Enabling the integration of energy improvements into mainstream home repair, maintenance and improvement practice in the UK.

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Summary

One of the many complex challenges in tackling climate change is the pressing need to achieve a major reduction in carbon emissions from existing homes. In the UK, this is made even more difficult by the age and slow replacement of the housing stock, and the high proportion in private ownership. Making the necessary improvements will require significant investment and disruption.

The home repair, maintenance and improvement market is demand-led and thriving, and offers practical opportunities to include energy improvements. The first point of contact for homeowners looking to get such work done tends to be mainstream building tradespeople: they could be the frontline in communicating, selling and implementing energy improvements.

While work has been done to try to understand better the views and needs of the households and homeowners, a perspective that tends to be missing in policy debate is that of the building tradespeople themselves. Using a grounded theory approach, and qualitative research techniques, building tradespeople, trade associations, merchants and suppliers were interviewed in order to develop a better understanding of standard practice within the local supply chain in relation to home energy improvements. This provided a basis for seeking solutions to some of the barriers that were identified. A second phase of fieldwork focused on the key role of the general builder and the training and support required to deliver home energy improvements within mainstream home repair, maintenance and improvements.

Recognising this as a socio-technical issue, a theory was developed, grounded in the practical realities faced by building tradespeople, using a multi-level perspective to create a picture of current practice and recommendations for change.

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List of acronyms and abbreviations

AECB	Association for Environmentally Conscious Building
APEL	Approach to recognising Prior Experiential Learning
BPIE	Buildings Performance Institute Europe
BRP	Building Renovation Passport
BSI	British Standards Institute
CPD	Continuing Professional Development
CERT	Carbon Emissions Reduction Target
CESP	Community Energy Saving Programme
CORE	Centre for Refurbishment Excellence
ECO	Energy Company Obligation
EED	Energy Efficiency Directive
EERS	Energy efficiency retrofitting services (market)
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
EU	European Union
EWI	External wall insulation
FIT	Feed-In Tariff
FMB	Federation of Master Builders
HNC	Higher National Certificate
ICT	Information and communication technology
LED	Light emitting diode
MCS	Microgeneration Certification Scheme
NHER	National Home Energy Rating
NVQ	National Vocational Qualification
NZEB	Near Zero Energy Building (can also be used to mean ‘Net’ Zero Energy Buildings)
PAS	Publicly Available Specification
R&M	Repair and maintenance

RdSAP	Reduced data Standard Assessment Procedure
RIBA	Royal Institute of British Architects
RHI	Renewable Heat Incentive
RMI	Repair, maintenance and improvements
SAP	Standard Assessment Procedure
SME	Small or Medium Enterprise
SWI	Solid wall insulation
VAT	Value Added Tax
VET	Vocational Education and Training

1. Introduction and rationale for the research

1.1 The knowledge gap

There is a growing body of research on the issue of 'retrofit' of energy improvements, set against the context of the need for a step change in the energy efficiency of existing homes. However, this tends to focus on detailed technical issues around the buildings and the application of retrofit technologies (Sustainable Development Commission, 2006, Boardman et al., 2005, Jones et al., 2013); on the user, the household and how they choose to retrofit (Wilson et al., 2013, Pelenur and Cruickshank, 2012, Mallaband et al., 2012, Stiess and Dunkelberg, 2013); what retrofit measures are undertaken (Hamilton et al., 2014, Centre for Sustainable Energy et al., 2008), or on how occupants use their homes before and after retrofit (Raw and Varnham, 2010). At a policy level, the focus has been primarily on how to achieve scale through national or area based schemes (URBED, 2010, Dixon and Eames, 2013, Boardman et al., 2005, Boardman, 2007, Sustainable Development Commission, 2006, De Groote et al., 2016).

Relatively little appears to have been written about the role of those that actually carry out the installation work, or to to develop and evaluate the practical detail that they face in terms of barriers and solutions. It is particularly striking that the views of building trades micro-enterprises, in achieving low carbon retrofit are rarely heard within policy debates, in spite of the significance of the role that they could play in delivering home energy improvements. These micro-enterprises tend not to be members of trade organisations or specialised accreditation schemes beyond those specifically required for their trades, and are mainly active at a local level. As the first point of contact for many homeowners who want building work done, they have a great deal of potential to influence these customers, and a wealth of knowledge to bring to retrofit. They could be the frontline in communicating, selling and implementing energy improvements.

Building work on existing homes can be broadly described as 'repair, maintenance and improvement' (RMI). Given the relevance of the RMI market, as set out in this chapter, this research aimed to fill a gap in knowledge by focusing on the views and experience of micro-enterprise building trades engaged in this market, and those that they connect with in their everyday work. Starting from this viewpoint, a

picture is built from the ground up of how the industry could be enabled to deliver the home energy improvements indicated as necessary by national policy.

1.2 Purpose of the research

The aim of the research, as established at the outset, was to:

Investigate the barriers and potential solutions to enabling delivery of energy improvements within mainstream home repair, maintenance, and improvement (RMI) practice in the UK.

In order to achieve this aim, the following objectives were set:

1. To develop an understanding of the context for including energy improvements in RMI, through researching standard practice in the local supply chain from the perspective of key actors – in particular building tradespeople;
2. To establish and explore opportunities for, and barriers to, the inclusion of energy improvements within RMI;
3. To produce recommendations for change that would enable an increase in delivery of the (full range of) energy improvement measures by the building trades engaged in the RMI market;
4. To develop a theoretical framework for the research results and conclusions.

1.3 Background and rationale for the research

1.3.1 Why the energy performance of homes matters

Climate Change

Set against the context of international concern about the impacts of climate change (United Nations, 1992, United Nations, 1998), and engagement in global and EU policy debate and targets, the UK's 2008 Climate Change Act committed the nation to cutting its greenhouse gas emissions by at least 80% by 2050 and 34% by 2020, against 1990 levels (H M Government, 2008). The legislation allowed for subsequent changes to made to the target, and in 2019 it was increased to 100% by 2050, on the advice of the UK Committee of Climate Change (Committee on Climate Change, 2019) and in the light of indications that climate change is accelerating faster than had previously been anticipated (Intergovernmental Panel on Climate Change, 2018).

The 2014 Climate Change Committee report on progress towards those targets noted that an 8% reduction in carbon emissions from buildings had been achieved, but that progress was slowing as the policy framework was changed, and the traffic light assessment for key measures such as solid wall insulation and low carbon heat was red (Committee on Climate Change, 2014). Subsequent progress reports indicate a continuation of this policy gap, with buildings as one of the key areas where effective policy is lacking (Commitee on Climate Change, 2016, Committee on Climate Change, 2018, Committee on Climate Change, 2019).

Achieving the necessary carbon reductions is unlikely to be achievable by each sector making the same level of savings. Some sectors are less able to, or would be less cost effective in, reducing carbon emissions. For example, a total shift away from fossil-fuel internal combustion engines for land transport, or substituting aviation fuel, require larger shifts in technology and infrastructure than energy conservation measures and the implementation of existing commercial technologies in buildings. To compensate for this, the buildings sector has to do more, so that, in effect, all buildings need to be "zero carbon" by 2050 (Department of Energy and Climate Change, 2011a, Ekins et al., 2013).

With home energy use accounting for 30% of the UK's final energy consumption (Department for Business Energy and Industrial Strategy, 2019a), and 22% of greenhouse gas emissions (Statistical Release: National Statistics, 2019) , improving the energy performance of our homes is a core element of achieving carbon emission reduction targets. The UK has some of the oldest and most energy inefficient housing in Europe, with 15.67m (57%) of our 27.4m homes built before even a basic level of thermal insulation was introduced into Building Regulations in 1965, and only 3.68m (13%) built since 1991 (Department of Energy and Climate Change, 2013).

Although what "zero carbon" means is still the subject of some debate, the scale of the ambition to reduce carbon emissions from our homes is clear. Current assessment methodologies provide an indication of what this means in practice for forward plans: the Standard assessment Procedure (SAP) (Building Research Establishment, 2014) and Energy Performance Certificates (EPCs) (H M Government, 2012a). SAP is the methodology used by the UK Government to assess and compare the theoretical energy performance of dwellings. The higher the SAP, the more energy efficient the building. EPCs are a measure of the level of energy

efficiency of a home, with ratings from A to G, where A is the most and G the least energy efficient. The SAP and EPC ratings are theoretical, based on a limited range of measurements and information about the materials used in a building, and there can be a gap between the theoretical (modelled) and actual (measured) performance of a building – which is referred to as the 'performance gap'. This may, for example, be due to differences from the model in actual performance of materials, heating equipment or occupant behaviour (Sunnika-Blank and Galvin, 2012). While bearing in mind such limitations, SAP and EPC are nevertheless useful broad indicators of the energy efficiency of the housing stock. In order for the UK to be zero carbon by 2050, almost all homes will need to be at the top of the 'A' band, with a SAP of around 100 (Boardman, 2012). As an indication of the scale of the task ahead, 2017 estimates of the percentage of homes with an EPC rating of C or above are: 30% in England, 28% in Wales, 42% in Scotland and 49% in Northern Ireland (Welsh Government, 2019b).

The 2010 recast of the EU Energy Performance of Buildings Directive (European Union, 2010) required that by the end of 2020 all new buildings should be 'near zero energy buildings' (NZEBs). This is loosely defined as a building that has a very high energy performance, with the nearly zero or very low amount of energy required provided mainly by energy from renewable sources, including energy produced on-site or nearby. The UK had set its own target for all new homes to be NZEBs by 2016, and the UK national plan to increase the number of NZEBs says that "by 2050, emissions from heating and powering our buildings will be virtually zero" (H M Government, 2012b). In 2015, however, this interim target was dropped (H M Treasury, 2015) and at the time of writing had not been replaced by an alternative timetable.

Security of Supply

The UK has been a net importer of energy since 2004 (Department for Business Energy and Industrial Strategy, 2019b), with implications both for the economy and for security of supply. Without the effective application of energy saving policies, dependency on energy imports is projected to continue to rise (Department of Energy and Climate Change, 2015). A key feature of an energy efficient home is that it requires the purchase of less energy to provide what a household wants and needs in terms of thermal comfort and energy using equipment. The cumulative effect of reducing demand from homes helps improve security of supply, by reducing the

amount of supply required – hence improving the energy efficiency of existing homes is an important contribution to security of supply.

Fuel poverty

Closely linked to this is the issue of fuel poverty. A fuel poor household in the UK is typically described as one which cannot afford to keep adequately warm at reasonable cost (Department of Trade and Industry, 2001). It is not surprising that affordable warmth is seen as the major fuel poverty issue in this country, with space heating accounting for 62% of home energy use (Palmer and Cooper, 2013). A more broadly applicable definition, however, might refer to the affordability of all energy services, with fuel poverty (access to affordable energy services) differentiated from energy poverty (access to any basic energy services). The latter tends to refer to access to electricity and clean cooking facilities (Atanasiu et al., 2014a).

The 2012 Hills Review for DECC recommended the adoption of a new indicator (known as the 'Low Income High Costs' indicator) of the extent of fuel poverty, such that households would be considered fuel poor if:

- they have required fuel costs that are above the median level, and;
- were they to spend that amount they would be left with a residual income below the official poverty line.

This approach introduces a measure for the depth of fuel poverty, the 'fuel poverty gap', defined as the amount by which the assessed energy needs of fuel poor households exceeds the threshold for reasonable costs (Hills, 2012).

The impacts on vulnerable households cannot be ignored - the Children's Society report, 'The Debt Trap – Show some Warmth', analysed the 2012 England Housing Survey and found that almost one third of families in England were affected, including 3.8 million children (Williams et al., 2015). The Committee on Fuel Poverty (for England) estimated in 2018 that there were 2.55m fuel poor households in England alone, with an average fuel poverty gap of £326 per annum (Committee on Fuel Poverty, 2018).

An energy efficient home, and/or one fitted with effective on-site renewable energy 'micro-generation' (a term used for generation at very small scale, such as for a single home), requires the purchase of less energy to provide the energy services a household wants and/or needs. This offers the only route to ensuring the avoidance

of fuel poverty in the long term. While the reduced risk of fuel debt is a significant factor, it should be noted that for a lower income household, improvements in energy efficiency may mean that they can afford these services where before they could not, and the benefits may be at least partly in improved comfort, rather than energy savings. Another potential co-benefit is improved health, with a close correlation between fuel poverty and excess winter deaths, cardio-vascular disease, respiratory problems and mental health (Koh et al., 2012).

1.3.2 Why the focus needs to be on existing homes

The energy efficiency of new homes is controlled through the application of increasingly stringent Building Regulations, set nationally, but deployed through local authorities. What Building Regulations for new buildings can achieve is limited by the fact that we are replacing buildings very slowly, with less than 200,000 new homes built per annum for every one of the past 10 years (Ministry of Housing Communities and Local Government, 2019b). It has been estimated that over 75% of the buildings we will be living in, in 2050, have already been built (Sustainable Development Commission, 2006), highlighting the need to make significant improvements to the energy performance of existing buildings, and to accelerate the rate at which this is currently being achieved. Even homes that have been built in recent years will need further improvements to achieve 2050 climate targets: in 2013, new homes had an average SAP rating of 81, equivalent to the bottom of EPC band B (Energy Efficiency Deployment Office, 2015).

1.3.3 Why retrofit is a challenge

There is a direct link between improving the energy performance of buildings and reducing both carbon emissions and fuel poverty, whether this is through improved energy efficiency or the use of household-level renewable heat and power to displace the need to buy so much energy. The question is how to achieve it in practice.

Achieving the level of energy improvement needed

Both government programmes and commercial markets have tended, to date, to focus primarily on measures delivering the quickest financial returns, resulting in selective delivery of (mainly single) measures. The focus on cost benefit in energy efficiency led to significant and rapid uptake of measures such as cavity wall and loft insulation and replacement gas boilers, together with the distribution of low energy

light bulbs (referred to as “lamps” in the industry). A similar focus on simple payback on investment led to a huge expansion in the market for micro-generation, particularly photovoltaic panels, during the period in which a Feed-in-Tariff was provided (2010-19). The measures that offer the best short-term cost benefit tend to be those that involve the least time and labour, and are typically those that require little additional building work or ‘finishing’ – but this does not include some of the measures that have a major impact on energy efficiency, such as solid wall insulation, or high cost measures such as energy efficent window replacements (Maby, 2011).

To achieve the significant improvements needed in the existing housing stock will require a more comprehensive approach, which enables and incentivises the achievement of the full potential for carbon savings in existing homes (Rogers et al., 2015). Walls are typically the area of highest heat loss from the home, and there are around 7 million homes in the UK that cannot be ‘cavity-filled’ because they have solid walls (Department of Energy and Climate Change, 2014). Solid wall insulation is estimated as having been applied to only 10% of relevant homes in England (Ministry of Housing Communities and Local Government, 2019a), 18% in Scotland (Scottish Government, 2018) and 19% in Wales (Welsh Government, 2019b). The complex and inter-related set of measures required also includes other building elements such as floors, as well as better management of ventilation heat loss, low carbon heating and home generation technologies (Boardman et al., 2005).

The Stroud District Target 2050 project carried out energy surveys of 248 local homes, which indicated potential average energy and carbon emission savings of 57-58% if all the applicable measures were to be applied, including thermal insulation, heating improvements and microgeneration. This study highlighted the range of thermal elements to be treated in older homes, with different wall and floor construction details as well as various roof configurations without lofts (Maby, 2011). While treating the house as an integrated whole offers the best chance for the most effective technical solutions, in practice, the limitations of funds and the disruption of building work while living in the home at the same time, means that the majority of renovation happens on a room by room basis, over an extended period of time (Fawcett and Mayne, 2012). Similarly, renovating housing stock on an area basis offers potential economies of scale, but would be difficult to achieve practically where a large proportion is privately owned – unless these are in very poor condition (and hence requiring major works) and with significant subsidies offered. Homeowners

would need a reason to accept the costs and disruption involved in renovation, and to comply with an externally imposed timescale.

Home owners' decision to invest in making home energy improvements

Given the costs and disruption involved for home owners, and the need to access finance for refurbishment, this will not happen overnight. With around 63% of UK homes owner-occupied (Ministry of Housing Communities and Local Government, 2019a, Welsh Government, 2019a, Northern Ireland Department for Communities, 2019, Scottish Government, 2019), a major challenge is that of motivating home owners to invest in such improvements. The motivation of individual homeowners for getting works done on their homes does not necessarily fit in neatly with the aims of government policy to reduce carbon emissions. They are more likely to be concerned about repairs and maintenance, or improvements such as extending the living space. Another influence can be following fashion – for example in the upgrading of kitchens and bathrooms, both of which are key areas for making changes that will affect energy use in the home (Maller and Horne, 2011).

An important contribution to improving the energy performance of homes could come from ensuring the realisation in practice of 'trigger point' opportunities to incorporate energy improvements offered by such general home repairs, maintenance and improvements (the RMI market), which home owners need or want for reasons other than energy or carbon saving (Energy Saving Trust, 2011). A key point for intervention can be moving into a new home, as this is a time that many households carry out refurbishment, and the best way to realise that opportunity is through the contractors who come into a home to undertake those tasks (ibid).

Knowledge, skills, quality and risk

There is a further aspect to this challenge. If we are to avoid creating a new set of problems, we need to know how to integrate retrofit technologies effectively into existing buildings and building services, and to apply this knowledge consistently. With 5.71m homes built before 1918 (Palmer and Cooper, 2013), our homes contain a wealth of architectural detail, with regional and local variation in design and materials. To future-proof these homes, and make it possible to keep them warm and comfortable while reducing the demand for energy supply and associated carbon emissions, is not a simple matter of applying a few standard measures. Attention must be given to the details of older buildings such as sloping ceilings, dormers and

bays, and energy efficient replacements or secondary glazing solutions for a wide range of window types (Maby, 2011). This presents challenges in terms of retrofit, both to preserve historic and aesthetic character, and to avoid the introduction of new risks, for example in relation to damp, overheating and the lack of adequate and appropriate ventilation (Hansford, 2015, Bonfield, 2016, Building Research Establishment, 2017). To address these issues effectively requires knowledge, skills and care, in terms of design, installation and communications (between, trades, between design and installer, and between installers and users).

The 'Build Up skills roadmap' prepared by the construction industry's four sector skills councils, in order to ensure that the UK meets the EU's energy efficiency targets, estimated that more than 250,000 tradespeople would need additional training in order for the UK to have the capacity to retrofit its buildings (SummitSkills, 2013). The roadmap focusses mainly on the technical skills that different trades will need in order to be able to specify, install and maintain the full range of retrofit measures required, but acknowledges the need for other professional skills for success, such as customer communication, selling and developing a business in energy efficiency. Similarly, PAS2030, the technical standard setting out the skills required to improve energy efficiency, a standard which underpinned Green Deal delivery expectations (H M Government, 2016), mentions the need for customer care and quality assurance skills alongside technical competencies in a range of technologies (British Standards Institution, 2014). This is in the process of revision, together with the development of an additional PAS (2035) 'Retrofitting Dwellings for Improved Energy Efficiency: Specification and Guidance' at the time of writing this thesis.

For professionals and tradespeople, there are some specialised knowledge networks that provide opportunities to develop skills and knowledge, such as the Association for Environmentally Conscious Building[1] and the Green Building Council[2] for building performance, and the Retrofit Academy[3] for the Retrofit Coordinator training course.

[1] www.aecb.net

[2] www.ukgbc.org

[3] www.retrofitacademy.org

1.3.4 The RMI market and the role of building trades

Making energy improvements to homes represents what could be a very significant market for energy efficiency products and installations. The December 2013 update to the UK's Energy Efficiency Strategy indicated that in 2011/12 the UK's energy efficiency market accounted for around 136,000 jobs and sales of over £18 billion (Risholt and Berker, 2013). The domestic sector is only a part of this, and an even more significant market is that of general home repairs, maintenance and improvements (RMI). RMI in total, across all buildings and structures, was an area of economic activity valued at approximately £28 billion (Killip, 2012) in 2009 compared with energy efficiency spending, through the energy company obligation Carbon Emissions Reduction Target (CERT) scheme, of £800 million in the same year.

Narrowing this down to the subsector of privately owned housing, Office of National Statistics (ONS) data indicates the value of Repair and Maintenance (R&M) work in Great Britain to have been around £5.8bn per annum in 2019, noting that the additional element of 'improvement' is not included in the data (Office for National Statistics, 2020). It should also be noted that the data in this set is based only on firms which are registered as being above the VAT threshold and for paying tax and national insurance as employers, and as such will not include all of the work done by those who are self-employed. With more than 900,000 self employed people working in construction in 2018 (Office for National Statistics, 2019b), the total value of work done in domestic RMI may therefore be considerably higher.

The significance of very small enterprises in this industry is highlighted by data for 2019 showing that of the 325,736 construction firms in Great Britain, 265,254 (81%) had 3 or fewer employees. These firms together employed more than half a million people, representing 38% of the 1.36m people employed in construction in Great Britain (Office for National Statistics, 2019a). Considering the statistics for R&M output, 72% of this work (by value) was done by firms with less than 10 employees and 55% by firms with less than 5 employees (Office for National Statistics, 2020).

The RMI market in the private domestic sector, in which very small enterprises play a major role, appears to offer massive potential for the inclusion of energy improvements to homes. The homeowner's need or wish for such works provides a route to market, and the associated costs and disruption may become relatively marginal when combined with relevant works.

1.3.5 Summary of rationale for the research

The energy performance of homes is critical with regard to carbon emission reduction and tackling climate change, alleviating fuel poverty, and security of energy supply. The focus here is on existing homes because of the very slow replacement of the housing stock. The trigger point opportunities provided by the thriving, consumer-demand-led, market for repair, maintenance and home improvements offer a significant route to market. This market is dominated by very small building trades firms, whose perspective is rarely heard within the policy debate. This gap in knowledge is the focus for this research.

1.4 Structure of the thesis

The thesis starts with setting the context for the research, and establishing the gap in knowledge that it aims to address. The grounded theory based methodology (Glaser and Strauss, 1967, Bryman, 2008) employed is then explained, including the way in which the literature review has been treated, by integrating it into the thesis in five stages, reflecting the way in which it has been integrated into the research:

- at the initial stage in establishing the context and the knowledge gap;
- review of literature on research methodology, to develop the approach and methodology employed in this project;
- introducing further literature as additional data gathered during the research itself, in the discussion chapters after each of the two phases of fieldwork;
- in reviewing relevant approaches as part of the process for development of a new grounded theory.

Treating literature as data, and adding to it at several stages was considered to be particularly appropriate for the topic of this research, as it is topical, both in the UK and elsewhere, with a growing body of contemporary literature emerging.

Two phases of field work were carried out, each building on the learning from the previous phase of fieldwork and literature review, and the structure of the thesis reflects this chronological order of work, as shown in Table 1.

Table 1: Structure of the thesis

Chapter	Details
1	Introduction to the topic, with initial literature review, establishing the knowledge gap and research objectives
2	Research strategy and methodology, including review of literature relevant to research methodology
3	Research phase 1 - fieldwork: methodology
4	Research phase 2 - discussion of results of Phase 1 fieldwork together with a review of relevant literature
5	Research phase 3 – fieldwork: methodology
6	Research phase 4 - discussion of results of Phase 2 fieldwork together with a review of relevant literature
7	Developing the theory: summary of findings and development of a grounded theory
8	Conclusions, including recommendations for further research

1.5 Definitions

1.5.1 Retrofit and energy improvements

The term 'retrofit' is commonly used in policy and research on buildings' sustainability, but without a commonly accepted definition. A broad working definition provided by Eames et al in their work on the Retrofit 2050 project is *'the directed alteration of the fabric, form or systems which comprise the built environment in order to improve energy, water and waste efficiencies'* (Eames et al., 2013).

In the context of this study, the term 'energy improvements' is used to refer to a subset of retrofit: adding energy efficiency measures or renewable heat and power installations to an existing building, whether as a one-off measure, in combination with other works, or as part of a general refurbishment. The measures employed may in practice reduce the overall quantity of energy required by the household, or replace purchased energy by on-site renewable energy generation. Examples of technologies currently available for energy improvements are given in table 2.

Table 2: Examples of energy improvement technologies

Energy improvement	Example technologies
Energy efficiency through fabric changes	Cavity and solid wall insulation; loft, flat roof and sloping ceiling insulation; floor insulation; draught-proofing; energy efficient replacement doors and windows; replacement or secondary glazing.
Energy efficiency through appliances or installed systems	Energy efficient lighting; energy efficient boiler and room heater replacements; voltage optimisers.
Energy curtailment	Improved time, temperature and lighting controls; zoning of heating systems.
Micro-generation of low carbon energy (heat)	Heat pumps; solar thermal; biomass boilers and stoves.
Micro-generation of renewable energy (electricity)	Photovoltaics; wind; micro-hydro.

1.5.2 Installers and building tradespeople

In order to differentiate between the specialist and mainstream industry, the term 'installers' is used in this thesis to describe companies or sole traders who install specific energy efficiency or micro-generation technologies. For the general building trades engaged in repair, maintenance, renovation and improvement work, including both construction and building services, the term 'building tradespeople' is used.

1.5.3 Local supply chain

The term 'supply chain' may be used to mean different things. In this thesis, it has been used to mean broadly a system of organisations, people, activities, information, and resources involved in moving a product or service from supplier to customer. In this case the product or service is energy improvements to existing homes, and the 'local' supply chain is the system that acts (actually or potentially) at a local level to deliver or enable such improvements. Some national policies and programmes will also have a direct bearing on, and relevance to, this supply chain, and actors operating across the country (such as energy suppliers operating energy or carbon saving obligation programmes, or contractors operating on their behalf) are part of this system, as long as they deliver directly to homeowners. The working definition of supply chain used here does not include the tracing of products beyond suppliers and merchants through to manufacture and natural resources.

2. Research strategy and methodology

2.1 Research approach

The research strategy and methodology are set out below, together with the reasons that this approach was chosen and how it was applied in practice.

2.1.1 Grounded theory

The research approach adopted is that of 'grounded theory', which can be broadly defined as the discovery of theory from data – a departure from the traditional focus on verification of hypotheses (Glaser and Strauss, 1967). Grounded theory can be seen both as a philosophy and a process for research: the core philosophy is that the theory developed is grounded in the data – the core question to ask (and to keep returning to) is what is actually happening in the real world field of activity that you are researching (Charmaz, 2006, Bryant and Charmaz, 2007, Glaser and Strauss, 1967). As a process, there are several key elements, which work together to support the defining philosophy, to remain grounded in practice. Grounded theory is essentially pragmatic, placing great emphasis on the practical rather than the abstract, and the premise that the value of any theory can only be gauged by how well it addresses real practical needs and how well it works in practice (Denscombe, 2011).

Grounded theory has developed considerably since it was conceived by Glaser and Strauss in the 1960s, and it has been adopted and adapted by researchers, while maintaining a constant set of core ideas (Denscombe, 2011). The defining components of grounded theory practice as established by Glaser and Strauss are summarised by Kathy Charmaz (Charmaz, 2006), one of the researchers who subsequently took forward and developed the approach further, as:

- Simultaneous involvement in data collection and analysis
- Constructing analytic codes and categories from data, not from preconceived logically deduced hypotheses
- Using the constant comparative method, which involves making comparisons during each stage of the analysis
- Advancing theory development during each step of data collection and analysis

- Memo-writing to elaborate categories, specify their properties, define relationships between categories, and identify gaps
- Sampling aimed towards theory construction, not for population representativeness
- Conducting a literature review *after* developing an independent analysis

The grounded theory approach was chosen for this research project for several reasons:

a) The selected field of research had relatively little previous work to draw on, so the argument for basing the work on previous research was particularly weak.

b) The main purpose of the author in carrying out the research was to identify practical solutions that might be applied to improve or enhance the delivery of home energy improvements, rather than just to provide a commentary. This is more likely to be effective if developed in collaboration with relevant key actors within the industry, an approach enabled by using grounded theory methodology.

c) The author had identified (in the process of her professional career) that the views and perspective of key delivery agents (in particular the micro and SME building trades) was missing from the public debate and policy documents that existed on the general topic of home energy improvements. In order to engage such actors, and justify the use of their time, it would seem advantageous to seek an approach which offers the best chance of providing results that are real and accessible to research participants – and a grounded theory approach is specifically designed to do this. A powerful reason for the development of grounded theory was to avoid the pitfall that *'data collected according to a pre-planned routine are more likely to force the analysis into irrelevant directions'*(Glaser and Strauss, 1967).

d) The use of theoretical sampling, typical of the grounded theory approach, is particularly relevant to this industry sector in that it allows for the high level of diversity and change within the industry, and does not require early identification of a fixed sample as representative of the generality. It

also allows for a ‘snowball’ approach to generating further contacts and samples, appropriate to an industry where communications and networks appeared to be largely informal.

Level of theory

Grounded theory is a mid-range theory, in that it falls between the ‘minor working hypotheses’ of everyday life, and the ‘all-inclusive’ grand theories’(Glaser and Strauss, 1967). The term ‘theory’ is used in a variety of different ways, but a common meaning (as intended here) is as an ‘explanation of observed regularities’. Theories according to this definition are often called ‘theories of the middle-range’, as opposed to ‘grand theories’, which operate at a more abstract and general level (Bryman, 2008).

In this case the approach is substantive (developed for a substantive or empirical area of enquiry), as opposed to formal (conceptual, could be applied to many empirical areas). The focus is on the substantive topic of home energy improvements, and the aim is to develop mid-range theory for this substantive area. This does not preclude the use and testing of a range of other mid-range theories in the process - grounded theory is not exclusive.

2.1.2 Variations on the pure grounded theory approach

Literature review

An adaptation of the pure approach set out by Glaser and Strauss (Glaser and Strauss, 1967) was adopted, in relation to the literature review. Rather than no literature review at all, a literature review was carried out at several stages and integrated into each phase of the research.

This is reflected in the structure of the thesis in that relevant literature is referred to in several chapters, rather than separated out.

Firstly a review of literature was carried out in order to be fully aware of the context (socially and politically). The nature of the topic is such that there was relatively little academic study directly related to it, but a significant amount of (mainly fairly recent) grey literature. This approach is endorsed by Cynthia Bogard who viewed newspaper reports (etc) as *‘dominant and elite voices in the public conversation about a social problem’* (Charmaz 2006) – that help the researcher to consider the emergent context, texts that tell the story behind other texts. This was considered useful in

understanding the world in which research participants would be operating, and establishing credibility for the work.

Lempert (Bryant and Charmaz, 2007) also deviates from classic grounded theory for pragmatic reasons: *' in order to participate in the current theoretical conversation, I need to understand it. I must recognise that what may seem like a totally new idea to me – an innovative breakthrough in my research – may simply be a reflection of my ignorance of the present conversation. A literature review provides me with the current parameters of the conversation that I hope to enter – it does not however define my research.'*

A limited review of literature is integrated, therefore, into the introductory chapter to the thesis, in order to set the context for the research. This established the relevance of the research topic and the gap in knowledge that the research aims to address. It enabled the author to clarify the research aims and to develop the objectives.

Secondly, a literature review was carried out in relation to the research strategy and methodology to be used, in particular the use and application of grounded theory. This element is integrated into this methodology chapter.

Thirdly, literature reviewed in the context indicated above can also be seen as data rather than as a separate task, and is therefore ongoing throughout the research. This fits well with the application of the grounded theory method, which accepts a non-linear approach, with ongoing phases of analysis and data collection (Charmaz, 2006). Reference to literature informs, and is integrated into, the discussion of results following each of the two phases of fieldwork.

Fourthly, literature was reviewed as part of the final stage of work, the development of a grounded theory to meet the research objectives. In this case, the focus was upon relevant theoretical approaches that might be applied in this instance.

Neutrality of researcher

A second variation on the pure grounded theory approach as set out by Glaser and Strauss in 1967 is that the researcher in this present project was already engaged in and knowledgeable about the field of research, and as such unable to be without opinions at the outset. The linking in of action research principles to grounded theory is relevant in this context, as proposed by Bob Dick in the collection of work by

different researchers in the SAGE handbook of Grounded Theory (Bryant and Charmaz, 2007).

A cornerstone of action research is that knowledge is derived from practice and practice informed by knowledge, in an ongoing process, and action researchers tend to reject the notion of researcher neutrality, understanding that the most active action researcher is often one who has most at stake in resolving a problem (O'Brien, 1998).

This would also seem to fit in with the interpretivist approach to grounded theory taken by Charmaz (Charmaz, 2006), differing from Glaser and Strauss in stating that data and theory are not 'discovered' – we are part of the world we study and data we collect. This approach is relevant to this research in that the author was for many years a practitioner within the energy advice industry and chief executive of a sustainable energy charity, which actively seeks to promote energy improvements to homes and to overcome barriers to achieving national and international targets for sustainable energy.

2.2 Research plan and methodology

2.2.1 Initial research plan

In designing the research and methodology, application of the grounded theory approach required a simple initial research plan as follows (Charmaz, 2006):

a. Definition of the research problem and opening research question(s)

b. Sensitising concepts: these are initial ideas to pursue and sensitise you to ask particular kinds of questions about your topic

c. Guiding interests: these are areas beyond the research question that interest you (for example in the Charmaz study of people with chronic illness, she was interested in how people experienced time and how this was affected by illness) (Charmaz, 2006).

d. Disciplinary perspectives: applying the perspectives of the relevant knowledge discipline or field, from which the researcher is starting. In this case this was the experience that led the author to identify this topic as a research interest, namely that of providing energy advisory services to households, managing home energy retrofit programmes, and developing carbon emission reduction,

home energy conservation, and fuel poverty strategy and action plans at local and regional level.

Research problem

Against the background described in chapter 1, the research began with the the aim of investigating the barriers and potential solutions to enabling delivery of energy improvements within mainstream home repair, maintenance, and improvement (RMI) practice in the UK.

To support achievement of this aim, a key objective at the start of the research was to develop an understanding of standard practice within the local supply chain in relation to home energy improvements, through researching the views of key market actors from different standpoints, across a range of building trades, merchants and suppliers. Of particular interest was the role of general builders in delivering home energy improvements, as these tend to be the first point of contact for homeowners. In order to find ways to push the agenda forward, it was important to identify the views of these key market actors on what changes might enable an increase in the quantity (and quality) of application of the full range of energy improvement measures.

The research objectives were the basis for the opening research questions, below, which were in turn used as the basis for prompt questions in semi-structured interviews. The prompt questions used in the two phases of fieldwork are provided in Tables 4 and 8, within the relevant chapters (3 and 5) describing each phase.

Opening research questions

- What do key market actors within, and relevant to, the local supply chain, think about making energy improvements to homes, now and in future?
- What are the barriers to realising the opportunities for energy improvements in general RMI work?
- What solutions could overcome these barriers, and what enabling mechanisms could usefully be provided?

Sensitising concepts

- Consumer (home owner) demand for energy improvements and influences on their decisions;

- Building tradespeople knowledge, communication skills, motivations;
- Coherence of supply chain for the range of measures needed: products, installers, information;

Guiding interests

- Achieving environmental sustainability: in particular targets for carbon emissions;
- Future-proofing older homes – keeping the built heritage but making it liveable in for all income groups;
- Local jobs, resilience of local economy;
- Hearing the voice of the small building companies – not usually heard;
- Small business survival and viability.

Disciplinary perspectives

- Consumer advice on energy use and energy efficiency;
- Development of local and regional strategy and action plans for energy conservation, carbon reduction and alleviation of fuel poverty. .

This initial research plan was the starting point for the work, and not a fixed approach which dictates the end result to be achieved. In using the grounded theory approach, the aim is for the research to follow where the data leads it, if necessary discarding aspects of the initial plan if these no longer seem relevant. (Charmaz, 2006)

As such, the details of the research plan evolved as the research progressed. This is described, together with the final plan as it evolved in 2.2.7.

2.2.2 Gathering Data

In undertaking a grounded theory approach, data collection may be of multiple forms, and should start at the beginning of the research project and continue throughout the research. The point is to generate theories, not to test them, and so the preference is for the use of methods that produce qualitative data that are relatively unstructured, such as open-ended questions, field notes based on observations, official reports and company records (Denscombe, 2011).

As indicated in 2.1.2. (a) above, a literature review is treated as an additional source of data in the use of the grounded theory approach, in order to aid in the development of theory, rather than as the starting point for development of a research hypothesis.

A number of data sources were envisaged for this project at the outset, including (but not exclusively):

- interviews with key actors within the field, in particular building trade operatives, but also others within the supply chain such as building control officers, builders merchants, and trade associations;
- grey literature, representative of the public conversation on the issues in hand immediately before and during the course of the project;
- reports, interviews and other data emerging from practitioners working towards similar aims;
- data from stakeholder and industry events and discussions ongoing within professional networks;
- academic literature related to the topic, for example research around the potential for home improvements, and innovation within the construction and energy efficiency industry.

In keeping with the grounded theory approach, however, the data to be collected was not pre-defined at the outset, and the sources set out above were not intended to be exclusive, rather to lead to further sources of data, to be followed for their relevance to the research. Data collection ceases when data 'saturation' is considered to have been reached – and this is when new data sources appear not to be providing new evidence or insights (Denscombe, 2011). This approach can be multi-staged, and is set out in outline by Charmaz (Charmaz, 2006). Based on this approach, the research plan as it evolved during the course of the work is represented in Figure 2 at the end of this chapter.

Interviews

The main source of data for the research was that of semi-structured interviews. The approach is described in outline below, with a more detailed description of the process and the participants at the start of the relevant chapters describing each phase of the fieldwork.

Phase 1

A first set of interviews were carried out during 2014-15, aiming to reach a range of key actors as identified above, to draw out qualitative results around the initial research questions and to gauge the views and perspectives of these individuals on the issue of making energy improvements to homes. A series of prompt questions were used in a semi-structured format, and the interviews were recorded and transcribed in full. Transcribing interviews was time consuming but enabled the researcher to collect fuller data, and avoid the risk of subjectivity in note taking. It also helped the researcher, by playing back the conversation, to gauge the response to the order in which the prompt questions were raised, and the interest of the interviewee in the different questions. Almost all the interviews in this phase were carried out in person, and the recorder used was a small digital device, which the interviewees were made aware of, and did not appear to be unduly concerned by.

The interviewees were generally contacted by telephone or e-mail in the first instance, and so had some initial knowledge of the research, and on this basis had consented to the interview. On the occasion of the interview, the actual interview was preceded by informal chat and introductions, during which the purpose of the research and identity of the researcher was re-stated. An information sheet was provided to confirm what had been verbally explained, along with a consent form for the interviewee to sign to confirm their agreement to participate in the research. The latter included a commitment to preserve anonymity, and a request for permission to record the interview, a request which no one refused in practice. This approach was submitted to, and approved by, the Welsh School of Architecture's ethics committee.

Phase 2

Following analysis of Phase 1 interviews, a literature review was carried out, focussing on the key issues raised during the interviews. In Phase 2 of the research, the results of the literature review were integrated with a discussion of the fieldwork findings, and some of the threads emerging were selected to form the basis of a second phase of fieldwork – research Phase 3.

Phase 3

Further semi structured interviews were carried out with general builders, suppliers of energy efficiency products and professionals involved in construction training and qualifications. The approach used was similar to the first phase, except that the

majority of the interviews were carried out by telephone, to facilitate a wider geographical range of respondents. Respondents were mainly identified through recommendation by other research participants, or through the researcher's existing professional networks.

Stakeholder and industry events, and discussions within professional networks

A second source of data used was a range of stakeholder and industry events in the professional networks that the researcher was engaged in, through her experience in working for a sustainable energy charity. This was an important source of data to indicate the nature of the discussions occurring at national level around the topic of improving the energy performance of homes. The emphasis of this source of data tended to be on those with an established interest in the energy efficiency and renewable energy industry, and as such provided a useful potential comparator to the interviews with local tradespeople.

The topic was relatively high on the political agenda during the early part of the research period, during which the government's Green Deal programme was launched (Department of Energy and Climate Change, 2010), as well as the National Energy Efficiency Action (Department of Energy and Climate Change, 2014) and Near Zero Energy Buildings Plans (H M Government, 2012b). However, following the failure of the Green Deal scheme (Rosenow and Eyre, 2016), and the 2015-16 review of standards in the retrofit industry (known as the Bonfield Review (Bonfield, 2016)), attention to this issue appeared to dwindle and policy to stall, with the national political focus on Brexit negotiations and potential consequences.

The resulting data was collected in a variety of forms, according to the nature of the event or discussion, and options available, and included meeting notes provided by the organisers (where these have been made public), power point presentations, and in some cases a published report - for example of a working group.

Data from other relevant sources

A third source of data was from related projects in which the researcher was involved as part of her professional life, which was for a sustainable energy charity that (among other things) ran a programme of energy advice for home owners, and coordinated programmes of home energy improvements. The data available from these sources provided useful background and context, however, were not as

targeted as the interviews carried out above, which were designed specifically to address the opening research questions. The data used here was the published results:

- The Countdown to Low Carbon Homes action research project, which ran from 2012-14 (Charalambous et al., 2014, Maby et al., 2014);
- Target 2050 Homes (2001-12), a practical programme which provided case studies of potential for energy and carbon savings in a wide range of local homes in and around Gloucestershire (Maby, 2011).

2.2.3 Theoretical sampling

The grounded theory approach has at its core the use of theoretical sampling – a selection of comparison groups for discovering theory, based on the theoretical relevance for furthering the development of emerging categories for relevance, NOT for population representativeness. Proponents of grounded theory consider this to be preferable to a fixed pre-planned routine for data collection, which is more likely to force the analysis into irrelevant directions (Glaser and Strauss, 1967).

Theoretical sampling allows you to choose any groups that will help generate, to the furthest extent, as many properties of the categories as possible, and will help relate categories to each other, and their properties. There is no definite, permanent or pre-planned set of groups, non-comparability is not considered relevant, and the total sample is not known until the work is completed.(ibid)

This approach is particularly useful in working with a fast changing industry, where the sample participants may themselves experience significant changes during the course of the research (such as companies going out of business, growing or changing their range of services).

You have to start somewhere, and in practical terms, theoretical sampling really only kicks in once the research is underway. An element of pre-determination is inevitable in selecting an initial sample: ‘initial sampling in grounded theory is where you start, whereas theoretical sampling directs you where to go’ (Charmaz, 2006). The initial sample interviewed in the spring and summer of 2014 consisted of 2 builders, 1 electrician, 2 Building Control Officers, 1 Planning Officer, 1 trade association and 1 builder’s merchant [participants A01B, A02B, A03E, B02M, C01P, C03BC, C04BC, D01 – see Table 2 in 3.1 for explanation of participant categories and numbering codes].

2.2.4 Coding

As a method for qualitative social research, grounded theory relies heavily on successful coding of data. Charmaz recommends two phases of coding - initial and focussed (Charmaz, 2006). Initial coding consists of studying fragments of data for analytical import. Focussed coding involves selecting the most useful initial codes and testing them against more extensive data. Glaser recommends using gerunds for coding as it helps to detect processes and stick to the data.

Charmaz (Charmaz, 2006) helpfully provides a three step guide to initial coding:

Step 1: name individual words, lines or segments of data

Step 2: select the most significant and/or frequent initial codes

Step 3: use initial codes to sort, synthesise and organise large amounts of data

...and a 'code for coding', as follows:

- remain open
- stay close to the data
- keep your codes simple and precise
- construct short codes
- preserve actions
- compare data with data
- move quickly through the data

In this research project, the interviews were fully transcribed, and the transcriptions read to identify initial codes, and then re-read to assign data to the different codes. Not every word or line was labelled in practice, as the informal nature of the discussions led them away from the core focus of the research at times. Some of the initial codes were later discarded as less relevant, while others were consolidated into key categories of relevance to the research.

2.2.5 Memo writing

A key technique used in grounded theory research is memo-writing. Memos form an intermediate step between data collection and writing a research paper – in that they offer a format for capturing small pockets of analysis, comparisons and connections that the researcher makes along the way (Charmaz, 2006). The approach favoured is for memos to be spontaneous and multiple. A simple format and register allows ideas and insights to be captured and chronologically collected for future analysis – enabling the researcher to trace the development of ideas.

This technique is particularly useful in researching a topic which is 'hot' in terms of developments within policy and the industry, and subject to debate. It offers a system for capturing ideas as they arise, and from a variety of sources, rather than purely at analysis stage, which provides a dynamic aspect to the research even at an early stage. In regard to the chosen research topic, the 'retrofit challenge' was quite high on the political agenda in the early stages of the research, within the context of security of energy supply, climate change mitigation targets, energy pricing and fuel poverty, as indicated by the 2010-15 government's emphasis on the 'Green Deal' as a flagship project.

2.2.6 Analysis and theory development

Data comparisons may be of both similar and dissimilar events, generally starting with the former. In relation to the research topic, the potential for data comparisons are both on an abstract and a very practical level. Examples of comparisons of similar practical events are the building of extensions or loft conversions, or the installation of new kitchens or bathrooms, by the same or a different builder, whether sustainable energy improvements were included - and why or why not?

As qualitative data sets, as envisaged for this research, tend to become large and complex, the application of Computer Assisted Qualitative Data Analysis Software (CAQDAS) was investigated. While a range of programmes are available, offering different benefits, the choice of NVivo was based on it being an industry standard and the potential to introduce a variety of data sets. The use of this software was in part to provide a single and efficient system for managing a variety of types of data, in this case interviews transcripts, field notes, memos and rough notes, as well as published research. A key feature of using this software in this research is to 'code and retrieve', in that the researcher can code the text on the computer and then retrieve

all the pieces of text to which that code was attached, across all the transcripts and field notes, so reducing the manual tasks necessary.

In deciding to use CAQDAS, the researcher was conscious of risks associated with this, such as the temptation to quantify findings, and the potential loss of the narrative quality and flow of interview transcripts and events, as well as the decontextualizing of data due to extracting it from its context to place it in a grouping of related fragments On the other hand, an awareness of frequency of codes and how these are grouped may enhance transparency, and hence allow a more explicit validity and reliability of the findings (Bryman, 2008).

To some extent the use of CAQDAS may be said to increase rigour in the analysis process , in that it facilitates a comprehensive scan of coded data in response to a query, and to ensure that the user is working methodically (Killip et al., 2013). It does not however eliminate human error or limitations as regards coding effectively in the first place. As with all tools, it must be used intelligently and with an awareness of the limitations.

On balance it was decided that the use of NVivo was advantageous, while bearing in mind the potential risks. In practice the researcher found it a useful tool for efficient storage, recording and coding of raw data in the form of interview transcripts, but reverted to the more familiar use of paper-based mapping exercises to group categories and concepts in the later stages of analysis.

The final stage of analysis involved the development of a new theory, grounded in the data and the field of research. This is described in detail in Chapter 7.

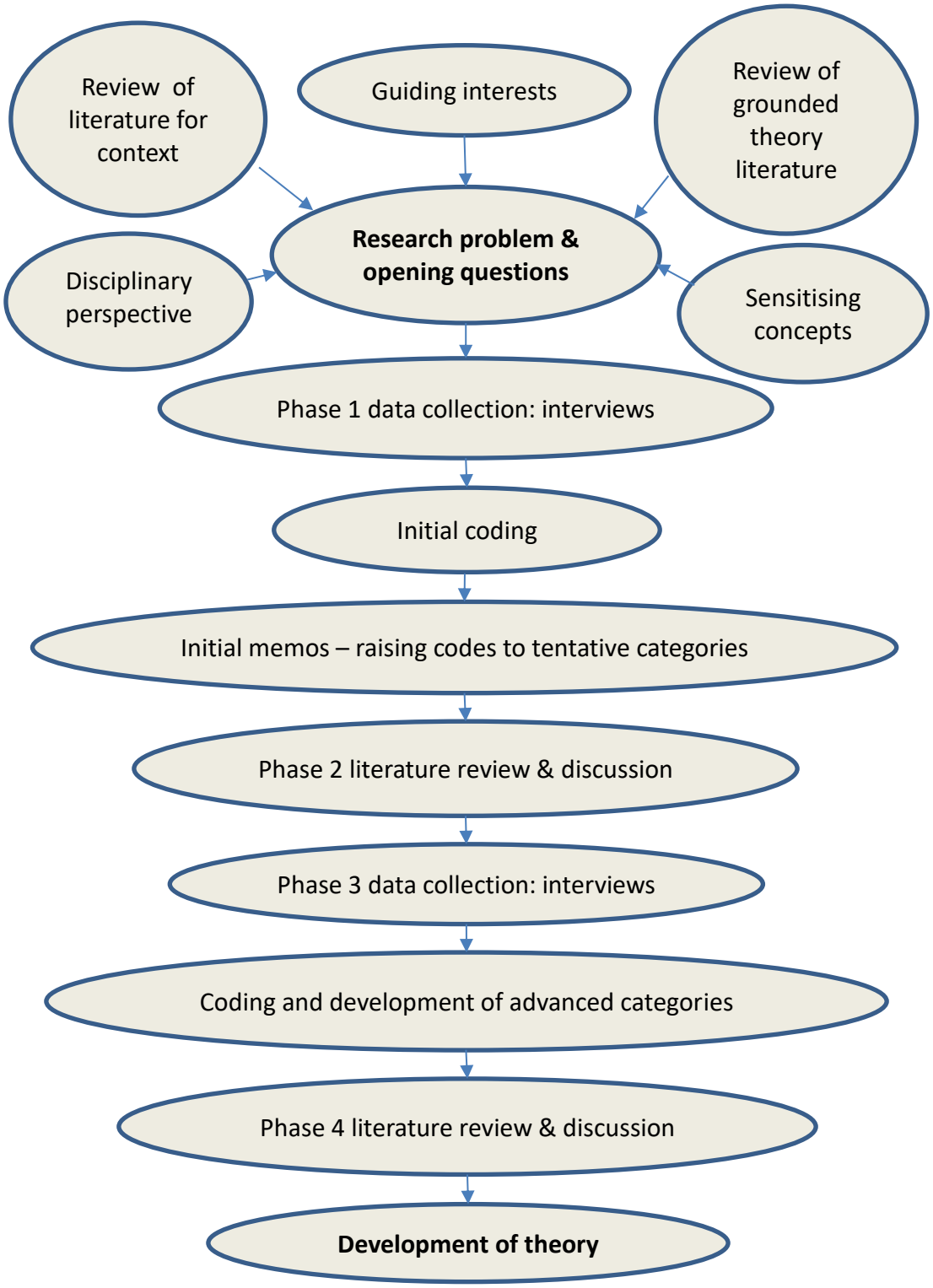
2.2.7 Final research plan

As described in 2.2.1, the grounded theory approach allows the research plan to develop as the data brings new knowledge to bear. The final research plan involved two phases of fieldwork, with analysis and literature review after each phase. Each phase informed and directed the focus for the next. The final stage of the work was to develop a new grounded theory based on what had been discovered.

The guiding interests and sensitising concepts identified at the outset remained relevant as the research progressed. The first phase of fieldwork provided a picture of how RMI building trades in the UK work in practice (Objective 1), in particular the informal local networks whithin which they operate - and identified the role of the

general builder as being of particular significance to the research. This shaped the second phase of fieldwork, and the subsequent literature review.

Figure 1: The research plan as it evolved in practice



3 Research Phase 1: fieldwork March 2014 – June 2015

3.1 Phase 1 data collection - interviews

Phase 1 of the research consisted of fieldwork, carried out between March 2014 and June 2015, to collect in-depth qualitative data from people working within the home repair, maintenance and improvement (RMI) market, in order to gain an insight into their perspective (gained from direct experience) on the issues involved in making energy improvements to existing homes. The target group was focussed on building tradespeople and 'retrofit installers', with a small sample of other 'key actors' such as builder's merchants, planning and building control personnel, and the most relevant trade associations.

Sampling

Following the theoretical sampling approach described in Chapter 2, the initial sample was guided by the aim of getting the views of a range of building trades engaged in RMI work on existing homes, but with an emphasis on those who did general building work and who may therefore be engaged in a wider range and scale of work. The sample was then extended to try and cover each of the main building trades (carpenter/joiners, plumbers/heating engineers, electricians, bricklayers, roofers), to gain a wider perspective.

The range also included a sample of other 'key actors' within the actual and potential home energy improvement industry, in order to gain a broad perspective on the issues, such as builder's merchants, planning and building control personnel, and the most relevant trade associations.

The full range of interviewees covered can be grouped into the following categories:

a) Small and micro building trades companies
b) Suppliers of home energy improvement retrofit products and materials
c) Planning and building control personnel
d) Relevant trade associations

No fixed number of participants was envisaged, rather the interviews continued until both a good range of trades had been covered, and the data had started to become repetitive. This is the 'theoretical saturation' point in the grounded theory approach (Denscombe, 2011), (Glaser and Strauss, 1967), as described in 2.2.2. above.

The research participants were identified and contacted through a variety of routes. The professional networks in which the researcher was engaged enabled contact with some trade associations and suppliers, and these contacts were generally interested and amenable to being interviewed.

Gaining access to trades people was more difficult. They tended to work within very small companies, to be out on site a great deal and to work to very variable schedules, so that making contact and scheduling appointments was not straightforward. It was necessary to establish some initial trust and interest in the work to encourage participation, as well as to be easily accessible as a researcher at a time and place that suited them.

This category of the sample was initially drawn, therefore, from neighbourhood and social contacts, and then by asking these to suggest others to interview. The use of social and neighbourhood contacts from which to draw the sample had an important advantage for the research in that it ensured that the sample was mainly relatively mainstream and without a specialist bias towards energy or 'green' technologies. This was complemented by a smaller sample from professional networks known to the researcher, and more likely to have a particular interest in energy efficiency, including the Association for Environmentally Conscious Building, the Centre for Refurbishment Excellence, and the Severn Wye Energy Agency 'Link to Energy' network of local installers. An attempt was made to reach a much wider audience by inviting Federation of Master Builders (FMB) members to participate, via the FMB mailing, but this did not elicit any responses. The lack of response confirmed that these busy small businesses were unlikely to respond without a personal introduction.

This approach had the advantage of providing a picture of views and networking within a specific geographical area (rural and small town), but the disadvantage of a lack of comparison with a different kind of area (such as urban). The addition of a scattering of 10 interviews from other areas did, however, provide a wider perspective against which the findings of the local research could be assessed. The rural slant to the sample was due to the location of the researcher (Monmouthshire). A collaboration with Leeds University (described below) provided the additional perspective of 5 interviews from West Yorkshire.

Almost all interviews were carried out in person (with only a handful by telephone or skype), and in the case of the building tradespeople this was typically in an informal

setting, such as at a kitchen table in the home of the interviewee or the researcher. This informality was helpful, in that it allowed the conversation to flow naturally, often with family or other household members coming in and out. In a few cases, the researcher was accompanied by her husband who is a general builder, and helped to make contacts and set up some interviews.

From the initial contacts with tradespeople it became evident that it would be difficult to set up appointments for interviews during the working week, rather it was necessary to be flexible and to fit in with the availability of the interviewee, which could change at short notice. The researcher started by contacting tradespeople living and working in the neighbourhood of her home, enabling her to be available at their convenience - they could drop in, or she could visit them on site or at their home at short notice. An alternative that worked well was to conduct the interview over a cup of tea in the evening or at the weekend, either at the home of the interviewee or the researcher.

In the case of Planning and Building Control personnel, Trade Associations and suppliers, interviews were carried out in a variety of settings, in their offices or at a convenient meeting place. One interview was carried out by telephone. While these interviews were potentially more formal in that the interviewees were professionals, conscious of their position in representing their organisations, the contacts had been made either through the researcher's professional networks or via other interviewees, and so were effectively 'warmed up' and interested in the topic. In these cases too it was found that the relatively informal approach using mainly open-ended prompt questions generated a useful flow of conversation and data.

There were 47 research participants in total in Phase 1. Of these 39 were interviewed individually, one pair were interviewed together (A23BR and A24R), and 6 participated in a recorded discussion at a conference. A list of participants is provided in Table 4.

During this phase of the research, an opportunity arose to collaborate with a researcher at Leeds University on a funded project of common interest (Installer Power), and the interview data is included here as part of Phase 1. The majority of the fieldwork was carried out by the author of this PhD thesis (listed as CM in the table below), with data from just 5 of the 47 research participants collected by Leeds University (listed as LU below). The collaboration brought the benefit of the

perspective of a researcher who had recently completed a PhD on a related topic (Owen, 2013), as well as the opportunity to publish a report which was disseminated within the energy efficiency industry and presented and discussed at several events at different locations in the UK during 2015-16 (Maby and Owen, 2015). The latter helped to validate the research conclusions at that stage beyond the geographical limitations of the interviews.

The 3 trade associations and one of the merchants/suppliers were national organisations. The other two merchants were in Gloucestershire and Monmouthshire. Of the remaining research participants, the majority (26) were drawn from the rural and market towns in the Welsh/English border areas of Gloucestershire, Herefordshire, and Monmouthshire. Of the remaining 15, 5 were based in towns in West Yorkshire, 3 in London, 1 in Surrey, 1 in Hertfordshire, 3 in Lancashire, 1 in Birmingham and 1 in Cornwall.

Of the building trades and installers, the majority (23) of the participants were either self-employed sole traders or had formed a company without any, or no other direct employees. 10 were in companies with more than one but less than 5 employees, and only 1 (a heating company) was in a bigger company of 16.

Figure 2: Number of personnel in participant building companies

In order to preserve anonymity in the analysis and discussion, participants were each allocated a unique reference number, with explanatory codes, provided in Table 3.

