but not committed to yet.
- Building envelope
  - Boundary issues need to be considered where the existing wall defines the boundary.
- An inability to maximise whole street / estate approaches to EWI
  - Estates and terraced streets often have a mix of council tenants and owner occupiers. One contractor said that the overall cost in a terraced street in Essex would have been lower had the council consulted owner occupiers to ask whether they were interested in installing EWI. The contractor subsequently discovered that some owners might have been prepared to make an investment. The resulting job required more detailing because a continuous finish was not impossible to achieve. EWI installations to date by energy companies in Essex and Luton have also been fairly 'scattergun' which has resulted in whole street approaches, and the resulting benefits, not being considered[56].
- Regulations, for instance
  - Compliance with different fire regulations on multi-storey and in different regions (e.g. Scotland for new build), require different materials and designs.
- Consequential impacts on neighbours and resulting liability claims
  - Specific cold bridging issues have been identified by ETI with attached properties where current standard designs could introduce mould issues within neighbouring properties, which in turn could lead to damage claims. This will require careful surveying and specification to avoid.
- Health & Safety
  - Health and safety does drive cost, but it is essential. Health and safety has to cover not only the safety of the workers, but also the occupants of the houses and neighbours. This requires a large number of procedures to be followed together with training and equipment overheads which can be hard for the 'man & van' sized companies to adopt and very easy for them to avoid, thereby undercutting large firms on price.
  - The trade body INCA has set up an 'Experienced Worker Scheme' with recorded scores per worker which are saved onto a chip on the worker's CSCS health and safety card (now expanded to cover skills). Random audited assessments have also been introduced to verify quality and prevent fraud within the system. The hope is that the SWI industry will mandate that operatives hold this card to raise standards.

[55] The major EWI installers have already carried out some pull out tests for their products on properties such as 'Wimpey no-fines' (these are post-war, mass produced houses that total around 500,000 units across the UK and represent an excellent target market for EWI). Additional benefits are the aesthetic improvement which could help gentrify urban/suburban areas.

[56] Source: BRE

- In this respect, the UK is seen as slightly ahead of the game on SWI skills and training compared to the rest of the EU and INCA is itself helping to shape a European Installation guidance document on SWI working with EU trade body, European Association of External Thermal Insulation Composite Systems (EAE).
- The National Insulation Association (NIA) led SWI Guarantee Agency (SWIGA)[57] is also helping to drive up industry standards by assessing all surveyors and operatives for competence and systems used. SWIGA is supported by many of the leading SWI system manufacturers.
- Construction (Design and Management) regulations (CDM) will apply for large programmes of EWI or IWI, where the value of the contract or number of labour hours dictates it. CDM is important in ensuring that the responsibility is borne by all parties, from client through to designer and installer. Provision may be needed to streamline the process to avoid excess costs due to CDM coordinators needed for main projects.

2.9 Innovation support needs

Annex 2 provides a review of current R&D support programmes that cover the SWI industry including TSB, ETI and EST. It also illustrates **the significant R&D activity relating to low carbon buildings and building technologies across a number of universities and UK institutions**. This includes research and demonstration projects focused specifically on SWI.

Consultations undertaken as part of this study have highlighted that R&D activity in the UK is critical to the development of technologies and installation approaches that are not only appropriate for the UK's diverse housing stock and climate, but also take account of UK-specific implementation and planning barriers. **It is one reason why SWI systems developed to suit the conditions of one country may not be immediately transferable into the UK market without demonstration and monitoring of performance**.

Current and recent R&D funding programmes, such as the TSB's Retrofit for the Future programme, are reported to have been effective at stimulating R&D activity relating to SWI and engaging researchers and industry. However, **interviewees have suggested that there needs to be greater support to encourage innovation and have identified a lack of funding as the main constraint to R&D activity relating to SWI**. Examples of priority areas for the future development of the SWI market, from interviewees involved in R&D, include:

- **Development of 'mass market' products, systems and manufacturing and installation techniques** - interviewees have suggested that most SWI technologies are likely to exist already and that the challenge is now a process of redesign and refinement to reduce manufacturing, supply and installation costs. It is also important to develop products and systems that are easier to install to reduce labour costs but also to 'design out' potential errors in installation, or 'idiot-proofing' products (for example, using tongue and groove systems for EWI panels to reduce the risk of incorrect installation).

- **Involving installers in R&D** - this is linked to the above point, and the fact that poorly installed technologies can make little or no difference to the energy efficiency of buildings. The importance of good quality installations not only emphasises the need to provide adequate and appropriate training for installers, but also suggests that installers have a valuable role to play in the development of products and systems that are easy to install. As noted elsewhere in this report, this is already happening in the larger companies.

- **The provision of detailed data on energy use and technology performance** - access to data is reported to be an issue for researchers and industry, given a relatively small evidence base relating to energy use in buildings and the performance of SWI technologies. This issue is already being addressed through the development of 'energy home' demonstrators under the TSB's Retrofit for the Future programme (which has a

[57] http://www.swiga.co.uk/

database showing house by house performance) as well as through the EST's solid wall field trials. However, there is significant scope for additional R&D activity for this type of project to contribute to the overall SWI evidence base, especially with the introduction of more innovative products.

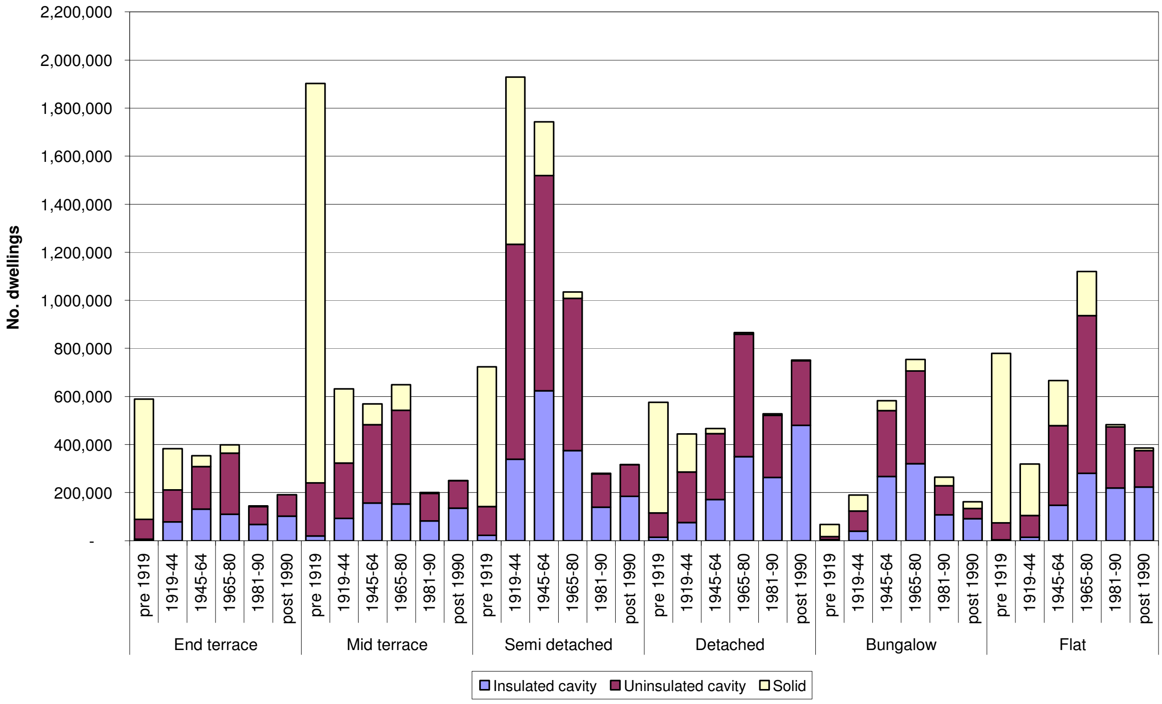
3 UK market review

3.1 Overview of the UK building stock

3.1.1 UK housing stock

The UK's housing stock is estimated at approximately 26.5 million dwellings[58]. Around 30% were constructed without cavity walls and comprise buildings with solid brick, solid stone, pre-1944 timber frame and non-traditional construction (e.g. concrete). Figure 3.1 illustrates the age of this housing stock and main types of building that have solid walls.

Figure 3.1 Cross section of the English housing stock illustrating the occurrence of solid walls



Source: English House Condition Survey

3.1.2 Non-domestic buildings in the UK

There are estimated to be 1.8 million non-domestic buildings in the UK, responsible for 12.4 per cent of UK carbon emissions[59]. These buildings comprise a wide range of different types and uses including: offices; schools, colleges and universities; factories and warehouses; retail shops and shopping centres; hotels, restaurants and leisure centres; libraries; and transport hubs and stations.

The non-domestic building stock represents a significant opportunity for the retrofit insulation market since much of it has poor energy performance. While it is difficult to compare the non-domestic and domestic sectors as they have different energy uses and patterns, the non-domestic market tends to be inefficient in its use or energy, seeing it as a business cost rather than an opportunity to reduce emissions. Often companies that seek more efficient premises will move rather than do up their existing buildings, leaving the less efficient properties unimproved. One estimate from 2009 suggested that about £27 billion per annum was being spent on the refurbishment of commercial and public buildings[60]. Two-thirds of this refurbishment spend (around £18 billion) was estimated to relate to commercial

[58] DECC, Special feature – Home insulation levels: New statistical release on home insulation levels, December 2010 *www.decc.gov.uk/assets/decc/statistics/publications/trends/articles_issue/1101-home-insulation-levels-trends-art.pdf*

[59] DECC, Carbon Plan, December 2011

[60] Kingspan, The UK's approach to the thermal refurbishment of non-domestic buildings, February 2009

buildings, with approximately £9 billion spent on public buildings. These figures are likely to have changed since the onset of the recession.

Many non-domestic buildings have poor fabric, inefficient plant, poor controls and low levels of occupant energy awareness and therefore represent a considerable challenge, but also a significant opportunity as the UK works towards its targets for carbon reductions. The specific issues and challenges relating to non-domestic buildings include:

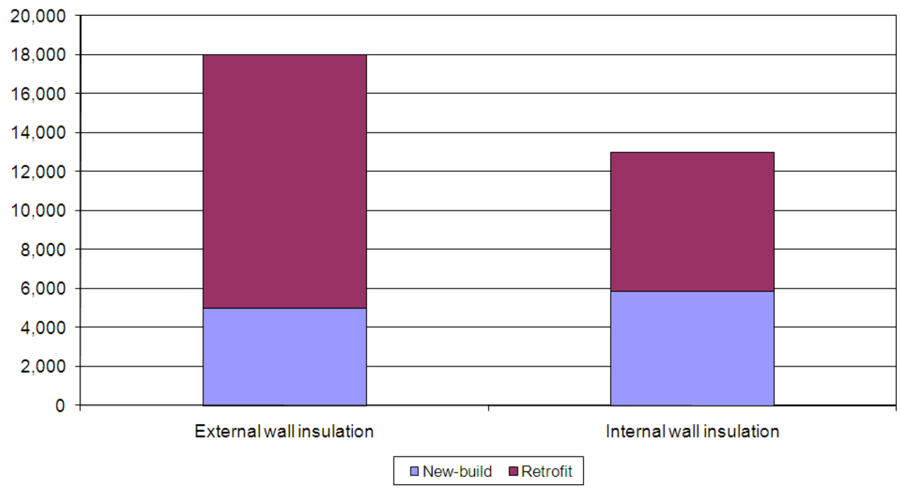
- A lack of understanding, knowledge and data relating to non-domestic buildings and their energy use;
- A reluctance to spend time and money on energy efficient improvements;
- Issues such as landlord-tenant problem, where energy performance improvements will benefit the tenant while the cost of improvements might be the responsibility of the landlord.

The existing stock of non-domestic buildings is younger than the domestic property stock and has a higher turnover. Many of these buildings could be fitted with SWI during refurbishment.

3.2 Solid wall insulation is a small fraction of the UK insulation market

Based on the latest installation estimates of SWI from CERT/CESP by DECC for the 2011/12 financial year[61], and using historical data to inform the proportion of the market that is new build related (see Figure 3.2 which shows around 11,000 SWI new build for 2008), we estimate that the total annual current market in the UK for SWI (both EWI and IWI) in new build and retrofit is now close to 40,000 installations – a 29% increase on 2008 figures.

Figure 3.2 Retrofit of SWI represents the most important proportion of the market, particularly for external walls (based on installations in UK in 2008)



Source: Energy Efficiency Partnership for Homes & EST, Review of solid wall insulation supply chain, May 2009

The information in Figure 3.2 for IWI should be treated with caution[62]. This is because whereas EWI is undertaken by specialist contractors who have a good idea of installation rates, IWI is carried out by contractors, general builders and even decorators. Consequently this level of insight is unlikely to be captured in any 'official' figures, so numbers are not easy to come by. Further, it is estimated that about 10-20% of the IWI market is flexible thermal lining materials.

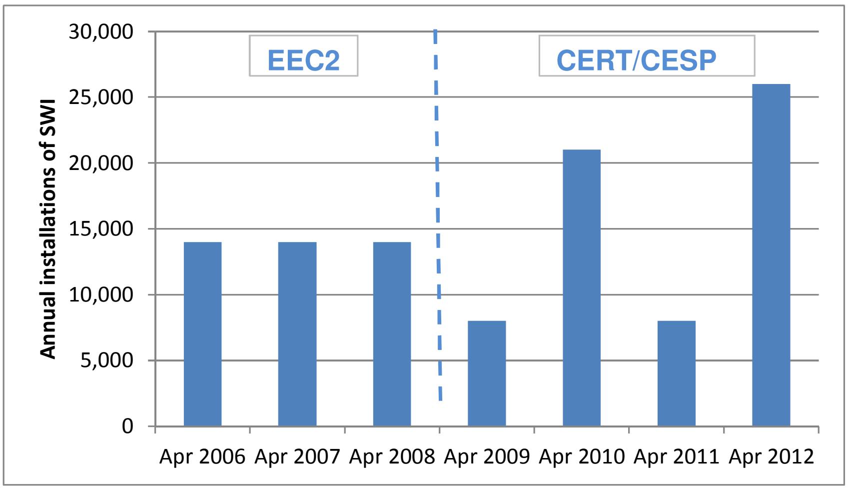
Using data from a number of sources, including published CERT and CESP installation figures, Figure 3.3 shows that over the past 7 years government driven insulation programmes have only recently started to bring about a more rapid rise in SWI installation

[61] DECC, Estimates of home insulation levels for April 2012, Published June 2012. Available at http://www.decc.gov.uk/assets/decc/11/stats/energy/energy-efficiency/5457-stats-release-estimates-home-ins-apr2012.pdf

[62] For IWI, the Energy Efficiency Partnership for Homes and EST report on solid wall insulation (2009) states that "just over half" is in the retrofit market so we have interpreted this to mean 55%, i.e. 45% in new-build

rates. However, given that combined installation rates for loft and cavity wall insulation have continued to rise rapidly under CERT to 1.49 million in 2009 and 2.24 million in 2010, the proportion of SWI installations has dropped dramatically from around 3% of total measures in 2008 to 1% in 2010.

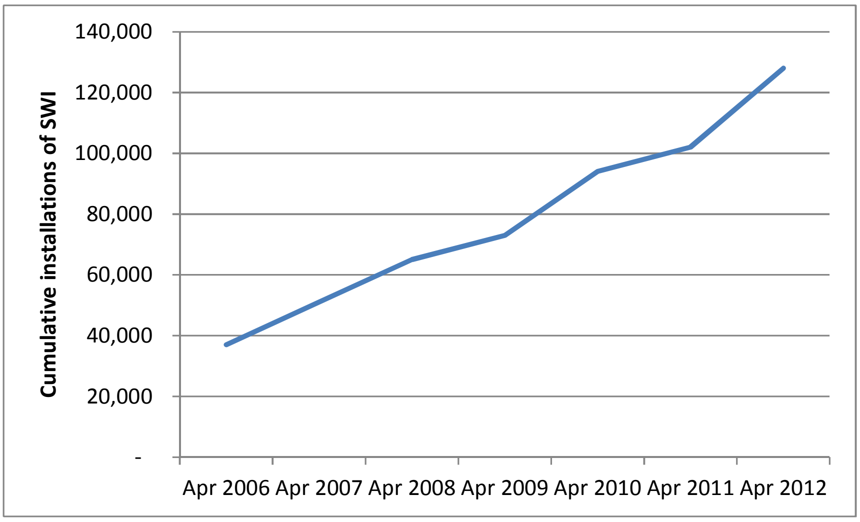
Figure 3.3 Annual SWI installation rate of retrofitted SWI under EEC2 (2005 - 2008) and CERT/CESP (2008 - 2012) (Thousands)



Sources: Energy Efficiency Partnership for Homes & EST, Review of solid wall insulation supply chain, May 2009 (which provide basis for EEC2 estimates between 2006 and 2008) and DECC, Estimates of Home Insulation Levels in Great Britain: January, March and April 2012 (which provide coverage since 2008)

However, in year to April 2012, around 26,000 properties were fitted with SWI (an increase of 28%) **marking a significant rise in total installations (to 128,000) relative to historical rates**. This is important evidence of the industry being able to respond quickly to increased demand for SWI and ramp up supply and installation.

Figure 3.4 Cumulative SWI installation rate of retrofitted SWI under EEC2 and CERT/CESP from April 2006 to April 2012 (Thousands)



Sources: Energy Efficiency Partnership for Homes & EST, Review of solid wall insulation supply chain, May 2009 and DECC, Estimates of Home Insulation Levels in Great Britain: January, March and April 2012. Note: combination of sources allows for a complete retrospective analysis of installation rates back to 2006

3.3 Much of the current demand for SWI is created by the obligations and standards set by public policy

3.3.1 CERT/CESP & local authority refurbishment programmes

As noted above CERT has to date been an important driver of the SWI market. The feedback from consultations with the SWI supply side reflects the reality that CERT is intrinsically limited because the funding levels are lower for SWI than cavity wall insulation (CWI). This is because the energy companies get more points per pound spent on CWI, although SWI scores more points per installation since it saves more carbon over its lifetime than either CWI or loft insulation. SWI therefore still represents a lower carbon return for money spent.

The Community Energy Saving Programme (CESP), which started in September 2010, is a CERT associate programme with a particular focus on hard-to treat dwellings (e.g. those with solid walls) in low-income areas. DECC is responsible for setting the overall CESP target and the policy framework and Ofgem is responsible for administering the programme. CESP was designed as a pilot for delivery of energy efficiency in the future. It has a more sophisticated carbon scoring system than CERT which provides more incentive to fit relatively costly insulation measures such as SWI. However, current guidelines for CESP/CERT funding only require a U-value of 0.35, not the latest 0.3 U-value, so anything better does not gain extra funding.

The extent to which local authorities contribute to schemes is down to respective negotiations with energy companies. In some parts of the country, where local authorities may have planned to commit more to SWI under CESP, feedback from consultations suggests that public spending cuts might slow such interventions. One company elaborated on this situation:

> *"A lot of SWI schemes were lined up but now they are pulling out because of match funding issues. Middlesbrough Council now has no funding available for SWI. It has 728 terraced properties which were identified as renovation targets and would include EWI".*
>
> *Source: SWI supplier*

Energy companies have to deliver CESP obligations by December 2012. The latest annual report on CESP[63] shows that EWI and IWI feature in 62% and 9% of CESP proposals respectively. To the end of December 2011, of a total of 25,826 insulation measures installed, EWI and IWI represented 11,409 (44%) and 976 (4%) respectively. CESP therefore continues to be an important driver of the SWI market.

The Green Deal will be complemented by a new Energy Company Obligation (ECO). This will draw on the strengths of the existing energy company obligation (i.e. under CERT and CESP) but also avoid some of the limitations. Important differences with the ECO are that SWI and CWI will need to be certified; there will also be a significant emphasis within the ECO on the installation of SWI and hard to treat cavities, recognising that these are an important methods of reducing carbon emissions but which also come at a cost that makes them ideal measures to support through the ECO.

This commitment to SWI within the ECO should help to help build longer term confidence in the SWI supply side, which in turn will provide more certainty in investment decisions.

3.3.2 New build market

The new build market is becoming increasingly important for firms as Building Regulations tighten and create an incentive to construct solid walls with SWI. A number of

[63] Ofgem, CESP Annual Report for year ending 31 December 2011, May 2012 is available for download at http://www.ofgem.gov.uk/Sustainability/Environment/EnergyEff/cesp/Documents1/120508%20CESP%20AR%202011.pdf

SWI system suppliers exploit this market and it is also an important market for some contractors.

3.4 The market has been shifting away from mineral wools and towards foams

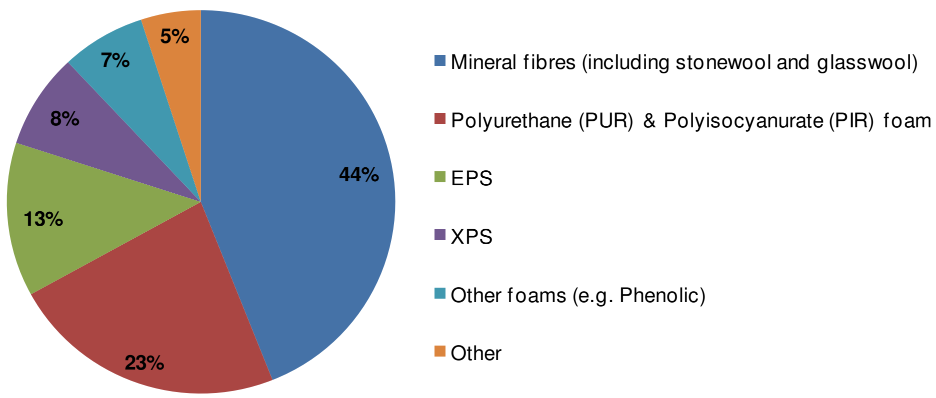
Insulated plasterboard or mineral wool and batts have been the mainstay of the internal wall insulation market. The main insulation suppliers for external walls have been Rockwall (mineral wool), Kingspan and EPS. Figure 3.5 and Figure 3.6 provides an indication of the market value of different insulation types for 2005 and 2010 respectively. Both charts show the **continuing dominance of mineral wools, at close to half the total market**.

Figure 3.6 illustrates the growing market share of Polyurethane/Polyisocyanurate (PUR/PIR) products. These now account for a little over one third (35 per cent) of the insulation market in terms of market value in 2010, compared to 23 per cent in 2005.

Comparison of the two charts shows that the **increase in PUR/PIR has been at the expense of polystyrene insulation** (i.e. EPS and XPS).

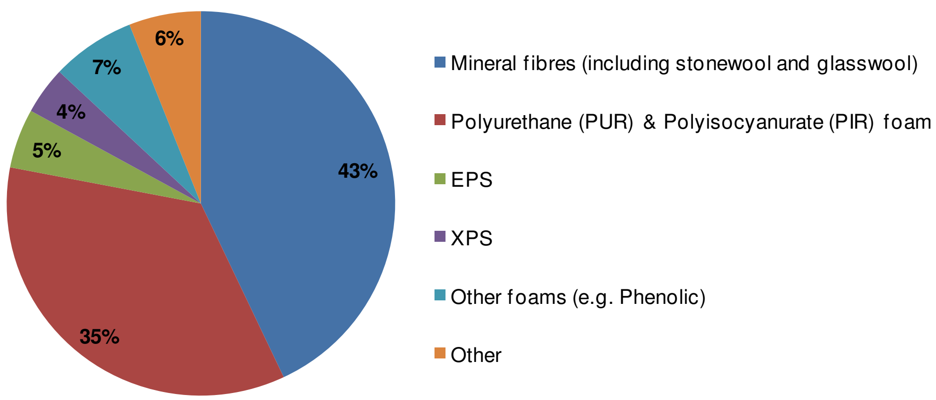
Some of the most innovative and leading edge forms of insulation, such as aerogels, have had limited use to date in the solid wall market and have really only been used on demonstration projects such as TSB's Retrofit for the Future. This is why they do not feature yet on such charts.

Figure 3.5 Insulation market value by insulation type (2005)



Source: AMA Research, quoted in Market Transformation Report on insulation (BNIW01, v.1.3), 2007

Figure 3.6 Insulation market value by insulation type (2010)

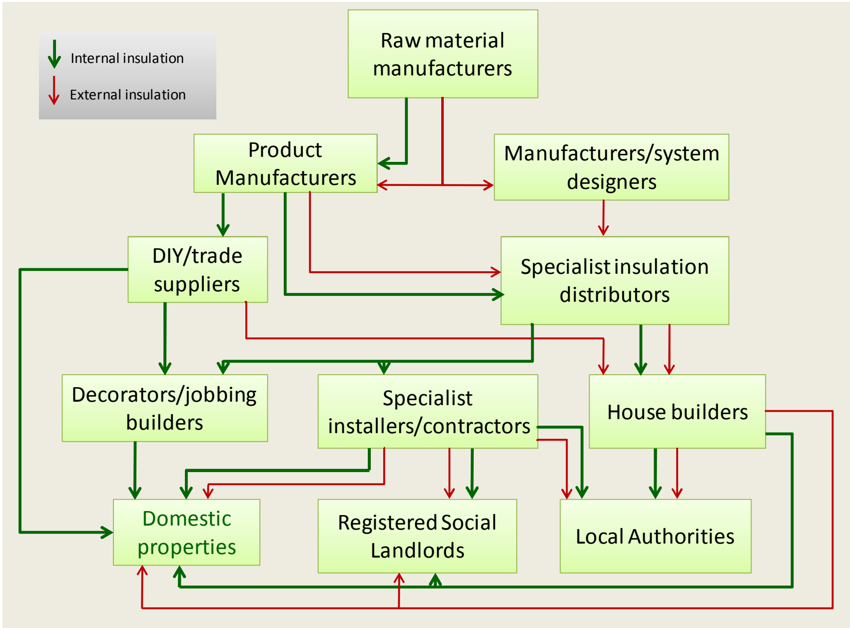


Source: BRUMFA

3.5 Overview of UK supply chains for solid wall insulation

Figure 3.7 illustrates the complexity of the SWI supply chain and shows the different routes that EWI and IWI products follow en route to installation. This also illustrates the role of DIY and trade suppliers in distributing internal wall insulation into the decorator and jobbing builder sector.

Figure 3.7 Material flows within the solid wall insulation supply chain



Source: Adapted from EEPfH/EST solid wall insulation supply chain review, May 2009

Although there is often a degree of separation between manufacturers/system designers and the contractors responsible for installation, SWI system suppliers do work closely with contractors to aid them in the design and specification of jobs and to help projects get through the planning process.

3.6 UK solid wall insulation supply chain

3.6.1 Overview of the sector

There are four main parts to the solid wall insulation market:

- The supply of raw materials;
- Manufacture of insulation;
- Supply of systems; and
- Installation of systems and insulation products.

Supply of raw materials

Germany chemicals companyt BASF is a market leader in the supply of raw materials to the insulation sector. Chemicals supplied include PUR, PIR and EPS. BASF has also invested in Aspen Aerogels which illustrates its interest in horizontal integration across different insulation raw materials and product types; this development could also help to bring much larger volumes of aerogels into the supply chain in the coming years. Another leading supplier is Saint-Gobain, a multi-national firm headquartered in France which also owns a major British EWI system supplier, Weber.

Insulation manufacturers

Due to the travel costs of exporting bulky insulation, especially for loft insulation, many insulation products sold in the UK market are manufactured here, often with imported raw materials. Some larger companies have manufacturing sites serving different regions of the

EU (e.g. Jablite has manufacturing in the UK and Germany; EcoTherm has manufacturing in the UK and the Netherlands). Table 3.1 provides examples of some leading manufacturers in each market, some of which have UK manufacturing sites.

Table 3.1 Examples of insulation manufacturers supplying the UK SWI market[64]

PUR sprayed / injected	PUR Foam board	PIR Rigid board	Phenolic foam board	EPS/XPS	Stone Wool	Glass Wool	Aerogels
BASF[65]	BASF	Celotex	British Gypsum	BASF	Knauf	Knauf	Aspen Aerogels[66]
Isothane	Isothane	Ecotherm	Kingspan	Jablite	Rockwool	Saint-Gobain Isover	
Others*	Knauf	Kingspan	Xtratherm	Springvale			
	Recticel	Xtratherm		Xtratherm			
	Others*	Others*					

*Source: GHK/BRE. Note * refers to other manufacturers who are members of leading trade bodies such as BUFCA, BRUFMA etc.*

Insulation manufacturers generally produce a narrow range of products and are often reliant on the R&D of larger companies such as from speciality chemicals suppliers. However, some manufacturers do fund their own R&D programmes and may well be produce market leading products in their respective insulation market.

Insulation products are either supplied direct to wholesalers as products ready for the IWI market or else are supplied to EWI system 'integrators' according to product designs and specifications.

Solid wall system suppliers

System suppliers source their insulation from manufacturers, and in several cases share the same parent company. There is a well established group of companies that has been supplying systems into the UK market (for EWI in particular) for 20-30 years. Some supply products into both EWI and IWI markets.

Most suppliers started out as UK firms but the majority are now part of foreign multinational companies including from Germany and France (e.g. Sto Ltd was formerly an import business in Scotland called CCS Scotseal that become wholly owned by Sto AG in 2004). Several foreign companies have also entered the UK market over the past 5 markets (but prior to the economic downturn), suggesting a growing and more competitive supply side for SWI. System suppliers in the UK include:

- Alsecco (Germany)
- Alumasc (UK)
- BASF (Germany)
- Dryvit (USA)
- Parex Group (France)
- PermaRock (UK – ultimately owned by Carillion plc)
- Powerwall Systems (UK)
- Sto (Germany)
- Structherm (Germany – ultimately owned by Heidelberg Cement)
- Weber (France – owned by Saint-Gobain Isover)
- Wetherby (USA – ultimately owned by Kraft)

[64] Note this list is illustrative and not exhaustive

[65] Typically sprayed on the underside of roof. Can also be used to line walls

[66] BASF is an investor in Aspen Aerogels

The box below provides a brief profile of a number ofSWI companies in the UK supply side to provide further market context and insight.

Alumasc Ltd is an EWI system supplier focused on the domestic and non-domestic refurbishment sectors, targeting social housing and hard to treat properties; it also supplies the new build sector. Its systems use a variety of insulation types.

PermaRock Ltd (part of Eaga plc in 2007 which itself was bought by Carillion plc in 2011), is the most established SWI supplier in the UK, having been operational for 30 years. The refurbishment market is its key focus, particularly for EWI. Its systems use a variety of insulation types. The company also supplies a product for the hard-to-treat cavity market.

Sto Ltd is part of the German Sto AG group which has over 4,000 employees across the EUTraditionally focused on new build in the domestic and non-domestic sectors, the firm has moved into retrofit in the UK and supplies both EWI and IWI. Sto's R&D and manufacturing assets are located in Germany.

Structherm Ltd is part of the Hanson Group, which in turn is part of German Heidelberg Cement AG. Since 1983 the firm has been supplying a unique structural cladding product that both strengthens and insulates. This product was the mainstay of the business until five years ago when the firm saw the potential to move into render systems. The firm is keen to source more products within the UK on both cost and sustainability grounds.

Wall Transform Ltd is an example of an innovative SME in the sector. The firm has been supplying EWI and IWI systems for 9 years. Awarded a NESTA grant of £30,000 for its first innovation, Wallreform, the firm has gone on to invent several new SWI systems. Despite having a small share of the SWI systems market, the firm is committed to promoting the uptake of affordable SWI and driving costs down in order to bring about a step-change in the deployment of SWI.

Installers

Most insulation types are installed by builders. However, there are specialist firms trained to use proprietary systems with render finishes supplied by many of the larger companies such as Alumasc, Sto, Structherm, Weber and Wetherby. Several of the larger firms use a large number of different systems from different suppliers to give them access to greater market opportunities.

Firms such as Eaga (now part of the Carillion Group) and the Mark Group are main contractors that have been delivering loft and cavity wall insulation (CWI) for many years. Some of these companies have also delivered SWI as part of the CERT programme, although in most cases work is subcontracted down to local specialist contractors. Since 2010, as a result of the introduction of CESP and the prospect of capitalising on a future Green Deal/ECO market opportunity, **larger contractors have started to take SWI seriously as a market and have been gearing up their operations, recruiting divisional heads and diversifying their service offers to embrace a potential growth market**.

3.6.2 Summary of the SWI supply chain in 2010

A detailed breakdown of companies across the SWI supply chain (from chemical suppliers, to insulation manufacturers, EWI system suppliers and contractors) was built up from industry consultations, Companies House data and the FAME database[67] as well as company websites. Key findings include:

- **Turnover across the EWI supply chain in 2010 is estimated at £186m** (Figure 3.8) **with employment of around 2,300** (see Figure 3.9).

[67] FAME, operated by Bureau van Dijk, primarily uses Companies House data. It was used for a number of companies for 2007, 2008 and 2009 data. Companies House was accessed directly for 2010 data and some 2009 data.

Figure 3.8 The EWI industry is estimated to have had a turnover of £186m in 2010[68]

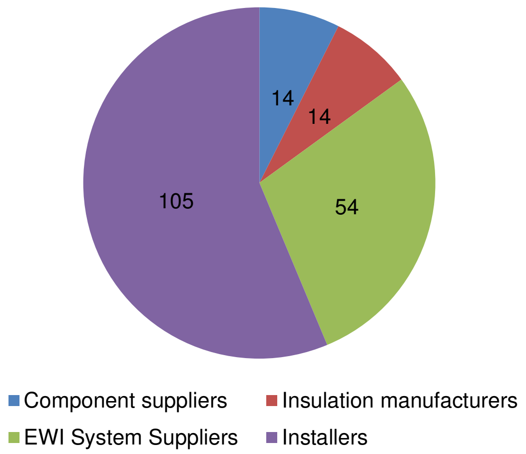
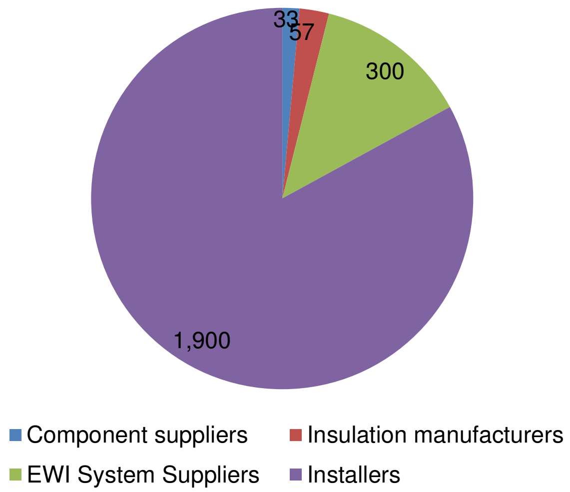


Figure 3.9 It is estimated that around 2,300 jobs were provided by the EWI industry in 2010, dominated by installers[69]



- **Evidence of recessionary impacts between 2007 and 2010 across the supply chain** including:
  - Declines in turnover in several large firms by 15-30%;
  - Reduced profit margins;
  - Reduced employment (in line with the wider construction industry – see Evidence box 2 below).
- **Several niche or smaller players operate in the sector.** This is illustrated by a number of non-disclosed accounts held by Companies House where companies fall below mandatory reporting thresholds (e.g. Alsecco).
- **There is a growing supply side of companies bringing SWI products to market**, thereby challenging market incumbents;

[68] Based on model assumptions specified in Section **Error! Reference source not found.** (i.e. £54m turnover of EWI system suppliers). Insulation manufacturers and component suppliers turnover based on respective shares of EWI system supply (i.e. 52% & 48%) which has been halved to allow for mark up in EWI suppliers. Turnover for installation sector assumed to be double EWI system supplier turnover

[69] *Ibid* – installer employment estimate originally sourced from INCA in the range 1,800 – 2,000

- **New innovations are in evidence through imports and distribution arrangements in the market.** For example, Aspen Aerogels, a leading US company, has supplied into the UK through an established player like Springvale.

Evidence 2: Employment levels in the UK construction industry will not return to 2008 levels until 2016

The Construction Skills Network (CSN)[70] - comprising ConstructionSkills in conjunction with Experian - tracks construction output and employment levels.

In 2008 the UK construction industry employed more than 2.6 million people. Following a 13% contraction in output in 2009 and employment decline of 375,000 workers from 2008 to 2010, the CSN 2012-2016 Blueprint for UK Construction Skills labour market intelligence report[71] continues to forecast an extended recovery period for the construction section, with output predicted to fall by 3% in 2012 and then slowly rising, but still only reaching 95% of its 2007 peak by 2016.

Employment is forecast to start growing in 2014 to return to 2008 levels by 2016. CSN estimates there are currently 49,450 plasterers and dry liners (the sub-sector in which SWI installers are mostly likely to sit) across the UK; employment in this trade is forecast to rise to 51,470 by 2016.

3.7 Performance review of the sector – 2007 to 2010

This section reports on the turnover, profit margins and employment of leading insulation manufacturers, EWI system suppliers and some of the largest installation contractors. The analysis draws mainly on publically available Companies House data, backed by sector knowledge built up from a literature review and consultations.In terms of data availability and quality:

- Across the four years some data points were missing for turnover and profitability. In order to account for these gaps, we used extrapolations based on the average annual rate of change in turnover for companies where figures were available[72].
- In cases where neither turnover nor actual profit/loss estimates were available, it was not possible to compute profit margins.
- Employment figures were available in most cases for all subsectors across the four years. Where these were missing, the same method as that used to determine missing turnover was employed to fill gaps.
- For very large companies, which are vertically integrated, it is difficult to split up and assign turnover to individual operations. This issue also arose for several EWI companies where their turnover represents more than just insulated render systems.

3.7.1 Insulation manufacturers – turnover and profitability

There was a slight decline in the aggregate turnover of the insulation manufacturing supply side[73] from 2007 to 2009, from £680m to £670m (see Figure 3.10). **Aggregate turnover for UK insulation manufacturers recovered somewhat in 2010, increasing by 6% to £712m**.

Over the 2007-2010 period, five major operators (Knauf, Kingspan, Lafarge Plasterboard, Rockwool and Recticel) together account for nearly 80% of overall turnover. Recticel's market share (in terms of its proportion of industry turnover in this sample) had increased considerably by 2010 (11%) relative to 2007 (7%).

