Appraisal of energy efficiency retrofit: government incentives and social housing organizations' perspective.

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APPRAISAL OF ENERGY EFFICIENCY RETROFIT

Government Incentives and Social Housing Organizations' Perspective

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SCOTT SUTHERLAND SCHOOL OF ARCHITECTURE AND BUILT ENVIRONMENT. ROBERT GORDON UNIVERSITY
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APPRAISAL OF ENERGY EFFICIENCY RETROFIT:

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A thesis submitted in partial fulfilment of the requirements of the Robert Gordon University

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CERTIFICATE OF ORIGINALITY

This is to certify that I am solely responsible for the work, which has been submitted within this thesis. Apart from where identified, by means of referencing, I confirm that the thesis has not been submitted to any other institution or body in consideration for any other degree or qualification.

Signed: _____

Date: _____

Suraj Paneru

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ABSTRACT

From the Scottish Social Housing Organizations (SHO) perspective there is a major challenge to be addressed; retrofitting their dwelling stock to meet the energy efficiency objectives of the UK and Scottish governments along with their own priorities such as tenant health and wellbeing and doing so when there are limited resource and a lack of tailored funding mechanisms that help SHO deliver them. The scope of the research is to determine problems and benefit criteria of social housing retrofit and then identify and assess potential solutions. This research looked at the range of social housing retrofit incentives, the different levels of related policies, and archival data regarding the nature of social housing retrofit activity. The research inquired from the key stakeholder social housing organization (SHO) perspective the extent and nature of the problems using interview and questionnaire methods. These methods made use of a sample comprising academics, policymakers, directors, and professionals directly involved in social housing retrofit issues. Regarding analysis, Inductive Thematic Analysis (ITA) was used to analyze the data from the semi-structured interviews, while the questionnaire was designed and analyzed using the Analytical Hierarchy Process (AHP) method.

Finally, based on the current research, the three major problems of the social housing retrofit were determined; i) There is contrast in Government's policy focus and SHO's priority for housing retrofit; ii) The ownership and control of energy efficiency retrofit is located in different places, and iii) There is not sufficient participation of the tenants, communities and potential private construction companies in the design and delivery of the retrofit measures. The research suggested that the way forward would be to address these problems through three approaches. Firstly, by focusing on the SHO priorities through localized retrofit incentives, giving the SHO or the local (not the UK or Scottish national governments) government outright control and ownership of the social housing retrofit. Secondly, by exploring areas of collaboration with innovative private sector construction companies. Thirdly, assuring the participation of tenants and communities at the design, delivery and post-retrofit project stages.

LIST OF RESEARCHER'S PUBLICATIONS

UK government's household energy efficiency incentives and social housing organizations' perspective on energy efficiency retrofit. Authors: Suraj Paneru, Amar Bennadji, David Moore, Robert Gordon University, Aberdeen. Published at https://plea2017.net/ Passive and Low Energy Architecture conference 2017, PLEA 2017 proceedings, volume ii, ISBN: 978-0-9928957-5-4, July 2017

Fuel poverty, UK's dilemma on climate change and Scotland's struggle for housing energy efficiency. Authors: Suraj Paneru, Amar Bennadji, Bruce Taylor, Robert Gordon University, Aberdeen. Published at http://www.plea-arch.org/index.php/plea-proceedings/ Passive and Low Energy Architecture (PLEA) conference 2015, PLEA 2015 proceedings, ISBN: (eBook, Proceedings) 978-88-941163-1-1, September 2015

LIST OF CONFERENCES

25 – 26 June 2015: (Poster and presentation) FUTURE 2015 CONNECTIONS, Sustainability Research in Action, An inter-disciplinary conference for PhD, Post Doc, and early career researchers, University of Edinburgh, Scotland

9 - 11 September 2015: (Paper and presentation) PLEA (Passive and Low Energy Architecture), 2015 - ARCHITECTURE IN (R)EVOLUTION, The 31th International PLEA Conference, Bologna Italy

1-2 March 2016: (Attended) CIH (Chartered Institute of Housing) Scotland Conference 2016 Scotland's Housing Festival 2016, Edinburgh, Scotland

31 May – 1 June 2016: (Poster and presentation) Facing the Future 2016 (Realising Resilience) Conference, University of Aberdeen, Scotland

14 - 15 March 2017: (Attended) CIH Scotland Conference 2017, Scotland's Housing Festival 2017, Glasgow, Scotland

3 - 5 July 2017: (Paper and presentation) PLEA 2017 Edinburgh, PASSIVE AND LOW ENERGY ARCHITECTURE, DESIGN TO THRIVE, the 33rd International PLEA Conference, Edinburgh, Scotland

LIST OF ABBREVIATIONS

AHP	Analytic Hierarchy Process
BRE	Building Research Establishment
CCF	Climate Challenge Fund
CERO	Carbon Emission Reduction Obligation
CERT	Carbon Emissions Reduction Target
CESP	Community Energy Saving Programme
CHP	Combined Heat and Power
CI	Consistency Index
CIH	Chartered Institute of Housing
CPI	Consumer Price Index
CR	Consistency Ratio
CRC	Carbon Reduction Commitment
CSIC	Construction Scotland Innovation Centre
DBEIS	Department for Business, Energy and Industrial Strategies
DCLG	Department for Communities and Local Government
DECC	Department for Energy and Climate Change
DHW	Domestic Hot Water
E=0	Net Zero Energy
EAS	Energy Action Scotland
ECO	Energy Company Obligation
EESSH	Energy Efficiency Standard for Social Housing
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate

EPC	Energy Performance Contract
ERGF	European Regional Growth Fund
ESCO	Energy Services Company
EST	Energy Saving Trust
EU	European Union
EVPA	European Venture Philanthropy Association
FIT	Feed in Tariff
FPEER	Fuel Poverty Energy Efficiency Rating
FRESH	Financing Energy Retrofit for Social Housing
GHG	Greenhouse gases
GOV.SCOT	Scottish Government
GOV.UK	UK government
HA	Housing Association
HEEPS	Home Energy Efficiency Programme for Scotland
HEEPS-ABS	HEEPS Area Based Scheme
HHCRO	Home Heating Cost Reduction Obligation
HVAC	Heating, Ventilation, Air Conditioning
ITA	Inductive Thematic Analysis
LA	Local Authorities
LIHC	Low income high cost
Ofgem	Office of Gas and Electricity Market
ONS	Office for National Statistics
PV	Photovoltaic
RdSAP	Reduced data Standard Assessment Procedure
RHI	Renewable Heat Initiative
RI	Random consistency Ratio

RSL	Registered Social Landlord
SAP	Standard Assessment Procedure
SFHA	Scottish Federation of Housing Association
SHO	Social Housing Organization

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1 INTRODUCTION

1.1 BACKGROUND OF THE RESEARCH

Household energy consumption is one of the major contributors to climate change, therefore there is an increased focus on household energy efficiency. According to the 2017 Department for Business, Energy and Industrial Strategies report (Waters 2017), the domestic sector accounted for 29% of the final energy consumption in the UK in 2016 which is second biggest contribution after transportation sector (40%); an increase of 3.1% from 2015. The residential sector accounted for 14% of total carbon emissions. And, the overall energy consumption has a direct effect on carbon emission because non-renewable sources which have high carbon emissions are still the major sources of energy in the UK. For example, the sources such as oil, coal and gas accounted for 3.1%, 9.4% and 45.3 % respectively for the electricity generation in the UK in last quarter of 2016 (Department for Business, Energy and Industrial Strategies 2017).

There are now 28.07 million dwellings in the UK (social rented 18%, private rented 19%, and owner-occupied 61%) (Department for Communities and Local Government 2017) but only around 160,000 new homes are built each year, and far fewer homes are demolished (Palmer 2013). Since domestic energy use accounts for more than a quarter of total energy consumption, this sector has been taken as a major area to focus on by the UK to cut carbon emissions. Apart from the carbon emission reduction issue, the UK government has also identified the energy efficiency of the property (and therefore, the energy required to heat and power the home) as one of the drivers of fuel poverty. Therefore, both addressing the fuel poverty and reducing carbon

emissions are interconnected and equally important issue of housing energy efficiency retrofit.

In Scotland, the *Climate Change (Scotland) Act (2009)* sets an interim target of a 42% reduction in emissions (compared to 1990) by 2020, and an 80% reduction target for 2050, with annual targets set in secondary legislation. To achieve this goal the Scottish government has established an Energy Efficiency Standard for Social Housing (EESSH) standard which the social landlords are expected to achieve by 2020. According to the Scottish government the EESSH will support the social housing sector in leading the way in the reduction of energy use and greenhouse gas emissions, help address fuel poverty levels in the social housing sector and help in achieving the Scottish Government's commitment to ensure that no-one in Scotland has to live in fuel poverty, as far as practicable, by 2016. This commitment was not achieved on suggested timeframe.

According to Milin and Bullier (2011) the lack of 'adapted' funding is a major barrier to the energy retrofitting of social housing in Europe. Here "adapted funding" means tailored or made especially to be suitable for a social housing retrofit purpose. Cost is playing a central role in the social housing retrofit campaign and numerous variables such as fuel poverty, carbon emission, local economy, time, local community, tenants' health and well-being, tenant participation etc. influence the dynamics of social housing retrofit projects.

The UK government, Scottish government, Scottish local governments, energy companies and Social Housing Organizations (SHO) form the parties who are responsible for delivering the retrofit measures. The European Union also plays a decisive role with respect to policy making in social housing retrofitting. However, there is sometimes a dilemma on their roles in delivering retrofit measures. There is also a dilemma on how to involve social tenant and communities who are the ultimate receiver of benefits of retrofit measure, in the retrofitting projects.

The Electricity and Gas (Energy Company Obligation) Order 2012 (GOV.UK 2012), is the UK government's major funding incentive for the energy efficiency retrofit of buildings. The latest (July 2017) data (Department for Business, Energy and Industrial Strategies 2017), of total Energy Company Obligation (ECO) measures installed up to the end March 2017 shows that only 13.4 % of measures were installed in the social rented sector while the owner-occupied sector received 71.9%, and the private rented sector received 14.7% of measures. The social rented sector comprises 17.64% and private rented sector comprises 19.03% of total dwellings in the UK (GOV.UK 2017). If compared to the number of measures received by both social and private rented sector, it is comparatively less than the private owner-occupied sector which comprises 63.09% of total dwellings.

1.2 Research Hypothesis

The above background leads to the following research hypothesis:

- There are problems in the achievements of energy efficiency retrofit incentives in both social and private rented sector.

Due to the researcher's interest and limitation such as time and resources, the research is focused on the social housing sector only. As mentioned earlier there are problems in social housing retrofit, especially in the funding and delivery mechanism of the measures.

1.3 Research Questions

From the research background, it is clear that there are constraints in the in the social housing retrofit sector. This research seeks to inquire, from the social housing Organization (SHO) perspective, about these problems. The questions that result for this research are: -

1. What are the major policies regarding social housing energy efficiency retrofit incentives?
2. What are the problems of social housing retrofit incentives?
3. How can the social housing sector become the recipient of more energy efficiency incentive measures?
4. What are the questions that need to be answered to maximize energy efficiency retrofits in the social housing sector?