Table 3: Research participant categories and reference codes

Code	Category	Sub code	Category
A	Building trades companies and sole traders	B	General builder
		CJ	Carpenter/joiner
		P	Plumber
		H	Heating engineer
		E	Electrician
		PD	Painter decorator
		R	Roofer
		SWI	Solid wall insulation installer
B	Suppliers of building products and materials	M	General builders merchants
C	Planning and building control personnel	P	Planning
		BC	Building Control
D	Trade associations		
E	Architects		
F	Homeowner		
G	Other related services		

A full list of participants in Phase 1 is provided in Table 4. The 47 participants consisted of 19 general builders, 6 plumbers/heating engineers, 2 electricians, 3 carpenter/joiners, 1 roofer, 1 bricklayer, 1 painter/decorator,1 solid wall insulation installer,1 air-tightness specialist, 2 architects, 3 builder's merchants,3 trade associations, 2 building control personnel,1 planning officer and 1 self-build homeowner.

Table 4: Research participants, Phase 1 fieldwork

Participant reference	Participant base location	Number of personnel	Interview date	Interview location	Research interviewer
A01B	Monmouthshire	1	22.3.14	Participant's home	CM
A02B	Monmouthshire	4	29.6.14	Participant's home	CM
A03E	Monmouthshire	1	10.8.14	Researcher's home	CM
A04B	Gloucestershire	1	20.10.14	Researcher's home	CM
A05B	Herefordshire	1	23.10.14	Researcher's home	CM
A06B	Gloucestershire	1	23.10.14	Participant's home	CM
A07CJ	Herefordshire	2	30.11.14	Participant's home	CM
A08B	Herefordshire	3	16.12.14	Participant's home	CM
A09CJ	Herefordshire	3	11.1.15	Participant's home	CM
A10C	London	1	3.2.15	Home of third party	CM
A11B	Hertfordshire	4	10.2.15	Federation of Master Builders	CM
A12B	Monmouthshire	3	16.2.15	On site	CM
A13E	Herefordshire	1	22.2.15	Researcher's home	CM
A14H	Herefordshire	1	1.3.15	Participant's home	CM
A15B	London	1	18.3.15	Federation of Master Builders	CM

Participant reference	Participant base location	Number of personnel	Interview date	Interview location	Research interviewer
A16B	Monmouthshire	1	20.3.15	Participant's home	CM
A17B	Surrey	1	31.3.15	By telephone	CM
A18P	Monmouthshire	1	29.3.15	Participant's home	CM
A19H	Herefordshire	16	31.3.15	Participant's offices	CM
A20SWI	Herefordshire	4	31.3.15	Researcher's home	CM
A21H	Cambridgeshire/ Birmingham	4	1.4.15	By telephone	CM
A22B	Monmouthshire	1	2.4.15	Participant's home	CM
A23BR	Gloucestershire	1	7.4.15	Pub garden	CM
A24R	Gloucestershire	1	7.4.15	Pub garden	CM
A25B	Gloucestershire	1	12.4.15	Researcher's home	CM
A26H	Monmouthshire	1	21.4.15	Participant's home	CM
A27B	Gloucestershire	1	9.5.15	By skype	CM
A28B	Cheshire	3	19.6.15	AECB conference	CM
A29B	Cheshire	3	19.6.15	AECB conference	CM
A30B	Cornwall	1	19.6.15	AECB conference	CM
A31B	West Yorkshire	1	24.1.15	Coffee shop	LU
A32H	West Yorkshire	1	11.12.14	Not recorded	LU
A33PD	West Yorkshire	1	27.3.15	Not recorded	LU
A34B	West Yorkshire	1	5.11.14	Not recorded	LU
B01M	Monmouthshire	N/A	17.10.14	Participant's offices	CM
B02M	London	N/A	23.5.14	Participant's offices	CM
B03M	Gloucestershire	N/A	2.4.15	Sports club café	CM
C01P	Herefordshire	N/A	13.4.14	Researcher's home	CM
C03BC	Herefordshire	N/A	7.5.14	Participant's offices	CM
C04BC	Herefordshire	N/A	7.5.14	Participant's offices	CM
D01	London	N/A	23.5.14	Participant's offices	CM
D02	London	N/A	18.11.14	By telephone	CM
D03	London	N/A	12.11.14	Private club	CM
E01	West Yorkshire	1	19.6.15	AECB conference	CM
E02	West Yorkshire	1	6.5.15	Researcher's home	LU
F01	Manchester	N/A	19.6.15	AECB conference	CM
G01	Gloucestershire	3	19.6.15	AECB conference	CM

Interview approach

The method used was that of semi-structured interviews, as described in sections 2.2.1 and 2.2.3. A series of prompt questions were developed to gain knowledge to help to address the opening research questions, as set out in Table 5. These were used as a starting point, but the conversations were allowed to develop freely.

Table 5: Semi-structured interview prompt questions, Phase 1 fieldwork

Research question	A: trades	B: suppliers	C: building control /planning	D: trade associations
Information about participant	Type of company Position in company Number employees	Type of company Position in company Nature of client base	Organisation Role	Position in association Number and type of members
What do key market actors think about making home energy improvements, now and future perspectives?	What energy improvements does your company offer?	What energy improvements does your company offer?	Do home energy improvements feature in your work?	What energy improvements do/could your members offer?
	Do you proactively market these?	Do you proactively market these?	What is your role regarding energy improvements?	Is this typically as one-off measures or part of other work?
	Is it an important part of what you do, or peripheral?	Is it an important part of what you do, or peripheral?	Is it an important part of what you do, or peripheral?	Is it an important part of what they do, or peripheral?
	Do you think it could be more important in future?	Do you think it could be more important in future?	Do you think it could be more important in future?	Do you think it could be more important in future?
	Do clients typically ask for or about energy improvements?	Do clients typically ask for or about energy improvements?	Do clients typically ask for or about energy improvements?	
	Are there opportunities to include them in other work you do?	Are you aware of opportunities to include them in other RMI work?	Are you aware of opportunities to include them in other RMI work?	
What are the barriers to realising the opportunities for energy improvements in general RMI work?	In doing energy improvements, are there any particular problems you have faced?	Have you encountered any particular problems In providing supplies for energy improvements?	Are you aware of any particular problems that clients have encountered in doing energy improvements?	What are the particular barriers or problems members face in making energy improvements, especially as part of other work?
	Can you give me an example of this in practice?		Can you give me an example of this in practice?	Can you give me an example of this in practice?
	Conversely, can you give examples of when this kind of work has gone well?		Conversely, can you give me an example of when this kind of work has gone well?	Conversely, can you give me an example of when this kind of work has gone well?
	Are you aware of problems that other building tradespeople have had?			

Research question	A: trades	B: suppliers	C: building control /planning	D: trade associations
What solutions could overcome these barriers?	What would avoid such problems in future?	What would avoid such problems in future?	What would avoid such problems in future?	What would avoid such problems in future?
	What would you like to happen to change/improve things?	What would you like to happen to change/improve things?	What would you like to happen to change/improve things?	What would you like to happen to change/improve things?
What enabling mechanisms are needed?	If you could imagine the perfect set-up to make it easy to include energy improvements to homes at every opportunity, what would this involve?	If you could imagine the perfect set-up to make it easy to include energy improvements to homes at every opportunity, what would this involve?	If you could imagine the perfect set-up to make it easy to include energy improvements to homes at every opportunity, what would this involve?	If you could imagine the perfect set-up to make it easy to include energy improvements to homes at every opportunity, what would this involve?
snowball	Can you recommend others to speak to?	Can you recommend others to speak to?	Can you recommend others to speak to?	Can you recommend others to speak to?

In practice these questions tended to prompt fairly wide-ranging discussions. It was also found that some sub-questions were helpful to develop a deeper understanding of working practices, for example:

- Responses from building tradespeople interviewed to the question about employee numbers drew out the point that they tended to collaborate informally with others, rather than directly employing them, so a further sub-question was introduced:
    - Are there other people or specific trades that you often work with?
- It was found that the question about marketing energy improvements and the client's response to the offer of energy improvements needed to be set in the context of marketing practice and clientele more generally, in order for this to make sense to the research participants, so further sub-questions were introduced:
    - How do you mostly find your customers?
    - How far do you travel for work?
- Similarly, the question about including energy improvements in other work, and the client's response to this suggestion was found to be too narrow, and a wider question evolved to bring out this point:

- What is the next step after you receive an enquiry, how do you go about planning the job?

While there was not a distinct pilot phase to the fieldwork, these additional prompts were noted after the first few interviews, and introduced as required. Allowing the approach to evolve in the light of responses is in keeping with the Grounded Theory approach, in which it is important to remain open to the data and to be guided by what it is telling you, rather than to apply a rigid structure from the outset (Charmaz, 2006).

3.2 Phase 1 - Results and next steps

This section sets out the main issues raised and opinions voiced by the research participants in the Phase 1 interviews. In line with the proposed methodology as described in Chapter 2, the interviews were all recorded, with the exception of one (A34B) which was a brief field-note. The transcriptions were studied, and some key themes identified. These themes were raised as initial codes, and the transcripts were then analysed against these codes, with comments relevant to each theme grouped, in order to draw out common views and variations in opinion on these different issues. Whilst contrary views and contradictions were noted, there was no attempt to achieve a quantitative indication of the predominance of specific views, as the material was of a qualitative nature and the questions designed to develop qualitative data.

Given the qualitative approach, and the nature and size of the sample, it was not anticipated that the results of Phase 1 would be conclusive, rather that they would provide: a picture of how the RMI market works at a local level; a general idea of the perspective of the building tradespeople on energy improvements; and some indicators for threads to follow to develop policy recommendations, or for further investigation. As the detail emerged, the themes were consolidated into broader categories, and memos used to capture some of the emerging ideas. These categories were then used as the basis for a review of literature, which forms Phase 2 of this research project, and is integrated into a discussion of the results of this phase of fieldwork in Chapter 4. The initial codes that were used, the categories into which they were grouped, and the relevance to the research objectives are set out in Table 6.

Table 6: Codes and categories: Phases 1 and 2

Initial codes	Categories	Research objective
Business shaping: • costing work • geographical range • getting work • links with other businesses/trades • business size and scope	How the UK RMI industry works in practice • Who they work with and how: working through informal local networks • Who does what: different roles in an RMI project	*1: Develop an understanding of the context for including energy improvements in RMI, through researching standard practice in the local supply chain from the perspective of key actors.*
Influencing customers to include energy improvements: • builder status with customer • customer preference and attitude • advice for homeowners	Driving inclusion of energy improvements in RMI	*2: Establish and explore opportunities for, and barriers to, the inclusion of energy improvements within RMI*
Regulations and incentives		
Building tradesperson views on energy measures		
Specifying and designing works	Getting it right: knowing what to do and how	
Information and advice for trades		
Suppliers and merchants • reliability and brand loyalty • sources of information and training		
Training and qualifications		
Risk and quality control		

4. Research Phase 2: Fieldwork results, literature review and discussion

4.1 Approach to literature review and presentation of results

The results of the fieldwork in Phase 1 were used as the basis for a second phase of literature review, focussing in particular on the key themes raised in the fieldwork. The literature review also served as an update on thinking on the issue of energy improvements to existing homes in the academic and political spheres, and in the industry more broadly. Both academic and grey literature were reviewed. The results of the literature review have been integrated with the results from Phase 1 in the discussion below.

The literature review was initiated at the same time as presenting some of the results of the fieldwork in Phase 1 within energy efficiency industry and policy circles in the form of a published report (Maby and Owen, 2015), which enabled the researcher to gauge reaction and engage in discussion around the potential implications.

The timing of this work coincided with an anticipated review of policy around energy efficiency following the election of a new UK government in May 2015, the demise of the government's Green Deal scheme, and the launch of a review of quality standards within the energy efficiency industry (the 'Bonfield Review' led by Peter Bonfield, later renamed 'Each Home Counts') (Bonfield, 2016). The results of Phase 1 of this research was presented as evidence to this review.

Whilst the opening research questions focussed on the views of key market actors within the local supply chain, it became clear in the course of Phase 1 research, that the work of building tradespeople and what they are able to do in terms of delivering energy improvements cannot be seen in isolation. It is both impacted and constrained by policy and programmes, at local and national level – which in turn are impacted by international agreements. A review of relevant current policy and programmes was therefore included as an additional theme, to preface the integrated discussion of Phase 1 results and literature below.

Thus the structure of this chapter is:

- Context: Policy and programmes - global to local
- How the RMI industry works in practice: the context for including energy improvements

- Driving energy improvements in RMI: influencing the homeowner
- Getting it right: knowing what to do and how
- Summary and next steps

Key issues relevant to the research objectives are noted in bold in text boxes throughout the discussion.

4.2 Context: Policy and programmes - global to local

The fragmented nature of both the industry and its direct customers makes it a particularly difficult area to reach and perhaps to understand for national policymakers, but while this may in part explain the lack of policy to address this, it does not diminish the necessity to do so. The scale of activity within this sector and its unique access to knowledge of, and decision making about, the buildings that constitute the private housing market, make it a crucially important area for policy and action towards achieving the challenging targets for reduction in carbon emissions, energy demand and fuel poverty.

The context within which RMI building tradespeople work is directly impacted by local and national government policy, which in turn is linked to European and global policy. To put current UK national policy into context therefore, the global and European policy framework is briefly reviewed below, before going into recent and current UK policy and programmes in more detail.

4.2.1 International agreements

Global concern about climate change sets a powerful imperative for action to reduce carbon emissions at all levels in society. Taken together, the key global agreements mean that every industrialised nation must deliver its part in the reduction in greenhouse gas emissions. While UK national commitment may wax and wane, the overall direction of travel is unlikely to change – which requires massive improvements in the energy performance of housing, as a major part of the change needed.

Of particular significance is the 1992 United Nations Framework Convention on Climate Change (UNFCC), which acknowledges the existence of anthropogenic climate change and the risks associated with it, as well as the difference between countries in terms of their contribution to the problem to date and their needs for economic growth going forward (United Nations, 1992). The 1992 agreement

provided the framework for a series of subsequent international conferences, aimed at agreeing a way forward for climate change mitigation. The 1997 Kyoto conference produced the agreement to set internationally binding emission reduction targets (United Nations, 1998), and the 2015 Paris 'Conference of the Parties' (to the Protocol agreed in Kyoto) agreed to aim for a limit to global temperature rise[4].

4.2.2 European initiatives and agreements

The recent history of the European Union has featured a series of strategic steps on climate change, which reflects a growing awareness, not only of the environmental impacts, but also of the need for energy security and the impact of energy resilience on economic competitiveness (European Commission, 2015a). The positive impact on jobs and growth is noted, where increased environmental sustainability is no longer seen as a risk to economic success, with more than one million workers employed, directly or indirectly, in renewable energy related sectors, and around one million in energy efficiency related sectors (European Commission, 2016a).

During 2014-18, several key areas of EU policy were reviewed and refreshed. While the UK has embarked upon a path of disengagement from the European Union since the referendum in June 2016, the influence of European legislation and regulation on how we do things in the UK is likely to remain strong – not least because countries that trade with the EU are typically required to comply with similar standards. Housing energy performance plays a key role.

Of particular relevance to this research are the establishment of EU targets for 2030 and 2050 for energy efficiency, greenhouse gas emission reduction, and share of renewable energy (European Commission, 2015b), which indicate the achievement of a consensus that action must be taken on both the demand and supply side (ibid). Setting ambitious interim targets on the path to the 2050 goal ensures a focus on immediate action – and this is backed up by a new governance system based on national plans for competitive, secure, and sustainable energy, to increase transparency, improve policy coherence and coordination across the EU, and to reduce uncertainty for investors (ibid).

These targets set the framework for the ambition for more detailed directives, such as those that relate to buildings and energy efficiency – which in turn, provide the

[4] https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

backdrop to UK policy on buildings. One of the most significant initiatives for home energy improvements is the (recently revised) Energy Performance of Buildings Directive (European Union, 2018), which requires member states to: set minimum energy performance requirements; develop national long term building energy renovation strategies, with implementation a national priority, measurable performance indicators and binding 2030 and 2040 milestones; develop a plan for transforming the building stock into a near zero energy one (NZEB); and a strong emphasis on stakeholder engagement. Reference is made to using trigger points in the life of the building to stimulate cost-effective deep renovations (EuroACE: The European Alliance of Companies for Energy Efficiency in Buildings, 2018), indicating an awareness of the opportunities provided by RMI work.

The 2015 European Commission's Communication on Delivering a New Deal for Energy Consumers restated the framework strategy vision of an Energy Union:

> *'with citizens at its core, where citizens take ownership of the energy transition, benefit from new technologies to reduce their bills, participate actively in the market, and where vulnerable consumers are protected' (European Commission, 2015a).*

The communication sets out an approach encompassing empowering consumers to act through better information on their consumption, more choices of suppliers and prices (including self-generation and use of self-generated power), and 'smart' homes and networks. This brings targets for decarbonisation down to the level of individual homes and consumers, highlighting the role of home owners and landlords who make the decisions on what they will invest in for their homes (as well as how they use them), typically engaging with RMI building tradespeople to get work done in practice.

Also of relevance is the EU Heating and Cooling Strategy (European Commission, 2016b), which includes as a key goal the renovation of existing buildings to reduce energy leakage. It highlights the need to replace older heating systems, with almost half of the EU's buildings using individual boilers installed before 1992, with efficiencies of 60% or less, and 22% of individual gas boilers, 34% of direct electric heaters, 47% of oil boilers and 58% of coal boilers older than 'their technical lifetime' (ibid). The 'distress purchase' issue is raised, where decisions on replacing old appliances are made under pressure, when a heating system breaks down. The strategy communication points out that the lack of useful and accessible information on comparative options and prices for people at these 'trigger points' leads to

continued use of older, less efficient technologies (ibid). The RMI industry is a key part of overcoming this barrier.

With reference to the renovation of buildings, the focus of this research, it is noted that two-thirds of buildings in the EU were built at a time when energy efficiency requirements either didn't exist at all or were 'limited' - and that it is anticipated that most of these will still be standing in 2050. Around 70% of people in the EU live in privately owned buildings, including owner-occupied and privately rented. The strategy also acknowledges that not only can significant savings be made through relatively simple interventions such as wall and loft insulation, and double or triple glazing, but that ***these are cheapest when done as part of other building works - and that installers are the 'market-makers' for many technologies (ibid).*** This is a clear indication of the relevance of this research to the challenge of improving the energy performance of homes, and not only in the UK.

Taken together, the EU and global targets and initiatives described above provide the context for policy in the UK, and support the aims of this research. They are also a useful indication of the fact that this challenge is faced in other countries, so that a sharing of experience and good practice can be of benefit.

4.2.3 UK national policy and programmes

UK national policy on home energy efficiency includes the strategic role of local authorities, financial incentives and support mechanisms, and regulation. The most relevant initiatives are discussed below.

The Home Energy Conservation Act

The Home Energy Conservation Act (HECA) (H M Government, 1995), marked an important step in establishing a degree of legal public responsibility for energy conservation and the particular role of local authorities.The legislation required local (housing) authorities (excluding top tier authorities such as County Councils, where a second tier, such as Districts or Boroughs, covers housing) to carry out a broad brush assessment of the energy performance of all housing in their area, across all tenures, and to develop a strategic plan to reduce energy consumption by 30% in 10 years.

The Local Area Agreement era of joint strategic planning during 2005-11 provided the opportunity to select energy, fuel poverty and climate change performance indicators as local priorities. This was backed up by the development of a new national statistic

for carbon emissions per capita, sub-divided into 3 sectors: domestic, business and transport. It excludes industry and aviation, but offers a useful top-level metric for local planning (Department for Business Energy and Industrial Strategy, 2017).

HECA is relevant to this research in that it gave Local Authorities a direct responsibility for housing energy performance in their territory – at a level which is accessible and meaningful to small businesses operating locally. It is also the level of government closest to citizens and responsible for housing, environmental health, economic development, land use planning and development control (including enforcement of Building Regulations) – all areas with relevance for housing energy efficiency. HECA provides a mechanism for linking the impacts of local action, such as on housing, to national targets, providing a level of governance which sits between the national level and the individual homeowner, and in which the RMI market, the focus for this research, operates.

Energy Performance Certificates

Since 2006, Energy Performance Certificates (EPCs) have been required when homes are built, sold or rented, under the Energy Performance of Buildings Directive (European Union, 2002). Produced in the form of a simple report, and based on an assessment of the home carried out by a qualified assessor, they give the property an energy efficiency rating from A (most efficient) to G (least efficient), together with information about the property's energy use and how it can be reduced. The ratings of buildings are based on calculated consumption (the asset rating) of primary energy use per year (kWh/m^2/year) for typical use of the building assuming a standardised occupancy pattern (Charalambous et al., 2014).

EPCs are relevant to this research in that they are intended to indicate to consumers the increased value or desirability of a home that is more energy efficient – supporting the argument for making such improvements. They are also a basic tool for indicating the level of savings that can be made as a result of energy improvements – however concerns have been raised as to their scope and accuracy in practice, and their effectiveness as an advisory tool (Arcipowska et al., 2014, Maby, 2011). This is explored further in section 4.4.

Building Regulations

Building Regulations (introduced nationally in the UK in the mid-1960s) set the minimum technical standards that building works must achieve, including controls on

the energy efficiency of buildings. The key section for this work is Part L (conservation of fuel and power), which is typically renewed and upgraded every few years (H M Government, 2013). In the early days this was done by setting maximum values for thermal transmissivity ('U-values') for the different elements of the thermal envelope of new buildings, but has developed into a more complex regulation with rules limiting overall energy consumption and carbon emissions (Dowson et al., 2012). The latest version in England is 2010, updated in 2013 – with a similar cycle in Wales and Scotland, with Building Regulation under devolved powers (Department of Energy and Climate Change, 2013).

The focus in terms of thermal efficiency has in the past been mainly on new buildings, but there is increasing recognition of the potential for application to the renovation of existing buildings, and enacted through separate (B) sections dealing with these. Current Building Regulations in England have (somewhat tentatively to date) introduced energy improvements to existing buildings in three ways, described in Table 7, and of particular relevance to this research (H M Government, 2013).

Table 7: Building Regulations on conservation of fuel and power for existing buildings, Part LB (2013)

Controlled fittings	Replacement windows and doors must be at least as energy efficient as those they are replacing (there is a similar requirement for boilers in part J Combustion appliance and fuel storage systems).
Renovation of thermal elements	Where a roof, wall or floor, which is external or divides a 'thermally conditioned' area from one which is not, is either replaced or substantially renovated, its thermal efficiency has to be raised to a specified standard, with reference to that of a new dwelling.
Consequential improvements	When building work is done which includes an extension, the introduction of new fixed building services or an increase to the installed capacity of any fixed building services, the energy efficiency of the whole building must meet a minimum specified requirement. This only currently applies, however, to buildings with a useful floor area over 1,000$m^{2.}$, taking it outside the scope of this research.

The Building Regulations for Wales have been devolved to the Welsh Government since 2014, and are similar to those for England, but benefitting from slightly stronger requirements and a clearer presentation within the Approved Document (Welsh Government, 2010).

Building Regulations were highlighted in Phase 1 fieldwork by building tradespeople as the key driver for energy improvements, and are generally respected and understood as essential to ensuring quality. If the Regulations stipulate energy

efficiency levels, then the builder does not need to fear being undercut on price - for example for including thermal insulation in an RMI job. This is significant in that it overcomes a major potential barrier to getting energy improvements into everyday RMI work.

> '*When you are doing a renovation you are tied by building regulations, and building regulations is energy efficient' [A12B]*

> *'Whenever you do a job, Building Regs are always involved, and if the Building Regs insist on a certain level of insulation, then the builder has to fit in with that and so does the customer, and anyone doing a quote will know that' [A01B]*

Some builders, however, noted that the Regulations were not as ambitious as they could be, and that there is a risk that they are not understood as setting only a minimum standard:

> *'Obviously you have to match Building Regs, but I have always tried to go further, because in the past Building Regs haven't been up to much.' [A01B]*

There can be a customer perception that Building Regulations 'cover' energy efficiency and no more needs to be done – for example that current levels of insulation are very high, because it's so much more than in the past.

> *'They think they've got loads (of insulation), it's compared to 10 years ago when they put it in last time' [A06B]*

Building Regulations also serve to drive the market for insulation (and potentially other products) from the merchant's point of view; they will stock what the Regulations require.

> '*It sells because it's regs. You can't build a property without using those products' [B03M]*

The driving force of the Regulations is summarised by the following builder:

> *'I think tradespeople in general tend to sort of lag behind – they are sort of led by Building Regs and by builders merchants, and who themselves lag behind, because they aren't bringing in the products until there's a reasonable demand, and there won't be a reasonable demand until the builders are*

demanding it, and so it seems to me that Building Regs is the most important factor in leading any change' [A03E]

Building Regulations are seen as an essential part of shifting towards lower carbon and more energy efficient building. The consistent 'direction of travel' of regulation is important; experience of low energy building is seen by some builders as putting them ahead of the game, knowing that it is coming in soon.

'It's great to have insight into that with the job I've just done…puts me ahead of my competitors' [A02B]

'Intervention, simple and powerful like Building Regs – any home improvement that has planning permission would have to have…and you can crank it up over time' [B02M]

The consensus is that consistent, long term policy is needed to help companies plan and invest, and that regulation is an important part of this, probably together with some kind of financial incentive – the 'carrot and stick'.

'Refurbishment can be a big opportunity. It could be a load of work when you buy a house or a landlord buys a house and wants to let it, those seem like very good natural intervention points which I think should be incentivised more.' [B02M]

'What they could do is say everyone who has had an energy certificate done and hasn't carried out the recommendations will have a penalty on their Council Tax.' [A11B]

There was recognition, however, that political considerations (and public opinion) had been limiting factors in recent years.

'…I thought we could hear a lot more of from government, bringing consequential improvements into the domestic sector, but once the media tagged it the conservatory tax it was dead on its feet' [C03BC]

'The most depressing thing I have heard for a long time was sticking on the Today programme and hearing that they were going to relax the rules.' [A05B]

Concerns were raised with regard to effective enforcement of Building Regulations. Tradespeople voiced frustration that the resources for Building Control to support and enforce Building Regulations have been reduced, with an associated risk to the

reputation of the building industry. Some were aware of non-compliance by others that was not effectively policed.

> *'We are more regulated but it's not being enforced…it's not being checked or if it's checked and found out, it's not put right' [A26H]*

There was a view expressed by some of the general builders interviewed that the introduction of private Building Control Bodies has allowed inconsistency, undermining of the authority of Local Authority Building Control. Private Building Inspectors are considered to be more lax than Local Authority Officers, and thought to be used by developers who want to cut corners. This view was echoed by a Building Control officer who raised the dilemma that is presented by having to compete with private Inspectors:

> *'I know I need to enforce…but if I do, in future they will take their business to someone else' [C03BC]*

It was also pointed out that the inclusion of sustainability in regulations is potentially more difficult to enforce than matters which are more directly related to health and safety – and sometimes more difficult to understand.

> *'…where the Building Regulations started out with keeping people safe…this is a different direction for the regulations, because nobody is going to die because there is not enough insulation in the walls' [C03BC]*

Complicating regulation or incentives could have a negative effect, because people may not understand how to comply, or be frightened off by the paperwork involved.

> *'Part L has become over complex for your average jobbing builder – I don't want to sound patronising here but the more complicated we make it the more likely it is to fail' [D01]*

> *'We got to the point about 20 years ago where they got rid of most of the cowboys…and then they overcomplicated things…and it's actually reintroduced the problem' [A05B]*

There may also be a problem of lack of awareness or understanding of the actual regulation – for example in relation to the requirement to insulate 'thermal elements' when these are renovated.

> *'You might only be doing that wall of the room, but you have taken off more than 25% of the plaster for that room….it's never really been clear if it relates*

to that room or the whole house…it's a similar situation with re-roofing – that if you re-roof a property you should improve the insulation value' [C04BC]

These responses from interviewees highlight the relevance of Building Regulations in improving the energy performance of existing as well as new buildings, but also point to some of the practical issues still to be resolved in applying this approach effectively.

This issue is not unique to the UK, and lessons may be shared with other countries. The need to integrate action on existing buildings into regulations is recognised at European level. The 2010 EU Energy Performance of Buildings Directive introduced a requirement for upgrading energy performance when buildings undergo major renovation (when 'technically, functionally and economically feasible'), (European Union, 2010), an approach taken forward in the 2018 revision (European Union, 2018).

The ENTRANZE project (www.entranze.eu) reviewed the building policies and programmes of the EU-27, and noted that, despite the EPBD requirement (referred to above), not all countries had reported specific mandatory codes associated with improving the energy performance of existing buildings (Atanasiu et al., 2014b). The ENTRANZE report makes reference to a study of the energy performance of Europe's buildings (Economidou, 2011), including a snapshot review of how building codes are applied to existing buildings, and commends examples where a performance-based requirement is used as well as restrictions on component replacements (as in 'controlled fittings' described in Table 6), such as the Swiss example where the thermal performance of a renovated building must not exceed 125% of the new building limit.

The impact of these regulations depends on several things: the strength of the requirements applied, the scope of applicability (such as size or type of building), and how effectively they are applied in practice. Potential weaknesses with the latter (as noted by intervewees quoted above) are lack of clarity as to how and when they must be applied, lack of awareness or full understanding of the details on the part of architects and builders, and a lack of effective enforcement. The latter is reflected in the findings of a study on compliance with Building Regulations in the UK, in relation to energy efficiency, (albeit focussing on new buildings) – where compliance levels as low as 35% were indicated. Underlying issues suggested included insufficient 'proper'

checks by building control, a lack of knowledge of energy efficiency on the part of building control, designers and developers, and builders, and a lower priority given to energy efficiency compared to other matters such as fire safety. There was also some indication of a lack of clarity as to responsibility for ensuring compliance on this relatively complex issue. (Pan and Garmston, 2012).

The European study referred to above indicates similar issues in other countries, noting that building control requirements prior to, during and on completion of the construction phase (typically involving announcement to the relevant authority, applying for permits and approval of plans, inspections and completion of certificates) can be critical to ensuring enforcement (Economidou, 2011). The study refers back to an earlier (2006) review of Building Control by the Consortium of European Building Control (CEBC), which describes the changes in building control systems in Europe over the previous two decades, with a move away from (generally local/regional) government-run building control functions to a more market based approach, noting that:

> *'there are growing calls for minimum quality assurance standards to be introduced in all countries to licence, audit and regulate the activities of individuals (both public and private) involved in undertaking the building control function'* (Economidou, 2011).

This reflects comments made by both builders and building control personnel in Phase 1 of this research.

In spite of weaknesses, these early attempts to apply Building Regulations to existing buildings are a crucial step towards effective buildings energy renovation policy – and could be the subject of detailed research and scrutiny for the UK, with its substantial older building stock.

Building Regulations are a key driver for home energy improvements, requiring effective enforcement.

The Westminster Sustainable Business Forum carried out an inquiry into the future of domestic energy efficiency policy, published in April 2016 (Pearson and Jaksch, 2016). The report argues for an extension of minimum energy efficiency standards to the owner-occupied sector, and that these should:

a) increase over time;

b) be mandated at the point of sale of a property;
c) tie in with consequential improvements, so ensuring energy improvements are triggered whenever major refurbishment is done (although the lack of definition of what constitutes a 'major' refurbishment is noted).

(ibid)

A 2010 review of the regulatory and support framework in Germany considered the energy efficiency requirements in the German Energy Saving Ordinance when replacing specific components such as the roof, windows or external wall, noting that these were limited by a cost-efficiency rule – such that the costs should be repaid through expected energy savings within the usual lifetime of the measure (Bürger, 2013). It is also pointed out that no action is required on existing buildings if no renovation takes place. Acknowledging that implementing an obligation to renovate buildings would be a strong intervention into the rights of private property owners, the study notes that the required level of deep renovation is not happening yet, and that something more needs to be done. One suggestion is a substantial increase in financial support, with a stronger emphasis on achieving deep renovation (as opposed to the shallow level achieved with most subsidies to date), and with a long time frame, so that property owners can plan these improvements to fit in with other activities, such as other renovation works. The study concludes that to achieve the 2050 targets, there is no alternative to a tightening of regulation, together with a substantial increase in support programmes. It is also pointed out that support needs to be long term and consistent – with a stop-go approach noted as being damaging to the industry, and particularly SMEs (ibid).

A long term approach based on regulation and mandatory standards is necessary to drive the market.

Financial support and incentives

Interviewees were not specifically asked about financial support and incentives, and most of the mainstream building tradespeople interviewed did not mention any of the current or recent programmes. Those that did confirmed the latter point in the study cited above, that any financial incentives and subsidies that are introduced should be long term, well signalled and followed through to avoid creating dependence and instability. A preference was voiced for a market that is not subsidy-dependent.

'…it's more the downsides of the subsidy culture for the companies involved, that there becomes a dependency on it.' [B02M]

Short term subsidies and financial incentives are potentially destabilising to the industry, with the potential for these schemes to be abused by those looking for a quick profit, creating an unsustainable dependence and a boom-bust subsidy-led industry.

Financial incentives and subsidies should be long term, well signalled and followed through to avoid creating dependence and instability.

Energy Efficiency Obligation and fuel poverty programmes

Since 1994, there have been sequential UK programmes of 'energy efficiency obligations', which oblige suppliers of electricity and/or gas to domestic consumers to achieve (and finance the achievement of) energy, carbon or cost savings through energy efficiency measures. The first ones were the Energy Efficiency Standards of Performance (EESOPS) 1,2 and 3 programmes which ran from 1994-2002, followed by the Energy Efficiency Commitment (EEC) 1 and 2 from 2002-8, the Carbon Emissions Reduction Target (CERT) and Community Energy Saving Programme (CESP) from 2008-12, and the Energy Company Obligation (ECO) from 2013 (Mallaburn and Eyre, 2013, Rosenow, 2011).

Apart from an initial phase where the funds from the energy companies were levied by the then electricity regulator, OFFER, and given to the Energy Saving Trust to administer (ibid), these programmes have been run directly by the energy suppliers themselves, and regulated by the relevant regulator (now Ofgem for both electricity and mains gas).

There have also been sequential programmes to improve energy efficiency focussed on potentially vulnerable households, in order to reduce fuel poverty, from the Homes Insulation Scheme (HIS), through the Home Energy Efficiency Scheme (HEES), and Warm Front (ibid) – until being integrated into the energy supplier obligation under the current Energy Company Obligation (ECO) programme (Department of Energy and Climate Change, 2011b). In recent years, Wales and Scotland have developed their own separate fuel poverty programmes.

Energy efficiency obligation funds are a key source of finance for home energy improvements, and as such the way in which they are administered and whether this

offers opportuntites for RMI building trades to deliver them is of relevance to this research. As the obligation targets have grown, these have become large scale programmes, which are tendered out to bidders that can bring both capacity and low prices, and as such have tended to favour large contractors (with British Gas dominating the boiler market). They have also focussed on a few technologies offering the quickest returns (such as loft and cavity wall insulation, low energy lamps and gas boiler replacements), leaving the more challenging (but significant) measures almost untouched (solid wall and floor insulation, energy efficient windows, low carbon heating). The result has been the rise (and subsequent fall) of large cavity wall and loft insulation contractors, emphasising the concerns raised by the interviewee [B02M] cited above regarding the instability of a subsidy-led industry. It is also notable that this has been largely peripheral to the mainstream RMI building industry. In relation to the aims of this research, this represents a missed opportunity, both to develop capacity with mainstream building trades active at local level, and to build such measures into everyday RMI work.

Energy efficiency obligation programmes have been introduced in other countries in Europe. The tendency for these and other larger scale programmes to focus on selected quick return measures only is reflected in a 2018 critique with regard to the failure of current initiatives to move beyond shallow levels of energy improvement. It argues that the resulting staged renovation is too slow to meet our climate change targets, as well as locking buildings in to an improvement only to an EPC level B or even C, with further improvements rendered unlikely for another 20-30 years. These conclusions are particularly striking as they are based on an analysis of the French energy renovation plans, which are supported by the energy transition law and are relatively ambitious, with a target of half a million homes to be renovated each year, (half of which should be occupied by low income households) and energy improvements to be included in all renovation work. An argument is made for the need to link public funds to deep renovation (only) and to industrialise building energy renovation in order to radically reduce costs. (Saheb, 2018)

A different problem cited in relation to subsidies is that centrally-imposed deadlines can result in poor quality work. For example, external wall insulation, applied in adverse weather conditions will not perform as designed (De Selincourt, 2015) - and contractors may be put under time pressures to do so in order to ensure that a scheme is completed by specified end date.

'…there was a lot of pressure from the utilities to say 'you're going to deliver this aren't you?' and I've been sat in meetings, with quite senior officials from the utilities and they've gone 'you've got to achieve this', and you go 'well the weather is absolutely terrible at the moment' etc, and two years down the road we are seeing some issues on doing that…it was almost like, 'if you can't do it tell us now because we'll get someone else in' [A20SWI]

Feed in Tariffs and the Renewable Heat Incentive

The Feed in Tariff (FIT) is a payment for electricity generated and fed into the national grid system. In the UK the government introduced an obligatory FIT in 2010, under which major energy suppliers would have to pay small scale generators of power a fixed rate for generation, to support the development of the market for microgeneration, such as solar PV, wind, hydro and CHP. The FIT was intended to be temporary, as a way to increase deployment of technologies to bring down the price to a point where it can survive in the market without further subsidy, and had previously been used successfully in several countries, such as the USA, Germany and Spain. The Renewable Heat Incentive, started in the UK in 2011, is a pioneering attempt to apply the same approach to renewable heat, and is offered for solar thermal, biomass boilers and heat pumps.

Both programmes have been popular, with take up far exceeding expectations. The impact in terms of deployment of renewable energy technologies has been significant. On the negative side, tariffs have been cut back more quickly than originally planned, and too suddenly for the industry which had developed to supply these technologies, resulting in a sudden downturn in installation numbers, job losses, and negative publicity. This reflects the comments made by interviewees about short term subsidies, and how destabilising these are to the industry.

The Green Deal

Following several years of preparation, the Green Deal was formally launched by the UK Government in January 2013, as a framework which aimed to enable private companies to offer energy efficiency improvements to home owners at no upfront cost, by creating a repayment scheme such that the cost of the work would be repaid through a charge on electricity bills. The concept was based on the 'Pay As You Save' concept that repayments should not exceed anticipated savings on energy bills, so that there would be no net cost to the homeowner, and that the debt stayed

with the house (or more precisely the holder of the electricity account) (Department of Energy and Climate Change, 2010).

The scheme was set out in legislation in the Energy Act (H M Government, 2011), and contained a number of elements, including the requirement for Green Deal certified providers offering Green Deal finance plans, and for Green Deal certified products, installers, advisers and home energy assessment processes (Construction Products Association Green Deal Project Team, 2012, Department of Energy and Climate Change, 2010).

The intention was that this would overcome two of the potential financial barriers to take up of measures, the lack of available capital to get the work done, and that the return on measures may be longer than the individual's term of ownership of the property. It was intended as a market mechanism, with funds ultimately coming from private sources. Additional costs to consumers included interest on the loans and repayment charges levied by the electricity companies who would have to collect them. The cost of the assessments also had to be taken into account.

The scheme is generally considered to have been a failure, and effectively ended in July 2015, in that the government stopped funding the Green Deal Finance Company, which was set up to lend money to Green Deal Providers (H M Government, 2016). Less than 2% of the 575,000 Green Deal assessments undertaken had resulted in the take up of Green Deal plans (Gardiner, 2015). The Green Deal, as a flagship policy instrument for retrofit, has been evaluated in several studies, and the financing and assessment processes of the scheme were identified as significant barriers to uptake (Marchand et al., 2015).

Reasons for the failure of Green Deal suggested by the industry include: the complexity of the scheme; the relatively high interest rate; the lack of strong legislative or regulatory support to help create demand (such as the decision not to take forward ideas such as reduced stamp duty or council tax rebates for taking up measures, or the full introduction of consequential improvements into Part L of the Building Regulations). Also cited are the costs to the supply chain of participating in the scheme, which would have to be passed on to customers in some form within the framework of the market mechanism that this was intended to be. Another limiting factor was the 'Golden Rule' which restricted loans to coverage of measures that

would result in repayments no more than anticipated savings (Dowson et al., 2012, Gardiner, 2015).

Another relevant insight was that energy efficiency measures were not generally valued by homeowners, unless combined with other household improvements (Pettifor et al., 2015), endorsing the aim of this current research. Other barriers are presented by the nearly 5m homes owned by private landlords (Palmer and Cooper, 2013), where the incentive offered by savings on energy bills is 'split', with the cost of building works generally covered by the landlord but the energy bills (and the benefits of any savings on these) going to the tenant.

The experience of the Green Deal highlights the need for policy to be grounded in the practical realities of home improvements, and the importance of considering these issues from the perspective of the key actors involved in delivery, on whom the success of the scheme depended, as well as homeowners. While it made sense to create an all-encompassing scheme, which included finance, quality control and assessments, the focus in developing the detail was on the requirements of finance providers. The building tradespeople interviewed in this research had either never heard of the Green Deal, or saw it (and other larger programmes, including the energy efficiency obligation schemes) as not intended or designed for micro-enterprise participation. This is confirmed by the dominance of bigger players in public procurement, and the use of measures such as free boiler servicing or energy assessments to gain competitive advantage or access to customers in ways smaller businesses could not afford.

Area-based approaches

'Area-based' retrofit is appealing to policy makers since it offers the opportunity to achieve significant reductions in energy use by focussing resources on specific geographical areas. In addition to the physical attributes and infrastructure of an area, the social or cultural attributes of that area influence which technologies move from 'possible' to 'installed' (Owen 2013). Whether or not there are builders and tradespeople in the area who are able to promote and install retrofit technologies will be one of those local factors.

Combining "Green Deal" thinking and an area-based approach, the Sustainable Housing Action Partnership's development of a "Community Green Deal" describes the range of equipment and techniques that need to be brought together for an

effective area-based approach to energy efficiency improvements in existing homes (URBED, 2010). An area-based approach ties in well with the strategic role of Local Authorities in developing Home Energy Conservation Act strategies and reports, and offers potential for engaging and supporting RMI building tradespeople in delivering home energy improvements, operating at a similar practical geographical scale. This is only likely to be realised, however, if the procurement approach is tailored to engaging local small businesses, rather than the larger companies that tend to dominate public contracts. A study of 'energy efficiency retrofitting supply chains' in Yorkshire and Humber identified three 'ideal' types of configuration based on the size and scope of the project, noting the degree of engagement of the local SME market in each case as well as the potential for economies of scale and standardisation. The research focussed on the growth of what they termed the UK's 'Energy Efficiency Retrofitting Services (EERS)' market, which they estimated at around £2bn in 2010, and saw as having significant growth potential – although it was indicated that this was related particularly to government initiatives (Genovese et al., 2013), which have since either ceased or reduced drastically (Pearson and Jaksch, 2016).

The research referred to above included a review of literature on EERS supply chains both in the UK and in other countries, and noted that in spite of differences, there were common features, such as that:

- Most companies offering EERS were very small, with less than 10 people
- Retrofitting projects were typically arranged on a private and individual basis, and possibly not commercially attractive to larger companies

Their review of literature highlighted several common barriers to this market, such as:

- Lack of information on the opportunities that energy efficiency offers
- Public procurement rules not conducive to large scale engagement
- Relatively low price of energy
- Safety and reliability concerns regarding new technologies
- Limited understanding of energy efficiency and performance contracting amongst financial institutions

(Genovese et al., 2013)

The findings of the research on the EERS market in Yorkshire and Humber corroborates the picture described above in relation to energy efficiency obligation

programmes, of a market based on larger scale initiatives led by government, energy supply company obligation schemes and/or local authorities, existing in parallel to the 'normal' RMI market, and with relatively little interaction. A few local businesses got some work, but generally only if they were already on the 'lists' of the 'middle men' of the larger contractors that won the tenders (as indicated in 4.2.3 above). Products were typically imported, with high cost implications, implying a lost opportunity to benefit market activity through potentially lower, more localised, costs, as well as potential to bring benefits to the local economy (ibid).

This was reflected in comments from some interviewees who had tried to engage in area-based programmes, where multiple levels of subcontracting caused frustration, not least in regard to the overheads that would be taken at each level. One heating engineer had tried to engage with a Green Deal programme in a big city, and noted the many levels of subcontracting involved. He had gone to the 'business to business' events held, but got no work from these, and thought they were probably just for show.

> *'It really shouldn't be administered by the big organisations….I know that x Council are subcontracting it to y, and y are subcontracting it to z, and z are subcontracting it to two or three different companies…I've worked for y on other occasions, and I don't understand why they've got to have three or four different mouths to feed in the food chain…' [A21H]*

An inevitable result of this lack of integration between the larger scale 'EERS' market and the mainstream RMI market is that the RMI trades do not benefit from (commercially attractive) opportunities to become familiar with the range of sustainable energy technologies available. This leaves them having to do this at their own risk, or to avoid such technologies altogether. Furthermore, the larger contractors who won much of this kind of work during the roll-out of such programmes have since tended to either disappear altogether or disband the teams that carried out EERS contracting. As identified in the description of UK policy and programmes in 4.2.3, this is arguably a wasted opportunity to develop capability and practice in the RMI market to deliver energy improvements.

> *'In a utopia you would not have it all run by these big businesses- there's always a vested interest…A lot of technologies could be a lot easier to access' [A10C]*

Contracting large scale retrofit programmes to large firms misses the opportunity to build capacity within microbusinesses who continue to operate in an area after such programmes have finished.

Another feature of such publicly funded programmes highlighted by the research described above, and of particular relevance to the issue of achieving good quality low carbon renovations, was that the focus was more on the delivery of products rather than on the delivery of customised solutions (ibid). A review of similar programmes in Wales commented on the fact that most retrofit programmes have tended to focus on an elemental approach, installing primarily the most cost-effective measures, and that the costs associated ranged from a few hundred pounds for shallow elemental retrofits up to £70,000 for a deep whole-house retrofit. (Jones et al., 2013). These costs and the disruption of deep retrofit are cited as the main barriers – and that to achieve deep retrofit we will need both new finance models and support from Building Regulations (ibid). Deep retrofit is defined in this paper as 60-80% reductions, and will inevitably require the application of a range of technologies, customised to each home, given the diversity of building types in the existing housing stock and the changes that are made to them over time.

4.2.4 Summary of current policy and programmes

Current UK policy and programmes

Since the change of UK government in May 2015, there has been a decline in demand-side policy and programmes. The Green Deal has not been replaced and the FIT scheme ended in March 2019. Local government resources (including Building Control) are increasingly stretched. A significant omission is a coherent policy in the UK for achieving the necessary energy improvements to existing homes. In 2015, the Select Committee on Energy and Climate Change conducted an inquiry into home energy efficiency and demand reduction, and Peter Bonfield (Chief Executive of BRE) was commissioned by the Secretaries of State for Energy and Climate Change and for Communities and Local Government to undertake an independent review of consumer protection, advice, standards and enforcement for UK housing energy efficiency and renewable energy (Bonfield, 2016). The brief for this study did not, however, include Building Regulations or any specific reference to driving or generating demand for home energy improvements.

The independent Committee on Climate Change delivered a 2016 Progress Report to Parliament that indicated that emissions had fallen by 3% in 2015 compared to 2014, and by an average of 4.5% a year since 2012 – but that this had been almost entirely due to progress in the power sector, particularly due to the expansion of renewables and reduction in coal for generation. There had been almost no progress in the rest of the economy – ***with a slow uptake of low carbon measures and behaviours in buildings, and the need for new policies indicated in every aspect of this sector*** (Commitee on Climate Change, 2016).

The 2018 report to Parliament by the UK Committee on Climate Change reported a 3% drop in overall emissions for the year, but highlights that this continues the UK trend for the past decade in reducing emissions mainly in the power generation sector, while the integrated policy required to reduce emissions from transport, industry and housing remains lacking (Committee on Climate Change, 2018).

The Department of Energy and Climate Change was abolished during this period (as was the government Select Committee on Energy and Climate Change), and responsibility for energy transferred to the new Department for Business, Energy and Industrial Strategy (BEIS), although Building Regulations remain with Communities and Local Government. The Clean Growth Strategy launched by BEIS in 2017 states the guiding principles in the government approach to reducing emissions as:

- to meet our domestic commitments at the lowest possible net cost to UK taxpayers, consumers and businesses;
- to maximise the social and economic benefits for the UK from this transition.

(H M Government, 2018).

The strategy contains some laudable objectives, such as phasing out the installation of high carbon fossil fuel heating in new and existing homes off the gas grid during the 2020s (starting with new homes), and developing a long term trajectory to improve the energy performance standards of privately rented homes, with the aim of upgrading as many as possible to EPC Band C by 2030, and for as many homes as possible reach a similar standard by 2035. These do not, however, add up to a coherent strategy – and the weakness of actual drivers to action is notable, as is the dilution of the EPC targets with the phrase: *'where practical, cost-effective and affordable'.* Addressing mitigation of climate change appears to be secondary to short term affordability. (ibid)

The introduction of minimum energy efficiency standards for privately rented homes (ibid) looks hopeful – but in practice the bar has (at least initially) been set so low (at band E for new tenancies from April 2018 and for existing ones from 2020), that it will do little to transform the housing stock, without a clear indication of a future tightening of standards. To make matters worse, implementation has been weakened by exemptions in relation to financing the measures, with limits on requirements for landlord investment, such that they are not required to carry out works beyond what can be funded, by mainly public sources (H M Government, 2015).

Another concern is compliance. Compliance in provision of EPCs is relatively low in this sector and local authorities (increasingly) lack resources to take enforcement action (CAG Consultants & Association for the Conservation of Energy, 2018). Resource constraints are reported to be limiting ability to take action even under the relatively powerful Housing Health and Safety Rating System (HHSRS), a risk evaluation tool which since 2004 has given local authorities the right to require improvements when an 'excess cold' hazard to health is identified, and in the case of default to undertake works and charge the landlord (ibid). A further problem is the lack of adequate data held by local authorities on private sector properties (ibid).

Regarding finance for measures, the Green Growth Strategy confirms the continuation of the energy efficiency obligation, with the focus for the next phase (known as ECO3) on low income households and alleviating fuel poverty, as opposed to the domestic sector more broadly. The continuation and further development of the Renewable Heat Incentive is positive, as is the support for heat networks. Apart from that there is reference to looking again at green mortgages, and other financial incentives via a planned call for evidence. (ibid)

The 2018 National Infrastructure Assessment includes a target of 50% of the UK's power generation to be from renewable energy by 2030, but disappointingly fails to give the same level of priority to the issue of buildings energy performance (National Infrastructure Commission, 2018). While not completely ignored, and including reference to the need for buildings which need less energy to heat, the text seems to imply that with the full deployment of relevant power and heat technologies (in the latter case involving heat pumps and electrification, and hydrogen replacing natural gas), the question of fabric energy efficiency becomes secondary.

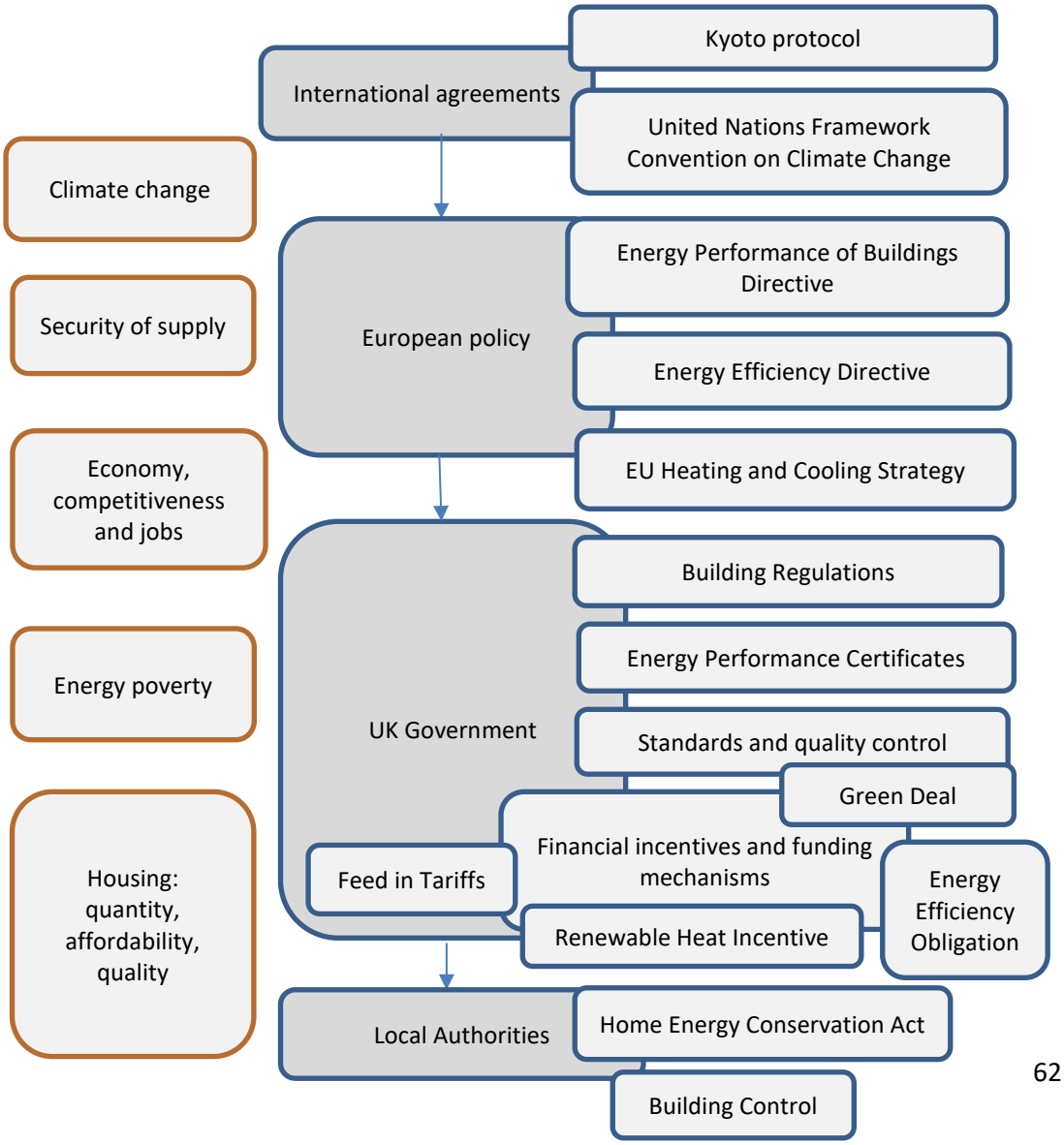
The weakness of UK government policy to implement the high level commitments at global and EU level contributes to a lack both of drivers for demand for energy improvements and the supporting mechanisms to enable it to happen.

There is a high level legislative structure in place to address climate change at global, European and national levels, but implementation regarding the energy performance of UK housing appears incomplete and stalled. The current focus is on quality control, but misses action on generating demand for home energy improvements.

From global to local, and from policy to implementation

Figure 3 summarises the policy and related mechanisms of relevance to home energy improvements, at different political levels, through from global to national and local activity, as described in this section (4.2).

Figure 3: Global to local: home energy efficiency and carbon emission policy



4.3 How the UK RMI industry works in practice

4.3.1 Keeping work local

The building tradespeople that were interviewed indicated that they generally worked at a very local level, and preferred to do so, for several reasons – practical, personal and economic.

One important practical point is access to known suppliers and other trades to work with. The time and cost of travel is another significant factor. Travelling to a different location for work makes it difficult to offer a price that is competitive with a business already based in that location.

> *'I would say 85% would be in a 10 mile radius' [A07CJ]*
>
> *'We try to keep it down to half an hour' [A06B]*
>
> *'I won't go any more than…20 (miles) is about the limit…I have even recently gone on Google and set a limit…If I could always work a mile down the road I would, but obviously living in a rural area like this …' [A02B]*
>
> *'The range is roughly 15 miles max delivered, and I wouldn't think people would travel more than 6 or 7 miles to collect' [B01M - merchant]*

The actual cost to a small business is important, but the opportunity cost when an individual has family or social responsibilities and activities is also a consideration which connects back to the motivations of these individuals. Expanding the business is not necessarily a top priority.

> *'No more than 20 miles now, it's because of the children, it's a balance between the two [A18P]'*
>
> *'Well, we've done a job in London before, but that is something I said I would never do again, it was so unenjoyable and time consuming, you spend so much of your time travelling that it's just not worth it…' [A02B]*

For a builder involved in several jobs at the same time, keeping an eye on the different jobs makes distance even more crucial:

> *'Anything that's far away is difficult to keep an eye on, especially if you are using sub-contractors.'[A27B]*

A few of those interviewed also mentioned the environmental impact of travelling a long way, and were conscious of the inherent contradiction in doing this to undertake ‘green‘ work.

However, longer journeys are made in exceptional cases, such as to carry out work for family or friends, or for more specialist work, which may be more interesting and tends to be better paid.

> *‘If it was stone masonry, I would travel further because the work is more specialist, whereas if it was general building it would be too competitive’ [A06B]*

Working locally is seen as important to build reputation and trust, both with customers and with other trades.