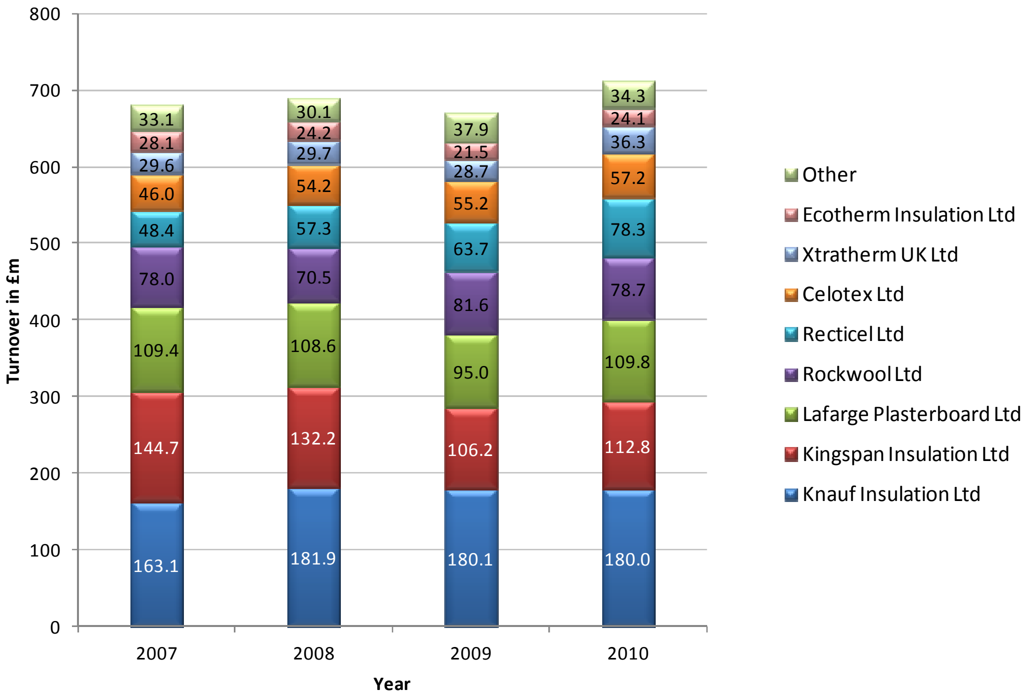
[70] See www.cskills.org/sectorskills/csn/index.aspx

[71] Available at www.cskills.org/uploads/CSN-Report-National-Overview_tcm17-28589.pdf [Accessed June 2012]

[72] For instance, where turnover estimates were not available for 2008, we used the average rate of change in turnover in 2007-2008 (based on instances where data was available) to estimate 2008 turnover

[73] Reported turnover figures apply to all forms of insulation produced by these manufacturers; it being too difficult to split out the SWI component from their turnovers. Manufacturers supply both the IWI market directly via wholesalers and through EWI system suppliers

Figure 3.10 Insulation supplier turnover declined from £680m in 2007 to £670m in 2009, before recovering to £712m in 2010



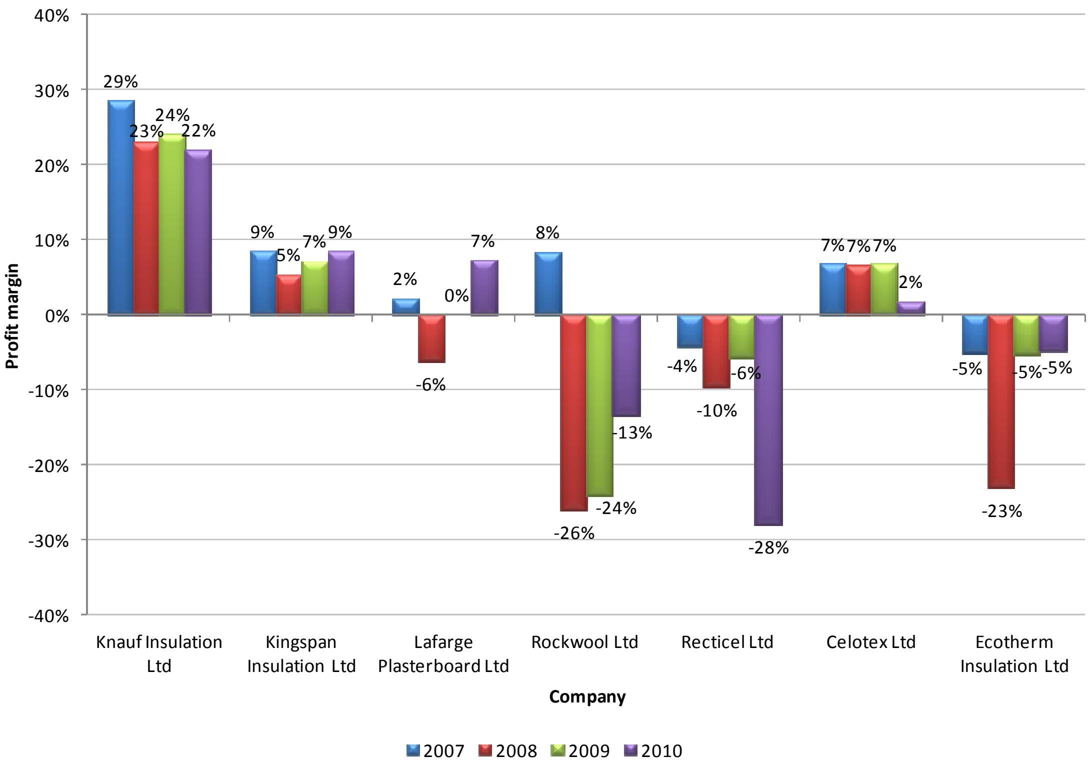
Sources: FAME companies database (accessed January 2011); company websites; Company House reports (accessed May 2012)[74]

Compared to somewhat stable turnover, there is **large variability in the profitability of UK insulation manufacturers**. For example, Figure 3.11 shows that in 2010 Knauf was the most profitable firm in the sector by a long margin, being over twice as profitable as the Kingspan and Lafarge. By comparison, Recticel's increased market share appears to be gained at a price, with profitability at -28% for 2010. Rockwool's profitability has shown a steady improvement over the period.

These findings indicate a variance in the financial health of companies, strong competition and a mixed outlook going forward. For example, one insulation manufacturer noted that if reasonable profit margins on their newly developed products were not going to be achieved, it may decide that further investment in manufacturing for applications in EWI is no longer worthwhile and might turn its focus to other product ranges.

[74] Average annual rates of industry turnover change used in data extrapolation for Xtratherm (UK) Ltd for 2007 and for A. Proctor Group Ltd and Xtratherm (UK) Ltd for 2008.

Figure 3.11 Profit margins – selected insulation manufacturers who supply into both IWI and EWI markets (2007-2010)



Sources: FAME companies database (accessed January 2011); company websites; Company House reports (accessed May 2012)

3.7.2 External wall insulation system suppliers – turnover and profitability

Figure 3.12 shows that for selected EWI suppliers[75] (which we believe to represent a very large proportion of total sector turnover[76]), **aggregate turnover is estimated to have declined by around 18% between 2007 and 2010, from £124m to £101m** (having peaked at £129m in 2008).

At face value, the market appears dominated by a few companies, the largest of which include Alumasc Exterior Building Products Ltd, Saint Gobain Weber Ltd and Sto Ltd. Indeed, these three firms alone appear to account for 75% of sector turnover in the 2007 to 2010 period. While Sto Ltd, part of the German Sto AG group, is understood to be almost exclusively focused on façade systems[77], Alumasc[78] and Saint-Gobain Weber supply more than just the SWI sector and therefore their turnover cannot be solely attributed to the EWI sector. Hence a degree of caution is required in interpreting the relative market sizes of the companies represented in this analysis.

In order to overcome this issue, and to ensure that our interpretation of the EWI supply side is as accurate as possible - and hence our economic impact analysis of potential future growth in the market (see section 5.3) is plausible - we estimated[79] the turnover in 2010 attributable to EWI as £54m. This estimate of turnover is also assumed to cover those companies not featured in Figure 3.12.

[75] Data was gathered on as many firms as possible to build an accurate representation of the EWI supply side. Companies not reporting turnover (e.g. smaller EWI companies and those owned by foreign companies) were not included in this analysis.

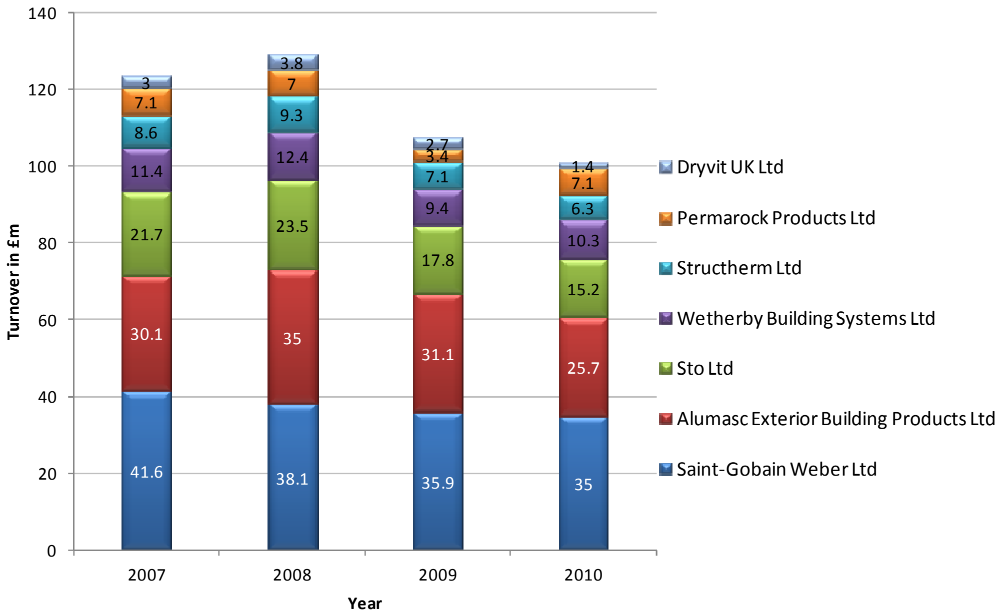
[76] Coverage of firms was validated with sector experts.

[77] See www.sto.com

[78] For example, Alumasc Building Products Ltd supply more than simply Insulated Render Systems through their Alumasc Facades division (www.alumascfacades.co.uk); they also supply green roofing and drainage (e.g.www.alumascrainwater.co.uk/)

[79] Based on market intelligence from consultations with industry experts and research

Figure 3.12 The external wall insulation system supply sector declined by 18% between 2007 and 2010 to £101m but the relative share of larger firms was little changed



Sources: FAME companies database (accessed January 2011); company websites; Company House reports (accessed May 2012)[80]

Profitability for four EWI system suppliers[81] shows a slightly improved situation in 2010, following large declines in 2009 (Figure 3.13). However, across these exemplar companies profitably is somewhat subdued compared to 2007 and 2008.

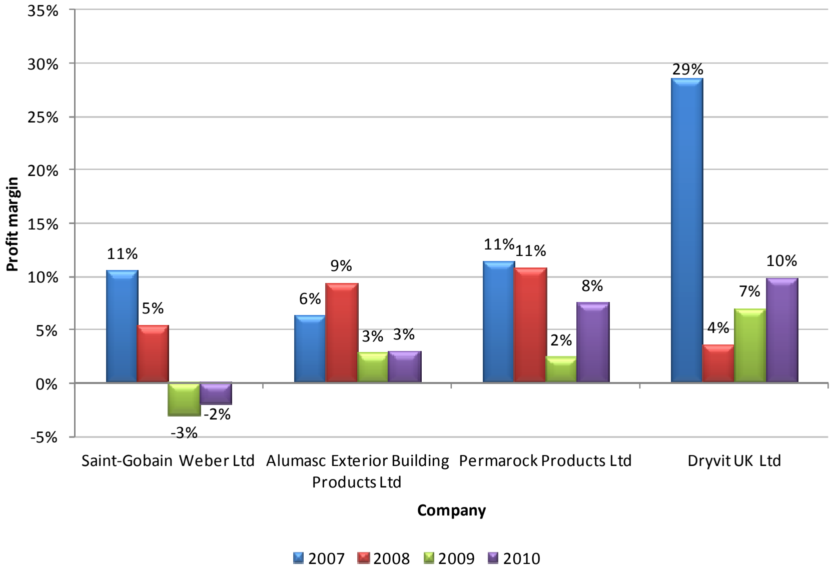
It is interesting to note that this study's consultations with EWI system supply companies in 2011 found a sector that was "hanging on" and awaiting the post-2012 'Green Deal' world with anticipation. This sentiment now appears to be matched by recent company data.

General expectations are that those companies that survive the current period will start to see the industry grow for the first time in years. One company predicted a "10-20 fold increase in the market to 2020". Conversely, without the Green Deal, one leading supplier noted that the industry was likely to stagnate and at worst decline.

[80] Average annual rates of industry turnover change used in data extrapolation for Sto Ltd, Structherm Ltd and Wetherby Building Systems Ltd for 2007 and 2008 and for Wetherby Building Systems Ltd for 2010.

[81] These were the only companies where complete data was available

Figure 3.13 Profit margins – selected external wall insulation system suppliers (2007-2010)

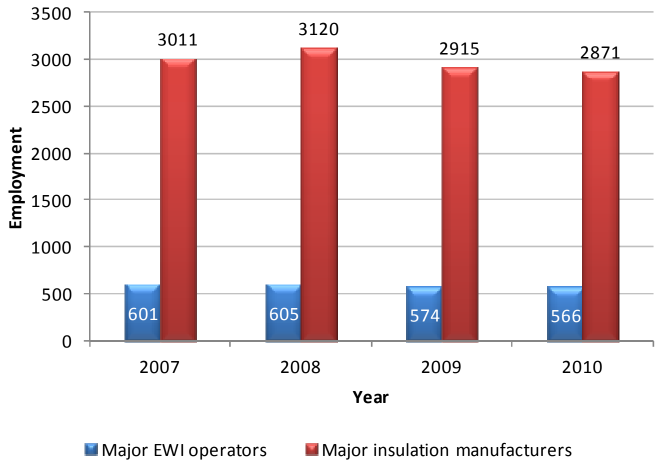


Sources: FAME companies database (accessed January 2011); company websites; Company House reports (accessed May 2012)

3.7.3 Employment in insulation manufacturers and EWI system suppliers

Since employment data is usually available for companies, it is possible to see that over the past 10 years, employment in insulation manufacturers and the EWI industry shows a strong and positive relationship with turnover. Whilst profitability has clearly been impacted by the economic downturn, this has not translated into large employment losses. **There have been only modest employment reductions between 2007 and 2010 of around 5% for insulation manufacturers and 6% for EWI system suppliers**[82] (Figure 3.15).

Figure 3.14 Overall employment – major EWI operators and insulation manufacturers (2007-2010)



Sources: FAME companies database (accessed January 2011); company websites; Company House reports (accessed May 2012)[83]

[82] Figures analysed for Sto Ltd, Alumasc Exterior Building Products Ltd, Dryvit UK Ltd, Permarock Products Ltd, Saint-Gobain Weber Ltd and Structherm Ltd (EWI) and for A. Procter Group Ltd, Celotex Ltd, Ecotherm Insulation Ltd, Isothane Ltd, Kingspan Insulation Ltd, Knauf Insulation Ltd, Lafarge Plasterboard Ltd, Recticel Ltd, Rockwool Ltd, Springvale EPS Ltd and Xtratherm UK Ltd (insulation manufacturers).

[83] Average annual rates of industry employment change used in data extrapolation for Wetherby Building Systems Ltd for 2007 and 2010 and for Isothane Ltd for 2010.

3.7.4 SWI installation sector – turnover and profitability

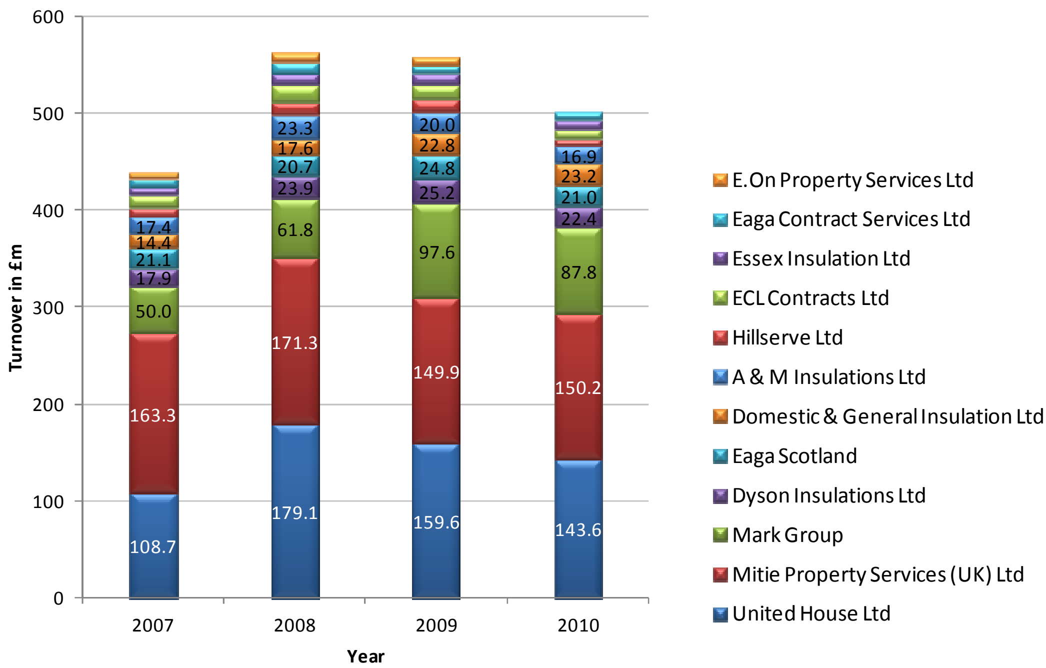
The SWI installation sector is characterised by a mixture of very large, multi-service contractors such as Eaga (Carillion), United House, Mark Group, Mitie, etc. together with a large number of medium to small contractors and numerous micro businesses (i.e. less than ten employees). Furthermore, there are high levels of subcontracting by major and medium sized installation contractors to smaller operators across the UK. Multiple subcontracting, where a job is cascaded down through several companies, is also not uncommon.

Whilst there are too many installers to analyse (for example, trade associations NIA and INCA both have over 40 installation companies as members), we believe that the selection of companies provides sufficient insights into sector performance and is likely to be representative of the wider sector.

Figure 3.15 shows that **insulation installers experienced a peaking of turnover in 2008 followed by a gradual downward trend, reflecting a general decline in outputs across the construction industry**.

Given the small current size of the SWI market, it is clear that most observed turnover is related to other forms of insulation installation (i.e. loft, CWI, etc.) as well as other types of property services.

Figure 3.15 Turnover – insulation installers (2007-2010)



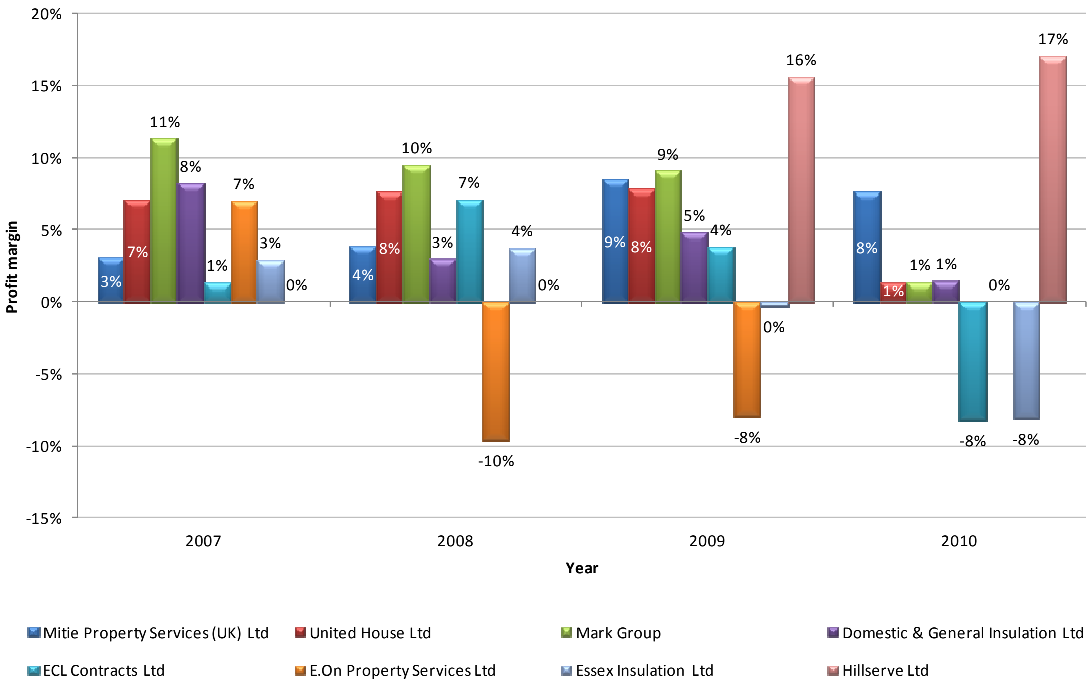
Sources: FAME companies database (accessed January 2011); company websites; Company House reports (accessed May 2012)[84]

[84] Average annual rates of industry turnover change used in data extrapolation for Eaga Contract Services Ltd, Dyson Insulations Ltd, A & M Insulations Ltd and Hillserve Ltd for 2007; for Dyson Insulations Ltd and Hillserve Ltd for 2008; and for Eaga Contract Services Ltd and Eaga Scotland for 2010; E.On Property Services Ltd was dissolved in March 2009.

Between 2007 and 2010, profitability in the sector has changed dramatically. Stable and modest profit margins in 2007 were followed by most companies experiencing steady declines (Figure 3.16). The performance in 2008 and 2009 of E.On Property Services was clearly atypical of the sector at the time and it subsequently ceased trading.

However, with the exception of Hillserve which appears to operate with exceptional margins, **few companies have been able to prevent a long time decline in their profitability**. By 2010, margins for many companies had fallen to record lows – for example ECL Contracts and Essex Insulation both saw significant declines between 2009 and 2010.

Figure 3.16 Profit margins of selected insulation installers (2007, 2009)



Sources: FAME companies database (accessed January 2011); company websites; Company House reports (accessed May 2012). Estimates for 2007 and 2008 unavailable for Hillserve Ltd; E.On Property Services Ltd was dissolved in March 2009.

3.7.5 SWI installation sector – employment

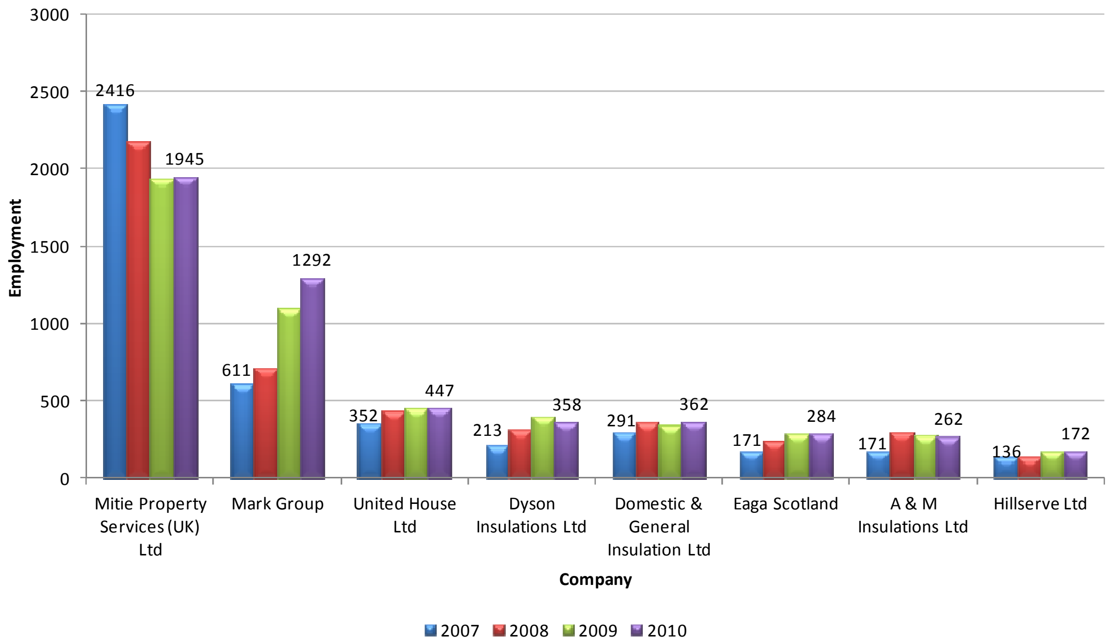
Figure 3.17 shows that, with the exception of Mitie Property Services, **the largest insulation installers had more UK employees in 2010 than in 2007**. Aggregate employment amongst major operators rose by 15% from around 4,600 employees in 2007 to over 5,300 in 2010. When compared to turnover and profitability rates, **these figures suggest that contractors have been reducing their prices to retain and win work, sustaining employment levels but at the expense of profitability**.

While this analysis illustrates the status of the largest installation contractors, **the SWI installation industry is dominated by small companies with an estimated total current workforce of around 1,800 to 2,000 skilled EWI installers[85].**

Many of these small companies are subcontracted by major contractors. For some firms this situation and difficult current trading conditions pose potential future problems (see Evidence box 3 below).

[85] INCA

Figure 3.17 UK-based employment of selected insulation installers (2007-2010)



Sources: FAME companies database (accessed January 2011); company websites; Company House reports (accessed May 2012) – selection of 8 companies with highest employment estimates[86]

Evidence 3: Current difficult trading conditions for many SWI installers may impact on the sector's ability to respond in future

Installers are currently facing difficult economic and trading conditions, both for new build and refurbishment. In some cases SWI installers have suffered significant losses for unpaid work where the main building contractor has gone bankrupt. The market has become even more competitive and cut-throat and there is increasing pressure for installers to cut costs to win work which in turns creates pressure to reduce labour costs, overheads and profits to remain competitive.

The costs of SWI materials apparently increased over the period 2010 – 2011, further squeezing labour costs and overheads (which installers cannot pass on to consumers) and profitability.

The stagnant market for SWI installations can affect the ability of installers to respond as and when demand improves. SWI installers will only be able to survive for a limited time in the current environment and there are risks that some will go out of business. This in turn could lead to skilled labour being lost from the market. Since the application of SWI is a specialist skill that takes time to master (i.e. like plastering, etc.) to rebuild a skilled labour force will inevitably take time.

There are some suggestions that employment reductions have already happened to an extent, with the most significant declines amongst the migrant labour force working in SWI installation. This reduction in installation capacity has not been a major issue to date (since new SWI contracts and work opportunities have also declined), but could present a barrier to future growth.

Trade association INCA has recognised this potential problem and has established an apprenticeship scheme to help attract and nurture new talent into the industry. It has also introduced a scheme to help people to undertake training in order to work in the SWI sector (e.g. plasterers). In addition, DECC has invested £2m (plus £500,000 from Construction Skills) to help upskill people so that the ramp up to significantly higher installation rates can happen over 3 years.

[86] Average annual rates of industry employment change used in data extrapolation for United House Ltd and Essex Insulation Ltd for 2010; E.On Property Services was written off and dissolved in March 2009.

3.7.6 Recent consolidation across the insulation installer base

It is of interest to note that in 2010, Centrica plc bought Hillserve (the most profitable contractor in 2009 and 2010 in this sample) and ECL Contracts. Centrica clearly see an opportunity for larger market share in the insulation installation sector over the next 5-10 years. The potential for the Green Deal and ECO to happen also makes any move into these markets by Centrica and other utilities more compelling. Interestingly, Centrica's acquisitions dovetail with others that the firm has made covering the installation of energy efficiency and microgeneration products. For example, through subsidiary British Gas, it bought Semplice Energy in 2009 which now forms part of its Energy360 service offer[87].

Carillion plc also acquired Eaga plc for £306m in February 2011, helping to considerably enhance its presence in the insulation market (including for CERT related installations).[88].

3.8 UK strengths and weaknesses

3.8.1 The potential size of the UK SWI market is comparable with that of other major EU economies but at all levels it has become increasingly international

The large potential market for SWI in the UK[89] - provides the **opportunities for scale up and economies of scale, especially in maturing supply and distribution channels[90]**. This could help to drive costs down, particularly for local installers.

Foreign-owned multinationals dominate the insulation supply sector. Leading firms in this category include BASF, Knauf, Rockwool and Saint-Gobain. There is also **vertical integration between insulation manufacturers and UK system suppliers** (e.g. Saint-Gobain owns Weber Ltd). It can be expected that **the same firms who dominate the EU SWI markets will continue to capitalise on growth in the UK market, with interactions on innovation between these markets as well**[91]. Sto AG, for example, has a large share of the EU market, and over 4,100 employees. The increasing presence and market entry of these firms in the UK SWI market indicates the:

- long term market opportunities that are clearly evident to foreign companies;
- potential for future innovations to be brought more quickly to bear on the supply of marketable SWI products;
- potential for further consolidation of the sector from such firms wishing to buy into established client bases and long UK track records should the SWI market start to grow at a faster pace than it has until now.

3.8.2 The UK has a relatively strong research base in sustainable construction

A large array of UK universities and research institutes are currently undertaking R&D relating to the sustainable construction sector (see Annex 2). The UK has a strong materials science base and is also well known for innovative manufacturing research. **A number of SWI suppliers are working with the university sector although the scale of this interaction appears somewhat small-scale and project focused**. There does not appear to be an overall industry thrust to coordinate leading edge R&D that would yield sector wide

[87] See www.energy360.co.uk/ for further details. In 2008 Centrica also took a 10% stake in CRM Fuel Cells for £20m - believed to relate to the potential for the proprietary fuel cell technology to be a major component in domestic micro-CHP boilers.

[88] www.bbc.co.uk/news/business-12430202

[89] The UK market is currently of a similar size to France but is considerably smaller than other EU countries including Germany and Poland (source National Insulation Association – market size table available at http://nationalinsulationassociation.org.uk/downloads/NEA%20Con%20-%20Copy.ppt

[90] Interestingly, the SWI supply side is understood to be less streamlined in other major EU markets than it is the UK. According to one EWI supplier, there are 130 EU manufacturers of render, although the company was unsure whether all of these firms supplied insulated render.

[91] Consultation with EWI system supplier

benefits, although some of the companies consulted would be interested to know how Government might fund something in this area.

3.8.3 The SWI sector needs to 'raise the bar' in commercialising more innovative forms of insulation system that utilise UK research strengths

To date the UK has been relatively poor at developing energy efficient building materials. This is a sector in which Germany and Scandinavia have developed a comparative advantage.

Whilst the UK has world leading low carbon house-builders helping to lead the way towards low and zero carbon housing, there is currently insufficient impetus and scale in demonstrating and testing the market. **The majority of projects either focus on building individual high-end homes for the 'environmentally-aware' consumer or focus on social housing, rather than testing and preparing for the mass-market, large-scale building of private housing**.

Nevertheless, UK companies have developed some world class technologies. More progressive legislative tools have also caused the UK construction industry and supplier base to adapt and introduce more low carbon products and processes[92].

The development of new technologies has tended to be characterised by the innovation of existing materials, rather than development and adoption of new, discrete technologies. Examples include the use of: concrete to retain and store heat; intelligent air flow design to cool buildings in warm weather; and hemp lime concrete. Low carbon materials not only deliver a reduced carbon footprint associated with the construction process; they also reduce energy requirements throughout the lifetime of the building.

3.8.4 R&D capabilities vary across the sector

Table 3.2 identifies specific strengths relating to UK capabilities compared to other countries. **Overall there is a mixed range of capabilities across the main insulation areas**. Some areas of R&D are dominated by foreign companies (whose main R&D assets are located outside the UK), whereas others have clear UK strengths. The market strength of BASF is evident across several key insulation types.

Table 3.2 Assessment of UK R&D/knowledge assets in production of solid wall insulation in relation to wider international activities[93]

Insulation type	UK Capability	Summary of strengths / weaknesses
Mineral wools	Low	Rockwool, Knauf, Saint-Gobain Isover and others dominate sector with R&D assets outside UK
PUR	Medium	Some indigenous suppliers like Isothane, although BASF intimately linked into entire industry due to bulk chemical supply. Main BASF R&D assets in Germany
PIR	Medium – High	Celotex (UK) and EcoTherm (UK/NL) are engaged in market leading R&D
EPS	Medium - High	Springvale and Jablite represent a solid UK presence. BASF represents strong competition in this space
Phenolic board	Medium - High	British Gypsum (part of Saint-Gobain Isover), Kingspan (UK) and Xtratherm (UK) are all engaged in market leading R&D
Aerogels	Low - Medium	Some early stage, pre-commercial R&D (helped by prospect of large market potential)
Insulated paper	High	Market leading Sempatap product produced by Mould Growth Consultants in Surrey

[92] BIS, DECC (2009), The UK Low Carbon Industrial Strategy, p.40

[93] This is illustrative and not exhaustive

3.8.5 The use of off-site construction methods is increasing

Increased off-site production has resulted in reduced wastage of materials in the UK building industry. The UK is seen as one of the leading markets for this, coupled with sophisticated procurement and 'just in time' construction methods compared to many other developed nations. Globally, Japan leads this market, where prefabricated houses account for roughly one in seven newly-built houses.[94] **There is an opportunity for the SWI installation sector to embrace these off-site production techniques in a more concerted manner**.

3.8.6 The UK has a positive trade balance in insulation materials

GHK conducted an analysis of UK trade over a ten year period using Eurostat's trade database, COMEXT, to investigate six major insulation materials applicable to the SWI market[95]. The analysis is designed to illustrate the relative strengths of the UK and any comparative advantage across the insulation sector. The trade codes used are described in Annex 3 which also provides a detailed breakdown of UK intra-EU trade for the six insulation types.

While the overall trade in insulation products with EU and non-EU countries was worth €260 million in 2009, the scale of the positive UK trade balance is very modest at €37 million (see Figure 3.18) and has reduced steadily since 2006.

Figure 3.18 Total trade balance for UK (intra-EU and extra-EU) between 2000 and 2009 (in million euros)

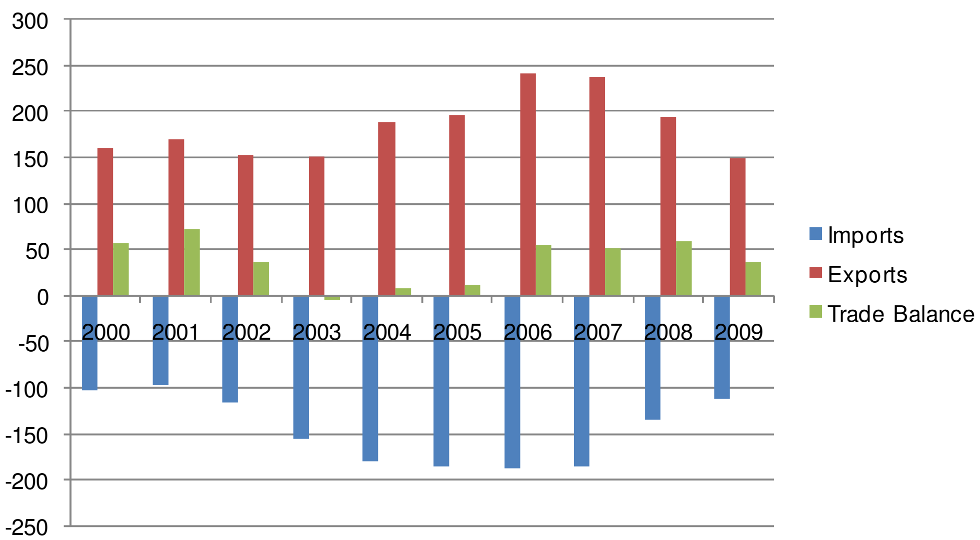
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Imports	-104	-96	-116	-155	-180	-185	-187	-185	-135	-112
Exports	161	169	152	150	189	197	241	237	193	148
Trade Balance	57	73	36	-5	9	11	54	52	58	37

Source: Eurostat COMEXT trade database

UK insulation exports were worth £148m in 2009, down from a high of £241m in 2006 - almost a 40% reduction since the recession and a level not seen since 2003.

Reference to Figure 3.19 shows a steady reduction in overall trade since the economic downturn hit the UK in 2007/8. This also clearly shows that overall trade in 2009 was no larger than that in 2000.

Figure 3.19 UK total insulation trade balance (intra-EU and extra-EU) between 2000 and 2009 (in million euros)



Source: Eurostat COMEXT trade database

[94] Carbon Hub, Zero Carbon Compendium. p.45

[95] Many of the insulation products investigated are also used in other insulation products

Using the latest trade data to 2009, and with the exception of chipboard, there does not currently seem to be any significant extra-EU imports for insulation materials. However, our consultations suggest that some SWI system components are now being sourced from as far away as China. Indeed, one company noted that brick slips for enhanced surface finishes for EWI are expensive, with most being currently imported from Germany at a cost of £30 or more per m^2. By contrast, ISO approved brick slips can now be imported from China at a cost of £5 per m^2 – a 5 fold cost reduction.

With a growing number of firms entering the market, and continued upward pressure on raw material costs, extra-EU imports from lower priced economies might be expected to increase over time. Such imports could help to make SWI products more cost effective. They might also help to fill any medium term shortfalls in production across the EU as demand for SWI increases. Clearly of course these imports also pose a threat to certain parts of the supply chain. Interestingly, a number of companies mentioned their policy to try to source products wherever possible from UK suppliers.

3.9 Constraints on innovation and market development across the supply chain

3.9.1 Constraints for insulation manufacturers

All of the insulation manufacturers consulted for this study have their own R&D capabilities and are actively involved in the development of new, better performing and cheaper materials and products. The R&D issues raised by these manufacturers tended to be specific in nature, such as difficulties developing new formulations of spray foam insulation, and issues with the installation of their IWI products.

Manufacturers described a range of constraints to innovation and market development, including:

- **High cost and security of supply of raw materials** - several manufacturers described the high cost and limited availability of raw materials as a major concern. Reports of raw material price increases of 25-40% over the past year have been reported. At least one manufacturer described having to continuously switch suppliers to achieve the most competitive costs and is now investing in increasing capacity to manufacture its own raw materials. Another reported that it had managed to reduce production costs in the past year despite being affected by raw material price increases. The overall message is that prices are currently only going one way at the moment. Manufacturers are having to respond accordingly in ways which might well lead them to make permanent (i.e. ‘locked in’) operational improvements. However, this will put them in a much stronger position over the longer term should prices start to fall.

- **Impacts of commoditisation and intensifying competition** - one insulation manufacturer noted that its supply to the EWI market has shrunk over the past 5 years due to the insulation market being commoditised and “competitors reducing their market price below a sustainable level”. Another manufacturer warned that the “industry cannot sustain further price cuts at a time when material prices and transport costs are ever increasing.”

- **Verification issues** – two manufacturers mentioned verification and certification issues as challenges to business growth[96]. One manufacturer described facing difficulties in demonstrating the importance of air tightness of SWI products, while another raised the low number ofUKAS accredited testing facilities in the UK as a key issue as products have to be sent to mainland Europe for testing, which further increases costs.

- **Manufacturing capacity constraints** – the scaling up of SWI activities is an issue for some. One manufacturer is investing in new machinery to increase manufacturing capacity to meet future demand for SWI, while another has experienced difficulties in recruiting people with appropriate skills.

[96] However, these insulation manufacturer concerns are different to those expressed about the overall costs associated with certification of SWI systems and relate more to the lack of appropriate labs in the UK as well as appropriate tests to verify product performance.

- **Inertia in the market holding back new insulation innovations** – one firm noted that the addition of graphite to EPS had greatly enhanced thermal performance but this came at a higher cost. However, the *"UK market does not appear ready to change from standard white EPS."*

3.9.2 Constraints for SWI system suppliers

The single most important issue and barrier to growth for SWI system suppliers is that SWI system costs are too high to attract consumer interest. This in turn restricts the ability of the sector to move the industry up a gear and achieve economies and scale. The need for greater cost effectiveness of SWI systems is widely accepted across the sample of companies consulted in this study. Efforts are focused on delivering innovation in materials and simplified installation processes, although significant cost reductions are unlikely in the short term due to reduced demand and increasing costs of materials and transport. There are reports of low profitability over the past two years and, although cost pressures are likely to continue in the short term, market conditions are reported to be starting to improve.

There is a potential risk that the need to be competitive in the current economic climate could result in inferior materials and components and uncertified systems being used, and lower quality installations, if SWI suppliers and installers were forced to try too hard to cut costs. This therefore raises potential issues of defective systems, reduced confidence in SWI and even injury or loss of life (due to the detachment of external SWI systems).

SWI system suppliers and installers were generally unwilling to speculate on future reductions in the prices of SWI systems, although one supplier suggested a decline of **10% by 2015; another said that declines of between 25-50% in EWI system supply prices were being sought**.

The cost reductions are expected to be achieved through innovation, as described above, but also through economies of scale in the production of SWI systems to meet the anticipated growth in demand. There are also likely to be potential cost savings amongst contractors by increasing their in-house capacity to deliver SWI, rather than the current sub-contractual model, though as noted above some may be less able to deal with this than others.

Some of the specific issues relating to innovation and market development include:

- **Certification** is a major constraint reported by most consultees. They consider it to be difficult, expensive and time consuming to achieve. Overall, it was felt that **the current certification process for new SWI products presents a significant constraint in terms of entry to the SWI market and the development of new products**. This process was also reported to involve significant duplication of effort from suppliers, while timescales are suggested to vary widely and can take as long as 6 or 12 months. The problem is made worse, in the view of some, by the low number of certification bodies in the market." For example, a few suppliers suggested that the costs of certification can well exceed £30,000 per certificate and, with each system requiring its own certification, these costs can quickly increase. Certification can also be a barrier to innovation as the use of new products to improve existing systems also requires certification, which increases the costs of making continuous improvements to products. While gaining certification can be a burden on suppliers, **certification overall helps provide confidence, safety and market opportunities for firms that have it** (see Evidence box 4 below). It is noteworthy that several of the major EWI system suppliers do not have systems listed in the Ofgem matrix of SWI suppliers, precluding them from CERT work.

- **Lack of support incentives** – one supplier described a lack of support incentives for R&D activity, suggesting that existing funding is focused on job protection rather than R&D specifically. The supplier has experienced difficulty accessing grants, even when jobs might be at risk if the development does not take place.