1.4 Research Aims and Objectives

1.4.1 Aim

The research aims to determine the problems and benefit criteria of energy efficiency retrofit in the social housing sector, in Scotland, from the social housing organizations' perspective.

1.4.2 Objectives

- Undertake the analysis of the recent UK, Scottish and European policies and incentives on social housing retrofit
- Explore SHO concerns and their perspective regarding social housing retrofit problems
- Determine retrofit benefit criteria from the SHO perspective
- Validate the determined retrofit problems and benefit criteria through primary research from the SHO perspective and allocate potential answers and suggestion for further research

The first objective of the research is to analyse UK, Scottish and EU policies and incentives on the social housing sector. This helps to study, analyse and define the key energy efficiency incentives in Scotland in general. The research background highlighted that there is a lack of adapted funding for social housing in the UK. Various problems with government regulations and incentives are identified at this stage. Some important lessons from successful EU project are also drawn.

The second and third objectives directly feed to the aim of the research. By interviewing various professional (directly related to social housing retrofit), their perspective, concerns and problems are determined. Then, the problems derived from the interview are reviewed through the questionnaire answered by SHO professionals. Finally, the problems are revised and allocated potential answers to each identified problem.

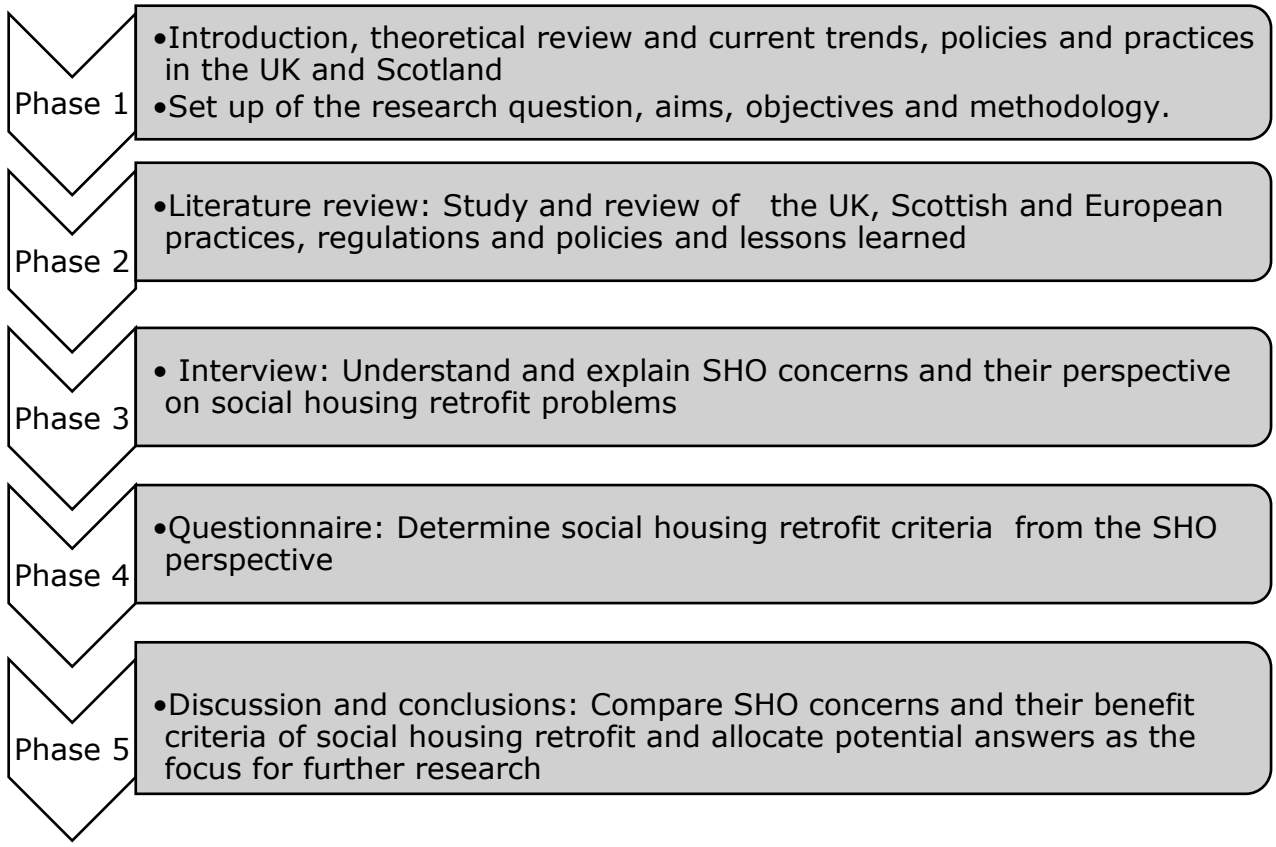


Figure 1: Research phases

Figure 1 shows the different phases of the research. Based on the above research objectives the phases as shown in figure 1 can be identified.

1.5 RESEARCH METHODOLOGY

Kumar (2014) and Yin (1994) have listed different types of research based on their application, objective enquiry mode, strategy, data analysis techniques etc. Figure 3 is derived from both Kumar (2014) and Yin (1994) to form the relevant research methodology for this research.

Application	Applied Research
Objective	Correlational Research and Explanatory Research
Enquiry Mode	Mixed Method Research
Research Strategy	Archival Analysis History and Case Study
Data Sources	Documentation Archival Records and Interviews and questionnaires
Data Analysis	Analytical
Reliability	Stability Representative and Equivalence
Validity	External Validity and Internal Validity

Figure 2: Research Methodology

The detailed research methodology is explained in chapter 3; "Research Methodology". Figure 2 is the summary of the research methodology applied in this research. This research is an applied research from the application point of view. The objectives of the research are mainly focused on discovering relationship and interactions between various concerns of those involved social housing retrofit. In terms of research approach, the research has taken both qualitative and quantitative approach. It has used archival analysis, history and case study, interviews and questionnaires.