> *‘I tend to go to areas that I’ve lived in and know people and built up customers’ [A16B]*

Reputation and trust are important for developing a stream of local work with good customers, and a strong local reputation helps the micro-enterprise in several ways: first, getting work through personal recommendations helps the tradesperson to vet customers and avoid potentially difficult customers and bad payers. This is a significant risk for a micro-enterprise, which may not have the opportunity to build up reserve capital to fall back on if cash flow problems arise.

Secondly, a personal recommendation starts the tradesperson on a better footing with the customer, and helps to reduce the number of quotes they have to do to get work, as opposed to the ‘one of three quotes’ situation, which can be very time consuming for a small business.

> *‘If I’ve got it from the advertisement, and they’ve never used me before, basically, I’m competing. If it’s word of mouth...you’ve done work for their friends, you’ve been highly recommended, they generally want you to do it. I mean, price is a factor, but…like I say, if it’s through advertising then generally you’re competing against two or three other plumbers.’ [A32H]*

Thirdly, local reputation can put a business in a better position to get confirmed work early in the design process, and to influence the detail of the project. This gives the tradesperson the opportunity to introduce energy improvements, recommending

measures such as thermal insulation, more energy efficient lighting or spotting opportunities for microgeneration.

An example of this was where a local builder was asked to fix a leaky flat roof, and highlighted to the landlady not only that this was an opportunity to insulate the roof (and the adjoining loft space), but also to put PV on it – both of which were agreed:

> *'Well, it's a massive step really, they've gone from having a flat roof and a loft with no insulation at all…and maybe with the solar panel she can recoup some of the money for the roof too…' [A04B].*

A different example is where a heating engineer replacing a boiler and hot water cylinder might suggest solar heating, or at least making a tank solar ready.

> *'…and making it solar ready, that's not regulation, it's just you being aware' [A26H]*

Many of the tradespeople interviewed said that they get most or all of their work through word of mouth recommendations. Advertising their business, if it's done, is highly localised, such as through parish newsletters or local free sheets. Advertising at this scale also helps with the visibility of these businesses, as does having a name and phone number on a van parked outside while work is undertaken, or having a board up outside projects.

> *'It's usually by word of mouth, but the jobs tend to come in clusters' [A02B]*

> *'The village newspaper is really the way, and it's very cheap' [A19H]*

> *'I find a lot of people have got your number from 'On your doorstep' because I think people like local' [A32H]*

While most of the tradespeople who spoke about advertising their businesses preferred this highly localised identity and approach, there were some who took pride in not advertising at all, and relying only on their reputation to bring them the work.

> *'Because of the way we work, it's purely on recommendation. So we'll get recommended because we've done some sash windows for someone, and then we'll go there and they'll ask 'do you know anyone who can put down an oak floor?'' [A09CJ]*

> *'Most of our enquiries are word of mouth. We've been in this business for 25 years.' [A21H]*

'Don't advertise at all, so it's all been word of mouth and repeat customers …or working for a select core of builders' [A03E]

This reliance on getting work through word of mouth recommendation means that building tradespeople working at local level are likely to place high value on quality, both of work and customer service. Their income depends on their reputation, and they are easily accessible for call-back requirements – both of which are strong motivations to deliver high quality work with minimum repercussions.

'We don't advertise….if your work is good enough you don't have to' [A05B]

'Don't market myself at all, I prefer to get word of mouth jobs – people who like my work pass on my information to others' [A01B]

'It's word of mouth and you get into ask a neighbour, ask someone you know in the village, or if someone's had works done, how did they do? They were brilliant. What were their name? And it gets passed around…And the reverse of it is if you do a bad job..' [A19H]

Even a second or third hand recommendation appears to be valued by customers:

'The woman calling got the recommendation from the decorator's wife's beautician' [A33PD]

Another type of personal recommendation is through an architect:

'They usually find out about work that I've done. Or I have a very good architect friend who, I'm on his list…' [A22B]

A variation on the theme of getting work through local recommendation by individual clients is that carrying out work on a building that is well known in the community, such as the church, pub, village hall, sports centre or school, can cascade into other opportunities.

'They trust me you see because if you work in the church you must be good' [A13E]

'They found us in the village newsletter and we did some work to the local pub, and from that the phone for about 3 weeks was inundated with 'can you come and service my boiler, can you come and repair this'…' [A19H]

'I think, when you're in a local community, word gets round, and people tend to quickly find out who are the best traders and who to avoid' [A33PD]

Although seeing the van around with its name and logo may bring in work, some tradespeople were not keen to have their phone number on there. General advertising is seen as carrying risks such as: being contacted by people who do not go ahead with work; being stuck in the position of competitive quoting with no assurance of work; working for a homeowner who is notoriously difficult to work for or is a habitual bad payer; or simply receiving too many calls to cope with.

> *'…just seeing the vans out and around, we think we've got a very strong logo with the vans marketing-wise, it's been very good for us' [A19H]*

> *'I go to see them first to see if they are of the suing type nature… I don't always take on everybody.' [A22B]*

> *'I think it's just as important for the builder to vet the customer as for the customer to vet the builder…there's a lot of people out there that take you on to do a job, and got no intention of paying you…' [A16B]*

One builder noted, however, that by not advertising he may be limiting the range of work he gets:

> *'I have been told by quite a clever businessman that's probably not the right way to do it, because the work is sort of targeting me as opposed to our company targeting the work that we really want...but it's always worked for me as a safety net really. Most people only recommend a builder to a friend or to someone they are happy that they could trust, they wouldn't' recommend me to someone that they thought would be awkward…' [A02B]*

Many of the building tradespeople interviewed indicated that they particularly wanted to deliver quality work, and to be recognised for this, both in terms of professional status, and reasonable financial reward. They were not generally motivated by a drive towards large scale delivery or expansion, even with its potential for larger profit. From this sample at least, it would appear that builders doing RMI work are aware that it cannot be rushed if you want to do it well. Higher quality work tends to cost more money, with more expensive products and materials, and more and/or higher skilled labour.

> *'One of the problems with our building trades is 99% is done on price and time, so the quicker you get it done, the more you earn..that's never going to be a recipe for quality is it? They don't build aeroplanes like that…' [A26H]*

This individual motivation for quality is not so obviously present in the case of larger contractors, where on the one hand an administrative level tends to stand in between the customer and the individual operatives, and on the other there is a less direct connection between getting work in and individual performance.

The preference amongst building micro-enterprises for personal recommendation rather than marketing to get work emphasises the importance of having a reputation for quality work and reliability.

Given the social, environmental and economic benefits, it is arguable that keeping work local contributes to a sustainable economy. It is also notable that this is typically work that is not subsidised or specifically incentivised, but for which there is an ongoing consumer demand. This means that is also likely to be economically sustainable - thus satisfying the three pillars of sustainable development as described by the United Nations[5] .

National policy in the UK (described in 4.2.3) does not appear to take account of this thriving local economic activity, nor to build on it in developing policy for improving the energy performance of existing homes. Most of the building tradespeople interviewed had no experience of working on a government, energy efficiency obligation or major local authority housing energy efficiency programme. A heating engineer who had tried to engage with Green Deal schemes reported that (based on information returned to a Freedom of Information request) of the 8,000 Green Deal installations registered, 7,980 of them had been with just one company: British Gas.

However, the local nature of building trades' RMI activity indicates a good fit with local delivery of integrated energy efficiency schemes, including the potential to link up with local authority regeneration and housing strategy and programmes, building control and planning, the provision of energy advice and assessments, and community scale awareness-raising and partnerships.

The local nature of the RMI market indicates a good fit with delivery of housing energy efficiency schemes, but national policy in the UK does not take account of or build upon this thriving market.

[5] https://www.un.org/ecosoc/en/sustainable-development

4.3.2. Informal networks

A significant feature of the highly localised RMI market, as noted in this phase of research, was the role of informal local networks. These networks have several different aspects to them, which could be seen as multiple overlapping sub-networks, made up of different elements, which perform different functions for building tradespeople and retrofit installers. These are further complicated by the lack of any distinct geographical boundaries, with one 'locality' overlapping with another.

Possibly the most important network is the social one which provides customers and builds reputation, as outlined above. A different but overlapping network is that between building tradespeople.

Many RMI building tradespeople are either self-employed sole traders or working in very small businesses of two or three people – for example, a general builder, a part time administrator/book-keeper, and an apprentice. Some of those interviewed had worked in larger SME building companies in the past.

> *"We have employed people in the past, but it's too uncompetitive to employ people. The costs of employing people are massive, and you are having to compete against people who haven't got employees' [A08B]*

> *'I work with a plumber who's brilliant and he knows his stuff, and very often perhaps there's a brickie or a carpenter, and everybody knows each other…because back in the 70s or 80s there used to be one big company and they used to employ everybody, right up to the finishing and painters and decorators, and they all used to look after each other' [A13E - electrician]*

There are many jobs which require more skills and time than an individual micro-enterprise possesses. Informal inter-trade networks are a way in which these small businesses can collaborate with other trades, or call on additional labour which is needed for a specific job - so enabling them to cover more major works. This is seen as a relatively low risk way of working compared to having a team of permanent employees, given the economic uncertainties of the time.

> *'We are carpenter/joiners, but there is also a team of people of other trades that I will bring in and I'll coordinate the whole thing, plasterers, roofers, lead-workers and so on' [A09CJ]*

'Well, I've got an electrician, plasterers, plumbers, who I use off and on, that sort of thing…' [A17B]

'They are all self-employed, they are there when I want them to be there' [A31B]

This way of working gives individual tradespeople the flexibility to take on jobs alone or to work with others according to the requirements of each job.

'Probably about 60-70% of what I do is subcontracted to other companies, so it's a bit of both really…' [A04B]

'We have a little sort of almost cooperative thing going….there's a couple of us builders, specific carpenters when you are getting into the intricate stuff, plumbers, electricians, plasterers…and I guess a lot of people work in the same way…I probably spend about 6 months of the year on average for myself and 6 months subcontracting.' [A05B]

'Usually there is a select core of builders that I work for, and they provide me with jobs throughout the year, and then it's filled in with smaller jobs from private customers that get hold of my number' [A03E – electrician]

Being self-employed was seen by some as a better option from the point of view of tax:

'You'll find a lot of them prefer to be on a subcontract basis because they get better tax benefits.' [A11B]

A third kind of local network is that between suppliers of materials and products and the installers and tradespeople that use them. These relationships can develop over long periods of time, with builders' merchants, plumbing and electrical suppliers providing a link to manufacturers and a local point of contact to discuss the details of requirements. They provide information on products rather than advice, and can be helpful in chasing manufacturers about problems with products.

'…I'm probably one of their best clients and they look after me and stuff like that, and they deliver to me…it will be there that same day….I've been with them since they started up' [A31B]

'It's a local supplier...it's only a small concern, electrical wholesaler…they are very good, they offer this 3 year guarantee. And I have had a few lamps, they

might have been in a batch that was bad, and they've taken them back and replaced them free of charge' [A03E]

The range and quantity of stocks held are dictated by demand, such as for insulation and heating products. For some technologies, such as solar and biomass, the local merchant may be bypassed, and supply links developed directly between manufacturer and specialist installers. This can have knock-on effects in terms of limiting the technologies that the local RMI trades have (easy) access to, in that they are not then stocked at the local builders' merchant. It may also create a 'closed shop' and reduce opportunities for price competition, On the other hand it could be argued that it cuts out a middle stage at which extra costs would be applied.

'I know the price that is being charged for these things, and it's exorbitant. The person that's making the money is actually the supplier and the installer. The person paying for it is the end user…the merchant is cut out of the equation because of the new government procedure they've put in place because these suppliers, these manufacturers will now go direct to the installer, and that's not the first time this has happened over the last twenty years.' [B03M]

Building a team for a job

Discussion of how a team can be brought together for a job that requires more than one trade raised the concept of the 'general builder', as someone who can offer the homeowner the full range of work, and bring in other trades as required.

The general builder is seen as someone who knows enough to project manage the other trades and step in to help when necessary, but this varies a lot in practice. One of the reasons for the variation is that learning to be a general builder appears to be ad hoc rather than through a formal training or qualification. Even where the general builder could do a task themselves, sometimes they bring in other tradespeople because they are quicker at their specialism:

'Well I think the more you do any type of work the more used to it you are, the more accurately you can quote for it, the quicker you can do the work.' [A01B]

…or because an accreditation is needed, whether as a legal requirement (as in gas and electrical work), to streamline notifications to building control (as in glazing), or to enable access to guarantees or finance (as in some insulation and micro-generation measures).

'We have joiners doing windows and doors, and glazers that glaze. We have them do it because we get a guarantee – we can do it but we don't because you don't get a guarantee at the end' [A12B]

'…we do work for solar by putting in wires for it and that, but it's a separate identity to us…we get people along that's qualified to do that. We do get involved but we would tell the client you could go to that company' [A12B]

There was more day to day collaboration reported between the construction trades (carpenters, joiners, bricklayers, plasterers, roofers), than with more tightly regulated and highly technical trades such as electricians and plumbers.

'The bricklayer and carpenter goes together typically' [A25B]

'I have got a good electrician, a good plumber, so I generally put them straight in touch with the client so they then just deal with each other…' [A02B]

'I tend to pick up from the plumber and the electrician – they seem to have to deal with all the renewables, in my level of work anyway…I learn as much as I can, I learn as much as I need to project manage it, so if I am talking to a client and they are talking to the plumber, I can sit there and understand what they are talking about.' [A02B]

These comments highlighted the importance of the relationships between the different tradespeople, and the informal networks developed between them.

'You are only as good as your worst bloke' [A16B]

Some respondents commented on the quality of these relationships, and the importance of the trust that is developed over time:

'We always use the same plumber and electrician, because the trades get on well with each other, we all know each other, and you can ask the trades to help each other on anything that links the trades together...Because of that we have a happy site.' [A08B]

These comments highlighted an important practical point - that working with people you know well makes life easier because you know people's day rates, typical costs, quality of work and availability. As well as trusting someone to deliver the right quality of work, there's the commercial aspect that people who work together are less likely to undercut each other on price or go direct to each other's contacts for work.

'When you work with friends you don't have to constantly have these conversations, you know there is no chance of them muscling in on someone else's…' [A05B]

Trust also allows tradespeople to talk to other trades that they know and respect, when they are working out how to do a job with new features, such as a type of material or technology, that they haven't used before.

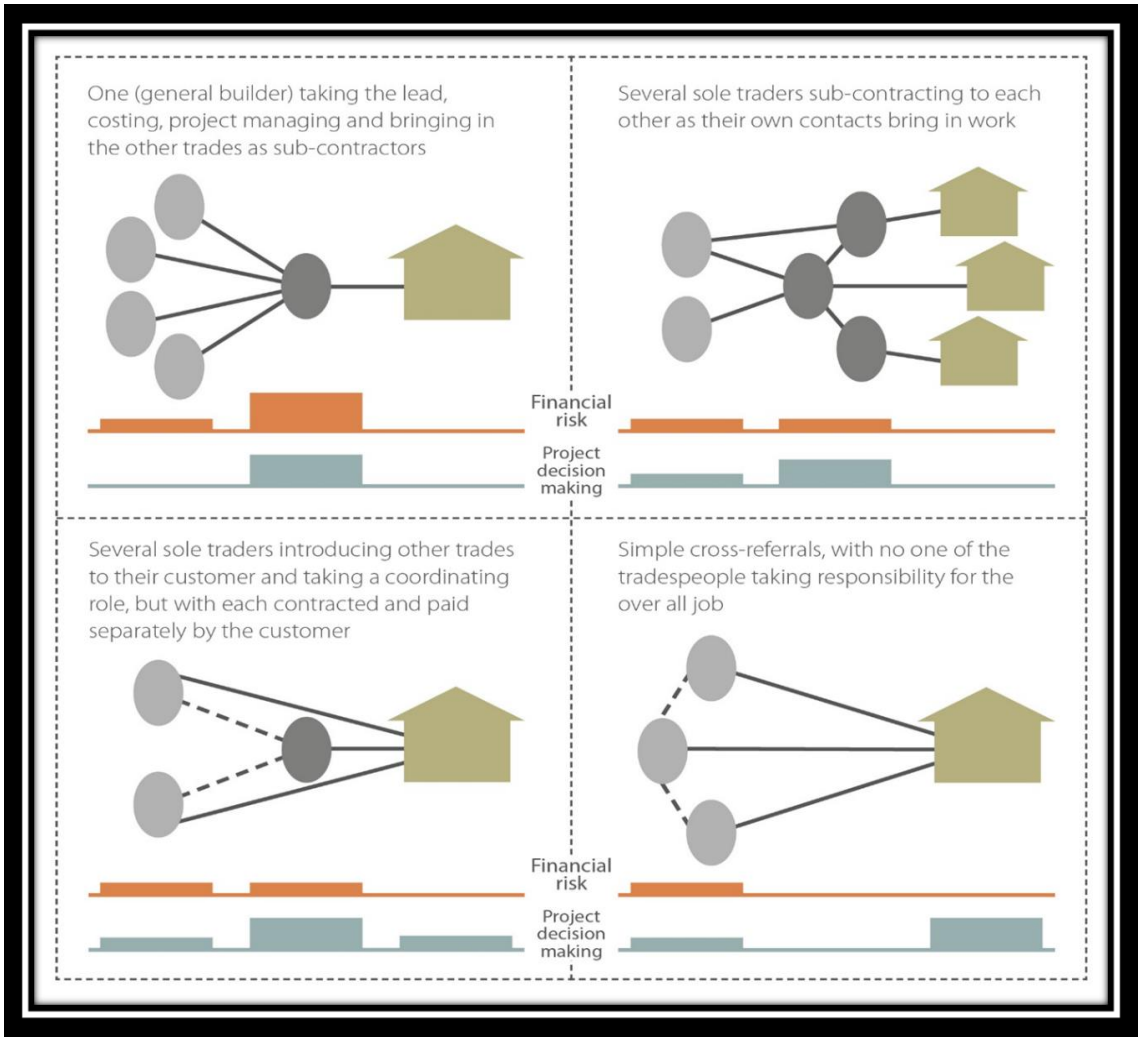
Responses from interviewees in Phase 1 indicated that in the RMI market either a general builder or one of the construction trades (often a carpenter/joiner) will typically take the lead in organising a job and coordinating the work on site. It may also be the case (with no architect involved in many cases) that they (in effect) design the work and specify the details. This could be anything from a list of works, broadly agreed with the homeowner, through to detailed descriptions to form the basis of a contract. Even where drawings are required for planning permission applications, these may be produced by a builder with the help of a draughtsperson. This multi-faceted role of the builder has important implications for the potential for inclusion of energy improvements.

In practice, there are many variations in the way that the team for a particular building project might be formed, and these have different impacts on who makes decisions and who carries the financial risks in a project. Examples of configurations found in the course of Phase 1 research are illustrated in Figure 4, including:

- One (general builder) taking the lead, costing, project managing and bringing in the other trades as sub-contractors;
- Several sole traders sub-contracting to each other on diferent jobs, depending on who has brought in the work;
- Several sole traders introducing other trades to their customer, and taking a coordinating role, but with each contracted and paid separately by the customer;
- Simple cross-referrals, with no one of the tradespeople taking responsibility for the overall job

The different ways in which informal groupings of building trade micro-enterprises and sole traders cooperate on a renovation project has implications both for decision making and allocation of risk. Of particular significance is the role of the key contact or link person coordinating the job – often the 'general builder'.

Figure 4: How building teams are formed for a project (Maby and Owen, 2015).



These examples may not illustrate all the variations that exist in practice. What this highlights is that there is no standard practice. Associated with this is the risk that the question of who is making decisions and who is carrying the risks may be poorly defined in many situations. Financial risk to the homeowner will also be affected by factors not explored here, such as contract and payment arrangements.

Informal networks and information diffusion

Reference to the type of informal network described above was not found in the research literature, although the concept of social networks more generally is recognised as significant in terms of social change and innovation. Case study research was carried out in 3 British communities in 2009, to understand the influence of social capital on information diffusion with regard to the adoption of energy efficiency measures. The research took as its starting point both diffusion of innovation theory (that the communication of information on innovations through a

social system encourages adoption) and social capital theory (that interpersonal communication is a key means of gaining resources, such as information on energy-efficiency innovations, for attaining certain goals) (McMichael and Shipworth, 2011) .

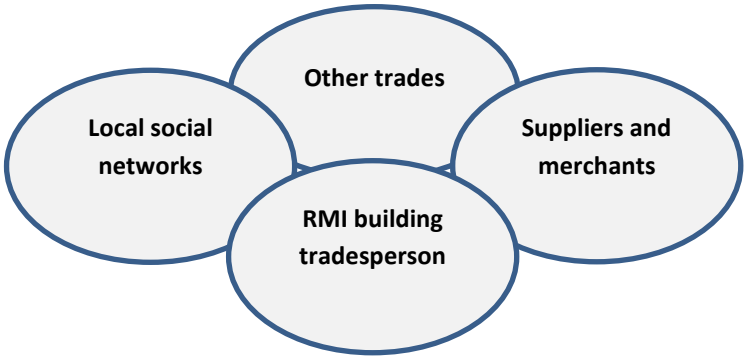
The research concluded that in general people preferred to get information from people they knew, and that information from personal contacts increased the chances of adoption by up to a factor of four – but that communities vary in their communication channels, and that people sought information on some technical and behavioural innovations and not others. In these case studies, people appeared to seek information on insulation and visual display meters, but less so on appliances, heating or lighting. Overall, however, it was concluded that social and community networks can significantly impact on diffusion of information and take up of measures.

While this research focussed on the consumer, it is relevant to the locally based building trades business or sole trader – as both the business people themselves and their customers live in the community and are consumers and part of these social networks. It also reflects the relevance of the three types of local network that were identified as significant to the RMI building tradespeople interviewed in Phase 1:

- The network of other building tradespeople to work with in putting together a team for a particular project
- The neighbourhood social networks through which they receive referrals for work
- The network which building tradespeople form together with the suppliers and merchants that they use

These networks and the way in which they overlap are illustrated in Figure 5.

Figure 5: RMI building trades and informal local networks



These networks provide a potential (albeit informal) route for shared learning and influencing practice. Information on new products and methods can be transferred between trades, and tradespeople get information from each other, as well as from their supply chain (product suppliers, and websites, and to a more limited extent the builder's merchants).

When developing policy which moves towards the deeper retrofit required to meet 'near zero energy buildings', understanding and working with the characteristics of these networks could help to enable and accelerate change. In seeking routes to dissemination of information and innovation, policy might be more effective if it reflected and built on the reality of the business and social networks that operate at local level, rather than attempting to create (or impose) centralised structures.

An insight from talking to building tradespeople in Phase 1 is that not all micro-enterprises are seeking or planning for growth. The maintenance of a steady level of 'good' work (for reliable customers) appears to be a more predominant objective. However, maintaining jobs (as opposed to creating new ones) rarely features as a headline target or objective in economic planning or political agendas, and economic development policy fails to acknowledge the strength and resilience of the micro-enterprise and the informal network as a positive response to economic insecurity.

A steady flow of work for reliable customers may be more attractive to the building micro-enterprises than business growth.

The value of the 'flexibility and agility' of such small and micro businesses is highlighted in a study by Gibbs and O'Neill., (Gibbs and O'Neill, 2014), and endorsed by the discovery of the informal networking approach described above - with companies or sole traders taking different roles in different projects, sometimes leading and at other times being brought in by other companies or sole traders. Genovese et al argue, however, that a construction company (presumably even at large scale) is often more dynamic and changeable in its supply chain compared to supply chains in other industries (Genovese et al., 2013).

The construction supply chain is relatively flexible and 'agile'. The informal networking approach typical of microbusiness RMI trades illustrates a particularly high level of flexibility, adapting the skill set to different projects on demand.

4.4 Driving energy improvements in RMI: influencing homeowners

4.4.1 Advising the homeowner

A particular challenge in delivering energy improvements to privately owned existing homes is that, unless the work is stipulated through regulations, the individual owners are the decision–makers, and must be willing to accept the disruption and generally to pay for the work themselves. This necessitates both being able to identify the opportunities and to decide on the detailed measures required. This knowledge may come from the tradesperson, the homeowner themselves, or a third party (such as an adviser, consultant or an architect where one is involved).

Advice from the building tradesperson

Research participants said that while there is a knowledgeable type of customer who researches and decides on the details of retrofit for themselves, in many cases, the tradesperson needs to suggest what and how things could be done.

> *'Certain people know exactly what they want… other people are not really sure and are looking for advice from people in the trade like me…' [A04B]*

> *You can say, while you are there you could do this and this and this will cost this' [A05B]*

> *'With a customer you just say well this is what you should have. I try to push them towards the LED lights because it's the best product that I've found, and they are made just down in the valleys there' [A13E]'*

An experienced general builder knows the value of using their expertise early on in a project and may be in a position to visit a house with a client when they are thinking of buying it, and to advise on what work could be done and what it might cost.

> *'I do a lot of advising to clients …before they buy a property…I advise them on extensions and renovations…I was trying to set it up as a company but I haven't had time' [A02B]*

Two participants identified a particularly knowledgeable type of homeowner, who researches and identifies solutions for themselves, right down to U-values and insulation thicknesses. In some cases the homeowner actually project manages the work – although there are many variations on this theme in practice.

> *'If it's a self-build they do a lot of homework themselves' [B03M]*

'This particular client I worked for had researched it so much she knew more than building control' [A02B]

The tradespeople interviewed generally understood the potential added value of energy efficiency measures, and that RMI work offers a practical opportunity:

'..if you were planning a new kitchen, say hang on a minute why don't you insulate the internal walls? Is it 9 inch solid or is it a cavity? Kitchen upheaval is a big thing, but a couple of days just insulating under the floor, insulating the walls, insulating the ceiling, putting a vapour barrier, isn't going to be an awful lot of time if you are refurbishing the kitchen…and when you thinking we won't be doing this for another ten years ..you've actually future-proofed that room.' [A17B]

They were aware that improving energy efficiency can save on running costs but are not always confident that they can convince the customer of this. This suggests that a source of independent advice could be helpful, in particular one that provides this level of quantifiable detail.

'…when I do my quotes, I try to explain that the energy efficiency measures I have included will decrease people's heating bills and so on and increase their comfort - but I am aware that other builders won't be quoting for quite so much insulation and therefore I may not get the job as a result' [A01B]

'I think it's very hard for people to see the correlation between the amount of insulation and how much is that going to save' [A06B]

Awareness of energy efficiency technologies and the benefits is not always supported by confidence in ability to convince the homeowner

Where the tradesperson is suggesting what can be done, as opposed to working to a defined brief from the outset, the extent to which the customer is receptive to these suggestions, and how ambitious the tradesperson is in their advice, varies with the situation and the relationship. Having worked for the customer before, or being personally recommended, establishes a basic level of trust which puts the tradesperson in a stronger position to make recommendations. This is particularly important if the recommendations incur additional cost, perhaps because it's for a higher quality product or for something extra to the customer's original enquiry, for

example additional thermal insulation within a general RMI job such as re-plastering or fitting a new kitchen.

> *'I am in quite a good place generally because I am recommended and I think what people like is because I will tell them what I feel should be done and I am pretty sure they are fairly comfortable that I am not doing it just so that I can make as much money as I can' [A09CJ]*

The disruption and inconvenience to the household of getting building work done was raised as a barrier, together with an awareness that this means it is better to get as much done at the same time as possible, if you are facing disruption anyway. This is an argument for including energy efficiency work (such as insulation) in general RMI work, with the most disruptive work typically offering the greatest opportunity for the inclusion of energy efficiency improvements.

> *'It's only if you are starting from scratch that you will get people interested in energy efficient, because they don't want the house ripped about' [A22B]*

There was also a recognition that the whole house approach to retrofit is ideal and delivers the best outcomes in terms of reducing energy consumption and delivering other benefits.

> *'The most interesting projects are when there's a whole house being ripped out and there's an opportunity then to design in all sorts of solutions into the whole refurbishment. You can always get a better outcome that way than if someone just wants you to retrofit a wall or a roof, if that makes sense.'[A27B]*

Customers often cannot afford to do everything at once, however, and a customer may only have one room or a particular element of the building fabric in their scope at present. Compromises need to be made in practice, to deliver what is possible on energy efficiency within this limited scope.

> *'But in a lot of other cases, people want great outcomes with hardly any money to spend, and there's always these tricky conversations about…I mean I always want to have the conversation about how much it will cost in fairly early because people have expectations' [A27B]*

Energy assessments: quantifying costs and benefits

In trying to communicate the potential benefits of retrofit, tradespeople identified the challenge of how to quantify the savings and benefits in a credible and consistent

way. They are aware that being able to quantify savings against costs would help their case, but not how to access this information. This implies the need for advice based on an energy efficiency survey of the specific home in question. This type of service has been developed over the years and has taken different forms, variously described as an ‘energy assessment’, or an ‘energy audit’ – terms used broadly to refer to various approaches used to translate the characteristics of a home into a measurement of energy performance and/or guidance for energy efficiency improvements (Ingle et al., 2014, Maby et al., 2014).

In practice, energy audits or assessments can vary both in detail and process. A site survey is typically carried out, although for a new building this is sometimes done by looking at the design, without going to site. It would generally be carried out by a qualified assessor, although there are alternatives that are based on self-completion. The assessment would involve as a minimum a measurement of heat loss elements of the building and the heating and hot water systems, but some of this may be estimated based on the characteristics of homes of that age and type. Some approaches go further and include lighting and appliances.

The energy survey is typically followed by a written report, with an assessment of building energy performance, and ideally an identification of improvement measures, with estimates of costs and savings. This is generally based upon a standardised approach to measurement, calculation and modelling, with fixed rules to ensure consistency, as in the Energy Performance Certificates required by the EU Energy Performance of Buildings Directive (European Union, 2010). The EPC has been developed essentially as a tool for property assessment at the time of sale or rental, rather than as an advisory report to assist a homeowner in planning a renovation. Whilst these two purposes may beneficially be brought together, the current form of the EPC in the UK is of limited use for advice, having been simplified for ease of delivery and to reduce costs. Limitations include the level of detail on the existing property, as well as the range and practicality of recommendations (Maby et al., 2016).

The building tradespeople interviewed in Phase 1 of this research were generally aware of the existence of Energy Performance Certificates (EPCs), and that these certificates can be useful in bringing attention to energy efficiency - but saw them as of limited use and inaccurate:

'I truly think the calculations made are too theoretical and the amount lost through draughts and so on are astronomical' [A11B]

While paying for an EPC is seen by many as a barrier, it was also reported by interviewees that driving down their price makes it impossible for them to be done properly. Inconsistency and inaccuracies may arise in practice.

'He's probably doing eight a day, whereas to do it properly you can probably only do two a day' [A26H]

'You mean to tell me that I'm going to a house, test its energy, put my name to a legal document that contractors and surveyors are going to read and I get paid £50? You're in cloud cuckoo land.' [A17B];

….so damaging both the reputation and intrinsic value and usefulness of the assessment and accompanying report.

'We need to get the detailing right, and the assumptions right for the assessments…to make them correct you need time on site, and who's got that time'. [A17B]

The UK incorporated an EPC model into the assessments for the ill-fated Green Deal, and investigation of how the Green Deal assessments were carried out in practice revealed huge variations in the recommendations made by different assessors on the same property (Pink et al., 2010). A study of the 'SAP' (Standard Assessment Procedure) basis for the UK EPC (and Green Deal Assessments) concluded that the large variance between the estimated and actual energy performance of dwellings may be a serious barrier to take up of 'bottom-up' energy efficiency measures. This study points out that SAP and RdSAP (the reduced data set used in EPCs) do not in fact estimate energy efficiency, but rather attempt to estimate the cost-effective performance of the building – so potentially creating a perverse incentive.(Kelly et al., 2012).

The problem of inconsistency and the impact on quality of pushing down costs are acknowledged in the independent review commissioned by the UK government after the failure of the Green Deal (Bonfield, 2016). Other points on this issue raised in the review include the need for energy assessments to take into account the whole building, and for recommendations to be practical and to consider the interaction of the proposed measure with the building as a whole and with other measures (ibid).

Some builders are aware of other assessment products, such as an NHER (National Home Energy Rating) assessment using full SAP data sets (NHER has been acquired by Elmhurst[6]), or the Parity Projects Home Energy Masterplan[7]**.** These tend to be more costly than a basic EPC, but offer a more comprehensive approach. One builder liked the idea of using the Parity approach and adding even more to it – which highlights the benefits there might be in being able to use such systems flexibly.

> *'….someone approached me to do a sustainable refurbishment, what I'd really like to do with them is to do a Parity assessment, add in my bits on biodiversity, and water and things like that as well, and work from there on what they want to achieve…the design and how they want it to look as well, but start from the beginning…In practice, what happens is I get someone who approaches me who is already half way through, and their architect's done a bit of a design, and there's a lot of compromises involved…'[A15B]*

Reviews of EPC implementation across Europe highlight the diversity in approach and variation in comprehensiveness and quality assurance, as well as the scope of information provided - and the limited market penetration or acceptance by users as a result of the relatively low reliability and lack of user-friendliness (Arcipowska et al., 2014).

The Energy Performance Certificate (at least in its current form) is not an adequate tool for advising on home energy improvements.

One of the shortcomings of energy audits in terms of consumer acceptance is the potential gap between the user patterns of the household in question and the standardised model used for the calculations of energy use. While it is necessary to use a standardised occupancy in order to assess buildings against a benchmark, this can be confusing if consumption data is too far from matching that of the household. A study in the US looked at an alternative approach using a compact set of self-reported behaviours in place of the standard model (Ingle et al., 2014). The study found that a comparison of modelled savings of heating-related conservation actions shows that energy savings from moderate behavioural changes are on par with retrofits for many homes, and argues that this approach enables not only the

[6] www.elmhurstenergy.co.uk

[7] www.parityprojects.com/households/home-energy-masterplan

modelling of household behavioural changes alongside retrofits, but also bringing behaviour into conversations with homeowners and 'into the technically oriented efficiency paradigm in general'. The study indicated that this could be achieved by a short survey, not time-consuming compared to the collection of technical data and of equal efficacy in achieving energy savings (ibid). It could potentially be delivered alongside the energy assessment. An example of this is the addition of an occupancy adjusted report to the basic calculation used for the EPC or its equivalent, such as in the Parity Projects Home Energy Masterplan, referred too above, which combines a detailed technical assessment with user behaviour analysis and advice.

In spite of these weaknesses, in the context of integrating energy improvements into RMI, an energy assessment can be a useful technical tool to give a homeowner a perspective on the energy performance of their home against the benchmark of other homes, and a broad indication of the impact of different improvement measures.

Multi-stage advice and support - throughout the retrofit journey

While they are a useful tool at the early stages of considering energy improvements, energy assessments are only part of the energy advice and support that homeowners may need. The advice and support needs of homeowners undergoing energy improvements was researched as part of the Countdown to Low Carbon Homes action research project, which trialled a community-scale delivery programme for home energy improvements, run by a non-profit energy agency (Severn Wye Energy Agency), of which the author of this thesis was the CEO at the time. This research indicated that homeowners often needed one-to-one advice to explain their EPC and its implications for them (Charalambous et al., 2014) .

A good quality energy assessment is a useful technical tool to give a homeowner a perspective on the energy performance of their home against the benchmark of other homes, and an indication of the impact of different improvement measures, but may need to be explained to a homeowner to maximise usefulness.

Homeowners also need to be motivated to get an energy audit in the first place – especially if they have to pay for it. This latter point is supported by the results of a survey of home energy audits in the USA, that not enough homeowners knew about or understood audits, and that the follow-through on recommendations after an audit is incomplete (Palmer et al., 2013).

Countdown to Low Carbon Homes concluded that the advice and support requirements were multi-stage, and that impartial bespoke advice and support throughout the 'retrofit journey' can be instrumental in overcoming many of the barriers to domestic retrofit. While the process for any one consumer cannot be assumed to be linear in practice, the provision for this journey needs to span from awareness-raising and demand creation, through initial enquiry and detailed technical advice (informed by an energy assessment as above), to assistance in prioritisation of measures, seeking providers (installers) and finance, and finally the post-retrofit adaptation of user behaviour. The key support role identified was to follow through and provide support throughout the process, which was described as occurring in 5 stages (Charalambous et al., 2014):

Stage 1: Considering retrofit

Stage 2: Impartial advice (assessing the property and identifying and quantifying measures and savings)

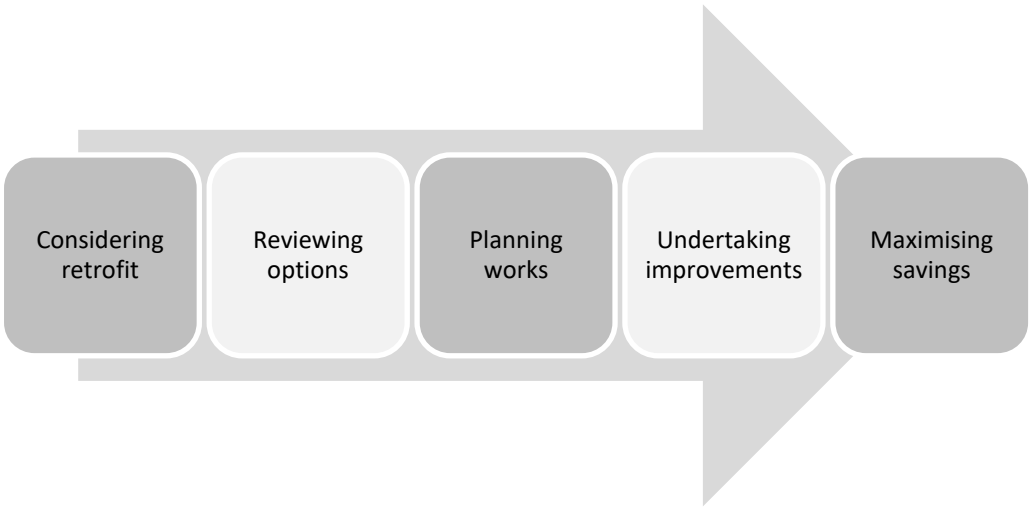
Stage 3: Planning works

Stage 4: Undertaking improvements

Stage 5: Maximising savings

Figure 6 offers an adaptation of this approach, replacing the 'impartial advice' stage developed by the project with the more generic 'planning works', which leaves it open as to how this is achieved.

Figure 6: The stages of a customer journey through energy renovation, (adapted from Countdown to Low Carbon Homes (Charalambous et al., 2014))



Homeowners would benefit from access to expert advice on energy improvements, and may need support at several stages of the renovation process .

A key aspect of the programme was to establish a network of local installers, to help home owners to find those closest to home. The longer term aim was to populate this network, not only with specialist energy efficiency and renewable energy installers, but also with mainstream local building trades companies, to maximise the benefits of knowledge exchange and joint marketing, and the realisation of trigger point opportunities offered by repair, maintenance and home improvement works (ibid).

This moves beyond 'advice' into a wider support and facilitation role. This programme of support to homeowners through the retrofit journey may be described as a type of 'one-stop-shop', in this case providing the advice role independently of the actual delivery of works This kind of approach, run by a non-profit agency working in partnership with local authorities, offers the benefit of advice which is both unbiased as regards which technologies are recommended, and relatively time-generous – but this is difficult to run at any scale without funding which is equally independent of bias. A different approach is to include the advice as part of the delivery of works, allowing it to be costed into the latter, but losing the commercial independence. The latter is closer to the situation where the builder in effect provides the advice, noted as occurring in the course of the interviews in Phase 1. In practice, these roles can be complementary and mutually supportive.

The lack of recognition in policy of the need to support the action phase of the 'retrofit journey' has been highlighted in commentary on EU policy, and appears to be a common gap in approach. The need for a technical survey is recognised, and to some extent the broad 'awareness-raising' required as a bedrock for demand creation, but the concept of 'advice' stops after the EPC, with its limitations as indicated above (Maby et al., 2016). An indication of a growing awareness of the need for a more comprehensive process is the inclusion in the EEU Horizon2020 programme of the topic 'integrated home renovation services' (topic identifier LC-SC3-EE-2-2018-2019)[8].

The concept of the 'one-stop shop' could be broadly described as an outlet which provides more than one related service – so avoiding the need for the consumer to

[8] ww.ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topic

go to more than one ‘shop’ to satisfy their requirements. The idea of the one-stop-shop for building renovation might be interpreted as including an advisory service, assistance in sourcing installers and suppliers and in identifying finance for measures, and support through the process (Erwin et al., 2016). Alternatively, it could perhaps consist of a general renovation service, which includes energy improvements. As part of the ‘One Stop Shop’ ERANET-ERACOBUILD project[9] a study investigated the opportunities and barriers to the establishment of a “one-stop-shop” with an integrated supply side, to counteract the fragmented offer in sustainable renovation of single-family houses and to increase the level of knowledge, skills and innovations (Cré et al., 2012). The one-stop-shop concept included providing reliable information and guidance for house-owners, and the study involved a survey of the Flemish construction sector, to find out the views and willingness of enterprises to cooperate in a one-stop-shop. The survey concluded that a large percentage of companies were willing to work together, but that there were socio-technical and know-how barriers (ibid).

The One-Stop-Shop project was reviewed in a paper ‘New business models for holistic renovation solutions of single family houses’, along with another research project called ‘SuccessFamilies’. (Haavik et al., 2011). Both projects focussed on single family houses in the Nordic countries, representing the biggest saving potential in the residential sector there. These projects built upon earlier research which identified this idea of a single contact point to enable a renovation project as a missing link between the single family house owner and the available offers of single solutions for renovation and/or energy efficiency installations (ibid). This description tallies with the author’s own observation when assessing the local market as a basis for developing retrofit programmes in Gloucestershire (Maby, 2011).

Haavik et al highlighted the ‘trustworthiness of the supplier’ as a key issue for any business model which offers an integrated service with an analysis of the house and recommendations for measures. The paper also pointed out that as a holistic energy efficient renovation project is a “new” and unknown service to most single family house owners and at the same time a costly investment, it is important for the suppliers to find effective ways of communicating through all phases of the buying process - with various challenges in each of the phases which may require different solutions (Haavik et al., 2011). A related insight comes from a Danish study which

[9] http://one-stop-shop.org/

considered the role of different actors in the renovation of a hotel, that highlighted the need for trust between the 'actors' involved, and the complexity of the process for extensive energy renovations – not because it is technically complex, but in the socio-technical interactions involved (Mosgaard and Maneschi, 2016).

The value of the 'one-stop-shop' approach, in its various interpretations, is endorsed by the conclusions of a study which analysed 42 energy efficiency businesses and their business models in 5 countries. The study concluded that these businesses were missing out on market opportunities due to their narrow focus on products rather than services, pointing out that to reach a mass market, these services are needed to facilitate the uptake of the products – alleviating 'decision-stress' and potentially providing non-energy benefits as well (Mourik and Bouwknegt 2017).

A single contact point or 'one-stop-shop' is a missing link between a home owner and the range of single technology offers for home energy improvements.

The researchers in the Nordic study (Haavik et al., 2011) pointed out the variations in how the renovation providers interacted with the home owner, and the implications for who takes on the risks in a renovation project. This echoes what was found in Phase 1 of this research, in relation to the variations considered in the informal local inter-trade networks as illustrated in Figure 5. The observation was made that the house owner may either be invoiced by each supplier of services and products, or by one main contractor who takes on the complete responsibility (ibid).

A further observation from the Nordic study (ibid) of high relevance to this research is that the supplier trying to offer a holistic solution has to compete for consumer attention with the single technology offers – and that most 'information only' provision (such as websites) tend to offer single solutions. A possible implication of this is that simplistic information sources (as opposed to 'advice', which may be both more holistic and tailored to the specific needs of the consumer) may actually obstruct the market for more holistic low energy renovations.

Suppliers offering a holistic solution have to compete with single technology offers, and simplistic information services may actually obstruct the market for more holistic energy renovations*, *by competing for consumer attention.

The literature review and exchange of knowledge within professional networks revealed some further examples and variations of the one-stop-shop approach, ranging from an advisory and facilitating role, with the addition of introductions to suitable contractors, through to a fully managed process, and the inclusion of different financing models:

The Danish BetterHome initiative is an industry-led partnership between four manufacturers: Danfoss, Grundfoss, Rockwool and Velux (Buildings Performance Institute Europe, 2018);(Leonardo Energy, 2018). As in Countdown to Low Carbon Homes, the scheme (in this case established as a private non-profit organisation) acts as a facilitator, introducing the installers to the homeowners but with the actual contract remaining between the homeowner and the installer. BetterHome oils the wheels of the process, featuring a software application on which the progress of the project is saved, including the initial to-and-fro on options and costs. Training is organised for installers, in installation and in selling the concept to the homeowners - with a strong emphasis on comfort rather than financial return on investment. Another feature is that one installer is responsible for coordinating the renovation, including any other trades they need to bring in, so that the approach is focussed on providing a service rather than selling a product. (ibid)

The Superhomes model[10] , developed by Tipperary Energy Agency takes this a step further, in that it manages tenders for the works. The programme is designed to bring homes up to an 'A' rating (under the Irish Building Energy Rating Scheme, BER), including insulation, heating equipment and renewables technologies, with funding for 50% of the costs.(Tipperary Energy Agency, 2018)

The Picardie Pass Rénovation[11] goes further still, managing the delivery of the works contracts, and providing a low interest loan, through a public-private partnership arrangement, using funds from the regional government and the European Investment Bank (EIB) (Région Haut de France, 2018).

The London-based Retrofit Works cooperative[12], launched in 2013, has both customers (as community 'advocates') and practitioners as its members, with a strong focus on locally active SME businesses. Quality assurance is emphasised,

[10] www.superhomes.ie
[11] http://www.pass-renovation.picardie.fr/
[12] www.retrofitworks.co.uk

with careful vetting of member businesses and the works checked and managed by a qualified 'Retrofit Coordinator'. The costs of these additional services are built into the contractor costs as an overhead. This reflects the localised nature of the businesses engaged in renovation, and is structured to be viable without public funding, although in practice, it is understood that London's local authority programmes have generated much of the work for the cooperative to date.

Over-time and whole house renovation

To understand fully the homeowners need for advice, the time dimension of making energy improvements must be taken into account. Technically the ideal scenario is for a home to be renovated to a low carbon standard in one carefully designed renovation, but in real life there may be many households that are not in a position to do this, for example because of cost, and the need to continue to live in the house. It is necessary therefore to recognise that at least some eco-renovation may (need to) take place over an extended period of time, with implications both technically and in terms of the need for appropriate support mechanisms. Fawcett and Mayne identify positive aspects to 'over-time' renovation, in terms of the adaptation of user behaviour, and the potential availability of new and improved technologies, as well as allowing people's ambition to grow over time as they learn (Fawcett and Mayne, 2012). This perspective recognises the importance of signposting opportunities for adding 'eco-renovation' measures to other works, the need to develop and build learning on spotting these opportunities amongst tradespeople and associated professionals, and the homeowners' need for ongoing advice and support over a longer period of time (ibid).

How can this be achieved in practice? One aspect of this is a different approach to energy audits to that typically represented by an EPC, not only to be more comprehensive in terms of building detail and recommendations for action, but to identify when and how these might be built into general repair, maintenance and home improvement works over time. This means moving from a 'snapshot' report into a working document that can be updated as changes are made and made available to subsequent owners and builders.

An example of how this might be done is provided by the concept of the 'building renovation passport' (Fabbri et al., 2016), in a recent study of three pilots in Flanders, France and Germany. The study takes as its starting point a recognition of the slow rate of renovation, and that the lack of knowledge about what to do, where to start,

and which measures to implement, in which order, stands alongside difficulty in accessing finance as key barriers to improving the energy performance of existing buildings. The 'building renovation passport' is described as a document outlining a long-term (up to 15 or 20 years) step-by-step renovation roadmap for a specific building, resulting from an on-site energy audit fulfilling specific quality criteria and indicators established during the design phase and in dialogue with building owners. It would include estimates for the expected benefits in terms of reduced heating bills, comfort improvement and CO_2 reduction. (ibid)

Energy improvements implemented over time in conjunction with RMI work could be supported by a long term renovation roadmap for a specific building, based on a detailed energy assessment. This could be combined with a repository of building-related information.

4.4.2 Household characteristics and attitudes

An insight from the experience of building tradespeople in relation to customer choices is that there are different types of customer, with different priorities. The same approach may not work with everyone – and the level of interest in energy improvements varies considerably.

The level of customer interest in different potential benefits was reported to vary widely. Cost in particular, was indicated as an important issue, but investigating what this meant brought out a variation in how cost was considered.

> *'I'd have trouble convincing people to go down the green route if they didn't want to, because I'm not – well I know it works and I know it saves money, but it's very expensive to put in, so to try to sell it to someone that is a bit reticent about putting it in would be a hard job' [A18P]*

> *'They wanted insulation in the floor, and then I said well there's no point in having insulation in the floor and not in the sides or the roof, and they were just shocked by the cost then…they never ever got back to me, and I worked out a price, and I never heard any more…' [A25B]*

Different customers might view costs differently. Some are worried about future running costs, and may be willing to spend now to save later, at least with encouragement to do so.

'When you talk 10 or 50 Watts you may as well be talking Chinese, but when you say the meter will spin 5 times faster with that one then they understand…'[A04B]

'…in a perfect world, as a builder, what you have is customers insisting on the highest quantity of energy efficiency measures, because they know it's to their advantage in terms of the costs of running the house….' [A01B]

'Definitely they are aware of the rising costs of electricity…all my customers are pushing towards LED lighting, more efficient lighting' [A03E]

Also with reference to LED lighting:

'…some need persuading a bit more than others because the cost implications are usually greater, but 95% of them are quite happy to go down that route and will pay that extra money...the initial outlay is usually a lot more, but when you show them the benefits, the amount they would save in costs…'[A03E]

On the other hand, it was reported that some very well-off customers were apparently unconcerned about running costs, and unconvinced about the value of spending money on energy efficiency.

'Some people don't care because they've got enough money and they don't care about the bills' [A06B]

'…he's looking to buy another house just so he's got a place to stay in London, and he's going to put a million pounds into it, and when I talk to him about saving on his heating there's no chance, and I reckon it could save him 50%. He wants to save it but he says I'm barking, at the idea of paying you x grand, and I said you would save it back in three years, and anyway you shouldn't be thinking about payback, you should be doing it, and it went straight over his head...' [A11B]

In some cases, the appearance or historic features of a home may take precendence for the homeowner over energy efficiency considerations:

'an enormous house….and its absolutely freezing because it's all solid walls, and she worries about spending money to heat it, and they're filthy rich.. they could afford to really heat it but it's a significant part of their household income that could go on it so they don't use it as much as they might…but she also

doesn't want to insulate the house because the interference or the perceived interference with the façade and all these other things..[A15B]

Converting interest into investment

In practice, an initial interest in energy improvements might not be carried through to a decision to invest in them. Money that could be spent on energy improvements comes from a finite pot from the point of view of most homeowners, and may have to compete with other wants and needs, such as a holiday.

'People only have a certain amount of money to spend, and if it's ….. more insulation or go on a Spanish holiday…. [A08B]'

'People always like the idea, but it's the cost that it comes down to, and if my price is higher because I have included more energy efficiency, they may well choose the cheaper one and forget all about the energy efficiency' [A01B]'

In some cases, older customers may be unwilling to spend on the more expensive energy improvements purely on the basis of reduced running costs, as they think they will not live long enough to get a return on their investment;

'…solar panels and all that, people were taking them when they are incentivised, but left to their own devices, they are going to think, no… well I won't be here long enough..' [A05B]

Many tradespeople are also aware of the wide range of co-benefits of energy efficiency, as well as savings on energy bills. These include the extra comfort and health benefits of staying warm and reducing damp, as well as protecting the environment through using less energy and producing less carbon emissions. Some of these concerns may encourage the knowledgeable builder to suggest energy improvements, as well as spotting opportunities in renovation and repair work.

'Well, usually people are worried about, say, damp, or they just want changes to their kitchen, or whatever, draughty windows perhaps, or double glazing doesn't work so well any more, or…' [A11B]

The homeowner's willingness to invest to improve comfort is sometimes the deciding factor, especially with encouragement from the builder.

'…I used to do a lot of loft conversions, and I always exceeded the insulation regulations because I thought it was so important, and people said how

wonderfully warm these spaces were…and my argument has always been a little bit of insulation on the overall cost isn't that much more, so it's always worth putting extra in if you can' [A01B]

'…trying to stay off your saving money thing for someone who is well off. Chatting about the comfy factor, you are sitting there talking and your feet are cold….there was customer of mine that I asked can you describe what your house is like now and she said I think of you when Strictly Come Dancing comes on and the family all come down to watch and we used to huddle together and feel cold, and now we spread ourselves out.' [A11B]

These comments are echoed by the conclusions of a study of German homeowners, which indicated a disconnect between public policy which supports retrofit and the lower than expected take-up by homeowners – suggesting that the economic savings are overstated, and that more emphasis on the co-benefits may yield better results as far as deep retrofit is concerned, while a more flexible approach encouraging take-up of more selective cost-effective measures tailored to specific buildings may be more widely acceptable (Galvin, 2014).

A study of market barriers to retrofit in the EU arrived at more fundamental economic conclusions, that people were not keen to improve the energy efficiency of their homes as they did not see a proportionate increase in the value of the property – and that a widespread problem was that energy prices do not include the external costs that use of energy causes, such as pollution (Tuominen et al., 2012). The latter study emphasised that the financial argument for energy improvements is unlikely to be enough to convince homeowners, and that promotional effort needs to focus as much on the co-benefits. (ibid)

The financial argument for energy improvements in terms of increased property value or energy bill savings is unlikely to be enough to convince homeowners to retrofit at the scale required. It is necessary to promote the co-benefits as well.

One of the barriers to take up of home energy improvements is illustrated by a study of home owners in New Zealand, which investigated the 'apparent disconnect' between the low level of adoption of energy efficiency technologies and the benefits of doing so, citing environmental, comfort, economic, health and social well-being advantages to be gained from improved home energy efficiency (Christie et al., 2011). The study identified 'disconnected behaviour' in that even when homeowners

knew and apparently understood the benefits, they were unwilling to invest in the technologies in question – a result which challenges the simple assumption of an energy efficiency market which performs according to rational decisions by the informed consumer. The study then went on to try to find out why, considering several factors (ibid):

- Psychological: homeowners, as individuals, are motivated to act because of their own internal attitudes, value orientations, morals, habits or demographic characteristics;
- Social psychological: homeowners' behaviours result from the need for social approval or due to biases in collective action;
- Behavioural economic: homeowners are not economically rational but rather are affected by unconscious cognitive influences causing them to make errors in their judgements;
- Technology and context: homeowners do not adopt such technologies because they perceive their dwelling or household context to be unsuitable to the technology's characteristics.

It is argued that only the last of these four factors is conscious behaviour – the others are all unconscious. The results of the study are illuminating: the main barrier appeared to be a preference for no change based on a perception of risk. At least three different kinds of risk arose: financial (even where subsidies meant that there was no upfront cost), technical (that there could be technical problems, even where not specified), and social (that they would place themselves outside the social norm by taking up these technologies) (ibid). This preference for no change underlines the challenge in generating consumer demand for home energy improvements – and the importance of ensuring that they are included with other works for which there is a demand (and a readiness for change linked to concerns other than purely for energy efficiency), as indicated by the thriving RMI market.

Homeowner preference for no change underlines the challenge in generating consumer demand for home energy improvements and the importance of ensuring that they are included with other works for which there is a demand: the thriving RMI market.

Market segmentation: understanding the consumer

Homeowners are not all the same. The prioritisation of, and order in which measures are taken is unlikely to be based only on the costs and benefits of the individual measures. Other factors include fitting around on-going use of the building and the ability of the occupants to adapt as works are done, the availability of finance, comfort needs and priorities, what is being said about different technologies in the media and the neighbourhood, and what relevant works are planned for reasons other than energy improvements (Tweed, 2013).

One of the merchants interviewed highlighted the point that householder demand tends to be linked to home improvement 'wants and aspirations' rather than specifically to energy improvements.

> *'They are not waking up on Saturday morning thinking how am I going to solid wall insulate my house' [B02M]*

Some homeowners, however, are driven by aspirations about making the home environmentally friendly and willing to invest heavily in this.

> *'People don't HAVE to insulate their walls. So all the clients are fairly aspirational…got some money or think they know how to get some…have an aspiration to fulfil, none of it essential…' [A27B]*

> *'You get retirees with plenty of dosh and they want to build their own house …and to make it more efficient, and they tend to want to manage it themselves' [A13E]*

A 2009 survey of more than 400 owner-occupiers of single-family detached, semi-detached, and row houses in Germany looked at motivations and barriers to retrofit, and the impact of different (simulated) policy measures. The results indicated that those most likely to go ahead were the ones who were both able to afford it financially, and for whom it was profitable (or at least perceived a such) – and for whom a 'favourable opportunity' presented itself, such as heating system that needs replacing or a building needing renovation. The latter point is emphasised as a major factor – linking to the central theme of this research. It is also seen as a barrier, however, insofar as many homeowners wait until building components reach the end of their useful life before considering replacement (Achtnicht and Madlener, 2014).

Haines and Mitchell's use of a 'persona-based' approach in response to the socio-technical challenges of energy renovation sought to understand the specific drivers and appropriate range of policy responses for each persona (defined as archetypal users who embody the goals and aspirations of real users) (Haines and Mitchell, 2015). They describe approaches used by others, ranging from the very generalised and limited in its practical usefulness (such as the 'interested, ambivalent or not interested' characterisation used by Pragnell, Spence and Moore), through to detailed market segmentation (typically commercially confidential).