Evidence 4: Product certification helps to raise standards in SWI

It is getting much harder to sell into the SWI market without certified materials and components. According to one supplier *"certification in the past was a 'nice to have' – now it's become essential"*. For example, certification is a pre-requisite for Ofgem certification which enables contracts to be won under CERT and CESP. Certification is also now a requirement of many local authority procurement procedures. Overall this can only be a good thing for the sector, helping to keep out companies that might be tempted to market/install systems, perhaps re-engineered to reduce costs, which might be of inferior quality as well as being potentially unsafe in the longer term.

- **Engineering constraints** – scaling up the level of SWI activities is an issue for some firms, particularly where current systems are not suitable for certain house types. This suggests the need for more demonstration trials to develop new systems that are fit for purpose. In this respect, one system supplier noted that they "would not touch a lot of streets with terraced properties because they are difficult walls to work with". In an effort to overcome some of the engineering constraints associated with 'scaling up', another system supplier described working with a number of local authorities to identify properties that could be used in development trials.

4 Technology projections for SWI and stock analysis

This chapter reports on the technology projections that have been developed for this study to illustrate the potential future deployment of SWI and its impacts to 2022 and 2050 across the UK housing stock. It explains:

- The current SWI installation rate and the projections or scenarios for future solid wall insulation installation in recent official reports, for example by DECC, the Committee on Climate Change (CCC), etc.;
- The types of SWI installations as well as the associated costs;
- The projections developed specifically for this study which are intended to reflect the technological innovations identified across the SWI supply chain (see Table 2.6) and how these can impact upon the wall U-values achieved, the cost of materials and fixings plus associated costs and the overall rates of installation;
- The assumptions used in the model built for this study; and,
- The results of the analysis.

The impact of policy initiatives such as potential tightening of Building Regulations as well as deployment projections underpinning the proposed Green Deal and ECO are explored together with how innovations within the SWI industry (including any potential support from government) might impact on the projections.

Whilst there are estimated to be 1.8 million non-domestic buildings in the UK, responsible for 17 per cent of UK carbon emissions[97], it has not been possible to model the deployment of SWI due to the highly diverse nature of non-domestic building types. However, clearly there will be opportunities to install SWI on many commercial buildings although much of this investment will depend on the long term investment planning of freeholders and the freeholder/tenant relationship relating to cost recovery of capital investments.

4.1 UK deployment projections for solid wall insulation by sector

Our approach to developing scenarios for deployment of SWI has been informed by an extensive body of literature published between 2007 and 2012. Key publications include:

- Pathways analysis to 2050, DECC (July 2010);
- Fourth Carbon Budget – Reducing Emissions through the 2020s, CCC (December 2010);
- Final stage Impact Assessment for the Green Deal and ECO, DECC (June 2012)[98].

Other information sources include Ofgem's CERT and CESP quarterly updates and EST/EEPfH (Energy Efficiency Partnership for Homes) on the energy efficiency market and the insulation supply chain[99]. The purpose of this section is to provide an overview of these detailed studies in order to demonstrate that all of them are consistent with each other.

4.1.1 Current levels of SWI activity

- The current level of SWI installations has previously been discussed in section 3.2 but it is helpful to look closely at what the key government programmes, CERT and CESP, are responsible for by way of SWI activity. **Since April 2008, around 63,000 installations**

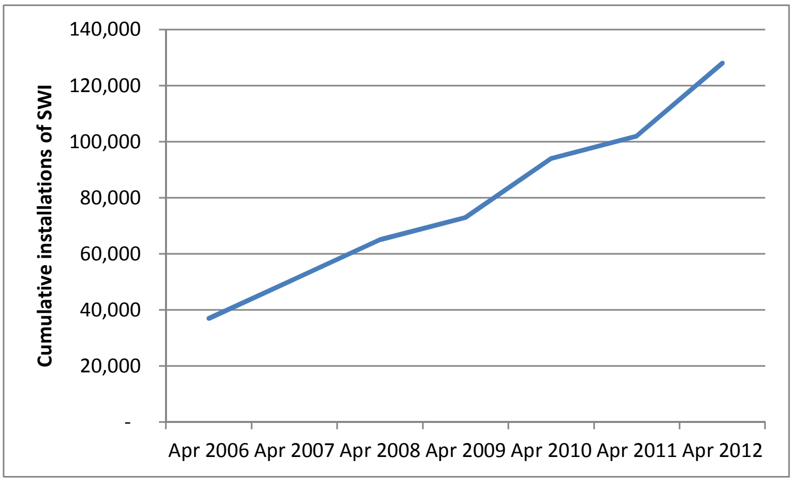
[97] UK Green Building Council, Carbon reductions in existing non-domestic buildings, March 2011

[98] The initial work on this study was informed by the Energy Bill Impact Assessment, published by DECC in December 2010

[99] For example, Defra, UK insulation sector supply chain review, February 2007 and EST/EEPfH, Solid wall insulation supply chain review, May 2009

have been delivered through CERT and CESP[100], equating to 15,750 per year, although the most growth has been in the past year[101] see Figure 4.1):

Figure 4.1 Cumulative SWI installations under EEC2, CERT/CESP (Apr 2006 - April 2012)



Sources: Energy Efficiency Partnership for Homes & EST, Review of solid wall insulation supply chain, May 2009 and DECC, Estimates of Home Insulation Levels in Great Britain: January, March and April 2012. Note: combination of sources allows for a complete retrospective analysis of installation rates back to 2006

An initially slow rate of deployment of SWI installations under CESP appears to have been overcome and **indications are that SWI (EWI in particular) dominates schemes (it is included in a high proportion of them**). Over the course of CESP this might lead to several tens of thousands of installations.

The EEPfH/EST SWI supply chain report (2009) established that there were about 20,000 annual domestic retrofit SWI installations (two-thirds of which are EWI), so **it appears that CERT and CESP are responsible for the majority of installations**.

Moving forward, the EEPfH report on the UK energy efficiency market made predictions (based on the earlier Defra supply chain review) for the number of IWI and EWI installations. It expects these to be dependent on a Supplier Obligation (which supports the earlier observation about CERT and CESP). The graphs below (Figure 4.2 & Figure 4.3) show the predictions in both the Priority and Non-Priority Groups (PG and NPG) together with the number of new-build installations.

[100] DECC, Estimates of home insulation levels for April 2012, Published June 2012. Available at http://www.decc.gov.uk/assets/decc/11/stats/energy/energy-efficiency/5457-stats-release-estimates-home-ins-apr2012.pdf

[101] Note that to January 2012, average SWI retrofitted installations per year were 14,250

Figure 4.2 Predicted annual internal wall insulation installations

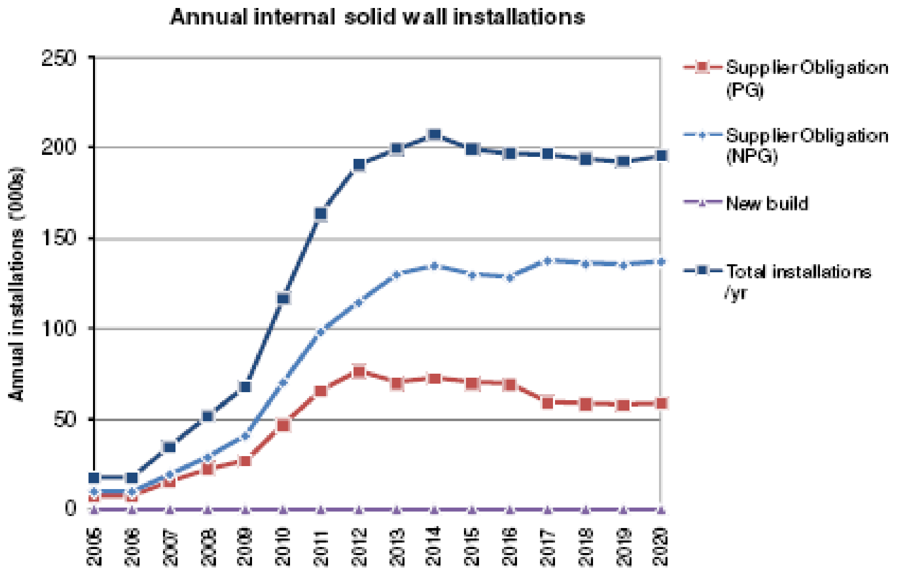
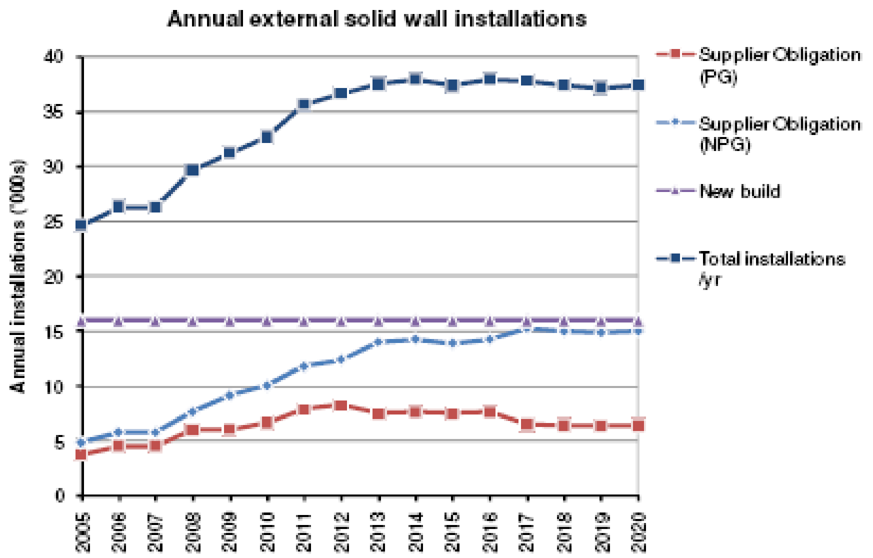


Figure 4.3 Predicted annual external wall insulation installations



Interestingly, this EEPfH report predicted strong growth in IWI installation rates to about 200,000 per year from about 2012 driven by a Supplier Obligation with the majority taking place in the Non-Priority Group sector. Conversely, the predicted growth in EWI installations is far more modest with only 6,000-7,000 installations per year in the Priority Group sector and up to 15,000 per year in the Non-Priority Group sector. **Overall, these predictions would result in just over 2 million SWI installations by 2020**.

4.1.2 The Fourth Carbon Budget – Reducing Emissions through the 2020s

The CCC's report on the 4th Carbon Budget examines the required reductions in emissions from buildings**. It assumes policies will deliver 2 million SWI installations by 2020 (out of a total population of some 8 million solid wall properties)** which is comparable with the predictions immediately above. This, together with other measures (cavity and loft insulation, replacement boilers, etc.), delivers a 2020 emissions reduction of 17 $MtCO_2$ in the residential sector.

The CCC's Medium Abatement scenario includes 3.5 million SWI installations by 2030, and its High Abatement scenario assumes 5.7 million installations by 2030. The heat demand reduction associated with further widespread SWI in the 2020s is around 13 TWh, or 3% of total residential demand for heat in 2030.

4.1.3 Pathway analysis to 2050

Allied to the 4th Carbon Budget is DECC's 2050 Pathway Analysis. This is a tool to help policymakers, the energy industry and the public understand the impacts of moving towards a low carbon economy. For each sector of the economy there are four options ranging from Level 1 (little or no effort to reduce emissions) to Level 4 (ambitious changes that push the physical and technical envelope of what can be achieved).

For reductions in domestic heating demand the tool uses improvements to the average Heat Loss Coefficient (HLC) of a UK dwelling on the basis of assumed take-up of a range of measures such as SWI, loft and cavity wall insulations and triple glazing. The SWI scenario assumptions in the Pathways analysis are:

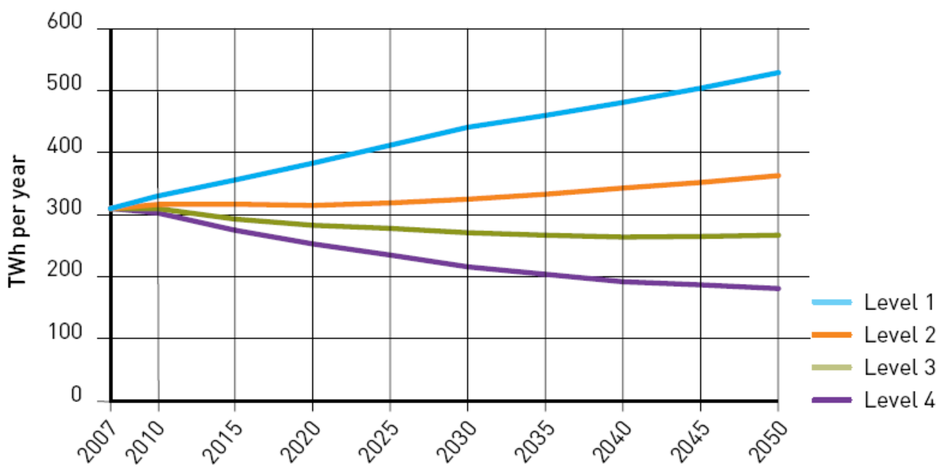
- Level 1 – 400,000 SWI installations by 2011
- Level 2 – 2 million by 2022
- Level 3 – 5.6 million by 2040
- Level 4 – 7.6 million by 2040

Looking at the Level 1 option, and having analysed deployment rates under both CERT (which will give no more than 50,000 SWI installations by the end of 2011) and CESP (which might lead to a further 20,000 to 30,000 by the end of 2011), we would suggest that the Level 1 estimate is on the high side. Certainly the current SWI deployment rate does not support the 400,000 figure, but it is unclear when it starts.

The predictions in Figure 4.2 and Figure 4.3 suggest a figure of 400,000 installations by 2011 but these were made in about 2008 and were perhaps too optimistic about the level of activity during 2009-2011 which had not materialised at that time. Trade associations, however, now report that installation levels have risen significantly.

The impact of these levels of SWI installation and the other energy efficiency measures on total domestic heat demand is shown in Figure 4.4.

Figure 4.4 Trajectories for total domestic heat demand under four levels of change



4.1.4 Final stage Impact Assessment for the Green Deal and ECO

The Final stage Impact Assessment for the Green Deal and ECO, published by DECC in June 2012 ('the IA'), details the costs and benefits associated with Green Deal proposals and how these could impact upon the level of SWI installations. DECC's understanding for the IA modelling was based on over 300 industry consultation responses including from INCA, NIA, Construction Products Association (CPA) and Construction Skills.

Annex A of the IA explains the approach and underpinning analytical assumptions used by DECC. Some of the key elements include:

- The potential for SWI is based on the number of solid wall properties within the housing stock. This is then adjusted to take account of existing insulation levels and number of properties expected to be insulated under existing policies by January 2013, leaving a total of 6.9m properties.
- The 2009 English House Condition Survey (EHCS) solid wall categories and age bands was mapped on to categories and bands in the Standard Assessment Procedure (SAP); these were then also grouped into three broad categories of wall:
  - Type 1 - System Build – comprising 345,000 properties
  - Type 2 - Pre-1966 9 inch solid brick – comprising 4,485,000 properties
  - Type 3 – Other solid walls – comprising 2,070,000 properties
- The IA uses three scenarios to forecast deployment of SWI to 2022:
  - Low - 825,000 installations
  - Central - 955,000 installations
  - High - 1,240,000 installations
- Installation costs for SWI are based on a simple linear relationship between the size of property and likely installation costs, as follows:
  - IWI - £42.5 x external wall area (m^2) + £1,900
  - EWI - £57.7 x external wall area (m^2) + £5,330
- Fuel prices have been increased over time to better assess the likely fuel saving benefits of measures.
- An 'in use' factor of 25% (and 33% for solid brick walls) is applied to SWI energy savings to reflect the estimated 'real world' energy savingsfrom SWI insulation measures compared to theoretical savings[102].

4.2 Assumptions and sensitivities in the model

This sub-section explains the specification of the model developed in this project to examine the impacts of different SWI deployment scenarios on carbon emissions. Supporting data tables and figures are provided in Annex 4.

The housing stock model developed for this report mimics that developed for the IA. It focuses on the costs of installing SWI, the impacts of technological innovations on cost and thermal performance, and seeks to provide a disaggregation of the dwelling types considered to achieve a more complete understanding of the unit costs and savings.

Data on occurrence of solid walls in domestic stock were taken from the English Housing Condition Survey. Each of these dwelling types was then modelled with the Standard Assessment Procedure for Energy Rating of Dwellings (SAP 2009)[103] using BRE's standard dwellings model. This give dwelling size and layout and so are helpful to understand the impact of insulation solutions. They were modelled with the same baseline, i.e. 225mm solid walls (U-value 2.1), 100mm loft insulation, basic double glazing (U-value 2.7), gas-central heating with average boiler (75%) and controls and 50% low energy lighting.

Assumptions were made about the development of Building Regulations. In terms of insulation improvement targets for the solid walls we have been guided by Building Regulations (England and Wales) Part L. The current (2010) U-value requirement for a renovated wall is 0.3. Based on past practice, it was originally anticipated in this study that the renovation requirement would follow the new-build requirement from the previous edition of Part L. This would have the effect of tightening requirements by 2013 to 0.28 with a further tightening by 2016 to 0.25. However, since the U-value requirement for renovations is now

[102] This work has been informed by research into measured performance of CWI since similar data on SWI is not yet available.

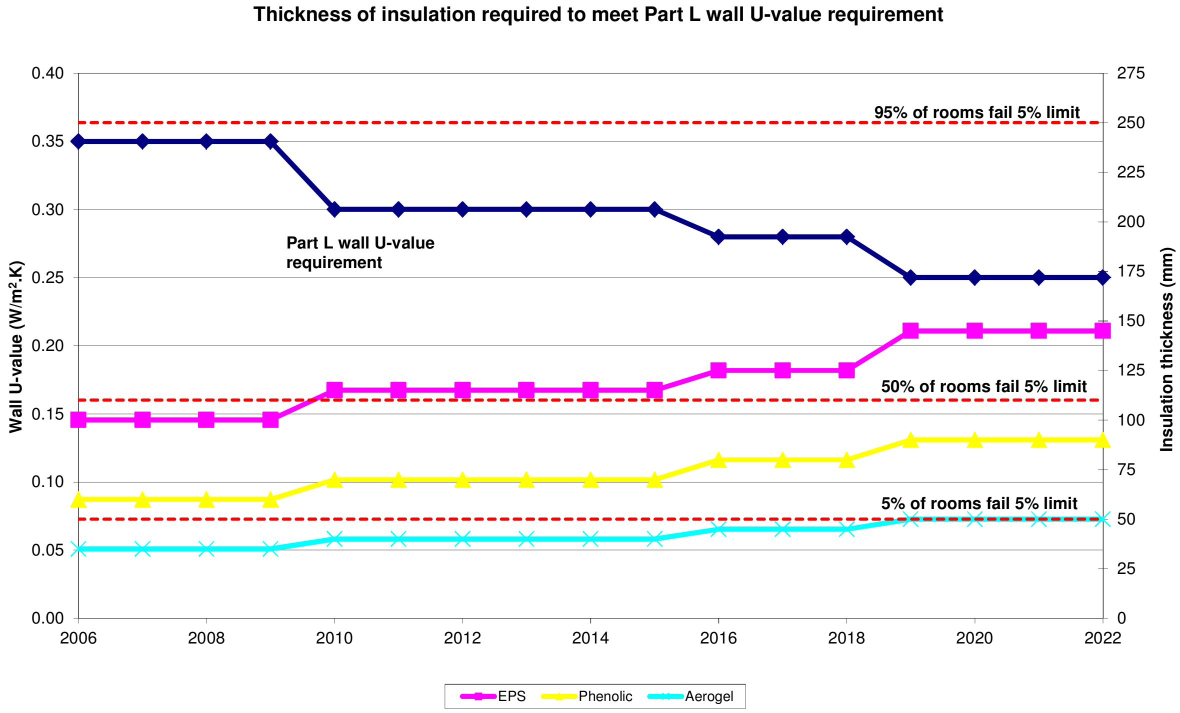
[103] BRE, The Government's Standard Assessment Procedure for Energy Rating of Dwellings (2009 Edition), Revised October 2010 [Available at http://www.bre.co.uk/filelibrary/SAP/2009/SAP-2009_9-90.pdf]

unlikely to change for some time, we have assumed that tightening to 0.28 will now occur in 2016, followed by further tightening to 0.25 in 2019.

Figure 4.5 shows the thickness of insulation (in this case EPS, phenolic foam or aerogel) required to meet these U-value requirements and whether this means that more than 5% of a room's floor area is lost as a result of using an internal insulation solution. The current Part L U-value requirement can be relaxed if more than 5% of the floor area is lost.

Figure 4.5 shows, at current performance standards, how increasingly demanding U-value requirements require a greater thickness of insulation which in turn result in a greater proportion of rooms failing to meet the 5% floor area limit. **However, the improvements in lambda values anticipated by the industry (10-50%) through innovation will facilitate the achievement of thinner insulation product thicknesses which helps suppliers maintain market share. This also makes for more efficient fixing methods, and opportunities in confined spaces.**

Figure 4.5 Thickness of insulation required to meet Part L wall U-value requirement



An improvement scenario in which only the solid wall is upgraded to 0.30, 0.28 or 0.25[104], was then considered for each dwelling type.

Although we have gathered a number of insights on SWI installation costs from discussions with the industry and literature review, the most recent SWI costs in the IA were used for both EWI and IWI. However, **an important finding is that for both EWI and IWI, but particularly with EWI, innovations in fixtures and fittings are not necessarily going to lead to significant cost reductions in overall installation costs because of the fixed extra costs**.

These costs were mapped onto DECC categories for SWI installations in the IA[105] and, for simplicity, an assumption was made that 'Type 2' solid wall properties (see section 4.1.4 above) applied to all properties in the model.

[104] We have assessed the impact of higher U-values than 0.25 and whether this is likely to provide better financial returns to customers. The reality is that a gradual improvement in wall U-values leads to a law of diminishing returns. For example, reducing U-values from 2.1 to 0.30 provides excellent savings whilst the extra benefit of going from 0.30 to 0.28 is small. Going beyond 0.25 is not considered realistic in the current context of price versus savings and insulation thicknesses. Clearly over the longer term innovations in materials will make this shift more cost effective and practical.

[105] Includes social rented, i.e. propertises owned by Registered Social Landlords (RSL) - a generic term for Local Authorities and Housing Associations where there are opportunities for large-scale EWI and IWI installations; private rented, where there is

Based on information obtained from consultations with industry (and summarised in Table 2.6), **it is suggested that the higher costs of supplying increased thickness of SWI will be cancelled out by innovations across the sector over time (i.e. better lambda values)**.

The other innovations summarised in Table 2.6 were then integrated into learning rate coefficients of between 15% to 25%, with learning rates expected to be slightly better for EWI since there is more scope for reductions with respect to fixtures and fittings. In light of more recent industry feedback which has informed the IA, our model also applied a learning rate of 15% to 2022[106] for both EWI and IWI. The revised learning rates were then applied to the costs and the costs for each dwelling type calculated.

In line with the IA, and Type 2 wall properties, an In use factor of 33% was used as well as a Thermal comfort factor of 15%.

The model generates simple payback estimates (in years) of SWI installations by dwelling type on the basis of the above costs and annual fuel savings.

4.3 Model results

Annex 4 contains a breakdown of results by dwelling type but a summary is presented here. The analysis of payback periods (which take no account of grants or subsidies) suggests that:

- **all installations (at least until 2021 and 2022 and then only for Registered Social Landlord properties) exceed the 15 year simple payback criterion**, so under the current regime it would be possible to relax the U-value requirement of Part L if desired;
- **for privately owned properties, simple paybacks for installations in 2013 are between 56 and 77 years**. These figures are comparable with the experience in Poland[107]. **However, over a 10 year period with the effect of energy price increases and learning rates taking effect, these drop to between 26 to 36 years in 2022**;
- **for Registered Social Landlord owned properties, where the extra costs are minimal (i.e. where the installation is part of a major renovation[108]), many simple paybacks in 2013 are between 26 and 38 years. However, over a 10 year period with the effect of energy price increases and learning rates taking effect, these drop to between 12 to 18 years in 2022.**

Paybacks vary considerably based on fuel type (e.g. electricity versus gas) and property type. The SWI market is also underdeveloped and hence greater efficiencies are likely to helped drive costs down, improving payback times.

These considerations help to underpin the logic for implementing the Green Deal and the ECO and will help to make it financially more worthwhile for householders and businesses to invest in SWI.

4.4 Carbon saving analysis

This section reports the results of an analysis examining the carbon savings possible from SWI installation from the domestic building stock modelled. Evidence box 6 below provides an explanation as to why this scenario analysis has focused on the domestic building stock.

Evidence 5: Modelling SWI impacts in the non-domestic sector

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potential for some economies of scale if a private landlord can undertake multiple EWI installations on say a house comprising flat; and owner occupied where EWI and IWI is focused on an individual installation.

[106] The learning rate beyond 2022 (i.e. to 2050) is assumed to remain the same.

[107] The Polish Building Research Institute suggests that the pay-back time for applying EWI to an existing dwelling is between 18 and 65 years (see Annex 1 for more information on research and regulations in Poland).

[108] The IA (2012) notes that cost reductions of up to 30% can be delivered by treating multiple properties, increasing to 40% for flats where there are greater economies of scale.

The rationale for focusing solely on the domestic building stock, as opposed to both the domestic and non-domestic sector, is due to a combination of factors. First, in order to get anywhere near a vaguely sensible model it would be necessary to undertake a large amount of work to build up the datasets. However, this creates a problem as there is very limited or no data on the occurrence of solid walls in the non-domestic stock; and there is no real idea as to the current rates of EWI installation.

Further, the EST/EEPFH Purple market research report (May 2009) suggests that the majority of the EWI market is residential. Hence, by focusing on the domestic sector we will have a representative view of the impacts from increased deployment.

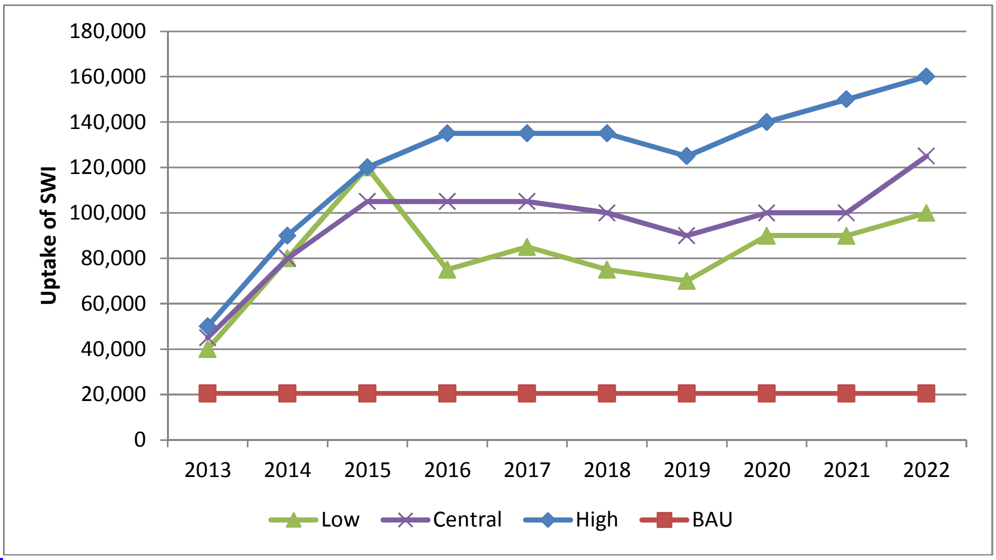
The situation is likely to be different for IWI but as we know this is harder to quantify. It is likely that a lot of (internal) refurbishment of non-domestic buildings is cosmetic as tenants come and go.

Four scenarios were considered for the 2013-2022 period:

- A **Business As Usual (BAU)** baseline of 20,500 SWI installations per annum[109] to 2022;
- **DECC Low scenario**, i.e. 825,000 installations by 2022 with the Green Deal and ECO commencingat the start of 2013. The main impact of Green Deal is assumed to be the private (i.e. able to pay) sector whereas the ECO is primarily responsible for the large-scale RSL installations of EWI. To 2022 this would represent a **five-fold increase** on the current installation rate;
- **DECC Central scenario**, i.e. 955,000 installations by 2022 with the Green Deal and ECO commencing at the start of 2013. To 2022 this would represent a **six-fold increase** on the current installation rate;
- **DECC High scenario**, i.e. 1.24 million installations by 2022 with Green Deal and ECO commencing at the start of 2013. To 2022 this would represent an **eight-fold increase** on the current installation rate.

Figure 4.6 provides an illustration of the increases in installations over time for each scenario. In each case we have just considered SWI improvements and not the other energy efficiency measures.

Figure 4.6 Assumed annual number of SWI installations under the four scenarios modelled



The BAU scenario means only 205,000 solid walls would be insulated by 2022 compared to 955,000 under a DECC Central scenario (which, as with the Low and High scenarios, includes the Green Deal and ECO taking effect).

109 For the purposes of the modelling this has been broken down as 14,350 EWI and 6,150 IWI installations.

Table 4.1 provides an overview of both annual and cumulative carbon savings for each of the four scenarios. These do not cover life cycle emissions, i.e. which relate to the transport of insulation and other embodied carbon in products referred to in earlier sections.

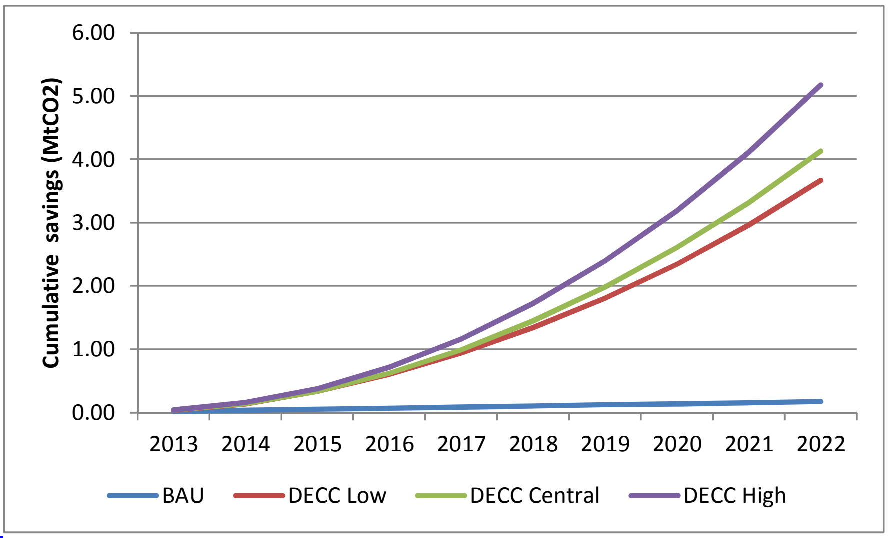
Table 4.1 Annual and cumulative carbon savings for each scenario to 2020

Scenario		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
BAU	Saving in year (MtCO2)	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017
	Cumulative saving (MtCO2)	0.02	0.03	0.05	0.07	0.09	0.10	0.12	0.14	0.16	0.17
DECC Low	Saving in year (MtCO2)	0.034	0.101	0.202	0.266	0.338	0.402	0.462	0.540	0.618	0.705
	Cumulative saving (MtCO2)	0.03	0.13	0.34	0.60	0.94	1.34	1.80	2.34	2.96	3.67
DECC Central	Saving in year (MtCO2)	0.038	0.105	0.193	0.283	0.372	0.457	0.535	0.622	0.708	0.816
	Cumulative saving (MtCO2)	0.04	0.14	0.34	0.62	0.99	1.45	1.98	2.61	3.31	4.13
DECC High	Saving in year (MtCO2)	0.042	0.118	0.219	0.334	0.448	0.563	0.672	0.793	0.922	1.061
	Cumulative saving (MtCO2)	0.04	0.16	0.38	0.71	1.16	1.72	2.40	3.19	4.11	5.17

Figure 4.7 illustrates the cumulative carbon savings under each scenario. The total cumulative carbon savings are far lower in the BAU scenario at 0.17 $MtCO_2$ compared to 4.13 $MtCO_2$ for the DECC Central Scenario.

Since this stock model focuses solely on SWI installations, the carbon savings will be considerably greater if other measures are installed at the same time.

Figure 4.7 Cumulative carbon savings under the four scenarios ($MtCO_2$)



The monetary value of the carbon savings from the four scenarios for 2020 are derived from the shadow price of carbon (or non-traded carbon prices) published by DECC[110] (see Table 4.2). **Under a central scenario, the value ranges from £11m for the BAU scenario, to £231m, £260m and £510m respectively for the three Green Deal (including ECO) scenarios.**

Table 4.2 Total value of cumulative carbon savings for 2022

Carbon price scenario	Non-traded carbon price in 2022	BAU	DECC Low (Green Deal inc ECO)	DECC Central (Green Deal inc ECO)	DECC High (Green Deal inc ECO)
Low	£33	£6m	£121m	£136m	£170m
Central	£66	£11m	£231m	£260m	£326m

110 For more details on approaches to valuing carbon, see Carbon Valuation in UK Policy Appraisal: A Revised Approach, Department for Energy and Climate Change, July 2009 [available at http://www.decc.gov.uk/assets/decc/What%20we%20do/A%20low%20carbon%20UK/Carbon%20Valuation/1_20090901160357_e_@@_carbonvaluesbriefguide.pdf]

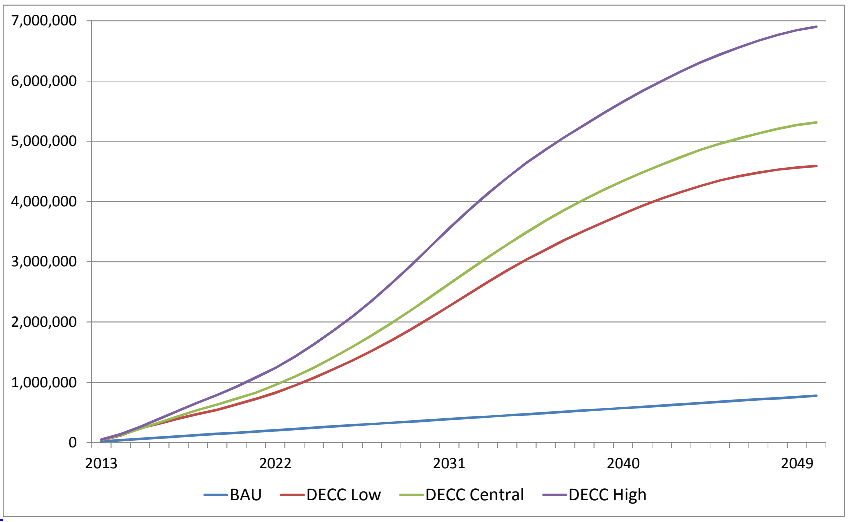
High	£99	£17m	£362m	£407m	£510m

4.5 Looking beyond 2022 to 2050

In order to provide an insight into the level of SWI market uptake for the domestic sector from 2022 to 2050, we have taken our four scenarios and used a standard S-curve (i.e. exponential growth that declines as market saturation occurs) to model the installation rates[111]. We have also been guided by DECC's Pathways to 2050 analysis, described above.

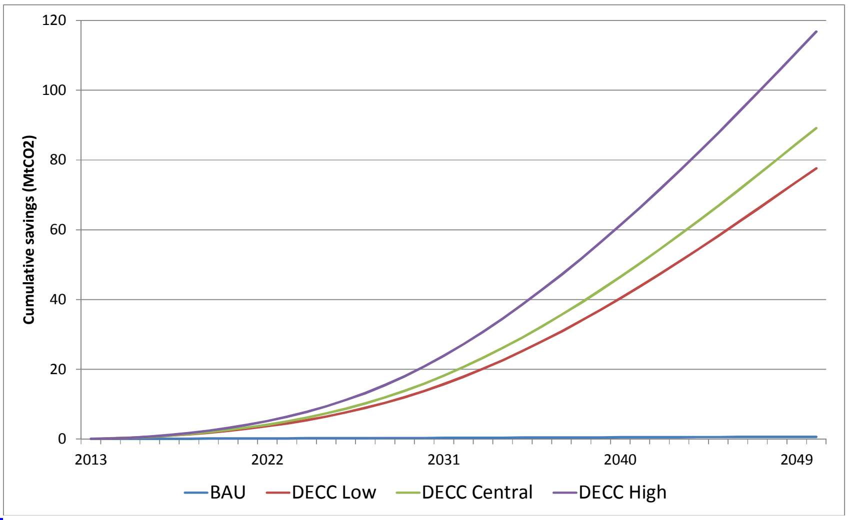
With respect to cumulative SWI installations, Figure 4.8 shows the exponential growth in installations for the DECC Low, Central and High scenarios (to reach 4.6m, 5.3m and 6.9m installations respectively by 2050). Under the BAU scenario total installations would just fall short of 800,000 installations by 2050. Annex 4 provides projections for the three DECC scenarios across the time period (as well as for carbon and energy savings).

Figure 4.8 Assumed SWI installations to 2050 for four scenarios modelled (cumulative)



In terms of carbon savings, the model suggests that by 2050, **cumulative carbon savings of between 78, 89 and 117 $MtCO_2$ respectively will be achieved for the three DECC scenarios compared to just 0.67 $MtCO_2$ for the BAU scenario** (Figure 4.9).

Figure 4.9 Cumulative carbon savings to 2050 for four scenarios ($MtCO_2$)



[111] BRE has used this approach before with respect to energy efficiency measures and it has worked reasonably well.

The monetary value of the carbon savings from the four scenarios for 2050 are derived from the non-traded carbon prices published by DECC[112] (see Table 4.3). **Under a central scenario, the value ranges from £142m for the BAU scenario through to £10.8 billion, £12.4 billion and £16.2 billion for the three Green Deal (including ECO) scenarios.**

Table 4.3 Total value of cumulative carbon savings for 2050

Carbon price scenario	Non-traded carbon price in 2050	BAU	DECC Low (Green Deal inc ECO)	DECC Central (Green Deal inc ECO)	DECC High (Green Deal inc ECO)
Low	£106	£71m	£8,228m	£9,454m	£12,380m
Central	£212	£142m	£10,790m	£12,389m	£16,191m
High	£318	£212m	£24,684m	£28,362m	£37,141m

[112] Carbon Valuation in UK Policy Appraisal: A Revised Approach, Department for Energy and Climate Change, July 2009

5 Market opportunities and economic impacts from SWI deployment to 2020

This section reports the insights on what SWI manufacturing, supply and installation companies think will happen in the market over the next 5 to 10 years as gathered in consultations carried out for this study. It summarises some of the likely innovations that could help to drive down system costs. It also looks at the economic and employment impacts of a step change in EWI deployment under the Business as Usual Plus scenario (as described in section 4).

5.1 The future of the SWI market

5.1.1 Potential impact of the Green Deal on the SWI sector

"SWI is regarded as a growth market over the next 10-20 years." EWI system supplier

Much of any future optimism for growth in the SWI sector depends on the Green Deal and the ECO, the introduction of which is expected to drive demand for SWI and deliver a better and wider choice of insulation measures.

Overall, **a key finding that is applicable across the supply chain, but particularly for insulation manufacturers, is that everyone is holding back from investment until they have more certainty of a market**. Manufacturers are ready to commit to greater production volumes and tool up – which will create cost savings through greater volume, plus innovations in new production processes - but they need to know what the market is likely to be worth. The same applies to those installers who are currently outside the SWI area – they will not invest in this market unless they can see a fast return.

That said, some insulation manufacturers did report investments in more environmentally sustainable production processes, as well as making assessments of costs and the economic viability of R&D options as a result of the Green Deal. **Insulation manufacturers also report making increasing R&D investments and improving manufacturing capabilities as a result of the proposed Green Deal, and ensuring that business processes are appropriate and prepared for an increase in demand**. This is driving a greater focus on researching and developing new products and overcoming issues (e.g. structural integrity, overheating, mould growth), and particularly those relating to the domestic retrofit market.

A large increase in the deployment of SWI, as a result of the Green Deal and ECO, could also help (speculated one SWI system supplier) to reduce costs and change the roughly 50:50 ratio between SWI materials and labour. However, installers report a more cautious approach at this stage, discussing potential implications of the Green Deal but not yet making any strategic decisions.

The development of new supply chain relationships was also described as being important in helping insulation manufacturers and system suppliers to exploit their technologies and make preparations to take advantage of the anticipated growth in the market. Moreover, some suppliers have suggested that the SWI market could stagnate or even contract without the Green Deal.