1.6 Research Approach (Research Philosophy)

The research involves the reasoning that 'any material or subject matter is made up of the opposite and contradictory sides in unity'. This concept is based on Marx's philosophy of *Dialectics* which is the method of reasoning which aims to understand things concretely in all their movement, change and interconnection, with their opposite and contradictory sides in unity (Engels 1975).

This approach of reasoning leads research to look at the issue of social housing retrofit as a subject matter which is made up of dialectics or the opposite and contradictory sides in unity. The opposite and contradictory sides of social housing retrofit are the constraints of retrofitting social housing stock and benefits of retrofitting social housing stock. To fully understand the issues of social housing one should look at the constraints and benefits of retrofitting social housing stock. Therefore, the constraint and benefits of social housing retrofit are looked in parallel using literature review and archival analysis in Chapter 2, interviews in Chapter 4 and questionnaire in Chapter 5. The constraints and benefits are analysed, and their interconnection is discussed using Inductive Thematic Analysis (ITA) in Chapter 4 and Analytical Hierarchy Process (AHP) method in Chapter 5.

Finally, the constraints and benefits are synthesised in Chapter 6 to create a holistic understanding of current issues of social housing retrofit in Scotland. The research does not try to look at the issues of social housing from a fixed definition based on various attributes, rather it explores social housing retrofit through the interconnection of constraints and benefits.

2 LITERATURE REVIEW

The review of the literature, which mainly discusses different policies in social housing energy efficiency retrofit in Scotland, is focused on the analysis of archival and historical data regarding the social housing retrofit. The review of the literature and archival analysis is used to compare and determine the interconnections between different levels, policies, incentives and other elements of the retrofit.

Sections of this chapter are focused on the definitions, theoretical review, and general introduction of the major elements of social housing energy efficiency retrofit. The archival analysis within these sections provide insights into the interconnections between various policy levels and their influence on social housing retrofit. From the review of the literature and archival analysis, chapter 2 answers the following research question;

- What are the major policy levels regarding social housing energy efficiency retrofit incentives?

By answering this research question the review of literature and analysis of archival data in chapter 2 feeds to the following research objective (1):

- Undertake the analysis of the recent UK, Scottish and European policies and incentives on social housing retrofit

Section 2.9.2 of this chapter summarizes the benefits of social housing energy efficiency retrofit from the review of literature which provides the foundation for chapter 5 (questionnaire). And section 2.10 summarizes the constraints of social housing energy efficiency retrofit from the review of literature which provides foundation chapter 4 (interviews).

The theoretical and conceptual literature was reviewed to answer questions such as; what is social housing? What is the current status of social housing in

Scotland? Why is social housing retrofit required? What does energy efficiency retrofit mean?

2.1 Literature Review Strategy

The Scotland specific articles by Buda, Taylor et al. (2013), Ingram (2014) and Curtis (2010) focused on specific technical issues related to building envelope and had recurring theme of historic conservation. The articles by Elsharkawy, Rutherford (2015), Sdei, Gloriant et al. (2015), focused on social housing sector and applied case study method that represented case studies from outside Scotland. The articles by Thakore, Goulding et al. (2015) and Pawson, Lawson et al. (2011) reviewed social housing energy efficiency from a holistic approach and discussed various barriers and policy developments in different countries regarding social housing retrofit. From the study of over 33 articles with focus on their subject of research, perspective and methods it was concluded that there was gap in the knowledge in energy efficiency retrofit of social housing sector in Scotland.

2.2 Social housing in Scotland

Social housing in Scotland is that housing owned and managed by public authorities and housing associations (registered social landlords or RSLs). Therefore, the Housing Associations (HA), Registered Social Landlords (RSL) and Local Authorities (LA) represent the social housing organization (SHO) as a whole. According to Housing Statistics for Scotland (GOV.SCOT 2015b), "Housing associations/RSLs are societies, bodies of trustees, or companies established for the purpose of providing housing accommodation on a non-profit making basis. They also provide housing for special groups such as the aged, disabled, single persons, or housing on a mutual or self-build basis…. are heavily engaged in the regeneration of inner-city areas through both rehabilitation and new building. Local Authorities housing means Dwellings owned by 26 of the 32 local authorities for social rent, e.g. Council housing".

This definition clarifies that social housing is non-profit housing provided to special groups of people. The definition further clarifies that the social housing organizations (SHO) also engage in regeneration and new building apart from renting/managing the existing housing stock.