The approach taken by Haines and Mitchell is somewhere in between these two, and offers some practical insights for anyone aiming to influence a homeowner to invest in energy improvements, with indications of the likely level of interest and why, as well as differing expectations of tradespeople. The 'Idealist Restorer', for example, gets involved and makes their own decisions on the details, while the 'Affluent Service Seeker' is more hands off, but expects reliability and high quality. The former is seen as 'very open to retrofitting energy efficiency measures and in an optimal order if the aesthetics of the home are respected, and interested in 'clever' energy saving technologies but only if the character of the home can be maintained', while the latter is 'open to incentive schemes and polices that generate income for the homeowner or add value to the property'. The 'Property Ladder Climber', on the other hand, is most likely to be interested in energy saving measures if they offer a return in terms of selling, and is unlikely to consider technologies with long payback times unless the cost of installation is passed on. The 'Stalled' (either due to lack of finance or lack of time – or both) is likely to be difficult to convince, although the former type may be open to grant-aided work. The 'Pragmatist' is possibly the persona which might be most open to the practical opportunities for energy improvements offered by RMI work. (Haines and Mitchell, 2015)

These insights into market segmentation concur (albeit in far more analytical detail) with the broad experience of interviewees in Phase 1, and suggest that supporting small building businesses to evaluate customers, identify what motivates their decisions and match those to the multiple benefits of improved energy efficiency could help to ensure inclusion of energy improvements within other works. It could also be helpful to assist businesses in matching what they can offer to different types of customers, taking account of the role the customer intends to play and how involved they will be in the work, how knowledgeable they are, and how much they are able or willing to spend. This may in practice be a skill that is innate to the

building tradesperson who has a direct dialogue and relationship with their customers, but could be helpful in promoting new services and products such as energy improvements, if they are not already doing so. Considerable thought is needed, however, as to practical methods to offer this support.

In promoting home energy improvements, it could be useful to support businesses in matching what they can offer to different types of customers, taking account of the role the customer intends to play and how involved they will be in the work, how knowledgeable they are, and how much they are able or willing to spend.

The ability of insulation installers to develop insights into the characteristics of the household they are approaching, based on visible indicators such as toys in the garden, was noted by Owen (Owen, 2013). The 'soft skills' in terms of communication and understanding and working with the needs and interests of different customers are highlighted. In further analysis, the many skills and attributes are tied into four suggested areas of capacity for energy efficiency installers:

1. Their technical capacity,
2. Adaptive or problem solving capacity,
3. Their interpersonal skills,
4. Their personal motivations in undertaking retrofit work. (Owen et al., 2014).

Some studies suggest that a lack of softer skills on the part of tradespeople in terms of client liaison and (perceived) reliability may be a barrier (Mallaband et al., 2012). Different clients will expect and require different approaches from the building tradespeople who come into their home, and responding appropriately to a client's expectations can be more than just a technical challenge (Haines and Mitchell, 2015). The ideal scenario is that the home owner has a specific interest in making the home energy efficient and environmentally friendly, and that this combines with the skills and capacity of the tradespeople they use, together with the capacity for trade and client to learn from each other (Fawcett and Killip, 2014).

The influence of installers may go beyond decision-making about measures, with homeowners not only influenced in what technology they adopt, but also how they use it, by the advice they receive from installers. The extent to which they trust and follow such advice may be affected by their view of the work that has been done, which is in turn affected by how they experience the installation process (Owen, 2013). This latter point was reflected in the Countdown to Low Carbon Homes

research, where the homeowner particularly remembered things such as whether the installer had left everything looking tidy, and the extent to which things had been explained to them in advance, such as the need to use electricity for the work, dig up parts of the garden, or have gaps in the work when they would go off site (Charalambous et al., 2014).

The difference between customers affects the role that the RMI builder fulfils. Different types of customer may require some different responses and capabilities from the builder, in addition to their core building role. Some possible variations are set out in table 8 (Maby and Owen, 2015).

Table 8: How customer characteristics may vary requirements from builders

Customer characteristics	Requirements from builder
Employs architect	Follow drawings and liaise with architect on specification where needed
Informed client with time	Learn from client
Informed client with cash	Follow and interpret client's specification and discuss solutions where needed
Informed client with no cash or time	Understand and interpret what client wants, identify and communicate options, design and specify job, coordinate and project manage.
Ill-informed client	As above plus informing and 'educating' client
Disinterested/hands -off client	As above, plus encourage/influence best decisions

(Maby and Owen, 2015).

A recent UK project combined elements of different processes to conceptualise retrofit and found, among other things, that the decision making and design process for renovations including energy efficiency is a long process, and that while the costs of energy efficiency measures were not a barrier in themselves, higher costs would make the decision making process even longer, with a key feature being that installers or designers are engaged in an iterative process to develop the optimum solution for that household (Wilson et al., 2013). This highlights the importance of communications in linking the different actors and parts of the retrofit process together. It also highlights the facilitating role in guiding such a process and maintaining momentum, as identified in Countdown to Low Carbon Homes, and to a greater or lesser extent in the 'one-stop-shop' model (Charalambous et al., 2014).

A related issue is the need to look at the 'whole house' as an integrated system of building fabric, services and users, with different measures taken impacting on each other and the whole system. Given that humans live there (and that it is not a sealed box), a home cannot be a perfectly controlled system – and effective solutions cannot

be just a ‘technical fix’ that does not take account of the occupants. Judson and Maller (2014) used a practice theory approach to analyse the intersection of renovations with homeowners’ practices, highlighting the disparity between policy and everyday life, and concluded that current policies and programmes focused on technical interventions to improve energy efficiency will have limited reach and impact. They suggest that (among other interventions) policies to reduce the environmental impact of housing should be reframed around and positioned to address the mundane practices of everyday life (Judson and Maller, 2014).

A study of home owners’ response to the UK government’s Green Deal programme (launched in 2013, and effectively abandoned by the end of 2015) found that energy efficiency is of potential appeal to all home renovators, regardless of their attitudes about energy efficiency, but that it needs to be considered at an early stage in the planning process for a renovation. This emphasises the role of the RMI building tradesperson as the first point of contact for the homeowner in many cases. In relation to the Green Deal, it was noted that their interest can be weakened by uncertainty about the financial benefits. A conclusion of high relevance to this research was that approaches like the Green Deal should target all renovations, not just those which are stand-alone energy efficiency improvements. (Pettifor et al., 2015).

Taking as their starting point the observation that the energy efficiency of a house may be improved as an additional advantage of home improvement, but rarely seems to be the main incentive for change, Mallaband, Haines and Mitchell considered what we might learn from previous home improvement experiences to help us understand how to achieve low carbon refurbishment (Mallaband et al., 2012). They noted that low interest rates could make investment in homes relatively attractive at a time when savings (in banks etc.) generate little income. Based on the views of a relatively small sample of 20 home owners, living in older properties, they observed that:

> ‘*the depth of property-related knowledge held by many householders regarding their older properties was surprising, causing great frustration when professionals did not share the same specialist knowledge’*.(ibid)

Householders in this research also complained of tradespeople not coming back with the requested quotations, and referred to this as ‘unreliability’ (ibid). The tradespeople themselves were not asked research why they had not provided quotations, and this author’s experience of speaking with microbusinesses suggests an alternative

explanation - that requests for competitive quotations can be very time-consuming and tradespeople need to prioritise confirmed work above requests for competitive quotes. Describing this as 'unreliability' may indicate a misconception on the part of the homeowner about the status of the transactional relationship, prior to any work being commissioned – encouraged by public guidance to 'get three quotes'. This lack of engagement with the building tradespeople themselves underlines the gap in knowledge which this present research seeks to address.

Wilson et al (2014) highlight the limitations of using applied behavioural research to analyse energy efficient renovation decisions solely in terms of drivers and barriers, arguing that renovation decision-making cannot be understood by looking at this issue in terms of:

> '*houses but not homes, energy efficiency but not home improvements, the one-off but not the everyday, and renovations but not renovating'*

(Wilson et al., 2014).

Setting this against a sociological view of homes and domestic life provides a more situated approach, which acknowledges the impact of removing barriers, but explains decisions as processes which happen as part of everyday domestic life, where there may be a variety of factors, both personal and contextual, that encourage motivation or obstruct decisions to make energy improvements – or to renovate at all (ibid).

An overall perspective from these studies is that extensive home energy improvements at the level required to meet climate targets is highly unlikely to be achievable without powerful policy interventions, either regulatory or financial. The motivation generated by policy then needs to be supported by installer knowledge and advice on what to do and how.

Extensive home energy improvements at the level required to meet climate targets is unlikely to be achievable without powerful policy interventions, either regulatory or financial.

Building tradespeson attitude and preferences

For the building tradesperson, energy efficiency is one of several considerations that they need to take into account in discussing options with a customer. Their experience will have formed their own attitudes and preferences. Some of those interviewed referred to other specific benefits provided by particular retrofit

technologies, such as energy efficient lighting producing less heat and improving fire safety, the sound-proofing benefits of double glazing, or underfloor heating allowing a household to get rid of radiators and improve the space and appearance of the home. While for some tradespeople this was part of a wider interest and knowledge in environmentally friendly solutions, for others this was more about simply being up to date with technology and offering a good service to the customer.

> *'I don't promote it, you know, solely as being energy efficient, it's just part of my job…even if it's just a little extension or a kitchen refit – just pointing out to people that if they have these recessed lights in the ceiling, that the old lamps were 50 Watts and they get incredibly hot and are a fire hazard, and you are replacing them with something that's cool and efficient, a fraction of the wattage, a fraction of the running costs, alright its expensive at the start but they like the savings they will get.' [A03E]*

> *'…the other thing I think is criminal is that when you buy a downlight, it comes with a free 50 Watt Halogen bulb, which is the worst bulb you could put in light fitting, they get red hot and they are the most maximum amount of usage you could have and arguably it's because they can't sell them any more…'[A04E]*

> *'It's finding the best way to explain and describe the benefits of energy saving...you know the way the secondary glazing market sells itself – it's sound proofing, not energy saving.' [A11B]*

In response to a prompt question about how to ensure more energy improvements could be included in RMI work:

> *'I would look at this from a different angle, I would make sure houses are always beautiful so no one will knock it down and build it twice. I would make the windows designed properly so they wouldn't rot. So the energy doesn't get used in having to make a new one. I tend to look at it as what's right for the planet not what's right for my pocket...' [A09CJ]*

Some specific comments were made in relation to the co-benefits of choosing underfloor heating, which can provide an even background heat and avoids the need for radiators, which in turn gives you more space and feedom in where you can place furniture. The longer term benefit of lower maintenance was also highlighted.

'It gives you a better spread of heat. It gives you complete freedom where you put your furniture because you don't have this thing slap on the wall that you don't want to block out, so I think if I was building new for myself now I would put in underfloor heating.' [A26H]

'Lower maintenance, you don't have to paint anything, you don't have to take 'em off the wall every time you want to redecorate.'[A26H]

Other longer term benefits identified were the potential increase in value or 'rentability' of a property.

'If I say look there's 10 inches of loft wrap up in this roof, make it cosier. It'll lower your heating bill. Well, that gives you a slight edge doesn't it'? [A26H]

'And making it solar ready, that's not regulation, it's just you being aware…yes, and it'll add value to the property and mean lower bills.'[A26H]

However, not all the tradespeople interviewed were enthusiastic about all retrofit technologies. An electrician had experienced practical problems such as the difficulty in accessing wiring in the loft after it has been insulated. He also noted that insulation offers a comfortable home for vermin.

'The additional insulation that goes in roofs is a nightmare in terms of vermin if they decide to make their home right in the middle of this additional layer that they put in, in all different directions up in the roof now, you say sorry I'm not getting up in there, because you've got over a foot…and then you can't get at it, and there's always a sign that they put up now saying 'danger do not walk on insulation'...maintainability is a nightmare…' [A13E]

Some builders had encountered damp problems linked to insulation in some way – due to the particular situation, the detail of the work, or choice of materials.

'It's depending on what the building is built of, where it is, how exposed it is, and what the quality of the work is like, because filling in cavities with insulation can be a problem if the cavity trays are not good and...'[A25B]

'I went on a very interesting course…all about the perils of badly specifying internal wall insulation materials - you know you put phenolic foam or polyisocyanurate (Celotex in other words) on a wall that needs to breathe and you might just stack up a whole lot of other problems in the future.'[A27B]

'…obviously it's regulation to put insulation under the floors now…but you don't want problems under floor, if that insulation gets damp, it will swell, and I've heard stories of it swelling and actually cracking the slabs…" [A25B

Another issue reported was damage to roofs during a solar panel installation.

'I've had to go back on jobs where solar panels have been fitted, and fitted badly, and they've broken tiles or slates, and stuck them back together with some sort of adhesive that lasts for twelve month, and then you've got the water coming in…..' [A25B]

Others indicated personal preferences, such as disliking the appearance of solar panels.

'With solar panels, I don't like them because I think they look awful, so why can't they make solar panels that look like slates? That would make me more keen on it' [A16B]

For some measures, the practical barriers (or the costs related to such practicalities) are the major obstacle, particularly in older buildings with space limitations.

'…occasionally I've had a space issue, maybe in converted dwellings, or where you have 2 dwellings converted into 4 flats for example, and they really should have had some insulation put on some walls, but there isn't always enough internal space' [A21H]

'…it's easy to put underfloor heating in a new build but it's not easy to do it on refurbishment unless you want to tear your floors up or raise your floor a little.' [A26H]

'They all would like underfloor heating, and if you get into underfloor heating, then you do insulate the floor. But you've got to dig the floor down 12 inches deep roughly, and people won't go to that expense, because it's a major drama in the house and you can't live there for a good few weeks' [A12B]

'..and the trouble with sloping ceilings is you've either got to take the roof off to do it, or take the ceiling down, and that gives massive implications on how much it's going to cost to do…'[A16B]

In one example, the building tradesperson was actually persuaded by the homeowner to include enhanced energy efficiency, and then continued to recommend it himself after that.

> *'Years ago I wouldn't put draught-strips in because I though well the windows are going to last 100 years, and the draught-strip just 10, but somebody … said please can you put them in because the house is so cold, and the windows are ancient. So I agreed to do it and found it made such a difference to temperature, and even if it just lasts 10 years well you can take them out and put new ones in… and it makes the window run better…very, very much warmer, but so now I recommend people to do it' [A09CJ]*

In some cases, concerns were raised about the detail specified by the architect.

> *'It's a stud wall with polythene behind it, now as a builder I don't agree with that, because I think it would cause sweating, but the architect specifies that every time' [A16B]*

Another builder raised concerns about the lack of focus on the condition and maintenance of a building as a basic standard before attempting to improve energy efficiency through the application of expensive measures.

> *'There isn't enough emphasis on doing a quality survey in the first place, and there's too many assumptions that everything is right anyway...so when you get into a property, you have masses of problems....We are not even doing the basic maintenance and structural stuff first, and if you can't get the basics right, then the efficiency issues, we're not even going to touch them.' [A17B]*

A variation in customer motivation which came up in these conversations, is the issue of the 'split incentive' between landlords and tenants. The term is used to describe:

> *'transactions where the benefits do not accrue to the person who pays for the transaction'* (Economidou, 2014).

In the context of energy improvements to rented properties this refers to the landlord paying for improvements which they are unable to directly benefit from, the benefits in comfort or reductions in cost accruing to the tenant. Tradespeople working for landlords across multiple properties recognised that this may contribute to landlords being less willing than owner occupiers to invest in energy efficiency.

'You give 'em a price and it includes TRVs and they say I don't want TRVs and you say well the law says you've got to….Because what the landlords say, and I hear it time after time, is 'I don't pay the bills – why should I worry?.....' [A26H]

4.5 Getting it right: knowing what to do and how

The previous section focussed on the homeowner as the decision maker in whether or not to include energy improvements in their RMI work. The building tradespeople are highlighted as important influencers in this process – whether or not supported by third party advisory or 'one-stop-shop' services, which can help both to make links between homeowners and tradespeople and to complement what they are able to offer. In order to deliver energy improvements effectively, it is necessary therefore that building tradespeople can obtain the knowledge and skills required – both to identify the opportunities and to deliver them. Those carrying out the 'general builder' role take this beyond the work of a single trade and take responsibility for more major projects, ranging across several trades, and requiring a wider skill set and range of knowledge.

This raises the question as to how, when and where building tradespeople can acquire such knowledge and skills – and to what extent this can and should occur within initial formal training (through college and apprenticeships), or later additional training. The apparent lack of any specific qualification for the general builder (noted in the course of the Phase 1 research) raises concerns given the central role that such tradespeople play in the RMI market generally, and in particular with regard to the potential for inclusion of energy improvements within RMI.

4.5.1 Designing and specifying energy improvements within RMI

In large or commercial projects where there is an architect and wider design team, there is normally a clearly defined process to make sure that design objectives are implemented: this is set out for example in the RIBA 'Plan of Work' 2013 (included in Appendix 2) (RIBA, 2013). For work on individual existing homes, there is no standard arrangement for who designs, specifies, implements and modifies building work. Homeowners embarking on works are generally unaware of this fact.

The interviews carried out in Phase 1 of this research highlighted that many domestic renovations are in effect designed by a builder, typically in discussion with the

homeowner and the other trades that they work with in their informal network – for example the builder may call up their usual heating engineer or electrician to talk through things while planning the job and preparing the estimate.

Architect involvement may vary from a full design and project management role to (more usually, in smaller domestic projects), providing an outline design, and not the detailed specification - or there may be no architect involvement at all. In this situation, a competent and confident general builder may in practice provide the entire design and specification, without recourse to an architect. This is rarely recognised in fees paid, appearing as part of the (unpaid) quotation work, or billed at a day rate which is typically much lower than that of an architect.

Even where an architect has drawn up a detailed specification, some builders report mistakes and lack of clarity in the specification, and some construction details or problems may only become evident once work has begun, and so need to be resolved on site (particularly with older buildings). If this happens then the builder will typically lead on developing a solution, sometimes in consultation with the architect or the client.

> *'I said you've got a few thermal bridging issues. And his* [referring to the architect]) *words were ' well they won't pick it up will they', and I said well I'm sorry but I don't care whether building control pick it up, I've picked it up and I'm not building it' [A17B]*

More than one of the builders interviewed in Phase 1 research above also pointed out that the variations in the details and condition of existing buildings means that even with a well-designed renovation, there are some decisions that have to be made on site during the renovation process.

Problems may arise in relation to gaps in delivery or communication where the expectations of the customer, architect and builder are not consistent with each other and not clearly set out or understood. In these situations the general builder, as the person on site with the customer, and typically the person with the broadest skills base, may at times be filling in the gaps ad hoc and without acknowledgement.

The building tradesperson plays a key role in domestic renovations, from design and specification, discussion of options with the homeowner, through to on-site coordination and decisions throughout the process.

4.5.2 Training, qualifications and accreditations

Many, but not all, of the tradespeople interviewed had trade-specific further education, through college and apprenticeship training. Real experience and working with skilled teachers or mentors is seen as the most valuable training. Qualifications are not always seen as essential in general construction trades, except where specific accreditations are legally required, such as for electrical or gas work.

College courses are trade-specific and there is not a clear educational route to becoming a 'general builder', with the closest category being perhaps the role of site foreman. Some of those interviewed had trained initially as carpenter/joiners; others had done several separate trade qualifications over time; or worked for their father's building company and gained a wider knowledge base by working with different skilled people.

> *'…it has to be a separate trade for everything…I done 5 years as an apprentice but I started work for my father, it was my father's company, he knew the other trades…when he employed people he put me with someone, two years with one trade and then he put me with another one' [A12B]*

Others had gained some of the necessary skills and knowledge through renovating their own homes.The lack of a standardised educational and training path to becoming a general builder has implications as regards the ability to take responsibility for the 'whole house', including its energy performance, and closely associated issues such as internal air quality and the movement of moisture within a building.

The UK lacks a clear educational route to becoming a general builder.

One participant raised as a concern the fact that trade apprenticeships are much shorter than they used to be. While this may be in part due to a reduction in the need to develop specific manual skills, due to modern machinery, it raises concerns about the status of the building trades in society, which is already felt to be very low and could be reduced further by cutting back on training.

> *'Before the First World War, probably even before the Second World War, you used to do a 7 year apprenticeship. Well, my dad did his apprenticeship as a decorator in the 60s and he did 5 years…and I did my apprenticeship starting 1989 and I did 3 years' [A09CJ]*

'No one seems to think that doing a job with your hands is a worthy thing, that you must be stupid, that it's something you do if you're thick' [A05B]

A corollary to this low status is that builders are expected to charge very little money which does not reflect the importance of their work to people's lives, homes and the value of the property they work on.

'People will pay a solicitor £120 for an hour and they will say it takes a long time to become a solicitor, and doctors will get £120,000 a year because it takes 7 years to qualify…as far as I can see it takes at least as long as that to become a true craftsman, but it's not recognised as a profession and something needs to change in my opinion…' [A09CJ]

In general, tradespeople working as sole traders or in very small companies tend to develop wider business and technical skills than in the more defined roles in big companies. Some take a lead in coordinating jobs with other trades involved and become general builders, able to plan, cost and coordinate complex building projects.

The Bonfield Review, which included extensive dialogue with representatives of the energy efficiency industry (involving mainly national membership organisations, and more major industry organisations), raised several issues in relation to training and qualifications. One of these is the need for more consistency and collaboration across the skills sector, and a more holistic approach to skills development, such that the industry begins to

'*embed core knowledge, including basic building physics, design stage and consumer interaction into all relevant vocational and professional pathways, including qualifications, training courses and apprenticeships'.*

A practical point was also made in relation to the need to ensure availability of alternative routes to accreditations for operatives who are already experienced 'on the job', an approach referred to as 'APEL (Approach to recognising Prior Experiential Learning)' (Bonfield, 2016). This raises the question as to whether existing building tradespeople need to develop additional skills and knowledge in order to deliver home energy improvements –in particular deep retrofit – and how this might be made available. Further training for experienced personnel is often referred to as 'Continuing Professional Development' or CPD.

CPD and specialist accreditations linked to energy improvements

The crucial need to engage the current workforce, and find ways to adapt existing skills to deliver the required energy improvements, as well as ensuring that training for new market entrants is more effective, was highlighted at the Salford Retrofit 2012 conference in relation to building trades, engineers and architects (Morris, 2012). Debate at policy level with regard to quality control, and in particular the 'performance gap', inevitably includes some reference to training, qualifications and accreditations. The phrase often used in policy debates is 'upskilling'. This can sound inappropriate and patronising to an experienced building tradesperson, who considers that they have already acquired the skills of their trade, but acknowledges and appreciates the need for continuous learning and refreshment of knowledge with respect to new products and changes in regulations. Similarly, the use of poorly defined labels such as 'green' and 'eco' and even 'environmental' and 'sustainable development' can be confusing and unhelpful, meaning different things to different people. (ibid)

The development of technology-specific accreditation processes, such as those devised to support the Green Deal (H M Government, 2016)) beyond the basic trade skills was contentious with installers in the Countdown to Low Carbon Homes project. The main problem raised was the cost (in both fees and time) to the business of gaining and maintaining the accreditation. Installers recognised the rationale for additional accreditations, but were frustrated by finding that acquiring them in practice was resource intensive, administratively burdensome and - to add insult to injury – seemed weak in terms of what they considered to be real quality control (ensuring that the work done in practice was of a good standard) (Charalambous et al., 2014). This view was further endorsed in the interviews with building tradespeople in Phase 1 of this research.

> *'There's a lot of people doing a lot of good out there but if we penalise them with more accreditation, we are going to kill them' [A17B]*
>
> *'…there needs to be a way to allow people to have the benefit without the strait jacket where people who are perfectly qualified to do the work but are not certified and so can't do it…' [D03]*

The risk is that spending more on administration actually takes away time and attention from doing work well on site, and from actual quality control of work – and of course adds costs, with the money going to 'middle men', not the installers themselves.

'I'd cut the red tape, there are a lot of people out there that know what they are doing already…' [A21H]

'When my dad started with the Council in the 60s there was one man with a clipboard who gave 40 men their jobs for the day, and when he retired there were 40 men with clipboards and two men to go and do the work…supposedly that's progress and being more efficient…' [A05B]

This adds to the view voiced by some interviewees that such accreditations are bought rather than earned. An additional problem arises with the delivery of accreditations through the private market, in that this can cause confusion for both homeowners and building trades companies - with lack of clarity as to which are (legally) required and which are optional, and in the latter case exactly what the benefits are. This opens up opportunities for abuse of trust.

'I think it [referring to a membership label implying quality] *allows people to get away with murder' [A09CJ]*

Accreditations that require a lot of additional paperwork are particularly burdensome for building trades microenterprises, which can afford only limited administrative capacity. Requiring additional accreditations could discriminate against the busy small business, the experienced and the self-taught.

'Every avenue of a business has got a lot more administration to run with it' [A17B]

This can result in the creation of a 'closed shop', which excludes people who are capable but not able or willing to invest in the accreditation. A linked problem is that separate and costly accreditations for specific technologies can reduce the ability of the tradesperson to offer a full range and choice appropriate to each situation.

It was noted that the status of the building trades in society is low, considering the importance to people's lives of what they do – and that the home is the most significant investment that most people will ever make. As such, the view was put forward that building tradespeople should be recognised as professionals, acknowledging the skills of experienced tradespeople, but avoiding the additional overheads of adding accreditations beyond the core requirements for their trade.

The households interviewed in Countdown to Low Carbon Homes said that trust and cost were the two strongest factors in choosing an installer, and most of the

households interviewed expressed a preference for using local companies. They showed little interest in accreditations, and did not typically recognise accreditations as an assurance of quality or trustworthiness, saying instead that they chose installers of energy improvements measures based on recommendations from family and friends as far as possible (Charalambous et al., 2014).

The standing of the installers as trustworthy was also enhanced by the connection with, and referral from, a local organisation (such as a local authority or the non-profit energy advisory organisation that ran the Countdown to Low Carbon Homes pilot) – even where it is made clear that no specific vetting procedures or guarantees of quality accompany the referral (ibid). This is reflected in the views of tradespeople cited in 4.3.2, who not only preferred the position of trust they held when recommended, but also the reduced risk to themselves of having a trustworthy customer, known to them through contacts.

This does not negate the value of CPD, rather it highlights the importance of providing it in the right way. It is arguable that private, market-run accreditations need to be streamlined and managed very carefully to avoid creating new problems and barriers, creating confusion in the market and adding cost to customers and tradespeople without necessarily ensuring quality. Time pressures resulting from additional paperwork requirements may even contribute to driving down quality in practice.

From the perspective of consumer information, public information should clearly differentiate between accreditations that are legal requirements (such as Gas Safe), and those that are desirable or required for other purposes, such as enabling access to guarantees or finance for measures. There are also several other factors which are unclear and confusing for the consumer in the plethora of schemes that purport to protect them, such are whether or not both products and installation are quality controlled, to what extent actual quality checks are made, and the relative strength of the different guarantees and warranties in practice. In view of the recommendations of the Bonfield Review, and the failure of the Green Deal (which included a framework designed to protect the investment by the finance provider, as much as the homeowner as a consumer), this issue is a particularly topical one, and is taken up further in the next phase of research and discussion.

Accreditations need to be simple, streamlined and transparent to the public and the industry to be effective, with a clear distinction between those legally required and those that are a 'desirable extra' and why, and clarity as to what extent they are quality controlled in practice.

Training and qualifications for building tradespeople – and in particular for the general builder - were identified as a key focus for the next phase of the research.

Informal learning processes and on-site communications

As described above, in practice the builder may be the person who in effect designs and specifies the details of a job, and some of this may be developed during the process of the work. Even where a detailed design has been completed in advance, there may be changes and decisions to be made during the process of renovating older buildings. This means that communications between architect, builder and other trades on site, (and the customer) are key to achieving quality. One of the builders interviewed described his role in explaining the detailing required for a very low energy renovation to other building tradespeople on site:

> *'...another barrier was that the builders on site didn't understand…it was a new language to them...it's all in the communication really – some of it gets quite complicated, for example EWI[13] where it meets roof insulation…you have to draw pictures…' [A27B]*

This is similar to to the 'toolbox talks' approach of on-site briefings, more commonly used in relation to health and safety. This approach could be more widely used to cover energy efficiency detailing, and to be more of a two way dialogue, where all parties can raise issues and suggest solutions. Skills and new approaches learned on one site are taken on to others, helping to develop the local market and build confidence in technologies through experience. This can also boost a business by raising the tradesperson's profile as someone who can do this kind of work. This might be supported by the provision of guidance on communications procedures and techniques, and dissemination of these as standard practice.

Even where a detailed design has been completed in advance, there may be changes and decisions to be made during the process of renovating older buildings. Communications

[13] External wall insulation

on site are key to achieving quality, and might be supported by the provision of guidance on communications procedures and techniques, and dissemination of these as standard practice, such as using the 'toolbox talks' approach of on-site briefings.

Another issue that this raises is that in practice, the time for on-site communications and joint problem-solving may be covered in the fees for an architect, but rarely for the building tradespeople. One possible conclusion is that time for communication and project management needs to be built into costings for the builder, especially where work at a higher than typical current standard is expected (such as in a Passive House build) or where newer and conceptually different technologies are being installed (such as heat pumps).

Good collaboration and communication between all concerned (builder, other trades, architect and customer) are key to achieving that quality and to ensuring that design details are fully understood and followed through.

> *'When you bring an architect on site, suddenly everything becomes slightly different, the customer acts in in a different way towards them…and in my experience the architect will rely on the guys on site to make everything work, because they don't know how to…' [A09CJ]*

Mistakes can occur because of a lack of experience of a particular technology, approach or detail. Once understood, this new knowledge can be transferred to future work on other projects. Air tightness detail is an example often cited.

A study of the Retrofit for the Future programme noted that the need for the installer to make decisions and changes on site during retrofit could contribute to the "performance gap" between the energy performance calculated at design stage and what a building actually achieves in use. These changes may be necessary in order to meet practical challenges not foreseen at the design stage, and are not necessarily a 'fault'. Rather than focussing in on the technology and the detail of the installations, this study suggests that to reduce the gap between intent and outcome (in looking to scale up retrofit programmes), attention should be shifted from what level of CO_2 reductions are to be achieved to how (delivery models) these radical reductions can be achieved and by whom (supply chain). This study identified three stages at which the performance gap may grow:

- design and specification: through lack of understanding of the impact of early design decisions, and lack of communication through later work stages, lack of understanding of the existing building conditions, and the reliance of modelling software on the expertise of the user;
- construction: either due to the use of inferior products, or poor installation – and lack of on-site quality assurance;
- handover: due to lack of aftercare arrangements, so that residents do not get any advice or support in how to use and maintain the new equipment.

(Gupta et al., 2015).

Janda and Topouzi look at influencing the quality of building works from another standpoint in their work on 'telling tales', where they characterise types of 'story', and argue the need for more 'learning stories' to support the take up of energy improvements (Janda and Topouzi, 2015). They cite the predominance of the 'hero story', in the archetype of which the hero accomplishes feats in an imaginary world, but somehow manages to save his or her own world by returning with a special gift or power that enables this ultimate success. The physical manifestations of the hero story is complemented by the psychological one, where the hero moves from 'limited awareness' of a problem to understanding the need for change, experimenting with it, and eventually mastering a new way of life. An example of how a hero story is applied to building retrofit is a depiction of an 'imaginary world shared by energy researchers, where building physics reigns supreme over users who act in supernaturally predictable and average ways.'

The learning story is more nuanced, and focuses on the search for meaning in specific times and places (ibid). This approach seems at first reading to be remote from the realities of the building site, but may provide some insights into the apparent gap in understanding between some of the wide range of people (and interests) involved in achieving building energy improvements. One example is the tension between those concerned with the preservation of the historic and aesthetic features of buildings and the needs of occupants for thermal comfort and affordable energy bills. Within the context of the drive to improve building energy performance, the ardent conserver of historic buildings can feel embattled, and see their role as isolated and heroic. For the builder trying to include energy improvements in renovation work, this can manifest itself in contradictions between the messages received from Building Control (implementing Building Regulations, including

conservation of heat and power) and Planning (with a brief to protect built heritage) – as described by one of the builders intervewed [A05B].

Another example is the policy maker who sees the building trades as the problem and is unable to move from that position to seeing them as an essential part of the solution, nor to construct the (inevitably nuanced) solution that would enable this. The heroic stance taken up is that of the protector of quality – or of the consumer coping with the 'cowboy builder'.

In both of these examples, an appreciation of the need for a more nuanced learning approach could help to bridge these different standpoints and move forward to achieving the consensus and consistency for an effective building energy renovation approach. This might be achieved by a more collaborative approach, enabling shared learning, between building tradespeople working on the wide range of existing buildings in the UK housing stock (and so able to develop a wealth of practical knowledge of building details) and those tasked with enforcement of both Building Regulations and Planning.

An insight from the 'innovators' in case study research into innovative practices in low carbon refurbishment in France and the UK, was that every project is unique so that it is not a question of turn-key solutions – and that a period of 'monitoring, adjusting and optimising' is needed, for at least two years (Killip et al., 2013). No suggestion was made, however, as to how this might be rolled out in practice, nor the inevitable cost implications. With regard to design of refurbishments, the need for feedback on monitoring to inform future projects, and the lack of this in practice was highlighted. A key insight is the need for effective integration and effective management of the various interfaces – between building elements, between systems and between different roles and responsibilities (ibid).

The point made in the study cited above, that every project is unique and a problem-solving approach is required to deal with this, is recognised by a general builder:

> *'I tend to work in older buildings, and they all have their unique problems, which always takes time to resolve, but I quite like that challenge, it suits me' [A01B]*

This view could be seen, at least for some, in the context of an interest in and care for older buildings, and respect for the materials and techniques used in the past – while recognising the challenges of working on them.

'I was fortunate enough to have a father who was expert in what he did, and a big enough company for me to be able to observe these things, and from that I've got this very broad wide experience of construction and all the different materials you can use, from reinforced concrete to soft bricks of 300 years old, and the ways you need to look at these things, how they interact together, and how they perform.'[A11B]

College training can only provides a basis for learning on site, and there is a need for ongoing learning and exchange amongst all concerned:

'…*we are all learning, there are no daft questions, and the more questions people ask the better…the colleges need to say basically we are giving you training to use tools – these tools will enable you to go on site and learn from more experienced contractors about repairs and maintenance in homes…but then it's also the duty of the architects and engineers to get out of their offices, go out on site, and instead of sitting in the office put a pair of overalls on, walk around and ask, 'why can't we do it this way*' '. [A17B]

The issue of the need for integration, both in design and coordination of works on site, has a bearing on the discovery in Phase 1 that there is no set way of managing works in a typical RMI job, and that this role may be covered variously by an architect, a builder, or in some cases even (at least partially) by the homeowner themselves. It is arguable that, as this role is often performed in practice by the general builder within a domestic RMI job, acknowledging this and ensuring that supporting information and training are provided would be the most practical solution. The appropriate solution may ultimately rest with the scale of the project and the cost implications, but it is clearly a critical role to ensure quality. The concept of the integrator role in building energy renovations is at the heart of the 'Retrofit Coordinator' diploma currently offered by the Retrofit Academy[14]. This role has more recently been taken up in the drafting of a new 'Publicly Available Specification' for building retrofit (British Standards Institution, 2018).

4.5.3 Sources of advice and information for building tradespeople

A further consideration in ensuring that building tradespeople have access to the requisite knowledge and skills for delivery of home energy improvements could be the provision of advice and information for the building trades themselves, and what

[14] https://www.**retrofitacademy**.org

form this could most usefully take. The interviews carried out in Phase 1 indicated that building tradespeople as well as home owners would benefit from access to expert and independent advice on energy retrofit, from a trusted source, at all stages of the process of getting building works done. This would support tradespeople to influence customers to take up energy improvements, and would help to avoid customers being confused by contradictory advice from different contractors. There is also a need for accessible advice and information for both tradespeople and homeowners about how to deal with risks and potential problems around retrofit, such as loft access and damp.

It was pointed out by more than one of the general builders interviewed in Phase 1 that Building Control could be a source of actual advice on low carbon building (and how to do things right in general), rather than purely for enforcement. It would be helpful to be able to have a dialogue with Building Control, to get their guidance on the right way to do things – or at least to talk through options.

> *'You should be able to contact your local council and speak to Building Control….you'll have to put drawings in and there is a fee…where years ago you could always get them out…you can't just chat to someone….and everyone is trying to cover their own backs…' [A12B]*

The Building Control personnel who are considered by tradespeople to do the job best are the ones who have real practical experience. There are risks in moving towards less experienced personnel, with a loss of expertise in the profession.

> *'… getting towards retirement now, they were builders who had maybe damaged a knee or something and they had years in the trade and knew building…but now you have young kids come out in a suit and tie and a brand new builder's hat… they have no experience of old buildings…they can't see a problem and work their way round it. If it isn't in a book they can't do it.' [A05B]*

One builder interviewed suggested that examples of good practice could be helpful:

> *'…if you could have accesss to a package..almost like manual really….say half a dozen ideas..you could put to your clients..' [A02B]*

This raises an interesting question: whether a refreshed and better resourced local authority Building Control function could be the basis for a local low carbon building

advisory service, building on local knowledge. This requires Building Control and Planning personnel to have real practical experience of building work as part of their training and development (the stereotype for entry to this role being the older experienced builder, as opposed to the fresh graduate).

The provision of locally accessible advisory capacity could be further enhanced by the development of local databases of good practice examples of energy efficient renovation of period properties, with technical details, highlighting opportunities to make energy improvements during RMI work, and enhancing the current Supplementary Planning Guidance system. This could also be used by builders as a reference to show customers and encourage them to consider different options.

A consistent and coherent approach from Planning and Building Control working together, and enhancement of this capacity at local level could create a local service that communicates, enables and polices good quality low carbon, low energy housing refurbishment as well as new building.

A well-resourced local building control function could be key to realising trigger point opportunities, with a potential advisory role and links to local examples of good practice.

There was a perception amongst research participants that change in how things are done within an industry takes time, but happens in the end. It can be obstructed, however, by contradictory messages from authorities (such as Building Control and Planning) – supporting energy efficiency while also making it difficult to retrofit effectively – and this can create frustration, and even cynicism, in that both authorities are perceived as coming from the same place – the local authority – so that contradictions between the two undermine their credibility.

Planning restrictions placed on listed buildings or those in conservation areas are an example of such contradictions and can seem impractical and illogical. These designations can prevent energy efficiency improvements which have the potential to improve and not detract from aesthetic and historic character, as well as making the property more likely to be a home fit for the future. Examples included an insistence on preserving 1960s or ‘70s features in a seventeenth century cottage because they were installed at the date of listing, or refusing permission to replace 20th century windows in a Georgian house with custom made double glazed timber replacements.

'People have got to live in these houses, and I fully support in principle what the listed people are trying to do, keep the heritage, but they put people's backs up by being so closed to very clever solutions' [A05B]

'The biggest battle I find is when people have come along and listed something in the 70s and said that's the way it is…' [A05B]

Product suppliers are a valuable source of information and advice up to a point, but this has its limitations when it comes to selecting technologies and looking at the integration of services within the whole house – not least because of the obvious risk of commercial bias.

'The trouble is with all the information you get now, is at the end of it they are trying to sell a product… and won't look across the broad spectrum with the amount of options you have' [A22B]

Great value is placed on support and after sales service from suppliers and merchants, however, and this is an important relationship.

'The branch I use is very helpful – if you've got a problem, you can ring them up and they sort it' [A32H]

'...the suppliers…because they are the experts. They will know more than the architects because the architects, the information that they have, they have got from the suppliers…' [B01M]

Small building companies have found that some of the bigger suppliers don't have time for them when detailed support is needed, such as with solid wall insulation on traditional construction. Those suppliers that <u>are</u> willing to help, however, offer a valuable service with (free) training and site-specific advice – a couple of the companies specialising in environmentally friendly products were mentioned particularly in this regard. This enables tradespeople to use specific products with confidence.

'I went on training with suppliers and they've been really good' [A27B]

'If they've had some training on a specific product that's the product that the contractor will tend to work with, across the board not just with insulation.' [A21H]

Another aspect of the relationship with suppliers is that building tradespeople place high value on reliability and durability of products, as they are the ones who are

called back if there are problems. This is a good reason for sticking with a brand, manufacturer, product, or supplier.

> *'I have been back to repair boilers that have been installed by other people, on the cheaper side…they're spending a fortune putting them right' [A26H]*

> *'I try to design things that can last forever. Now whether it's more expensive and takes longer to do, I think that all ways around its good economic sense to do it that way. I have worked on windows that are 200 years old and are still there and I have worked on windows that are 25 years old that you have to take out…' [A09CJ]*

4.6 Summary and next steps

While the nuances of the results of Phases 1 and 2 raise issues for further investigation, some key points were drawn out at this stage, with reference to the first three of the stated objectives for the research. These are summarised in Table 9. These insights provided a vision for an idealised scenario for supporting the energy retrofit of homes, set out in Figure 8.

Table 9: Summary of key points from Phases 1 and 2 of the research

Objective 1: Develop an understanding of the context for including energy improvements in RMI, through researching standard practice in the local supply chain from the perspective of key actors.
• Micro-enterprise building tradespeople typical of the RMI sector in the UK have a preference for working locally (4.3.1); • They tend to cooperate though informal local networks to deliver the more substantial projects (4.3.2); • There is a preference for personal recommendation rather than marketing to get work, so reputation matters (4.3.2); • A steady flow of work for reliable customers may be more attractive to the building micro-enterprises than business growth (4.3.2); • The building tradesperson plays a key role in domestic renovations, from design and specification, discussion of options with the homeowner, through to on-site coordination and decisions throughout the process (4.5.1); • Some (often 'general builders') take a lead in coordinating work on site, and often specifying and even designing the work – either without an architect or complementing the role of the architect (4.3.2); • The UK lacks a generally recognisable educational route for general builders (4.5.2); • The different ways in which informal groupings of building trade micro-enterprises and sole traders cooperate on a renovation project has implications both for decision making and allocation of risk (4.3.2);

- Even where a detailed design has been completed in advance, there may be changes and decisions to be made during the process of renovating older buildings. Communications on site are key to achieving quality (4.5.2).

Objective 2: Establish and explore opportunities for, and barriers to, the inclusion of energy improvements within RMI

- Awareness of energy efficiency technologies and the benefits is not always supported by confidence in ability to convince the homeowner (4.4.1);
- The Energy Performance Certificate (at least in its current form) is not an adequate tool for advising on home energy improvements (4.4.1);
- Suppliers offering a holistic solution have to compete with single technology offers, and simplistic information services may actually obstruct the market for more holistic energy renovations, by competing for consumer attention (4.4.1);
- Homeowner preference for no change underlines the challenge in generating consumer demand for home energy improvements and the importance of ensuring that they are included with other works for which there is a demand: the thriving RMI market (4.4.2);
- Building Regulations are a key driver for home energy improvements, and need to be effectively enforced, providing a 'level playing field' in which quality cannot be undercut (4.2.3);
- Extensive home energy improvements at the level required to meet climate targets is unlikely to be achievable without powerful policy interventions, either regulatory or financial (4.4.2);
- Contracting large scale retrofit programmes to large contracting firms misses the opportunity to build capacity within microbusinesses who continue to operate in an area after such programmes have finished (4.2.3);
- There is a high level legislative structure in place to address climate change at global, European and national levels, but implementation regarding the energy performance of UK housing appears incomplete and stalled. The current focus is on quality control, but misses action on generating demand for home energy improvements (4.2.4);
- The local nature of the RMI market indicates a good fit with delivery of housing energy efficiency schemes, but national policy in the UK does not take account of or build upon this thriving market (4.3.1);
- The construction supply chain is relatively flexible and 'agile'. The informal networking approach typical of microbusiness RMI trades illustrates a particularly high level of flexibility, adapting the skill set to different projects on demand (4.3.2);
- Supply chain reliability (from merchants and online suppliers through to manufacturers) matters for the small building company, in terms of product quality and consistency, follow up and replacements when there are problems, site-specific advice on the use of products and materials – and even free training in regard to more major works such as wall insulation (4.5.3);
- There is a lack of clarity around the requirements for, and value of, different building trade qualifications and accreditations (4.5.2);
- Communications are important at all levels: between builder and customer, between designer/architect where involved and builder, and between trades on site – including finding solutions to issues arising in the course of the work (4.5.2).

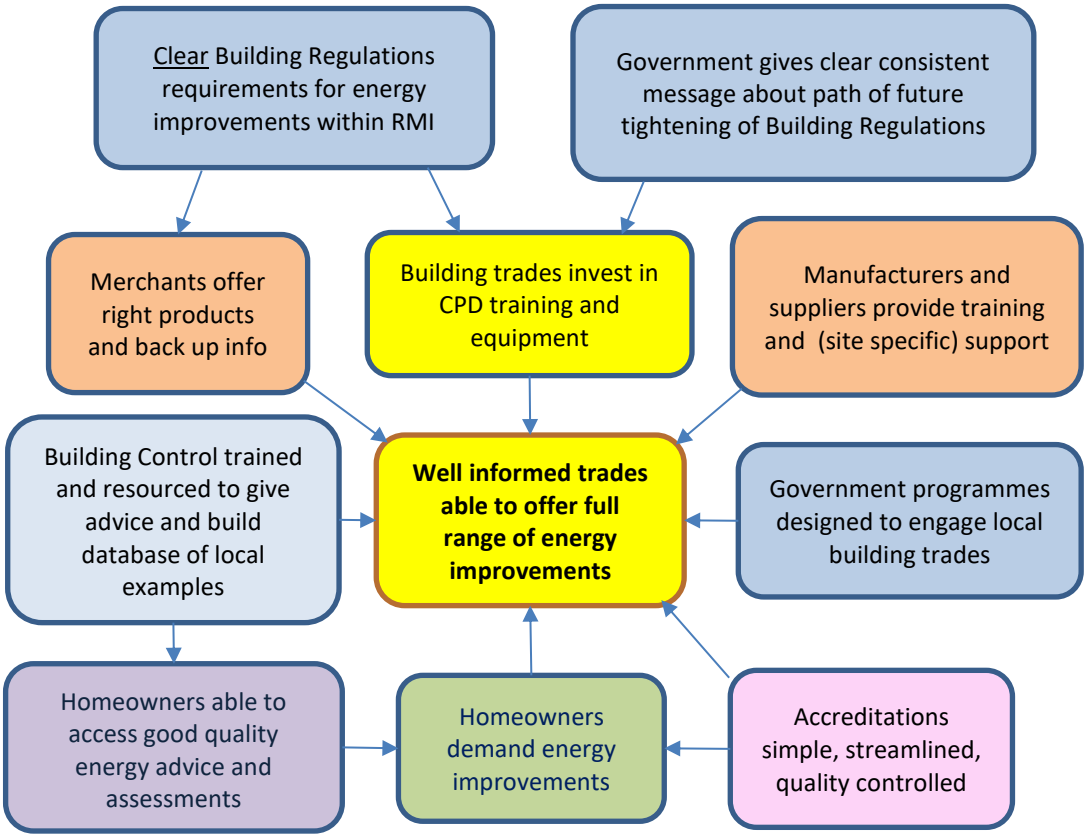
Objective 3: To provide recommendations for change that would enable an increase in delivery of the (full range of) energy improvement measures by the building trades engaged in the RMI Market

- A long term approach based on regulation and mandatory standards is necessary to drive the market (4.2.3);
- Financial incentives and subsidies should be long term, well signalled and followed through to avoid creating dependence and instability (4.2.3);
- A good quality energy assessment is a useful technical tool to give homeowners a perspective on the energy performance of their home against the benchmark of other homes, and an indication of the impact of different improvement measures, but may need to be explained to a homeowner to maximise usefulness (4.4.1);
- Homeowners would benefit from access to expert advice on energy improvements, and may need support at several stages of the renovation process, and to take them through the 'retrofit journey' (4.4.1);
- Energy improvements implemented over time in conjunction with RMI work could be supported by a long term renovation roadmap for each home, based on a detailed energy assessment. This could be combined with a repository of building-related information (4.4.1);
- The financial argument for energy improvements in terms of increased property value or energy bill savings is unlikely to be enough to convince homeowners to retrofit at the scale required - promote the co-benefits as well (4.4.2);
- Homeowner preference for no change underlines the challenge in generating consumer demand for home energy improvements and the importance of ensuring that they are included with other works for which there is a demand: the thriving RMI market (4.4.2);
- In promoting home energy improvements, it could be useful to support businesses in matching what they can offer to different types of customers, taking account of the role the customer intends to play, how involved they will be in the work, how knowledgeable they are, and how much they are able or willing to spend (4.4.2);
- A single contact point or 'one-stop-shop' is a missing link between a home owner and the range of single technology offers for home energy improvements (4.4.1);
- Communications on site might be supported by the provision of guidance on communications procedures and techniques, and dissemination of these as standard practice, such as using the 'toolbox talks' approach of on-site briefings (4.5.2);
- A well-resourced local building control function could be key to realising trigger point opportunities, with an advisory role and local examples of good practice (4.5.3);
- Accreditations need to be simple, streamlined and transparent to the public and the industry to be effective, with a clear distinction between whether they are a legal requirement or 'desirable extra' and why, and clarity as to what extent they are quality controlled in practice (4.5.2).

The colour coding introduced for Figure 7 and subsequent diagrams (where relevant) is as follows, indicating which key actors are involved:

Government/public sector	blue
Building trades	yellow
Supply chain to trades	orange
Homeowners	green
Standards, training and quality assurance	pink
Advisory service	purple

Figure 7: A supporting structure for home energy improvements within RMI



As noted at the beginning of this chapter, it became clear in the course of Phase 1 interviews that the work of building tradespeople and what they are able to do in terms of delivering energy improvements cannot be seen in isolation, but are both impacted and constrained by policy and programmes, at local and national level, which in turn are impacted by international agreements. Section 4.2 explored the policy and programmes that provide the context for making energy improvements to existing homes, aspects of which contribute to Objective 3 of this research. Looking at this 'bigger picture' also provided some initial ideas for Objective 4, the theoretical framework for the research, which are explored here, and expanded in Chapter 7.

In considering the ‘big picture’ for building energy renovation in the UK, it is difficult to ignore the impact of the Green Deal, introduced as a comprehensive approach which would revolutionise and transform energy efficiency, but which in fact heralded a collapse of the domestic energy efficiency market (Rosenow and Eyre, 2016). Created as a ‘top-down’ scheme, to attract large scale finance, it failed to take into account the practical realities for the other key actors in the ‘system’: the home-owners, the providers and the installers, who were expected to participate in an extraordinarily complicated scheme, and to invest in expensive accreditations and loans. The simple mismatch of the ‘Golden Rule’ with the deep retrofit needed to meet policy targets was just one of many weaknesses.

Green Deal approached the problem from the perspective of policy makers in a highly centralised political system and economy, and of (how they perceived the needs of) big finance. Academic literature provides many useful insights into consumer behaviour and decision-making. This present research project looks at the big picture from a different standpoint – that of the RMI building trades, and in talking to building tradespeople about their work in Phase 1, a picture of a primarily localised and connected ‘system’ emerged, consisting of a number of components, both formal and informal. The informal (overlapping) local networks through which they operate day-to day are represented in Figure 6, consisting of:

- the local social networks through which they mainly get their work
- networks of other trades that they collaborate with
- the suppliers and merchants from whom they get products and materials

An important formal component to add to this picture was that of the regulatory framework, largely represented for the RMI building tradesperson by Building Regulations and Planning, both of which are enforced at local authority level. As noted, the localised system in which the RMI tradesperson operates is also heavily impacted by national policy. Stepping beyond the purely local perspective, and looking at the issue of building retrofit in the context of urban sustainability more broadly, Eames et al (2013) emphasise the need to develop knowledge and capacity across the sectors, including public agencies, private sector and multiple users – and the need to systematically ‘re-engineer’ urban infrastructure. Arguing for a more coherent and connected approach to the key questions of ‘what, who, why and how’ in urban retrofit ‘regimes’, they conclude that the ability to achieve the required

transitions will require greatly enhanced inter- and transdisciplinary working, and an integrated ***socio-technical perspective*** on long-term systems innovation (Eames et al., 2013).

In their paper to the 2013 eceee summer study, Killip et al looked at the issue of housing refurbishment in the context of socio-technical systems, an approach which takes into account social and organisational as well as technical factors, and that changes in technology within society cannot be seen simply as pursuing technical solutions. The observation is made that innovation and change involves the co-evolution of new technologies and new social practices. This approach is then applied to the need to introduce the 'new' technologies required for low carbon retrofit into mainstream RMI building practices. While not discounting the importance of product innovations, it is noted that as advanced refurbishments can be achieved using existing technology, this suggests that the task of retrofitting housing stocks should be considered a market breakthrough, not a technical breakthrough problem. Reference is made to the importance of understanding the working practices of the key actors delivering this market activity – that is the installers and building tradespeople - if we are to understand how to achieve this breakthrough, endorsing the aims of the present research. (Killip et al., 2013)

Gibbs and O-Neill (2014) considered the niche role of entrepreneurs based in the private sector in stimulating a transition to a green economy, and the path from niche to mainstream. Recognising that such entrepreneurs do not act in isolation, but within social and economic networks, they concluded, that to understand the scope for individual entrepreneurs to influence change, they must be seen '*within the extant sociotechnical regime within which they operate'*. They noted that such a path is neither linear nor unproblematic, and that not only are those innovations most aligned with the mainstream the most likely to succeed, but some may lose some of their innovative features as they become assimilated (ibid). A reflection for policy is that the perception of 'green building' as a niche activity, rather than a cross-cutting necessity to 'green' all construction (or all economic activity) risks being self-fulfilling, with the 'green economy' and its anticipated growth reverting to a niche activity as public or government-directed funding fade out (ibid). This raises the question of whether and how public funding is envisaged within a longer term strategy – for example by being phased out in tandem with the phasing in of other policy or fiscal measures, such as tighter regulation.

RMI businesses do not operate in isolation, but within a socio-technical regime, to which a multi-level perspective may be applied in analysing how change can occur.

Kivimaa and Martiskainen considered the role of intermediaries in the transition to low energy buildings, based on a review of European case studies, noting that the qualitative case study literature on low energy building innovation is limited, particularly in the context of the existing building stock (Kivimaa and Martiskainen, 2016). Using a definition of innovation intermediaries as *'actors who create spaces and opportunities for appropriation and generation of emerging technical or cultural products by others who might be described as developers and users'*, this study links a multi-level perspective on socio-technical change to theories of strategic niche management . The levels described include a:

- 'landscape' level of trends and events, including climate change, EU policy, oil depletion, ICT[15] and financial crises;
- 'regime' level of intermediary actors, noting both the dominant construction industry and the smaller and more fragmented maintenance and repair practices, regulation and policies influencing the building infrastructure, planning and building control practices, and actual building occupants;
- 'niche' level, such as whole house retrofit, Passive House, smart homes and solid wall insulation (ibid).

Although the focus is on innovation intermediaries, this study is of particular relevance to this research, in that it provides an analytical perspective of the UK home energy retrofit industry, and includes RMI microbusinesses in the range of key actors involved. The levels described reflect many of the issues and influencing factors raised by interviewees in this research, (with the exception of ICT and smart homes) – although the arrangement of actors into the different levels might look different from the standpoint of the RMI building tradesperson. The intermediary in several of the case studies reviewed in the above-mentioned study was a local authority, although several types of potential intermediary are identified for this sector, such as architects and other building professionals, building managers, regulators, foundations, and innovation platforms. In the Countdown to Low Carbon Homes action research, the intermediary was the energy agency (an independent charity), working in partnership with a group of local authorities - and the solution

[15] Information and communication technology

developed was a type of one-stop-shop, in that it provided technical advice, support with finance and links to installers (Maby et al., 2014).