5.1.2 R&D activities and tightening regulations

There were mixed views on the importance of the R&D asset base in the UK to the future development of SWI technologies. **Some insulation manufacturers and system suppliers felt that it is critical that the UK undertakes R&D to ensure the safety, security and performance of systems in UK conditions, while others suggest that Germany would be better placed to lead on SWI R&D activity**.

The dominant position of German-owned companies in the SWI market is perhaps a reason why foreign products are already commonplace in the UK market, while **UK SWI suppliers have typically described focusing on the UK market, rather than pursuing export opportunities**.

Firms have already been investing in R&D to ensure that their product ranges will either comply with more stringent building regulations or reduce the required width of insulation in the face of tighter regulations. **The Building Regulations (Part L) and the requirements of BRE's "Code for Sustainable Retrofit" have been mentioned as key considerations in the development of all new products**.

Insulation manufacturers suggest that Building Regulations are having a significant impact on their R&D activities, particularly around air tightness, fire safety, lambda values, etc., and were seen by some as a market opportunity, increasing demand for new technologies and better performing products. However, **most system suppliers in the sample felt that the regulations were unlikely to have a significant immediate impact on SWI systems and R&D activities as their products can already meet these requirements**.

The insulation manufacturers also reported that product ranges over the next five years were likely to incorporate new technologies that deliver improved thermal performance, but with minimal impact on thickness. In many cases, innovations would help to reduce the thickness of SWI systems.

5.1.3 Future technology opportunities for the sector

The need to explore more innovative forms of SWI system in the medium to long term will be an essential ingredient in driving prices down. Innovation could come from a number of areas, including the incorporation of novel forms of insulation with significantly improved performance compared to current types.

Significant price reductions of 20-30% or more could be possible from widespread adoption in the industry of external dry lining systems which could eliminate the need for wet trades when installing EWI. **Signs of an emerging market for niche applications of external dry lining systems are now visible in the UK particularly amongst some SMEs**. Further R&D and demonstration could help to make these SWI innovations ready for mass market deployment (see section 6.4 for further insight into how this could be achieved).

The integration of phase change materials into insulation could also help to increase the value proposition of SWI to consumers, particularly if it is able to save energy by improving the thermal mass of the building (i.e. by reducing the need for gas central heating on very cold days or by reducing the use of air conditioning on very hot days). These novel and 'smart' insulation materials are currently only being trialled in a limited number of commercial and domestic settings. The potential savings also need to be examined in much greater depth (see section 6.5 for further insight into how this could be achieved). However, the likelihood that improved materials will come on stream over the next 10 to 20 years, coupled with the chances of much hotter summers and significantly increased fuel costs in the same period, could make such innovations an essential part of the energy efficiency package for all buildings.

Furthermore, these **supply side innovations could be combined with improvements and efficiencies in the way that SWI is installed to help reduce costs even further**.

Clearly there is a lot for the industry to contemplate and plan for if it is also to 'step up to the plate' and help make mass deployment of SWI a reality over the next decade.

5.2 Potential impacts of mass market adoption

Manufacturers, system suppliers and installers were asked about a number of possible impacts resulting from a 'potential mass market adoption of SWI'[113] and the likely importance of these impacts for their business. The results are presented in Table 5.1, Table 5.2 and Table 5.3. There is wide variation, with many impacts having low importance for some businesses and very high importance for others. Given the small sample sizes, these results should be treated with caution.

For insulation manufacturers and EWI system suppliers the responses suggest an **emphasis on having to invest more heavily in R&D (including staff recruitment) and**

[113] Defined as 2m homes retrofitted with SWI by 2020

manufacturing capacity, enhancing manufacturing processes and work more closely with suppliers in order to drive down costs and compete more effectively. Most EWI systems suppliers felt they could invest in their manufacturing processes and capacity without necessarily requiring staff, suggesting **there is scope for productivity gains to be achieved in this sector**.

Table 5.1 Importance of potential impacts on the operations of insulation manufacturers from a potential mass market adoption of SWI (n = 4)

Impact Statements *We will need to...*	Not relevant	Small importance	Medium importance	Large importance	Very large importance
Invest more in our R&D product capability to compete effectively			1	3	
Recruit more staff dedicated to R&D		1	1	1	1
Work closely with our supply chain to drive down overall SWI system costs		1	1	2	
Enhance our company's manufacturing processes to compete effectively	1			2	1
Invest in new manufacturing capacity in the UK		1	1	1	1
Import greater volumes of insulation to fill potential shortfalls in our supply	1	1	2		
Recruit new manufacturing staff	1		2	1	
Work closely with our installer base to drive down SWI installation costs		1		3	

The responses also suggest that firms will seek to import insulation from their sister companies overseas.

There is a general recognition amongst all responses of the **importance of collaborating between manufacturers, system suppliers and installers to drive down overall system costs**. Manufacturers and system suppliers perceive working with their own suppliers as more important than working with installers in driving down costs. However, in discussions with companies it is apparent that some of the larger EWI installation contractors do work with system suppliers in developing more innovative systems that can be easily installed.

Table 5.2 Importance of potential impacts on the operations of EWI system suppliers from a potential mass market adoption of SWI (n=4)

Impact Statements *We will need to...*	Not relevant	Small importance	Medium importance	Large importance	Very large importance
Invest more in our R&D product capability to compete effectively		1	1	1	1
Recruit more staff dedicated to R&D	2		1	1	
Work closely with our supply chain to drive down overall SWI system costs			2	1	
Enhance our company's manufacturing processes to compete effectively	2			2	
Invest in new manufacturing capacity in the UK	2			2	
Import greater volumes of insulation to fill potential shortfalls in our supply	3		1		
Recruit new manufacturing staff	3			1	
Work closely with our installer base to	1	1	1		

Impact Statements We will need to...	Not relevant	Small importance	Medium importance	Large importance	Very large importance
drive down SWI installation costs					

The responses from installers highlight the importance of marketing the benefits of SWI more effectively to the customer base so that consumers can make informed decisions.

Table 5.3 Importance of potential impacts on the operations of insulation installers from a potential mass market adoption of SWI (n=2)

Impact Statements We will need to...	Not relevant	Small importance	Medium importance	Large importance	Very large importance
Reduce installation costs of SWI to ensure we remain competitive				1	1
Work closely with insulation suppliers to drive down overall SWI system costs		1		1	
Recruit and train staff so that they have the specialist skills to install SWI			1	1	
Market the benefits of SWI more effectively to inform decision-making					2

5.3 Impacts on turnover and employment of growth in the market to 2022

5.3.1 Establishing current turnover and employment attributable to SWI

The purpose of this section is to understand the economic impacts of the BAU and DECC Central scenarios in the deployment projections of Section 4. We have focused on producing growth estimates solely for the EWI industry, an important and discrete element of the SWI value chain. This is because it is not possible to generate realistic estimates for IWI supply and installation due to the difficulties of gaining estimates from insulation manufacturers and the diffuse nature of the installer industry.

An analysis of turnover and employment data sourced from Companies House for the majority of the EWI system supply side suggests that turnover of the sector is £101m in 2010 (£106m in 2009) with employment of 566 (2010), compared to 577 in 2009. Based on feedback from market experts on likely company operations within the EWI market (i.e. ignoring parts of major companies which are supplying into other parts of the construction industry), including potential market ranking, we have been able to refine this analysis and produce more realistic figures. We estimate that **the EWI supply side was worth around £54m in 2010, employing 300 people.**

On the EWI installer side, there is estimated to be a total current workforce of 1,800-2,000 skilled EWI installers[114]. It is claimed that a 4-man team can install 70-100 semi detached houses per year depending on their efficiency levels. This equates to a potential maximum delivery of around 50,000 semi-detached properties per year. The market value of EWI is used as a basis for understanding installer turnover which we estimate at around £105m for 2010 or around double the turnover of the EWI supply side based on the value added from this part of the supply chain.

This would give total EWI supply and installation employment at around 2,300. Based on an estimate of UK construction industry employment of around 2.22 million people in 2009[115], this suggests that just 0.1% of the industry is focused on EWI.

[114] Source: INCA

[115] See decline forecasts published in February 2010 by the Construction Skills Network http://www.cskills.org/newsandevents/news/csnoutputs2010.aspx

5.3.2 Forecast turnover and employment for EWI to 2022 under a ‘Business as Usual’ scenario

Given the assumptions listed above (including current skilled installation workforce and their likely capabilities – the BAU scenario), and using reported EWI installation rates for 2008 (EST, 2009) and more recent analysis of CERT and CESP, Table 5.4 below sets out the current deployment rate (consistent with those in section 4) and its impact on jobs and turnover to 2020.

Table 5.4 Projections of EWI market to 2022 assuming ‘Business as Usual’ (BAU) scenario, based on 2010 market estimates

	BUSINESS AS USUAL												
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
EWI industry turnover in £m (based on per unit material price below)	54	54	54	**54**	54	54	54	54	54	54	54	54	**54**
Employment in the EWI system supply sector	300	300	300	**300**	300	297	276	266	256	247	239	231	**224**
Units per FTE supplied by EWI sector (illustrates productivity gain)	48	48	48	**48**	48	50	52	54	56	58	60	62	**64**
EWI units installed per annum	**14,350**	**14,350**	**14,350**	**14,350**	**14,350**	**14,350**	**14,350**	**14,350**	**14,350**	**14,350**	**14,350**	**14,350**	**14,350**
Cumulative units installed from 2013				**14,350**	**28,700**	**43,050**	**57,400**	**71,750**	**86,100**	**100,450**	**114,800**	**129,150**	**143,500**
Cost per unit (£) materials supplied	3,763	3,763	3,763	**3,763**	3,763	3,763	3,763	3,763	3,763	3,763	3,763	3,763	**3,763**
Employment projections for 2012 and beyond for skilled EWI installers	1,900	1,900	1,900	**1,900**	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	**1,900**
Units installed per employee	8	8	8	**8**	8	8	8	8	8	8	8	8	**8**
Total EWI supply side and EWI installer employment	**2,200**	**2,200**	**2,200**	**2,200**	**2,200**	**2,197**	**2,176**	**2,166**	**2,156**	**2,147**	**2,139**	**2,131**	**2,124**

Assumptions underpinning this analysis include:

- 14,350 external solid wall units installed annually – 70% of the total 20,500 SWI installations per annum with the balance comprised of IWI;
- No new entrants into the EWI industry (or equivalent new entrants with average employment intensities and prices);
- Skilled EWI installers can reach 25 units per employee at full capacity, but the distributed nature of the market and lack of scale up in installations means employment efficiencies are hard to obtain;
- Market prices for EWI systems are assumed to be constant to 2022;
- There are limited price reductions owing to ‘learning on the job’, product scale up economies and system innovations, but we have factored in gradual productivity improvements for the manufacturing supply side from 2015 in delivering EWI systems to the market which has an impact on EWI supply side employment.

By 2022, under the BAU scenario, there will a cumulative total of around 186,550 EWI installations, a EWI system supply side turnover that is still around £54m and total employment in supply and installation of around 2,100, representing a slight decline on current employment as a result of productivity increases in manufacturing.

5.3.3 Forecast turnover and employment for EWI to 2022, assuming a 2.5% price reduction per year due to innovation and cost pressures

The DECC Central growth scenario represents a realistic ramping up of annual EWI installations through to 2022 from the current baseline EWI installation rate of 14,350 EWI units per year (which is assumed to be stable until the end of 2012). From 2013 we have modelled an increase in installation rates (consistent with those in section 4), rising to 30,000 in 2013, 70,000 in 2018 and 88,500 in 2022 (see Table 5.5)[116].

116 The total annual DECC Central installation rate for SWI by 2022 is 125,000 suggesting 37,500 IWI installations per year by then, assuming a 70:30 split between EWI and IWI.

Table 5.5 Projections of EWI market to 2022 assuming a DECC Central scenario, based on 2010 market estimates

	BUSINESS AS USUAL			DECC CENTRAL SCENARIO									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
EWI industry turnover in £m (based on per unit material price below)	54	54	54	**110**	179	192	204	216	226	252	261	255	**259**
Employment in the EWI system supply sector	300	300	300	**625**	1000	1000	1091	1083	1077	1067	1063	1063	**1106**
Units per FTE supplied by EWI sector (illustrates productivity gain)	48	48	48	**48**	50	55	55	60	65	75	80	80	**80**
Units installed per annum	**14,350**	**14,350**	**14,350**	**30,000**	**50,000**	**55,000**	**60,000**	**65,000**	**70,000**	**80,000**	**85,000**	**85,000**	**88,500**
Cumulative units installed from 2013				**30,000**	**80,000**	**135,000**	**195,000**	**260,000**	**330,000**	**410,000**	**495,000**	**580,000**	**668,500**
Cost per unit (£) materials supplied	3,763	3,763	3,763	**3,669**	3,577	3,488	3,401	3,316	3,233	3,152	3,073	2,996	**2,921**
Units installed per employee	8	8	8	**12**	18	20	22	24	26	26	28	28	**28**
Employment projections for 2012 and beyond for skilled EWI installers	1,900	1,900	1,900	**2,500**	2,778	2,750	2,727	2,708	2,692	3,077	3,036	3,036	**3,161**
Total EWI supply side and EWI installer employment	**2,200**	**2,200**	**2,200**	**3,125**	**3,778**	**3,750**	**3,818**	**3,792**	**3,769**	**4,144**	**4,098**	**4,098**	**4,267**

This scenario uses a different set of assumptions to the BAU scenario. For example, productivity gains in the manufacturing and supply of EWI are greatly improved in response to the large increase in installations. Other differences include:

- **market prices for EWI systems decline in real terms by 2.5% per year** from 2013 owing to a mixture of 'learning on the job', product scale up economies, system innovations, production innovations and competition pressures. This is in the same sort of target range that some suppliers suggest should occur in the market (i.e. a 25-50% reduction in prices).
- **the need for immediate recruitment in EWI installers to achieve forecast rates.** We have assumed that there are efficiency gains both from multiple renovations and improved installation techniques such that such that teams can reach 28 units per employee by 2022 (compared to current maximum envisaged of around 25).

A summary of the DECC Central projections is shown in Table 5.6. **By 2022, the ramp up in EWI installations will yield supply side turnover of £259m, total EWI system supply side employment of around 1,100 (a 370% increase) and installer employment of around 3,150 (a 66% increase).**

Table 5.6 EWI projections to 2017 and 2022 based on 2.5% price reductions for systems

	2010	2017	2022
EWI turnover	£54m	£216m	£259m
Cost per unit installed	£3,763	£3,316	£2,921
Price reduction compared to BAU (above)	-	13%	29%

Whilst innovations such as mass deployment of dry lining systems (see next section) might be expected to reduce the installer base considerably, by eliminating the need for wet trades, we do not consider the scale of this potential job loss or any second or third order impacts across the economy that might result from these job reductions.

It should also be noted that all the increases in employment considered relate to the solid wall insulation sector; there would be a corresponding reduction in employment and investment in other sectors, with an ambiguous net effect on aggregate employment levels that is beyond the scope of this project to consider.

5.3.4 Industry issues surrounding achievement of future deployment

The labour market might experience a short term constraint, particularly if 2011 and 2012 prove to be more difficult years than anticipated such that people leave the sector. However**, the labour supply is likely to catch up with the demand for work in the long term, helped in part to new training schemes, for example those established by INCA for apprentices and those wishing to train up for doing EWI work**[117]. Furthermore, there is

[117] Mike Threadgold, Business Development & Technical Manager, Renocon & Chair of INCA skills and training working group

understood to be sufficient current capacity in the skilled EWI installer workforce to more than cope with a ramp up in installations, at least to around 45,000 units per year[118].

Costs would fall if main contractors started to 'self deliver' rather than following the current sub-contracting model, although the in-house capability of many main contractors in this respect is regarded as variable. Some are not regarded as being sufficiently well geared up to do this type of work.

[118] INCA

6 Potential innovation support programmes for SWI

6.1 Background

The SWI industry has developed and proven technology options which have been designed to be installed on the vast majority of domestic and commercial solid walled properties in the UK. Given the low paybacks for the technology, there is clearly scope for investing in potentially game changing insulation products and systems that make the SWI offer to consumers more economically palatable.

As noted in previous sections, the small scale of the current market coupled with generally low profitability does act as a brake on investment. However, as has been illustrated in the Technology section of this report, the industry is pursuing a number of approaches to reduce costs at all points in the supply chain.

Yet there is scope to go further, and faster. Support for both refinements to existing products and RD&D funding of new innovations which can be deployed at scale could help to bring about a significant cost reduction. This in turn could stimulate greater demand and deployment of SWI technologies.

6.2 Development and evaluation of potential support interventions

This study's terms of reference called for the development of a set of interventions that can be potentially supported to tackle the observed market failures and other barriers to innovation within the SWI industry.

A number of suggestions for potential public sector support were obtained from consultations with the SWI sector. These included:

Direct interventions to support technological and engineering innovation, or research, development and demonstration

- The development of external wall dry lining systems;
- Modelling and application of new generation materials (e.g. phase change materials);
- Development and testing of novel systems (e.g. dynamic flow insulation).

Indirect interventions which support innovation

- Assistance for SWI suppliers in achieving certification of new SWI products;
- Greater evidence of the financial and energy performance of SWI products and systems;
- A full review of the whole insulation market to identify appropriate solutions for all types of wall, including non-traditional systems;
- Research into consumer awareness, engagement and uptake, and potential impacts of the Green Deal (including workforce and skills requirements).

The final suggestion from SWI system suppliers and installers on ways in which government could help to increase the uptake of SWI is detailed in the Evidence Box below.

Evidence 6: Consumer-focused interventions could help promote the demand for solid wall insulation

The SWI supply side would like to see government raise awareness and promote the benefits of SWI and the industry solutions available to householders. The introduction of mandatory minimum standards for the energy efficiency of buildings was also mentioned, as was the provision of greater incentives to encourage the uptake of SWI, rather than cavity wall insulation. A more general point raised by one manufacturer was the need for commitment and consistency from government in terms of the measures that will be applied to support and encourage the SWI market. Without this commitment, there is a risk that the industry will remain cautious and hold back from investing and preparing fully for the potential increase in uptake of SWI (due to the Green Deal).

We have focused on two interventions which we believe will help to address key constraints in the sector:

- The first constraint is the high cost of EWI systems for the demand side. This is a result of EWI being mainly based on wet render which is costly to apply using skilled labour. We have investigated the potential economic and environmental benefits for a **programme to support the development and demonstration of new dry lining systems (DLS)** to significantly reduce the costs of EWI. We have considered an initial amount of £4 million for public funding;
- The second constraint is the value proposition of IWI systems. Improved functionality from **incorporating phase change materials (PCMs) into IWI systems in domestic buildings**, which would theoretically help smooth temperatures in homes as well as reduce energy usage, could potentially create faster paybacks for the IWI. The modelling of PCMs integrated into insulation across the domestic housing stock is vital in helping confirm the energy savings that these novel materials can bring about. Further demonstration of the benefits of PCMs in real household environments with monitoring and evaluation is also required as to date they have been only demonstrated in commercial settings. The total for public funding for this package of support would be around £1 million.

We have already carried out market sounding of both these innovation interventions, which would be at least 50% match funded by industry, and have had confirmation that firms would be interested in bidding into such a support programme for the SWI sector.

We believe the SWI sector would also benefit from:

- **Continuation of more detailed solid wall trials**, expanding them to cover more property types and new systems, in order to build up a larger database of performance by house type;
- **Continued support to demonstrate more innovative SWI technologies alongside other building fabric interventions** via a programme akin to the Retrofit for the Future programme;
- **Investigating the need to support the development of innovative insulation materials** that can help take SWI performance to a higher level post 2020 as well as offer most cost effective products. The UK has R&D capabilities in aerogels and related insulation technologies which could be stimulated through government funding support (see Evidence Box below). However, it was not possible in this study to comprehensively map the innovator landscape in this field to build a stronger case for intervention.

Evidence 7: Potential for the UK to develop comparative advantage in advanced solid wall insulation technologies

Inorganic aerogels such as silica or metal oxide-based have been around for 80 years but have only recently been introduced into building construction, having previously been reserved for space exploration and insulation of gas pipelines. Aspen Aerogels Inc. (Aspen), based in Massachusetts, USA is the current market leader in producing insulation for the built environment. Not only has Aspen managed to successfully license and/or supply its products Spaceline (for internal wall insulation) and Spacewall (for external wall) to the likes of Proctor Group (Scotland) and Springvale (Northern Ireland), it also has ambitions to develop a manufacturing facility in the EU. German chemicals giant BASF's subsidiary BASF Venture Capital GmbH led a €15.7m investment round into Aspen in October 2010 - no doubt prompted by its horizontal integration ambitions across the building insulation market, especially in the EU. At the time, Don Young, CEO of Aspen commented: *"The global building and construction market offers a significant opportunity for aerogel technology, and BASF and Aspen will join forces to target and rapidly penetrate the European market."*[119]

Inorganic aerogel technologies are understood to be currently under development in several UK SMEs[120]. Inorganic aerogels used currently are very expensive to produce so there is a clear

[119] Aspen Aerogels press release (8 October 2010) – see http://press.aerogel.com/index.php?s=118&item=267

[120] Source: BRE

rationale for researching the options available through the organic aerogel route (e.g. phenolic or formaldehyde based) in order to determine whether they are robust enough to provide the longevity of currently available options (i.e. 50 years plus). However, organic versions tend to be less fragile or friable. Clearly if large scale production of more rigid and compressible aerogels could be developed this could open up a new stream of supply.

Furthermore, aerogel hybrids and other products are of particular interest such as polymer coatings and heat dispersing pigments. The latter technology area is of interest due to the propensity for the external building fabric to heat up in the sun, resulting in conduction though the wall and the potential for overheating in the summer. By dispersing this heat before it has the opportunity to enter the fabric, a more constant temperature can be maintained in the building fabric, reducing the potential need for mechanical cooling inside the dwelling.

Further identification of companies is required in order to carry out some market sounding of a potential open call focused on 'game changing' insulation for the built environment. A key aim would be to stimulate the commercialisation of environmentally benign, thin insulations solutions. A key objective would be to help bring new technologies to market from the UK research base with direct impacts that would include substantial energy savings, carbon savings and export potential into other EU markets faced with similar challenging long-term (i.e. 2050) carbon reduction targets.

This section continues by setting out the background, rationale and likely benefits and costs from the four potential interventions listed above. As requested by DECC, a preliminary and high level cost benefit analysis has been undertaken on the first two options.

6.3 Approach to analysis of the interventions

A cost-benefit analysis of the project has been conducted according to DECC guidance. The approach requires a statement of the programme rationale and additionality, and the definition of the counterfactual and the direct and indirect impacts. The direct and indirect impacts from the intervention should be monetised (and discounted) as far as possible, based on available evidence concerning the direct and indirect impacts. These include:

- Public and private investment from UK sources;
- Costs/ benefits versus the counterfactual (e.g. lower costs of installing SWI insulation);
- Energy savings[121];
- Carbon savings (based on the non-traded price of carbon as the SWI sector falls outside the EU ETS traded sector[122]);
- RD&D spillovers[123].

At this conceptual stage a full analysis has not been completed, but the framework has been followed as far as possible. We have considered the probability that the intervention leads to successful innovation (for example, by considering a low, central and high change of success).

Potential benefits relating to the potential additional UK value added from new export markets are not monetised, due to the very high degree of uncertainty surrounding economic displacement and crowding out effects.

[121] Valued according to *Valuation of energy use and greenhouse gas emissions for appraisal and evaluation*. June 2010. HMT, DECC. http://www.decc.gov.uk/assets/decc/statistics/analysis_group/122-valuationenergyuseggemissions.pdf

[122] *Carbon Valuation in UK Policy Appraisal: A Revised Approach* Climate Change Economics, Department of Energy and Climate Change July 2009

[123] i.e. either the potential leakage of knowledge gained from RD&D activities to other organisations, depriving the innovator of the full benefits of their investment. The estimate was derived by the Deparment for Business, Innovation and Skills, and is based on the literature which ams to quantify the difference between the social return to innovation and the private return to innovation, i.e. the externality.

6.4 External dry lining research, development and demonstration (RD&D) assistance

6.4.1 Background to programme and features

Whereas dry lining systems (DLS) have become the preferred option for internal wall insulation, wet renders are the most commonly used system for external wall insulation despite the negative impact this technique has on installation time and costs associated with scaffolding, wet trades and installation time.

Consultations with two UK firms that have developed external DLS systems for the UK market indicate that the use of external DLS could reduce EWI system costs by at least 20% - 30% depending on the type of building they are fitted to[124]. For example, independent verification[125] of Parasol Panels' external DLS at a park homes site in Cornwall showed that the system produced overall cost savings (i.e. system and installation) compared to a wet render system by 50%. The firm sees no reason why similar cost savings cannot be achieved for other types of property.

An RD&D programme would help companies to understand better the current challenges and limitations of external DLS systems as dictated by appropriateness to each building type – for example, depending on height, fire safety regulations and method of construction. It would help to fund RD&D into more advanced systems than currently have been considered, not only by those with systems under development but by the EWI industry overall who remain focused on wet render systems.

Consultations with those firms that have developed external DLS systems do not indicate any immediate drawbacks relative to wet systems.

6.4.2 Rationale for intervention

Demonstrator projects are important as external DLS are largely unproven on most housing types. There is a lack of information about manufacturing processes, installation costs, thermal performance, and the durability and longevity of installed systems. DLS innovators have highlighted the lack of funding opportunities as a key constraint to innovation. Obtaining test data which is necessary for certification is also reported to be overly time-consuming and costly.

Support and assistance to develop dry-lining technologies appropriate for mass market adoption would help address key issues in the installation of EWI, including:

- The cost, time implications and specialist skill requirements associated with wet renders. One study[126] estimated that a three stage 10mm thick silicone acrylic texture render[127] represented 35% of an installed EWI system cost;
- Wet weather, which can cause installation issues and delay.

Support could be targeted at the development, certification and demonstration of new types of external DLS. The principal aim of the programme would be to assist companies in the R&D and production of new products that are ready to be demonstrated on houses. This could comprise assistance with:

- the integration of new insulation materials into existing systems;

[124] Based on estimated cost reductions of at least 22% (supply and fit) of external DLS system proposed by Wall Transform Ltd with potential for more depending on house types and particular situations. Estimates also based on proportion of EWI system costs (supplied and fitted) for external render (i.e. 35%) quoted in Purple Market Research, *Solid Wall Insulation Supply Chain Review*, for EST and Energy Efficiency Partnership for Homes, May 2009 – work done by *Robert Lombardelli Partnership*

[125] Undertaken as part of a project installing Paraclad30 for 10 park homes in Cornwall with Scottish and Southern Energy and Cornwall County Council, and the Gamston Mobile Park Home trial with National Energy Action (NEA)

[126] Purple Market Research, *Solid Wall Insulation Supply Chain Review*, for EST and Energy Efficiency Partnership for Homes, May 2009

[127] 3 stage render comprising base coat and mesh, primer paint and silicon acrylic texture finish cost in colour to suit (to walls and reveals). It is the top coat that seals the wet render system.

- the development of new systems;
- the testing of the durability of panels across wide range of temperatures and weather conditions to ensure desired performance is achievable;
- certification of market ready products.

Secondary elements of a programme could include support to investigate:

- Improvements in manufacturing processes that can minimise on-site installation efforts (e.g. pre-coated panels);
- Measurement / surveying methods (e.g. laser measurement / 3D imaging) that might minimise on-site installation costs / times;
- How to simply but securely attach panels to buildings and each other to maximise thermal performance and 'design-out' the likelihood of errors during installation.

6.4.3 Does the UK have the capability?

We have identified two companies with relevant products that are active in the UK market: the first SME is selling an external DLS product for 'park' homes, but is interested in looking at other markets; the second SME has already been selling EWI and IWI for 8 years, has developed a patent pending external DLS product and is seeking BBA certification. See section 2.6.2 for further details on both companies.

Saint-Gobain Isover's subsidiary, British Gypsum, is the UK's market leader in the manufacture and supply of internal DLS (i.e. plasterboard and plasters). Saint-Gobain Isover itself has also developed an external DLS in France (see below). The company overall is therefore likely to be an important player in any future external DLS market – and could well act as a 'cornerstone' partner for certain RD&D[128].

6.4.4 Is there a large market opportunity?

There is a significant UK market opportunity for external DLS technologies that can address current challenges, particularly in light of the high costs of existing EWI systems relative to other forms of insulation (e.g. cavity wall insulation).

External DLS technologies are suitable for domestic and non-domestic buildings and new build and retrofit markets. However, they will not be appropriate for all properties since they will affect the appearance of the property and will not be compatible with heritage/conservation properties.

It will be important to ultimately have a number of external DLS on the market (including systems with interchangeable insulation) in order to give the customer choice and not be dependent on any on system supplier.

6.4.5 What would a successful innovation programme look like?

The programme will stimulate a number of companies and research centres, both from within and outside the SWI sector, to collaborate in the RD&D of novel DLS for EWI.

6.4.6 Is the idea ready? (timeliness and impact)

Such a programme would be very timely and its impact could be significant, given that external DLS have yet to become mass market products in the UK and also with the proposed Green Deal helping to promote SWI. There is also a need to research, develop and refine the technologies in preparation for mass market deployment / adoption across different types of housing stock. The technology is already being applied to park homes which represent 400,000 homes (or 5% of the 8 million solid wall housing stock).

[128] British Gypsum's innovation programme aimed to introduce a number of products in 2010, including new boards, plasters and drylining systems. They also planned to launched a new range of thermal laminate products (i.e. plasterboard panels with an additional layer of thermal insulation) – see http://www.british-gypsum.com/sustainability/economic_sustainability/innovation.aspx

Dry-lining systems require less specialist installation which is beneficial for mass market adoption since a larger number of people can install them.

6.4.7 How will public funding make a difference? (added value)

The two UK companies currently identified as either developing/selling dry-lining EWI technologies are small SMEs and would particularly benefit from the support; there are almost certainly other UK SMEs (both large and small) who will have considered this application.

A programme could accelerate the deployment of external DLS technology which might otherwise fail to have the necessary industry impetus, particularly with regard to its suitable for retrofitting to different building types.

An intervention could help overcome various market failures by generating:

- Information and access to capital, accelerating the commercialisation of products (e.g. through exploiting linkages to appropriate research and industry contacts) and levering in more investment;
- Information benefits which could help to overcome demand side information failures with consumers.

One SME noted that the high costs of R&D and demonstrating products and systems was a key barrier followed by the ability to upscale manufacturing operations to meet demand.

RD&D is also required to ensure that external DLS products can perform as well *in situ* as existing EWI systems: the risk of incorrect installations and defective systems could reduce confidence in SWI. For example, a system failure could cause injury or loss of life.

6.4.8 What is happening in this area outside the UK?

French insulation giant Saint-Gobain Isover has an external DLS system (Isover Plus) which is based on glass wool. Whilst it could be brought into the UK market it is a very thick (deep) system and there are doubts as to whether there are many houses with overhangs that could accommodate such a design. As it stands, the system would require significant tailoring for the UK market, for example by using a phenolic board. Isover commented that *"there is potential for dry [lining] systems of which Isover Plus is one, based on low lambda glass wool. The constraint is the thickness required as opposed to high performance foam."*

Looking beyond Isover, it is unclear what the market capability is in other continental European companies.

6.4.9 If clear benefits then why aren't the large players doing something already?

New systems involve considerable cost in tooling up the production lines. The cavity and loft insulation programmes instigated by government such as CERT clearly provided a market for companies to allocate investment into. Industry is similarly waiting for a clear indication of the potential markets for external DLS before investing in this area.

Isover may introduce its DLS system if a UK market can be established. However, as noted above, this will require further R&D to develop a thinner product. It would also be necessary to conduct demonstration trials of any system in the UK.

6.4.10 What are the likely costs of such a programme?

£8m of R&D funding (up to 50% public funding; the rest from industry and the research base).

6.4.11 What are the likely benefits from such a programme?

The potential outcomes and benefits of the programme include:

- Development of market-ready products that will help to tackle different building types at reduced cost to current wet render systems;
- Overcoming practical installation issues; and
- Demonstrating in-situ performance.

There is also potential to integrate PCM materials into these new systems (see the next proposed support intervention).

6.4.12 Assessment of costs and benefits

In approaching an economic valuation of such an investment one is faced with a number of areas of uncertainty. These include:

- Uncertainty about whether the RD&D investment will result in new products in the market place (relating to success of the project and firms' willingness to invest in the final development, production and marketing of the new products);
- Uncertainty about how the market will respond to the availability of the new products and in particular how many additional EWI installations there will be.

There are therefore many contingent events to be considered. The project is expected to provide industry with new information (and thus options) on the basis of which new investment might be triggered. There are challenges to modelling such scenarios. For present purposes a model has been developed to generate estimates of the net present value of the investment on an expected value basis. The model considers social costs, in the form of the:

- DECC and private investment;
- the system (material and labour) costs of the incremental deployment of SWI in the with-project scenarios;

And benefits in the form of:

- the reduced system costs relating to SWI deployment that would have occurred without the innovation;
- energy savings (valued at the long-run variable cost of supply for domestic gas);
- carbon savings (valued at the untraded price of carbon as defined for each year in Government guidance) under specified assumptions for the above factors and the average carbon saving per additional installation.

The benefits arise from the investment providing:

- development, certification and demonstration of new types of external DLS across different types of the domestic housing stock;
- information about improved product specification and performance on which companies can base decisions on product development and manufacturing and market investment;
- knowledge that can inform policy development and advice for consumers.

Carbon and energy savings per installation are assumed to be the same as for traditional EWI systems. The economic returns of the programme depend on how the savings influence programme costs and the marketplace, including the fundamental issue of how many domestic properties could benefit from such external DLS systems.

Lower cost DLS systems:

- would reduce the costs associated with energy efficiency retrofit programmes mandated by public policy;
- could result in a higher level of consumer demand for EWI.

Table 6.1 Examples of the assumptions used in the model

Factor	Assumption
Assumed impact of intervention on aggregate market demand - high	10%
Assumed impact of intervention on aggregate market demand - low	5%
Assumed probability of market impact	10%
Average energy savings per installation	9,435 kWh
Conversion factor - kWh nat gas to kg CO2 (Defra)	0.183580
Average carbon saving/year/home (taking into account rebound)	1.7
System cost after project, year 1, £	5,500 – 6,500[129]
System cost saving with project, year 1, £	1,500
Learning rate, year 2 onwards	2.5%
Discount rate	3.50%

6.4.13 Main conclusions

There are so many uncertainties in modelling a project such as this, and so many assumptions that can shift the precise outcome, that it is unwise to get distracted by the individual numbers and more helpful instead to focus on the main messages that the modelling suggests.

In this instance these are that:

- As the reference installation rate improves (i.e. as transition to a Green Deal-type environment takes place under the DECC Central scenario) the return on the project improves rapidly.
- In a Green Deal scenario, an innovation that reduces unit deployment cost has a significant benefit. Under conditions closer to business as usual the case for investment becomes less clear. In a Green Deal world the current project would be worth funding (on an expected value basis) even if the expected probability of success is very low (less than 1%).
- The project is still worth supporting in a baseline scenario world, though the expected net present value is significantly smaller.
- The more sensitive consumer demand is to the installed price, then the better the return on the investment.
- The value of the project improves as the carbon price increases (a similar result is obtained for energy price).

A major uncertainty is how far the market would in fact respond to the improved product being available. This study has focused largely on the supply side of the market but observed that payback periods under current price conditions are high. If a 20% cut in installed price of EWI results in a 5% increase in demand then the return from the project is much less than if that same 20% cut results in a 20% increase in demand.

[129] This depends on whether there has been no change in unit price under BAU compared to a 2.5% decline since 2013 in the DECC Central scenario.

6.4.14 Discussion of costs

Investment costs were estimated at £8m in total, spread over three years. Guidance was that the capital costs of any new production equipment or facility needed to manufacture the innovative products should be excluded (such costs are unknown).

The system (material and labour) costs of the incremental deployment of SWI in the with-project scenarios are estimated at £7,500 (BAU) to £6,500 (DECC Central) per unit in the first year (2018), declining at 2.5% per unit per annum in recognition of learning. These costs are substantial. The more responsive the market is to the fall in price generated by the project's innovation, the larger the scale of these 'additional costs'.

There are some methodological challenges with their inclusion. For instance these costs are presumed to reflect individual consumers choices (or a collective choice via public policy) made in rational expectation of benefits, benefits that will often accrue outside the timescale of the present model (e.g. a cost incurred in 2029 will generate 20 years or more of benefits).

The 'answers' therefore are heavily influenced by what time period is modelled – the last year of benefits selected and the last year of new costs (i.e. new installations). If the SWI installations are projected out to 2030 and benefits also projected no further than 2030 then the model picks up a full set of costs but only a fraction of the benefits.

This exercise involves modelling a period of rapid ramp-up in installations, and the installation costs (and savings thereof) figure much more prominently in the results than carbon and energy savings (which are the end purpose of the investments). Indeed, if the system costs of additional installations arising from the project are treated as a social cost then they can 'swamp' the energy and carbon savings generated (and the savings made on installing the installations that would have happened without the project) if (1) consumers are assumed to be price-responsive (2) the modelled period of time ends before the flow of benefits.

To resolve this problem the model was adjusted so as to recognise (costs of) installations to 2022 and benefits to 2040. It therefore assesses the value of the innovation project in terms of its impacts on the ramp-up of SWI installations in the period to 2022.

6.4.15 Discussion of benefits

Lower system costs

The 20% cut in material and labour savings results in savings relating to SWI deployment that would not have occurred without the innovation. These savings are estimated at £1,500 per unit in the first year, declining at 2.5% per unit per annum in recognition of learning.

In the baseline scenario, the expected aggregate value of these savings (based on just a 10% probability of success) is estimated at only £43,000 in 2018 (the first year of deployment) rising to £1.0m in 2022. This compares to £0.22m in 2018 to £1m in 2022 in the DECC Central (Green Deal & ECO) scenario. If realised, the savings are therefore more substantial (ten times those indicated above), especially in the Green Deal and ECO scenario where £10m of material and labour savings would be realised.

Energy savings

Annual energy savings are small compared to system costs during the period in which large scale deployment is in progress, especially when assessed on a long run supply cost basis (rather than at retail prices). If the project was successful the annual energy savings in 2022 would be approximately £1.75m in a baseline scenario and £10m in the DECC Central (Green Deal & ECO) scenario. The expected value is taken to be 10% of that.

Value of carbon savings

Each installation is assumed to result in a 1.7tCO_2/yr savings. If the project was successful the estimated value of carbon savings in 2022 would range from £180,000 to £6.1m depending on the carbon price (i.e. low, medium, high) and the deployment scenario, and £2.0m to £71.4m by 2040. The expected value is taken to be 10% of that.

6.4.16 Results

The results are shown in Table 6.2 and Table 6.3 below. As noted above, given the inherent uncertainties and assumptions made the figures should be regarded as indicative of the general performance of the project. Under a 10% chance of success, the NPV has been found to be positive for all circumstances only under a Green Deal plus ECO (DECC Central) scenario; at a 50% chance of success, the NPV is positive thoughout.

Table 6.2 Estimates of the NPV of external DLS project under different scenarios at 10% chance of success , installations to 2022 and benefits to 2040

	NPV, £million		
Scenario	**Low C Price**	**Central C Price**	**High C Price**
BAU with 5% increment	-£3.0	-£2.2	£3.1
BAU with 10% increment	-£2.2	-£0.7	£10.0
DECC Central with 5% increment	£0.9	£5.5	£37.2
DECC Central with 10% increment	£5.5	£14.7	£78.2

*Notes: Assumes **10%** change of product reaching market, 1.7tCO_2/yr/installation carbon saving, 3.5% discount rate, DECC untraded carbon prices and long run energy supply costs for domestic gas (central price) taken from Interdepartmental Analysts Group Toolkit, December 2011.*

Table 6.3 Estimates of the NPV of external DLS project under different scenarios at 50% chance of success, installations to 2022 and benefits to 2040

	NPV, £million		
Scenario	**Low C Price**	**Central C Price**	**High C Price**
BAU with 5% increment	£0.12	£4.0	£30.4
BAU with 10% increment	£4.0	£11.7	£64.6
DECC Central with 5% increment	£19.3	£42.3	£201.0
DECC Central with 10% increment	£42.3	£88.4	£405.7

*Notes: Assumes **50%** change of product reaching market, 1.7tCO_2/yr/installation carbon saving, 3.5% discount rate, DECC untraded carbon prices and long run energy supply costs for domestic gas (central price) taken from Interdepartmental Analysts Group Toolkit, December 2011.*

6.4.17 R&D spillovers

The R&D spillovers of a £4m public investment, applying the standard sets of assumptions used in BIS' methodology for such calculations, are shown in Table 6.4.