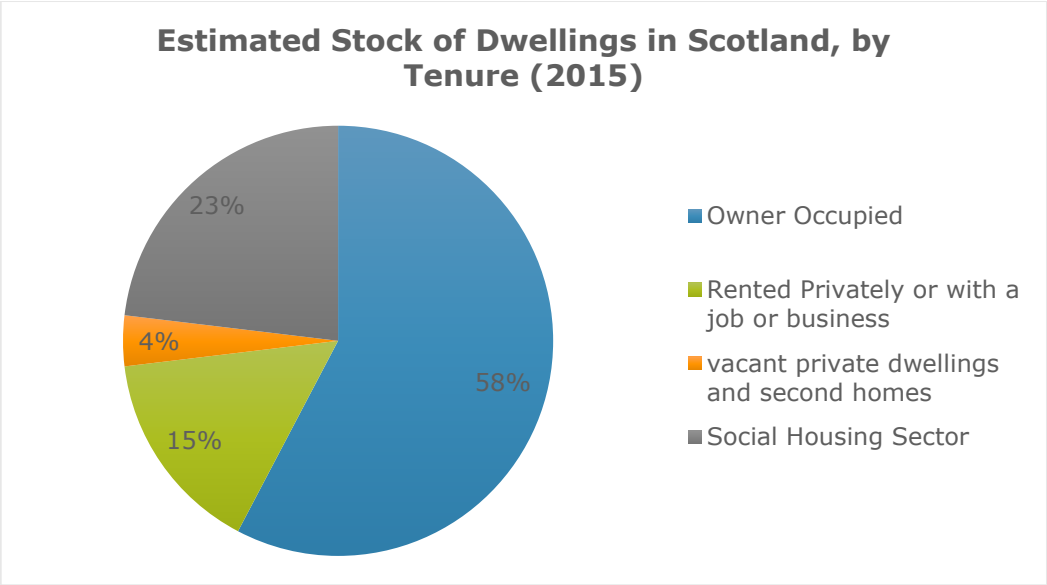


Figure 3: Estimated Stock of Dwellings in Scotland by Tenure (2015), Source: GOV.SCOT, 2017b

There are 2,567,000 dwellings in Scotland, among which 595,000 houses are socially rented/ social housing (GOV.SCOT 2017b). Apart from being significant in terms of number, social housing is particularly important because the tenants are mainly old aged, low income and vulnerable by some means. Due to the tenant type, any retrofit of these houses is both important and challenging. SHO retrofit investments are mainly driven by government incentives and the SHO's duty to provide housing to modern/current standards.

Figure 3 shows the total estimated dwellings in Scotland by tenure according to GOV.SCOT (2017b). 23% of the total dwelling stock in Scotland are social sector dwellings, while there are 15% private rented dwellings and 58% owner-occupied dwellings.

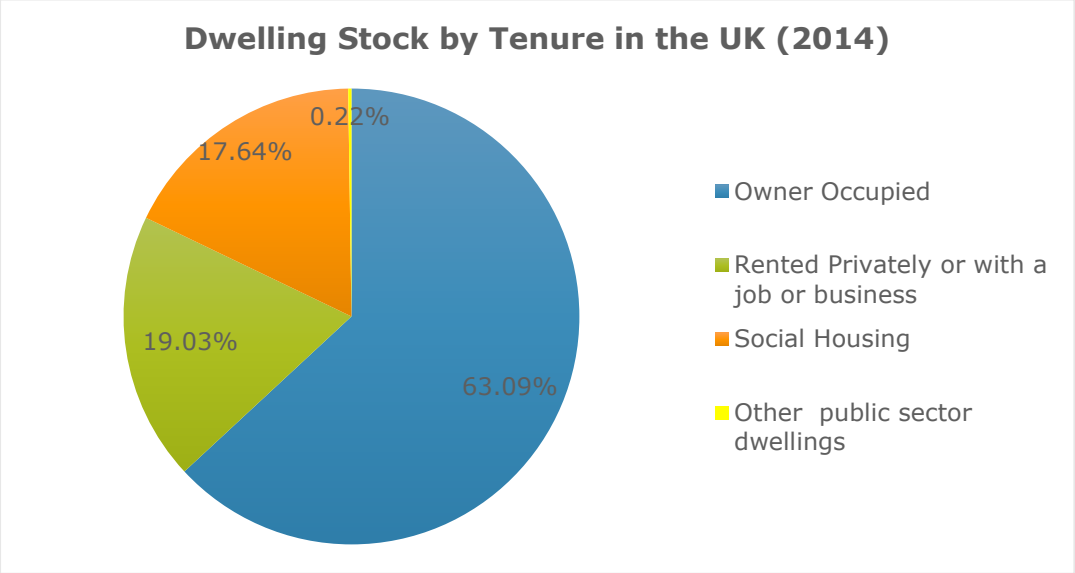


Figure 4: Dwelling Stock by Tenure in the UK (2014), Source: GOV.UK 2017

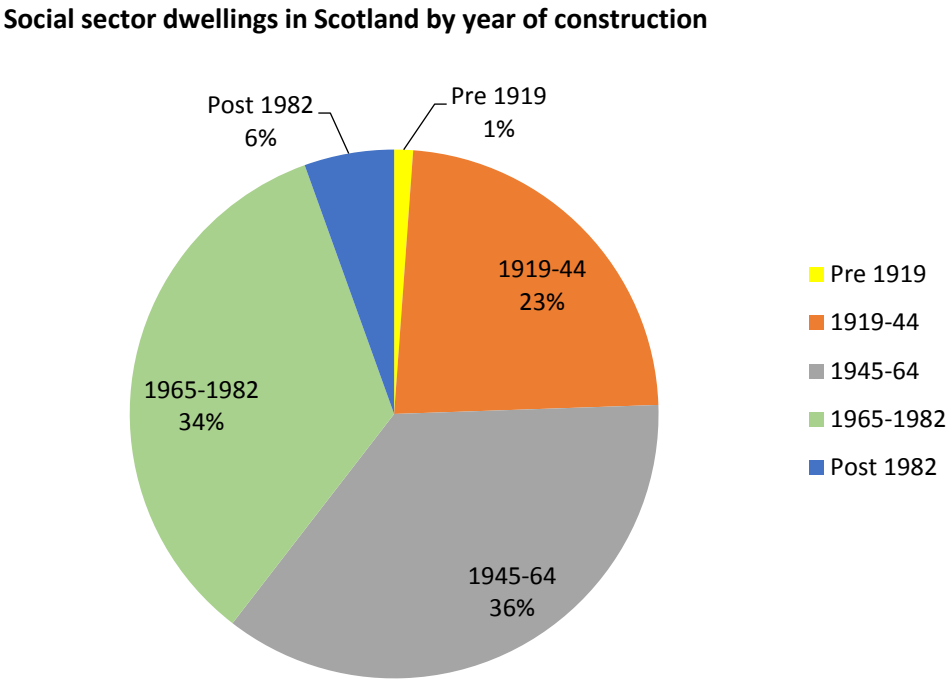


Figure 5: Public Sector dwellings in Scotland by year of construction, Source: GOV.SCOT, 2017a

Figure 4 shows the total dwelling stock in the UK by tenure. From the figure, it can be seen that there are 17.64% social sector dwelling in the total dwelling stock in the UK. This figure suggests that the ratio of social housing sector

dwelling in Scotland is 6% more than overall UK average. Both figures suggest that owner-occupied dwellings are the most common dwelling type in the UK.