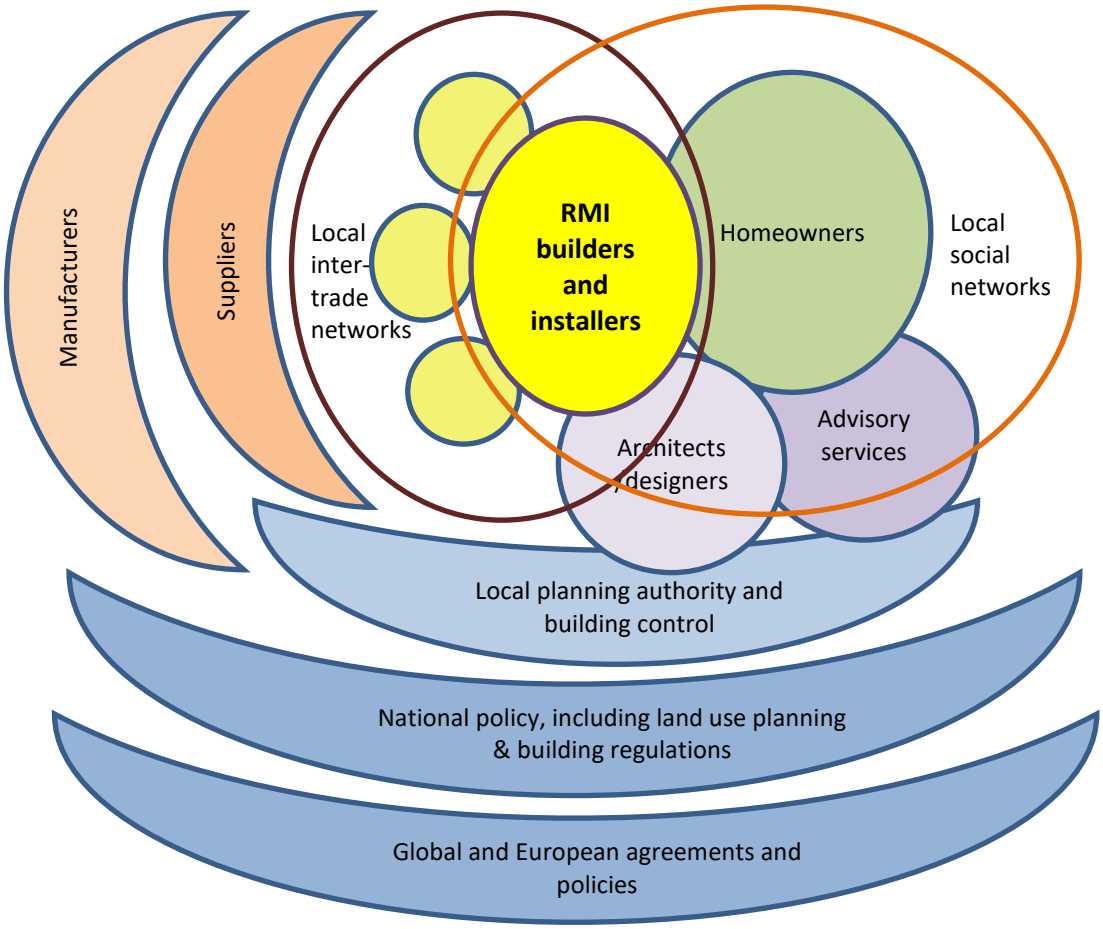
Business models that extend beyond single technologies and engage with intermediaries in other sectors have a role to play in shifting the practice of including energy improvements in RMI (and deep retrofit in particular) from niche market to mainstream.

Taking the perspective of the RMI builder as the basis for looking at the socio-technical system in which they operate, Figure 8 offers a starting point for the development of a multi-level perspective. Local social networks in this diagram may embrace both homeowners (the customers for energy improvements and RMI work) and the builders and installers themselves. They may also include elements of local advisory services, if, for example, these are embedded in community organisations – however, they may also be part of or closely connected to local authorities. This diagram offers a general overview of the way in which the different networks and influences may operate in practice, and is not intended as a definitive description of the system in which the RMI builder operates.

The colour coding used in Figure 7 is continued in Figure 8, as follows.

Government/public sector	blue
Building trades	yellow
Supply chain to trades	orange
Homeowners	green
Standards, training and quality assurance	pink
Advisory service	purple

Figure 8: The RMI builder within a socio-technical system



Next steps

The research in Phases 1 and 2 highlighted that there is no standard process for drawing together a team for an RMI project, where this demands more than one trade – such as a renovation or extension. In the RMI market, the SME building firm that might have offered a full service of this kind in the past is less common than very small businesses and sole traders. To fill this gap in provision, individual building tradespeople use informal local networks to construct their teams, enabling them to be flexible in who they need for each job.

The tradesperson who takes a lead in this case is typically described as a 'general builder', and their role in practice can cover a range of tasks including customer liaison, specification and costing of a job, and coordinating the work on site. An architect may not be involved in domestic RMI projects, or only at a superficial level. The builder is often the person with whom the homeowner discusses what they want done, and advises on the possibilities – and so is in a potentially very influential role in terms of including energy improvements in the work. While the homeowner is

ultimately the decision maker, as the owner of the property who will have to commission and pay for the work, and live with the results, it is typically the general builder who is first point of contact for them in seeking to get the work done. RMI works offer practical opportunities to include energy improvements, but there can be barriers in terms of the priorities of customers and what they are willing to pay for, and a lack of (other) advice and information to indicate benefits such as energy savings and comfort, as well as environmental impact. If the 'trigger point' opportunities for energy improvements arising from general RMI work are to be realised, this requires the builder to notice and identify the opportunities, know, in practical terms, how to act on them and then to encourage, persuade (and even assist) the homeowner to take them up.

The importance of the 'integrator' role is highlighted in relation to achieving a whole house approach to energy improvements and avoiding design risks. While this might be identified as a new professional role, it seems both more practical and economically realistic to accept that the builder is filling the gap in taking on this role and looking at how this can best be supported. It was striking in speaking to general builders that (in the UK) no specific educational route to qualifying for this role was identified, nor an accreditation on which to build such support.

In the light of the these discoveries, ***the role of the general builder in relation to the different roles within an RMI project (in particular in relation to energy improvements within RMI), was taken as the key theme for the next stage of fieldwork.*** This stood out as the most significant issue, as well as the one on which the literature review confirmed that the least work had been done. Linked to this was the question of learning and communications – both formal and informal. Effective inclusion of energy improvements in RMI work requires knowledge and experience of the measures and technologies, which raises the question as to when and how this can be provided in the development of the builder's skill-set. An obvious first place to look for this was training and qualifications, to see to what extent sustainable energy and energy 'retrofit' is, or could be, included.

Another key theme arising from Phases 1 and 2 was the role of Building Regulations as a key driver for the take up of home energy improvements, and how this might be achieved in practice in existing buildings. This is an under-researched area of interest for future focus, which lends itself potentially to an international review of successful approaches, and as such was outside the scope of this research.

5. Research Phase 3: 2017-18

5.1 Phase 3 data collection

Building on what was learned in Phases 1 and 2 of the research, a further phase of fieldwork was carried out between July 2017 and January 2018. As indicated at the end of the previous chapter, the area selected as a focus for this next phase of fieldwork was the role of the building tradesperson in specifying energy improvements, and managing their delivery in practice, and how the general builder learns to do this. This was chosen as it is key to the ability of the RMI industry to have an impact on the energy performance of the existing building stock – and of immediate relevance. It also stands out as an area on which little research has been done to date, and hence represents a particularly significant gap in knowledge, as indicated by the literature review carried out after the first phase of interviews, and included in the discussion in the last chapter.

This is a role which is both influential and responsible, but is (surprisingly) not well defined or formalised in domestic building work in the UK. It should be noted that this does not necessarily mean that the work is of poor quality, or deliberately avoiding the rules – rather that there is a lack of definition in the 'rules', and (at least a proportion of) the industry seems to have found, out of necessity, its own way to deliver quality work. The search for where and how to support these key actors within the existing RMI industry to promote energy improvements led to questions about the definition of the role and the core qualifications and training.

Two areas in particular stand out as lacking in definition:

- The task of designing and specifying the work – with an overlap (or potentially a gap) between the role of an architect and a builder;
- The role of leading and coordinating the work, integrating different trades, liaising with the customer and so on.

The key questions developed for this phase of research, building upon what was discovered in Phases 1 and 2 were:

- How do general builders learn to design and specify building work?
- What do they need to enable them to include energy improvements, and what support do they need to enable them to do this (well)?

- Is their role in doing this understood /acknowledged/supported within the supply chain – and by homeowners?
- Are the boundaries between roles blurred and/or is there a gap in relation to the roles needed to carry out domestic (energy) renovations effectively?

As interviews commenced, it became clear that the first question was too specific, and needed to be widened to how general builders learn their trade in general.

Sampling

Following the theoretical sampling approach, as in Phase 1, this phase of the research aimed particularly to fill a gap in knowledge by focussing on the perspective of the mainstream building trades, and therefore, this group were the initial target for the second round of interviews.

The focus on learning and supporting information led to identification of a second key category, that of suppliers of energy efficiency products and materials, as they were highlighted by building tradespeople in Phase 1 as key sources of training and information.

A third category that was added was construction training professionals, in order to gain a better understanding of how the question of energy impovements might feature within the field of construction education.

No fixed number of participants was envisaged, rather, as for Phase 1, the interviews continued until both a good range of views had been covered, and the resulting data had started to become repetitive.

Sampling differed from Phase 1 in that in Phase 1 research participants were mainly recruited through local neighbourhood and social networks, while in Phase 3 the emphasis was on professional networks, follow up conversations to presentations of the findings of Phase 1 and contacts made at relevant events. Several people suggested others to speak to, so that the research was followed through a chain of discussions, particularly as regards training and qualifications.

Table 10 is a reminder of the codes used in Phase 1, with the addition of the category ‘H’ for construction training professionals. As in Phase 1, participants were allocated a unique reference number, so that they can be quoted in the research, with their anonymity preserved.

Table 10: Research participant categories and reference codes - updated

Code	Category	Sub code	category
A	Building trades companies and sole traders	B	General builder
		CJ	Carpenter/joiner
		P	Plumber
		H	Heating engineer
		E	Electrician
		PD	Painter decorator
		R	Roofer
		SWI	Solid wall insulation installer
B	Manufacturer or supplier of building products and materials	M	General builders merchants
C	Planning and building control personnel	P	Planning
		BC	Building Control
D	Trade associations		
E	Architects		
F	Homeowner		
G	Other related services		
H	Construction training professionals		

Interviews

A list of interviewees is provided in Table 11. Initially it was planned to return to some Phase 1 participants, and two builders interviewed in Phase 1 were interviewed again, but as the responses brought similar data to that collected in Phase 1, this was abandoned in favour of new participants. 18 further interviews were carried out, with 7 general builders, one heating engineer, 5 suppliers of energy efficiency materials, one trade association, and 4 construction training professionals.

Table 11: Research participants, Phase 3 fieldwork - interviews

Reference	Category	Bbase location	No.staff	Date	Int'view location
A01B	General builder	Monmouthshire	1	24.7.17	Researcher home
A11B	Geneal builder	Hertfordshire	4	16.8.17	phone
A35B	General builder	London	1	4.8.17	phone
A36B	General builder	Worcestershire	3	9.8.17	phone
A37B	General builder	Brighton	5	2.8.17	phone
A38H	Heating engineer	Cambridgeshire	4	3.8.17	phone
A39B	General builder	Worcestershire	1	10.8.17	phone
A40B	General builder	Cheshire	2	12.1.18	phone
B04	Supplier	Worcestershire	n/a	1.8.17	phone
B05	Supplier	East Anglia	n/a	15.8.17	phone
B06	Manufacturer/supplier	national	n/a	29.8.17	phone
B07	Manufacturer	national	n/a	22.8.17	phone
B08	Supplier /installer	national	n/a	29.8.17	phone
D04	Trade association	London/nat'nal	n/a	2.8.17	phone
H01	Training professional	South Wales	n/a	20.9.17	Café
H02	Training professional	London/nat'nal	n/a	1.9.17	phone
H03	Training professional	N. Wales	n/a	7.12.17	phone
H04	Training professional	S.W. Wales	n/a	6.12.17	phone

Round table discussion

In addition to interviews, a half-day round table discussion was held in London on November 23rd 2017, in cooperation with the Association for the Conservation of Energy. With the title '*More and Better: integrating high quality energy retrofit into home refurbishment'*, this brought together 17 experts from a range of energy efficiency, building trade and policy backgrounds. Participation was by response to invitation, which was at the discretion of the Association. The participants were:

- 1 building trades trade association (also an interviewee in Phase 3)
- 1 general builder (also an interviewee in both Phases 1 and 3)
- 2 government policy professionals
- 1 Local Authority policy professional (Greater London Authority)
- 1 architect
- 1 major insulation materials supplier, which also does installions
- 1 energy advisor
- 1 energy efficiency programme manager
- 8 research academics/consultants

The round table took the form of an informal discussion, using the results of Phase 1 as an initial stimulus, with discussions around trigger points and how to turn these into action, considered at four stages of a renovation project: initial enquiry and work to develop the brief, design, on-site work and handover marketing of energy efficiency measures, training, competencies, qualifications. A second stimulus presentation was given by Gavin Killip of the Environmental Change Institute, Oxford University, focussing on business models and structure.

The full report of the round table is provided in Appendix 2 and is used as a source of additional data for the Phase 3 results and the discussion in Phase 4.

Interview approach

The same interview approach was used as in Phase 1, which was that of semi-structured interviews, as described in sections 2.2.2. A series of prompt questions were devised and used as a starting point, but the conversation was allowed to develop freely, and in practice it was found that the intevewees quickly picked up on issues of interest stimulated by the research topic, and were able to talk at some length about them, without further prompting. The prompt questions used as a starting point in this phase are set out in table 12.

Table 12: Semi-structured interview prompt questions, Phase 3 fieldwork

Research question	A: trades	B: suppliers	D: Trade Associations	H: Construction training
Info. about participant	Type of company Position in comp. No.employees	Type of company and clients Position in comp.	Position in assn. Number and type of members	Role in organisation Courses covered Geographical range
How do gen. builders learn their trade, in particular how to design and specify building work?	Do you design/specify renovation/ improvement work? If not, who does that for your work?			
	Describe the process of how you plan a job.			
	How have you learned to design/specify building work?			
	Does this typically include energy improvements e.g energy efficiency/ renewables?			
	Do you find any particular problems with designing/ specifying this kind of work?			
	Are there types of work you would avoid because of potential problems?			
Is their role in doing this understood /acknowledged /supported within the supply chain – and by homeowners?	Do your clients generally understand that you are designing and specifying the work for them?	Are you aware of general builders designing/specifying renovation or improvement work? What do you think about this?	Are you aware of general builders designing/ specifying renovation or improvement work? What do you think about this?	Are you aware of general builders designing/ specifying renovation or improvement work? What do you think about this?
		Does your co. provide advice to builders doing renovations/ improvements? Would this be a good idea? Can you envisage how to do this?		Is designing and specifying work part of the training for any of the specific trades you run courses for? If so, does it work well in practice - any feedback?

Are the boundaries between roles blurred and/or is there a gap in relation to the role needed to carry out domestic renovations effectively?	How does what you do compare to the work of an architect, architectural technologist or surveyor?			How are courses structured in general?
	Is there is a clear separation between these roles/ should they be more clearly defined in practice?			Are you aware of the RIBA plan of work ? Would an equivalent for general builders be useful, for when no architect involved?
	Should there be a qualification to be a general builder?	Should there be a qualification to be a general builder?	Should there be a qualification to be a general builder?	Should there be a qualification to be a general builder?
	If so, could it include designing and specifyings? Or how else can someone learn and gain the knowledge to do this?	If so, could it include designing and specifying? College or experience based? What about those already doing this? Could suppliers be involved, and how?	If so, could it include designing and specifying? College or experience based? What about those already doing this?	If so, could it include designing and specifying? College or experience based? What about those already doing this?
What do they need to enable them to include energy improvements, and what support do they need to enable them to do this (well)?	What needs to be done to ensure renovations, improvements etc, especially those intended as low energy/ low carbon, are well designed and managed on site?	What needs to be done to ensure renovations, improvements etc, especially those intended as low energy/ low carbon, are well designed and managed on site?	What needs to be done to ensure renovations, improvements etc, especially those intended as low energy/ low carbon, are well designed and managed on site?	What needs to be done to ensure renovations, improvements etc, especially those intended as low energy/ low carbon, are well designed and managed on site?
	What kind of support or training would help general builders to do this and do it well?	Other views on how to support and ensure quality in relation to low carbon renovation, in terms of delivery by mainstream building trades?		Do your courses include low carbon renovations? Are these aspects core or optional? What are your views about this?
	Have you (good or bad) examples of support/ training from suppliers/others?			
Research question	**A: trades**	**B: suppliers**	**D: Trade Associations**	**H: Construction training**

5.2 Phase 3 results and next steps

The interviews were transcribed in full, and reviewed along with the notes from the round table discussion, following the same detailed methodology as applied in Phase 1. The transcripts were scrutinised for key themes, and these were used as nodes for analysis. The transcripts were then reviewed a second time and specific results drawn out.

The discussions during the interviews led the research to a new range of literature, the review of which formed a new phase (4) of the research. The results of phases 3 and 4 are presented in the form of an integrated discussion in the next chapter.

6. Phase 4: fieldwork results, literature review & discussion

6.1 Introduction to discussion

Phase 3 of the research consisted of a second phase of fieldwork, as described in Chapter 5. It aimed to explore further key issues identified by Phase 1, in particular the role of the building tradesperson in specifying energy improvements and managing their delivery in practice, and how the mainstream builder offering general building services learns to do this. This led to a discussion of training and qualifications in construction and building services, and where builders can get advice and information on new products, technologies or techniques. In considering how to ensure things are done 'right', quality control and enforcement were also discussed.

This chapter presents the results of the second phase of fieldwork in the form of a discussion, within which is integrated a further review of relevant literature prompted by these results. In some cases literature was specifically mentioned by interviewees, such as the Sainsbury Review (Sainsbury, 2016), the Bonfield Review (Bonfield, 2016) and the Qualifications Wales report on construction education (Qualifications Wales, 2018).

The discussion has been set out along the lines of the themes discussed in the interviews, ranging from the concept of the general builder and how individuals develop the knowledge and skills needed, to how a builder learns to design and specify works, and what tools or assistance they currently use or might find useful in order to do this as well as possible. The chapter is divided into two sections, the first covering current practice (Objectives 1 and 2) and the second to identify recommendations for change (Objective 3).

6.2 The current situation

6.2.1 Roles and tasks in a renovation project

Lack of definition of roles

Continuing a theme that arose in Phase 1, there was further confirmation from some of the builders interviewed in Phase 3, of the blurred lines between what an architect or a competent general builder might do in terms of design, specification and project management. The term 'design' is taken in the context of this research to mean a plan or drawing produced to show the general appearance and layout of a building, while the 'specification' provides the details of materials, dimensions and services.

The builder may step into the breach out of necessity, taking on responsibility for the whole project.

> *'What people do nowadays, well a lot of people that I do work for…they might employ an architect just to get planning permission and then they get somebody like me and say can you build that, and I look at it and say yeah of course I can, and then suddenly the architect disappears….and I become the sort of designer/specifier etcetera, because from a planning application drawing, there's very little detail on it, and then I have to produce a finished product…basically there's no go between, between you and the client.' [A35B]*

This can include providing the detail for the design and the specification, pricing, negotiating, site management, client liaison and so on. This can be an opportunity to talk about energy improvements.

> *'…I'll be presented with a set of fairly vague drawings of what the finished product should look like. And inside those drawings are obviously all the little details that nobody wants to think about right at the beginning, so it's where all the plugs and switches and radiators have to go, and I usually work that out. I work out how big the radiators have to be in rooms, and if they are interested in insulation I talk them through the methods of insulating floors, ceiling, walls if they want to go down that route.' [A35B]*

When asked about the same issue, this was confirmed by an insulation manufacturer, who noted that design could be carried out by a building tradesperson or an architect, and that this could be anything from a sole trader to a major architectural practice.

> *'Yes, I think we, I, was aware of it as an employee of a major insulation manufacturer…..this was one of the recurring themes when I was involved in the Bonfield Review, where the designer is a major figure in the work that we are trying to do…the designer can be someone with a white van, or a designer as we might recognise it, as a major practice.' [B07]*

It would appear that many builders find they have to fill the gap left by either the absence of an architect on a project or the limitations of what the architect has provided (whether because it's all they have been commissioned to do, or the service provided is lacking in some way). If this role is to be fully acknowledged, and they are asked to accept 'responsibility' in the way articulated in policy discussions, then their work of this nature will need to be paid for at the right level, and supported effectively

through training. The enabling mechanisms need to be put in place for any level of policing to be positively useful. This is taken into consideration in developing recommendations in the second part of this chapter.

There may also be an issue to consider with regard to liabilities and insurance. Is the architect holding back on what they are providing for a reason? This could, for example, be that they have only been commissioned at a relatively superficial level, and would charge more for the next (potentially more risk-laden) stage of detailed specification, and the subsequent stage of actually project managing the work. Is the builder in this case covering this more difficult and risky part of the work, and at a far lower cost – either charging nothing additional or at builder's rates rather than architect's? And does the home-owner understand that this is what they are asking them to do?

Awareness of this role being taken in practice and the implications in terms of knowledge, skills, and accountability cannot be ignored if we are to achieve the necessary energy improvements and ensure that the work is of high quality. This requires a common understanding of the various roles, so that the supporting structures can be in place (and in the right place), as well as the controls.

> *'…we are looking at to see how does this fit within the whole area of skills and improvements in accountability…the builder is actually the designer, but if you talk to the builder about what that means in terms of the skills, responsibility, accountability, and the roles they have to play, and then you talk to someone else, I think there is a disparity…' [B07]*

Building upon this understanding of what happens in current practice and finding ways to make sure that it is done well is challenging – but realisation is an important first step.

> *'Realisation is the first step, that there are parts of the industry that need to improve. Realising that you are the designer, and that as the designer you have obligations and responsibilities and liabilities, and if you accept that is part of the role, do you then believe that you have the support, the experience to make the judgements that you are making? …the reality of the situation in some senses is that everyone is thinking that someone else is responsible for this…' [B07]*

As an indication of an awareness that they are offering something additional of value, some builders may decide to charge a small fee for the initial advice. This can help to cover the cost of the time they spend on jobs that don't come to fruition. It is likely to be a small charge compared to that of an architect or consultant.

> *'When people haven't got plans and they want somebody to come and chat to them, I actually charge a fee now, of £125 plus VAT, and it's like a site survey we call it, and I'll go out for an hour… I'll do sketches for them… I come back to the office and we type them up a basic price and what we think. And that's worked fantastically, especially for people that are buying houses. Because architects don't work for nothing, solicitors don't, accountants don't, surveyors don't…I probably do one or two of those a week….' [A40B]*

The lines between the roles of, and responsibilities for, designing, specifying and managing the actual build may be poorly defined in RMI work. A general builder may take on some or all of these tasks.

Project stages and continuous dialogue

In considering roles within a renovation project, the importance of a dialogue with the homeowner is emphasised, to develop practical solutions. This can involve a considerable amount of time and effort, before any work is agreed.

> *'..it's listening, looking, understanding the construction of the building …then coming up with a concept which that person might accept.' [H01]*

An important aspect of this is for the builder to work through what the homeowner wants with them, and to explain the practical implications.

> *'There's many times that I've been into houses where somebody has said and I want this and this, and I've gone, 'OK that's fine, I can sort that bit out but I'm going to have to do this, and then it's all going to have to be made good again 'oh, why can't you?' Well because your joists run that way, and you want me to run a cable that way and I'm going to have to drill through the joists to get from there to there. 'Well can't you go round?' Yes, but I'll have to go outside and back in again – happy for me to put a bit of conduit on the wall? No…well then I'll have to go through, and I'll have to take a bit of ceiling down. 'Why' Because there's a flat roof above…' [H01]*

It may also require changes and new decisions as the work progresses. When asked whether there is any real difference between what he is offering the customer and what an architect can do, one builder reported that in his experience he can offer something more user friendly and tailored to the real needs of the homeowner. Based on his own experience, his view was that using an architect on a domestic renovation was generally superfluous, as well as expensive (sometimes leaving the customer short of funds to complete the work satisfactorily).

> *'Often I come in after say a client has had dealings with an architect who's sorted out plans which perhaps have been quite costly, and the client then finds that the architect isn't really coming up with what they want and they've already spent a lot of money getting to that stage…I think people are quite relieved to find a builder who can not only do the work but can also talk about possibilities and make good choices about materials and style and so on. There's a lot of builders out there who can do that. I am not unique.' [A01B]*

He pointed out that the homeowner might not understand what the architect is suggesting, until too late.

> *'….they can have quite complex drawings from an architect and they actually find it hard to look at it and understand what they're buying…It's not until the building starts to go up that people realise what the architect has chosen, and sometimes they think 'oh I'm not sure I would have chosen it that way'. [A01B]*

This general builder described the way he worked with a domestic renovation client as being one of 'continuous dialogue', and felt that this catered better to the needs of both the client and the building, allowing them to try out different things and make changes as the work develops.

> *'…the way I like to work is with a continuous dialogue with the client because I'm fully aware that as a building grows then ideas change…and then to keep changing, with new drawings and new calculations and so on can be an expensive process using an architect…but using a builder, and I've always found Building Control very flexible…I think it's more likely that a client can get what they want.' [A01B]*

The cost of the architect's time can make it difficult for the homeowner to ask for changes and engage in a longer dialogue as they develop their understanding about what the options are. The builder on the other hand is on-site, and doesn't charge as

much for their time, as well as being able to assess and advise on both the practicality and the likely costs of making changes to initial plans.

Another point made is that an architect might add to the cost of a building with the choices made – and the builder can see the potential impact on costs.

> *'...sometimes architects will overcomplicate a small extension… the customer just wants to extend their kitchen or something like that, and they tend to overcomplicate it, and ask for sort of materials and things which aren't really off the shelf, and you think well, it doesn't justify that…' [A39B]*

The views of builders presented here provide a useful perspective on the role that they find themselves playing in practice, and the financial implications for homeowners, but cannot on their own be taken as a full and balanced view on the potential value of engaging an architect in domestic renovation. This might form the topic of further research.

Domestic renovation work tends to involve ongoing dialogue between builder and homeowner, and the builder taking a lead on design and specification can be beneficial to the homeowner in terms of accessibility, approachability and cost.

One of the builders interviewed runs a business which specialises in eco-renovations, offering architectural expertise and energy assessments as well as managing the actual works on site through several teams of sub-contractors. They report also being drawn into general renovations, which are not specifically eco-oriented, but that this then gives them the opportunity to use this 'trigger point' to recommend energy improvements in dialogue with the client:

> *'We try and explain to them what our speciality is, and of course we will do your house renovation, but if you would like to have a little chat about what we could do over and above what you have specified here…and what the benefits might be…'* [A37B]

A heating engineer saw it as part of his role to advise the homeowner on energy efficiency as well as just selling and installing heating systems. He actively tried to do so at the initial stage of working with a customer – which could trigger further energy improvements, even though his company does not offer these themselves.

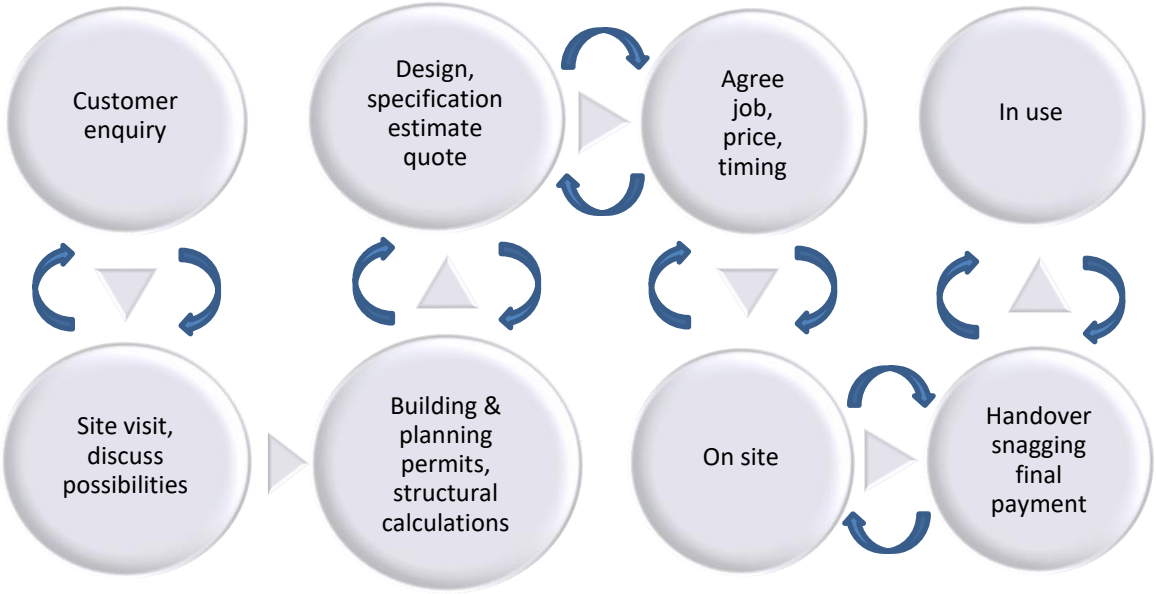
'…its part of our standard survey form… we know if it's a solid wall, you just know these things from experience…we'll go in the loft anyway to check their tanks, so we will see that insulation, and we'll say well you've only got 50mm and you should have daa di daa, or if they've got cavity walls…sometimes you can't tell until you actually take the boiler out… and then we show them – you've got an open cavity here…' [A38H]

He offered an EPC as a way both to formalise such advice on energy improvements, and to help (by charging for it) to pay for the time spent.

'We get a few enquiries where people say 'I'm thinking of changing my heating system but I'm not sure what to do', so we go along and do an EPC as the base for it and then talk it through, well you could do this or that, and we talk about the benefits and we'd often run through, if they wanted a heat pump or to stick with oil maybe, if they are off the gas network.' [A38H]

Asking builders (in Phases 1 and 3) to describe the way in which they work provided a picture of the possible stages of a major RMI project. The uniqueness of every situation was emphasised, particularly in working on older buildings, in that every customer and building is different, but a generalised schematic representation of the stages involved is given in Figure 9, where the arrows indicate the to and fro of the ongoing dialogue between builder and homeowner.

Figure 9: The stages of a home improvement or renovation project



These stages of work, based on the practical experience of general builders can be compared to the formal RIBA plan of work[16] (included in Appendix 1), which sets out the tasks involved in the different stages of a renovation project, providing a guide to larger and more complex building projects, in particular new buildings (RIBA, 2013). While rather too detailed (and linear) for a domestic RMI project, using this approach to define the stages of a project could be a useful basis for identifying potential gaps, overlaps and assumptions in terms of the tasks and responsibilities in an RMI job. In the light of the practical realities and cost limitations of the typical domestic RMI job where there are not a vast array of different professions involved, this research has identified that it may be the general builder who manages the entire process, as well as delivering many of the stages.

Taking the steps outlined above as a starting point, these are listed againt the most relevant of each of the 8 stages set out in the RIBA plan (ibid) in the first two columns of Table 13, and the question of who is involved at each stage is considered in the fourth column. The missing stage in the the RIBA plan, between 5 and 6 can involve considerable to-ing and fro-ing in practice, as homeowners review costs and make final decisions. ***This is a crucial stage, in which energy improvements may be included or discarded in practice.***

Table 13: RIBA Plan of Work project stages vs a typical RMI project

Stage	RIBA Plan of Work	Stages of typical RMI project	Who is involved
1	Strategic Definition	Customer enquiry	Homeowner & general builder or architect
2	Preparation and Brief	Site visit, general assessment of building characteristics and condition, discussion of options	Homeowner & general builder and/or architect
3	Concept Design	Outline design, planning, building control, structural calculations as required	General builder and/or architect
4	Developed Design	Design, specification, estimate or quotation	General builder and/or architect
5	Technical Design		
		Agreement on job details, timing and price	Homeowner and general builder and/or architect
6	Construction	On site works	General builder with tradespeople as required; possibly with architect oversight
7	Handover and Close Out	Finalisation, handover, snagging, final payments	General builder and / or architect
8	In Use	In use, and possible follow ups	Homeowner and general builder and /or architect

[16] www.ribaplanofwork.com

A 2017 study takes as its starting point that the source of the performance gap between design and actual energy use in low carbon housing renovation is not only in the lack of accuracy of building energy models, and user behaviour, but also in a lack of quality assurance and poor integration of the intermediate stages between design and implementation within the retrofit process (Topouzi et al., 2017). The study builds on the RIBA Plan of Work approach and proposes a 'retrofit-specific Plan of Work', which essentially takes the stages in the RIBA plan and presents them as a continuous cycle rather than a linear process, with feedback loops at all stages. The study concludes that there are a complex mix of social influences, conflicting interests and unintended consequences which can push a retrofit project towards a more or less successful result (in terms of energy performance and quality). Typical problems include technological solutions poorly matched to household characteristics, or conflicting advice to homeowners, while an example of positive approaches is collaborative problem solving on site. (ibid)

This study also makes the observation that the RIBA plan of work misses one of the necessary stages for work on an existing building – the assessment of the building as it is, including built form, age and type of construction, and any symptoms of pathologies such as damp (ibid). This step is included in the stages of the typical RMI job proposed in Table 13. These stages may be obvious practical necessities to an experienced builder, but not necessarily documented or acknowledged as their role.

A simplified and adapted version of the RIBA Plan of Work approach for domestic RMI projects could be developed as a checklist for homeowners and builders to use to ensure responsibility for different roles is agreed and acknowledged.

6.2.2 What is a general builder?

A general builder, in the sense that this concept has developed through this research project, can be defined as a tradesperson offering a service that covers the full range of work that may be needed for building construction, repairs, maintenance and services. In practice, there are many variations to this concept. Builders have reached this point through a variety of routes, and may have preferences, limitations or particular specialisms within this broad range. As described in the results of Phase 1, the way these services are provided (in the UK) may be through a group of informally networked or subcontracted tradespeople, where in the past it was more typically a local building company directly employing most of the relevant trades.

From the point of view of the customer, they are simply looking for ‘a builder’, and may not have formulated a more precise or detailed view of the specialisms required (or even the actual work that they want done). This view is corroborated by the FMB (Federation of Master Builders), who reported that they have more than 100 categories of tradesperson on their search engine, but still find that the majority of enquiries select the category ‘builder’. As a result they always recommend that new members registering on their website use the ‘builder’ category as well as any trade or specialism they may have – because potential customers look at that category, whether they are wanting general renovations, kitchen or bathroom refurbishments or other works. This is possibly because this formal differentiation of trades is not familiar to the general public.

The scale and nature of work offered by an individual builder or a building company may be bounded in a generalised way, in terms of the typical building size and characteristics that a builder is experienced in working on, for example single family homes and small office buildings as opposed to tower blocks and system build. The services offered are otherwise very broad-ranging, and responsive to demand.

> *‘So now we do repairs and maintenance on London residential properties, we build new, we do anything from mending a leaky washing machine to multi-million quid. In-house we do everything really..dig the holes, put foundations in, brickwork, plumbing, gas, electrics, plastering, decoration.‘ [A35B]*

The lack of specific boundaries in terms of the nature of the work is very much a feature of this kind of service, and there appears to be a normalisation of the ‘always learning’ attitude. This is very different from the division of labour that characterises a more industrialised approach – and which can be seen in ‘system build’.

> *‘I’ve done everything from the groundwork to the drainage to the footings, the brickwork – except for the plumbing and electrics, I’ve done everything….it’s basically whatever job comes along’ [A39B]*

> *‘Well I do the full design and build, so I have a full time plumber, the electrician is a sub-contractor but really he is full time with me, and I also have 2 gas engineers that I can call whenever I want.. ‘[A40B]*

General builders tend to fill the gaps in provision within the domestic RMI market, from design and specification through to project management and customer service.

A construction training manager confirmed this view of what a general builder is, and also the lack of definition of this role in construction education – except at a relatively low level, where the work might be described more as a labourer or maintenance person, rather than a builder.

> *'If you said 'general builder' to me I'd tend to think of a small builder who does a variety of things, he may be a bricklayer or a carpenter by trade, but he turns his hand to other things. But in education terms the only point that you hear the word 'general' is right at the bottom, in terms of a 'general construction operative', which is basically labourer/ground-worker - the term is not used anywhere* [in UK education] *other than that.' [H03]*

The lack of a specific qualification for the work of a general builder was confirmed by another training professional:

> *'What you find normally is that perhaps a bricklayer would do this kind of work, perhaps alongside a carpenter or a plasterer, and they would share each other's knowledge and pick up one another's skills and the trade…you end up with someone who calls themselves a builder, who may have been a plasterer by trade, or a bricklayer or a carpenter or whatever, but have self-taught and learnt the other trades, but didn't really have a formal qualification as a builder, because there isn't one.' [H04]*

General building services for domestic RMI at the high level for which there is a demand in practice is not recognised in construction education in the UK.

The training professional quoted above had identified the need for multi-trade skills, and had worked on developing a qualification for this, but recognised that what was currently available was at a relatively low level, and suited a maintenance person – for example working for a social housing provider, as part of a managed team.

> *'I did some work on that, it probably started a good 10 years back, looking at a multi-trade qualification, and I did that with C-skills[17]. Because there was already a multi-trade qualification, but only at Level 2, and having looked at that I didn't really think it was fit for purpose.' [H04]*

[17] Construction Skills

The qualification in question is a Level 2 NVQ Diploma called Building Maintenance Multi-trade Repair and Refurbishment Operations (Construction) (QCF 601/4297/2). In terms of the wider range of general building work, this interviewee recognised that what would be needed to deliver the 'general builder' would be a higher level qualification:

> *'Well we are going at Level 3 at the moment, but what you've got to look at, I think you've got to look at different routes, that you get a maintenance route, but also that you get a general builder route as well*.' *[H04]*

The level of the qualification is clearly a relevant issue and is considered further in regard to formal qualifications in 6.2.5 . An explanation of the levels referred to above is provided in Appendix 4.

A general builder is expected to cover the full range of building and building services work needed for domestic RMI . This is at a higher level than simple maintenance.

The possible name for the role described above was discussed with research participants, in view of the fact that this broad role appears both to exist and to be in demand by customers: possibilities might be General Builder or Master Builder.

6.2.3 General builder: skill and knowledge requirements

Discussion of the role that the general builder takes in practice highlighted the need to understand the scope of the work in practice, and the range of requirements in terms of knowledge and skills.

Multi trade knowledge and awareness

The general RMI builder has to have a wide knowledge of what is possible and the products that are available. This is part of the value of what they offer, and what the customer seems to need. This dependence on the knowledge and 'advice' of the builder indicates the importance of their potential influence as regards opportunities to recommend the most energy efficiency products or energy improvements that could be included with other works.

> *'…most people don't really know where to go to find things like kitchens they like. Or bathrooms, now there are such a vast range of products that people can choose from, it's just confusing really, I think, for a client who perhaps*

only renovates their house once every 15 years .. And because I'm doing it all the time I happen to know the best type of shower valve, the best type of this, that and the other…' [A35B]

'… general builder covers so many things – if you've got a city and guilds in bricklaying, and one in carpentry and one in plumbing, you know – a general builder is doing little bits of everything. It's something that you pick up by looking at other tradesmen, gradually…' [A36B]

The general builder also needs to learn the rules and regulations across all the trades: this is a wide range of knowledge in practice. You don't have to have every detail at your fingertips, but enough knowledge to know what to check and how, in each situation.

'Well, not only does it include the technical side of it, which you learn, but often you learn as you go along. I've learned all of the electrical rules and regs., gas, all this sort of thing, mainly as I went along. I could have gone to college I suppose but that would have only been for one topic…I know about plastering, drainage, all these sort of things…' *[A35B]*

General builders need to have good general knowledge of all the building trades, and the ability to coordinate them on site.

General knowledge of features of existing buildings

A different aspect of the breadth of skills and knowledge needed is to know about the range of existing buildings and their peculiarities. Being a competent RMI builder tends to be more demanding of knowledge and experience than building new.

'… if you are building brand spanking new, all this can be detailed at the beginning, and if you're building a block of flats, then every flat's the same, and it's quite easy… but when you're renovating, adapting, extending existing structures, some of which can be quite crumbly, you just have to have a sort of nose for it, to understand how the house works and everything else.' [A35B]

A knowledge of older buildings will involve awareness of conservation issues, as well as the structural details. This is helped by familiarity with local variations in traditional building methods and materials, an added bonus to working locally, as noted in the first phase of fieldwork.

'We did one house that had IWI on the front and EWI on the back, because it was a great example of the Victorian terrace with beautiful fronted brickwork, which was just never going to have external changes to …' [A37B]

Being a competent RMI builder means developing good general knowledge of existing buildings and their peculiarities.

Measuring, estimating and pricing

The ability to measure accurately and to estimate quantities for pricing are essential skills for the general builder. The training for a quantity surveyor was indicated by some as a good background for running your own building business, and the value of learning from experienced people is highlighted.

'…I spent my time measuring drainage on site, when the diggers were there I was watching them digging the holes and measuring the depth and what the quantities were to cart it away, and the foundations going in and all the way up, and the roof, so I literally measured every single trade from the foundations up to the ridge slate, and all the electrics and plumbing too. So I got a taste, I knew how buildings got put together….Measured and measured and measured and learned value…' [A11B]

'…. the Director was very experienced, very old fashioned, but I learned more off him in 2 years than anyone I've ever met… Initially, there was a Manager, and I was down to be the Contracts Manager, and they had a QS [Quantity Surveyor]*, a secretary and an estimator. So again I learned off them, very quickly...the business, management techniques, how you deal with insurance companies, how to take control of a job and do it the right way as well as making money…' [A40B]*

Measuring, estimating, pricing are essential skills for running a building business

Problem-solving and troubleshooting

The importance of problem-solving as a key skill is highlighted – and when questioned about learning to include energy efficiency or renewable energy, the response was that this is no different from other building work:

'It's all the same thing. It's all about problem solving, about working out different ways to solve a problem and then trying to choose the best.' [A01B]

One aspect of problem-solving is dealing with existing building defects and pathology, for example in relation to damp problems - and this is an interesting area of knowledge and skills in relation to renovation, with strong links to energy efficiency and comfort.

'I joined my father's company in my 30s, which was wood worm and dry rot and remedial treatment...The amount of buildings that I saw…all kinds of ancient homes. I was there when they opened them up, and I could see all the decay, I could see the problems…We would go through the process of seeing what needed to be done to put it back together in a responsible manner so it doesn't rot again…reinvented myself 25 years ago and started doing small niche top end domestic projects….either refurbishing or converting them, and I have a genuine interest in saving energy. I knew all these buildings leaked like a sieve…so I thought what else is on the market, what's the new technology, what's the thinking, and started including it in my recommendations and specifications…' [A11B]

A review of qualifications in construction by Qualifications Wales found that the majority of employers they interviewed placed greatest value on core, interpersonal, problem-solving skills and the ability to take on a wider range of tasks than those prescribed in qualifications (Qualifications Wales, 2018).

Problem solving and troubleshooting are key skills for RMI work on existing buildings.

Project, people and business management

Clarke et al (Clarke et al., 2017) refer to 'transversal abilities', including planning, communication, coordination and evaluation, and note that these abilities are recognised in the German vocational, educational and training (VET) system for construction education. Several interviewees mentioned the wider skills needed, in order to be a successful general builder, such as general building site management issues (such as health and safety), and coordinating the work of others on site:

'..it's all very well being a builder and mixing up the sand and cement, you have to organise people to do it…its people management' [A35B]

If these are sole traders (a common approach as has already been identified) and not direct employees, it may not be seen as 'management' as such – rather it is the kind of relationship between tradespeople that grows organically as they get to know each other and their respective skills and personalities. Not everyone necessarily wants to take on the responsibility of coordinating the work of others, but equally some people take better to being told what to do than others. Getting the relationships right on each site is yet another skill to develop for the general builder.

Other aspects include project and wider business management skills.

> *'If you look at the skill set that they need….there's brickwork, carpentry, plastering, electrics, all sorts of stuff, but also they need the skills to run their own business, marketing, promotion, customer care. To run a small building company it's a really broad set of skills, competencies…we're running training on asbestos, working at heights, and also stuff on cash flow, financial management, marketing…courses on e-commerce, digital marketing.' [D04]*

Business management can cover many things, including all the administration and financial management (as well as the essential skill of pricing mentioned above), while project management involves managing each job, coordinating trades and materials, liaising with clients and so on.

> *'So going back to the training, the key is going to college, and out of college go through the different management hoops, like contracts manager, quantity surveying – you are the financial overseer for the project… I would measure and go out on site and be part of the negotiating group that negotiated all the contracts with the sub contactors…I would control those contracts.' [A11B]*

One of the builders interviewed found that the project management skills developed in a previous role was useful.

> *'So we started project managing little eco-renovations – pretty much started on mum and dads house...and discovered that to incorporate everything they wanted was incredibly difficult…to find the right suppliers, who were giving the right sort of advice, who weren't just trying to flog their own solutions, was incredibly hard… But ultimately what I realised is that this is actually about project management, which I've done…We went from doing little jobs to whole house renovations fairly quickly.' [A37B]*

He found by adapting the right software and organisational approach he was able to run several teams and projects at the same time.

> *'On top of all the SAP software and stuff we use a Builder Trend online project management system…' [A37B]*

Coming from a different background a bricklayer who developed his role to be a general builder remembered the value of learning about site management at college.

> *'When I did site management at college, its filling in paperwork a lot of it, knowing what you've got to ask for, what insurances to ask for, what qualifications, what you are liable for..you have to do a little project on site,to spatially break down the site, where you would put the site cabins and where the materials would go…' [A39B]*

A joiner who worked his way up through the ranks at a City Council remembered the training as a junior as being very good, but noticed the lack of management training as he was promoted through site foreman to contracts manager. He later became a general builder and ran his own company.

> *'I would say that ***Council is one of the best companies I've worked for, for training. Even as a Joiner, we used to have training for kinetic lifting, health and safety, customer service. That's as a Joiner, then as a Charge Hand, there wasn't much training for the middle (well you're not really management are you, for the first tier)...there is no training really.' [A40B]*

Project and business management are key skills, transferable from other roles.

Both theoretical knowledge and practical experience

The importance of developing both theoretical knowledge and practical experience was emphasised. The combination of college and working with skilled and experienced tradespeople gives the best chance of learning the full range of skills, both the more traditional and newer ones.

> '*In HNC you have a module which is quantity surveying, so you learn to do it properly. And you do brickwork and learn about all the different bonds, it's not only being told on site but also in the book how it's meant to be done' [A11B]*

'I used to ask 'why are you doing this and what are you doing that'… there's lots of things that I've been taught over the years that basically a college course wouldn't teach you…for instance planing timber up with an old wooden plane…and lots of ways, not cutting corners but getting a better product and a better finish, by learning off someone with experience that he'd been taught and he'd been taught before that…..' [A40B]

The importance of learning over time from an experienced person is something that several of those interviewed remembered as of considerable value. This is less easy to achieve with companies not able to afford to directly employ a full building team over any length of time, and with shorter apprenticeships.

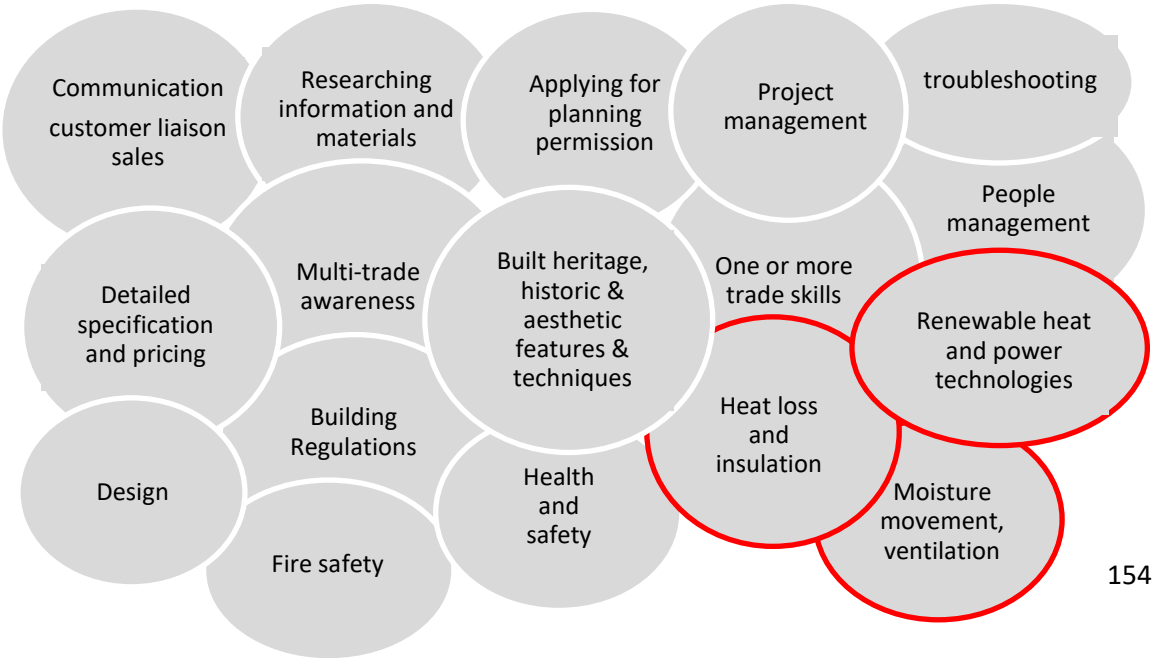
'…back 20 years, when my father was in charge...I was an apprentice, my two brothers were apprentices, and we had one or two carpenter apprentices and two bricklayer apprentices, he trained them to work like he wanted them to…' [A36B]

Theoretical and practical knowledge and skills are required, implying both college and apprenticeships.

Summary of general builder skills and knowledge requirements

Taking into account the perspective of the interviewees noted above, Figure 10 provides an indication of the range of skills and knowledge required for general RMI building. The specific areas related to energy improvements are outlined in red.

Figure 10: Skills and knowledge a general RMI builder needs



6.2.4 How people become general builders and learn their trade

A training professional interviewed questioned whether anyone actually aims to be a general builder when they start out in training or working life, as opposed to developing into one to meet the demand that they encounter in practice in the market place. This perspective was reflected in the experience of research participants who are successful general builders, who were asked about how they got to where they are today. The routes taken are various, but some common themes emerged, around gaining experience beyond one trade, developing both practical experience as well as theoretical knowledge, learning to project manage and an attitude of, and appetite for, continuous learning.

> *'I went to college on day release. I did the path to HND in building construction, you did HNC first, and because my A levels were so bad I had to start off on City and Guilds, general construction. In general construction at that stage you had the Mitchells books and went through this with the tutor, and they would set you exercises on drawing building construction, sections and details, so you would know how deep a drain had to be and how a roof was pitched and all that kind of stuff.' [A11B]*

> *'I was a civil engineer, got a degree in civil engineering many years ago, worked on big public works jobs such as airports, airfields mainly for the Ministry of Defence, and motorways, and then went into business on my own, again many years ago, and went I came to London in about 1984, I just started on residential work, and I just built up from there really. '[A35B]*

> *'I came back from being overseas, having done a Masters in environment, development and policy…I wanted to do something in the built environment, and became a Code for Sustainable Homes Assessor, and a SAP Assessor… but actually didn't really enjoy doing that because it was very number crunching heavy, form ticking and all that sort of thing…What I was much more interested in, was not talking about all of these wonderful things that everyone had been banging on about for so long, but actually doing it.' [A37B]*

Training in a construction trade which involves you being on site for a large part of the project can be the starting point for becoming a general builder. Typical examples are to start as a carpenter, joiner or bricklayer. Being on site can provide the opportunity to observe and learn about and from the other trades.

'I started off as an apprentice joiner at 16, with a local building company. The range that we got taught was very good to be fair. We did a lot of domestics, a bit of commercial, a little bit of industrial, but I was privy to all the different trades and so I picked up quite a lot of knowledge from being 16 to right throughout my apprenticeship, where I used to ask different trades all the time…I realised while I was serving my time that as much as I enjoyed being a joiner, and carpenter, I saw my future in management. I liked the organisational side of building, and I tended to ask lots of questions of each trade, keep me eyes and ears open, and to learn that way.' [A40B]

'What I've always said to them really, is that basically you need to be decent enough to do the brickwork, because everything else follows around it, and if you do the brickwork you tend to be involved right from the beginning, you do the footings, and then you are there right throughout the job really, and then you can notice what's happening with other trades, and learn from it. But you can only really learn by doing it. '[A39B]

The bricklayer above pointed out that if he hadn't branched out into a wider range of work, he would have had to change career anyway as he had problems with his back, which meant that bricklaying all the time would have been impossible. He also prefers the variety of a wider range of work.

'I like the variation, and to be fair I am glad I have done, because I have had problems with my back, and if I do constant bricklaying, for weeks and weeks, it's not good for your back at all….if I was purely specialised in brickwork, I probably would have had to take a different career path by now.' [A39B]

A training manager confirmed the point about certain trades being on site for longer, and so learning more about the work involved in building more generally.

'A lot of builders tend to be carpentry and joinery people – the reason for that I think is that you take a carpenter or joiner, he is involved with the build from ground through to completion – he's there on site isn't he? If you are there from start to finish, it's much easier for a carpenter to understand the project management of a renovation project or a small extension, and then of course get the necessary other trades in.' [H03]

He also suggested that the academic abilities of those learning carpentry or joinery tend to be higher than other construction trades (not including building services), and

produces people more able to take on the project management responsibilities of a general builder.

> *'The other things is…I could give you data.. carpentry and joinery of the biblical trades, attracts the more academic and brighter candidates…(take plumbing and electrical out of it, on your construction crafts)… so what happens is, they tend to end up in project management, and then branch out self-employed ' [H03]*

One of the steps that can lead from another role (such as an engineer or surveyor) to becoming a builder is doing some major work on your own home, finding out what is involved, and realising the potential opportunity this brings – including a potential profit margin.

> *'I needed to build an extension at home, I didn't have much idea of financing - as a site manager you're not really taught that much about the financing side, you usually have a QS and an estimator. So I borrowed £50,000 on my mortgage in 1998/99, and then I sat at my table and drew some plans, to build an extension to make it a 4 bedroom semi...but I built it for something like £18-20,000…I had money left in what I had borrowed.' [A40B]*

This might then be followed on by neighbours asking for something similar and so it can grow into a viable business, based around one locality.

> *'And then my next door neighbour said to me, could you build me one? So I sat at my kitchen table, and I hand drew the plans. And a neighbour over the road said could you do me one? And then a neighbour round the corner. And I realised quite quickly that if you can develop a niche, of being a bit different from everyone else, you're going to be busy.' [A40B]*

A strong theme emerges around the importance of learning by doing, the need for practical as well as theoretical experience (as noted in the previous section), and learning from others.

> '*I suppose I am one of those builders that is self-taught, and I think in a way, most are…because you can't have courses for everything, and with these hands-on trades often the best way to learn how to do something is to start doing it. You accumulate experience of your own, but you accumulate*

experience of others too. When you are working with someone who knows what they're doing, you learn other ways of doing the same thing.' [A01B]

With respect to the details of specifications, there is considerable learning by experience and from each site , especially when it comes to the variety of older buildings, and especially for the most sensitive historic buildings. A supplier of lime plasters, with a great deal of experience of wattle and daub and timber frame noted:

'.. a lot of the builders that come to me are already in tune if you like, so it's not as if a builder who works on a Grade 2 listed building one week … and therefore has to use particularly breathable or whatever products, and then the following week go and work on a Grade 2 listed building… and just throw up sand and cement…they tend to be tuned into the right materials..' [B05]

In the absence of a formal educational route, it appears that general builders have developed their skills and knowledge in response to the needs and demands of the job. The different paths they have taken provides an indication of the skills required.

In the absence of a formal educational pathway, general builders have developed their skills and knowledge in a variety of ways, responding to the demands of the job

Some of the examples of the route taken by the general builders interviewed are summarised in Table 14.

Table 14 : How some successful general builders learned their trade

Participant	Qualifications	Experience
A01B	Degree in chemical engineering	Renovated own home(s), asked by others in neighbourhood to do theirs, built work from there.
A11B	HNC General Construction	Trained as quantity surveyor with major contractor, with college on day release; took on management of family woodworm/dry rot business, built this into renovation and housebuilding company.
A17B	Plumbing, bricklaying, carpentry, lead-burning – typically Levels 2 or 3. Domestic Energy Assessor.	Worked with father in his local building business and later took it over.
A35B	Degree in civil engineering	Civil engineer on large public contracts overseas, started residential building business on return to UK
A36B	HNC in Building Construction	Worked with 2 brothers in father's building firm, ultimately taking it over with his brothers.
A39B	Apprenticeship in bricklaying; advanced craft and 'series600' course covering site management, surveying, measurement, costing	Self-employed from 19, and gradually took on a wider range of jobs over time. Back problems made wider range work than just bricklaying preferable.
A40B	Apprenticeship in joinery.	Apprenticed with small building company, then to local authority as joiner, rose through ranks to foreman, project manager, contracts manager; phase in private building /groundworks business, renovated own home, then neighbours' and grew own building business from there.

6.3 Recommendations for change

6.3.1 Training and qualifications

Should there be a qualification for a general builder?

This research has highlighted the significance of the role of the general builder who leads, coordinates and specifies domestic RMI work, in both influencing demand for, and delivering, home energy improvements. It has also identified a gap in provision of a clear education and qualifications pathway in the UK for this role. This gap is confirmed by the Sainsbury Review, which identifies 15 technical education 'routes', with typical job role for those listed under construction (numbers employed: 1,625,448) described as: bricklayer/mason, electrician, building/civil engineering technician, carpenter/joiner, construction supervisor (Sainsbury, 2016).

As indicated in section 6.2.4, the builders interviewed had reached their level of skill and knowledge through a variety of informal routes, including starting with training in

a single trade and gradually taking on responsibility for bringing in and coordinating others, moving from another profession such as engineering, surveying or project management and applying transferable skills, and building or renovating their own house and then being asked by neighbours to do something similar for them.

A training policy professional interviewed thought that the lack of a clear training and qualifications pathway to becoming a general builder might be because it wasn't what people set out to do in the first place. The exception is perhaps those who worked in a family general building business and were specifically encouraged to learn across all the trades.

> *'Are young people looking to be a general builder, or to have a role within the construction industry? What sparks their interest? You might get excited by thatching, or working at height…I'm not sure whether there is a strong identification with what being a general builder actually means.'[H02]*

Participants in the round table discussion thought that not only are there labour shortages in the building sector (for example, not enough bricklayers to meet the government's housebuilding targets), but also that few people aspire to become general builders – and that people do not know exactly what it means, echoing the comment above.