Table 6.4 R&D spillovers

Assumed public R&D Expenditure (PV)	**£4,000,000**		
	Low	**Central**	**High**
Gross External Return (Social Return – Private Return)	20%	25%	30%
Less Leakage	40%	25%	10%
Less Displacement	30%	20%	10%
Net External Return	£336,000	£600,000	£972,000

Depending on the participation in the programme there is potential for:

- Leverage of overseas corporate R&D finance into the programme, and also foreign industry experts (e.g. from Saint-Gobain Isover);
- Foreign companies within the UK EWI supply side to utilise the research and sell into non-UK markets, thus creating economic leakage of UK R&D.

6.5 Role of Phase Change Materials (PCM) in domestic solid wall / whole house insulation

6.5.1 Background to programme and features

Retrofit of SWI (coupled with other forms of insulation) has implications for how the modified building reacts to extremes of temperature. For example, by increasing the level of insulation, there is potential for overheating on very hot summer days and a loss of thermal mass to control the heat capacity of properties in the winter. Before embarking on a programme of mass retrofit, there is an opportunity to incorporate additional functionality into the insulation that is used. One example is laminated foam board that provides a 'passive' control system by modulating the heat load of a building.

Phase change materials (PCMs) could deliver this functionality. PCMs simulate the thermal mass properties of a solid structure. In certain conditions they absorb heat that is then released at a later time. Typically, as a room temperature rises to 22 degree Celsius, the material in the PCM (e.g. an organic encapsulated paraffin wax or an inorganic salt hydrate), melts and absorbs the heat through the changing of phase from solid to liquid. This continues for a further 6 degrees of temperature change up to 28 degrees Celsius. When the room temperature drops down to 18 degrees, the heat is gradually released, usually at night. The heat can be expelled from the room by natural or mechanical ventilation.

In the winter the heat can be retained in the room to moderate the heat needed to return the room to comfort levels when next occupied. Heat is stored and released to avoid drawing on energy supplies at peak times, typically morning and evening, when huge demand is met by fossil fuels. This is referred to as peak-lopping. The ability of phase change materials to store heat when fuel is cheap and distributed later in the day works on a similar principle to storage heaters. PCMs can be incorporated into a number of products, including ceiling tiles, gypsum board, magnesium oxide panels or clay panels.

6.5.2 Rationale for intervention

Currently it is the norm to include vapour control layers (VCL) on the back of plasterboard when fitting insulation. This prevents moisture entering the structure/insulation/cold areas to prevent dampness and rot. This is an accepted industry standard. If IWI is to be used, PCM could also be used to counter the loss of thermal mass. This can be achieved by way of specifying a type of finishing board that has PCM integrated into it.

Current building energy models do not provide a value for the potential energy savings of PCMs across UK building stock. The lack of information on when PCM will provide benefits to consumers, and the extent of those benefits, is a barrier to the development of this market, and in turn discourages companies from investing in tooling up to produce these hybrid products at the economies of scale required (see Evidence Box).

Evidence 8: More sophisticated modelling is needed to provide a better understanding of benefits from PCMs

From this current study's modelling of the potential energy savings that PCM can offer in a domestic setting, it is evident there are shortfalls in the Standard Assessment Procedure (SAP) 2009 model (used to model energy savings in the building stock). At the moment SAP allows an adjustment of the Kappa values (i.e. the thermal admittance of the fabric, its storage potential) of the wall surface to allow for a reduction in the cooling requirement of the dwelling. What it cannot do is generate a heat saving potential through heat storage in the fabric.

While the need for reduced mechanical cooling is a very important part of the properties of PCMs (i.e. since the insulation will improve comfort levels in the event of high temperatures and potentially reduce the need for air conditioning), equally important is the potential to store heat that can be used to even out the demand for peak power, providing thermal comfort levels through energy purchased at low cost, off peak times. With a potential increase in baseload generation from nuclear power, the need for taking advantage of the off peak availability of inflexible energy delivery will become increasingly important. Carbon savings can be increased if energy can be purchased and stored for later release. Current off peak electricity costs are a third of peak rates, so the fuel bills savings are also considerable, and coupled with a programme of insulation will give greater potential savings.

Where electric storage heaters have been installed into properties with very poor thermal performance (as well as properties not on the gas mains), they have tended not to deliver the required comfort levels because of the poor building fabric and a lack of understanding by occupants on how to optimise their use. PCMs will provide a similar facility for storage of heat, but the control is passive. For this to work effectively the system needs to be designed to suit the property. Building models need to calculate the PCM required to deliver the savings, based on all the other factors within the property. Currently poor air-tightness reduces the effectiveness of the Kappa value of the dwellings as it must be taken into account along with insulation to achieve true savings.

Another benefit of providing additional functionality to the energy models is that more realistic U-values for non standard walls could be built up. Currently there is much debate around older walls having a much better performance than a standard 9 inch wall.

Secondly robust data gathered from demonstration projects are needed to validate manufacturers' modelling data, both in controlled conditions and occupational circumstances. These data can be fed into energy models used by government.

Demonstrating the energy and carbon savings achievable through the use of PCMs and hybridised insulation and PCM products could provide the impetus for manufacturers to invest in developing products to deliver PCMs and hybrid products.

6.5.3 Does the UK have the capability?

There are three leading producers of PCM products:

- BASF, with its Micronal® product;
- DuPont, with its Energain® material; and,
- Saint-Gobain, with its Maxit range.

While all these companies are foreign owned – a factor relevant hence to any UK focused support programme - both BASF and Du Pont have a R&D presence in the UK; Saint-Gobain's R&D centre is in Paris.

UK companies are now incorporating these PCM products into their own insulation systems, thus creating relationships and demonstration opportunities that the major manufacturers of PCM will be reluctant to back away from. One SME consulted for this study, for example, is a British R&D company specialising in incorporating PCM into practical applications (e.g. ceiling tiles, wall panels) for use in both new build construction and retrofit of commercial and residential buildings. The company has also installed its ceiling tile into DECC's headquarters as part of the TSB Whitehall Initiative[130] (details of the product and performance are shown in the Evidence Box below).

[130]See further information at http://www.datumphasechange.com/index.php?department-for-energy-climate-change-decc-london

Evidence 9: PCMs provides a passive cooling system at half the cost of a radiant chilled ceiling

One SME consulted for this study reports that the indicative cost of its internal wall lining system is between £50 - £70/m^2. It has 40mm of phenolic insulation with a thermal conductivity of 0.21W/m.K. The phenolic board can be reduced in thickness to 20mm to reduce costs further (as well as the system's overall thickness). The £50/m^2 cost is based on the wall system with a latent heat storage capacity of 457kJ/m^2 which provides a cooling capacity of 123Wh/m^2. The £70/m^2 cost is based on a latent heat storage capacity of 609kJ/m^2 which provides a cooling capacity of 164Wh/m^2. The internal wall lining panel is compared to a radiant chilled ceiling which provides between 45-65Wh/m^2.

Source: BRE, communication with SME, March 2011

Another UK firm, but a US subsidiary, is also understood to be working with a UK university on a project to develop a new wall lining utilising PCMs for thermal storage in buildings.

6.5.4 Is there a large market opportunity?

The market for insulation materials is already large. The potential to achieve further energy savings and improved comfort levels could enhance the value proposition to customers by reducing payback times. In particular there may be environments where there may well be a need for such materials, such as dwellings with heavily glazed facades (particularly with a south facing orientation), in the south west of the country.

6.5.5 What would a successful innovation programme look like?

A successful innovation programme would provide demonstrator assistance that attracts large market players and SMEs developing PCM-integrated insulation products.

6.5.6 Is the idea ready? (timeliness and impact)

There are a small number of PCM installations in the UK but nothing on the scale required to move the market forward at a pace that would enable large scale capture of the benefits of PCM in the pre-2020 period in any large scale roll-out of SWI. PCM demonstration sites, using products from the three leading companies in this sector, include:

- BRE has demonstrated PCM products at two buildings in its Innovation Park at Watford.
- The ceilings of the internal training rooms at Jaguar Land Rover Training Academy, Warwick, are fitted with PCM. There is mechanical ventilation only, and no air conditioning. It is claimed that the product is over performing.
- PCM is incorporated into plasterboard walls at the BASF House in Nottingham University to provide active temperature management. Passive ventilation is used to dissipate discharged heat.
- Daneshill House in the London Borough of Stevenage is using salt hydrate PCM from a Swedish SME. Claims of a 90% reduction in air conditioning use have been made.
- DECC is trialling ceiling tiles supplied by a UK SME in its headquarters.

6.5.7 How will public funding make a difference? (added value)

An intervention could help to:

- Overcome current inertia and a lack of investment across the major firms who have the means to scale-up the supply of PCM-based insulation products into the UK market.
- Deliver information from which the scale of the heat savings that PCM-based insulation products could deliver for the domestic housing stock could be estimated.

Longer term, growth in the market could also attract new R&D assets and potentially manufacturing capability into the UK.

6.5.8 What is happening in this area outside the UK?

Climator of Sweden is supplying a salt hydrate based PCM. The Danish Building Research Institute and Aalborg University have also developed the SBim tool to analyse building performance. It incorporates a PCM module for calculating the heat capacity of an installation. It calculates savings in cooling through reducing summer overheating as well as winter modulation of heat loads.

6.5.9 If clear benefits then why aren't large players doing something already?

Whilst individual demonstrator projects are illustrating the benefits from PCM, current building models do not provide a value as to the energy savings of PCMs across the domestic building stock.

Without a full appreciation of the market potential (i.e. overall energy savings), manufacturers will not invest in tooling up to produce hybrid products at the economies of scale required to make them affordable for the mass market. There is therefore an information failure for the industry to overcome which no one company is currently willing to overcome.

6.5.10 What sort of mechanism would best achieve the outcome?

Two potential projects have been identified, as described below.

<u>Project 1: Development of SBEM model for PCMs to work with SAP</u>

BRE has been working with two manufacturers to develop a tool to feed into the Simplified Building Energy Model (SBEM). SBEM is the industry standard for new build and non domestic buildings and was developed by BRE for the Department for Communities and Local Government. The tool will model the thermal mass properties of PCM, and demonstrate the kW/h savings that can be achieved though the installation or retrofitting of the PCM. The tool would be developed to work with the Standard Assessment Procedure (SAP), therefore providing the capacity to be used for the existing stock.

However, **a significant amount of work would be required to take this existing work to the level where the information becomes of real use to the sector** (for example, a first step is to undertake a thorough parametric analysis). The objective would be for the Government to match fund the cost with input from companies in the sector. BRE has contacted a number of companies to confirm their interest in the project.

<u>Project 2: Demonstration of PCM in different types of housing and under different occupational conditions</u>

Thermal modelling of the performance of PCMs within a controlled environment is needed to inform the collective understanding of deployment challenges. The opportunity of this project would be to install and demonstrate PCM in different types of housing (e.g. brick cavity, timber frame) at different locations. **Timber frame houses are a key area for intervention, as they do not have any thermal mass due to the lightweight nature of their construction**.

The project would have the added benefit of developing an understanding of how to prevent overheating in these properties in the UK, but also understand how PCMs could be developed for heat storage in these and similar lightweight structure, including steel and other panel systems.

A number of properties and tenures would need to be identified, solid wall, cavity, timber frame and other non traditional stock types. With the different tenure types this may cover up to 20 properties.

For more specific testing of materials under controlled conditions, **mock up houses can be created in a laboratory setting, so that seasonal conditions can be simulated**. These enable parameters such as solar gains, energy demands and thermal comforts levels within the houses to be calculated and assessed. By pursuing accelerated seasonal conditions it would be possible to evaluate the benefits of the different products coming to market to see that they achieve the required criteria for recognition under a modified Energy Model.

Understanding occupational behaviour in existing houses is important for potential product refinement and gaining insights into consumer acceptability. In this project **PCM would be installed in a number of homes to gauge how the materials work in occupied properties**. This would be coupled with a detailed domestic energy management system that was able to deliver heat at optimal rates, for least cost and least CO_2.

Engagement with social landlords is one strategy for securing management of the projects and also ensure long term data coming back through a controlled tenure.

To provide a balanced view on fuel use patterns it would be also beneficial to:

- Find a balance between properties managed by social landlords (which can generate long term data through controlled tenure) and owner occupiers (since 70% of the UK housing stock is owner-occupied);
- Test on properties with different occupancy patterns to demonstrate the effectiveness of the materials with varying property use, families or elderly occupants requiring comfort levels over the whole day compared to full time employed.

6.5.11 What are the likely costs of such a programme?

Project 1 – it will cost a total of around £200k to undertake the detailed parametric analysis and then translate this into an updated model. Public match funding of 50% will cost £100k.

Project 2 – all materials supplied free by industry but cost of installation, monitoring and validation and evaluation will require public funding requirement of £900k.

6.5.12 What are the likely benefits from such a programme?

Project 2 of the programme will validate the technical claims of the manufacturers under different heat load conditions (i.e. hot and cold occupational behaviour). This will help them to understand how to achieve the best temperature range at which to deliver the phase change, as well as modify their products for delivery to the market.

6.5.13 Assessment of costs and benefits

Table 6.5 provides estimates of the R&D spillovers from the investment based on the standard BIS methodology.

Table 6.5 R&D spillovers

R&D Expenditure (PV)	**1,000,000**		
	Low	**Central**	**High**
Gross External Return (Social Return – Private Return)	20%	25%	30%
Less Leakage	40%	25%	10%
Less Displacement	30%	20%	10%
Net External Return	£84,000	£150,000	£243,000

The presence of major foreign firms in the market means both the potential to bring in R&D investment capital to the UK and overseas expertise, but also the potential for economic leakage. There would also be potential for companies within the UK to use modified PCM materials and products through the demonstrators and hence to gain comparative advantage over non-UK suppliers, particularly in developing a track record of installations and validated performance which they could then export.

Cost differentials between IWI and IWI integrated with PCM

Using available PCM/insulation products figures (from a SME consulted for this study – see Evidence 6 Box above), the inclusion of PCM materials into the insulation boards results in a system supply cost of between £50 - £70/m^2 (where the range relates to different performance levels for the PCM/insulation board). This compares to supply and install cost of £69/m^2 for internal dry lining wall insulation in 3-bed semi-detached house (2009 prices)[131]. **Assuming installation costs are double material costs (i.e. £34.5/m^2), this means there is 43% differential between current IWI insulation and a novel PCM impregnated product** that is currently only being demonstrated in 'showcase' exemplar projects – and most of these are in commercial premises.

Clearly there is a large uncertainty relating to the cost reductions that could be achieved through volume manufacture. Examination of the likely cost curve trajectories for commercialising other novel products is an important consideration for further cost benefit analysis of this intervention.

However, the presence of three major chemical companies in this market gives confidence that there will be strong competition to produce volume product at a price that will enable cost effective products to be deployed. **The mixture of scale, learning and market competition, combined with energy savings, could help to achieve a net benefit from deployment of PCM insulation product**.

This might require a degree of vertical consolidation between PCM suppliers and product manufacturers. However, there are precedents for this in the building products supply side.

Assessment of carbon savings

To consider potential carbon savings we analysed the refurbishment of a solid-walled 3-bed semi (a 'typical' property) using conventional internal SWI (to give a wall U-value of 0.3) and then again using internal SWI combined with PCM.

As noted above, the SAP model is not designed to model PCMs. However, we were able to use the facility in SAP to model both the U-value and thermal capacity of the dwelling's individual structural elements (walls, floor etc.) rather than using the default thermal mass calculation.

We have used the heat capacities of common construction materials from Table 1e of the SAP technical guidance manual and for PCMs have used figures supplied by DATUM for their Whitehall case study. **This modelling showed that there is small reduction (of order 0.5%) in both the annual CO_2 emissions and the total current fuel costs.**

We then modelled a fixed air conditioning system in the two refurbished dwellings to see if the PCM has an impact. We found that there is an impact due to the PCMs, compared to the conventional SWI solution without PCMs, since the PCMs reduce the times when the air conditioning is required and hence reduces the increase in CO_2 emissions attributable to the system. However, we found that the impacts are very small, equating to a few kg of CO_2 and a limited cost saving per year.

We then translated these figures into the stock model. This shows that the cost and carbon savings are minimal, at less than £10 million and less than 0.05 $MtCO_2$ respectively, even under the DECC High scenario. However, w**e believe these figures represent the absolute bottom end of any savings attributable to PCMs, not least because the SAP model was not designed for this purpose.**

The upshot is that there are numerous limitations in SAP which lead us to conclude that what is needed is an extensive parametric study to understand all of the factors that are important, e.g. glazing, internal gains, orientation, thermal mass, shading, location (i.e. results could be very different for dwellings located in warmer parts of the country such as the South West), urban vs rural (heat island effect), the overheating temperature threshold used, etc., together with the development of a more robust model and experimental testing. These have already been outlined above.

These factors address PCMs as a means to help manage overheating. If we are to look wider and to exploit PCMs as thermal stores then there is also a need to look at heating demands, heating patterns, occupancy factors etc.

[131]Quoted in Purple Market Research, *Solid Wall Insulation Supply Chain Review*, for EST and Energy Efficiency Partnership for Homes, May 2009 (source: Robert Lombardelli Partnership)

Conclusions

The challenge for any government funded demonstrator programme is to show that the mass installation of these novel insulation materials in the domestic setting will yield **potential energy savings that come close to closing this price gap**.

Given that the demonstration projects outlined above, where PCM has so far been installed, are showing much greater savings being achieved than at first envisaged suggests a strong case for further research. The limitations of the current modelling across the domestic building stock, which we have illustrated above, is also precisely the reason why a more robust approach is required in this area.

6.6 Continuation of work like the EST SWI field trials

6.6.1 Background to programme and features

EST is the UK's leading impartial organisation helping people save energy and reduce carbon emissions. In 2010 EST started a £900,000 solid wall field trial to investigate the energy savings from SWI. It was due to last between 9 and 18 months. Following DECC's decision to reduce funding under the Environmental Transformation Fund, EST saw £600,000 being cut from the trial budget. However, given the interest from the SWI sector, EST continued the trial and sought industry investment to fill the shortfall in funding, by specifying, supplying and installing systems at no cost and provide money for ongoing monitoring.

75 solid walled properties throughout England are involved in the trial and various SWI system manufacturers / suppliers are collaborating. A large number of these properties had already had SWI installed and have had their walls tested; a much smaller number have been insulated with "off the shelf" systems that have been fitted elsewhere.

Features of the trial are that each home:

- has no micro-renewables installed;
- does not intend to add any further insulation measures (e.g. loft) that might blur findings.

Post-insulation monitoring and evaluation of house performance is critical to determine the energy saving potential of the measure. The trial will also involve an evaluation of the customer experience which participating householders have received. A final report is due to published during the Summer 2012.

The trial dovetails with the TSB Retrofit for the Future programme since the monitoring protocols are the same. Post occupancy evaluation will also be conducted. For example, the occupiers will be asked what have been the findings/challenges over a 2 year period.

The first phase of the field trial, completed in Spring 2011[132], collected baseline data from the energy and fabric performance of each dwellings. A wide range of measurements were undertaken, including:

- air tightness testing;
- gas / electricity use;
- internal / external temperatures;
- wall U-Value measurements;
- internal / external thermography;
- SAP assessments;
- wall surface temperature measurements; and
- internal humidity.

6.6.2 Rationale for intervention

One of the current challenges with energy efficiency measures is that, once installed, they may not achieve the savings that were originally claimed. For example, cavity wall insulation

[132] http://www.energysavingtrust.org.uk/scotland/Consultancy-and-certification/Energy-monitoring-and-technology-field-trials/Technologies#9

may in practice provide only 60% of the expected energy savings[133]. Overcoming the lack of information and data on energy use and SWI performance will be critical to mass market adoption of SWI and will help to tackle the main challenges. These include:

- Costs of installed systems and length of payback times;
- Raising awareness of SWI opportunities amongst regular builders and encouraging them to invest in the required skills and certification;
- Reduced room sizes and changes to the appearance of properties;
- Length of installations and disruption caused by different products, systems and techniques; and,
- The quality of installations and impact upon energy performance.

6.6.3 Does the UK have the capability?

The UK has a strong capability in SWI comprising a number of European market leading SWI manufacturers, system suppliers and installers that could potentially participate in this programme and supply or install SWI products and systems for testing as part of the field trial.

6.6.4 Is there a large market opportunity?

The trial of a large number of products and systems across a range of different property types will provide valuable information on the performance of SWI technologies. This information should enable suppliers to refine and improve products and systems and provide opportunities to raise awareness of strong performing technologies amongst the customer base, which has the potential to have a significant impact on the uptake of SWI in the UK.

6.6.5 What would a successful innovation programme look like?

The aim would be to build on the existing trial by identifying the precise energy savings across different owner occupied properties with a mixture of EWI and IWI being the sole insulation measures.

After appropriate properties have been identified, the programme would install and monitor different SWI products and systems from a range of manufacturers and system suppliers. Unlike the existing EST trial, the new programme would focus on leading edge systems that could be market ready but struggling to be adopted, potentially because they are too costly.

The programme would improve SWI knowledge and provide valuable performance data for the system supply side and end users (i.e. baseline data on environmental conditions and utility spend pre and post SWI installation, including airtightness monitoring and thermal imaging and a post occupancy evaluation after a 2 year period).

The programme could also link with the suggested intervention for expanding the Retrofit for the Future programme, as the two programmes have already been collaborating and are using the same monitoring protocols. This could achieve a blend of SWI specific interventions, coupled with a TSB programme that brings in other novel technologies.

6.6.6 Is the idea ready? (timeliness and impact)

The existing SWI field trial illustrates the appetite amongst the SWI supply side for demonstration projects.

6.6.7 How will public funding make a difference? (added value)

The principal benefit from the intervention is understanding the energy performance of different products and systems in real house conditions;

By continuing a trial, the programme will help to provide the long term monitoring of performance and overall energy saving impacts.

[133] Richard Miller, Head of Sustainability, TSB

An intervention could help overcome various market failures such as information benefits arising from an intervention (i.e. which could justify the scale of the heat savings in the domestic housing stock from SWI measures). This in turn might also help overcome demand side information failures with consumers. It will also lead to more insights being obtained on the challenges of mass deployment under the Green Deal.

6.6.8 What is happening in this area outside the UK?

Relevant activity outside the UK is not known.

6.6.9 If clear benefits then why aren't large players doing something already?

Despite the established nature of SWI technologies, there has never been a dedicated large-scale trial in the UK to demonstrate the direct energy savings solely from SWI measures. Furthermore, the main companies supplying EWI systems in the UK market are SMEs.

The only intervention that large players – such as BASF, Du Pont and Knauf - are understood to have had is around whole house (new build) demonstrators. These look at a range of energy-efficient measures and generally do not isolate performance by individual measures.

6.6.10 What sort of mechanism would best achieve the outcome?

A continuation of the current EST SWI field trial is considered the best mechanism for this intervention given the independent and impartial nature of the organisation and its ability to engage and work with a range of manufacturers and system suppliers, and collate and disseminate data (relating to a range of products and systems) across the industry. Furthermore, the EST has already undertaken the planning and surveying work for the programme so could 'hit the ground running'.

6.6.11 What are the likely costs of such a programme?

Additional funding of up to £500,000 would help to ensure the programme is completed. However, some of this could be sourced as match funding from industry.

6.6.12 What are the likely benefits from such a programme?

Continuation of the field trials will help to shed new light on the actual performance of SWI in isolation from other measures for new forms of SWI system. This in turn will provide a more robust indicator of performance for different types and brands of SWI. This could help:

- Confirm the true energy savings from the technology (which may be higher or lower than models have to estimated), enabling suppliers to refine their technologies if necessary;
- Raise the overall level of competition within the SWI industry by introducing a potential performance ranking (akin to an energy label for SWI);
- Verify performance claims from suppliers which will provide confidence to customers;
- Provide a level playing field around information supplied to customers.

6.7 Expand the RftF programme/ use another Government programme to deploy more innovative SWI systems

6.7.1 Background to programme and features

The TSB's £17m 'Retrofit for the Future' (RftF) competition is part of the 'Low Impact Buildings Innovation Platform' and was developed in partnership with DCLG and HCA. RftF aims to enable building and renovation companies to retrofit social housing stock through a number of demonstrator projects to improve energy performance.

The intention was to test out what could be done in an extreme way (i.e. 80% carbon reductions) with today's Best Available Technologies (BAT) and hence to determine what the current installation and scale up challenges are and what might need to be resolved.

The initial design phase involved 194 organisations (including housing associations, architects and construction companies) receiving up to £20,000 each to develop design and feasibility studies and prepare proposals for demonstrator projects. In Phase 2, 87 of these proposals were then selected to carry out retrofits on social housing, receiving an average of £142,000 to demonstrate deep cuts in carbon emissions and exemplar energy efficient measures in UK social housing.

The existing RftF programme is due to end in 2011. However, each demonstrator project will be evaluated by the Energy Saving Trust for at least 2 years. This will include assessments of the potential for lower cost, volume implementation across the remaining UK social housing stock.

6.7.2 Rationale for intervention

Around 50% of demonstrator projects feature solid walls, which will help provide information and data on effectiveness, cost of installation and lessons learned. The difference between RftF and the EST SWI trials is the latter deals solely with SWI measures (external or internal) rather than a range of retrofit measures which are combined in a project specific design.

Further redesign and refinement of the SWI approaches that have potential for large scale implementation is needed to improve and hone the appropriateness and cost effectiveness of the materials, overall design and installation techniques. The potential to trial new technologies in this scale up phase – for example, PCMs integrated into IWI or new insulations materials, could also extend the project's original remit.

There was considerable demand for the programme (less than half of the proposed projects proceeded to phase 2) suggesting that a large number of potential technologies did not proceed to the full demonstration stage.

RftF has been described during consultations for this study as being particularly effective at bringing together industry and research organisations and encouraging the exchange of ideas and information.

6.7.3 Does the UK have the capability?

The UK has significant capability in terms of low carbon building technologies, including those relating to SWI. This is evidenced by the large number of applicants, and phase 1 participants, of the RftF programme and the large proportion (50%) of projects featuring SWI technologies.

6.7.4 Is there a large market opportunity?

The demonstration of a large number of low carbon building technologies and SWI technologies into old houses will provide valuable information on their performance in terms of energy efficiency. Projects are required to assess their potential for lower cost, volume implementation. There is massive potential to roll out successful measures and installation methods across the UK housing stock.

6.7.5 What would a successful innovation programme look like?

The programme could continue to focus on whole house "holistic" refurbishment solutions to achieve an outcome based specification, but perhaps not to the extreme level previously required under RftF (i.e. 80% reduction in emissions). It could incorporate more innovative pre-commercial insulation technologies to understand performance challenges (e.g. demonstrating new and novel aerogel technologies developed in the UK as well as aerogel hybrids and other products such as polymer coatings and heat dispersing pigments).

It could also look to further develop and refine those technologies that have greatest potential for mass market adoption, and/or focus on smaller scale projects to demonstrate SWI technologies alone or as a combination (e.g. using a 'mix and match' approach) with the intention of delivering lower cost, simpler and less labour intensive installations of SWI, 'designing out' the potential for manufacture and installation errors.

6.7.6 Is the idea ready? (timeliness and impact)

The RftF programme already exists but is due to end in 2011. A new programme could be scheduled for 2-3 years time, to dovetail with potential advances in novel insulation types including PCM/insulation products.

6.7.7 What are the likely costs of such a programme?

Funding of between £3-4 million could start to make a difference to this area, if the focus was solely on deploying more novel materials.

6.7.8 How will public funding make a difference (added value)

TSB has already added significant value through the RftF programme and would have the potential to add further value if the programme was extended, expanded or developed.

6.7.9 What is happening in this area outside the UK?

TSB is providing ~£1m funding for a cross-Europe Era Net competition – tentatively called "Scaling Up Retrofit" and involving Austria, Finland and Switzerland (France & Germany not involved) - which will look at a variety of building technologies. Some of these countries are experts in external cladding of apartment blocks and TSB believes that UK could benefit from this learning opportunity.

6.7.10 If clear benefits then why aren't large players doing something already?

Large players are already involved in R&D and some have engaged in RftF projects, although the programme is open to all companies and encourages the participation of SMEs with innovative technologies and ideas.

6.7.11 What sort of mechanism would best achieve the outcome?

The RftF programme is considered the best mechanism for delivery given the high levels of awareness associated with the programme, the work that has already taken place, and the linkages with research organisations, industry and government.

The intention is to use the results and data to feed into the:

- Cross-Europe Era Net project (see above)
- Energy Technologies Institute (ETI) 'thermal envelope' building programme
- Future Government procurement decisions

The Knowledge Transfer Network for the Modern Built Environment (MBE-KTN) will be used to diffuse the results of the competition widely across the industry.

6.7.12 Challenges

TSB currently does not intend to repeat the RftF programme as the evidence suggests that scale up issues, not technologies per se, are the main future challenge for retrofitting old housing stock. TSB considers that for SWI, design/installation challenges (i.e. issues of detailing, fixings, avoiding cold bridging, eaves, drainpipes, windows etc.) are more important than technology development - *"assembly and installation appear to be where too much of the cost lies and where it's all going wrong."*[134] Whilst this sentiment may well be true for current SWI technologies, it takes no account of the potential for future technologies to be better performing and potentially easier to apply with further research.

TSB would welcome a conversation about future technology needs for SWI and how these could be supported. Clearly TSB has to consider the R&D needs of the entire building industry in the design of any future programme of support, particularly in gauging whether UK companies will benefit from any intervention.

One related area being considered in the Low Impact Buildings area covers supply chain development, mixing on-site and off-site systems. This is likely to be worth around £5m but not commencing until around 2013/2014.

[134] Richard Miller, Head of Sustainability, TSB

6.7.13 What are the likely benefits from such a programme?

An expansion of the RftF programme to include more innovative technologies (instead of 'off the shelf' as in the current programme) will help to demonstrate the next generation of technologies that could be refined and made ready for mass deployment in the late 2010's/post 2020 era.

The opportunity to enhance the energy savings from current SWI systems, and thus drive down further the costs of this energy efficiency measure, will be a large benefit. Such a programme could also enable UK companies to bring new products to market and establish some comparative advantage with companies in continental Europe and North America.

6.8 Summary

A summary of the purpose and impacts from all four interventions is shown in Table 6.6.

Table 6.6 Overview of proposed innovation support interventions

Potential Intervention	Public funding £m	Outcomes	Economic Impacts	Environmental Impacts
External dry lining research RD&D assistance	£4m	Overcome information and access to finance market failures Accelerated development of appropriate solutions Export potential to e.g. Germany, France	Reduced installation costs frees up consumer spending Reduced costs of mandated retrofit programmes	£23 million to £57 million under the two BAU scenarios, up to £172 million and £305 million in 2016 for two Green Deal scenarios.
Role of Phase Change Materials in domestic solid wall / whole house insulation	£1m	Overcome information market failures Investment into pre-commercial/ market ready products Potential to attract R&D investment capital to the UK Export potential for first mover advantage	Increased money into economy from consumers Reduced costs of mandated retrofit programmes Reduced costs of grid balancing	Potential energy & CO_2 savings but more sophisticated modelling is required to demonstrate
Continuation of EST SWI field trial to explore impacts of further EWI and IWI systems	£0.5m	Overcome information market failures Accelerated development of appropriate solutions	Increased money into economy from consumers Reduced costs of mandated retrofit programmes	Energy savings CO_2 savings
Expand RftF programme to deploy more innovative SWI systems	£4m	Overcome information market failures Investment in close to market and pre-commercial market ready products	Increased money into economy from consumers Reduced costs of mandated retrofit programmes	Resource savings Energy savings CO_2 savings
Total	**£9.5m**			

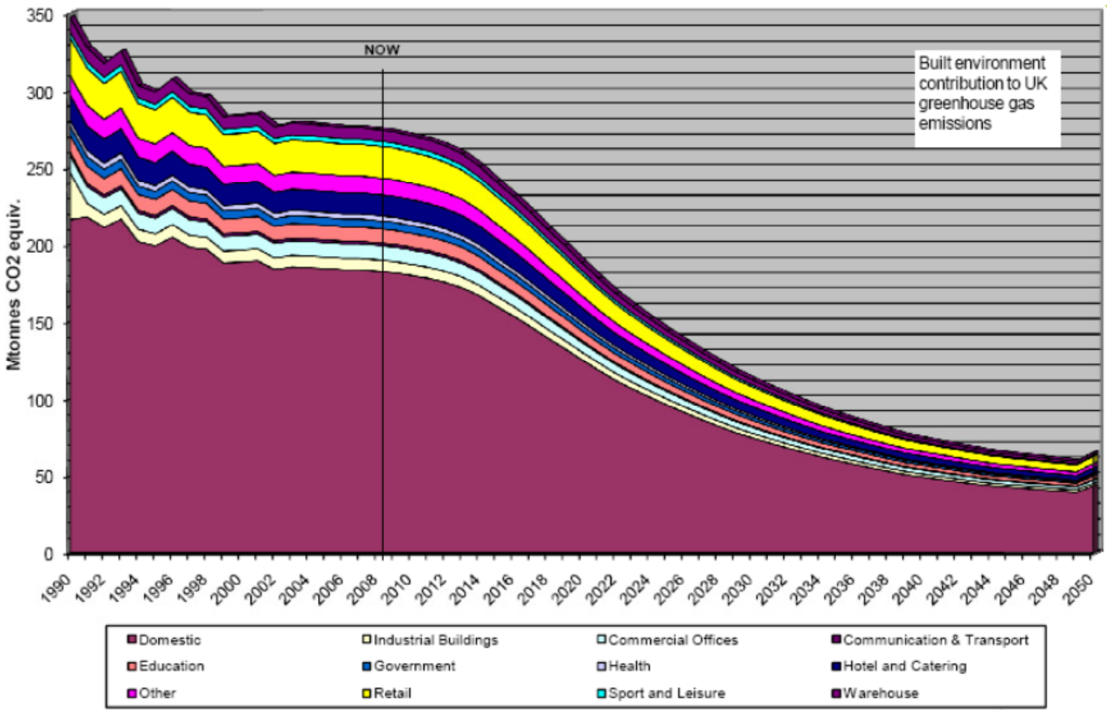
Annex 1 Policy review

Setting the context - UK building stock

The character of the UK's building stock has a large influence on energy use and carbon emissions. Reducing emissions associated with energy use in new and existing buildings is one of the key challenges as the Government seeks to drive emissions down towards its carbon targets and pursue its energy security objectives.

Energy use in the domestic building stock consumes around 30% of total energy consumption and this usage level has risen by 23% over the last 35 years, generating around 40 million tonnes of carbon emissions per year[135]. Figure A1.1 outlines the relative significance of the various component parts of the built environment to UK Greenhouse Gas (GHG) emissions. This clearly outlines the substantial part played by the domestic housing market - and hence the significant market opportunity that exists for the retrofit of cost effective energy efficiency products.

Figure A1.1 Built environment contribution to UK greenhouse gas emissions



Source: UKGBC: Built environment contribution to UK GHG emissions

The two most important categories of building are:

- Domestic dwellings – of which there are expected to be 32 million by 2050, 21 million requiring refurbishment;
- Industrial buildings (includes commercial and retail stock) - the majority of which were built prior to 1950.

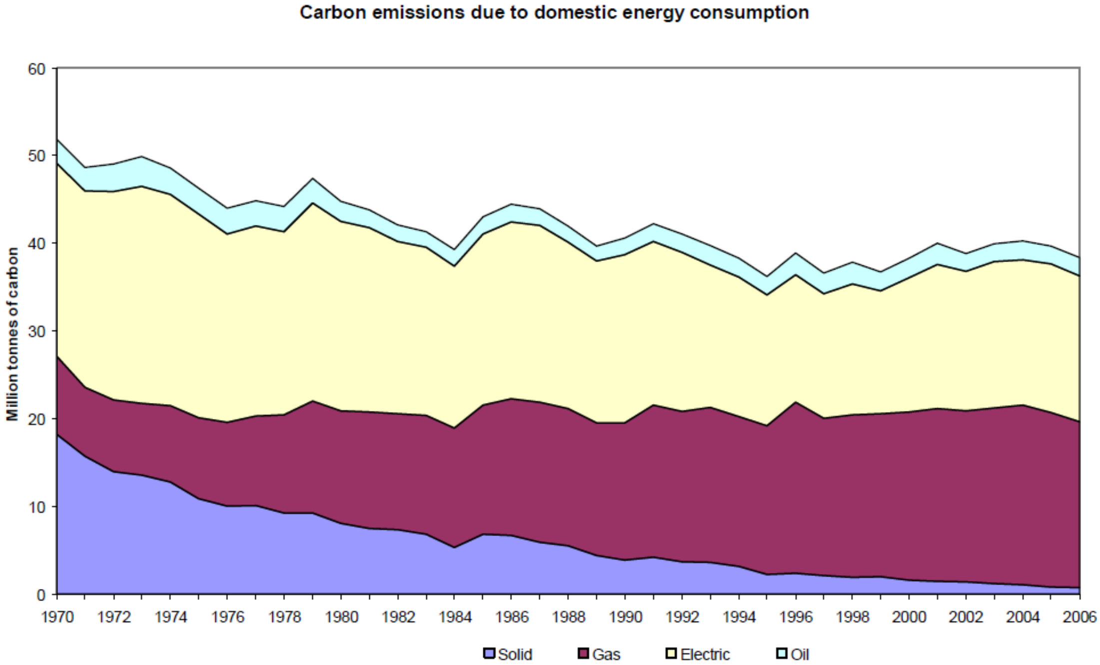
Energy efficiency improvements, such as loft and cavity insulation, have kept carbon emissions down since 1970. The move to gas from solid fuel (which is more carbon intensive) over this time has also helped (see Figure A1.2). However, there are estimated to be around 8 million solid walled houses in the UK[136], of which over 95% are assumed to have little or no insulation[137] and hence contribute significantly to the UK's carbon budget.

135 BRE, Domestic Energy Fact File, 2008 [available at www.bre.co.uk/filelibrary/pdf/rpts/Fact_File_2008.pdf]

136 DECC, Special feature – Home insulation levels: New statistical release on home insulation levels, December 2010 *www.decc.gov.uk/assets/decc/statistics/publications/trends/articles_issue/1101-home-insulation-levels-trends-art.pdf*

137 This is based on an estimate of 30,000 properties being installed each year over the past 10 years – 300,000 retrofits would equate to just 3.75% of the solid walled domestic stock.

Figure A1.2 Domestic energy consumption has reduced from 52m tpa in 1970 down to 38m tpa in 2006



Source: BRE, Domestic Energy Fact File, 2008[138]

Energy saving opportunities available from re-engineering the building stock include:

- Reducing the need for energy – e.g. preventing heat transfer through the building fabric by adding insulation; and
- Using energy more efficiently in the building – e.g. by better control of the building environment, including ventilation and using low energy products.

Changes in consumer behaviour can also deliver savings in energy use.

Policy is helping to stimulate the adoption of SWI

The active development of policy on building energy efficiency seen in recent years is continuing

The **Climate Change Act 2008** sets a legally binding target of at least an 80% cut in greenhouse gas emissions by 2050, to be achieved through action in the UK and abroad. There is also an emissions reduction target of at least 34% by 2020, and both of these targets are against a 1990 baseline. The Act introduced a carbon budgeting system which caps emissions over a five-year period and the first of these will run from 2008-12, The Government must report to Parliament on its policies and proposals to meet the budgets, and this requirement was fulfilled by the **UK Low Carbon Transition Plan**.

Reducing emissions in the home is a key part of the meeting these targets. The Government says that 2050 emissions from homes need to be cut to almost zero by using energy more efficiently and using more low carbon energy. The UK Low Carbon Transition Plan aims to cut emissions from homes by 29% on 2008 levels by 2020 and sets out a range of actions that will ensure this goal is achieved.

The Government has a number of programmes to improve the energy efficiency of the existing housing stock and reduce carbon emissions. The primary one is the **Carbon Emissions Reduction Target (CERT)** which is supported by a statutory obligation on energy suppliers to improve the energy efficiency of their customers' homes[139]. This focuses

[138] BRE, Domestic Energy Fact File, 2008 [available at www.bre.co.uk/filelibrary/pdf/rpts/Fact_File_2008.pdf]

[139] CERT followed on from Energy Efficiency Commitment Programme, EEC 1 (2002-2005) and EEC 2 (2005-2008)

on the delivery of simple cost-effective measures such as energy efficient light bulbs, cavity wall insulation and loft insulation, although there are carbon uplifts designed to encourage the uptake of SWI with the so-called Market Transformation Activity (see Box). Under CERT energy suppliers will need to spend £2.8 billion on carbon reduction measures between 2008 and 2011 to meet their targets. There has not been a significant uptake of SWI to date relative to cavity wall and loft insulation measures.