From the figure 5, the existing stock of public sector dwellings in Scotland is comprised mostly of dwellings built between 1945-1964, followed by 1965-1982, and 1919-1944 respectively. This shows that the 94% of the public sector dwellings were built before 1982. And 60% of the dwelling in Scotland are more than 53 years old (GOV.SCOT 2017a).

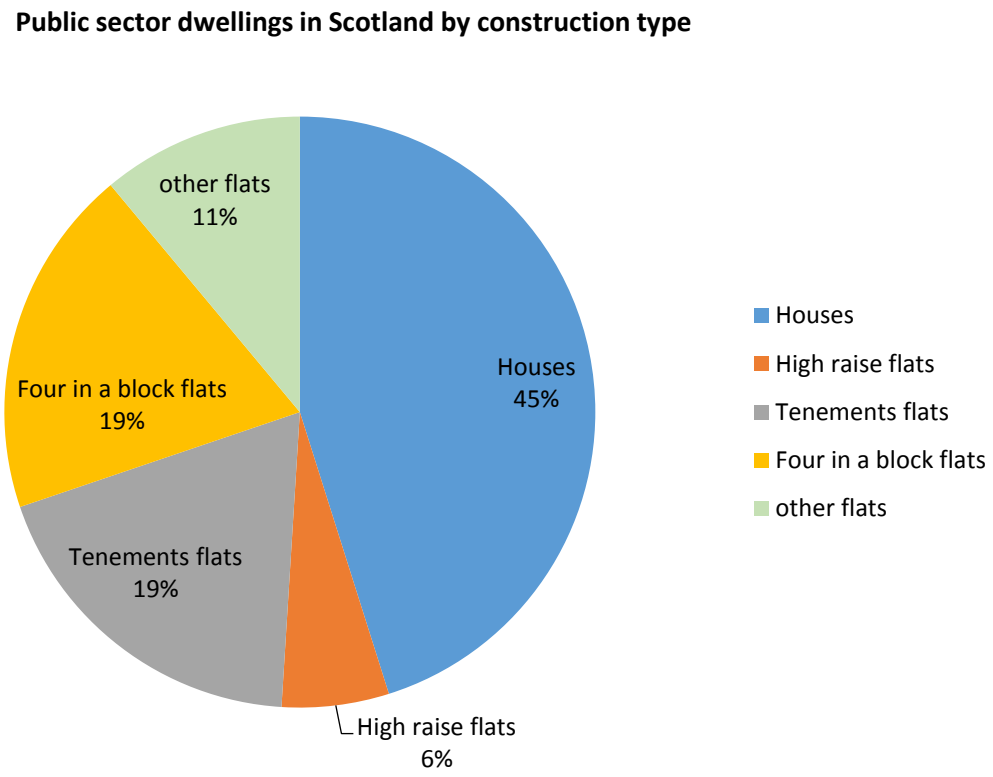


Figure 6: Public sector dwelling in Scotland by construction type, Source: GOV.SCOT, 2017a

From figure 6, it can be concluded that the most common public sector dwellings type in Scotland by construction type are houses (45%) followed by tenement flats (19%) and four-in-a-block flats (19%). High rise flats are the least numbered dwelling types in Scottish social housing sector. The definition of dwelling type according to GOV.SCOT (2017a) is as follows;

- House: A dwelling divided vertically from every other dwelling and with its principal access from ground level. Include detached, semi-detached and terraced houses.
- Flat: A dwelling on one floor, which only occupies a part of the building.
- High rise flat: A flat in a building of 5 storeys or more with a lift.
- Tenement flat: A flat in a building of two or more floors containing two or more flats with a shared access.
- 4 in a block dwelling: A building that contains 4 flats, each with their own access.

Apart from providing housing to the special need population of society, the social housing sector is also involved in retrofitting. The Scottish government has set the Energy Efficiency Standard for Social Housing (EESSH), by which it aims to improve the energy efficiency of social housing, reduce energy consumption, fuel poverty, the emission of greenhouse gases, and make a significant contribution to the targeted reducing carbon emissions by 42 percent by 2020 and 80 percent by 2050. This last action is in line with the objectives set out in the Climate Change (Scotland) Act 2009 (GOV.SCOT 2016).

Figure 7: British Iron and Steel Federation (BISF) house, source: author

Figure 8: BISF house during external wall insulation (EWI), source: author

Figure 9: BISF house after retrofitting EWI, source: author

2.3 Energy Efficiency Retrofit Measures

Green retrofit means "conducting interventions that would make buildings more "sustainable" and "smarter", in terms of indoor environment quality, use of water, maintenance operations, energy uses control" (Filippi 2015). There are many types of energy efficiency retrofit measures in practice, depending on the client's requirements and building type.

Both the Green Deal and Energy Company Obligation (ECO) are the major household energy efficiency retrofit incentives in the UK. The following are the

retrofit measures currently (2017) installed using Green Deal Finance in the UK:

- Window glazing
- Solid wall insulation
- Cavity wall insulation
- Loft insulation
- Lighting replacement
- Boiler replacement
- Other heating
- Other insulation
- Microgeneration (photovoltaics, wind, solar etc.