It would appear that people develop more typically into being general builders in response to the demands of the market.

> '*I think you kind of transition to become a general builder though by virtue of the market – you develop a client base and that client base requires a variety of different services…once you are in the industry the market requires you to operate in perhaps different ways, which is why CPD is so important' [H02]*

With this in mind, a general builder qualification might usefully be presented as a development opportunity to successful students of individual trades.

The lack of a formal educational route poses a problem for policy-makers, wishing to embed sustainability into building practice, and to assure quality. It also makes it difficult to plan for a low carbon future housing stock, and to ensure that there are skilled people to deliver programmes. A robust and accessible system for education and training must be an important part of enabling this to happen. If there is no specific qualification, how can a customer know that they are getting someone who

knows what they are doing? Another consideration is that the current lack of qualifications for the general builder may reflect badly on the status of the building trades.

> *'They (trade associations etc) should be working to build up the professional image anyway, but the trouble is there is no formal qualification that's recognised by the general public for the builder' [A11B]*

It should be noted that the lack of a qualification does not necessarily mean that work is of a poor quality. A common feature of those interviewed, in fact, was the localised nature of their market and dependence on local reputation. Where available, positive referrals from satisfied customers may be a safer guide to quality than an accreditation or statement of qualifications. As described in 4.5.2, the indications from the Countdown to Low Carbon Homes project were that the involvement of a local authority or non-profit advisory service was more important in reassuring customers (Maby et al., 2014). Using a local builder also offers more reassurance that you will be able to bring them back in case of any problems.

> *'Well I think most people would say you should use someone who has already been recommended. To just get somebody out of yellow pages is asking for trouble. And I think it's the same for architects…you should use someone who has been recommended to you.' [A01B]*

When asked whether they think there should be a qualification to be a general builder, the response from interviewees was mixed. From a builder:

> *'Personally I don't think qualifications tell you how good someone is, it's their product that matters, and that can be judged by seeing what they have done for others.'[A01B]*

From a trade association:

> *'Well yes that's the whole problem. Successive governments have refused to regulate building in this country. If you look at something like gas work, there's CORGI or Gas Safe, and for electricians you know you've got to be qualified with EIC/NIEC, but with building there's nothing…'[D04]*

From an insulation supplier:

'I think there should. Anybody can buy a van and call themselves general builder and then get involved in all sorts of stuff and even with the best intentions not get it right.'[B08].

In response to the question about a general builer qualification, a senior manager for an insulation manufacturer reflected on the problems he had encountered in trying to establish qualifications and standards for insulation installations.

'What I have seen is that at every turn there has been a growing push back that no this is not necessary…so my qualified yes, it's a good idea - the qualification is that, without being too despondent, I think we have spent potentially decades, lowering the level of skills and demonstrable skills that the industry has…We have to put in place all the necessary support and it has to be a transition…That's not me backtracking on the fact that we should have higher standards, but that it's a long road…' [B07]

One of the problems cited was the cost of achieving qualifications, and the strings that come with sponsorship, such as the commercial interests in particular products.

'It's a lovely idea. The trouble is a builder is just something you can get up in the morning and call yourself. The trouble is with qualifications, they are expensive. So you end up with sponsorship, and then you end up with vested interest...' [B05]

A different perspective was presented by a senior person in construction and building services at an FE College, for whom this suggestion raised concerns about a loss of respect for the need for specific expertise within the individual trades.

'There isn't one and there never should be one….one person will never know the complexity of every single trade.. in a house that's probably not as critical because there are not quite such complex issues to deal with on all trades, but there are developing complex issues on some trades…In particular I'm talking about building services, the control of services, smart homes. Now the problem with that is that as we go further into the low carbon economy, that complexity reaches out to the building fabric, and what the building actually does without the services…One person can't be all things to all things, and the more complex buildings become, the less that person is going to be able to exist….and that person needs to take on higher education to project manage rather than to try and do everything.'.[H01]

This last comment is not so much an argument against the need for a generalist to coordinate the work, however, as a wish to see proper acknowledgement for individual trade specialisms, and a confirmation of the need for the generalist role to be at a reasonably high level. The use of the term 'building physics' is linked to the need for 'whole house' awareness in design, including both heat and moisture movement within a building. The level at which this is studied would need careful consideration in practice.

The HNC (Higher National Certificate) in Construction was mentioned as possibly the closest to a qualification that would prepare someone to be a general builder. This is a level in between A-levels and a degree. It was mentioned by some builders ([A11B], [A36B], [A39B]) as an objective that they either achieved or considered going on to before getting drawn away into paid work. It is possible, however, that it is seen in practice more as a pathway to management on larger construction sites, rather than preparing you for a wide range of work on domestic properties. Or that, as mentioned above, people might start off along that pathway and not complete it because they get paid work and find there is no demand (or financial support) to go back to college and complete the next level of training.

> *'…a general builder at the scale of domestic, maybe small commercial properties, renovations, extensions, maybe new-builds as well, but bespoke one-offs…they are project managers as such really, aren't they? How would they get the knowledge? It's quite difficult really, because the only vehicle really is the HNC in construction, that would probably accredit them, but it's quite time-consuming…' [H03]*

The trainer in this interview pointed out that the course tends to favour commercial building and this confirms the lack of expectation that those working on domestic properties would complete it. The higher level building qualification for domestic RMI or one-off construction seems to have been neglected.

> *'…yes it does support domestic work, but….I am delivering an HNC at the moment, in building services, and focussing on a commercial project as a vehicle for delivery. I've chosen two assignments, assignment one is 'appraise the building services for efficiency and efficacy, in a given building and write a report to the client', who is an FE provider. And the second assignment will be to come up with a design solution for an extension onto that same building. So even I am choosing a commercial building, because at level 4 HNC a*

domestic property is probably too simplified, and not sophisticated enough to meet the learning outcomes.' [H03]

The recent review of training in construction by Qualifications Wales specifically raises a number of very relevant points – for example that:

(a) most of the construction work in Wales is repair, modernisation and retrofit
(b) there is a need for trades people to be more 'multi-trade' - but this is not reflected in education or training
(Qualifications Wales, 2018).

It stops short, however, of recognising the gap in provision as the role of the general builder. The considerations also stop well short of of considering the need to train builders to design and specify sustainable refurbishment.

A major supplier of insulation, who developed an extensive training programme during the development of the Green Deal, voiced concerns about the capacity of small building companies to do their own design and specification, because they are not trained to do so.

… small builders specifying, without knowledge of the complete home and how everything comes together is where it all goes wrong…in a renovation job, they go in and do their part which might be a very small part of what actually needs to be done for it to be efficient..but don't really have that whole house approach to it or any sort of building science knowledge….we would like building physics and the more holistic approach to home renovations to be more mainstream.' [B06]

In terms of designing for low carbon and energy sustainability, this is not something that any of the individual trades are likely to have learned as part of their core training. Some may have learned part of it. For a general builder to be able to design holistically for the energy performance of the building is an additional knowledge area, however it is to be learned.

'I think the gap, for the general builder….is understanding how energy flows in and out of buildings….the carpenter and joiner, he's not going to have that. The plumbing and heating guy, yeah they'll have an understanding of heat loss, but of course they won't understand necessarily structures and how to deal with buildings, because obviously the need is to make the building as energy efficient as possible first and then to put plant in to offset what the

envelope of the building can't cope with, isn't it? So it's a set of skills. You probably could break that down into a shorter course, for a qualification that would bring it all together.' [H03]

Asked about whether learning to design and specify for whole house renovation could be built into building trade training, this training manager could see that this might be possible at Level 3 (roughly equivalent to A-level), and appropriate for someone doing general building work.

'… you don't necessarily have to be able to design the heating system or whatever it is, it could be electrical, or LPG, gas, solid fuel … it's coming up with something that brings it all together… how heat flows in and out of buildings, how domestic hot water is used, how energy is used for cooking heating, lighting…pitched at the right level, level 3 for domestic work is probably adequate' [H03]

The role of general builder able to deliver domestic RMI, requires a clear and credible educational pathway, and a qualification at an appropriate level to incorporate design and specification of works including energy improvements.

The Federation of Master Builders (FMB) have recently taken up this issue, launching a new campaign for a 'general builder' qualification, recognising that this would help to professionalise the image of the industry (Federation of Master Builders, 2018).

Embedding sustainability in construction education

As part of the quest to identify how to integrate sustainable energy and low carbon technology into mainstream building trades work in the long term, research participants were asked broadly about training and qualifications for the building trades. One of the issues that came up was the difference between providing such topics as 'add-ons' or embedding them into training across the board.

'I think we have won the argument now that sustainability and the principles of sustainable construction are an embedded activity right across the construction process, in the same way that health and safety is, rather than being a bolt on. 5 or 6 years ago we were developing courses in stand-alone units in sustainable construction and no-one was doing them…that makes it much more of a challenge, because you are not just trying to sell one course to people… you are actually trying to change the whole system… whether it's

what a carpenter needs to know, and a Level 2 diploma about what an air tightness barrier looks like, right through to sustainable design and professional training.' [H02]

In practice, it's not just the building trades that need the right knowledge and skills. The role of other key actors such as architects, Planning and Building Control is also highly relevant. The round table discussion highlighted the potential role of architects, where they are involved – but that they tended to have their own agenda and needed to be encouraged to think beyond the defined project to 'consequential improvements'. Planners, through planning policy and guidance, can also have an influence, mortgage lenders and surveyors have a part to play, and the importance of the role of Building Control and Inspectors has already been identified in Chapter 4.

'We are going to have to train Building Inspectors, and that highlights a part of the problem. There's a need for a huge education programme across the country.' [D04]

Sustainability should be embedded into core training for <u>each</u> of the building trades and related professions.

Scope, level and structure of training and qualifications

Embedding sustainable energy and low carbon technologies into standard trade training is one step forward for achieving home energy improvements. Developing a more holistic understanding of how applying these technologies impacts on the building as a whole is a step further. More broadly, the scope and level to which building tradespeople are trained was raised by several interviewees. A diagram explaining the qualifications levels 1 to 8 that are currently used in the UK, and how they relate to Vocational Qualifications, apprenticeships, GCSEs, A-levels, HNCs and higher education is provided in Appendix 3.

When a builder takes on the responsibility for deciding what to do on a wider renovation job, (including in effect designing and specifying the job), the debate around integrating the work of the different trades on a building goes beyond a general awareness of different trades – and the 'whole house' concept and the need for an understanding of 'building physics' is sometimes raised. This relates to the interaction between different measures such as thermal insulation and ventilation, and the impact on both heat and moisture movement within the home and through

the fabric itself – with implications for the risk of damp, as well as energy efficiency, comfort and health.

Integrating the work of different trades effectively includes the ability to treat the house holistically in terms of heat and moisture movement.

The need for the general builder to have a good general knowledge of the work of all the trades and the ability to treat the building holistically has implications for training and qualifications. The training lead from a major insulation supplier raised this as a major concern regarding gaps in construction training, along with a lack of training on renovation generally (as opposed to new build). Rather than seeing this only as part of a 'general builder' training, the suggestion was made that it should form (or be part of) a kind of foundation for people going into any of the trades.

> *'…one of the colleges we support…they have little or no renovation training, or even for that matter, whole house training, building physics in anything they do, and I think, for me, it should almost form the foundation of any construction training programme because any field you go into, you would need some sort of knowledge of how your work impacts another. And how it all comes together.'' [B06]*

The foundation concept was echoed by others:

> *'…in terms of that generalist introduction to construction, and the importance of that, the fact that this fragmentation of the industry has tended to move us towards people specialising at a very early stage in their learning and development. There is a shift away from that now.' [H02]*

These comments raised wider questions about the way that building trades training is structured. The issue of funding for training and how this is arranged, who pays and what they will pay for has to be considered as part of this, as indicated by an insulation materials supplier:

> *'…the college…often approach us to work with them on dry-lining or landscaping on the brands that we support, and I was saying that you need to be willing to go over and beyond what you get funding for…and that will mean that your students come out differentiated. You are value-adding… And that's where I see this coming in, so almost like a module which… could be included*

in a formal curriculum. But at the moment, the starting point is probably the more forward looking colleges delivering it as an add-on.' [B06]

This issue was taken up by the Green Construction Board (formed in 2011 as the sustainability work stream of the Construction Leadership Council[18]. The Board produced a guide to sustainable building training (Green Construction Board, 2017). The document is high level, listing 'learning outcomes' in generalised terms, for construction and building services engineering trades respectively, with a similar list for managers and supervisors. While the latter importantly includes the requirement to '*know the role of dependent trades in the build process and their impact on the energy performance of buildings'*, no mention is made of ability to design or specify for low carbon renovation, nor recognition of the role of building trades in coordinating work themselves. Also missing is any reference to communicating low carbon renovation processes to contractors. (ibid)

With reference to the need for a broader general knowledge to underpin specialist trade training, one of the training professionals interviewed mentioned a pilot led by Build UK[19], an alliance of industry bodies:

'…one of the work streams is skills, and they are in the pilot phase of a construction foundation year….students get an overview of construction, understand how trades come together, building physics,the impact of one over the other and how the elements interact, but they also get exposure to project management etc.' [B06]

This is seen as a way to raise standards and quality across the board. The interviewee in question presented it rather more from an industry perspective than in terms of a holistic education or jobs strategy, in that it would 'raise the bar' in terms of entry requirements as well as delivering a more highly qualified workforce.

*'… that's very much a starting point for how things are done up front, so it's much more a general construction module, including building physics, which if you include it in FE [*Further Education] *training will raise the bar of the level of students coming in. We will almost change the quality of the students coming out just by changing the requirements and the curriculum.' [B06]*

[18] www.greenconstructionboard.org
[19] www.builduk.org

In Wales, something similar was reported by a construction training professional to be under discussion:

> *'...it's a really sound model for the construction industry, because it captures things that are currently missing…at stage 1, students coming in will be delivered training and education on all aspects of construction, both the built environment and building services, because these are two very different pathways. At stage 2 you start breaking up into sectors.…From the word go we teach them about health and safety so why can't we also teach them about how a building gets to be or maintains its energy efficiency or improves its energy performance?' [H01]*

Others questioned the extent to which the necessary knowledge can be provided within a foundation module, but supported the principle of ensuring that all trades, as well as those going into more general services and management should receive a broader education, including sustainability along with essentials such as health and safety (and also fire safety).

> *' I think these things have got to be embedded throughout the qualifications....perhaps tested separately at the end…There is a CIOB* [Chartered Institute of Building] *Level 4 higher apprenticeship in site supervision, I think we were talking about maybe having something before that to give people a better understanding. But I'm not sure at the trades level, about some of the stuff we're talking about, that might be slightly too high a level at the very first stage. But if you left it as a kind of additional or a higher unit at the end, lots of people wouldn't do it...' [H04]*

The need to modernise and improve building trades' education was stated clearly by an interviewee with many years of experience, as a tradesman, a manager and a specialist adviser. This is partly about learning about new products, but also relates to the integration of the different trades, and the impact of individual measures on the whole house or building. The issue of fire safety was highlighted as an example.

> *'…building maintenance work has moved on apace, over the past, well, 10, 15 years, and the qualifications haven't moved with them. There are so many new products and different ways of doing things now, the qualifications need to catch up…energy efficiency and so forth, which is more at the forefront now, which needs building into the qualifications, as does improvements*

around quality, fire safety and all the rest of it. When you think of the Grenfell situation, and how bad that was…anybody could have got into that building and done work, even down to people putting in telephone cables, television cables and so forth, who could quite easily bridge fire safety compartmentation….' [H04]

Taking a holistic approach to the whole building is a step further than embedding sustainability into the work of each trade, and could be seen as part of set of foundation skills for building trades education.

A recent review of the expertise needed for low energy construction argues that the technical requirement of low carbon construction to treat a building as a single thermal unit (colloquially referred to sometimes as 'whole-house' retrofit awareness) in turn demands an effective social interaction between the trades – effective communications and coordination are crucial (Clarke et al., 2017). An insight from this study which particularly chimes with commentary from the fieldwork and discussions within the industry is that the problems which occur at the physical interfaces in low carbon refurbishment, such as the joints between different building elements and materials (Rickaby, 2015), are reflected in the social divisions between trades, particularly where they are operating under different contractual conditions (Clarke et al., 2017).

This 'gap-identification' approach might be similarly applied to the gaps in formal coverage of the many tasks required to fulfil an effective low carbon refurbishment – design, specification, on-site coordination and so on. It could also be applied to the communications between different building professions – architects, surveyors, builders, building inspectors and planning control.

The need for a holistic and integrated approach applies, therefore, to the physical interfaces within a building, to the different trades working on site, and to the different building professions that might be involved. The core role linking these different elements in practice is typically the general builder – and the most significant gaps appears to be the lack of a formal definition or acknowledgement of this role.

Qualification levels

One issue that emerged was a concern regarding the level of qualification seen as sufficient for delivery, and the standard at which it is typical to go on to full time

employment. This highlighted the question of costs and funding. The cost of going to college has to be taken into account, and not everyone is sponsored by their employer. This leaves a gap which does not appear to be filled (sufficiently) by public funding.

> *'The professional construction qualifications I think are not as well funded by government as it was – they pulled the plug on all the technical qualifications…there's a big policy gap to be honest' [H02]*

More than one builder interviewed mentioned that they had considered going on to a higher level, but had stopped because they started doing actual paid work, and didn't need the further qualification for this – or were not sponsored to do it so would have had to take time away from work and pay for it themselves.

> *'I got a day a week deducted out of my wages because my boss said he couldn't afford to send me to college...I did my 3 or 4 years, I did my advanced craft as well…but I had to pay my own fees, so on the week that I finished my indentures, I gave him a week's notice and I finished.'[A40B]*

> *'For college, you have to specialise in one, so I qualified in bricklaying, and when I finished my apprenticeship, I went on to do advanced craft and then a course that was called series 600 back in the day, it's sort of like site management, surveying, measurement and costing…I just stopped short of doing the HNC…The main reason I stopped was that I was self-employed at 19, and the last 2 years at college I did pay for it myself. If I had gone on to do the HNC, I would have had to have a couple of days off work, and the cost of the course was a lot more, so I thought well I'll stop as I am'[A39B]*

The latter pragmatic decision did not mean that there was no interest in going on to further training and qualifications, should the opportunity arise:

> *'…and if eventually I need to have that course, hopefully I am with an employer at the time which might put me through it, but I have never needed to...' [A39B]*

As noted in 4.5, the pressure to get out and earn as soon as possible, rather than continue with formal training, is there within the microbusiness too, where the financial pressures may in fact be even greater – however in the self-employed situation the individual is in a position to make their own decision about investing in

further training, and in the small business the business owner is more likely to want and need the higher level of skill and wider knowledge base for their staff, and to be able to see the return on this investment.

Investigating vocational education and training for heat pump installations, Gleeson identifies a trend towards de-skilling within the heating market, due to packaging of products and an increased use of 'rule of thumb' for specification. He points out the negative consequences for the effective introduction of low carbon technologies, reminding us that the energy performance of heat pump systems is heavily dependent not only on the product and its installation, but also on the design, installation and commissioning of the whole system. Gleeson describes the change in the UK heating and plumbing market from the 1950s when central heating first started to become the norm in new heating installation, to the present day – with a shift from an expectation that the heating engineer would calculate heat loss, radiator, pump and pipe sizes to a 'combi culture' where specifications are done by rule of thumb and systems are bought as a package of equipment by the installer (Gleeson, 2015).

This was reflected in comments by an interviewee [H03] who delivered building services training, that at Level 3 calculations are taught, but trainees seem rarely to use them in practice, as the norm is to go by rule of thumb. Those leaving formal education at Level 2 do not even learn to do such calculations – learning only about central heating components and their installation (ibid). Moving on to the more design-sensitive heat pump installation against this background requires a step change in approach and skills development. Gleeson notes with concern the emergence of bespoke short courses for heat pump installation as a stop-gap, and their inadequacy in terms of coverage of design aspects as opposed to purely the installation, particularly if seen as a bolt-on to nothing more than a Level 2 qualification (ibid). While such courses (a three day course is given as an example) may adequately cover the installation process, they cannot fill the gap in design capability left by the inadequate basic level of an industry peopled by Level 2 plumbers – therefore relying on design being done by another 'suitably qualified person' (ibid). This approach adds cost to the installation of heat pumps, compared to the basic gas central heating system installation as a rule of thumb package – and misses the opportunity to enhance the skills of the installer.

A parallel could be seen in low carbon building more broadly, in that the increased sensitivity of the detailing in a very high performance building envelope requires either a high level of knowledge and skill on the part of the tradespeople building it, or tight supervision by (other) design and site coordination personnel. The latter approach raises costs and social complexity, increases division of labour, and reduces the status of the building trades. Achieving the former is a longer path to tread and requires a reversal of recent and current trends in Vocational Education and Training (VET), as noted by Gleeson, who sets the challenges faced by the heat pump industry against a broader perception of degradation in VET in the UK, linked to the loss of the public sector bodies (the nationalised industries and local authority direct labour organisations). These provided a pathway and support structure for personnel to move up through the levels, pacing practical experience with academic learning. (ibid).

The tendency for construction (including building services) trainees to leave education at Level 2 (and for this to be considered the norm) is noted with concern in academic studies (Brockmann et al., 2010a, Clarke et al., 2017) and by training professionals. The expectations of industry as to the level of training that is considered to be the norm for each trade is inextricably linked to the status of the building trades, and the broader question of standards within the industry.

> *'I think we do incremental reform rather than wholesale, and that's probably right because the needs in the industry are incrementally changing…. I think there's something in there around challenging the minimum standards that industry operates to, and I think there is an appetite within industry, certainly within the Construction Leadership Council, to raise the bar on the industry's expectations on minimum standards, which is at Level 2 basically.' [H02]*

This view was echoed by an experienced tradesperson, who had moved into management and later into consultancy and training. The duration of apprenticeships is a related issue.

> *'I think it really should be a 3 year apprenticeship. There's lot of companies that do it over 2 years and they take their apprentices up to Level 2, and at Level 2 you're deemed to be competent. Personally I think Level 3 should be where we set competence' [H04]*

The level to which a building tradesperson is qualified before leaving training is significant with regard to their ability to deliver quality work, including energy improvements, and should be raised to a minimum of Level 3.

In 2016,a review of technical education in England, commissioned by the government, proposed the development of a new 'T level' qualification (Sainsbury, 2016).

> *'..equivalent to A level but technical…There is going to be a generalist first year, and then potentially moving towards a specialism. But I am now wondering if there is an option not to move into a specialism, I am sure there would be, and you can then carry on, on that generalist pathway.' [H02]*

According the the government website, T Levels are set to come on stream in September 2020. They are to follow GCSEs and will be equivalent to 3 A Levels. These 2-year courses are described as having been developed in collaboration with employers and businesses so that the content meets the needs of industry and prepares students for work, with classroom learning and 'on-the-job' experience during an industry placement of at least 45 days. The aim is that these will provide a basis for going on to skilled employment, further study or a higher apprenticeship[20].

The courses announced include one on construction design, surveying and planning, which includes sustainability, and several relevant areas of building physics. It is not clear, however, whether RMI work on existing buildings will be covered sufficiently – or if the scope will be focused more on new building and civil engineering works.(Department for Education, 2018)

Education is a devolved matter and there are some differences between England, Northern Ireland, Scotland and Wales. However, many of the concerns highlighted above are echoed by the recent review of construction education in Wales by Qualifications Wales, which concluded that: the current system is complex, confusing and lacking in coherence; that progression routes are not clear; and that it tends to suit the needs of large employers only (Qualifications Wales, 2018). One reason given for the complexity of the system is that it caters for different kinds of student.

[20] https://www.gov.uk/government/publications/introduction-of-t-levels/introduction-of-t-levels

'People always say the system is so complex. But it's complex because we have young people coming in as new entrants, more mature people coming in as new entrants, people transitioning from related trades. There's a huge amount of churn in the construction industry. People come and go… we lost 40,000 people from the industry in the recession. And they've never come back, so there are people out there who have got the skills…so it's no single pathway' [H02]

Another reason for the complexity may be the less than straightforward way in which training and qualifications for building trades are developed and funded. In general it involves a mix of college and apprenticeships, but the decisions on what and how, how long and to what level appears to be dictated by a mixture of public policy and commercial interests, and the overall strategy and system is not very clear. In this context however, the National Occupational Standards provide the core framework.

'You have National Occupational Standards of which there is a finite number…they may not be around for some areas in the future but they are still used in construction. They form the basis, they provide the standard for all qualifications which are owned by awarding organisations, and then colleges deliver to those awarding organisation's specifications. It's like a web of a system, and it's currently under reform as well…' [H02]

A specific issue raised by a training manager was the need for help to bridge the gap between the manual skills taught up to Level 3 and the more academic approach at Level 4 (HNC level).

'We do find that, people who have worked their way through the trades, and got to Level 3, you try to get them to progress to level 4 and that is a gap, and a problem. Qualifications Wales have recognised that the progress from 3 to 4 isn't good. We need something to bridge that gap between levels 1,2 and 3 and the hands-on skills, to the more academic level 4 and beyond.' [H03]

'It could be that they are managing everything in that home, all trades. The only thing that stops them is the maths. If they are no good at maths they can't go on - because construction at a higher level – well, construction management is probably the pathway that they'd go, because although there's maths in there it's applied within science and materials… but if they wanted to take a different route then you really need the maths…' [H01]

The problem is with the educational levels of those entering training: the basic skill attainment has to come either before or in the middle of this pathway to higher level qualifications. In practice it would be good for both options to be available, and for school leavers to know this in advance: some may be more ready and motivated for further academic learning later on.

> *'It's a big jump. From competence at Level 3, particularly in construction crafts, it tends to be hands on, and you prove your competence and your learning outcomes through doing things with your hands. Very little written work, very few calculations, the maths is generally GCSE. Then you go up to HNC and all of a sudden you have to start writing – you need academic writing skills which they don't have, how to put essays together, how to write reports…and then dealing with the maths and the science to deal with being able to design….they can't cope with it, and we end up having to put in bridging courses to get them from Level 3 to Level 4.' [H03]*

The same trainer noted the resistance to dealing with calculations in practice, even amongst plumbing trainees:

> *'If you do a plumbing level 3, it's all there, the design aspect of it, and newer learners would go through a more rigorous exam process, so a level 3 plumbing learner will work on U values…they will be given a U value and they will calculate the heat loss of a building or a room, and then they'll be asked to size the radiators or the plant. They will also do some pipework calculations, but…they are quite complicated calculations…..so by the time they get out there and practice, they don't do that, they just guess it.' [H03]*

The step between some academic levels is a big one for some students – in particular in moving from the more manual to more academic skills. Bridging courses are needed – for example in maths.

Work-based learning and apprenticeships

A particular issue was raised with regard to the impact on the content and level of training of the commercial interests of the larger employers dominating the current system for employer-led apprenticeships. One aspect of this is the cost of having apprentices at college instead of on site earning for the company – but another is that the larger employers are more likely to run larger scale programmes where labour is

divided by function and task, resulting in the need for a narrower set of skill requirements than are likely to be needed more widely in the domestic self-employed or microbusiness employment they may find themselves in after qualifying.

> *'It's the employers that I suppose in the end guide us to exactly where it is or what it is that they want out of the training. However it's very important once you've got to that point to give them things they need, that they don't necessarily know that they want - because employers have a blinkered view which centres around what's going to make them money, and very few have the foresight to look outside that box and see what's available.' [H01]*

This view was echoed by a trade association, who noted that this is reflected in the level at which training is set for apprenticeships

> *'With apprenticeships, over time, standards have been watered down…my father did a 7 year apprenticeship…..but if you do a carpentry apprenticeship now you are more likely to do a Level 2 apprenticeship' [D04]*

The interviewee quoted above argued that the aim should be Level 3 rather than 2, but noted that the bigger companies wanted to keep to Level 2, suiting their needs.

> *'The standards for apprenticeships largely have been set by the very big companies…who would want a carpenter to work on an estate where they may be putting in 200 houses…to fit the architraves on the door frames, skirting boards and they will crane in a staircase and fit it… basically doing production line type of work…just go in, do the frames and skirting boards in this house, go to the next house and do the same thing. A Master Builder might want the apprentice to work on making the door, making the staircase. Bricklayers on those projects are generally just laying bricks in straight lines, they are boxes, modern houses, whereas a Master Builder might want curves, arches, ornate brickwork around fireplaces…They want a whole different standard, but the big companies don't want that. It's no use to them' [D04]*

This has a direct impact on employability for the apprentice who goes on to seek work in a small business where wider skills are required.

> *'What a Master Builder might want of an apprentice is very different – and sometimes they take someone on who has done an apprenticeship and found*

that they are almost useless because they have got very narrow very limited skills.' [D04]

As the trade association above pointed out, however, the majority of apprentices are trained by the small or medium builder. They estimated that it's the SMEs who are doing probably 60% of the training, and thought that a large proportion of apprentices will go on to work in small business, or actually run their own businesses. It can be difficult, however, for small companies to support apprenticeships. A Welsh charity, Cyfle Building Skills[21], is addressing this issue with a shared apprentice scheme to enable apprentices to get a wider range of experience, spending shorter periods of time with different businesses. This is a model which seems to address some fundamental issues in terms of training in a way which is both practical and economical, but it does depend on a degree of public sector funding.

'... we employ them and then (for want of a better word) rent them out to the contractors 3 days a week and they go to college 2 days a week…We move them around different employers to get wider experience, also a lot of them wouldn't be employed by smaller builders because they can't commit to taking them on for a 3 year period. But they are more than happy to take them on and train them on a day by day or week by week basis.' [H04]

Bigger employers have strong influence on shape of training and apprenticeships, and tend to shape things to fit their commercial needs, whilst much of the subsequent employment available is in micro-businesses.

Participants in the round table debate echoed the view that large companies dominate the definition of competencies required, and felt that individual workers in the sector do not seem to have a voice.

The growth of 'work-based learning' can be traced to the introduction of Modern Apprenticeships in England in 1994, with employers receiving subsidy for employing trainees, and an approach to VET which is 'skill' or 'task-based', relating to relatively narrow job roles (Fuller and Unwin, 2003). This is compared unfavourably with the 'occupational' model in the Netherlands, France and Germany, which aims to enhance individual capacity and potential within a broadly defined occupational field (Brockmann et al., 2010a). The latter would seem far better suited to the

[21] www.cyflebuilding.co.uk

development of the well-rounded, multi-trade and whole-house aware tradesperson needed for low carbon renovation – or indeed to the delivery of domestic RMI work in general. The occupational model also incorporates a greater degree of general education (ibid), and the lack of this approach in England (there are variations to this approach to a greater or lesser degree in Scotland and Wales) may well relate to the relatively low status of vocational qualifications, of apprenticeships, and ultimately of the building trades themselves, in a vicious circle of decline.

This insight is expanded upon by Mazenod, and described in terms of an 'expansive-restrictive' continuum in a study which compares apprenticeships in England, Finland and France. It concludes that the French and Finnish programmes tend towards the expansive and the English programme towards the restrictive end of the continuum, the latter having a lower level of general educational content and limited access to knowledge-based qualifications. (Mazenod, 2016).

Another example of the more expansive approach is the educational programme for bricklayers in Germany, where a broad curriculum, including maths and physics, covers a range of construction occupations in the first year, with separation into sub-sectors in the second year, and more specific trade specialisation in the third. Notably, they are expected to gain experience in a wide range of contexts (covering new building and renovation, housing and industrial) and to learn how to run the whole job – whether working alone or in a team, including planning, coordinating and documenting the work. (Brockmann et al., 2010a).

An additional comment on the 'modern' apprenticeship approach in England is that a single scheme is being used to try to do three different things: to provide craft skills, to provide a sub-degree level qualification for technicians, and to bring young people who have under-achieved in the educational system so far into the labour market (typically into semi-skilled roles) (Brockmann et al., 2010a).

Mazenod cautions that the English system for apprenticeships cannot be improved in isolation, rather that it must be treated in the context of the education and training system as a whole, which is highly segmented, with divisions between the academic and vocational programmes (Mazenod, 2016). The theme of silos and divisions was echoed by a construction training professionsal:

> *'The whole system is set up to perpetuate a silo approach to construction. Federations and associations are basically set up based on occupations,*

qualifications are set up based on occupations and functional roles. The same with professional bodies. And we are moving now towards needing skills in the built environment to build systems, not just compartmentalise buildings comprising bits of wall and building services operating independently. Buildings for the future will need to be built systems…' [H02]

The 2016 'Sainsbury Review' recognised the need, in technical education, to:

'..*enable the development of the knowledge, skills and behaviours required to perform successfully in specific occupations, not just the narrower job role-focused needs of individual employers.'* (Sainsbury, 2016)

It also acknowledged that there are lessons to learn from technical education in other countries, such as France and Germany, noting the low status of 'vocational', compared to academic, education in England, and recommending the use instead of the term 'technical education' to refer to education which 'draws its purpose from the workplace rather than an academic discipline' (ibid). Other recommendations include a simplified structure, clearer paths to different occupations, and progression routes to higher qualification levels. More effective integration of college and employment-based learning is highlighted as a success factor in other countries, such as Norway, the Netherlands and Switzerland (ibid). While continuing to promote the idea of separate streams for academic and technical education, an easier move from one to the other is recommended.

Participants in the round table discussion thought that current levels of training and qualification in the UK were poor compared to countries such as Australia or Germany, and more government support is needed for vocational training.

The fundamental approach to apprenticeships should be reviewed, with a view to returning to an occupational rather than a task-based model.

The apparent shift towards a lower skilled construction workforce by narrowing the scope of the education and training on offer, appears to be in direct conflict with the needs of developing a high quality sustainable construction and renovation industry. What is needed instead is a more highly skilled building workforce, able to understand the complexities of low carbon renovation and retrofit.

Funding for apprenticeships needs to support experience that will prepare students for RMI building work in SMEs and microbusinesses.

Educational requirements for an RMI general builder

Taking into consideration the experience of interviewees and the literature cited, an outline of educational requirements for a general builder equipped to deliver low carbon renovation would need to include the areas and capabilities listed in Table 15. A sample of the research participant references are included against each item below to indicate who raised these points during the interviews.

Table 15: Educational requirements for an RMI general builder

Aspect	Content	Research participants
Foundation/ Core	• Literacy and numeracy to minimum level 2 • Researching information and materials • Producing written estimates and quotations	HO1,HO3 A01B,A35B,A36B,A37B, A39B, A11B,A40B
Cross-cutting/ transversal	• Project management • People management and coordinating work on site, working with multiple trades • Communication skills, ability to manage effective dialogue with customers, including explaining technical terms • Business management and marketing • Problem-solving and trouble-shooting • Health and safety, fire safety	A11B,A35B,A37B A34B,H03,H04 A35B,A39B,A40B,D04 A11B, D04 A01B,A11B,A40B H04
Technical	• Good general knowledge of main construction and building services trades: carpentry/joinery, bricklaying, roofing, groundworks, and drainage, plumbing, heating and electrical services • General knowledge of microgeneration and household scale renewable heat technologies • Heat loss and energy demand, and associated carbon emission calculations • Reading and interpreting technical drawings • Renovation design and specification, sourcing materials and products, accurate measurements and quantity calculations • Knowledge of moisture movement in buildings, and causes and remedies for damp • Knowledge of ventilation requirements and provision, and building details for low air infiltration and passive buildings	A35B, A36B, A40B, H01, H04 A27B, A37B, H03 A37B, B06, H03 A02B, A27B A11B, A35B,B07,H03 A11B,A16B,A09CJ,B07, D04 A27B,D04
Scope	• Practical (including on site) and theoretical • Urban and rural • New build and existing buildings • Modern and traditional, including sensitive built heritage conservation	A11B,A36B,A39B,A40B A11B,A40B A35B,H03,D04 A05B,A09CJ,A11B,A37B, H01,B05,D04

6.3.2 Getting it right: advice, information and quality control

In considering how the ensure that mainstream building trades engaged in RMI are able to deliver energy improvements, training and qualifications were the obvious starting point. This is not the whole story, however. This section looks at sources of information and advice, ongoing learning and quality control.

Information and advice for building trades

Asked about what they think needs to be done to make sure that renovations, particularly those that involve energy efficiency and renewable energy, are well designed, specified and managed on site, responses highlighted access to information and advice from suppliers, merchants and Building Control (as noted in Phase 1).

> *'Well I just learn about it. I go into the builder's merchant. And I know the company Celotex, I ring them up, they've got technical departments, I sometimes ring and ask 'what's the best way of insulating this?'' [A35B]*

Some tasks are seen as relatively standard and repetitive, so that previous experience will mean you know what to do and how to do it.

> *'…we've done it over a number of years, so we've just picked up on the fact that, you know, insulated plasterboard…it's been a while since we've gone for battens and insulating between them…it's just inherited knowledge I suppose.' [A36B]*

Other situations require the builder to have problem solving skills themselves, to make effective use of the information available – and the value of sometimes being able to talk through ideas with others.

> *'…problem solving is what building work is all about, and that's what you are doing all the time…obviously you need a level of experience to do that, but sometimes you are working with new products and you also need to be willing to ring up the supplier to discuss how to use it in that particular situation….equally I have found that whatever the situation I can work out a way myself or perhaps working with another builder on site – you draw up some sort of compromise to fit in with that particular situation. I've always found Building Control Officers very helpful too.' [A01B]*

The provision of this kind of support from a manufacturer or supplier helps ensure that their products are used as they want them to be.

> *'If you use a particular product on a regular basis then that company would like you to use that product in ways that they recommend, and I know that some companies, insulation producers for instance, I have been on some courses, and I know that they offer their own trouble-shooters to come out and look at particular problems and give you advice....' [A01B]*

This was endorsed by a local supplier of windows and doors, who takes pride in providing a professional service.

> *'We've got the website, where we list the current energy rated products. And we'll type out a specification for them...I think the builders will ask me:without being big headed, I think I have a fair amount of knowledge.' [B04]*

Relying on advice from just one commercial source does, however, requires the builder to apply their own judgement as to reliability:

> *'…they want to sell you a product, they'll tell you about it, and I don't think they'll tell you any fibs, obviously they want to say their product's the best product, but for instance, with foil-backed insulation, it comes in different thicknesses, there are several companies that make the stuff …' [A35B]*

Assuming that building trades people want to get things right and to keep up to date, there appears to be a lack of effective mechanisms (for example by the government or local authorities) to communicate with industry, for example to ensure that they know about changes to Building Regulations.

> *'Say I want to know a specific building reg change, I ring up Building Control and ask…if you go online there's lots of forums, if you go on the local government website, it's a bloody never-ending jumble of all sorts…And even now, you go on Google and type in and you get lots and lots of forums but there's no actual dedicated website that can say – I remember I got solar hot water, and there was no one platform and you had to go to a lot of websites to find out…' [A40B]*

In response to a question about whether a local supplier of doors and windows had much contact with the local Council, the concern about the privatisation of this function was raised again.

'Not really….the main people have all gone to private organisations and their builder base has sort of followed them….I think the problem is that Building Control seem to be privatised. There are quite a few different Building Control companies now that are not employed directly by the local Council' [B04]

One interviewee who had spent a major part of his career with a Local Authority raised the point about quality in relation to tendering and sub-contracting, citing the drop in standards as a reason for leaving his job. This was some time ago, but is still relevant today to the situation where the public sector is tendering out for works.

'….the DLO[22] was reducing and it became mainly subcontracting, and they always go for the cheapest. And the cheapest, as you know, within this industry isn't always the best…I used to have constant struggles and battles because I've got high expectations…' [A40B]

New products and continued learning

Picking up on the point above regarding the 'culture' around quality and learning, an important element in getting the specification right is to be open to learning about new products, and an acceptance that this learning process is continuous. The confidence to move forward is not to be underestimated – and this is another area where a combination of practical and book learning will probably help. Working with new products, and being willing to do so was cited as an area where some builders may be understandably nervous, but need to be able to adapt. This is part of continued learning and highly relevant to the inclusion of energy improvements in RMI work.

'…people have got to be willing to be open to new ideas and new products. A lot of builders I feel make the mistake of getting used to using one particular product and trying to have one solution that fits all…but I also know a lot of builders who want to do the best possible job, so I think you've got to be willing to think differently and do things in a slightly different way to fit in with a particular situation…' [A01B]

Learning something new can sometimes mean learning something very, very old (anew)…as indicated by a supplier of specialist materials for traditional buildings.

[22] Direct Labour Organisation

'I think most decent builders actually want to do the right thing…but there's huge financial implications with all of this for companies, and like most of us I suppose they stick to what they know. I've got 3 or 4 good customers with lime, who will phone up and just check over one or two facts….I had one ring up yesterday and he said, 'a traditional building, but it's got a 9 inch brick wall at one end, they've just got a new baby, the room at that end is going to be the nursery and it's a cold wall – if we put your insulated lime plaster on will it make it better?', and I said it'll be better than nothing but if you can spare the extra space then put 30mm of cork on first, cork's great and its easy and no trees are harmed in the process.' [B05]

Another builder mentioned trade journals too as a way of keeping up to date.

'Well I'd look on the internet for stuff on installing and choosing insulation, and then I'd probably try and source it from a local builder's merchant…..there's a fair bit in there, I think, I often pick up Professional Builder, the free trade journal, and over the years, there's been lots of articles about things like that which are quite interesting.' [A36B]

A less positive view of reliance on manufacturer's information was expressed by a training professional – and a concern about both lack of training and how to judge the value of the information provided.

'… people do get a bit of information from the manufacturer and think they can do a job, and whereas perhaps they haven't had the training to do the job, and think the manufacturers instruction will be enough, which it might be, but often it's not, so from a college perspective I think it's about awareness and developing a critical eye for sources of information. At the minute there's no good way of saying what's a good source of information and what isn't.' [H02]

A couple of general builders working on domestic RMI work who were interviewed in Phase 1 noted that they did not always get the site-specific support they would like for their small one-off projects from the larger suppliers. This may be because the main market for such suppliers is the large scale programmes, which tend to be contracted out to larger specialist contractors. Companies that specialise in insulation work are possibly the opposite end of the building trades spectrum from the general RMI builder working on domestic properties. One major supplier of insulation products estimated their (UK) market share of insulation work to be 25-30%. They

have their own in house installers (doing cavity, external wall and loft insulation), and also a network of contractors, installing their products. Their main work is under the energy supplier energy efficiency obligation. They were concerned about people using their products who were not trained to do so.:

> *'If you look at the measures that are involved, some will be a DIY type measure so anybody could just go and buy the product and do that, but nobody could go and buy cavity wall insulation. We only sell our certificated products, such as external wall insulation, internal wall insulation and cavity wall insulation to companies that we have trained and approved for those measures.' [B08]*

The supplier quoted above accepted the idea that insulation work could be built into training for a general builder – so was not insisting that insulation work be kept separate, only that training was needed to ensure that their products are used correctly. Manufacturers of wall insulation (particulalry external) generally develop building systems for their products, with set processes for installation and combination of products, designed to minimise the risk of problems such as damp - and require installers to be trained to use these (Killip et al., 2018).

An insulation manufacturer voiced similar concerms:

> *'External wall insulation isn't just a bit of an add-on, it's a constructional trade. You are affecting the external shell of the envelope, its resistance to weather - you are affecting it in a major and substantive way. I don't mind that people feel a job is well within their capabilities, as long as it suggests they have a higher level of skill, but I think often people think this is an easy thing and you don't have to pay much attention to detail….' [B07]*

In contrast, when a general builder was asked about whether they do insulation work, he said they would do it if it was part of a building job, but not as a stand-alone job – because insulation work was seen as a lower level skill.

> *'Well, generally they wouldn't want to pay craftsman's money for insulation…so mostly its someone who is half way between a labourer and you know, most of it is I wouldn't say non-skilled but a lot of it is sort of semi-skilled, isn't it…I mean I know lads who – well they couldn't go on site and lay bricks…' [A36B]*

Discussing this further, it appeared that this view had been developed in relation to loft and external wall insulation – while it was agreed that internal wall insulation might be more skilled and more in line with what the craftsman builder might deliver.

> *'We do do it (referring to internal solid wall insulation) occasionally, yes, because older properties, you know people will say, solid walls, we've got a problem with condensation, and we can cure that, you know, we can insulate the inside walls' [A36B]*

It was suggested that the way in which the energy saving obligation schemes have been delivered may have been a factor in the view of the insulation industry as low-skilled.

> *'Unfortunately the energy company energy saving schemes have created a culture where the way they have been set…as a carbon saving obligation…the energy companies saw it as an obligation and a sufferance to deliver it at lowest cost. They didn't see it as an obligation to deliver warm, dry, safe, low energy homes that were a pleasure to live in. And there has been a drive to do this as cheaply as possible' [B07]*

Supplier training to enable the mainstream building trades to make effective use of their products might form part of a broader programme of support and knowledge update, if this could be built into a service for the building industry in a way that is accessible, affordable and attractive. As noted in 6.3.1, taking time away from site is costly, and on-site learning techniques could prove popular for the digitally equipped modern tradesperson.

> *'We did research on how employers wanted to access training. Very often it was manufacturer led, they wanted to sell products, lunchtime seminars, that sort of thing…it's increasingly about digital technology…a massive untapped potential because any learning that you have to put down your tools and go away from the site is short term business loss, although long term gain' [H02]*

The need to integrate training with 'real' work to give it context is highly relevant to new trainees and apprentices as well as for continued learning.

> *'…Apps and that sort of thing, if you can provide the learning at the point at which the person needs it…and you can provide not just the 'this is what you need to do' but also 'this is why you need to do it'. And you've got all that*

contextual learning through learning at the point of need. So learning becomes a constant activity, not something that you have to leave site to do.' [H02]

In relation to continued professional development for the existing workforce, privately run specialist courses of particular relevance were mentioned – in particular the 'Retrofit Coordinator' course currently provided by the Retrofit Academy[23]. Concerns were raised, however, about whether the perceived need for certain knowledge or skill sets can be met through a reliance on market forces to drive demand for such training.

'…it's very dependent on market forces. So you can have your Retrofit Coordinator qualification, which we know everybody needs, well we know there are people who need it, but if the market forces aren't there to drive people, then very quickly it would drop away...' [H02]

Builder licensing and links to opportunities to update the industry

The Federation of Master Builder's campaign for a new general builder qualification is one part of a three part policy proposal – the other two elements of which are the development of a system of licensing for construction firms, and mandatory warranties for Building Control approved work. The campaign has been informed by a review carried out for the Federation by Pye Tait Consulting (Pye Tait Consulting, 2018), which builds on earlier work for Welsh Government (Pye Tait Consulting, 2014), and a report done for the UK Government Department for Business snd Industrial Strategy in 2013. .

The Pye Tait study for the Welsh Government considered builder licensing in practice (referencing their 2013 study for BIS) in other countries, such as Denmark, Germany, Netherlands and some Australian and US states. The conclusion of the report (which involved consultation with stakeholders within the industry) was generally positive in favour of the introduction of licensing, and that this can replace the confusing and ineffective mix of voluntary schemes in operation. An earlier (2012) study for the LABC (Local Authority Building Control) is cited which found that consumers have little faith in voluntary schemes. The Pye Tait report also highlighted necessary considerations such as effective enforcement, public awareness and information, and

[23] www.retrofitacademy.org

that any licensing scheme is backed by a well-publicised central database of licensed contractors which is kept constantly up-to-date.

The three elements of the FMB proposal are mutually supportive. It would be difficult to establish licence requirements without a relevant basis in formal qualifications, while the introduction of mandatory warranties provides an enforcement mechanism. The key driver for the FMB campaign is to drive up quality and professionalism within the RMI building industry, by creating a clear and obligatory control mechanism, which is visible and comprehensible to consumers and the industry alike.

A significant aspect of this approach in relation to the inclusion of energy improvements in RMI work is the mechanism that it offers for continued learning and updating on new technologies and products. The requirement to update licences can be tied in to formal CPD (Continuing Profesional Development) and the licensing framework can provide a communications channel between statutory bodies and the industry – which is missing at present. The lack of any communication on changes to the Building Regulations, and the reasons behind them, was mentioned by interviewees in Phase 1. Such communications could also work in two directions – enabling statutory bodies to receive feedback from the industry and gain intelligence on how things are working in 'the real world'.

A recent study of heating engineers, who tend to work alone and separately, described the informal networking between them as a 'community of practice', which is mutually supportive, but noted that informal learning can lead to different interpretations of regulations. In the case of gas heating engineers, the legal requirement on them to be registered under the 'Gas Safe' system means that they are part of a system of updates and communications, which ensures that information is clear and comprehensive. This study endorsed the findings of this present research, that continuous learning is part of working in the building construction and building services industry (Wade et al., 2016).

Contradictions about what is 'right'

Another problem highlighted is the contradictions that can arise between those responsible for technical standards and those interested in historic or aesthetic character. This issue was also raised in Phase 1, as a frustration for builders when Planning and Building Control disagreed.

'..the standard situation on a site is that you've got a building conservation officer and you've got building control and the two do not see eye to eye at all…BuildingCcontrol want things up to the Regs and that's their brief. Building conservation want everything left alone, or at least replaced how it would have been done 300 years ago' [B05]

This can also be relatively subjective and not a matter of standard rules to follow.

'Ticking the box for conservation is far more difficult because every conservation officer across the country has a different take to everything.. as long as the products are not doing any damage to the building, they're lime, they're breathable, they're elastic, they're reversible, and if they don't tick all of those boxes it then comes down to individual conversations with individual conservation officers.' [B05]

The authorities with regard to conservation of built heritage are nevertheless seen as relatively powerful.

'There's a far tougher lesson, if you're a contractor and you work on a listed building and you do something wrong, and you are caught by the conservation officer, then it's going to cost you money, and nothing concentrates the mind more than a financial hit…' [B05]

The theme of inconsistency came up again, with a builder who works in several local authority areas, and finds that different Councils interpret some aspects of Building Regulations differently, without any obvious reason why.

'…if you're a registered builder as such, wouldn't there be sort of a, I mean you could log onto a certain Building Regs site, that you could research what was the current Regs? Where I'm based, there's 3 sort of different Councils, and each area is slightly different in what they ask for than the others…I think mainly, it's down to the interpretation of the Building Control Officer which comes out, they don't seem to sing from the same hymn sheet as such…. the last issue I had was with thermal blocks, what sort of blocks I could use in Malvern, I couldn't use in Worcester, but to this day but I don't honestly know the reasons…' [A39B]

A more specific point was made in relation to insulation and the lack of agreement on the right way to do things in at least some situations or in relation to some

technologies. If the experts do not agree, how can the general builder be sure that they are getting it right?

> *'The retrofit business is in turmoil, we've still got the boffins not agreeing on how things should be done…every time I come to any of these courses, these talks, there's more and more information…You could go off to sit with another boffin who is extremely well read in their subject and they would talk about how wonderful lambs-wool insulation is, or cork or some kind of a hemp packed material, or straw that is natural, for warmth on the inside…and some of them would actually rubbish what another person… there isn't a single perfect solution, and you've got to take a view on each and every house within the budget that the customer has got…' [A11B]*

This lack of consistency in the view of experts on how to do things was reflected in the experience of a trade association representative (not a technical expert), who was renovating his own home

> *'I have renovated a 500 year old cottage, a timber framed building…I asked a lot of those people the same question about this same property, which had every sort of issue going, but what really struck me was the different responses… and I came to the conclusion it's a bit like economics, in some respects there as many opinions as there are people… it is not an exact science.' [D04].*

In relation to the knowledge held by builders (as opposed to other kinds of building professional) the importance of knowledge of local building characteristics was acknowledged, and that this was gained through experience, both direct and learnt from others. One of the issues he had to tackle was rising damp, and there were different views about how to deal with this in such an old building.

> *'….actually how buildings work, breathe….I talk to local builders and they go back generations and they've got a better understanding of how these buildings were actually made… and a lot of them were built on oak beam foundations…and if you didn't know that you might be missing a trick...What you get is one or two builders who have basically worked on every house in the area over many years, so they have a really good understanding of what you would call the traditional vernacular buildings of the area' [D04]*

The same interviewee pointed out the limitations that might be imposed by not sourcing the right materials for specific needs of older buildings – perhaps because a builder is in the habit of using the same supplier, and sourcing supplies more widely takes time - and time is money for the small business. Good builders may be booked up with work for some time ahead, and customers will not be happy with delays.

> *'…they might be aligned to a particular supplier. Sometimes some of the solutions might be going outside of where you normally get your materials from…and there's no one in your area that sells the type of products that might be the best ones to use…Margins are very small on a building project…and things that cause time delays are a problem. The best builders will have their order books for…they'll say I'm not taking on any projects for 3 months, 6 months. I spoke to one who said I'm fully booked for 3 years." [D04]*

A specialist in products for the renovation of traditional buildings was keen to find solutions to enable older buildings to be more sustainable and comfortable, and recognised that a degree of compromise was needed between the needs of sustainability and preservation of historic character.

> *'I now look at the company more as a supplier who supplies sustainable building products that tick the box of conservation, rather than the other way round, I think.' [B05]*

> *'…the whole external wall insulation market…it's all driven by phenolics, and modern polystyrene boards which do not work on a solid wall building…there is a gap in the market. I think in Germany they have a different attitude, I mean obviously they have historic buildings in Germany but…I think people are more keen on modern buildings and modern built types, and it's probably us being British and slightly obsessed with anything old…' [B05]*

Participants in the round table discussion pointed out that there are key skills shortages, including a lack of real deep technical understanding amongst site managers in the private sector and that in the absence of government laboratories, it is difficult to know where to go for this level of expertise.

The issue of quality control in low carbon retrofit is not just about ensuring compliance – there is also a need for clearer and more complete and consistent

guidance on how to do things right, as well as embedding sustainability into training and education for the next generation of building tradespeople and installers.

Quality control and accountability

In section 6.2.1, the roles and tasks within a renovation project were considered and it was noted that a holistic approach to the design, specification and management of a project is not only a matter of training and skills, but also of awareness of responsibility, and of where and how to get information as and when it is needed.

> *'.. we are at interesting stage…people are being questioned as to what level of design is actually going into the building…when challenged to say well are you now happy to take responsibility for ventilation, for heat bridging details, for all the other things that in an abstract sense you could say are part of design, there is now only with some people the start of a conversation which is 'I don't really know what to do, how do we find out what to do?' [B07]*

There is the associated risk of a builder not taking responsibility themselves for compliance with regulations – by suggesting that this is passed over to the supplier.

> *'We've got a window company in the town, that, there is building work going on next to our showroom, and they undercut us, and I went to have a look at it when they started to fit it, and they haven't complied with document Q which is the latest one for security, there's timber cladding on part of the building with windows in and they haven't put a fire break between the windows, and I've pointed it out to the builder, and he said ' well how am I supposed to know about the regulations? They are a professional window company, they should supply the correct product" [B04]*

One of the times that you would expect such checks and balances to operate is when a house is sold – but doubts are raised as to whether this even works in practice, with indemnity insurances sold as an alternative to getting proper certification.

> *'I don't think the general public are bothered about it – with the FENSA scheme, when it was introduced in 2002 – if you hadn't got the paperwork and you changed your windows, it was supposed to stop the sale of the house. But if you get to that stage and you are selling a property, the solicitor would just sell you an indemnity insurance policy. So it renders the scheme useless. So they don't go and check the building to see if it's compliant.' [B04]*

The same supplier pointed out the problem with the lack of control (or advice) that can occur if products are purchased through less specialist routes, and the extent of the problem. He also proposed a solution:

> *'It's the builders that go to the trade sheds that have the problem, because they'll just buy the cheapest window they sell, and there's no control…They could be selling a window for new build or for an extension or a replacement, and they won't ask the question where it's going…I think all the trade warehouses should see the certificate of building control consent, or if it's a competent person's scheme, see the relevant certificates before they supply the window, so they know they are supplying the right product. But the industry doesn't want that...there's allegedly 14,000 window installers, companies, and less than 10,000 which are registered with any of the schemes.' [B04]*

A heating engineer sounded a note of caution about builders making uninformed decisions about heating – although they also suggested this could have been done by someone saying they were a heating engineer and not in fact being properly trained/qualified.

> *'We often get called in to troubleshoot, and I know so many properties that have had extensions done by builders and they've had radiators put in extensions and they haven't been piped in correctly, or sized correctly, and the systems haven't been adequate, because they just don't know how to design or size a radiator, put adequately sized pipes in…we get called in, because their extension's cold.' [A38H]*

When asked how to make sure that this kind of mistake doesn't happen, the response indicated that it was a wider issue about quality/regulation. Even where the system of qualifications is in place (and it has already been noted that it is not in the case of the general builder), it appears that there is no simple process in place for the customer to check if a building tradesperson has the relevant qualifications.

> *'Well it's making sure that all the trades, it's the same with the electricians – these builders also have electricians that they work with and may or may not be a qualified electrician' [A38H]*

This raises a more general issue about how to control quality in the industry more closely. One solution, as noted above, is to require all building tradespeople to have a

license to work, that is easily recognisable to the public, and comes with requirements for training and CPD. Making this a legal requirement ensures a level playing field, which is preferable to voluntary additional accreditations – which risk a two tier industry where those choosing not to engage can undercut others. It could also provide the basis for policing the unregistered installation of products bought online or from trade sheds – a point raised above by the window supplier and echoed below by a heating engineer. This interviewee pointed out that it's relatively easy but ineffective to simply add more rules to those already doing things well, while failing to find a way to control those that sidestep the rules.