CERT allows energy companies to undertake **market transformation activity**, designed to incentivise the funding of activities or technologies that are not yet mainstream. This applies to the promotion of solid wall insulation or micro-cogeneration (micro-CHP) units. Any firm installing such measures, for which accurate carbon savings can be attributable, is eligible to receive a 50% uplift for any installations.[140]

The **Community Energy Saving Programme (CESP)** is a CERT associate programme with a particular focus on hard-to treat dwellings (e.g. those with solid walls) in low-income areas. CESP is seen as a pilot for delivery of energy efficiency in the future. It has a more sophisticated carbon scoring system which provides more incentive to fit relatively costly insulation measures. It is due to end in December 2012.

In October 2011, the **Energy Act 2011** came into law. Amongst several other provisions, the Act granted the Secretary of State to make regulation to establish the framework to implement the **Green Deal** and to authorise people to act as Green Deal assessors, providers and installers and to regulate their conduct. The Green Deal creates a new financing framework to enable the provision of fixed improvements to the energy efficiency of households and non-domestic properties, funded by a charge on energy bills that avoids the need for consumers to pay upfront costs. This will enable more expensive measures such as SWI to be more easily deployed.The underpinning framework for the Green Deal has now reached the secondary legislation phase, being approved by the House of Lords in July 2012. The framework now includes:

- powers to set parameters around the use of this facility to ensure consumer protection for both the originator of the work and subsequent occupiers;
- powers to limit access to the financial mechanism in the framework to the installation of measures that are expected to deliver savings exceeding the level of the charge; and
- an obligation on energy companies – the ECO – which will take over from existing obligations to reduce carbon emissions, and will work alongside the Green Deal by targeting appropriate measures at those households likely to need additional support – in particular those containing vulnerable people on low incomes and hard-to-treat housing

As currently envisaged:

- Green Deal measures must be recommended by an accredited, objective adviser to confirm that they are suitable and they have to be installed by an accredited installer;
- Advisers will make recommendations on interventions drawn from a list of Green Deal approved measures. A list of products, materials and specifications will be contained in a Code of Practice that will be updated regularly to enable technological improvements to be recognised;
- Measures must meet the 'Golden Rule', i.e. the expected fuel bill savings must be greater than the costs of installing the measures (plus associated financial costs) attached to the energy bill, and the length of the repayment period should not exceed the lifetime of the measure (which is 36 years).

The scheme directly addresses the constraints on access to finance that can prevent households and businesses investing in energy efficiency improvements. Those consumers who commit to efficiency improvements will make savings on their energy bills through reduced energy consumption. The Green Deal is not a capital loan and is made on the property at which savings are made, rather than the individual who accesses the scheme. It

[140] CERT Target Funding,Briefing Note, EST, June 2008

therefore transfers with ownership of the property. DECC estimates that the supply chain could support 100,000 jobs across the UK within five years.

The Green Deal will be supplemented by a new **Energy Company Obligation** from October 2012. This draws on the strengths of the energy suppliers' existing obligations (i.e. under CERT/CESP) but also avoids some of its limitations. The new obligation will underpin the Green Deal and focus particularly on those householders (e.g. the poorest and most vulnerable) and those types of domestic property (e.g. hard to treat walls) which cannot achieve financial savings without a measure of additional support on top of the Green Deal finance.

A combination of regulatory and fiscal drivers underpin the growth of the energy efficiency across the built environment

CO_2 reduction in the built environment is driven by policies such as:

- **Introduction of progressively tighter Building Regulations**, including the necessity to improve the existing stock, which is driving changes in new build design standards. Looking specifically at SWI, Part L to the Building Regulations (England & Wales) has performance requirements for solid walls when they are upgraded or refurbished. Specifically, Part L1B (2010 edition) requires an improved wall U-value of 0.30 W/m2.K (or better), up from 0.35 from 2006. A lesser provision is acceptable if meeting this U-value requirement entails a significant loss in floor area (defined as >5% of the internal floor area of the room bounded by the wall) or the simple payback for the measure >15 years. The list of approved measures and the framing of the Golden Rule in the Green Deal needs to be consistent with the requirements of Part L.
- **Planning laws** (e.g. the Merton Rule);
- **"Zero Carbon homes" policy commitment**: this will apply to 100% of new houses by 2016 followed by public buildings by 2018 and other non-residential buildings by 2019. There is to be a minimum fabric energy efficiency standard, the level of which is being reviewed, and the remainder of the zero carbon target could be met through developers investing in local energy projects, possibly via an existing local tariff mechanism.
- **Code for Sustainable Housing**, this introduced in December 2006 on a voluntary basis but became mandatory from May 2008; with each new home being assigned a star rating that reflects its overall sustainability performance.

Economic incentives for non-domestic users to reduce their energy consumption and hence look into energy efficiency measures include:

- **Climate Change Levy** (2001)
- **Carbon Reduction Commitment** (in force 2010)

The development and commercialisation of technologies for the built environment is primarily driven by recent Building Regulations. These stimulate innovative design and construction. Such innovations respond to the growing imperative among the design, construction and property management industry to reduce resource consumption – energy, water, materials and land – thereby reducing 'bottom line' capital and operating costs. The fact that 80% of energy costs arise during the service life of buildings[141] also provides a compelling market driver for the commercialisation of innovative technologies for both the new build and retrofit markets.

An important stimulus for an increase in the scale of this market will be not only the availability of finance but also the extent to which lenders can be encouraged to offer more innovative **green mortgages** which will help to stimulate investment in energy efficiency by spreading the high upfront payments over the life of the mortgage[142]. A small number of mortgage providers are helping to encourage the retrofit of existing stock. These have developed from an initial range of lending based on carbon offsetting (Hanley Economic Building Society, Teachers Building Society, Giraffe) to specific green mortgages or loans

[141] http://www.nationalplatform.org.uk/uksra/consumption.jsp

[142] A 'Green mortgages report', Energy Efficiency Partnership for Homes, April 2007 provided a review of the sector www.eeph.org.uk/uploads/documents/partnership/Final%20Green%20Mortgages%20Report.pdf

such as those provided by Yorkshire Building Society, the Cooperative Bank, the Norwich & Peterborough Building Society and Ulster Bank. The Ecological Building Society also ties special interest rate deals to EPC bands.

Public sector assistance may still be required to encourage financial institutions to provide such green mortgages.[143]

Devolved administration policies for solid walls

Whilst Wales follows English Building Regulations (Part L), the Scottish Building Regulations (2010) have tightened standards for new build, down to U-values of 0.22 W/m2.K. However, the retrofit position in Scotland is very different as it does not have the same provisions for work on an existing thermal element as for England & Wales, requiring only U-values of 0.7 W/m2.K to prevent condensation/moisture problems. Given discussions with the EWI supply side, it appears that performance in practice is better than this since most are using systems which conform to Part L in England & Wales.

Local issues

External insulation requires planning permission since it changes the appearance of a building. This is particularly an issue for heritage buildings and conservation areas.

Examples of policies used to promote the take up of solid wall insulation across the EU and in member states

EU policy

The EU buildings sector, comprising residential and commercial property, accounts for around 40% of final energy use in the EU[144]. Households alone were responsible for 26% of final energy consumption in 2006[145]. Buildings are therefore one of the main sectors to be covered by the Effort Sharing Decision (406/2009/EC) which will require emissions to be cut by 10% from several sectors not covered by the EU ETS. The potential for cost-effective energy savings from buildings is about 30%, meaning that in 2020 the EU's final energy consumption can be reduced by as much as 11%[146]. In addition, most of energy efficiency and savings technologies are already cost-effective and on the market but further innovation is still possible.

The main legislative instrument affecting energy use and efficiency in the buildings sector is the **Directive on the Energy Performance of Buildings** (EPBD; 2010/31/EC), the recast of which has recently entered into force. The main objective of the EPBD is to promote cost-effective improvement of the overall energy performance of buildings, whilst taking into account local conditions and requirements.

The revised EPBD now covers all existing buildings and certain minimum energy performance requirements have to be met, not only when they undergo major renovations but also when individual building elements (e.g. windows, heating systems) are replaced. These requirements are set up by Member States and should gradually be aligned with cost-optimal values. The recast requirements for nearly new buildings would mark a radical change in the way EU buildings are constructed after 2020. High-quality energy performance certificates, reports from the inspection of heating and air-conditioning systems and the requirements for information provision on Member States are important for increased awareness and could stimulate gradual market transformation towards more efficient

[143] Sunday Times (21 July, 2009)

[144] European Commission (2008): Impact assessment of a proposal for a recast of the EPBD (2002/91/EC), available at:

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SEC:2008:2864:FIN:EN:PDF

[145] European Environment Agency (2009): 'Final energy consumption by sector in EU 27', available at http://www.eea.europa.eu/data-and-maps/figures/final-energy-consumption-by-sector-in-eu-27

[146] Fraunhofer ISI and partners (2009): 'Study on the Energy Savings Potentials in EU Member States, Candidate Countries and EEA countries – Final Report', available at:

http://ec.europa.eu/energy/efficiency/studies/doc/2009_03_15_esd_efficiency_potentials_final_report.pdf buildings. Furthermore, the new articles on penalties and quality control would ensure improved implementation.

Activities related to buildings represent a large part of the EU economy (about 9% of GDP and 7-8% of employment[147]). The benefits to households and affected businesses of improving the energy performance of buildings are two-fold. First, reductions in energy bills can increase the profitability of businesses and/or increase the disposable incomes of households. As a consequence, an increase in household real income (for example due to a reduction in price of SWI) would lead to mixture of consumption and savings, and therefore business investment because of the increase in savings. Second, improving energy efficiency often requires that changes are made to construction techniques or material usage, or necessitates the retro-fitting of the existing building stock (i.e. with better insulation and glazing). Demand for related goods and services may therefore be expected to increase, with implications for employment along the entire supply chain.

It is estimated that this policy will achieve minimum reductions in energy consumption of 5-6% (equivalent to 60 – 80 Mtoe per year) and CO_2 emissions by 5% (160 to 210 Mt per year) by 2020[148] - in the same order of magnitude as the estimated emissions cuts from the eco-efficiency of energy using products and the inclusion of aviation in the EU ETS[149] - creating directly 280,000 to 450,000 potential new jobs. These jobs would mainly be in the construction sector itself as well as for the services of energy certifiers, auditors and inspectors of heating and air-conditioning systems.

The **Construction Products Directive (CPD, 89/106/EEC)** applies to any products made for permanent integration in construction works. The CPD sets out a number of essential requirements in terms of working life, mechanical strength and stability, fire safety, hygiene, health and environment, safety in use, noise protection, energy economy and heat retention. The Directive established the framework in which the European construction industry has operated since 1989. Key elements are:

- Harmonised European standards for construction products adopted by the European standardisation bodies (CEN and/or CENELEC);
- A system of European technical approvals to assess the suitability of a construction product in cases where there is no harmonised standard and a standard cannot, or cannot yet, be prepared;
- European Organisation of Technical Approvals (EOTA), which groups together the national approval bodies, is responsible for drawing up guidelines for technical approvals.

To further enhance the internal market for construction, the European Commission in May 2008 presented a proposal to replace the CPD with a new Regulation that aims to remove remaining regulatory and technical obstacles to the free circulation of construction products in the EU. The new regulation introduces standards at EU level which will replace the myriad of national standards. Implicitly it also introduces a common terminology, which is important in this new field of development.

A recent development for the retrofit market has seen the introduction of a new rule for **European Regional Development Framework (ERDF)** interventions relating to housing in all Member States. A number of UK regions have taken advantage of this new ruling which allows up to 4% of structural funds to be used for the purposes of deploying energy efficiency improvements and renewable energy technologies in the existing social housing stock, in order to support social cohesion. This will enable a range of innovative measures to be demonstrated on a large scale and support the SME base in the UK to increase capability ahead of increasing demand.

[147] European Commission (2008): Impact assessment of a proposal for a recast of the EPBD (2002/91/EC), available at:

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SEC:2008:2864:FIN:EN:PDF

[148] See footnote 76.

[149] EEA (2009):'Greenhouse gas trends and projections', November 2009 (accessed at http://www.eea.europa.eu/publications/eea_report_2009_9/?b_start:int=24&-C=)

Member State policies driving the retrofit of buildings including SWI

Many EU countries have set emissions targets for buildings coupled with major incentive schemes to help change consumer and industry behaviour around both new build and retrofit:

- **Germany** - The original target of reducing carbon emissions by 12% by 2012 was achieved in 2007. The revised target involves a 40% reduction by 2020. The German Government provides loans and direct grants to encourage homeowners to improve the energy efficiency of newly built and existing buildings. These loans and grants are provided for a range of measures including SWI. The subsidised loans are available for up to a maximum of €50,000 per dwelling and a period of up to 30 years. The scheme allocates €1.45 billion in loans per annum and has provided more than 450,000 loans, worth €24 billion for more than 1.2 million dwellings since 2001.
- **France** - The Grenelle Building Plan includes the thermal renovation of existing buildings and aims to cut their energy consumption by at least 38% by 2020. Measures include: interest free 'eco-loans' of up to €30,000 per dwelling (or €300 per square metre) for thermal renovation of existing properties; subsidised 'eco-loans' for social housing; a 5.5% VAT rate on installation, maintenance and renovation work; and, tax credits to enable households to deduct part of the cost of energy improvement work from their income tax bill. France aims to renovate 400,000 dwellings per annum from 2013, including 800,000 high energy consuming dwellings by 2020 (more than 230 KWh per square metre per annum).
- **Austria** - Austrian Federal Law on Environmental Support is considered an international example of an efficient and effective funding instrument in the environmental sector. For retrofit, state policy for energy efficient design offers specific financial support to consumers for biomass, solar and heat pump systems, who can also claim rebates for purchasing energy-efficient appliances.
- **Sweden** - Target set in 2006 to reduce energy use in residential buildings by 20% by 2020. Progressive energy taxation and high performance construction standards. 2006 Energy Declaration of Building Act includes support for the purchase of energy efficient windows and biomass boilers for up to 30% of the cost.
- **Poland** - The Polish Energy Efficiency Act is currently under debate in the Polish Parliament and has been redrafted some 17 times! The energy efficiency targets have been reduced in the redrafts and Poland currently aims to achieve a 9% energy saving by 2016, which is likely to make achieving the EU target of 20% by 2020 very difficult. However, energy efficient housing construction and retrofit of existing buildings is slowly creeping into the Polish market. There are many challenges ahead, particularly encouraging construction firms to meet the higher costs in constructing energy efficient buildings and households to invest in energy efficient measures. The Polish Building Research Institute suggests that the pay-back time for applying EWI to an existing dwelling is between 18 and 65 years, while the cost of a passive house in Poland is some 36% higher than a standard house.
- **Hungary** - In June 2010, the Hungarian Government announced a large-scale programme to support complex renovations of Hungarian residential and public buildings from 2011, integrating key recommendations from a large scale retrofit modelling study (conducted in 2010).[150]

The extent to which regulatory differences across key EU markets impact on price/innovation within the EU SWI sector – and therefore create momentum in system price reductions for the UK – is difficult to establish.

[150] http://www.privatbankar.hu/cikk/lakoingatlan/hazai_kkv_kal_ujittatnak_fel_tobb_szazezer_lakast_37287 (link to announcement, in Hungarian)

Global

In contrast to the EU, currently lax regulations in China are creating a building 'footprint' that will quickly open up a massive retrofit market if regulations change[151]. China is the world's largest construction market, accounting for half of new buildings built per year. By 2015 half of all buildings in China will be less than 15 years old. However, the regulatory framework is not as stringent regarding energy standards for new domestic and office space compared to European standards. Four times more energy is required per m^2 for heating and cooling in China compared to Europe. Changes to this regulatory framework could potentially open up market opportunities for technology areas where the UK has a strong capability including around supply of building fabric materials (i.e. UK setting up manufacturing plants in China). UKTI is forging relations with China across a number of low carbon technology areas to help capitalise on these emerging market opportunities.

[151] Zero Carbon Hub Compendium 2009

Economic, employment and environmental impacts from retrofit/renovation

This section summarises the modelling studies that have examined the economic and employment impacts of large scale retrofit of the building stock in the UK, EU, Ireland and Hungary. The **key conclusions from these studies are that large reductions in domestic emissions can be achieved by making significant public investments. However, these costs can be offset by recurring and substantial annual energy savings and positive employment impacts**.

UK housing stock

The WWF's *How Low?* study[152] conducted extensive modelling of the UK's entire domestic housing stock. It concluded that with the right package of financial and support policies, cuts of 36% in residential emissions could be achieved by 2020, and by 2050 the necessary 80% cuts are possible. The suite of technologies focused on in the report included solid wall insulation and low, ground source heat pumps and solar water heating. The report established FTE (full time equivalent) jobs created and GVA (Gross Value Added, i.e. turnover minus cost of bought-in materials, components and services) for each scenario. The report assumed 25% for GVA for external and internal wall insulation.

EU buildings sector

Scenario development has been undertaken for the EU construction sector by the European Insulation Manufacturers' Association (Eurima). A 'Factor 4' scenario envisaged a 75% reduction in emissions in the long term. As part of recent work for DG Employment, GHK has compared these results to a business as usual (BAU) baseline assuming the Energy Performance of Buildings Directive (EPBD) and final uses of energy and energy services Directive are strictly applied across the EU (see Table A1.1). Jobs include all direct employment in thermal insulation and energy efficiency works. The investment-employment conversion rates are based on two reports by Ecofys for Eurima[153 154].

Table A1.1 Impact of energy reducing policies on direct employment in the EU construction sector compared to BAU[155] (Source: GHK)

Scenario	Method	Direct impact (FTE) in EU
Eurima - Extension of EPBD to all dwellings - Energy intensity reduced in 10 new Member States - CO_2 emissions reduced by 70m tonnes or 16% a year (baseline unspecified)	Investments required to achieve targets cost €25bn in EU15 and €4.7bn in 10 new Member States every year. Using the technical ratio developed by Ecofys (160-500 thousand €/year/FTE in EU 15 and 35,000 €/year/FTE in 10 new MS) this results in 50,000-150,500 and 135,000 additional jobs respectively. However, if additional investments in energy efficiency in new Member States were made job creation would fall to 20,000 - 50,000	50,000 to 150,500 in EU15 135,000 or 20,000- 50,000 in new Member States depending on policy
Factor 4 (2030) - Energy used in residential sector reduced 75% - CO_2 emissions reduced by 75% in 2030	Implementing this programme requires €137bn a year to 2030. Based on investments, housing stock and job-investment ratios a 53,000 €/year/FTE ratio is calculated: (investment required per m^2/year times m^2 housing stock)/ (investment needed/1 FTE)	2,585,000
Factor 4 (2050) - Same as above but time horizon of 2050	Implementing this programme requires €73bn a year to 2050. Job creation is based on same ratio as Factor 4 2003 scenario	1,377,000

[152] WWF, '*How Low?* Achieving optimal carbon savings from the UK's existing housing stock' . April 2008. http://www.wwf.org.uk/wwf_articles.cfm?unewsid=2620

[153] Ecofys (2005): 'Cost-effective climate protection in the building stock of the new EU member States, beyond the EU energy performance of buildings directive', report for Eurima.

[154] *ibid*

[155] BAU scenario assumes yearly investment of €11.6bn in EU25 leading to a reduction of 34m tonnes of CO_2 a year at a 2010-12 time horizon or 8% (baseline year unspecified). The direct employment impact is an additional 65,000-107,500 jobs per year.

Although the method of projecting employment changes on the basis of labour intensity and future sector activity captures a large proportion of the gross effect and some structural changes and cost effects are assessed qualitatively, the wider economic changes induced through price and demand, innovation and multiplier effects are missed out and the quantitative projections should be treated with caution.

The study provides a detailed analysis of the likely developments within the construction sector and provides good qualitative assessments of job implications. Because of the uncertainty of international and EU policy developments post-2007 and the impending financial crisis, some assumptions made are now out of date (the study was concluded before the adoption of the EU's 20-20-20 and 10% targets). Many of the assumptions on energy and emissions are not always clearly stated and so they cannot easily be linked with any particular EU policy mix.

Ireland

Research carried out in Ireland in 2009 estimated that a proposed national scheme to upgrade the energy efficiency of around 1.2m Irish homes, mainly built before 2002, would create up to 32,000 building industry jobs. The improvements would require investment of around €14.5 billion over a period of 12-15 years but would result in an estimated €1.4 billion per annum of energy savings[156].

Investment in energy efficiency can therefore have substantial supply chain impact. In many cases the retrofitting of existing housing stock requires products such as secondary window glazing and insulation material to be manufactured, the products to be installed, and the waste products to be recovered and recycled. Employment opportunities are therefore likely to exist throughout the supply chain and are likely to facilitate changes in the skills demanded by employers. This demonstrates how shifts in demand for an existing technology such as wall insulations generated by regulation and changing prices (i.e. energy through the ETS or taxation) can be an important driver of employment impacts.

Hungary

An in-depth study carried out by the European Climate Foundation in 2010[157] examined the employment impacts that might result from a large-scale building retrofit programme in Hungary. The models assumed that retrofits would commence in 2011. Particular emphasis was given to looking at impacts to 2020, but models were able to generate potential energy savings to 2059. Models were developed for residential (6 classes of housing) and public building stock (6 classes but less variation than domestic) to support "deep" retrofits, i.e. bringing buildings as close to passive house standards (consumption of 15kW/m^2/year for heating). Four scenarios were used: fast, medium and slow implementation, as well as 'suboptimal retrofit' (undertaken given the very substantial potential lock-in effects and CO_2 emissions impacts from such poor renovations).

Key conclusions from the study are that:

- Between 52,000 and 131,000 net new jobs could be created in 2020 from a fast and deep retrofit programme.
- A deep retrofit programme, at the end of its implementation, allows savings of 85% of final heating and natural gas imports to be significantly reduced by 2030;
- Adopting a high efficiency retrofitting standard to passive house would result in substantially higher employment impacts. But the investment needs are substantially higher - €4.5bn for a 'fast and deep' retrofit programme versus €2bn for a 'slow and deep' retrofit programme.

[156] Institute for International and European Affairs (IIEA) (2009): 'Jobs, Growth and Reduced Energy Costs: Greenprint for a National Energy Efficiency Retrofit Programme', available at:

http://www.iiea.com/publications/jobs-growth-and-reduced-energy-costs-greenprint-for-a-national-energy-efficiency-retrofit-programme

[157] European Climate Foundation, Employment impacts of a large-scale deep building energy retrofit programme in Hungary, June 2010

Annex 2 The interface between science, R&D and business

Background to understanding the rationale for intervention in low carbon technologies

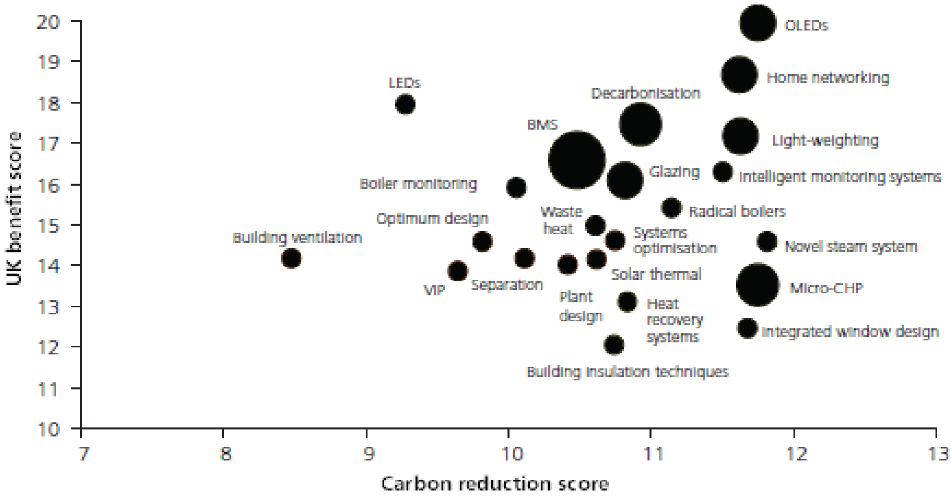
Research and Technological Development (RTD) support initiatives and programmes improve both the Government's and the market's understanding of the challenges for SWI technology adoption

Figure A2.1 provides an assessment of non-commercial energy efficiency technologies (as at 2007) in terms of their cost-effectiveness of carbon reduction benefit (x-axis) and potential economic benefit for the UK (y-axis). The size of the co-ordinate reflects the total potential carbon reduction associated with each technology. Analyses of this type help to prioritise R&D investments in low carbon building technologies - particularly those that will achieve large efficiency improvements and carbon reductions whilst building UK competitive strengths in new technology areas.

The chart shows that the largest potential carbon reductions are associated with Building Management Systems (BMS) and Micro-CHP systems (eligible for market transformation activity under CERT). The technologies of greatest economic benefit to the UK are typically high-technology products including organic LEDs, home networking, LEDs, BMS and intelligent monitoring systems, while the most cost-effective technologies for reducing carbon emissions range from organic LEDs, to Micro-CHP and integrated window designs.

Building insulation techniques achieve the same level of carbon reductions as solar thermal and glazing, however, they score the lowest on UK benefits scoring – an indication of the dominance of foreign ownership within the sector which is covered under the market review of this report.

Figure A2.1 Energy Efficiency Technologies by Potential for Carbon Reduction and UK Economic Benefit



Source: Commission on Environmental Markets and Economic Performance 2007

UK Research & Development support programmes

Low carbon building projects and programmes operating at the science, business and R&D interface in the UK include:

EPSRC Projects

- Carbon Vision Buildings Project (CaRB) was a good example of a low carbon building initiative involving a wide range of academic and private sector partners. Completed in 2008, it developed computer models that made it possible to pinpoint effective ways of cutting carbon emissions arising from energy use in buildings. Partners included De Montfort University, University College London, University of Reading, University of

Newcastle-upon-Tyne, University of Sheffield, Royal Institute of Chartered Surveyors (RICS) and Energy for Sustainable Development Ltd.

- Technology Assessment for Radically Improving Asset Base (TARBASE) is a £1.3 million, 4-year initiative focusing on the scope for retrofit measures to reduce carbon emissions by 50% by 2030. For example, this could be achieved through: greater use of CHP in buildings; greater use of building materials with improved insulating properties; and greater use of renewable energy technologies. The project is being led by Heriot-Watt University and also involves the University of Ulster, University of Surrey, University of Nottingham, BSRIA, Integer, CIRIA and JB&B.
- The ESPRC is also funding the Network for Comfort and Energy Use in Buildings (NCEUC) project, which is co-ordinated by London Metropolitan University. The network aims to define and promote the research effort needed to understand and enhance the thermal comfort of building occupants whilst also minimising the energy use of buildings. There are currently more than 300 members of the network, representing 33 countries.

Technology Strategy Board (TSB)

There are significant existing and emerging commercial opportunities for both retrofit and new buildings and the TSB is currently developing technologies and supply chain solutions with industry for retrofit and new buildings through discrete programme activity. Since May 2008, TSB has spent over £35m in more than 400 projects through its Low Impacts Buildings Innovation Platform[158].

For retrofit, this funding includes the £17m 'Retrofit for the Future' (RftF) competition[159] which was developed in partnership with DCLG and the HCA. The project is focussed on whole house "holistic" refurbishment solutions to achieve an outcome based specification of an 80% reduction in emissions.

Implemented between 2009 and 2011, the programme aims to retrofit UK social housing stock of all ages in order to meet future targets to reduce CO_2 emissions and energy use. Open to all companies, including those not currently engaged in the construction sector, RftF aimed to stimulate the UK market for energy efficiency and to encourage the participation of SMEs with innovative technologies and ideas by asking for designs that would lead to 'deep cuts' in CO_2 emissions.

Overwhelming demand for Phase 1 of the competition, with 194 design and feasibility studies developed, led to Phase 2 taking 86 of these studies (covering 119 dwellings) and providing 100% funding to implement each as a "whole house" solution. The key area of focus was to achieve ambitious, cost-effective carbon and energy reductions with potential widespread applicability across the UK low rise building stock. Around 50% of the 86 projects feature solid walls, so there will be a great deal of information to report on effectiveness, cost of installation and lessons learned. The construction phase of the dwelling retrofits is now complete as is post completion air-tightness testing and thermal imaging. As at May 2012, most RftF projects are now well into their 2 year monitoring phase (generating data every 15 minutes, this will provide 6 million data points for analysis), and TSB is planning to start making the monitoring data available later in 2012.

A database of all projects[160] provides the retrofit 'strategies' for each house, giving insights into the suite of insulation and other measures employed per job as conceived in the application. .

The results from the project will feed into future Government procurement decisions and the Knowledge Transfer Network for the Modern Built Environment (MBE-KTN) will be used to diffuse the results of the competition widely across the industry.

R&D into innovative materials is being encouraged by the TSB and EPSRC. £10 million is being invested in 16 innovative projects aimed at developing new materials technologies to

[158] www.innovateuk.org/ourstrategy/innovationplatforms/lowimpactbuilding/lowimpactbuildingcompetitions.ashx

[159] http://retrofitforthefuture.org/

[160] http://retrofitforthefuture.org/projectbrowser.php

help meet energy challenges. For insulation, the most relevant project is the 'Energy Efficient Bio-based Natural Fibre Insulation' project. Led by Bangor University in collaboration with Hemcore Ltd, Natural Building Technologies, Nonwovens Innovation and Research Institute, Plant Fibre Technology, Rachel Bevan Architects and Consultants, Scitech, Wates Construction, and the University of East London, the project aims to develop a sustainable, thin and highly efficient natural fibre insulation solution, suitable for the new build and retrofit markets.

TSB has also funded projects investigating the properties of paint, including its potential to offer insulation.

Energy Technologies Institute (ETI)

ETI is a £500m public private partnership focused on overcoming barriers to the deployment of low-carbon technologies by establishing projects in a diverse set of market areas.

The ETI Low Carbon Building Programme contains a **domestic retrofit programme.** BRE is managing a consortium for this programme and is currently looking at what is necessary to deliver a step-change in retrofit in order to deliver the Government's headline carbon reduction targets. The £3m, two year programme aims to design supply chain solutions to improve the energy efficiency of the 26 million UK homes that are expected to still be in use by 2050. This involves analysis of the technical challenges, evaluating the most cost effective and efficient methods of retrofitting existing housing stock through low-carbon conversions in large volumes, as well as understanding the ability of the supply chain, consumer acceptance and the role of legislation and initiatives in facilitating this.

Energy Saving Trust (EST)

EST is tasked with helping people save energy and reduce carbon emissions.

Solid wall field trials programme

In 2010 EST commenced a £900,000 solid wall field trial[161] to investigate the energy savings from SWI and identify the barriers and challenges of installing SWI including understanding customers' perceptions of the installation process[162].

The aim was to identify energy savings on different housing stock with a mixture of EWI and IWI being the sole insulation measures. Such a programme would improve SWI knowledge considerably and provide excellent performance data for the sector and end users.

The objective was to monitor baseline data on environmental conditions and utility spend within properties for some time before installing SWI, and then to monitor houses afterwards to see the longer term impacts from the insulation measures. Air tightness monitoring and thermal imaging would also be carried out.

75 solid walled properties throughout England are involved in the trial and various SWI system manufacturers / suppliers are collaborating. Most systems will "off the shelf" systems that have been fitted elsewhere.

Features of the trial are that each home:

- has no micro-renewables installed;
- does not intend to add any further insulation measures (e.g. loft) that might blur findings.

Monitoring and evaluation of house performance is critical for EST so the intention is to fit and monitor the SWI in a controlled manner. The trial dovetails with the TSB Retrofit for the Future programme since the monitoring protocols are the same. Post occupancy evaluation will also be conducted. For example, the occupiers will be asked what have been the findings/challenges over a 2 year period.

The first phase of the field trial, completed in Spring 2011[163], collected baseline data from the energy and fabric performance of each dwellings. A wide range of measurements were undertaken, including:

[161] One of three EST trials that include LEDs and advanced heating controls

[162] Consultation with Matt Colmer, Head of Technology, EST (2011)

- air tightness testing;
- gas / electricity use;
- internal / external temperatures;
- wall U-Value measurements;
- internal / external thermography;
- SAP assessments;
- wall surface temperature measurements; and
- internal humidity.

External and internal solid wall insulation was installed as appropriate in the 75 properties during the summer of 2011, with post-insulation monitoring undertaken to determine the energy saving potential of the measure. The trial will also involve an evaluation of the customer experience which participating householders have received. A final report is due to published during the Summer 2012.

EST thoughts on the use of SWI for houses

EST regards SWI as a difficult insulation measure to sell to homeowners. From a purchaser perspective, critical issues include:

- changes in the look of the house;
- reductions in room size;
- disruption (it might take 3 weeks to install); and
- long payback times.

The fact that SWI is not yet deployed at scale also makes it difficult because there is much less awareness of the technology amongst homeowners.

While SWI system manufacturers work mostly with local authorities, utilities and housing association who understand the product, most home owners work direct with builders so EST believe a key to mass adoption of SWI is to ensure the interest of the small, jobbing builder. Currently there are challenges to this because:

- builders are unlikely to invest in the skills needs and certification unless they can see immediate returns;
- availability of SWI materials is not as widespread as it needs to be (for example, it is hard to obtain orders within 24 hours from suppliers).

Other issues that need to be well thought through include:

- product certification;
- correct information provision, since mispecified and badly installed SWI will badly impact on the sector;

It is the intention of the SWI industry to industrialise the process and look at whole house approaches etc. This may be good for forced deployment (i.e. through the ECO) but for the 'able to pay' market under Green Deal EST's work suggests householders will want to renovate over a three year period and wish to have the ability to draw down funds over that period rather than as a one-off. Indeed, EST's work on 'trigger points'[164] amongst householders shows that there are far more emotional triggers with purchasing decisions than might otherwise be appreciated. The payback problem for SWI is not insurmountable. Double glazing for example does not payback rapidly but people like to fit it for reasons that go beyond improving energy efficiency – noise and security being two of the added benefits. EST believe that in the future SWI is likely to be sold alongside, say, a kitchen refurbishment project, when there is a good opportunity for the builder/fitter to ask the homeowner whether they would like to add insulation at the same time.

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[163] http://www.energysavingtrust.org.uk/scotland/Consultancy-and-certification/Energy-monitoring-and-technology-field-trials/Technologies#9

[164] www.energysavingtrust.org.uk/Publications2/Corporate/Research-and-insights/Trigger-points-a-convenient-truth

DECC

DECC is planning to launch an Energy Entrepreneurs Fund, which will have a budget of up to £35 million from 2012-2015 and which will provide financial support for small and medium-sized firms to develop and demonstrate low carbon technologies. £20 million of the fund will be targeted at energy efficiency technologies. Further details on technologies that will be eligible for funding will be made available on the Low Carbon Funding Landscape Navigator website in due course. Other energy efficiency programmes include a heat storage competition, opened in May 2012, which aims to assess the performance of advanced thermal storage which can be intergrated with heat technologies to help balance peak loads to the grid.

Further details of these and other innovation programmes can be found on the innovation page on the DECC website.[165]

BRE

Rethinking Refurbishment

BRE is gathering information on 500 properties around the UK to gain a clear understanding of interventions across all property types, particularly solid wall dwellings. The data will inform future projects on best practice particularly for hard to treat properties.

National Refurbishment Centre (NRC)[166]

Allied to Rethinking Refurbishment, the NRC is a nationwide demonstration initiative that seeks to foster a more joined-up approach to developing the practical measures needed to refurbish buildings in volume. Its objectives are to:

- support the delivery of a step-change in the national delivery of green refurbishment;
- actively promote the use of data and information collected from 500 exemplar projects;
- develop a large repository of independent data which will help research and enable stakeholder work streams to make practical evidence-based decisions.

It involves industry stakeholders including EST, British Gas, Sanit-Gobain, Kingfisher, BASF, Kier and Constructing Excellence.

UK centres of expertise and excellence in developing Solid Wall Insulation

Science and technology assets (universities, RTOs)

Table A2.1 summarises the relevant low carbon building research expertise across universities in the UK and shows the broad geographic spread and range of research expertise. **It shows three EWI companies, Structherm, Wall Transform and Powerwall Systems, have relationships with universities. Another, Jablite has worked with a spin-out from Aberdeen University.**

Table A2.1 Location of Academic Institutes for Low Carbon Building / Solid Wall Insulation

Region	University	Main area of focus
North West	University of Salford: Energy Salford and the Research Institute for the Built & Human Environment	Energy generation, conversion and demand reduction, socio-economic issues and aspects of a low-carbon lifestyle, energy resources. Includes the Salford Energy House
North East	University of Newcastle-upon-Tyne	Involved in the EPSRC-funded CaRB project

[165] http://www.decc.gov.uk/innovation

[166] www.rethinkinghousingrefurbishment.co.uk/page.jsp?id=1763

Region	University	Main area of focus
Yorkshire & Humberside	University of Sheffield: Building Environments Analysis Unit	Energy and environmental issues in the built environment, Recent projects include: Energy Efficient Social Housing (EESH) project to test performance of new energy efficient homes in Bradford; and, Carbon Reduction in Buildings (CaRB) project to model carbon use in buildings
East Midlands	Nottingham University: Energy Technologies Research Institute	Low energy buildings and sustainable building design Also involved in TARBASE project The University also worked on a Retrofit for the Future project using Wall Transform Ltd's product
	Loughborough University: Centre for Innovative and Collaborative Construction Engineering, and London-Loughborough Centre for Doctoral Research in Energy Demand	Sustainability and building performance, innovative construction technologies London-Loughborough Centre for Doctoral Research in Energy Demand is a partnership with UCL Structherm Ltd sponsors a PhD to investigate more innovative mechanical fixings for their EWI systems
	De Montfort University: Institute of Energy and Sustainable Development	Low and zero carbon energy technologies and low energy buildings. Involved in the CaRB Project: modelling the economic impact of various carbon saving measures
South West	University of Bath – Sustainable Energy Research Team and BRE Centre for Innovative Construction Materials	Low carbon buildings: Inventory of carbon and energy Innovative and sustainable construction materials
	University of West of England: Faculty of Environment and Technology	The Centre for the Study of Sustainable Building explores the opportunities for buildings to contribute towards carbon savings through the adoption of low carbon designs, technologies and use patterns.
	University of Exeter - Environment and Sustainability institute	Energy efficiency
South East	Southampton Sustainable Energy research group	Commercial buildings refurbishment, advanced façade technologies and energy performance, in particular the impacts of different façade systems and structures on energy consumption and indoor comfort
	Brighton University: Centre for Sustainability of the Built Environment	Life-cycle environmental performance of buildings, including modelling and monitoring internal and external environmental conditions and energy consumption. Projects include 'Developing PCM wall-linings for thermal storage in buildings'
	Oxford Brookes University: School of the Built Environment and Oxford Institute for Sustainable Development	Low carbon buildings and building technologies to enhance energy efficiency, and energy assessments of buildings (new build and refurbishment)
	University of Oxford: Environmental Change Institute	Researching people's behaviour in relation to building energy use, and analysing building-related technologies. Recent projects include: examining the issues of achieving 50% carbon savings from UK building stock by 2030; policy recommendations to help encourage householders to make their homes greener; and, integrating sustainable energy systems into public buildings and more than 6,000 new and existing homes in communities across Europe.