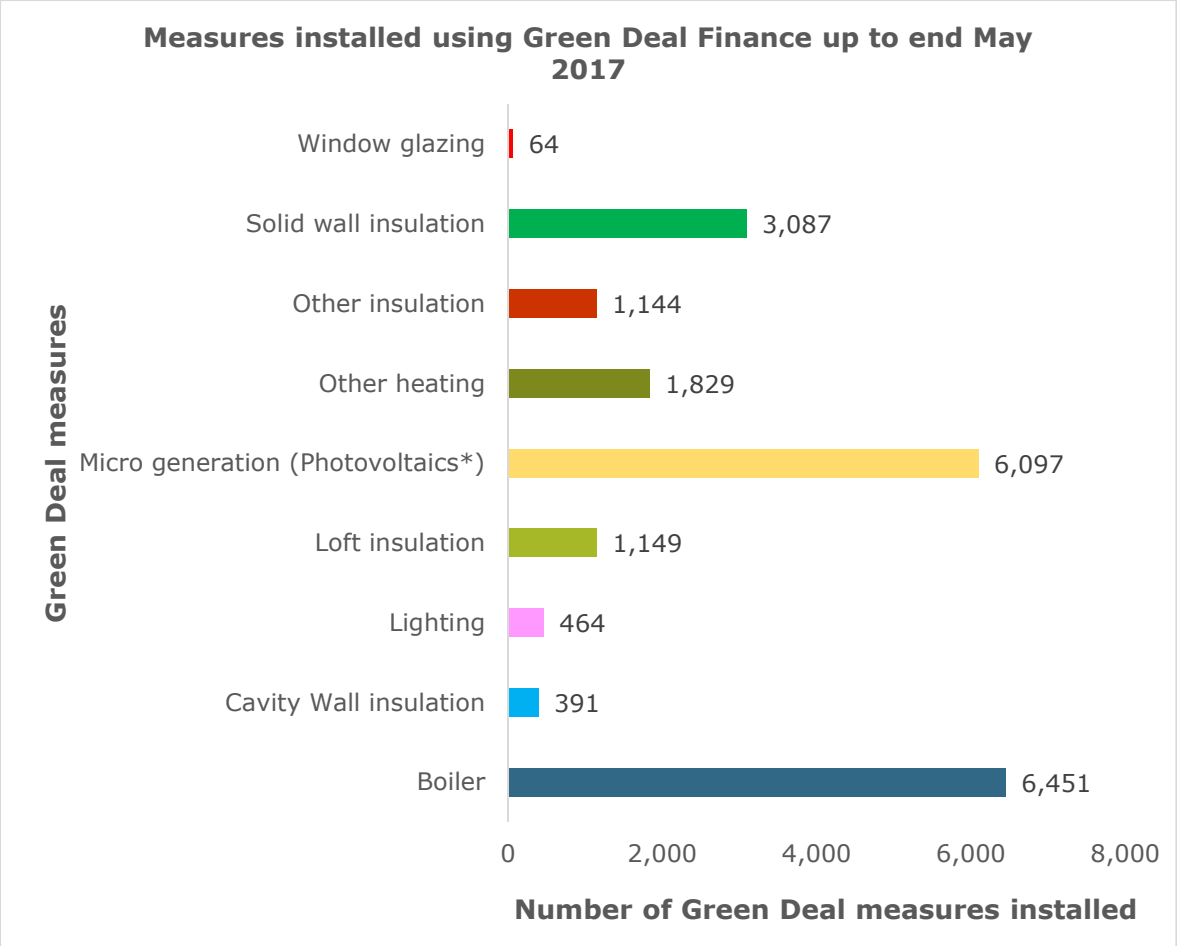


Figure 10: Measures Installed Using Green Deal Finance up to end May 2017, Source: Department for Business, Energy and Industrial Strategies (2017)

Apart from the listed measures in figure 10, any other measures or interventions that make a building more energy efficient and sustainable can be defined as a green retrofit. Figure 10 shows that the highest number of installations from the Green Deal Finance scheme was the installation of a new boiler (6,451), followed by photovoltaics installation (6,097) and solid wall insulation (3,087). Loft insulation, cavity wall insulation, heating measures and lighting were also installed but at lower levels.

Since household energy consumption is one of the major contributors to carbon emissions, the UK and the Scottish government have both taken household energy efficiency as one of the major infrastructure priorities, and many incentives and policies have been focused on it. More details on these incentives will be discussed in the next section, but here the focus is on the following data in figure 11, which shows the latest status of ECO and Green Deal schemes installation by tenure in the UK from the Household energy efficiency national statistics (Department for Business, Energy and Industrial Strategies 2017).