> *'What you've got to do is to say that anybody has to have a licence to work, I mean in gas we are licensed to work…1.6m gas boilers are fitted every year, 1m are registered - so 600,000, which is about 40%, aren't registered, so who is installing them?… us good guys have got to work to all these rules and pay all this extra money for accreditation, bureaucracy and red tape, but these people who are fitting these 600,000 boilers that aren't registered, they can still get away with it, they can undercut me…' [A38H]*

Of relevance to this is the development of the 'Each Home Counts' Quality Mark approach, a key recommendation of the 2015-16 'Bonfield Review' (Bonfield, 2016). This has been launched as a voluntary approach, building on the existing 'Trustmark' scheme – however, no evaluation of the success or impact of the latter appears to have been done in preparation for this. The Bonfield review (ibid) noted not only that the existence of a range of energy efficiency and renewable measures, and incentives to support them, had not resulted in sufficient consumer take-up, but also that there was a problem with quality in the industry. The conclusion appears to be that the establishment of a Quality Mark will solve both of these problems, assuming that uncertainty about quality is the main barrier to take up. The world of standards and quality assurance is not, however, necessarily familiar and transparent to consumers in general. The evidence appears to be missing that shows that consumers will (a) be more willing to invest in energy improvements under such a Quality Mark, and (b) give preference to providers who are operating under such a scheme (rather than selecting on the basis of cost and/or personal recommendation).

If the assumptions underpinning the initiative are not correct, then there is a risk that the introduction of the Quality Mark may reduce activity in the industry, for example by increasing costs, restricting access to markets for smaller businesses, and even

raising concerns amongst consumers about potential risks. There is also a significant risk of developing a two tier industry – with an apparent 'elite' group joining the new brand, and the 'rest' taking up a cheaper and less regulated option. It can be difficult for building trades (whether mainstream RMI or specialist in energy improvements) to decide to invest in additional non-obligatory quality assurance schemes, particularly at a time when publicly funded programmes that may have offered a market for such work have been severely curtailed.

> *'.. a lot of people are saying we don't mind doing any of this stuff as long as everybody else does it too, and a lot of people seem to be frightened that they will be the only one who…takes on the cost burden of taking time to assess the property properly, to ensure all the details are right and that all the materials and everything are right which may mean a higher priced job…they need to know that there isn't another option, an 'installation light '. There has to be confidence across the industry that there is one standard and the standard is doing it right...but we are in a de-regulatory environment, where people say I won't do it because the bloke down the road won't do it' [B07]*

It was pointed out that a more targeted (and draconian) approach is needed to really tackle the problem. A solution was suggested for the problem of unregistered boiler installations, similar to the one for windows:

> *'We know there's 600,000 boilers not registered, why can't we do what we do with TVs? If… every boiler that is sold, however, builders merchant or internet, then all you ask for people to say is the Gas Safe number of the installer who is going to fit it and the address its going to. There's no data protection issues there, and with that you've then got an audit trail… If you buy a TV you have to say the address that it's going to, so that the TV licensing authorities have got the opportunity to follow it up.' [A38H]*

Raising the level of compliance and enforcement in the most regulated industries must be complemented by a serious attempt to reach the unregulated (such as boilers sold through trade 'sheds' and unregistered window installations).

On the broader question of quality control, concern was raised again (as in Phase 1) about the lack of Building Control resources as local authorities struggle with lack of funds, and the unease about private building inspectors and their independence.

'There seems to be less and less officers doing the work, so inevitably somethings got to give.. I've found Building Control Officers always get back to you, always turn up when they said they will, but you can see with time the pressure's going to be too much on them. Personally I think there should be more Building Control Officers, they should be employed by Councils, they shouldn't be private…I wouldn't be surprised if corners are cut and I think you need a truly independent Building Control Officer to do that work…" [A01B]

Quality control requires effective and adequately resourced enforcement, independent of commercial bias.

The issue of quality assurance and accountability has been raised repeatedly in policy discussions around buildings in recent years, both renovation and new build. The tragic fire at Grenfell Tower in London in June 2017 highlighted the lack of accountability at the scale of a major renovation project. Investigation into the factors leading to the fire is ongoing at the time of writing, but has already thrown up a range of issues of relevance to this research. The tower had been renovated, with external cladding, including insulation, and witnesses highlighted the way the fire spread at speed across the outside of the building, apparently via the new cladding. Discussion since has focussed on whether the Building Regulations were not strict enough with regard to fire safety or whether they had been contravened, and if so, how? The obvious first issue that occurred to observers was that the material used in the cladding and/or the insulation was highly combustible – a strange and shocking decision for residential high rise, one of the most vulnerable types of building in terms of fire safety. The independent review led by Dame Judith Hackitt concluded that the problem is much bigger than a single technical detail, however, and that:

'…*the current system of building regulations and fire safety is not fit for purpose and that a culture change is required to support the delivery of buildings that are safe'. (Hackitt, 2018)*

The testing and labelling of products was identified as unfit for purpose (ibid), a point endorsed by a round table discussion involving experts and parliamentarians in January 2018 – noting the confusing use of the term 'limited combustibility' and of two different flammability classification schemes for building materials (Euroclass and BSI) (Westminster Sustainable Business Forum, 2018). The latter pointed out the limitations of the testing being done indoors, rather than outside – a point endorsed

and further explained by the Fire Safe Europe group: that indoor testing is subject to reduced times and not a reflection of a real life situation (Fire Safe Europe, 2017) .

One of the specific conclusions of the review was that the roles and responsibilities of those procuring, designing, constructing and maintaining buildings are unclear (ibid) – a point which chimes with the findings of this research. It is striking that these conclusions coincide, given the potentially conflicting drivers between this research (seeking ways to achieve low carbon renovation) and the Hackitt review (driven by concerns about fire safety,and with negative connotations regarding retrofit of thermal insulation).

The Grenfell review also concluded that current building regulations and guidance (in the form of Approved Documents) were ambiguous and inconsistent, and that the *'processes that drive compliance are weak and complex with poor record keeping and change control in too many cases'* (Hackitt, 2018). Further investigation reveals that the UK has an unusually complicated set of options for demonstrating compliance with Building Regulations compared to other countries, including:

- submission of drawings, specifications and calculations to public Building Control Bodies (by two different routes);
- submission of drawings, specifications and calculations to commercial Approved Inspectors;
- submission of 'Building Notices' (unsupported by other documentation) to local Building Control Bodies – and this can be to any local authority in the country, not necessarily the one where the building in question is located;
- self-certification of some aspects of projects by approved Competent Persons, who are usually contractors or installers.(Rickaby and Maby, 2018)

This range of options may appear to ease the path for those managing developments, but it is confusing and creates several problems and risks. The complexity of options, involving a mix of commercial and public-sector organisations, makes it difficult to discern where responsibility and accountability lie. This can lead to uncontrolled risk where elements of the building that are certified using different options interact (in practice, different elements of a building may be self-certified by more than one organisation) and where self-certifiers make changes that result in unintended consequences of which they are unaware. Local accountability is lost, and there may be a 'race to the bottom' among certifying bodies as they compete for contracts with developers who choose the cheapest (and, therefore, potentially least

thorough) bidder. Most other countries operate simpler systems, and some include only public bodies in the process, which makes it easier to ensure that the public interest is protected. (ibid)

While these concerns may be of particular relevance to larger scale projects such as the renovation of a high rise block of apartments, the issues raised are broadly applicable to the renovation of a single family home: the complexity of options, lack of clear lines of accountability, and the potential for conflict of interest where certifiers or inspectors are employed by the developer or contractor, rather than being fully independent. The latter concern was raised by general builders working at a small scale in rural Herefordshire in Phase 1 of this research. A system which is not clear, transparent and accessible will not facilitate public accountability – whether the public is a single consumer, a tenant's association or even the small building company or tradesperson attempting to do the right thing in a competitive marketplace.

The various components of quality assurance within the UK building industry are summarised in Appendix 4. They consist of standards, qualifications and accreditations, regulations, certification, warranties and guarantees, and compliance and enforcement. Of specific relevance is the PAS 2030: Improving the energy efficiency of existing buildings (specification for installation process, process management and service provision)[24], which was developed to try to bring together the relevant standards, with the Green Deal in mind (British Standards Institution, 2014). PAS 2030 is undergoing revision to cover more specifically the installation of energy efficiency measures, with the addition of a second PAS (2035) to cover the broader scope, taking in energy assessment and advice, design, and coordination (British Standards Institution, 2018). This is a challenging task, both in terms of incorporating all the necessary detail for high quality retrofit, and ensuring accessibility, practicality and acceptability to the industry. Bearing in mind the wide variation in application from a complex renovation through to single measures, discussion is ongoing regarding how to ensure quality assurance without creating unnecessary barriers to smaller projects. The revised specifications are due to be published during 2019.

The existence of a standard does not ensure that is is used or achieved. A crucial issue in terms of impact is accessibility to the industry, not least in view of the cost of

[24] https://shop.bsigroup.com/ProductDetail - accessed 28/5/18

purchasing the standards (an online single licence for PAS2030 costs around £80 in May 2018), and the gap between the language in which they are written and their practical application within the 'marketplace' and on site. The PAS described above are generally unfamiliar to those within the mainstream building industry, and the only interviewee that mentioned them was a supplier of energy efficiency products [B07].

The quality assurance framework in relation to building work in the UK is a confusing mixture of public and private, and it is not easy for consumers to understand who does what or where to go to find out. Even just within the area of qualifications, the Sainsbury Review concluded that the market-based approach has created confusion and recommended moving to a single awarding body (Sainsbury, 2016). There is a lack of clarity as to what is legally obligatory (must have) and what is additional and if so why it might be desirable (nice to have). It can be very difficult for a consumer to know the difference (and the advantages and disadvantages) between offers, with widely varying levels of actual assurance built into their procedures. If the system if unclear to consumers, they will not be in a position to make informed choices.

The report for the Welsh Government concerning builder licensing concluded that

> *'The key issue with the plethora of existing schemes is the potential for confusion among consumers, a belief that certain schemes are a mark of proven quality where no such assessment takes place, and the lack of muscle to take any kind of direct enforcement action where adverse consequences occur or where inspections have found building work or other installations to be sub-standard'. (Pye Tait Consulting, 2014)*

It is arguable that achieving quality across the industry, both for retrofit of energy improvements and the wider renovation and improvement market within which it exists, cannot rely on voluntary engagement from market actors, based purely on the assumption that consumer demand will drive this.

This does not deny the need for standards and quality control within home energy improvements, as in all building and renovation work. The shift towards very low emission buildings is particularly challenging with respect to the older building stock, and issues of ventilation and moisture movement within buildings, in addition to the general building concerns around structural and electrical safety, fire safety and combustion appliances. The ideal would seem to be a comprehensive and consistent set of standards, embedded in a coherent and transparent system of training,

certification, compliance and enforcement – and supported by effective communications both to industry and consumers. It must be made much easier to do energy improvements right than not – while not making it too difficult to do them at all.

Quality control that effectively protects consumers requires a clear and transparent system that consumers and the industry can understand, and which makes it easier to implement energy improvements right than not, while not making it too difficult to do at all.

Government communications and strategic direction

A fundamental point about government communications was raised by an insulation supplier, who pointed out the tension between trying to push for quality standards, and the current political paradigm with respect to less regulation. It is very hard for leaders within the industry to make the necessary improvements within this context.

> *'I think it's also about a culture that it matters. I read something recently...saying that it isn't so much the government may have revoked or changed building regulations or their interpretation, but there has been a clear signal that has permeated the industry that regulations and standards are something that someone else has imposed on us, and we don't really want them but we have to have them, and it sort of creates the tone of…it's not that important…there is quite a piece of work to be done to change the culture, and part of that is to change the tone coming from the highest levels within government that this stuff matters….' [B07]*

A powerful message came through with respect to the need to drive the retrofit industry through the demand side, as well as dealing with quality on the supply side, and that the two are inter-related. The demand for energy improvements is necessary to drive the motivation to learn how to do it.

> *'… you have to think what would motivate them to become very well informed and knowledgeable on the materials, building physics etc, and I would say it's if there is a demand for this from the customer…There's not a huge amount of demand from the clients, they are often as ill-informed as the builders…You can create the most wonderful database, and standards, but if people don't know about them, and you don't have reason for it…' [D04]*

The need for an effective (strategic) communications plan by government was stressed by one interviewee, and that this requires careful thought, planning (ahead) and to be implemented over time.

> *'It's not something that you can mandate all of the population to do…like seat belts, that you can say as from tomorrow everyone wears one - as from tomorrow everyone has a whole-house responsible retrofit... there has to be a more nuanced and persuasive case made, to drive it. The population are all on a different, what you could call a customer journey…you have to have interventions and messaging and communications….what you would do in government is segment your audience and start to identify who are the low hanging fruit in terms of making a difference and what do they need…' [D04]*

A heating engineer who offered EPCs to his customers voiced frustration at the lack of progress on raising awareness of EPCs, having invested in this capability, and felt that government bore some responsibility for this.

> *'…we tried to raise the profile of EPCs, but when you are swimming against the water…we've said to the government for years that they need to raise the profile of the EPC, everyone knows what an MOT is even though there isn't a Ministry of Transport any more, but if you say EPC people say I don't know what that is…' [A38H]*

In the round table discussion there were calls for more government work on segmentation and identification of consumers who were most likely to respond to marketing of energy efficiency measures (as noted in 4.4). A related comment from an interviewee was that low carbon retrofit at present can be seen as something of a luxury item, not least because achieving significant energy improvements (sometimes referred to as 'deep retrofit') tends to be a bespoke service, given the differences between homes, particularly older homes that have had changes made to them over time. An example was described of a house that was retrofitted to get rid of damp, costing £76,000. The interviewee reflected on what this means strategically.

> *'So it is a niche market for very wealthy people, who can employ people…. that specialise in working for very wealthy people with a barn to convert or a nice big house, with the time and the space to have all these things done, and do everything they want to reduce carbon and so on…but really the rump of the building stock in this country.. where we can make the biggest difference*

on the government targets, are ordinary everyday houses, where people just don't have that sort of money…those people are employing your everyday builder…' [D04]

It was also pointed out in the round table discussion that even a 'perfect' deep refurbishment may not suffice for the remaining life of the building. Demographic and lifestyle changes may necessitate changes in the building. For action at most of the life-stages of the building, the need for minimum energy efficiency standards to drive the market was noted (whether for individual products or the building as a whole). Doubts were voiced as to whether marketing 'nudges' are enough to drive change or whether regulation is also needed. Marketing messages need to be continuous and reinforcing, as well as designed to appeal to different market segments.

There is a need for more effective government communications to the industry and the public, setting out the strategic direction of travel in low carbon renovation, and backing it up with regulations and marketing messages.

6.4 Summary of discussion

Drawing from the fieldwork described above, a number of key issues emerged, relevant to the research objectives. These are summarised in Table 16, and developed further in the discussion and further literature review in the next chapter:

Table 16: Summary of key points from Phases 3 and 4 of the research

Objective 1: Develop an understanding of the context for including energy improvements in RMI, through researching standard practice in the local supply chain from the perspective of key actors.

- General builders tend to fill the gaps in provision within the domestic RMI market, from design and specification through to project management and customer service (6..2.2);
- A general builder is expected to cover the full range of building and building services work needed for domestic RMI. This is at a higher level than simple maintenance (6.2.2);
- General building services for domestic RMI at the high level for which there is a demand in practice is not recognised in construction education in the UK (6.3.1).
- The lines between the roles of, and responsibilities for, designing, specifying and managing the actual build may be poorly defined in RMI work. A general builder may take on some or all of these tasks (6.2.1);
- In the absence of a formal educational pathway, general builders have developed their skills and knowledge in a variety of ways, responding to the demands of the job (6.2.4);
- Domestic renovation work tends to involve ongoing dialogue between builder and homeowner, and the builder taking a lead on design and specification can be beneficial to the homeowner in terms of accessibility, approachability and cost (6.2.3);
- General builders need to have good general knowledge of all the building trades, and the ability to coordinate them on site (6.2.3);

- Being a competent RMI builder means developing good general knowledge of existing buildings and their peculiarities (6.2.3);
- Problem solving and troubleshooting are key skills in RMI work on existing buildings (6.2.3);
- Measuring, estimating and pricing are essential skills for running your own building business (6.2.3);
- Project and business management are key skills transferable from other roles (6.2.3);
- There is a clear need for both theoretical and practical knowledge, implying both college and apprenticeships (6.2.3);
- Bigger employers have strong influence on shape of training and apprenticeships, and tend to shape things to fit their commercial needs, whilst much of the subsequent employment available is in microbusinesses (6.3.1);
- Integrating the work of different trades effectively includes the ability to treat the house holistically in terms of heat and moisture movement (6.3.1);

Objective 3: To provide recommendations for change that would enable an increase in delivery of the (full range of) energy improvement measures by building trades engaged in RMI

- A simplified and adapted version of the RIBA Plan of Work approach for domestic RMI projects could be developed as a checklist for homeowners and builders to use to ensure responsibility for different roles is agreed and acknowledged (6.2.1);
- Sustainability should be embedded into core training for each building trade and the related professions (6.3.1);
- Taking a holistic approach to the whole building is a step further than embedding sustainability into the work of each trade, and could be seen as part of set of foundation skills for building trades education (6.3.1);
- The role of general builder able to deliver domestic RMI, requires a clear and credible educational pathway, and a qualification at an appropriate level to incorporate design and specification of works including energy improvements (6.3.1);
- The level to which a building tradesperson is qualified before leaving training is significant with regard to their ability to deliver quality work, including energy improvements – Level 2 as an industry norm is too low and a minimum of Level 3 is recommended (6.3.1);
- The step between some academic levels is a big one for some students – in particular in moving from the more manual to more academic skills. Bridging courses are needed – for example in maths (6.3.1);
- The fundamental approach to apprenticeships should be reviewed, with a view to returning to an occupational rather than a task-based model (6.3.1);
- Funding for apprenticeships needs to support the type of experience that will prepare students for RMI building work in SMEs and microbusinesses – where they are most likely to find employment (6.3.1);
- Raising the level of compliance and enforcement in the most regulated industries must be complemented by a serious attempt to reach the unregulated (such as boilers sold through trade 'sheds' and unregistered window installations (6.3.2);
- Quality control requires effective and adequately resourced enforcement, independent of commercial bias (6.3.2);
- Quality control that effectively protects consumers requires a clear and transparent system that consumers and industry understand,and which makes it easier to implement energy improvements right than not, while not making it too difficult to do at all (6.3.2);
- The issue of quality control in low carbon retrofit is not just about ensuring compliance – there is also a need for clearer and more complete and consistent guidance on how to do things right, as well as embedding sustainability into training and education for the next generation of building tradespeople and installers (6.3.2);
- There is a need for more effective government communications to the industry and the public, setting out the strategic direction of travel in low carbon renovation, and backing it up with regulations and marketing messages (6.3.2).

7. Constructing a grounded theory

7.1 Summary of the research structure and results

7.1.1. Research structure

The aim of the research has been to investigate the barriers and potential solutions to enabling delivery of energy improvements within mainstream home repair, maintenance, and improvement (RMI) practice in the UK. This was underpinned by the following objectives:

1. To develop an understanding of the context for including energy improvements in RMI, through researching standard practice in the local supply chain from the perspective of key actors – in particular building tradespeople;
2. To establish and explore opportunities for, and barriers to, the inclusion of energy improvements within RMI;
3. To produce recommendations for change that would enable an increase in delivery of the (full range of) energy improvement measures by the building trades engaged in the RMI market;
4. To develop a theoretical framework for the research results and conclusions

This chapter summarises the conclusions to the first three objectives, and uses these as the basis for responding to the fourth.

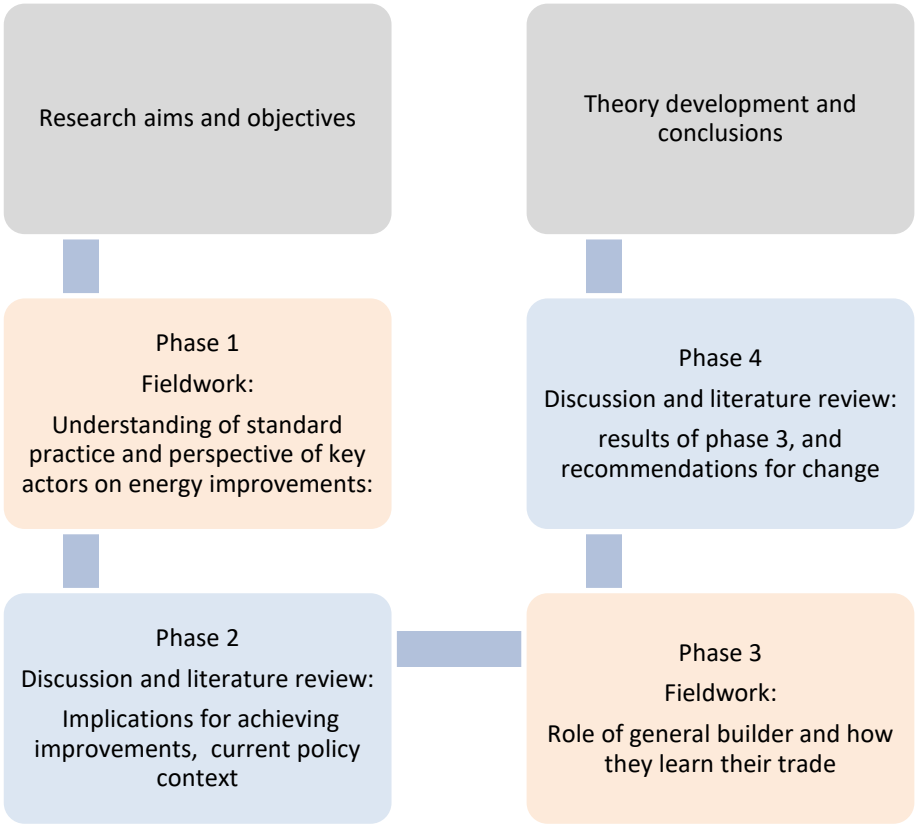
Following a grounded theory approach, the research began with fieldwork, using theoretical sampling. The first phase of fieldwork (Phase 1) informed the development of a picture of standard practice for mainstream building trades within the UK repair, maintenance and home improvement market, and the perspective of key actors within this industry as regards making energy improvements.

Phase 2 of the research considered the implications for achieving such improvements, drawing on both academic and ‘grey’ literature, to set this in the context of current policy and thinking. Whilst the opening research questions focussed on local activity, the results of the first phase of fieldwork highlighted that local building market activity does not operate in isolation from policy and is impacted by decisions made by government. A review of relevant current policy and programmes was therefore included as an additional theme, to preface the integrated discussion and literature review which forms this phase of the research.

Phase 3 consisted of a second phase of fieldwork, which investigated further a key issue identified in Phase 1: the role of the general builder and how they learn their trade, given the significance of this role already identified. In particular this phase explored the lack of recognition of this role as a specific trade within the existing educational and qualifications framework in the UK. This led to further insights of relevance to the research objectives, which were considered in the discussion and further literature review which formed Phase 4 of the research.

This chapter represents the final stage of the work, reviewing what has been learned and formulating a new grounded theory based on these insights.

Figure 11: The structure of the research



An overview of the research participants is provided in Table 17 below. Two of the interviewees also participated in the two 'round table' group discussions (one in Phase 1 and one in Phase 3), as indicated in brackets but not included in the total participants.

Table 17: Overview of research participants

Category	Interviews	Round table group discussions	Total participants
Building trades			
general builder	21	3 (+1)	24
plumber/heating engineer	7		7
electrician	2		2
carpenter/joiner	3		3
bricklayer	1		1
painter/decorator	1		1
roofer	1		1
insulation installer	1		1
Other			
trade associations	4	(+1)	4
planning/building control	3		3
architects	1	2	3
Self build homeowner		1	1
training professionals	4		4
merchants/suppliers/manufacturers	8	1	9
academics/consultants/researchers		8	8
public sector policy professionals		3	3
other services/advisers etc		3	3
Total	**57**	**21 (+2)**	**78**

7.1.2 Summary of research findings

The key overarching themes that have emerged from the research are summarised as follows:

RMI building trade businesses: micro-enterprises working locally through informal local networks, getting their work through personal recommendations; with reliance on reputation.

Roles and responsibilities in a domestic RMI project: not formally defined in practice, with implications for decision-making, accountability and risk.

The key role of the 'general builder'**:** in advising, specifying, and coordinating RMI work though not formally recognised through education, qualifications or licensing.

Vocational education and training (in relation to buildings): fundamental reforms required both in general scope and particular requirements for embedding sustainability knowledge and skills, levels of qualification for construction education, and better tailoring to the needs of small businesses.

***Driving demand**:* need for a long term strategy, strengthening of Building Regulations, advice to homeowners, market segmentation, government messaging and communications, policy and programmes that engage effectively with local RMI industry and building capacity.

Getting it right: enabling and enforcing in order to make it easier to do things (including energy improvements) right rather than wrong or not at all; clarity and transparency of accreditation and quality control systems for consumers; consistency of messaging; availability of advice to building trades and supply chain reliability; key role of local authority Building Control.

These themes are referred to in developing the theoretical framework in 7.2 below.

7.2 The theoretical framework

The research has followed a grounded theory approach, and as such deliberately began with fieldwork, rather than with a hypothesis. In this final stage of the work the results and learning are considered against the context of an emerging theoretical framework, in order to formulate a grounded theory.

7.2.1 A socio-technical approach with a multi-level perspective

This research is about change within the mainstream RMI market, this change being to bring about a shift in the inclusion of energy improvements in housing as part of mainstream RMI work from the niche to the mainstream, so that it becomes the norm. This includes taking what could be termed ‘innovation’ and translating this into mainstream practice. The theories of innovation diffusion, transitions and strategic niche management are therefore all relevant. It is argued below that application of a socio-technical approach with a multi-level perspective reflects particularly well what was discovered in the fieldwork, and provides a useful framework against which to analyse the drivers, obstacles and gaps to achieving energy improvements within RMI.

7.2.2 Review of relevant theoretical approaches

Market Transformation and Diffusion of Innovation

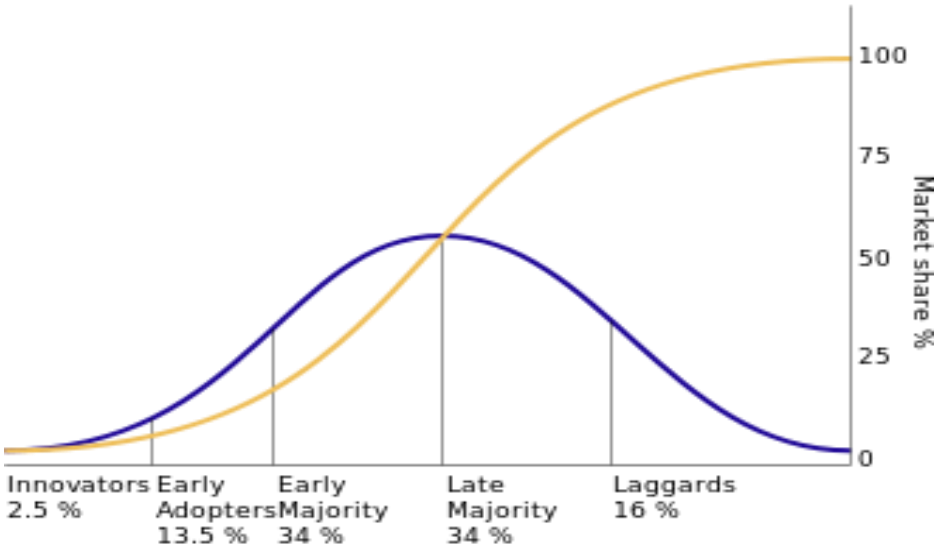
One relevant broad field of study in which to place this research is Market Transformation (MT), an approach developed in the US in the 1990s in relation to the uptake of more energy efficiency products and appliances, and influential in

developing EU policy on energy-using products, such as the energy label. Market Transformation is essentially a policy objective, and describes a set of strategic interventions in a market (Nadel et al., 2003). This offers a useful context for this research, which aims to understand what is needed to increase the inclusion of energy improvements within domestic RMI work in the UK - on the basis that the latter is a healthy, demand-led market, which offers a very large quantity of opportunities daily for such interventions. The aim would thus be to transform the RMI market into one in which the inclusion of energy improvements at every opportunity is the norm.

Thinking around MT within a market economy naturally focusses on decisions by consumers. MT planning tends to focus on 'adoption' of energy efficiency products or measures, and how this adoption spreads through society - from the 'early adopters' through to more/most efficient choices becoming standard practice. Linked to MT is thinking around the 'diffusion of innovation' through a social system, based on the idea that that the communication of information on innovations (such as more energy efficient products) through a social system encourages adoption (Rogers, 2003). In the context of this research, early adopters can be identified as households investing in energy improvements, as part of the RMI work they undertake. The social system through which this innovation is diffused is largely that within which the ***RMI building trade businesses*** doing the work operate, as in Figure 6 (4.3.2): the informal local social networks, both of homeowners and building tradespeople, and the merchants, suppliers, planning and building control personnel, and architects with whom they interact in the course of their work.

Rogers developed the diffusion curve (shown in Figure 12) to represent how this happens, plotting the rate of adoption as market share (shown in yellow) against time and illustrating a point at which a critical mass is achieved - when the number of individual adopters (shown in blue) ensures that the innovation is self-sustaining.

Figure 12: The diffusion of innovations. https://aceee.org/portal/market-transformation, downloaded 3/11/18 17.51



Key: Blue line = consumers adopting a new technology; yellow line = its market share

As an example of the application of MT, you might start by introducing a system for comparison of energy performance, develop a system for labelling this, trial it to test out its effectiveness and acceptability to consumers, then make it mandatory – and once it has been sufficiently deployed you can then use it as the basis for regulating out of the market the least efficient products. The application of this approach to energy using products in the UK has been documented by the DECADE programme (Boardman et al., 1997).

In the case of home energy improvements the consumers are in the main home-owners (owner-occupiers and landlords), and to a lesser extent tenants, where the latter generally have limited ability to make changes to the building or building services. Installers and building trades could also be seen as consumers in that they purchase products and materials – but they also play another role as influencers in that they discuss (and recommend) choices with home owners, as confirmed by interviewees in Phase 1 of this research. Policies that could be seen as part of an MT approach to home energy improvements delivered through the RMI market might include:

- Energy labelling of products that a builder may purchase and/or install for a home-owner, such as lamps, boilers, refrigeration equipment, cookers;

- Application of Building Regulations to existing buildings, through restrictions on controlled fittings, renovation of thermal elements and consequential improvements;
- Setting of minimum energy performance standards, applicable at trigger points, such as sale or rental – or through processes for quality control of rentals such as landlord registration or licensing schemes;
- Fiscal measures to encourage improvements, such as variable Council tax or Stamp Duty;
- Provision of appropriate financial mechanisms tailored to the needs of energy renovations – such as Pay As You Save programmes;
- Quality standards for retrofit.

MT tends to focus on the adoption of energy efficient products within a market, and how this builds from small beginnings to scale. While MT thinking provides a useful context for strategic planning in the quest to achieve energy improvements to existing homes, the challenge is more complex than that for a single product such as an energy efficient freezer, which for example, involves a supply chain consisting of the design, manufacture, wholesale and retail of a limited range of models for freezers. Making energy improvements to buildings, on the other hand, involves a supply chain consisting of the manufacturers and suppliers for a wide range of products and materials across the spectrum of building fabric and services – as well as the specialist installers and mainstream building trades which are the focus of this research. In the case of buildings, those responsible for design and specification and the regulatory authorities are also implicit in the market change. Domestic RMI work could therefore be seen as an interaction of a number of different markets, rather than one clearly defined one. These are markets for a range of products and services, and with energy improvement measures both as an integral part (such as a high efficiency boiler, insulation-backed plasterboard or a high performance window), and as individual markets within this mix (such as cavity wall insulation or solar panels).

The complexity of the broader RMI market is not only technical (both choice of products and in that products and materials may be combined in different ways), but also in terms of who does the work, and how it is organised. The lack of a standard approach to the division of ***roles and responsibilities in a domestic RMI project***:, as identified by this research, make it particularly difficult to apply a straightforward MT approach. This is highlighted by the ***key role of the general builder,*** who must

be able to bridge and integrate the wide range of technologies and specialisms involved.

Socio-Technical Transitions

In the face of such complexity, the limitations of the MT approach on its own was recognised by Killip (2013) in a study of low carbon refurbishment, in which he characterised building refurbishment as consisting of a multiplicity of overlapping markets. This refers not only to the markets for the different technologies involved, but also to the overlapping construction, renovation and property (sale and rental) markets. Killip notes that quantitative analyses of the application of existing technologies to the existing building stock indicates massive potential, even without any further technical innovation – and that the challenge is one of deployment of these technologies – a market rather than a technological breakthrough, and a need essentially for systemic change. To complement the relatively narrow MT focus on market transactions, he combines it with Socio-technical Transitions theory (Killip, 2013).

The transition towards a more environmentally sustainable use of technology can be described as 'socio-technical' because there are societal aspects to the changes required, such as in consumer and user behaviour, policy and markets, as well as the use of new technologies (Geels, 2004). This perspective was reflected in the findings of this research, in that the decisions about what energy improvements were included in RMI work was affected by specific consumer preferences, and the views and experience of the building tradesperson, as well as formal regulations and the technical options relevant to the building and RMI objectives in question. Several other studies on the issue of retrofit and housing energy improvements use a socio-technical approach (Bijker et al., 1987), acknowledging the reality of technological change as something which is inseparable from society on several levels: such as consumer choice and preferences, diffusion of knowledge (and innovation) through social channels, and user behaviour. Tweed focusses on the latter in his socio-technical study of household responses to a retrofitted home (Tweed, 2013).

In reviewing the expertise needed for low energy construction, Clarke, Gleeson and Winch (Clarke et al., 2017) argue that the technical requirement of low carbon construction to treat a building as a single thermal unit (sometimes colloquially referred to as 'whole-house' retrofit awareness) in turn demands an effective social interaction between the trades – implying ***a socio-technical transitions framework***.

This was confirmed by the informal collaboration between building trades identified in this research, and the importance of on-site communications between trades and with the homeowner (as noted in the theme ***getting it right***).

These studies, and the relevance of the socio-technical transitions approach are broadly confirmed by the results of this research, and further emphasised with respect to the importance of local social networks to RMI building tradespeople, both in the way they get their work and how they collaborate with each other to put together a team for a particular job. The limitations of a simplistic MT approach are further underlined by revealing the additional complexity introduced by the lack of a standardised approach to the processes of design, specification, and coordination of work on site. Returning to the aims of this research – the transition required is to move from a situation where opportunities for including energy improvements arise daily but are only occasionally taken, to one where such inclusion is the norm.

There are several problematic aspects of the systemic change described by Killip (Killip, 2013) which are of particular relevance to this research. In a similar vein to this research he starts from the observation that the cheap and easy measures are not enough to achieve the low carbon targets. He notes that in order to achieve deeper carbon savings, more complex renovations are required, where the distinction between the work of different trades blurs, and it becomes increasingly important to take into account the interaction between building elements and services, as well as the movement of heat, air and moisture through a building to realise the full benefits of measures and avoid unintended negative consequences. This requires both an effective connection between theory and practice and the ability of operatives to take an integrated approach. Killip identifies the need for an 'integrator' role – a theme which chimes with this research, in which it has been identified as a role which is taken in practice by the 'general builder'. Killip notes the significance of VET (Vocational Education and Training), the potential for gaps and overlaps between roles in a retrofit project, and the existence of a niche low carbon renovation market (such as AECB members). The question addressed here is how this can move from niche to mainstream.

This research builds upon Killip's work, looking at the same core issues, but focussing in on the issue of integration of energy improvements into mainstream RMI work, and from the specific standpoint of the mainstream building trades. By using a grounded theory approach and focussing on semi-structured interviews with building

tradespeople themselves in the first instance, this research was directed by the perspective of the key actors operational in RMI delivery. Key insights in relation to ***vocational education and training*** are the lack of a recognisable and effective educational route to becoming a general builder, and the need to embed sustainability broadly (and energy improvements in particular) into this role and as well as across the building trades and related building professions.

Social Capital Theory

McMichael and Shipworth's 2009 case study research (referred to in 4.3.1) took as its starting point both diffusion of innovation theory and social capital theory (that interpersonal communication is a key means of gaining resources, such as information on energy efficiency innovations, for attaining certain goals). They concluded that social and community networks can significantly impact on diffusion of information and take up of measures, and that in general people preferred to get information from people they knew (McMichael and Shipworth, 2011).

This research both confirms and builds further upon this latter insight with respect to the preference of local building tradespeople for word of mouth referrals, and the lack of need (or wish) for general marketing, except possibly on a very localised basis, such as parish magazines. Social capital theory reflects well the localised way in which RMI microbusinesses work within their local communities, as described by interviewees in this research, but does not describe the wider system in which they operate – such as the impact of national policy, building regulations, and the wider social influences on customer preferences – key to ***driving demand*** for energy improvements.

Strategic Niche Management and the Multi-Level Perspective

Returning to the different scale levels of socio-technical transitions, the concept of a multi-level perspective (MLP) appears to be the most useful and relevant to the aims of this research. This was introduced in the summary of the first two phases of work in section 4.6.

Rotmans describes 'transition' as a long-term social transformation process which involves structural change to society (or a complex subsystem of society), large-scale technological, economic, ecological, social, cultural and institutional developments that influence and strengthen each other, and interactions between developments at different scale levels (Rotmans, 2002, Rotmans and Kemp, 2002).

Of particular relevance to the findings of this research is the work on strategic niche management by Geels (Geels, 2004, Geels and Schot, 2007) in which the multi-level perspective is set out as:

- Micro-level (niche): the commonest source of new ideas and practices
- Meso-level (regime): encompassing forces, typically resistant to change
- Macro-level (landscape): trends and events, providing the context in which change may be helped or hindered

Strategic niche management focusses particularly on new technologies, bridging the gap between Research and Development, and market introduction. At first this might appear to be a step back from the focus of this research. However, the MLP has practical applicability, in that the actions at the micro level are the ones that directly impact on low carbon renovation, but do not occur in isolation, and are constrained or supported by those at meso and macro level. This reflects the experience of the RMI building tradespeople as reported in this research, where their activity is both influenced and constrained by what is happening more broadly in policy and the economy (both directly and via the views and wishes of homeowner customers), which could be seen as 'landscape', and at the regulatory level (regime).

Gibbs and O-Neill (referenced in section 4.3.3) looked at the socio-technical process for the movement for green entrepreneurship from niche to mainstream, and the barriers involved – not least the potentially self-fulfilling perception of 'green building' as a niche activity (Gibbs and O'Neill, 2014). This present research builds directly on this issue – looking at what might be referred to as 'green' renovation measures and how these can be integrated into the everyday work of mainstream building trades. The innovation or 'niche' in this case is not only in terms of adoption of specific technologies, but also in a broad or systemic approach to RMI work, to always include technologies to improve energy efficiency and reduce carbon emissions wherever possible. Gibbs and O'Neill pointed out that businesses do not operate in isolation, even when they are innovative entrepreneurs - rather within a socio-technical framework, that is impacted upon by both regime and landscape level influences and constraints.

Transitions literature highlights challenges and limitations to the use of this approach in analysing and managing transitions. An example is that the two way relationship between the levels (with each influencing the other) doesn't necessarily illustrate the power relations involved (ibid). Another is that the MLP could be enhanced by

reflecting business dynamics in such interactions between levels: in this case niche-regime in particular (Geels, 2010). This is reflected in the findings of this present research, in that the perspective presented by interviewees was that their ability to act is both directed and constrained by policy and regulation, as well as customer demand. The power relations remain top down, even if innovation is bottom-up.

With their focus on the green entrepreneurs as innovators, Gibbs and O'Neill (Gibbs and O'Neill, 2014) placed the mainstream building industry in the category of 'regime'. The RMI industry might, however, be differentiated from the larger corporations engaged in building new housing in this respect. Looking at the issue of energy improvements in housing from the perspective of the mainstream RMI building trades, there is an argument for placing the RMI microbusinesses instead at the micro-level, in that the RMI businesses interviewed appear to be responsive to change and adaptable – creating new business structures to cope with current economic insecurity, and problem-solving in their everyday work..

Kivimaa and Martiskainen (referenced in 4.3.3) pick up on the multi-level perspective of socio-technological change in their case studies of intermediaries in low energy building renovation, identifying as relevant intermediaries local authorities, building professionals, building managers and 'foundations' (Kivimaa and Martiskainen, 2016). The results of this research do not contradict these findings but develop this further, by building a picture of all those that the building trades and homeowner come into contact with in getting RMI work done, and which may therefore have an influencing role. This includes public and third sector organisations, as well as the local authorities which stand out as key intermediaries in the case study examples.

Further work on this topic developed the definition of an intermediary in sustainability transitions, with a typology of five intermediary types, again within an MLP framework (Kivimaa et al., 2018). Although some characteristics of intermediaries within both the niche and regime levels overlap with roles taken by general builders in practice, in general RMI tradespeople do not fit any of the specific categories. An example of overlap is the role of 'process intermediary' in interpreting regulations and options for a homeowner in discussing possible work, and in facilitating renovation (where a builder may do this in place of an architect). The conclusion that *'many necessary intermediaries appear to emerge during the transition, when different actors respond to knowledge, coordination and services gaps regarding the alternative solutions in*

the market...' (ibid) also reflects the role sometimes taken by general builders as noted in this research.

Also of relevance to the focus of this research is the 'middle-out' concept described by Janda and Parag (Janda and Parag, 2013), in which building professionals are characterised as 'middle actors' in between the 'top' of government and 'bottom' of clients and customers. These middle actors are considered to have influence upstream, downstream and sideways – and it is pointed out that this influence can be both positively enabling or the opposite as regards energy efficiency and low carbon measures. An emphasis is placed on vocational training as a solution, on the basis that building professionals are more likely to encourage what they are confident about offering themselves. It is noted that renovation programmes would have a higher chance of success if they took into account the ways in which building tradespeople operate – which underlines the relevance of this research. (ibid)

The middle-out approach offers a useful additional perspective which seems consistent with socio-technical transitions and MLP.

7.3 A grounded theory for integrating home energy improvements into mainstream RMI

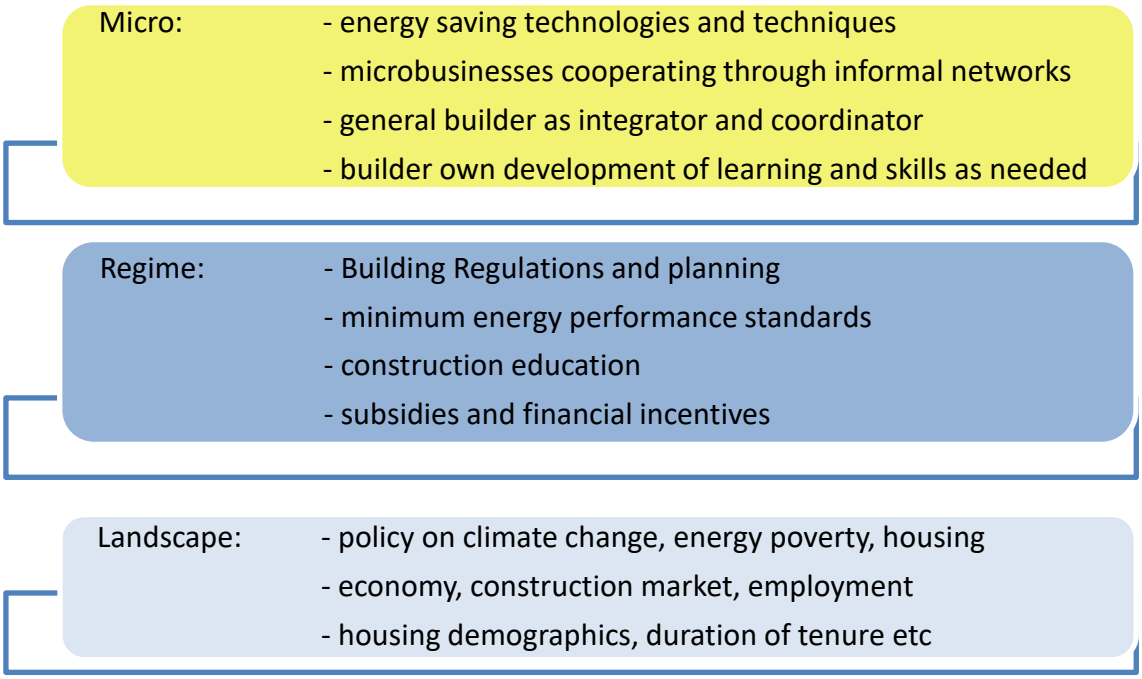
Using the MLP approach to this topic, the main innovation occurs at the micro level and is the inclusion of energy improvements within RMI. But there are other innovations to consider, as indicated by the fieldwork in this research:

- The development of the microbusiness and/or self-employed tradesperson and use of informal networks for combining trades on jobs, as a response to economic insecurity and market fluctuations;
- The evolution of the role of the general builder to fulfil the multi-tasking role of overall project lead (including the role of 'integrator' as referred to by Killip);
- The approach to ad-hoc self-training for the above role adopted by general builders in the context of a lack of a specific educational pathway or qualification for this role.

The regime level consists, for example, of building regulations, planning, tax (property, income, VAT). The landscape level consists of policy on climate change, housing, energy poverty, from global through to local, and economic situation – and

impact on home ownership, duration of tenure, investment in housing by individuals and others.

Figure 13: A multi-level perspective to home energy improvements in RMI



The theory developed against this background is that:

a) ***RMI microbusinesses are innovators at the micro level***. This is evidenced by the agility of the locally active building trades in responding to changes in the landscape and finding positive ways forward:
    - To survive economically;
    - To collaborate across trades;
    - To provide the necessary 'integrator' roles in domestic RMI through the development of the role of the general builder, filling in the gaps where this role has been diluted by change at regime level
    - By finding ways to learn and develop skills and experience to perform this role on an individual and ad hoc basis, in spite of the lack of a formal pathway or acknowledgement within construction education

    These innovations are both a logical response to the economic landscape and a strength, that it would be wise to build upon (and be careful not to stifle). This would support the shift from niche to mainstream of an industry that can

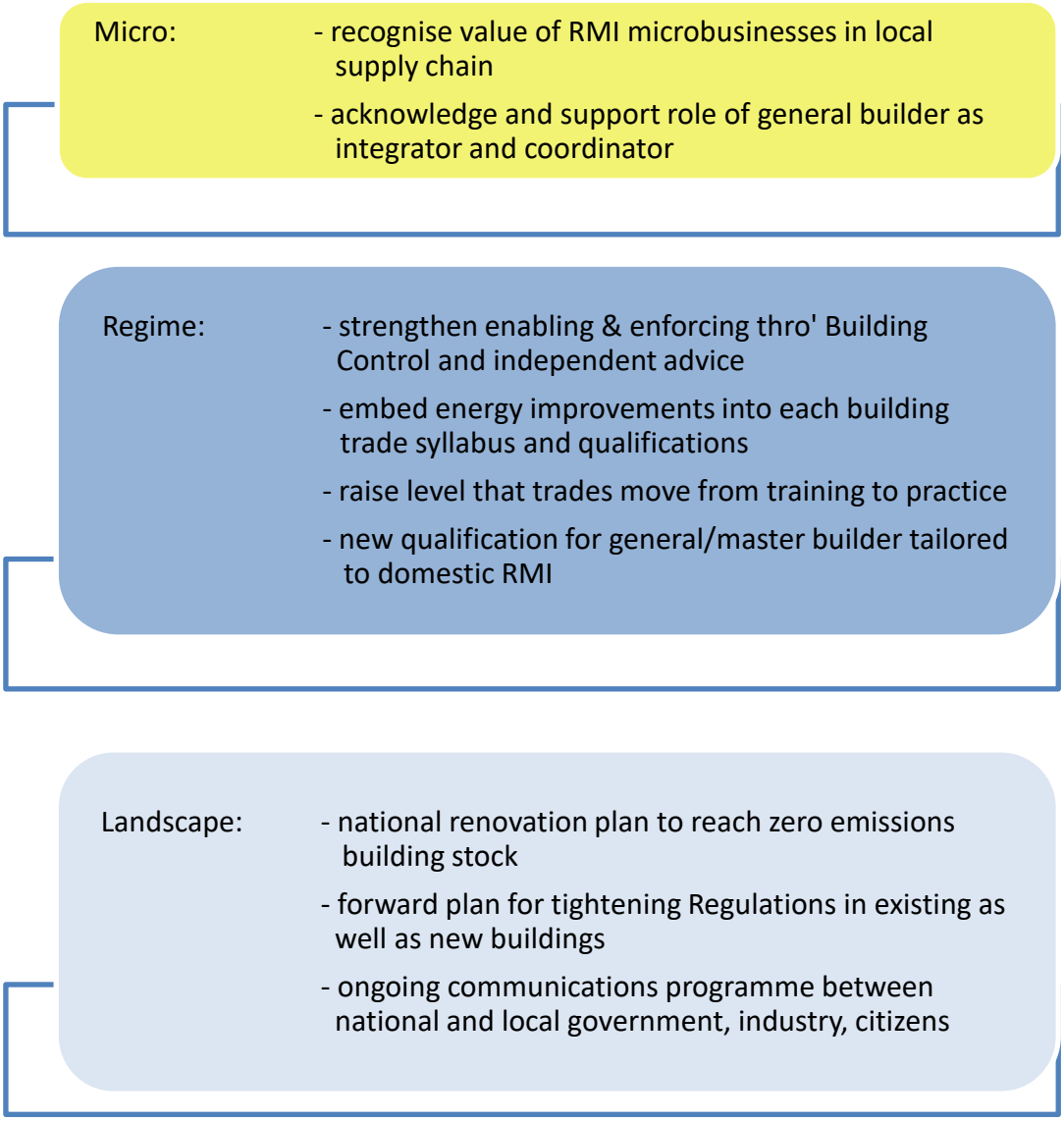
enable more (and good quality) energy improvements in housing to occur through the opportunity provided by the healthy, demand-led RMI market.

b) This can be done by ***strengthening the regime-level structures*** within which this industry operates to ensure this activity is actively encouraged and enabled, for example through:
    - Embedding sustainability (including energy improvements) into each of the building trade training syllabuses and qualifications (and related professions, such as architecture, building control, planning);
    - Raising the 'normal' level at which trades move from training into practice to reflect the increased sophistication of technologies for low carbon renovation (with consequential lift in status of building trades);
    - Developing a new qualification tailored to the requirements of the master/general builder working on housing and other small and medium scale RMI – to include design and specification, site coordination and management, and incorporating sustainability as a core theme throughout;
    - A strengthening of the key enabling and enforcing roles at local level – in particular through Building Control, and provision of commercially independent expert advice (whether through local government or a form of non-profit one-stop-shop).

c) This needs to be supported at ***landscape level*** by providing:
    - A forward plan of increasing building regulations on energy performance in existing as well as new buildings – to tie in with a national renovation roadmap as required under the revised EPBD, leading to a zero emissions building stock;
    - An ongoing communications programme between the levels of national government, local government (as enforcers and enablers of the 'regime', as well as accessible to citizens and local businesses), the industry and the population / home-owners – that explains and maintains awareness of both the reasons behind, the direction of travel and the practical application of these initiatives.

These recommendations for change are illustrated in Figure 14 below. These are described in the context of the different levels (micro, regime and landscape) but require sharing of learning and communication between levels in order to be effective, as indicated in the third bullet point under 'landscape'..

Figure 14: Recommendations for change: home energy improvements in RMI



8. Conclusions

Set against the context of global and national objectives for mitigating climate change, and the slow replacement of the UK housing stock, this qualitative research project has focussed on making improvements to the energy performance of existing homes. The work addresses a gap in knowledge in relation to the missed opportunities to include energy improvements within everyday practice in the thriving, demand-led, home repair, maintenance and improvement market – and in particular to understand the perspective of those who deliver this work on the ground.

The research aim was to investigate the barriers and potential solutions to enabling delivery of energy improvements within mainstream home repair, maintenance, and improvement (RMI) practice. The objectives underpinning this were to:

1. Develop an understanding of the context for including energy improvements in RMI, through researching standard practice in the local supply chain from the perspective of key actors – in particular building tradespeople;
2. Establish and explore opportunities for, and barriers to, the inclusion of energy improvements within RMI;
3. Produce recommendations for change that would enable an increase in delivery of the (full range of) energy improvement measures by the building trades engaged in the RMI market;
4. To develop a theoretical framework for the research results and conclusions.

Using a grounded theory approach, the research sought to develop insights of practical relevance to the research participants and the market within which they operate (Charmaz, 2006, Denscombe, 2011). As such, the focus for qualitative data collection was building tradespeople in particular, with an important but secondary focus on others within the supply chain with whom they interact in the course of their work including, but not limited to: builders merchants and suppliers, building control and planning, and the construction education establishment.

This chapter sets out the research conclusions, addressing each of the research objectives and the main aim, discusses limitations to the research and makes recommendations for further research.

8.1 Research conclusions

8.1.1 Objective 1: Insights into standard practice in the RMI local supply chain

Based on the qualitative data gathered, key insights were gained into standard practice within the UK's RMI market, helping to set the context for the inclusion of energy improvements within such work. Developing a better understanding of how people work in this market, and the practical realities that they face, is key to the development of a theory which is grounded in practice. As such, this was the first objective to be achieved (through the first phase of fieldwork), and from which the rest of the work flows.

Working in local informal networks

Establishing the kind of work that RMI building tradespeople are able and willing to offer, where, and at what scale, are critical aspects of working practice of relevance to the potential for inclusion of energy improvements.

The building trade micro-enterprises which characterise the UK domestic RMI market and their tend to work at a local level, for several mutually beneficial reasons: practical, economic and personal. Linked to this preference for working at a local level is the value placed on quality work and reputation, and for personal recommendation rather than marketing to get work. This is discussed in 4.3.1.

Local building tradespeople tend to work as sole traders or very small businesses, and are not necessarily looking for growth. A steady stream of quality work for reliable customers is seen as offering a better quality of life and less risk, while taking on employees is seen as a high risk, and a limitation to flexibility. Delivery of larger or more complex projects is enabled by cooperation through informal networks (described in 4.3.2), where a customer liaises initially with one building tradesperson, who then brings in others to assist on the job. These more substantial projects might range, for example, from renovating part of a home, a new kitchen or bathroom, through to a complete renovation, extension, or loft conversion. They might involve several trades, both construction and building services. RMI work, and the skills required to deliver it, have the potential to include the full range of low energy solutions, from thermal insulation and energy efficient technologies for heating, hot water, cooling and lighting, through to household scale renewable heat and power.

The multiple role of the general builder

It is generally assumed that an architect carries out certain tasks on a renovation project, in particular the design, but also sometimes the detailed specification and project management. Discussions with building tradespeople, however, indicated that in a domestic RMI job, all or part of the design and specification of the work, including any necessary planning permissions and building control approvals, may in practice be carried out by a builder – either without an architect involved in the project at all, or complementing the role of the architect. Similarly, the coordination of the work on site, and the ongoing liaison with the customer, may be undertaken by a builder. These issues are discussed in 4.5.1 and 6.2.1.

A builder who offers a wide range of building services, and can manage a project which involves more than one trade, is typically referred to as a 'general builder' (described in 6.2.2) - despite the lack of a specific accreditation or qualification that identifies this role in the UK.

Taking the lead in all or some of the roles of design, specification, customer liaison, coordination on site, completion and handover implies responsibility for decision-making, including with regard to energy. It can also involve financial risk, for example, resulting from: a customer that holds back payment; penalties for late completion; or cash flow difficulties arising from paying for materials, labour and/or sub-contractors ahead of receiving payment from the customer. As described in 4.3.2, a variety of arrangements may be made in practice to share the risk and to an extent the responsibility, such as: each tradesperson being contracted separately to the customer rather than acting as sub-contractors; customers paying directly for materials; and in some cases the customer themselves choosing to project-manage the work.

Interviews with builders indicated that in renovation work on older buildings, some details (or the extent of potential problems) will be unknown until the work is underway, so on-going communication, on-site experience and a very broad range of building skills and knowledge are needed (discussed in 6.2.3). The contribution of the 'general builder' to this kind of problem solving is not always recognised or understood. In effect, general builders tend to fill the gaps in provision within the domestic RMI market, from customer liaison, and design and specification, through to project management and completion.

Domestic renovation work therefore tends to involve ongoing dialogue between builder and homeowner, with choices and decisions needed at different stages of the work, as discussed in 6.2.1. There are perceived benefits to the homeowner in terms of accessibility, approachability and cost, in such situations when the 'general builder' takes a lead on managing the work, in comparison to working with an architect.

Quality and reliability

The local building tradesperson who gets their work through personal recommendation relies on their reputation for quality and reliability to result in recommendations for future work. As a result, a strong desire was expressed for effective enforcement of regulations, and a 'level playing field' in which quality cannot be undercut. Concerns were raised with regard to the lack of adequate resourcing of the Building Control function within local authorities in this respect, and the loss of independence of this role where private inspectors are directly employed by commercial developers as an alternative to the local authority service. These issues are discussed in 4.2.3.