Region	University	Main area of focus
	University of Reading	Involved in the EPSRC-funded CaRB project
	University of Surrey	Involved in the EPSRC-funded TARBASE project (led by Heriot-Watt University)
London	Imperial College: Centre for Energy Policy and Technology	Retrofitting low carbon technologies to existing buildings
	University College London: Energy Institute, the Bartlett Faculty of the Built Environment, and the London-Loughborough Centre for Doctoral Research in Energy Demand	Carbon reduction in buildings, regulations for building thermal efficiency, and is also involved in the 'Low Energy Victorian House' project with Camden Council and Kingspan London-Loughborough Centre for Doctoral Research in Energy Demand is a partnership with Loughborough University
	London Metropolitan University: Low Energy Architecture Research Unit (LEARN)	Research focuses on the efficient use of energy, sustainability and high levels of visual and thermal comfort Also administers the EPSRC-funded project, Network for Comfort and Energy Use in Buildings (NCEUB)
	University of East London	Involved in the TSB-funded 'Energy Energy efficient bio-based natural fibre insulation' project (led by Bangor University)
	South Bank University: Faculty of Engineering, Science and the Built Environment	Research and demonstration of low carbon energy technologies in the built environment
	Centre for Efficient and Renewable Energy in Buildings (CEREB)	The design, operation and management of technologies for future low carbon buildings - both new build and retrofit
Scotland	Aberdeen University: Institute of Energy Technologies	Energy efficient building design Spinout company (EnergyFlo), a building engineering consultancy specialising in low energy and modular building design, construction and innovative technologies for new and refurbishment projects EPS insulation supplier Jablite is producing its new Dynamic EWI in partnership with EnergyFlo
	Heriot-Watt University	Technology Assessment for Radically Improving the Built Asset Base (TARBASE), aimed at identifying appropriate carbon saving technologies for existing buildings Delivery of projects under the national 'Adaptation and Resilience in a Changing Climate' programme
	University of Strathclyde: Energy Systems Research Unit	Research into approaches to energy demand reduction in the built environment and the introduction of sustainable means of energy supply
	University of Edinburgh: BRE Centre for Fire Safety Engineering	Professor Asif Usmani working with Powerwall Systems[167]
	Edinburgh Napier University: Building Performance Centre	Low Carbon Building Technologies Gateway project aims to support innovation and enterprise in relation to low carbon building technologies from concept through to market outreach

[167] http://www.powerwall.co.uk/index.php/news/

Region	University	Main area of focus
Wales	Cardiff University: Low Carbon Research Institute, Centre for Sustainable Design of the Built Environment and BRE Centre for Building Systems and Informatics	Low carbon energy generation, storage and distribution; carbon reduction and energy efficiency in the built environment; the energy graduate school; improving the performance of existing buildings.
	Bangor University	Is leading the TSB-funded 'Energy Energy efficient bio-based natural fibre insulation' project to develop a sustainable, thin and highly efficient natural fibre insulation solution, suitable for new build and retrofit.
Northern Ireland	University of Ulster	Involved in the EPSRC-funded TARBASE project (led by Heriot-Watt University)

Sources: EPSRC, Low Carbon Task Force 2009, GHK/BRE company consultations & company websites

Leading academic institutes are: Nottingham University; Cambridge University; Imperial College; Cardiff University; and University of Bath due to their close relationships with industry.

Universities have traditionally focussed on Technology Readiness Levels (TRL) 1 to 3 whilst the industry interest is around TRL 4 – 5 (see Figure A2.2). **There remains a disconnect between most UK academic research into building technologies and industry uptake.**[168]

Figure A2.2 Summary of Technology Readiness Level stages

TRL	Technology status	Description
1	Basic principles observed and reported	Scientific research begins to be translated into applied research and development.
2	Technology concept and/or application formulated	Practical applications of basic key principles can be 'invented' or identified. The application is still speculative: there is not experimental proof or detailed analysis to support the proposal.
3	Analytical and experimental critical function and/or characteristic proof of concept	Active research and development is initiated: analytical studies to set the technology into an appropriate context, and laboratory-based work to physically validate that the analytical predictions are correct. These should constitute "proof-of-concept" validation.
4	Technology / part of technology validation in a laboratory environment	Following successful "proof-of-concept" work, basic technological elements are integrated to establish that the "pieces" will work together to achieve concept-enabling levels of performance. The validation is relatively small scale compared to the eventual technology: it could be composed of ad hoc discrete components in a laboratory.
5	Technology / part of technology validation in working environment	At this level, the reliability / scale of the component being tested has to increase significantly. The basic technological elements must be integrated with reasonably realistic supporting elements so that the total applications can be tested in a 'simulated' or somewhat realistic environment (which is almost always the working environment for energy technologies).
6	Technology model or prototype demonstration in a working environment	A major step in the reliability / scale of the technology demonstration follows the completion of TRL 5. At TRL 6, a prototype going well beyond ad hoc or discrete components is tested in a working environment.
7	Full-scale technology demonstration in working environment	TRL 7 is a significant step beyond TRL 6, requiring an actual system prototype demonstration in the working environment. The prototype should be near or at the scale of the planned operational system and the demonstration must take place in the working environment.
8	Technology completed and ready for deployment through test and demonstration	In almost all cases, this level is the end of true 'system development' for most technology elements. This might include integration of new technology into an existing system. Represents the stage at which an example of the technology is tried and tested
9	Technology deployed	In almost all cases, the end of last 'bug fixing' aspects of true 'system development' and represents the point at which the technology is proven, but not necessarily yet commercially viable in either a free or supported market. This might include integration of new technology into an existing system. This TRL does *not* include planned product improvement of ongoing or reusable systems.

Source: UK Environmental Transformation Fund Strategy, September 2008[169]

The UK university and R&D base has been helping SWI manufacturers and system suppliers to refine their products and systems for new build and retrofit markets. The RftF programme

[168] Discussion with BRE

[169] http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file47575.pdf

has been described during consultations as being particularly good at bringing together industry and research organisations. This includes researching the new build and retrofit markets for SWI. Some examples of collaborations between universities and industry players include:

- **Structherm** has been working with the Centre for Innovative and Collaborative Construction Engineering (CICE) at Loughborough University on a number of R&D projects. One such project has focused on the Fastbuild product, a flexible system of prefabricated concrete panels (of variable size) with a bespoke method of fixing, using special brackets and channels, to enable rapid on-site assembly of new buildings. Structherm sponsors a PhD at Loughborough University to investigate more innovative mechanical fixings for the Fastbuild product and improve understanding of the capacity and potential of the system to be used across a range of different buildings and structural layouts.

- **Jablite** has worked in partnership with EnergyFlo Construction Technologies, a spin-off from Aberdeen University, to develop Jablite Dynamic EWI, the next generation of external wall insulation. This system uses air movement through the insulation to reduce heat loss and then pumps the recovered heat back into the building.

- **Powerwall** has had a close working relationship with the University of Edinburgh over many years. Projects have included: the development of methods for assessing thermal efficiency, structure strength and fire resistance levels to improve the insulation properties and performance of Powerwall insulation panels and lightweight building systems; and, the development of systems to create "intelligent buildings" optimising performance, energy efficiency and occupant comfort.

- **Wall Transform** has worked with Nottingham University and Domestic and General on a 'Retrofit for the Future' project. The project involved using Wall-Reform, Wall-Transform's energy saving plaster/render, on top of 150mm insulation board to improve IWI. Wall-Reform System II, incorporating Kingspan boards and Wall-Reform render, has now been launched and can achieve a U value of 0.3.

- **OMNOVA Wallcovering (UK)** is working with the University of Brighton on a project to develop a new wall-lining utilising phase change materials (PCMs) for thermal storage in buildings. The PCM wall-linings are being developed to function as passive heating and/or cooling systems to improve thermal comfort for occupants and reduce energy consumption.

- **E.On** has been working with the Building Environments Analysis Unit (BEAU) at the University of Sheffield on a project ranked the most popular types of UK properties according to their energy efficiency and graded real-life streets from A* to G. The project links closely with E.On's 'Energy Fit' scheme to increase awareness and inform homeowners about the energy performance of their property.

Recent developments have seen some universities and industry players funding exemplar 'energy homes', in which to install new technologies and undertake research to identify ways of maximising the energy performance of the UK's existing stock of traditional, solid walled properties. Examples of these low energy buildings include:

- **Creative Energy Homes, University of Nottingham** – The University of Nottingham is building a number of real homes on the main campus to conduct research into energy efficiency and low/zero carbon housing. The houses will be occupied to see how lifestyles and the new technologies impact upon energy use. Each house is being built with support from different industry sponsors including BASF, E.On and Saint-Gobain to explore how materials can help cut energy use in the UK's existing building stock. The E.On house is a 1930s style house, which will be upgraded to include SWI alongside energy-efficient appliances, glazing and heating systems, and aims to achieve passive house standards. The house was occupied, and monitoring began, before any new technologies were installed to create a baseline against which to assess energy performance. The BASF house aims to showcase affordable, energy efficient building products and materials and is being constructed with structurally insulated panels and insulated concrete formwork.

- **Energy House, Energy Salford** – The University of Salford has constructed an "old-build" traditional 1920s Salford style house, built inside a laboratory, to study domestic energy consumption. The Salford 'Energy House' was recently unveiled at the UK's first conference on the retrofit challenge, Retrofit Salford 2011, in January 2011. The environmentally controllable laboratory can independently adjust levels of heat, light, humidity and wind to enable the development and testing of new low-carbon materials, technologies and products, including SWI, for the retrofit market.

- **Low Energy Victorian House, University College London** – The Bartlett Faculty of the Built Environment at UCL is working in partnership with Camden Council and other partners, including Kingspan, to refurbish a solid wall semi-detached Victorian house located in a conservation area in Camden. The demonstration project aims to achieve a 90% reduction in the house's carbon emissions using a variety of energy efficiency measures including Kingspan IWI, whilst offering an opportunity to research, experiment and report on the outcomes of the various measures used.

- **Low Energy Whole House Refurbishment** – Knauf Insulation is involved in a project to internally insulate a 1890s Victorian mid-terrace house, using Knauf's Polystud IWI system (and Knauf's metal stud system for comparison). The project aimed to install effective and efficient low energy refurbishment systems that could be delivered by any competent builder for a minimal additional costs over a normal refurbishment. The project found that the additional cost of the Polystud system would have a pay-back time of seven years based on energy savings of £400 per annum. In a similar demonstration project, Knauf Insulation is working with Glasgow Caledonian University to transform another Victorian house into a low energy home using a variety of energy efficiency measures including Knauf's IWI.

Commercialisation assets (demonstrator centres, incubators)

Several centres in the UK specifically target the commercialisation of new technologies through market adoption of business-led academic research. Table A3.2 provides details of those centres providing tailored support to companies developing new construction methods.

Table A2.2 R&D centres for low carbon buildings in the UK

Region	Name	Remit
North West	Centre for Construction Innovation (CCI)	CCI supports construction sector R&D, helping to facilitate the Construction Change Agenda throughout the region. It addresses issues in the built environment such as sustainability, design, procurement, skills and construction processes. Delivers £6m Construction Knowledge Hub in partnership with Salford, Lancaster and Liverpool Universities which aims to help companies increase competitiveness, productivity and respond to climate change
East Midlands	Sustainable construction iNet & iHub[170]	The i-Hub or Innovation Hub of the Sustainable Construction iNet is the £9m iCon building in Daventry. This will support the UK sustainable construction industry. iCon East Midlands, the partnership that is driving the multi-million-pound project, is made up of representatives from: WNDC, East Midlands Centre for Constructing the Built Environment (EMCBE), University of Northampton, Building Research Establishment (BRE), Daventry District Council and other universities.
Yorkshire & Humberside	SaBRE	A joint venture between Sheffield University and BRE. The project provides a range of services to industry; including collaborative research; consultancy;

[170] http://www.eminnovation.org.uk/construction/Default.aspx

Region	Name	Remit
		expert witness; testing and analysis; and product development.
East of England	Building Research Establishment (BRE)	BRE collaborates with a range of research establishments to offer sustainable design, construction and management advice for all types of buildings.
	Institute for Manufacturing & SmartLIFE, Cambridge	IfM links academic research with industry through bespoke research and dissemination. The SmartLIFE project aims to address three challenges of housing delivery in growth areas: affordability; sustainability / energy efficiency; and skills / capacity shortages in the construction industry

Sources: organisation websites

Annex 3 Trade code analysis for insulation materials

EU production and trade in insulation materials

The EU production of thermal insulation was estimated to be worth €11.7 billion in 2005[171] in an impact assessment study for the European Commission of the Construction Products Directive (see Table A3.1 below). GHK attempted to replicate that analysis for the current study by analysing the Eurostat PRODCOM database, looking for both EU and UK production figures in order to see the relative manufacturing strengths of UK industry. However, the NACE codes used for the classification of production data did not include the products in question (e.g. there was no product code matching the product label). As a result, no further data analysis for production was undertaken.

Table A3.1 Trade statistics for Thermal Insulation Products in the EU 2005 (€ million)

	Production EU-25	Consumption EU-25*	Intra-EU trade	Imports (extra EU)	Exports (extra EU)
2005	11,700	11,079	3,843	594	1,215

*Notes: * recalculated from original figures as: Production + Imports – Exports. Source: RPA 2007*

In the same impact assessment study noted above, intra-EU trade in insulation products in 2005 was estimated to be worth 32% of total production[172]. This implies that some companies had strategically located manufacturing plants able to supply across member state markets. Clearly the weight of many of these (often clay based) insulation products creates high transport cost pressures for all but the most localised exports. This would also apply to some lighter insulation materials like glass wool which incur high transport costs due their volume.

The same study also found a small level of imports of insulation products into the EU, implying a strongly competitive EU supply side, able to export 10% of its production capacity outside the EU. This is important as it indicates that the EU at that time had a degree of spare capacity that could have been redirected towards member state markets should there have been sufficient market demand.

Eurostat COMEXT Trade codes

Eurostat's trade database, COMEXT, allows detailed product code analysis of trade. The table below shows the codes used for this analysis. They cover a range of potential insulant materials, though these products will apply to more than just solid walls.

Table A3.2 Trade codes for insulation materials[173]

Code	Generic insulation term	Detailed description of insulation materials covered by code
680610	Mineral wools	Slag-wool, rock-wool and similar mineral wools, including intermixtures thereof, in bulk, sheets or rolls
680620	Expanded clays & mineralss	Exfoliated vermiculite, expanded clays, foamed slag and similar expanded mineral materials, including intermixtures thereof

171 RPA (2007), 'The policy options for Revision of Council Directive 89/106/EEC (Construction Products Directive)', for DG Enterprise & Industry

172 RPA (2007), 'The policy options for Revision of Council Directive 89/106/EEC (Construction Products Directive)', for DG Enterprise & Industry

173 Source: Eurostat COMEXT trade database

680690	Mixed insulant materials	Mixtures and articles of heat-insulating, sound-insulating or sound absorbing mineral materials (note, this excludes articles of light concrete, asbestos-cement, cellulose fibre-cement or the like, mixtures and other articles of or based on asbestos, and ceramic products).
680800	Chipboard	Panels, boards, tiles, blocks and similar articles of vegetable fibre, of straw or of shavings, chips, particles, sawdust or other waste of wood, agglomerated with cement, plaster or other mineral binders (excluding articles of asbestos-cement, cellulose fibre-cement or the like).
680911	Plasterboard faced / reinforced with paper	Boards, sheets, panels, tiles and similar articles, of plaster or compositions based on plaster, faced or reinforced with paper or paperboard only (excluding ornamented and with plaster agglomerated articles for heat-insulation, sound-insulation or sound absorption).
680919	Plasterboard	Boards, sheets, panels, tiles and similar articles, of plaster or compositions based on plaster (excluding ornamented, faced or reinforced with paper or paperboard only, and with plaster agglomerated articles for heat-insulation, sound-insulation or sound absorption).

GHK analysis of insulation trade codes

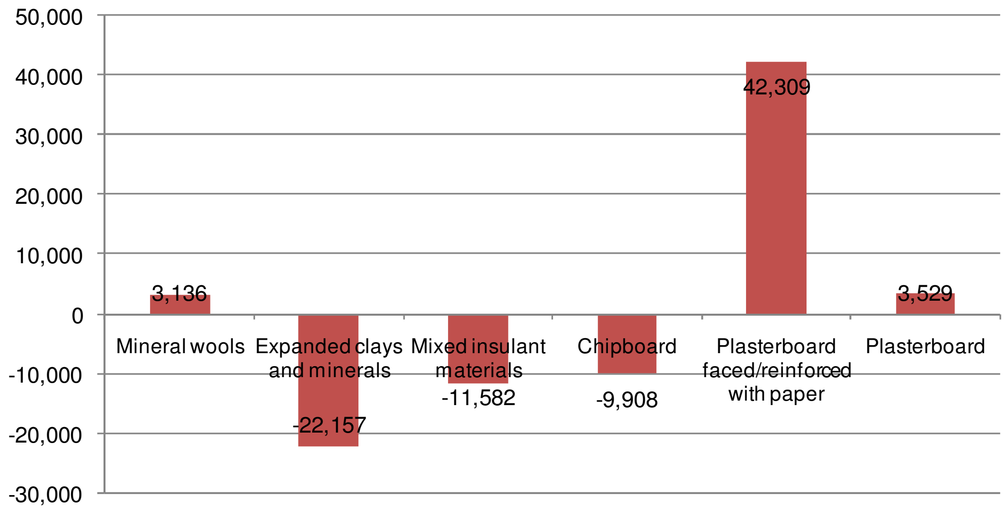
In summary, for intra-EU trade, the UK had a marginally positive trade balance in 2009 for mineral wools and plasterboard together with a significant positive trade balance (the first since 2001) for plasterboard faced / reinforced with paper - the latter potentially indicating the effects of the economic downturn in the UK (i.e. that there is spare product available for export to other EU member states), or else shows the impact of either a new plasterboard production plant that has opened in the UK, or else additional manufacturing lines that have been brought on stream at existing facilities. Conversely the UK had a small trade deficit for expanded clays and minerals, mixed insulant materials and chipboard.

Table A3.3 UK intra-EU trade balance for selected products (in thousand tonnes)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Mineral wools	-16.8	-12.4	-11.4	-11.8	-14.3	-11.3	-16.0	-4.8	-0.9	3.1
Expanded clays and minerals	0.5	-1.5	-7.7	-40.9	-92.6	-87.5	-84.3	-150.8	-96.6	-22.2
Mixed insulant materials	-52.2	-17.1	-5.0	-15.2	-9.0	-5.7	-9.5	-8.4	-3.9	-11.6
Chipboard	24.6	21.9	11.4	-2.3	-5.0	-19.4	-17.8	-21.0	-19.6	-9.9
Plasterboard faced/reinforced with paper	46.9	34.9	-20.2	-183.6	-234.1	-196.0	-156.6	-53.1	-5.5	42.3
Plasterboard	10.3	11.1	17.9	14.0	10.4	12.6	6.9	6.2	2.1	3.5
Total	13	37	-15	-240	-345	-307	-277	-232	-124	5

Source: Eurostat COMEXT trade database

Figure A3.1 UK intra-EU trade balance in 2009 for selected products (in tonnes)



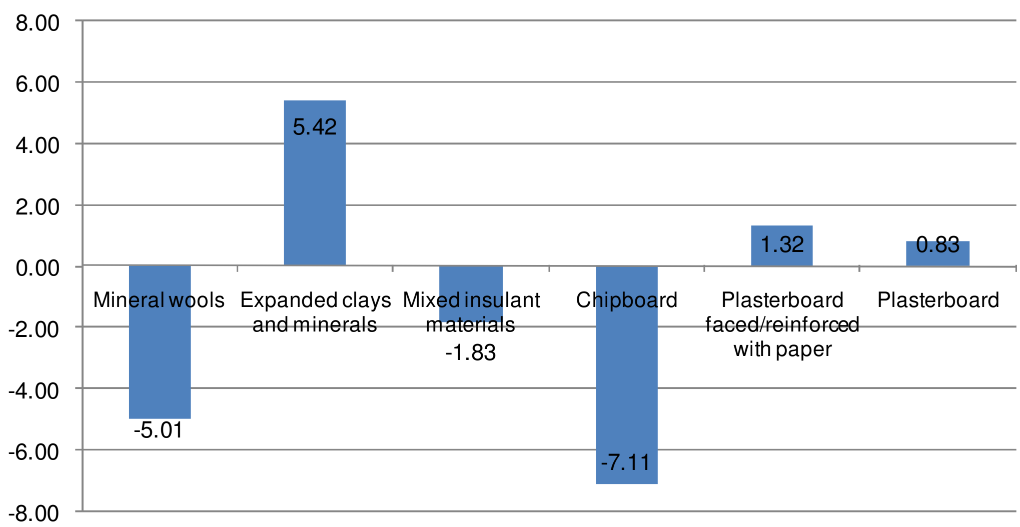
Source: Eurostat COMEXT trade database

Table A3.4 UK intra-EU trade balance for selected products (in million euros)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Mineral wools	-0.93	1.99	-3.47	-8.59	-10.89	-17.17	-3.20	5.78	3.52	-5.01
Expanded clays and minerals	-1.13	-0.66	-2.09	-1.02	8.06	5.48	7.22	7.57	7.62	5.42
Mixed insulant materials	-7.17	-7.56	-7.96	-14.38	-6.03	8.58	3.19	11.02	9.57	-1.83
Chipboard	15.95	19.87	11.47	3.90	1.73	-8.84	-10.42	-16.01	-10.52	-7.11
Plasterboard faced/reinforced with paper	8.50	4.57	-5.36	-28.55	-36.62	-28.57	-18.07	-18.79	0.31	1.32
Plasterboard	5.74	3.22	3.55	3.43	4.15	4.16	3.78	3.71	1.57	0.83
Total	20.96	21.43	-3.85	-45.20	-39.59	-36.37	-17.50	-6.72	12.08	-6.38

Source: Eurostat COMEXT trade database

Figure A3.2 UK intra-EU trade balance in 2009 for selected products (in million euros)



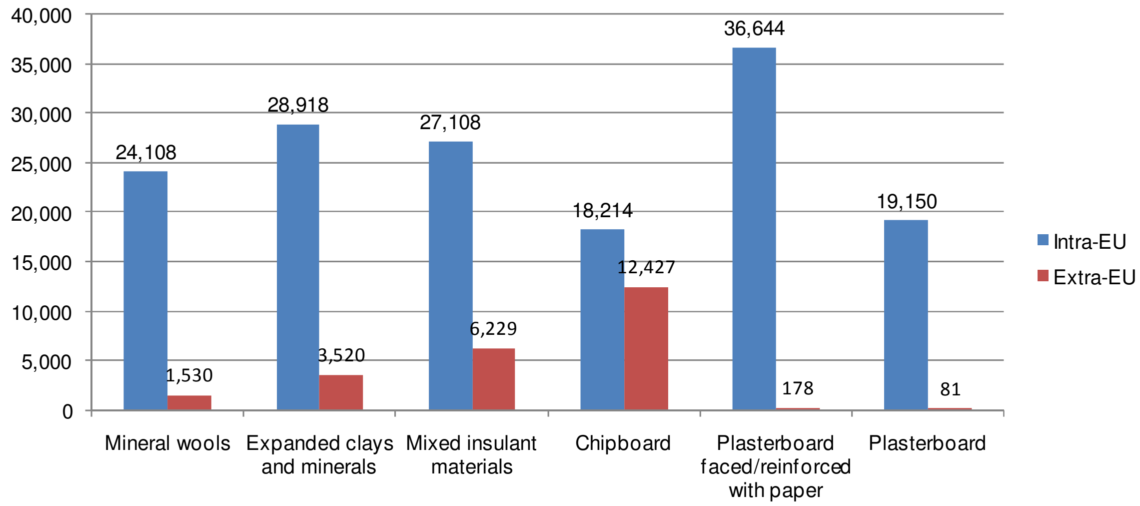
Source: Eurostat COMEXT trade database

Table A3.5 UK intra-EU and extra-EU imports for selected products (in thousand tonnes)

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Intra-EU	Mineral wools	27.1	23.6	23.1	26.5	32.0	32.9	42.1	34.6	23.3	24.1
	Expanded clays and minerals	7.3	4.5	11.8	47.1	103.9	97.9	94.5	161.8	105.3	28.9
	Mixed insulant materials	66.1	29.0	25.3	27.4	30.0	35.7	35.9	36.3	33.9	27.1
	Chipboard	7.2	8.4	10.6	18.3	18.9	21.7	21.8	25.3	22.5	18.2
	Plasterboard faced/reinforced with paper	31.6	37.8	92.5	265.1	345.3	270.5	266.1	141.3	79.1	36.6
	Plasterboard	13.8	11.8	13.4	14.5	20.0	17.6	20.7	18.4	20.3	19.2
Extra-EU	Mineral wools	2.6	2.2	2.0	1.9	2.2	1.9	1.8	1.5	1.8	1.5
	Expanded clays and minerals	49.7	56.4	56.4	30.7	7.4	4.8	4.9	7.4	5.6	3.5
	Mixed insulant materials	5.8	7.3	7.7	10.2	11.2	10.1	7.5	9.3	9.4	6.2
	Chipboard	0.3	0.2	0.6	0.7	2.4	2.0	3.8	7.2	10.2	12.4
	Plasterboard faced/reinforced with paper	0.3	0.4	6.7	31.9	54.5	48.9	3.1	4.6	0.1	0.2
	Plasterboard	0.3	0.1	0.1	0.1	0.1	0.7	0.2	0.1	0.2	0.1
Total		212	182	250	474	628	545	502	448	312	178

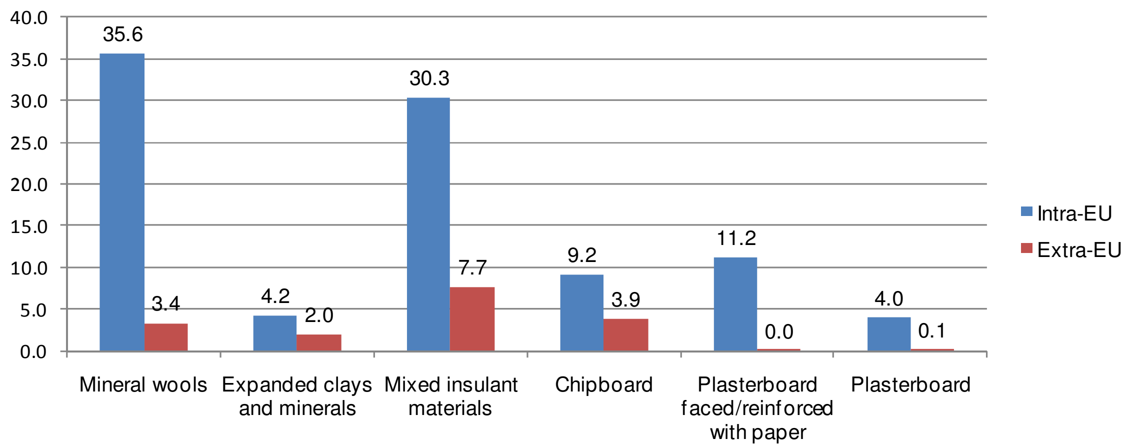
Source: Eurostat COMEXT trade database

Figure A3.3 UK intra-EU and extra-EU imports in 2009 (in tonnes):



Source: Eurostat COMEXT trade database

Figure A3.4 UK intra-EU and extra-EU imports in 2009 (in million euros)



Source: Eurostat COMEXT trade database

Table A3.6 Total insulation exports from the UK between 2000 and 2009 (in million euros)

		2009	2008	2007	2006	2005	2004	2003	2002	2001	2000
Intra-EU	Mineral wools	30.62	39.77	51.70	42.17	31.85	26.80	24.99	25.82	25.88	22.06
	Expanded clays and minerals	9.65	15.54	17.35	17.76	14.39	16.07	4.95	3.40	2.65	4.24
	Mixed insulant materials	28.51	46.72	55.84	53.50	53.13	37.96	25.57	31.16	28.81	31.70
	Chipboard	2.04	1.07	1.78	1.70	0.83	10.94	12.64	16.77	23.11	19.74
	Plasterboard faced/reinforced with paper	12.55	15.74	20.85	26.76	15.91	19.53	11.76	12.42	14.67	22.19
	Plasterboard	4.81	6.23	7.26	7.82	8.02	7.90	6.07	7.20	5.77	8.63
Extra-EU	Mineral wools	9.75	10.99	35.36	33.12	28.71	30.16	18.11	9.48	11.57	13.33
	Expanded clays and minerals	5.81	11.86	8.84	8.19	7.03	9.27	5.22	19.14	21.25	14.61
	Mixed insulant materials	35.63	42.57	34.77	46.71	33.88	26.67	34.11	15.81	22.95	10.97
	Chipboard	7.68	1.45	2.23	2.55	2.43	3.06	5.49	9.27	9.72	11.99
	Plasterboard faced/reinforced with paper	0.30	0.58	0.33	0.54	0.25	0.45	1.43	0.94	1.42	0.53
	Plasterboard	0.88	0.73	0.57	0.47	0.28	0.34	0.15	0.68	1.30	0.85
Total		148	193	237	241	197	189	150	152	169	161

Source: Eurostat COMEXT trade database

Table A3.7 Total trade balance for UK between 2000 and 2009 (in million euros)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Imports	-104	-96	-116	-155	-180	-185	-187	-185	-135	-112
Exports	161	169	152	150	189	197	241	237	193	148
Trade Balance	57	73	36	-5	9	11	54	52	58	37

Source: Eurostat COMEXT trade database

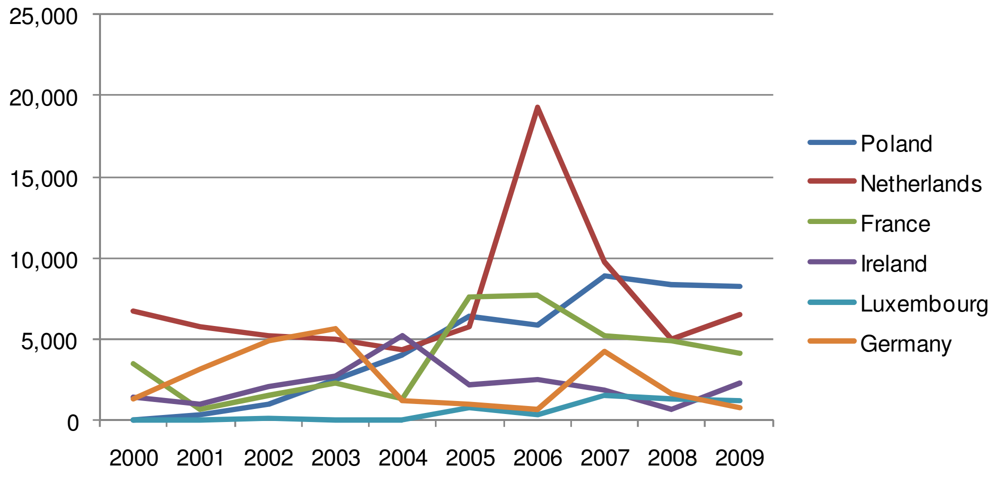
Trade analysis of imports into UK over a 10 year period for 6 main types of insulation

Besides wide variations in material supply prices across member states, and collapses in price since 2007, the following analyses show that by insulation type:

- Poland and the Netherlands are now the two leading suppliers of **mineral wool** to the UK, with France third. The Netherlands dramatically reduced its supply since 2006.
- Denmark is now virtually the only bulk supplier of **expanded clays and minerals** to the UK following a collapse in Belgium supply since 2007.
- Germany has grown steadily over the past 10 years to become the dominant supplier of **mixed insulant materials**. France has virtually dropped out having been the main exporter in 2000, at a level twice that now supplied by Germany.
- Germany, Hungary and Ireland are the main suppliers of **chipboard**.
- After a peak in 2005 of 225,000 tonnes from Germany, supply of **plasterboard (faced/reinforced)** into the UK has now virtually ceased.
- The Netherlands is virtually the only supplier of **plasterboard (standard)** at 170,000 tonnes in 2009.

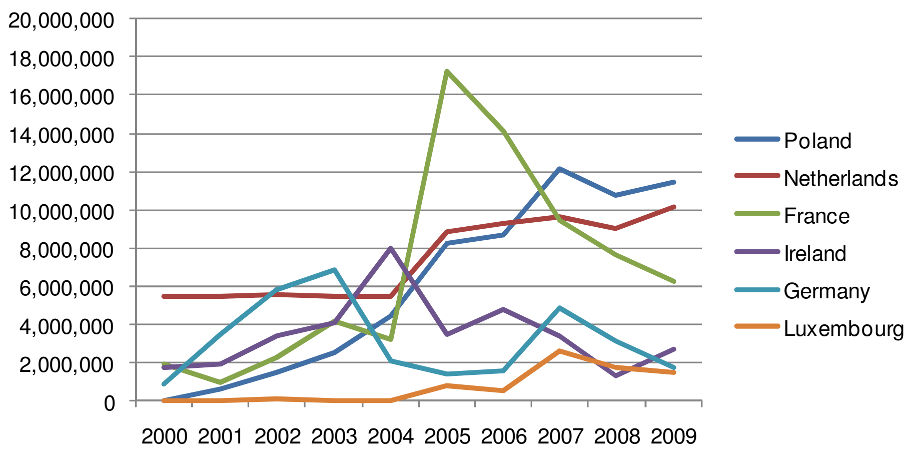
Mineral wools

Figure A3.5 Intra-EU import partners of UK with highest volume of trade for mineral wools (in tonnes)



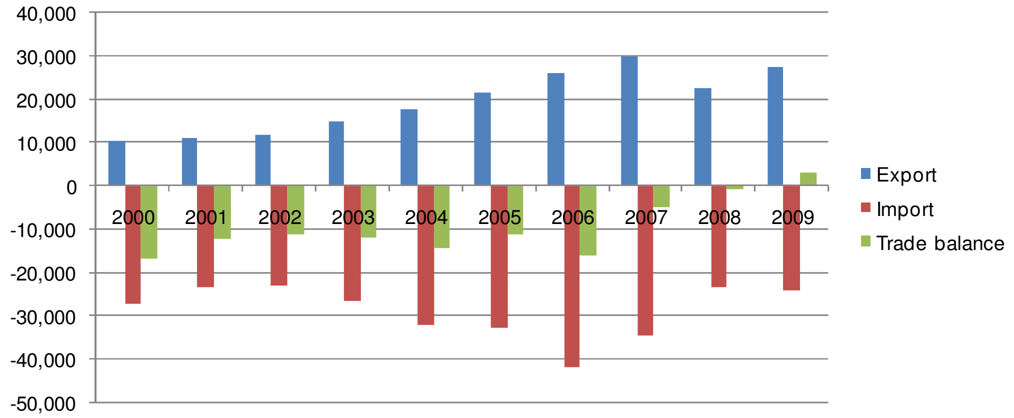
Source: Eurostat COMEXT trade database

Figure A3.6 Six intra-EU import partners of the UK with highest volume of trade for mineral wools (in euros):



Source: Eurostat COMEXT trade database

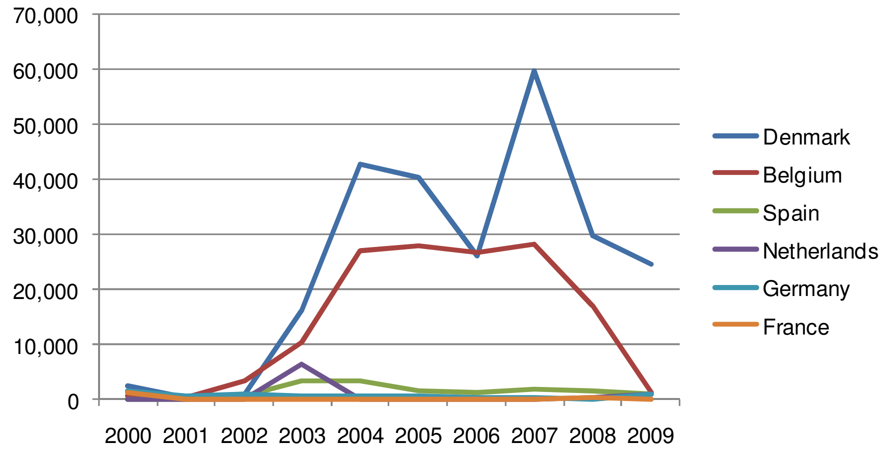
Figure A3.7 UK trade balance for mineral wools (in tonnes):



Source: Eurostat COMEXT trade database

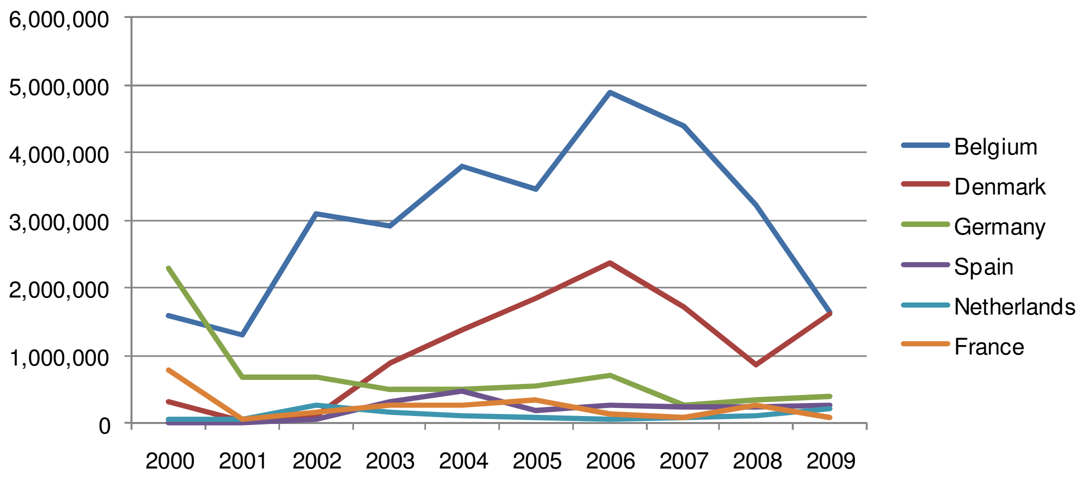
Expanded clays and minerals

Figure A3.8 Six intra-EU import partners of the UK with highest volume of trade for expanded clays and minerals (in tonnes):



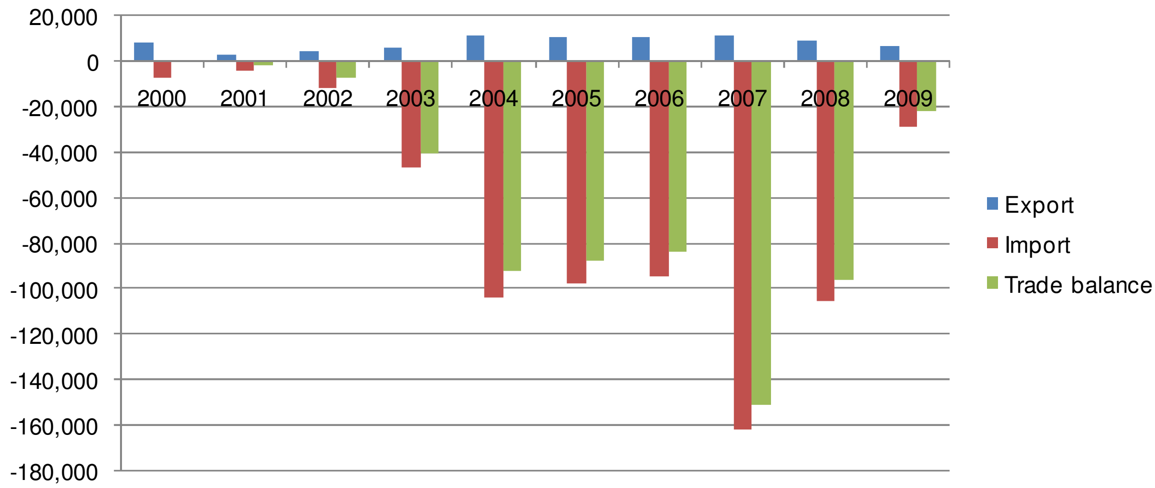
Source: Eurostat COMEXT trade database

Figure A3.9 Six intra-EU import partners of the UK with highest volume of trade for expanded clays and minerals (in euros):



Source: Eurostat COMEXT trade database

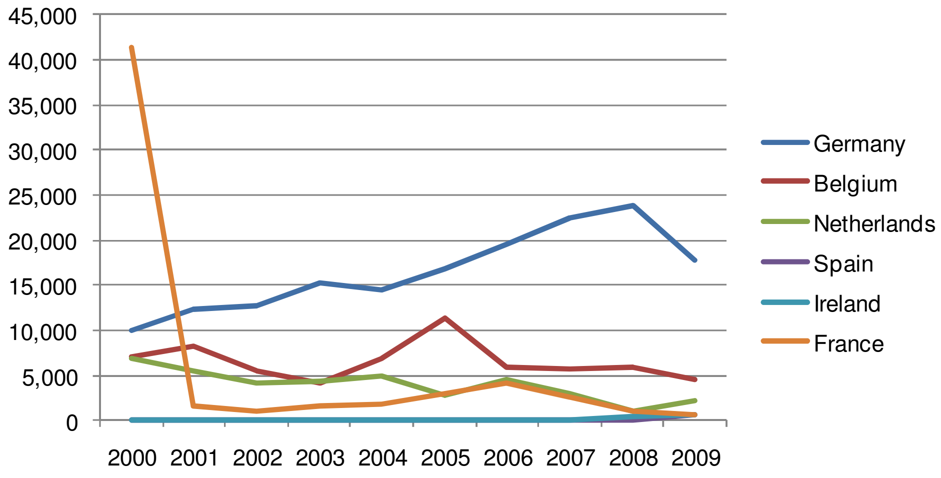
Figure A3.10 UK trade balance for expanded clays and minerals (in tonnes):



Source: Eurostat COMEXT trade database

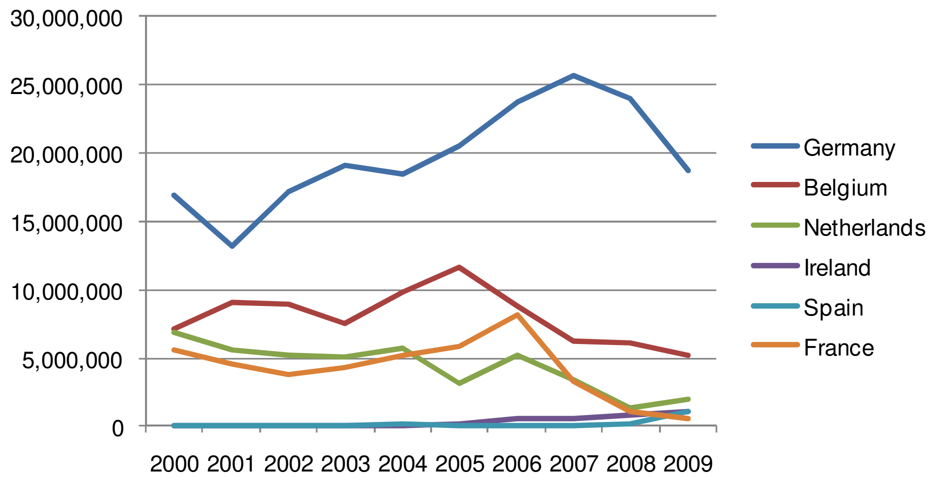
Mixed insulant materials

Figure A3.11 Six intra-EU import partners of the UK with highest volume of trade for mixed insulant materials (in tonnes):



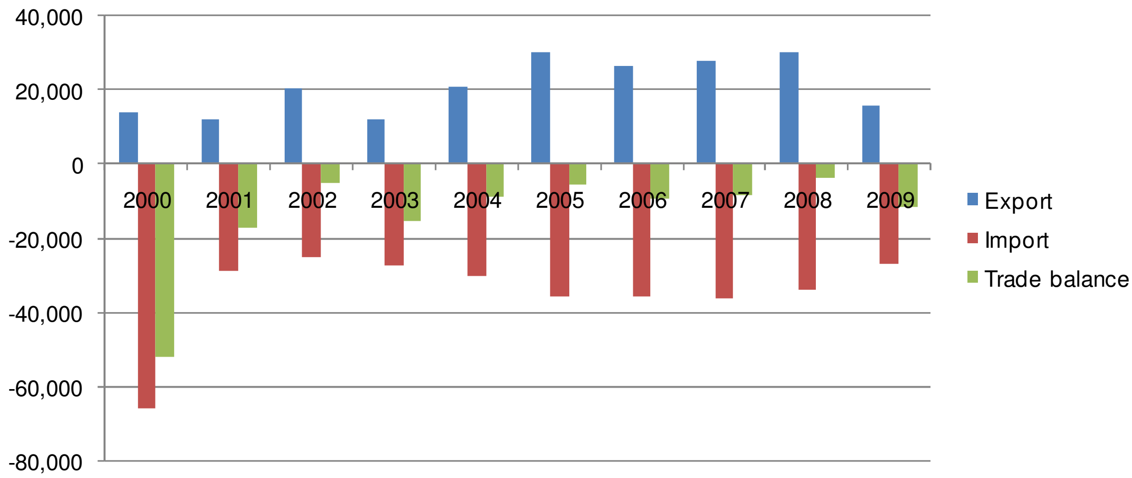
Source: Eurostat COMEXT trade database

Figure A3.12 Six intra-EU import partners of the UK with highest volume of trade for mixed insulant materials (in euros):



Source: Eurostat COMEXT trade database

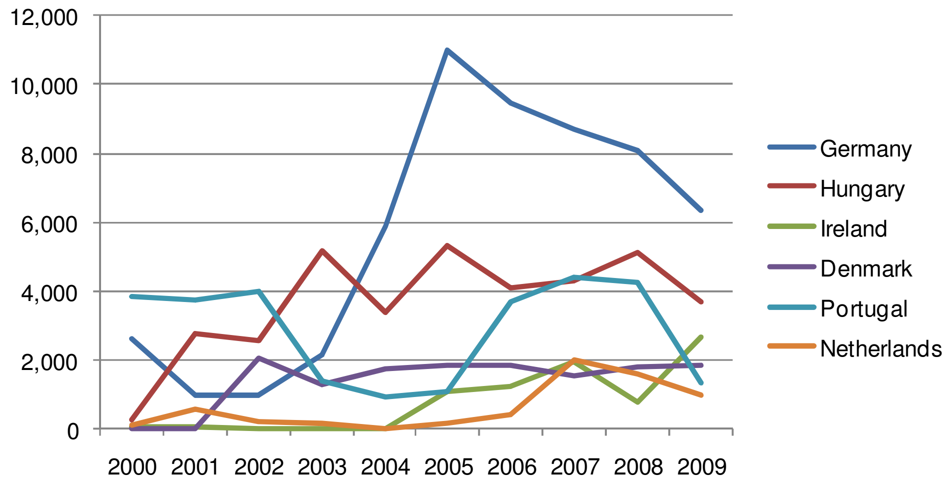
Figure A3.13 UK trade balance for mixed insulant materials (in tonnes):



Source: Eurostat COMEXT trade database

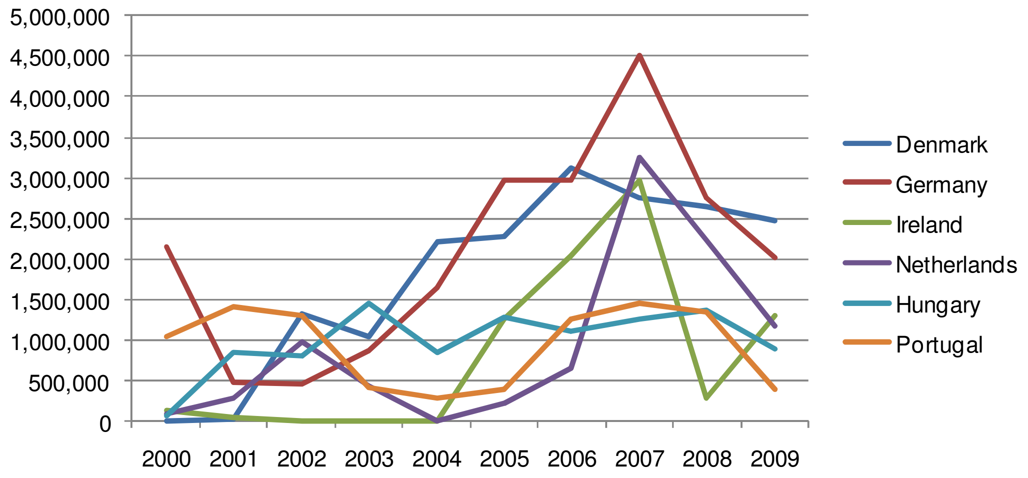
Chipboard

Figure A3.14 Six intra-EU import partners of the UK with highest volume of trade for chipboards (in tonnes):



Source: Eurostat COMEXT trade database

Figure A3.15 Six intra-EU import partners of the UK with highest volume of trade for chipboards (in euros):



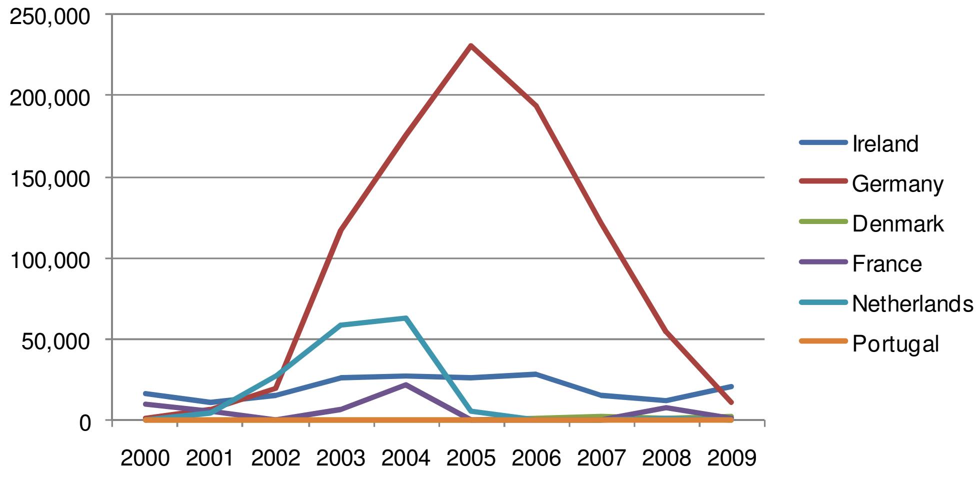
Source: Eurostat COMEXT trade database

Figure A3.16 UK trade balance for chipboards (in tonnes):

Source: Eurostat COMEXT trade database

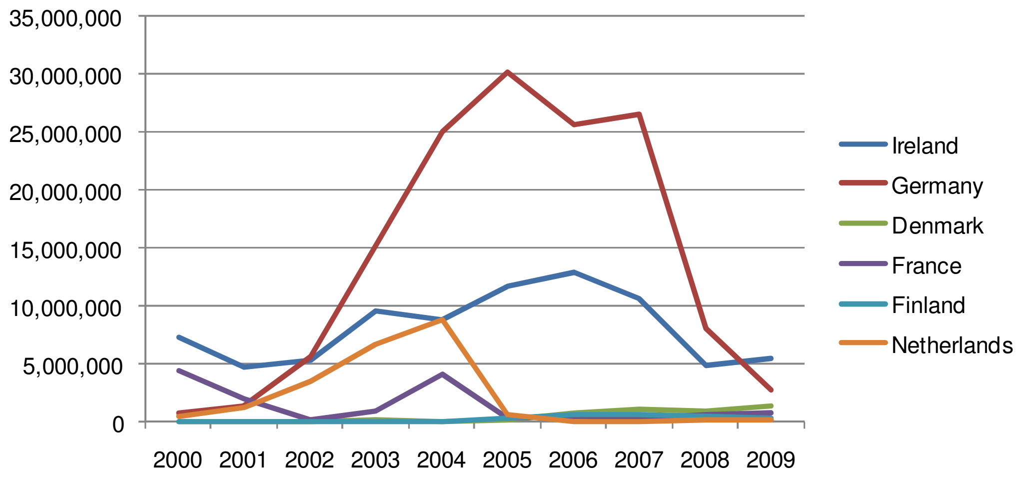
Plasterboard faced/reinforced with paper

Figure A3.17 Six intra-EU import partners of the UK with highest volume of trade for plasterboards faced/reinforced with paper (in tonnes):



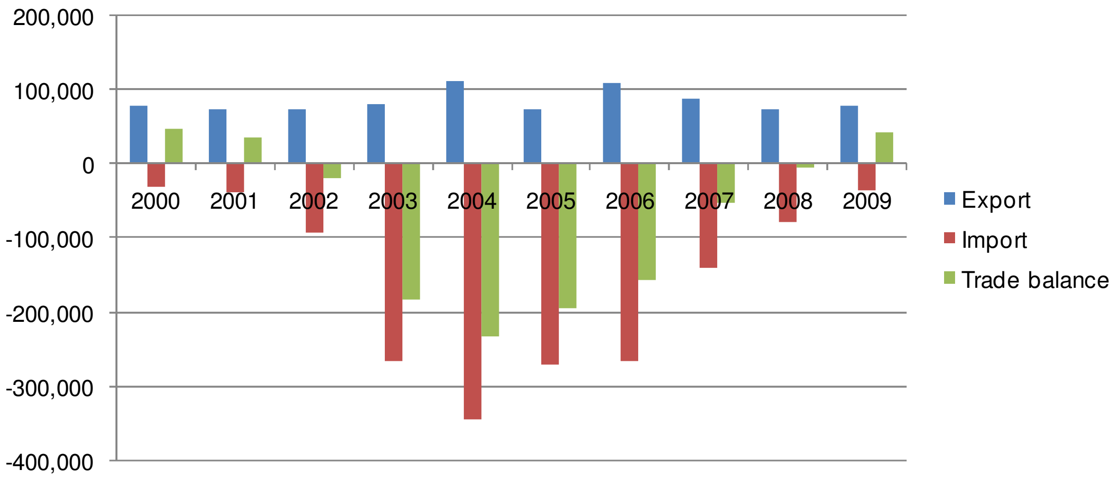
Source: Eurostat COMEXT trade database

Figure A3.18 Six intra-EU import partners of the UK with highest volume of trade for plasterboards faced/reinforced with paper (in euros):



Source: Eurostat COMEXT trade database

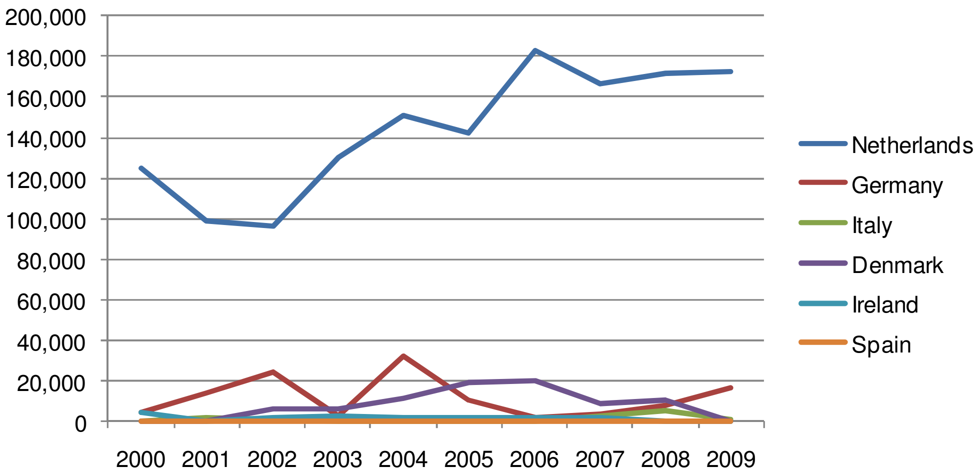
Figure A3.19 UK trade balance for plasterboards faced/reinforced with paper (in tonnes):



Source: Eurostat COMEXT trade database

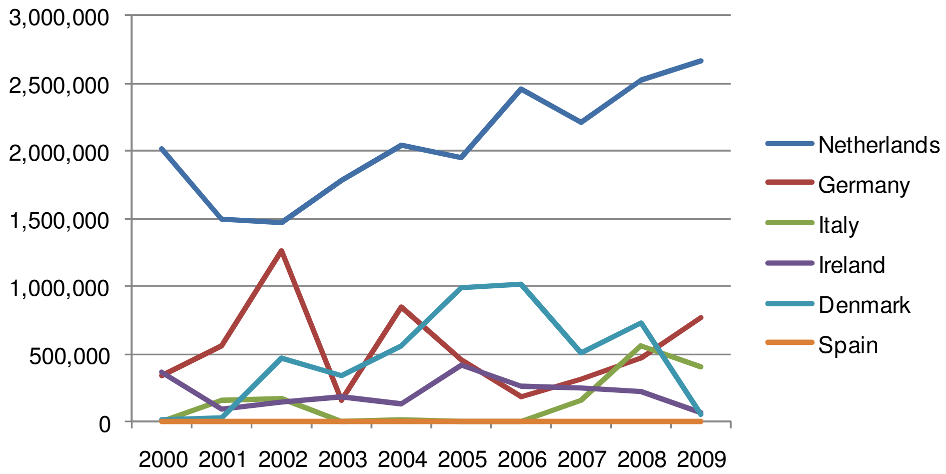
Plasterboard

Figure A3.20 Six intra-EU import partners of the UK with highest volume of trade for plasterboards (in tonnes):



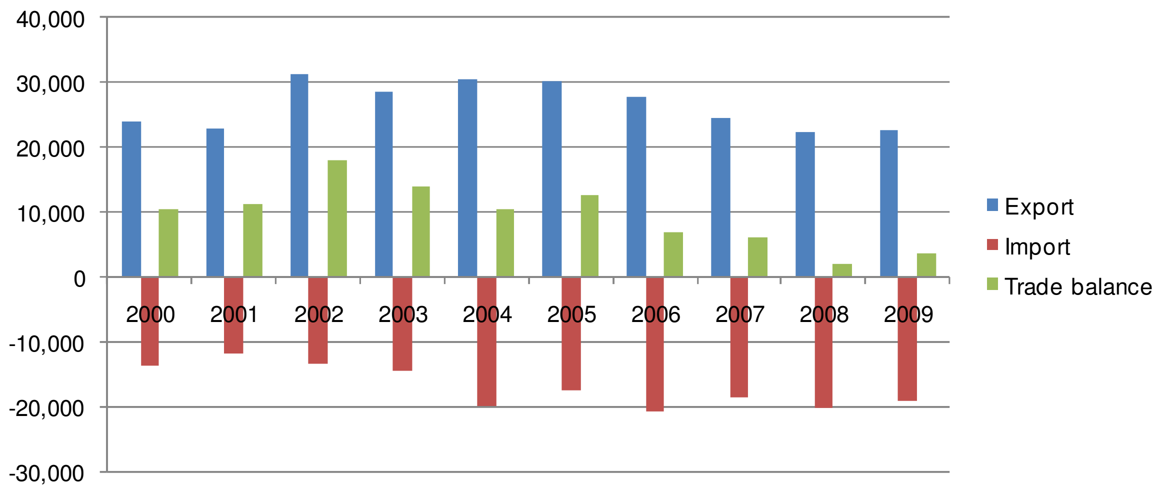
Source: Eurostat COMEXT trade database

Figure A3.21 Six intra-EU import partners of the UK with highest volume of trade for plasterboards (in euros):



Source: Eurostat COMEXT trade database

Figure A3.22 UK trade balance for plasterboards (in tonnes):



Source: Eurostat COMEXT trade database

Comparison of GHK trade analysis values with other market studies

Innovas examined the UK low carbon and environmental goods and services market for BIS in 2009. Within the building technologies sector, it found UK exports worth £1.35bn in 2008. These consisted of products associated with windows, doors, insulation and heat retention and monitoring and control systems. Exports accounted for just over 10% of the value of the building technologies market. These exports comprised:

- **£400 million (29%) associated with insulation and heat retention equipment, particularly materials for cavity wall insulation, fibre insulation for roofing and granular insulation materials**;
- £500 million (37%) associated with windows, particularly insulated alloy window frames and advanced plastic thermally insulated window frames;
- £330 million (25%) associated with doors, including insulated alloy doors, but especially insulated plastic doors;
- £125 million (9%) associated with monitoring and control systems.

The largest export markets are Spain (£78m), Italy (£77m), Hong Kong (£74m), Malaysia (£73m) and China (£72m).

Our analysis of insulation exports in the above section fits reasonably well with the Innovas analysis, particularly since it is likely to have looked at a broader range of products.

Position of UK construction producers in the global market

There are currently over 6,600 companies in the UK building technologies sector, employing approximately 107,000 people[174]. The sector benefits from a number of internationally significant businesses - 28 of the top 100 construction companies in Europe are based in the UK[175], operating in countries across the globe, including those with the highest volume of construction projects (i.e. the Gulf, China, EU Member States, Hong Kong, India, Japan, Russia, and USA). These construction companies operate in extremely diverse collaborative networks composed of contractors, consultants, building materials and product producers, highlighting the potential for market growth in emerging sectors and a possible opportunity for the UK.

Whilst these larger companies are important (and have the potential to capitalise on opportunities offered through the construction of low carbon buildings), the UK construction industry is dominated by SMEs which suggests greater collaboration between SWI companies in the future may help them to exploit market opportunities in the EU.

However, and as seen in the SWI market, the UK construction materials sector has been undergoing consolidation in recent years, with many UK companies now being part of international companies[176]. This trend seems set to continue.

[174] INNOVAS, 2009: 33

[175] Evidence presented in Deloitte, European Powers of Construction Report, 2007 (available for download at http://www.deloitte.com/view/en_GB/uk/industries/eiu/publications/433230d76720e110VgnVCM100000ba42f00aRCRD.htm)

[176] http://archive.corporatewatch.org/profiles/construction/construction.htm

Annex 4 Technology projections & stock analysis – supporting material

Installation costs for EWI and IWI

SWI costs used in this study were based on those used in DECC's Final IA for the Green Deal (June 2012).

Cost data had been informed by extensive industry consultations and other studies including the EST/EEPFH Purple Market Research report entitled *'Solid Wall Insulation Supply Chain Review'* (May 2009), a summary of which are broken down in Tables A4.1 and A4.2. For an EWI installation, besides materials and fittings, extra costs cover scaffolding, making good etc. These are broken down for a 3 bedroom semi detached house in Table A4.1.

Table A4.1 Estimates of EWI costs in a 3 bed Semi (2009)

	External Wall Insulation in 3-bed Semi (Wet render system) ($80m^2$)	Approx. cost
Materials & Fitting	50mm Phenolic Foam Insulation mechanically fixed to existing walls	£3,225
	20mm Phenolic Foam Insulation to external reveals	£725
	Overall 10mm Silicone Acrylic Texture Render applied as three-stage: base coat and mesh, primer paint and silicon acrylic texture finish cost in colour to suit (to walls and reveals)	£2,650
	Other: stainless steel head, corner and edge beads to the render, full depth PPC stop beads to base and party wall junctions	£1,000
	Total for materials and fitting	**£7,600**
Extras	Scaffolding	£2,000
	Take down and refix rainwater downpipes and cabling	£300
	Protection of garden	£150
	Standard under-cill extenders to under windows	£240
	Removal and disposal of defective render and mould	£500
	Take down and refixing of items e.g. lights, alarm box, doorbell, satellite dish or cable box, outside tap etc.	£200
	Extending existing boiler flue or overflow pipes, plus removal and refixing of gas pipework	£300
	Adjustment to door canopy, windows, etc.	£150
	Creating a larger roof overhang to cover the new insulation (if required)	£3,000
	Total for extras if all required	**£6,840**

Source: Robert Lombardelli Partnership (quoted in Solid Wall Insulation Supply Chain Review, May 2009)

Not all of the above extra costs would be incurred on every project but they could range from £3-7k which means that for EWI the extras could make up 30-50% of the total installation cost.

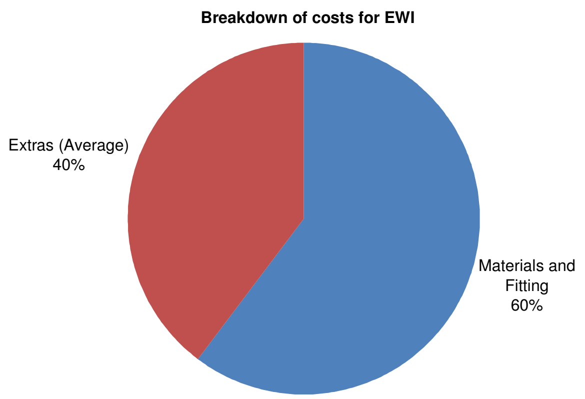


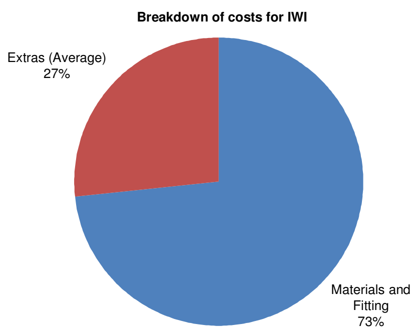
Table A4.2 Estimates of IWI costs in a 3 bed Semi (2009)

	Internal Wall Insulation in 3-bed Semi (80m^2)	Approx. cost
Materials and Fitting	- Plasterboard system: 12.5mm plasterboard tapered edges, fixed with screws to 38 x 100 softwood studs at 600 centres - 85mm Polyfoam Floorboard Standard Insulation between studs - Taped and finished flush, fill all joints with joint filler - Surface finished with one coat Drywall Top Coat	£3,870
	27mm liner board insulation to internal reveals	£820
	Galvanised metal: corner and edge beads to the system	£810
	Total for materials and fitting	**£5,500**
Extras	Remove skirtings and window boards and replace with new / wider ones to match existing	£1,100
	Removal of damp / mould areas	£250
	Take off and refix items, e.g. radiators, pipework, electric sockets & switches, electric wall lights, sundry other items	£250
	Remove air brick and refix new air brick flush with new finish	£75
	If bay window, form neat junction all round	£75
	Remove and refix metal gas pipework	£250
	Painting - 2 coats plus gloss finish of woodwork	£800
	Box in SVP with battens, insulation and plasterboard, in corner of room, full height	£200
	Total for extras if all required	**£3,000**

Source: Robert Lombardelli Partnership (quoted in Solid Wall Insulation Supply Chain Review, May 2009)

Again, not all of the above extra costs would be incurred on every project but they could range from £1-3k which means that for IWI the extras could make up 15-35% of the total installation cost.

In both cases therefore, but particularly with EWI, innovations in fixtures and fittings are not necessarily going to lead to significant cost reductions in overall installation costs because of the fixed extra costs.



Modelling of energy savings and payback times for SWI installations to 2022

The following assumptions were made:

- DECC Central scenario used;
- All SWI installations on Type 2 solid walled properties;
- Lifetime of SWI = 36 years;
- 15% learning rate occurs to 2020;
- In use factor of 33% and thermal comfort factor of 15%;
- Increasingly stringent U-value requirements of 0.3, 0.28 and 0.25 occur to 2022;
- Central gas prices (following DECC IAG Toolkit) are used – energy price savings calculated in year the first saving occurs. Simple payback calculated using installation costs divide by energy price;
- Calculation of savings shortfall (i.e. where energy savings are insufficient to meet the original SWI installation costs and hence could be made up for by grants or subsidy) – see minus figures in red at bottom of Table A4.4 - are based on weighted average of gas prices over a 36 year period, starting in 2013.

Table A4.3 Installation rates, costs, energy savings and annual fuel savings

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
U-value	0.3	0.3	0.3	0.28	0.28	0.28	0.25	0.25	0.25	0.25
All - No. installations	**45,000**	**80,000**	**105,000**	**105,000**	**105,000**	**100,000**	**90,000**	**100,000**	**100,000**	**125,000**
Detached	9,268	16,476	21,625	21,625	21,625	20,595	18,535	20,595	20,595	25,744
Semi	6,848	12,174	15,978	15,978	15,978	15,217	13,696	15,217	15,217	19,022
End terrace	5,019	8,922	11,711	11,711	11,711	11,153	10,038	11,153	11,153	13,941
Mid terrace	6,442	11,452	15,030	15,030	15,030	14,315	12,883	14,315	14,315	17,893
Flat	17,424	30,976	40,656	40,656	40,656	38,720	34,848	38,720	38,720	48,400
of which, Social Registered - No. installations										
Detached	43	76	100	100	100	96	86	96	96	119
Semi	836	1,486	1,950	1,950	1,950	1,857	1,671	1,857	1,857	2,321
End terrace	1,033	1,836	2,410	2,410	2,410	2,295	2,066	2,295	2,295	2,869
Mid terrace	1,136	2,020	2,651	2,651	2,651	2,524	2,272	2,524	2,524	3,155
Flat	7,864	13,980	18,349	18,349	18,349	17,475	15,728	17,475	17,475	21,844
of which Owner Occupied & Private - No. installations										
Detached	9,225	16,399	21,524	21,524	21,524	20,499	18,449	20,499	20,499	25,624
Semi	6,012	10,688	14,028	14,028	14,028	13,360	12,024	13,360	13,360	16,700
End terrace	3,986	7,086	9,301	9,301	9,301	8,858	7,972	8,858	8,858	11,072
Mid terrace	5,306	9,432	12,380	12,380	12,380	11,790	10,611	11,790	11,790	14,738
Flat	9,560	16,996	22,307	22,307	22,307	21,245	19,120	21,245	21,245	26,556
Total cost of SWI per house (£)										
Private										
Detached	12,781	12,568	12,149	11,542	10,772	9,874	8,887	7,850	6,803	5,783
Semi	9,012	8,862	8,567	8,138	7,596	6,963	6,267	5,535	4,797	4,078
End terrace	8,486	8,345	8,067	7,663	7,152	6,556	5,901	5,212	4,517	3,840
Mid terrace	7,322	7,200	6,960	6,612	6,171	5,657	5,091	4,497	3,898	3,313
Flat	5,953	5,854	5,659	5,376	5,018	4,600	4,140	3,657	3,169	2,694
Registered Social Landlord										
End terrace	5,940	5,841	5,647	5,364	5,007	4,589	4,131	3,649	3,162	2,688
Mid terrace	5,125	5,040	4,872	4,628	4,320	3,960	3,564	3,148	2,728	2,319
Flat	3,572	3,512	3,395	3,226	3,011	2,760	2,484	2,194	1,901	1,616
Total energy savings (MWh)										
Detached	79,411	141,175	185,292	185,292	185,292	176,469	158,822	176,469	176,469	220,586
Semi	34,199	60,798	79,797	79,797	79,797	75,997	68,397	75,997	75,997	94,997
End terrace	21,001	37,335	49,003	49,003	49,003	46,669	42,002	46,669	46,669	58,336
Mid terrace	24,988	44,424	58,306	58,306	58,306	55,529	49,976	55,529	55,529	69,412
Flat	50,612	89,977	118,094	118,094	118,094	112,471	101,224	112,471	112,471	140,588
Annual energy savings per house (MWh)										
Detached	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
Semi	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
End terrace	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
Mid terrace	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
Flat	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Annual fuel savings per house (£)										
Detached	229	247	251	251	237	220	220	221	221	222
Semi	134	144	146	146	138	128	128	129	129	129
End terrace	112	121	123	123	116	107	108	108	108	108
Mid terrace	104	112	114	114	107	100	100	100	100	100
Flat	78	84	85	85	80	75	75	75	75	75

Source: BRE & GHK (2012)

Table A4.4 Payback times for privately owned and Registered Social Landlord owned properties

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Simple Payback time (Years)										
Private										
Detached	56	51	48	46	45	45	40	36	31	26
Semi	67	61	59	56	55	54	49	43	37	32
End terrace	76	69	66	62	62	61	55	48	42	35
Mid terrace	71	64	61	58	58	57	51	45	39	33
Flat	77	70	67	63	62	62	55	49	42	36
Registered Social Landlord										
End terrace	26	24	23	21	21	21	19	17	14	12
Mid terrace	38	35	33	32	31	31	28	24	21	18
Flat	32	29	28	26	26	26	23	20	18	15
Savings shortfall per house (£)										
Private										
Detached	4,607	4,393	3,975	3,367	2,598	1,700	713	- 324	- 1,371	- 2,391
Semi	4,248	4,098	3,802	3,374	2,831	2,198	1,502	771	33	- 687
End terrace	4,494	4,353	4,075	3,671	3,160	2,564	1,909	1,220	525	- 152
Mid terrace	3,621	3,499	3,259	2,911	2,470	1,956	1,390	796	197	- 388
Flat	3,182	3,083	2,888	2,605	2,247	1,828	1,368	886	398	- 77
Private										
End terrace	1,948	1,849	1,655	1,372	1,015	597	139	- 343	- 830	- 1,304
Mid terrace	1,425	1,339	1,171	928	619	259	- 137	- 553	- 972	- 1,382
Flat	801	741	624	455	239	- 11	- 287	- 577	- 870	- 1,155

Notes: (2) Registered Social Landlord is a generic term for Local Authorities and Housing Associations; negative prices indicate savings gained during the lifetime of the SWI installation.

Source: BRE & GHK (2012)

Modelling of SWI from 2013 to 2050

The following assumptions have been used for the DECC Low, Central and High scenarios:

- All SWI installations carried out on Type 2 solid walled properties;
- Central non-traded carbon prices (following the DECC IAG Toolkit) are used;
- Central gas prices over the period (following the DECC IAG Toolkit) are used;
- A U-value requirement of 0.25 remains in place beyond 2019;
- The lifetime of SWI was assumed to be 36 years (as in the IA) – the impact of installations fitted in 2013 (and hence failing to provide savings after their 36th year) are assumed to be negligible.

Table A4.5 DECC Low Scenario – outputs from modelling of installations to 2050

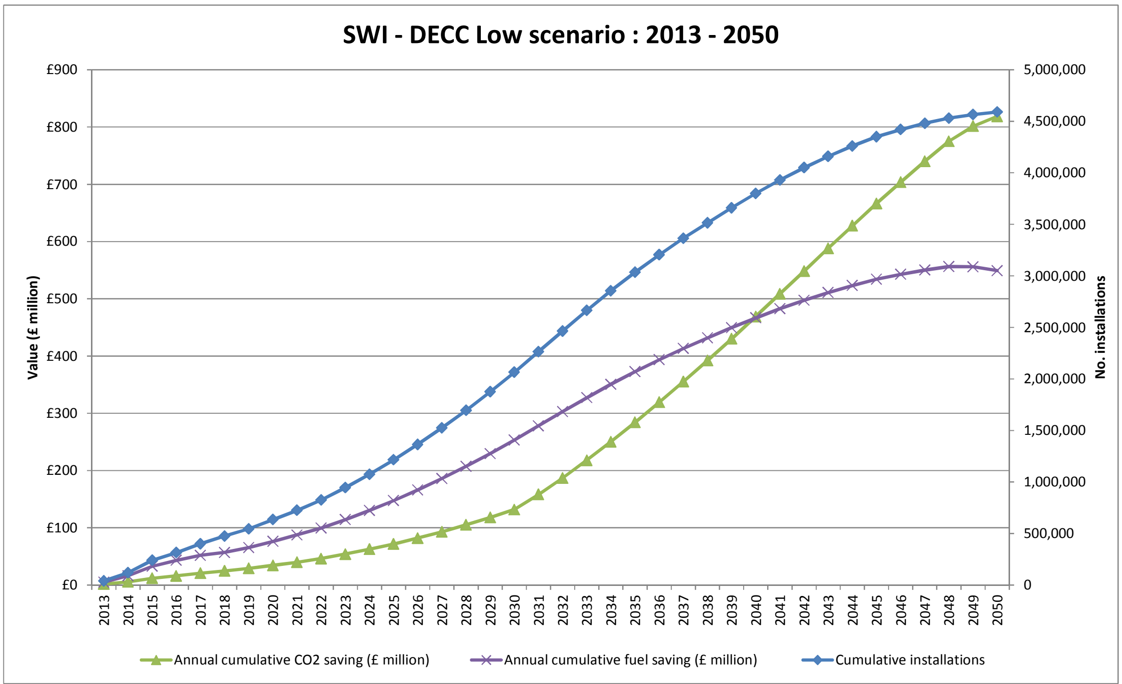


Table A4.6 DECC Central Scenario – outputs from modelling of installations to 2050

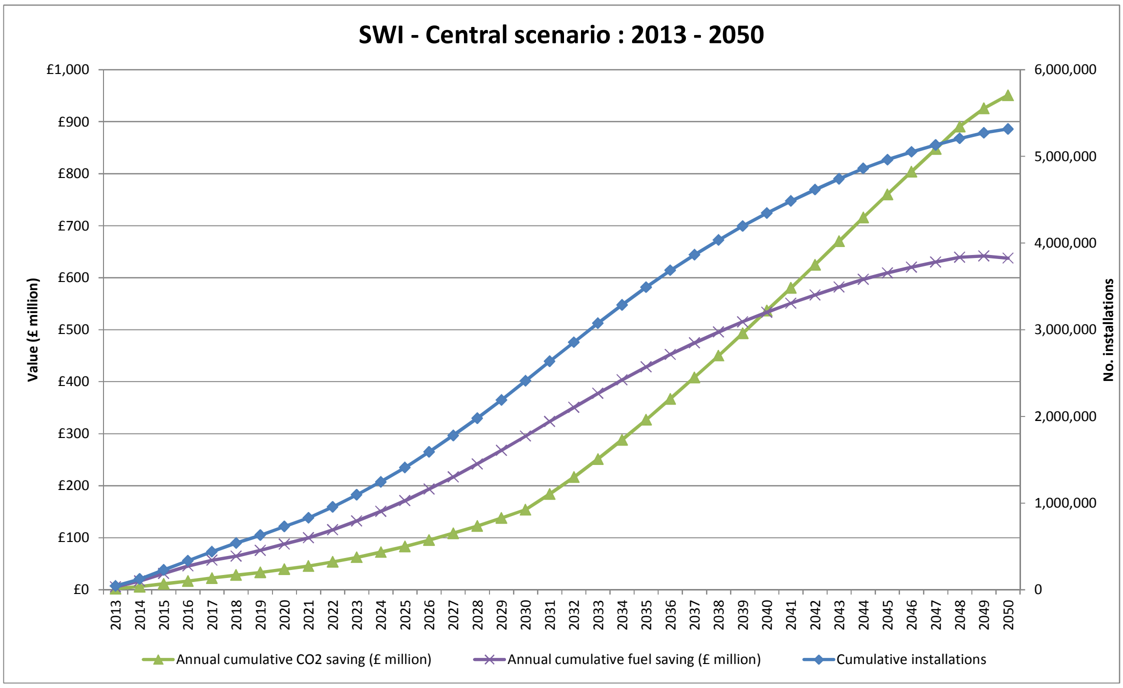
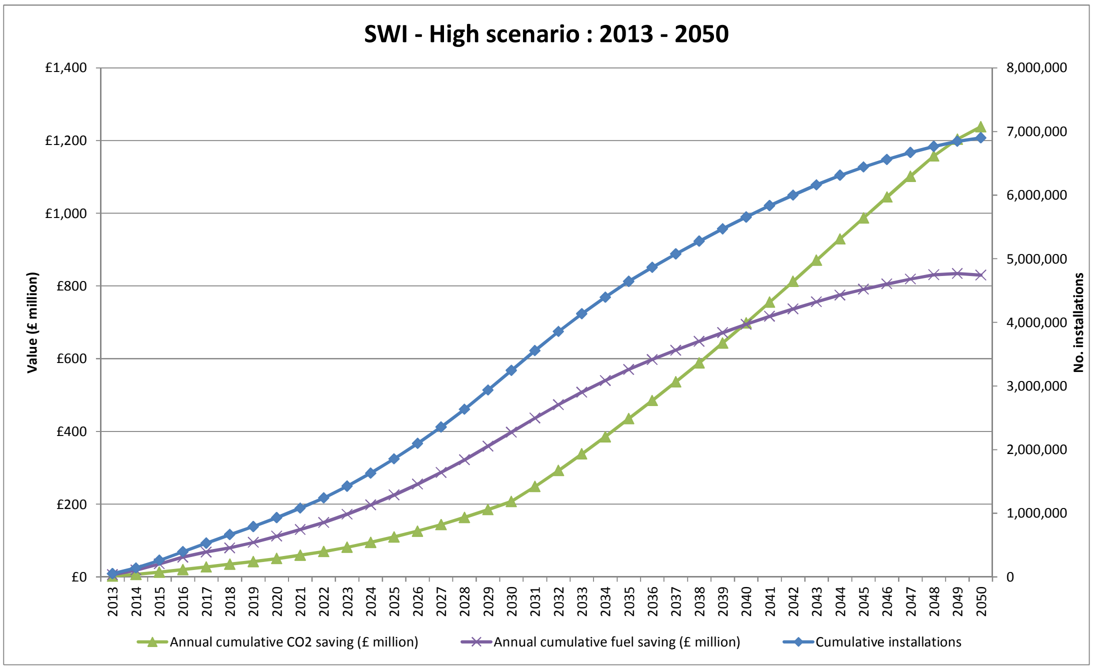


Table A4.7 DECC High Scenario – outputs from modelling of installations to 2050

This scenario assumes the entire potential UK stock of 6.9 million solid wall homes that could be fitted with SWI have it installed by 2050.



Annex 5 Study consultees

8 Insulation manufacturers

6 Solid wall insulation system suppliers

3 Solid wall insulation installers

Nottingham University

INCA

BRUMFA

TSB

ETI

EST