A related issue of importance to the small building company is supply chain reliability (from merchants and online suppliers through to manufacturers) – in terms of product quality and consistency, follow-up and replacements when there are problems, site-specific advice on the use of products and materials, and even free training in regard to more major and complex works such as solid wall insulation (discussed in 4.5.3).

8.1.2 Objective 2: Opportunities & barriers to including energy improvements in RMI

The research highlighted both opportunities and barriers as regards delivery of home energy improvements within RMI. These were identified within both stages of fieldwork, and developed further through review of literature.

Influencing homeowners

RMI works offer a wide range of practical opportunities within which to include the full range of energy improvements. Building tradespeople, who are generally the first point of contact for homeowners seeking to get such work done, can be influential in advising homeowners and developing the brief, as discussed in 4.4.1. Interviewees described the dialogue with homeowners around their requirements and what the options might be, in the initial stages of a job. They noted that their influence on

decisions was typically greater when they were in a trusted position, due to being known locally and having been recommended by other customers.

There can, however, be barriers in terms of the priorities of customers and what they are willing to pay for. Further, building tradespeople indicated that they were aware of the benefits in terms of energy bill savings, comfort and environmental impact, but that they cannot always convince the homeowner to make energy improvements where such measures may cost more and are not obligatory. Independent advice indicating specific savings for the home in question could help to overcome this barrier, but is not generally available in the UK at present.

The significance of the general builder role

General builders tend to fill the gaps in provision within the domestic RMI market, from design and specification through to project management and customer service. A general builder is expected, by the customer, to cover the full range of building and building services work needed for domestic RMI, as described in 6.2.2.

Home owners who want works done on their home are not always able to identify the specific trade they need in advance (unless for example it is clearly a bulding services job, such as an electrical or heating system repair), and tend therefore to contact general builders in the first instance – as highlighted by the fact that this is by far the most commonly used search category in the Federation of Master Builders search facility.

These factors mean that the role of the general builder is key to achieving home energy improvements, particularly through the ‘trigger point’ opportunities provided by RMI work (Energy Saving Trust, 2011). This could, for example, be the chance to install thermal insulation when renovating a wall, roof or floor, specify high efficiency windows when replacements are required, or introduce renewable or other low carbon technologies when maintaining or upgrading heating systems. This highlights the importance of what influences the general builder’s view, how and where they can access the information and resources needed to deliver such improvements, and whether their training enables them to do so.

Builder training and qualifications

Effective inclusion of energy improvements in RMI work requires knowledge and experience of the measures and technologies, which raises the question as to when and how this might be provided in the development of the builder's skill-set (both currently and in the future). In terms of formal training and qualifications (discussed in 6.3.1), however, this research has revealed that the 'general' or 'master' builder role is not defined as such in construction education in the UK, and there is no recognisable educational pathway by which to qualify as a general builder in the domestic market. In practice, those performing this role were found to have developed their skills and knowledge in a range of different ways, such as training in one trade and gradually starting to coordinate others out of necessity, through the experience of renovating their own homes, or building on transferable skills such as engineering project management.

Further investigation, through interviews with construction training professionals and literature review, indicated that construction education and training in the UK appears generally complex and confusing, with a lack of clarity around the requirements for, and value of, different qualifications and accreditations, whether for those entering the trades or as additional training at a later stage. This presents a barrier to effectively incorporating sustainability and other cross-cutting knowledge and skills. The design and specification of renovation projects, incorporating the work of several trades, and requiring an understanding of the interaction between them does not appear to feature within educational provision for the building trades – meanwhile this is a task frequently taken on by the general builder in practice, within the demand-led RMI market. With this gap in provision, it is difficult to see how to ensure the addition of important and sensitive requirements in low carbon renovation, such as to ensure adequate and appropriate ventilation, avoid overheating, and take into account heat and moisture movement within a building.

In addition to the lack of provision for the general builder role, the shift to low carbon is not well reflected in construction and building services education for individual trades – both specific to each trade and as a cross-cutting issue. The level to which building tradespeople are trained is relevant - and the tendency to see Level 2 as the industry norm to leave training - presents a barrier to enabling adoption of lower carbon technologies and the more sensitive design needs of low carbon renovation.

A related issue is the length, content and quality of apprenticeships. One interviewee [A09CJ] pointed to pre-World War 2 apprenticeships of 7 years, while his father had done a 5 year apprenticeship in the 60s, and his own (late 1980s) apprenticehip had been just 3 years. A recent review of construction qualifications in Wales reported apprenticeships as short as a few months in some cases (Qualifications Wales, 2018). Under current arrangements, bigger employers have strong influence on training and apprenticeships, and tend to shape things to fit their commercial needs (often focussed on new build), whilst much of the subsequent employment available is in microbusinesses (often working within the domestic RMI market). Concerns regarding the narrowness of content, and inadequacy as a preparation for working life are highlighted in academic literature (Brockmann et al., 2010a, Clarke et al., 2017, Brockmann et al., 2010b).

Communications and consistent messaging

The importance of communications at all levels is highlighted (as noted in 6.3.2), not only at high level from government, but also at project level: between builder and customer, between designer/architect (where one is involved) and builder, and between different trades on site – including finding solutions to issues that might arise in the course of the work. This can be critical to achieving the aims of very low carbon renovation, where everyone involved may be on a relatively steep learning curve.

There is a need for more effective government communications to the industry (in particular the small businesses that predominate within the RMI industry) and the public, setting out the strategic direction of travel in low carbon renovation, and backing it up with regulations and marketing messages. A specifically relevant point raised by interviewees was the lack of communications about changes to Building Regulations, and the reasons for these – critical for the industry to be able to keep up to date, and to have a clear picture of the progressive shift in regulation towards low carbon that would give confidence to invest in the skills and knowledge development required. There appears to be no mechanism at present for communications between statutory authorities and RMI building tradespeople, with the exception of those working witin the specific registration requirements of gas and electrical services.

Another aspect of communications highlighted was the difficulty faced by building tradespeople in convincing homeowners to invest in energy improvements, unless supported by consistent messaging, such as through government policy and independent advisory services.

Regulations and enforcement

Building Regulations were identified by interviewees as a key driver for energy improvements, as discussed in 4.2.3. From the building tradesperson's perspective, these dictate what can and can't be done in practice, so overcoming homeowner resistance to any additional costs incurred in including energy improvements in other works. Interviewees indicated a desire for a powerful and commercially independent Building Control function, so that they could not be undercut on price by those not following the rules.

It was noted by an experienced Building Control Officer [C03BC] that the inclusion of sustainability in regulations is potentially more difficult to enforce than matters which are more directly 'black and white', such as those related to health and safety, and are thus sometimes more difficult to understand, interpret and implement. Complicated regulation or incentives could have a negative effect, because people may not understand how to comply, or be frightened off by the paperwork involved. There may also be a problem of lack of awareness of the actual regulation – for example in relation to the requirement to insulate 'thermal elements' when these are renovated [C04BC].

Another barrier cited is inconsistency between Building Control and Planning, for example where conservation of built heritage conflicts with thermal insulation or retrofit of microgeneration.

The issue of quality control in delivering energy improvements is not just about ensuring compliance. There is also a need for clearer and more complete and consistent guidance on how to do things right, as well as embedding sustainability into training and education for the next generation of building tradespeople and installers. Building tradespeople as well as home owners would benefit from access to expert and independent advice on energy retrofit, from a trusted source, at all stages of the process of getting building works done. This is discussed in 6.3.2.

The role of local Building Control personnel as a potential source of knowledge and advice was raised, along with frustration that this was not generally made available, whether through lack of capacity or that this is not accepted as part of their role. A well-resourced local Building Control function could be key to realising trigger point opportunities, with a potential advisory role and links to local examples of good practice.

Raising the level of compliance and enforcement in the most regulated industries needs to be complemented by a mechanism to engage the unregulated (such as boilers sold through trade 'sheds' and unregistered window installations). Quality assurance schemes which are not obligatory risk creating a two tier industry, with additional cost and time burdens placed on those that participate in such schemes, potentially helping those that don't to undercut on price.

Incentives and the impact on the market

The local nature of the RMI market indicates a good fit with delivery of housing energy efficiency schemes, but national policy in the UK does not take account of or build upon this thriving market. The incentives developed have not been made accessible to this market, but have rather tended to encourage large scale programmes run by large corporations, missing the opportunity to build low carbon renovation capacity with the mainstream RMI market, as discussed in 4.2.3 and 4.2.4.

Problems were cited in relation to subsidies and financial incentives being short term. This is seen as destabilising to the industry, and risk attracting those looking for a quick profit, creating an unsustainable dependence and a boom-bust industry which tends to be peripheral to the mainstream building industry. Programmes with centrally-imposed deadlines to achieve installation targets by a specific date can also result in poor quality work - for example, external wall insulation applied in adverse weather conditions, or cavity wall insulation installed where the the location or wall condition indicated that it could increase the risk of damp.

8.1.3 Objective 3: Recommendations for change

In considering what could enhance the opportunities and help to overcome the barriers to getting home energy improvements into the UK's existing housing stock through the RMI route to market, this research concludes that there are a number of gaps in provision.

Policy and practical plans for implementation

From the policy perspective, while there is a (high level) legislative structure in place to address climate change at global, European and national levels, implementation, as regards the energy performance of housing in the UK, appears incomplete and stalled. This is discussed in 4.2.4.

Consistent, long term policy is needed to help companies plan and invest, and regulation is an important part of this, linked to incentives as appropriate – the 'carrot and stick'.

There is a need for more effective government communications to the industry and the public, setting out the strategic direction of travel in low carbon renovation, and backing it up with regulations and marketing messages. This should be part of a comprehensive communications strategy.

Roles and tasks within a renovation project

The different roles in a renovation project can be poorly defined in practice, which can lead to a lack of clear lines of responsibility, as discussed in 6.2.1. For the RMI builder this can mean taking on more tasks than are acknowledged in practice, and they may not be aware of the responsibilities that some of these carry. A simplified and adapted version of the RIBA Plan of Work approach for domestic RMI projects could be developed as a checklist for homeowners and builders to use to ensure responsibility for different roles is agreed and acknowledged.

Skills, knowledge, training and qualifications

A wide ranging set of skills and knowledge is required to be a successful general RMI builder, as described in 6.2.3, including:

- good general knowledge of all the building trades, and the ability to coordinate them on site;
- good general knowledge of existing buildings and their peculiarities;
- general RMI design and specification of works;
- problem solving and troubleshooting;
- measuring, estimating and pricing;
- project and business management.

The role of general builder able to deliver domestic RMI, requires a clear and credible educational pathway, and a qualification at an appropriate level to incorporate design and specification of works including energy improvements. This should be supplemented by a credible and accessible programme of CPD for the existing workforce. Integrating the work of different trades effectively requires this also to include the ability to treat the house holistically in terms of heat and moisture movement. The RMI builder's knowledge base must also include:

- heat loss and thermal insulation;
- efficient heating, cooling and lighting;
- renewable and low carbon heat and power generation technologies

Considering construction and building services education more broadly, sustainability should be embedded into the core training for each of the building trades. Taking a holistic approach to the whole building is a step further than embedding sustainability into the work of each trade, and could be seen as part of set of foundation skills for building trades education.

The level to which a building tradesperson is qualified before leaving training is significant with regard to their ability to deliver quality work, including energy improvements. Level 2 as an industry norm for leaving training may be too low and a minimum of Level 3 necessary, in order to be able to take on the relative sophistication of low carbon technologies and fabric details.

The step between some academic levels is a big one for some students – in particular in moving from the more manual to more academic skills. Bridging courses are needed – for example in maths.

There is a clear need for both theoretical and practical knowledge, implying a need for both college education and practical apprenticeships. However, the fundamental approach to apprenticeships should be reviewed, with a view to returning to an occupational rather than a task-based model, in order to prepare building tradespeople better for RMI work, as opposed to the more limited demands of homogeneous new building. It is noted that under current arrangements, bigger employers have strong influence on shape of training and apprenticeships, and tend to shape things to fit their commercial needs, whilst much of the subsequent employment available is in microbusinesses. Funding for apprenticeships needs to support the type of experience that will prepare students for RMI building work in SMEs and microbusinesses, where they are most likely to find employment.

These issues are discussed in 6.3.1.

Getting it right – advice, information and quality control

Quality control requires effective and adequately resourced enforcement, independent of commercial bias. Raising the level of compliance and enforcement in the most regulated industries must be complemented by a serious attempt to reach

the unregulated (such as boilers sold through trade 'sheds' and unregistered window installations).

Quality control that effectively protects consumers requires a clear and transparent system that consumers and the industry can understand – and which makes it easier to implement energy improvements well than not, while not making it too difficult to do at all. The issue of quality control in low carbon retrofit is not just about ensuring compliance – there is also a need for clearer and more complete and consistent guidance on how to do things right, as well as embedding sustainability into training and education for the next generation of building tradespeople and installers.

Work on existing buildings often requires problem solving on site, to adapt energy saving technologies to the multiplicity of different features that may be encountered in practice. The use of onsite communications processes similar to 'toolbox talks' may help to ensure effective solutions are developed and understood, involving dialogue between tradespeople on site and those responsible for design. Good practice guidance on the use of such approaches may be of benefit.

A clearer and more comprehensive system for qualifications and training within the construction industry, that takes account of the requirements of the domestic RMI market, and the practical realities of working within micro-businesses, could be the first step in a move towards a licensing system for all building trades. This would in turn provide the mechanism for regular communications and two way dialogue between the industry and statutory authorities, and facilitate technology and regulation updates and other aspects of continuing professional development.

These issues are discussed in 6.3.2.

8.1.4 Objective 4: A theoretical framework

Chapter 7 explores the theoretical framework for this research, which is about change within the mainstream RMI market, the change being to shift the inclusion of energy improvements in housing as part of mainstream RMI work from the niche to the mainstream, so that it becomes the norm. This includes taking what could be termed 'innovation' and translating this into mainstream practice. The theories of innovation diffusion, transitions and strategic niche management were all found to be relevant. The theoretical framework selected as most relevant as a structure for the research conclusions is that of a sociotechnical approach with a multi-level perspective, as this reflects particularly well what was discovered in the fieldwork, and provides a

useful framework against which to analyse the drivers, obstacles and gaps to achieving energy improvements within RMI.

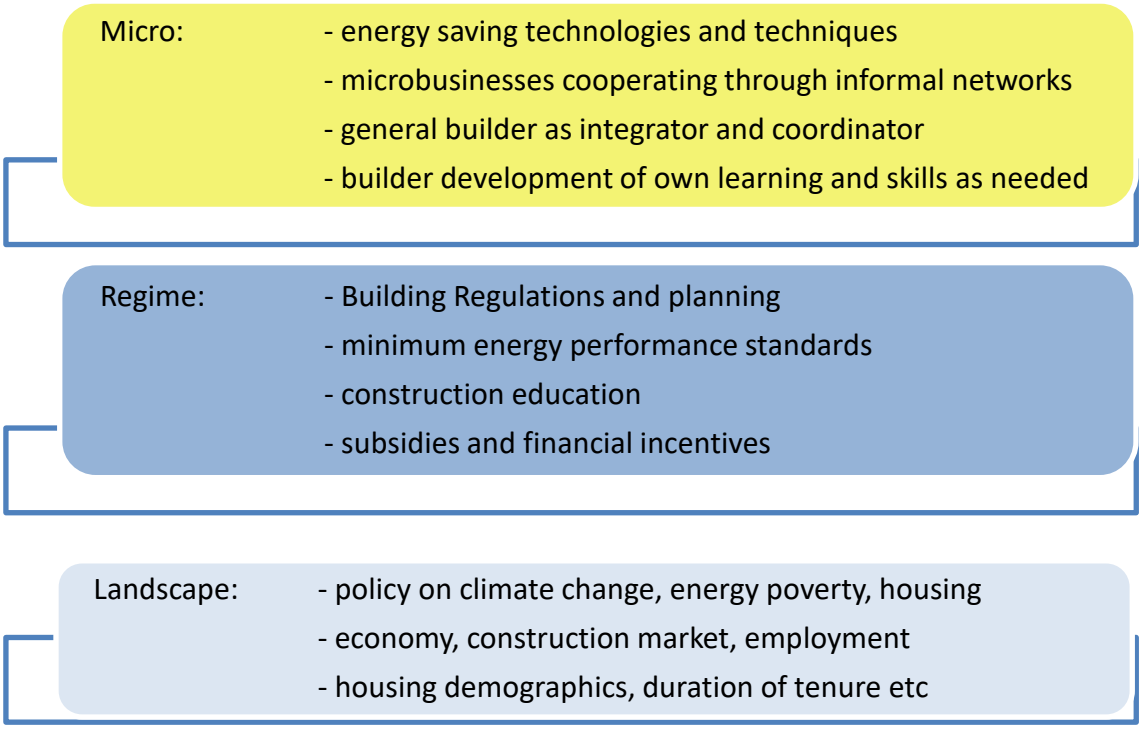
Using the MLP approach to this topic, the main innovation occurs at the micro level and is the inclusion of energy improvements within RMI. But there are other innovations to consider too, as indicated by the fieldwork in this research:

- The development of the microbusiness and/or self-employed tradesperson and use of informal networks for combining trades on jobs, as a response to economic insecurity and market fluctuations;
- The evolution of the role of the general builder to fulfil the multi-tasking role of overall project lead (including the role of 'integrator');
- The approach to ad-hoc self-training for the above role adopted by general builders in the context of a lack of a specific educational pathway or qualification for this role.

The regime level consists, for example, of building regulations, planning, tax (property, income, VAT). The landscape level consists of policy on climate change, housing, energy poverty, from global through to local, and economic situation – and impact on home ownership, duration of tenure, investment in housing by individuals and others.

Applying this framework, the picture developed of standard practice within RMI in the UK is set out in the three levels of micro (or niche), regime and landscape as in Figure 13.

Figure 13: A multi-level perspective to home energy improvements in RMI



The innovations identified at micro level are both a logical response to the economic landscape and deficiencies at regime level, and a strength. It would be wise to build on them to support the shift from niche to mainstream of an industry that can enable more (and good quality) energy improvements in housing to occur through the opportunity provided by the healthy, demand-led RMI market.

This can be done by ***strengthening the regime-level structures*** within which this industry operates to ensure this activity is actively encouraged and enabled, for example through

- Embedding energy improvements into each of the building trade training syllabuses and qualifications;
- Raising the 'normal' level at which trades move from training into practice to reflect the increased sophistication of technologies for low carbon renovation (with consequential lift in status of building trades);
- Developing a new qualification tailored to the requirements of the master/general builder working on housing and other small and medium scale RMI, to include design and specification, site coordination and management, and incorporating sustainability and energy improvements throughout;

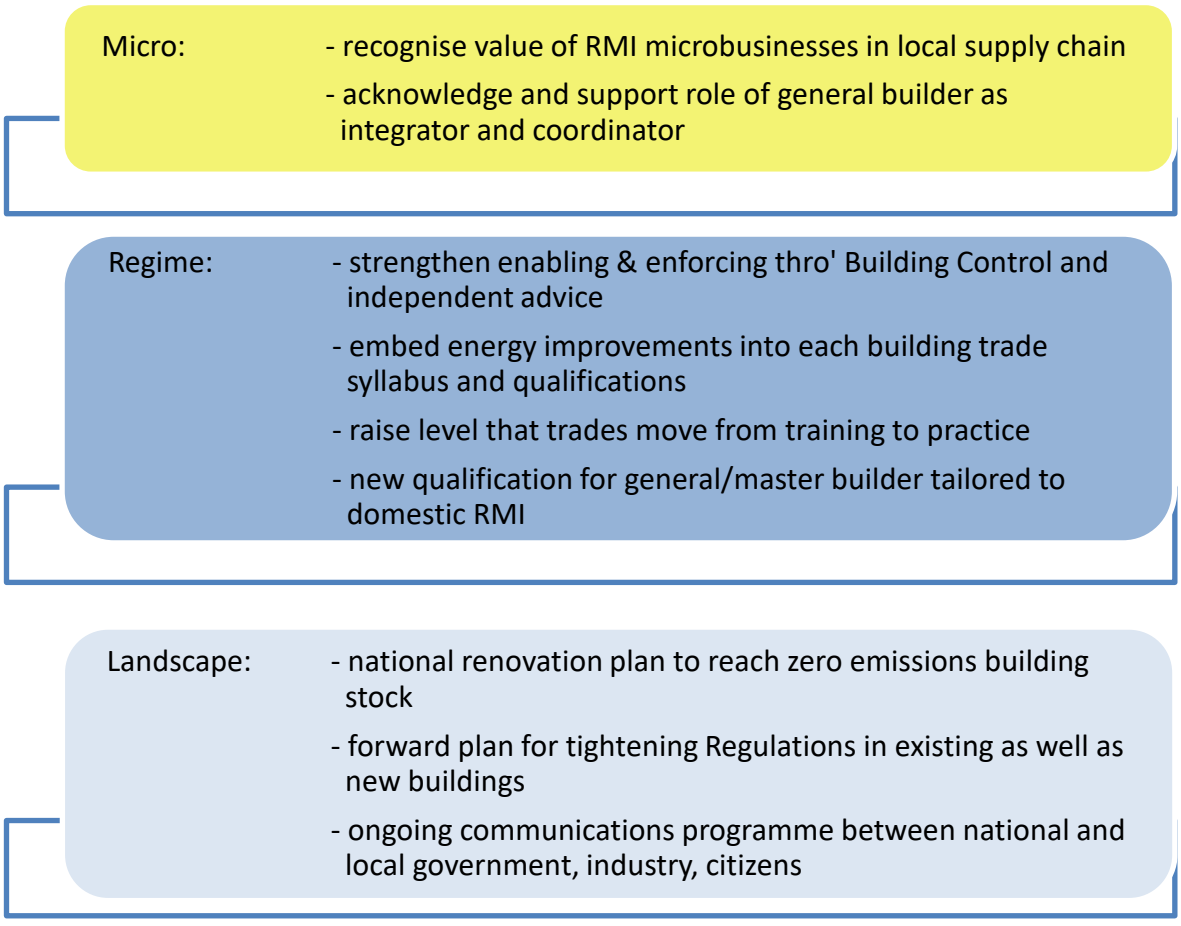
- A strengthening of the key enabling and enforcing roles at local level – in particular through Building Control, and provision of commercially independent advice (through local government or non-profit one-stop-shop).

This needs to be supported at ***landscape level*** by providing:

- A forward plan of increasing building regulations on energy performance in existing and new buildings, to tie in with a national renovation roadmap as required under the revised EPBD, leading to a zero emissions building stock;
- A communications programme between the levels of national government, local government (as enforcers and enablers of the 'regime', as well as accessible to citizens and local businesses), the industry and the population / home-owners – that explains and maintains awareness of both the reasons behind, the direction of travel and the practical application of these initiatives.

Within this framework, the recommendations for change are set out in Figure 14.

Figure 14: Recommendations for change: home energy improvements in RMI



8.1.5 Conclusions to the main aim of the research

The main aim of the research was to investigate the barriers and potential solutions to enabling delivery of energy improvements within mainstream home repair, maintenance, and improvement (RMI) practice. A number of barriers were identified: the role of the general builder has key potential for delivery, but is not adequately supported to deliver energy improvements, either through formal education and training, effective application of Building Regulations or other measures to drive demand, national policy or government communications and messaging. The research concludes that there are solutions to these barriers, and that they occur at different levels (micro, regime and landscape) within the wider socio-technical framework, an emerging understanding of which has resulted from this research. In order to address these barriers effectively, a consistent long-term approach across these levels will be required.

8.2 Research limitations

The conclusions arrived at in this research are subject to a number of limitations in terms of data collection. The most significant of these is that the sample is relatively small, compared to the number and range of businesses and individuals that are likely to be active within the RMI industry in the UK. The results are essentially qualitative in nature and not quantitatively proven. This is consistent with the grounded theory approach, in which sampling is aimed towards theory construction, rather than population representativeness (Charmaz, 2006).

A second limitation is that although efforts were made to engage primarily with mainstream building tradespeople (and other key actors), rather than those specialising in ‘green’ technologies and renovations, a bias may still exist in relation to those who agreed to participate - as the research was introduced to participants as being about improving the energy performance of existing homes. This may also have encouraged participants to show more enthusiasm towards actions that promote energy improvements.

Thirdly, access to building tradespeople active at very local level meant that the geographical scope of research participants was relatively limited, and has a rural and market town bias, reflecting the area in which the researcher is based. This latter issue was partially ameliorated by a scattering of interviews more widely, and the two group discussions (hosted by national organistaions, in London and Sheffield) but

without the range that an intensive localised research initiative in other areas might have delivered.

8.3 Recommendations for further research

There are a number of areas that would benefit from further research, building upon this work. Some aspects that stand out as requiring more detailed consideration are discussed below.

To address the limitations indicated above, a comparable research project might be carried out in a very different area (or areas), such as a large city. The conclusions around the shape and structure of the building trades businesses and the way in which they operate through informal networks might also be reviewed against a larger sample, for quantitative results, and compared with the way in which the RMI industry has developed in other countries. This way of working appears to have developed in response to economic circumstances, but has obvious advantages in terms of flexibility and low risk. A question to explore is whether this type of business shaping is advantageous as a long term solution, and what the alternatives might be.

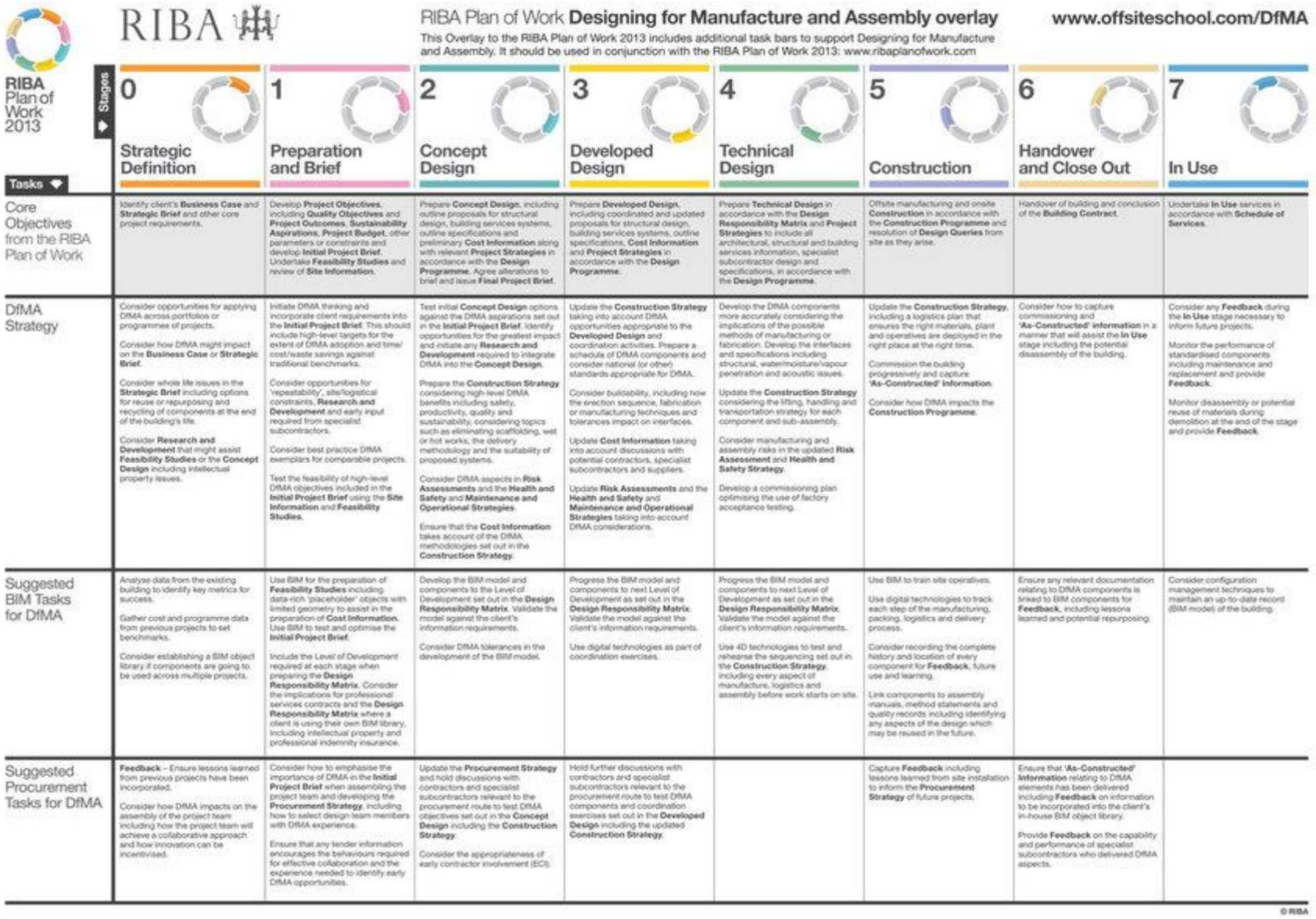
A related issue to explore further in terms of business shaping is the wider potential for a ‘one-stop-shop’ approach, incorporating (for example) advisory and energy assessment services into the business model, and at what scale this might work best within the UK. As regards advice, it would be beneficial to research the practical application and effectiveness of the ‘Building Renovation Passport’ approach as has been piloted in different countries, and how it might be applied in the UK.

While this research aimed to fill a gap in knowledge in terms of the perspective of the building trades, this highlighted a lack of clarity in terms of the role of architects in domestic renovation work, which might be further explored.

This research has highlighted the significance of the role of the general builder as it has evolved in practice in the UK, and the need to acknowledge that this role exists in practice and to support it to take advantage of the practical opportunities provided by the RMI market to deliver home energy improvements – both at a far higher rate and to a good quality. Some of the key components of this support have been identified: an effective driver through Regulations, with a clear forward plan to tighten these over time; development of a clear educational pathway to provide the skills and knowledge for the low-carbon renovation-ready RMI general builder; effective long term housing stock renovation plans backed up communications between Government, industry

and citizens. The detail of these different aspects needs further research and development - in particular:

- An international review of examples of the use of Building Regulations to generate low carbon renovation, and the development of a method for systematic progressive increase over time as a path to a zero carbon emissions (and even an energy positive) housing stock for the future;
- A skills analysis of the requirements for a 21st century low-carbon-ready Master Builder for the domestic RMI market – and the development of the appropriate syllabus and qualifications framework to support it;
- An international review of general builder qualifications, CPD and licensing frameworks, and assessment of the most appropriate approach for the UK.
- A review of communications between the different levels of activity (micro, regime and landscape) in regard to making energy improvements to existing housing, such as how changes in policy or Building Regulations are communicated to the building trades engaged in RMI work, and how such key actors in the shift to a lower carbon housing stock might be better enabled to provide feedback from their practical experience of delivery to the regime and landscape levels.



RIBA

RIBA Plan of Work **Designing for Manufacture and Assembly overlay**

www.offsiteschool.com/DfMA

This Overlay to the RIBA Plan of Work 2013 includes additional task bars to support Designing for Manufacture and Assembly. It should be used in conjunction with the RIBA Plan of Work 2013: www.ribaplanofwork.com

RIBA Plan of Work 2013

Stages

Tasks

Tasks	0 Strategic Definition	1 Preparation and Brief	2 Concept Design	3 Developed Design	4 Technical Design	5 Construction	6 Handover and Close Out	7 In Use
Core Objectives from the RIBA Plan of Work	Identify client's **Business Case** and **Strategic Brief** and other core project requirements.	Develop **Project Objectives**, including **Quality Objectives** and **Project Outcomes**, **Sustainability Aspirations**, **Project Budget**, other parameters or constraints and develop **Initial Project Brief**. Undertake **Feasibility Studies** and review of **Site Information**.	Prepare **Concept Design**, including outline proposals for structural design, building services systems, outline specifications and preliminary **Cost Information** along with relevant **Project Strategies** in accordance with the **Design Programme**. Agree alterations to brief and issue **Final Project Brief**.	Prepare **Developed Design**, including coordinated and updated proposals for structural design, building services systems, outline specifications, **Cost Information** and **Project Strategies** in accordance with the **Design Programme**.	Prepare **Technical Design** in accordance with the **Design Responsibility Matrix** and **Project Strategies** to include all architectural, structural and building services information, specialist subcontractor design and specifications, in accordance with the **Design Programme**.	Offsite manufacturing and onsite **Construction** in accordance with the **Construction Programme** and resolution of **Design Queries** from site as they arise.	Handover of building and conclusion of the **Building Contract**.	Undertake **In Use** services in accordance with **Schedule of Services**.
DfMA Strategy	Consider opportunities for applying DfMA across portfolios or programmes of projects. Consider how DfMA might impact on the **Business Case** or **Strategic Brief**. Consider whole life issues in the **Strategic Brief** including options for reuse or repurposing and recycling of components at the end of the building's life. Consider **Research and Development** that might assist **Feasibility Studies** or the **Concept Design** including intellectual property issues.	Initiate DfMA thinking and incorporate client requirements into the **Initial Project Brief**. This should include high-level targets for the extent of DfMA adoption and time/cost/waste savings against traditional benchmarks. Consider opportunities for 'repeatability', site/logistical constraints, **Research and Development** and early input required from specialist subcontractors. Consider best practice DfMA exemplars for comparable projects. Test the feasibility of high-level DfMA objectives included in the **Initial Project Brief** using the **Site Information** and **Feasibility Studies**.	Test initial **Concept Design** options against the DfMA aspirations set out in the **Initial Project Brief**. Identify opportunities for the greatest impact and initiate any **Research and Development** required to integrate DfMA into the **Concept Design**. Prepare the **Construction Strategy** considering high-level DfMA benefits including safety, productivity, quality and sustainability, considering topics such as eliminating scaffolding, wet or hot works, the delivery methodology and the suitability of proposed systems. Consider DfMA aspects in **Risk Assessments** and the **Health and Safety** and **Maintenance and Operational Strategies**. Ensure that the **Cost Information** takes account of the DfMA methodologies set out in the **Construction Strategy**.	Update the **Construction Strategy** taking into account DfMA opportunities appropriate to the **Developed Design** and coordination activities. Prepare a schedule of DfMA components and consider national (or other) standards appropriate for DfMA. Consider buildability, including how the erection sequence, fabrication or manufacturing techniques and tolerances impact on interfaces. Update **Cost Information** taking into account discussions with potential contractors, specialist subcontractors and suppliers. Update **Risk Assessments** and the **Health and Safety** and **Maintenance and Operational Strategies** taking into account DfMA considerations.	Develop the DfMA components more accurately considering the implications of the possible methods of manufacturing or fabrication. Develop the interfaces and specifications including structural, water/moisture/vapour penetration and acoustic issues. Update the **Construction Strategy** considering the lifting, handling and transportation strategy for each component and sub-assembly. Consider manufacturing and assembly risks in the updated **Risk Assessment** and **Health and Safety Strategy**. Develop a commissioning plan optimising the use of factory acceptance testing.	Update the **Construction Strategy**, including a logistics plan that ensures the right materials, plant and operatives are deployed in the right place at the right time. Commission the building progressively and capture **'As-Constructed' Information**. Consider how DfMA impacts the **Construction Programme**.	Consider how to capture commissioning and **'As-Constructed' Information** in a manner that will assist the **In Use** stage including the potential disassembly of the building.	Consider any **Feedback** during the **In Use** stage necessary to inform future projects. Monitor the performance of standardised components including maintenance and replacement and provide **Feedback**. Monitor disassembly or potential reuse of materials during demolition at the end of the stage and provide **Feedback**.
Suggested BIM Tasks for DfMA	Analyse data from the existing building to identify key metrics for success. Gather cost and programme data from previous projects to set benchmarks. Consider establishing a BIM object library if components are going to be used across multiple projects.	Use BIM for the preparation of **Feasibility Studies** including data-rich 'placeholder' objects with limited geometry to assist in the preparation of **Cost Information**. Use BIM to test and optimise the **Initial Project Brief**. Include the Level of Development required at each stage when preparing the **Design Responsibility Matrix**. Consider the implications for professional services contracts and the **Design Responsibility Matrix** where a client is using their own BIM library. Including intellectual property and professional indemnity insurance.	Develop the BIM model and components to the Level of Development set out in the **Design Responsibility Matrix**. Validate the model against the client's information requirements. Consider DfMA tolerances in the development of the BIM model.	Progress the BIM model and components to next Level of Development as set out in the **Design Responsibility Matrix**. Validate the model against the client's information requirements. Use digital technologies as part of coordination exercises.	Progress the BIM model and components to next Level of Development as set out in the **Design Responsibility Matrix**. Validate the model against the client's information requirements. Use 4D technologies to test and rehearse the sequencing set out in the **Construction Strategy** including every aspect of manufacture, logistics and assembly before work starts on site.	Use BIM to train site operatives. Use digital technologies to track each step of the manufacturing, packing, logistics and delivery process. Consider recording the complete history and location of every component for **Feedback**, future use and learning. Link components to assembly manuals, method statements and quality records including identifying any aspects of the design which may be reused in the future.	Ensure any relevant documentation relating to DfMA components is linked to BIM components for **Feedback**, including lessons learned and potential repurposing.	Consider configuration management techniques to maintain an up-to-date record (BIM model) of the building.
Suggested Procurement Tasks for DfMA	**Feedback** – Ensure lessons learned from previous projects have been incorporated. Consider how DfMA impacts on the assembly of the project team including how the project team will achieve a collaborative approach and how innovation can be incentivised.	Consider how to emphasise the importance of DfMA in the **Initial Project Brief** when assembling the project team and developing the **Procurement Strategy**, including how to select design team members with DfMA experience. Ensure that any tender information encourages the behaviours required for effective collaboration and the experience needed to identify early DfMA opportunities.	Update the **Procurement Strategy** and hold discussions with contractors and specialist subcontractors relevant to the procurement route to test DfMA objectives set out in the **Concept Design** including the **Construction Strategy**. Consider the appropriateness of early contractor involvement (ECI).	Hold further discussions with contractors and specialist subcontractors relevant to the procurement route to test DfMA components and coordination exercises set out in the **Developed Design** including the updated **Construction Strategy**.		Capture **Feedback** including lessons learned from site installation to inform the **Procurement Strategy** of future projects.	Ensure that **'As-Constructed' Information** relating to DfMA elements has been delivered including **Feedback** on information to be incorporated into the client's in-house BIM object library. Provide **Feedback** on the capability and performance of specialist subcontractors who delivered DfMA aspects.	

Appendix 2: Round Table report

CAN Mezzanine
49-51 East Road
London, N1 6AH

Association for the Conservation of Energy

More and Better: Integrating high quality energy retrofit into home refurbishment

Summary

This is a report on an ACE round table, which brought together experts from a range of energy efficiency and building trade backgrounds, to discuss how more, and better, energy retrofit can be integrated into home refurbishment work.

This is an important topic because of the size of the market for repairs, maintenance and improvement (RMI) and the potential for building tradespeople and their clients to influence one another and hence drive increased uptake of energy efficiency improvements.

The building sector is complex and fragmented, and refurbishment projects may involve many different contractors. This presents challenges for the integration of activities that are not – as yet – routinely demanded by clients or proposed by contractors.

Such integration will require action on both the demand and supply sides. On the supply side:

- There is a need for more, and better, training for building tradespeople at all levels. The market at present is short of labour and short of skills. This training need is not only linked to energy efficiency measures, but the broader need to increase the professionalism of, and respect for, people in building trades offers an opportunity to also increase awareness and understanding of the energy performance of buildings.
- Regulation drives supply side awareness and understanding, as well as stimulating demand.
- We need to think about new business models for integrating energy efficiency measures into a range of modernisation / upgrade projects. Kitchens and bathrooms are a good place to start as both are significant sub-markets within RMI.
- There are examples of successful business model innovations in the UK and elsewhere that could potentially be scaled up.

On the demand side:

- How do we persuade clients to demand comfort as an outcome of a refurbishment project?
- Householders require effective advice, useful assessments of energy performance and quality assurance that they can trust.

- Regulation has driven increased energy performance very effectively and is seen by many as the clearest and most effective way to drive demand.
- There was a lack of consensus at the table over the best ways to market energy efficiency measures, but agreement that we need to understand better which consumers will respond to improved energy performance as an idea, and which should be sold measures alongside other, more interesting improvements.
- Incentives may be particularly helpful in providing the 'what's in it for me' for homeowners when modernising and upgrading, as this may be a particularly difficult time to make basic energy efficiency measures interesting.

We urgently need pilots, at an appropriate scale, of new business models to encourage increased integration of energy efficiency improvement into refurbishment work. We need seed funding capital for such pilots, together with a willingness to take risks, be open about mistakes and learn from them.

Participants

Donal Brown	Sustainable Design Collective / Centre for Innovation and Energy Demand
Jenny Coles	Centre for Sustainable Energy
Sarah Fletcher	Greater London Authority
Colin Gleeson	University of Westminster
Rod Janssen	Energy in Demand
Gavin Killip	Environmental Change Institute, University of Oxford
Catrin Maby	
Mari Martiskainen	Centre for Innovation and Energy Demand, University of Sussex
Barry Mortimer	Federation of Master Builders
Argyris Oraiopoulos	ACE
Alex Rathmell	EnergieSprongUK
Fiona Riddoch	
Dave Robson	InstaGroup
James Sharples	Dept for Business, Energy and Industrial Strategy
Natasha Sogol	Dept for Business, Energy and Industrial Strategy
Louise Sunderland	
Robert Tiffin	Tiffin Group
Joanne Wade	ACE

Introduction

An ACE round table, held in November 2017, brought together experts from a range of energy efficiency and building trade backgrounds, to discuss how more, and better, energy retrofit can be integrated into home refurbishment work.

This report is intended to contribute to policy development following the publication of the government's Clean Growth Strategy and to respond to the government's Call for Evidence on Building a Market for Energy Efficiency.

Our thanks go to the energy efficiency and building professionals who attended the workshop, for contributing their time and knowledge to the conversation. Particular thanks to Catrin Maby and Gavin Killip, for their presentations at the round table. The key points summarised here represent the views expressed by individuals at the meeting; they do not necessarily represent a consensus view. However, where there was a large majority support for a view, or significant disagreement, we have tried to indicate this in the text.

Presentation: retrofit from the perspective of the RMI building trades

Catrin Maby presented her latest thinking on how to mainstream energy efficiency improvements, drawing on her ongoing PhD research at Cardiff University. The presentation slides are provided in Appendix A.

Key points included:

- The size of the opportunity offered by the repairs market, a market of around £18 billion per year in the private owner-occupied sector alone
- The complexity of the sector; the number of trades involved in any one refurbishment project and the dynamics between them; the number of different ways the public categorise the profession; and the number of different ways in which general builders advertise themselves
- There are examples of interested builders encouraging more energy efficiency investment; from their recommendations and on-site observations, greater investment is encouraged
- Personal referrals are important in this sector – they save time, bring credibility and increase trust
- There are a number of quality control issues that must be tackled, including the value of various accreditations and concerns about private sector Building Control inspections
- We need to think about how we define the qualifications / experience needed for a high quality
  'general builder' and how we communicate that to householders
- There is a jigsaw of changes that could make the system work better from an energy efficiency perspective. These are summarised in the final slide of the presentation and include: ○ A number of enhancements to the building regulations ○ Effective advice, assessments and quality assurance for the homeowner ○ Improved training

and increased professional status for general builders ○ Increased training and support from product manufacturers ○ A government programme designed to engage local building trades

Discussion

The discussion immediately following Catrin's presentation raised the following points:

The research is in-depth but relatively small-scale and potentially could have a rural / South West England bias. However, attendees working in other, more urban, parts of the country commented that the findings were similar to their own experiences, especially regarding complexity and variety of interfaces between the consumer and tradespeople.

Significant barriers to progress remain the lack of building physics understanding on the part of the tradespeople and lack of knowledge plus focus on lowest price on the part of the consumer. Government policy needs to address the whole system – supply of and demand for energy efficiency measures. There was some support around the table for the idea that well enforced regulations are the clearest and most effective way to overcome these problems.

Examples from other countries that we could learn from include:

- Scandinavian one-stop shops where one person guides the homeowner all the way through the renovation process
- German experience that government financial support increases the quality of renovations rather than increasing the rate of renovation

Round table discussion: trigger points and how to realise them

This session explored the moments in the life of a building[25] that offer opportunities for energy efficiency and the types of solution that might capture these opportunities. Elements of the discussion cut across all stages of the life of a building, whilst others were specific to particular opportunities.

Cross-cutting issues

The central need for better training of, and more respect for, building tradespeople was a recurring theme of the discussion, raised by many participants. There are key skills shortages, including a lack of real deep technical understanding amongst site managers in the private sector and, in the absence of government labs, it is difficult to know where to go for this level of expertise. There are also clear labour shortages in the sector (for example, not enough bricklayers to meet the government's housebuilding targets) and few people aspire to become builders – people do not know exactly what it means to be a builder.

Our current levels of training and qualification are considered very poor in comparison to countries such as Australia or Germany and apprenticeships / skills development schemes do

[25] Maintenance, modernising and upgrading, major refurbishment, complete home renovation, and distress purchases

not seem to lead anywhere. Large companies dominate the definition of competencies required, and individual workers in the sector do not seem to have a voice here. There needs to be greater government and public support for vocational training in general.

There was an interesting discussion around the role of marketing and ways to market the basic energy efficiency measures[26]. Whilst there was agreement that marketing of energy efficiency at the moment is drab, there was disagreement over whether or not it could be made any more interesting to consumers.

People involved in deeper, whole house refurbishments tended to feel that it could, with a 'make your neighbours jealous' factor coming into play, whereas those more involved in installing single, more traditional measures, tended to feel that these measures are inherently boring to consumers and hence need to be promoted alongside other things that are more interesting. There were calls for more government work on segmentation and identification of consumers who were most likely to respond to marketing of energy efficiency measures.

The issue of step by step refurbishment versus deep whole house retrofit did come up. There were differing opinions on the question of whether linking energy efficiency improvement to repairs and maintenance was the best way to reach long-term targets. However, the point was made that even a 'perfect' deep refurbishment will not be a 'one-off' that is good enough for the remaining life of the building.

The need to think also about demographic and lifestyle changes, and the link to changes in the building, was raised. We noted that the next iteration of the Energy Saving Advice Service will be looking at life events trigger points.

For action at most of the life-stages of the building, we noted the need for / value of minimum energy efficiency standards (whether for individual products or for the building as a whole) in driving the market on both the demand and supply sides.

Maintenance

The main point discussed here was whether marketing nudges are enough to drive change or whether regulation is appropriate in some cases. Marketing messages need to be continuous and reinforcing[27], as well as cleverly designed to appeal to different market segments. No conclusions were reached.

Modernising and upgrading

This trigger point was suggested as a good place to start increasing energy efficiency action, particularly in the social housing sector. However, the potential tension between

[26] Work by the Centre for Sustainable Energy on encouraging early adopters may be of interest. More details of this can be found here: https://www.cse.org.uk/downloads/file/do-the-next-million-first-transforming-the-owner-occupier-retrofit-market.pdf

[27] Smoke alarms were given as an example here, where numbers increased in response to information campaigns, but then tailed off when the marketing was stopped

incremental changes during this type of work and reaching whole house renovation by 2050 was raised as an issue.

Kitchen and bathroom upgrades are a good place to start looking to provide more information and advice on energy efficiency because both are significant sub-markets within RMI; we need to talk to the relevant trades to understand how energy efficiency can be integrated here. In business model terms, we need to think about how energy efficiency measures could be integrated into a range of upgrade / modernisation projects.

Also on the topic of information and advice, the idea of renovation passports was raised here. This has potential, but it has to be high quality and it has to be something that homeowners read and use; there need to be levers to encourage people to keep records of retrofit and repair works.

It may be most difficult to make basic energy efficiency measures interesting at this trigger point, so the 'what's in it for me' for homeowners may need to be via incentives.

One specific training point made here was that the relevant NVQs for heating and plumbing need to include the selection and installation of smart heating controls.

Major home refurbishment / complete home renovation

Change of ownership is a key trigger point here, and existing building regulations may drive future market pull. But it was noted that, even in new homes, the regulations and quality are not good enough.

New business models here are most likely to emerge around offers to early adopters, and the messages used need to be around health, comfort and a nice living environment.

Distress purchases

This trigger point offers an interesting finance example which we may be able to learn from: all local plumbers have access to finance offers for replacement boilers.

Presentation: innovative business models from the UK and France

Gavin Killip presented some thoughts on the sorts of innovation in business models that could increase delivery of improved energy performance as part of renovation work. The presentation slides are provided in Appendix B.

Key points made by Gavin included:

- The construction sector is of the right size to deliver what we need (around £125 billion per year, of which about £24bn for housing RMI) but not at the moment of the right quality
- The individuals in the supply chain have no stake in the long-term success of their projects, and no commitment to it (Egan review, 2002)
- Should we transform the existing industry, or should we replace it with something better?

- UK case study demonstrates that a team ethic and a bonus scheme designed to foster shared responsibility, together with on-the-job problem solving and an on-site management team can lead to improved quality and happy clients who are advocates for the work with their neighbours
- France case study demonstrates how a co-operative structure, with technical support services and energy performance contracting, can deliver results. In this case, 0% loans were used as a marketing tool; loan administration was carried out by the co-operative.
- We need to try some of these business models at an appropriate scale, make mistakes and learn from them. Piloting the approaches with seed funding capital of around £10million could be an interesting approach.
- Getting to our 2050 targets requires a series of steps, not one giant leap, and we will need to learn and improve as we progress through these steps. We need to enable honest reporting of failures and learning from them.

Discussion

Another case study we can learn from is that of EnergieSprong (in the Netherlands for longer-term experience, but also in the UK). We should also look to learn from other sectors. By learning, the riskinduced element of interest on capital finance can be reduced.

The site manager role is crucial, as is promoting team work as an expected behaviour.

Group discussions: integrating energy throughout the RMI process

This session discussed the phases of an RMI project, who is involved in each, and what might encourage and enable influencers to propose energy efficiency work.

Phase 1: initial enquiries / developing the brief / design, specification and quotations

The client has to be the driver at this stage. Do we understand well enough what they are looking for, what influences their decisions, and who is speaking to them when they are making these decisions? There is a barrier of cultural issues (e.g. preferring older homes) and we need to think about how we can get clients to demand a level of comfort as an outcome from the project.

Thinking specifically about landlords as clients, an energy performance improvement can be in their business interests, but they don't know anything about it. Affordable comfort could be a selling point for them. Buy-to-let mortgages could offer a route to engaging landlords and channelling relatively low cost finance towards energy efficiency investment. However, strong enforcement of the minimum efficiency standards, together with a clear future trajectory, may be the strongest lever we have here.

Architects may be involved here. They tend to have their own agenda, which is not necessarily either a good or a bad thing. Minimum standards are a driver. There are now energy performance elements in initial training for architects, so new architects are more

capable in this area than less recently qualified practitioners. We need to think about how to encourage architects to think beyond the defined project to 'consequential improvements'.

Planners, through planning policy and guidance, can have an influence here. There are examples of guidance (for example, from Uttlesford District Council during the late 90s / early 2000s) that encourage energy efficiency improvement in older, traditional buildings. There are also examples of local planning policies requiring standards that are higher than those demanded within the building regulations, although this is no longer an option for local councils. Planners are also constrained by resource issues.

Phase 2: technical issues / building control / planning permission / modifications to design

The key influencers at this stage identified during the discussions were mortgage lenders and surveyors.

Mortgage lending is one route to harnessing the long-term cash flow of energy efficiency work. It is important to link the level of energy efficiency to mortgage affordability (as the LENDERS project has done), to overcome the use of assumptions about energy costs. But we should be careful to avoid 'golden rule' style issues. Perhaps a league table of mortgage lenders' portfolio average energy efficiency would be a driver here. It is also interesting to consider how retail mortgage lenders will respond to pressure from institutional investors (e.g. Barclays green bond) and whether this response will happen quickly enough. The power of regulations (in this case minimum efficiency standards at point of sale) would be a strong driver for mortgage lender action.

Skills improvements was seen as an important driver for change amongst quantity surveyors, as was getting energy efficiency properly into the book of things that quantity surveyors have to check when valuing a property.

Phase 3: onsite building work

The range of people in contact with the homeowner at this stage is large, and all should be involved in conversations about energy efficiency: all trades, product manufacturers, merchants, building control, planners, neighbours, friends and family.

A number of options were proposed, to support effective communication between these influencers and the householder. These included some elements of training: structured CPD was mentioned, as was the need for tradespeople to know not only about the available options but also how to sell them. Selling more efficient options within the specifications of the project is easier than introducing entire technologies that are not already included. A visual approach to selling new options (e.g. use of thermal cameras) can be effective.

The concepts within 'lean construction' were mentioned: how can these be applied at the small end of the market?

Access to information on-site is also important. Options proposed here included a ready-reckoner for existing buildings, based on a small number of archetypes; and also the need for information to be visual.

Trust in tradespeople is a necessary precondition. The householder must have confidence in the people they are employing, and in taking their advice. This links to a more general point about persuading homeowners that the cheapest price is not necessarily the best option for them.

Phase 4: handover

There needs to be support available for the homeowner after their use of a new system over the first heating season post-installation. Homeowners' fundamental understanding of how to use heating systems needs to improve.

Post-script

Since the workshop, a sector deal between the Government and the construction sector has been announced. This includes commitments to industry modernisation and skills improvement that could address some of the points raised above. More details of the deal can be found here:

https://www.gov.uk/government/news/government-and-industry-cement-deal-to-give-ukconstruction-the-edge

Appendix 3: Credit and Qualifications Framework for Wales

Appendix 4: Quality Assurance in UK building industry

Standards
The BSI (British Standards Institute) define a standard as 'an agreed way of doing something. It could be about making a product, managing a process, delivering a service or supplying materials – standards can cover a huge range of activities undertaken by organizations and used by their customers' (https://www.bsigroup.com/en-GB/standards/Information-about-standards/what-is-a-standard/).

In practice a range of different standards are used within the building and energy efficiency industry, for products or for installation processes. These may be British Standards (BS), European Standards (CEN), or international ones (ISO, the International Organisation for Standardisation).

An important example is the PAS 2030: Improving the energy efficiency of existing buildings (specification for installation process, process management and service provision**),** which was developed to try to bring together the relevant standards, with the Green Deal in mind (British Standards Institution, 2014). A PAS is a Publicly Available Specification, which the BSI website tells us is '*a document that standardizes elements of a product, service or process. PASs are usually commissioned by industry leaders – be they individual companies, SMEs, trade associations or government departments'* (ibid). PAS2030 specifies requirements for the installation of energy efficiency measures (EEM) in an existing building (residential and non-residential, but not new build), and includes '*definitive requirements for the design content to be inspected and validated by installers as well as the methods, processes and procedures to be employed in their installation, commissioning and handover'* (https://shop.bsigroup.com/ProductDetail - accessed 28/5/18). PAS 2030 includes:

- Requirements in respect of installation processes, process management and service provision
- Criteria relating to installation methods, equipment and tools
- Product or system and material suitability
- The commissioning of installed measures
- The training, skills and competence of the people undertaking such installations (ibid)

PAS 2030 is undergoing revision to cover more specifically the installation of energy efficiency measures, and with the addition of a second PAS (2035) to cover the broader scope, taking in energy assessment and advice, design, and coordination (British Standards Institution, 2018). The revised specifications are due to be published during 2019.

Qualifications and accreditations
Qualifications and accreditations relate to the installers or tradespeople who carry out the work. A qualification is an educational term – a formal award to an individual for

achieving a specified standard, tested through various means, typically written tests and/or formally assessed projects or tasks.

An accreditation is broader, in that it is the formal recognition by an authoritative body of the competence to work to specified standards, and may be awarded to an organisation or an individual. It might be based partly on qualifications, but also includes process and management matters – such as the existence of effective quality management systems. The requirements for qualifications may also be adjusted by allowance for the value of proven experience (APEL: Accreditation of Prior Experiential Learning).

Certification

Certification is a formal written notification by a third party of the conformity of a product, process or service to specified requirements (Murthy, 2017), based on provision of specified evidence. An example is the Microgeneration Certification Scheme, (MCS) which certificates installations which have been done by registered and certified installers, using products which meet the relevant standards. The installers have to meet certain requirements in terms of evidence of competence, as well as complying with a consumer code of practice, which covers things such as the integrity of information provided to the consumer. The MCS certificate is the gateway to the Feed in Tariff or Renewable Heat Incentive, but is not otherwise a legal obligation under current Regulations.

Regulations

A regulation (such as Building Regulations) sets a legal obligation to follow certain rules, and typically includes reference to standards, qualifications and accreditations.

Compliance and enforcement

Critical to all of the above is how this is implemented in practice. One aspect is how compliance is achieved and evidenced, and the other is how it is enforced. There are two different approaches to consider: a competence approach, which is based on ensuring the installer complies with the minimum level of qualifications and accreditations, or a performance approach, through which the actual installations are checked. The problem with relying on competence only is that competence does not ensure performance in all cases – time and commercial pressures for example may mean that quality is affected. Checking performance (such as site audits of work) tends of course to be relatively expensive, so a level of compromise may be chosen in practice, such as a percentage of site audits in the early stages of accreditation of a new installer or the instigation of a series of audits only when a complaint is received.

Warranties and guarantees

The use of guarantees and warranties is part of the system of quality assurance, as a fall back when things go wrong. A guarantee is generally a commitment that validates the durability or quality of an item or service, and is usually provided without an additional charge. A warranty is a kind of insurance to cover all or part of the product or works, by providing for repair or replacement.

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