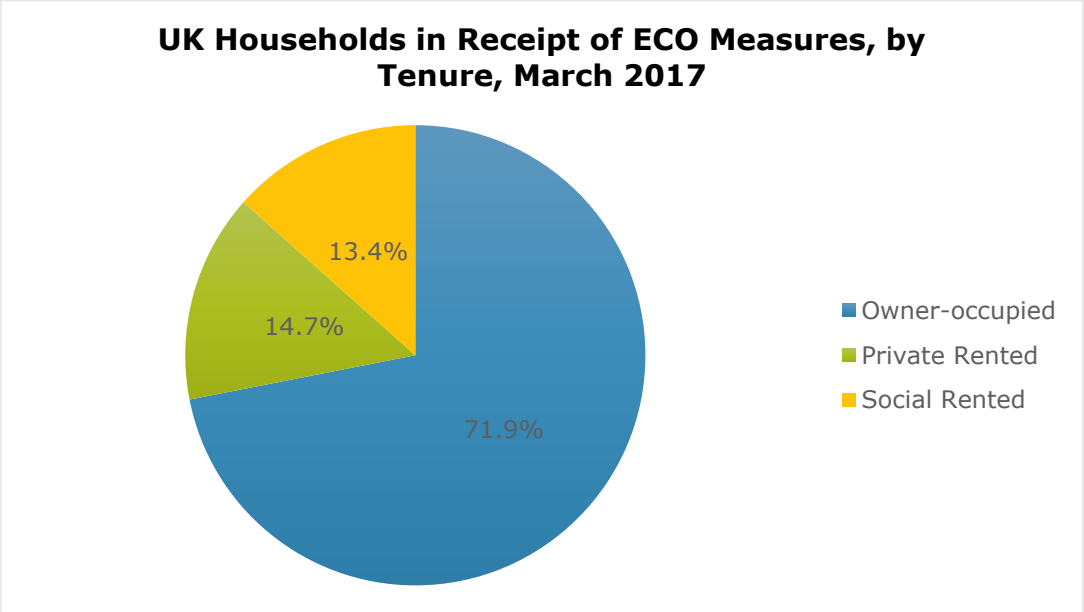


Figure 11: UK Households in the receipts of ECO Measures, by Tenure, Source: Department for Business, Energy and Industrial Strategies, 2017

From figure 11 it can be seen that the majority of the ECO measures (71.9%) were installed in the private sector, mainly in the owner-occupied sector, while the Social housing sector received the least support (13.4%). The figure raises an important question to investigate; why the social housing sector is not able to obtain more ECO measures in comparison to the private sector.

The flagship energy efficiency incentive by the UK government, introduced in 2011 and officially launched in 2013; the Green Deal was said to support ECO and "revolutionise British properties" (DECC 2015), but lagged way behind expectation and only managed to assess 694,516 properties and deliver 20,676 measures by May 2017, but also cost the Department of Environment and Climate Change (DECC) £240 million between 1 April 2011 and 31 March 2015. The National Audit Office published a report in April 2016 criticizing the Green Deal for "not only failed to deliver any meaningful benefit, it increased suppliers' costs – and therefore energy bills" (The National Audit Office 2016).

Home Energy Efficiency Programmes for Scotland (HEEPS) is the Scottish Government's flagship delivery vehicles for tackling fuel poverty and improving the energy efficiency of the domestic housing stock. According to GOV.SCOT (2018a) 55,000 measures were installed in Scotland across all schemes (including HEEPS & ECO) in 2015/16. And almost 100,000 energy efficiency measures have been delivered to households all over Scotland through HEEPS schemes since it started in 2013. The report highlights that solid wall insulation, hard-to-treat cavity wall insulation, and gas central heating systems as the main measures delivered by HEEPS. More information on HEEPS is given in section 2.6.1 below.

2.4 EU INCENTIVES

EU regulations are converted into national standards/regulation in the UK, therefore most of the key UK and Scottish energy efficiency incentives and policies are the direct result of EU legislation. In this section, one of the most important EU directives dictating building energy efficiency and retrofit is discussed. Apart from that, the literature review also looked at two EU projects; Milin and Bullier (2011) and Housing Europe (2013) to understand if the UK can learn from them. These EU projects acknowledged that the lack of adapted funding is a major barrier to retrofit projects and aimed to make large-scale retrofit projects profitable enough so that they can take off by themselves. Their main focus was cost-efficiency. These projects resemble the private sector-led growth intended by Green Deal (DECC 2015) but with a quick project delivery time and targets larger co-ordination and knowledge sharing among stakeholders.

2.4.1 Energy performance of buildings directive (EPBD)

By implementing EPBD (Recast 2010), European parliament directs EU member States to take necessary measures to ensure that minimum energy performance requirements for buildings or building units are set with a view to achieving cost-optimal levels. The states should take the necessary measures to implement a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements.

To comply with the EPBD, the UK and Scottish governments have developed the national standards and secondary legislation. Energy Performance of Buildings Directive (Recast, 2010) was introduced in the UK as secondary legislation on 9 January 2013 (GOV.UK 2018c) and the EPBD has been transposed in Scotland through Building Standards legislation and The Energy Performance of Buildings (Scotland) Regulations (2008) as amended

(GOV.SCOT 2018b). The UK government's methodology for calculating energy performance of dwellings is an SAP methodology which complies with EPBD.

In terms of existing buildings, the member states are required to provide appropriate financing and other instruments to catalyse the energy performance of buildings and the transition to near zero-energy buildings. They are also required to take the necessary measures to ensure that when buildings undergo a major renovation, the energy performance of the building, or the renovated part thereof, is upgraded in order to meet minimum energy performance requirements set accordance to EPBD. In the case of UK and Scotland, the incentives such as Green Deal, ECO, HEEPS and FITS are such financing and market instruments to catalyse the energy performance of buildings.

The EU member states are also obliged to establish a measure to inform the owners or tenants of buildings or building units of the different methods and practices that serve to enhance energy performance. This also requires the member states to establish a system of certification of the energy performance of buildings and display of energy performance certificates (European Committee for Standardization 2007). Provision of Energy Performance Certificate (EPC) is the UK measure for the implementation of the directive.

2.4.2 Financing energy Retrofit for Social Housing (FRESH)

Financing Energy Retrofit for Social Housing (FRESH) is an EU project which finances social housing retrofit through Energy Performance Contract (EPC). An EPC is a contractual arrangement in which an energy service company (ESCO) designs and implements an energy retrofit with a guaranteed level of any energy savings. The energy savings are used to reimburse the ESCO's initial investments (although EPC can also be financed directly by the owner). The owner or the tenant may benefit from a part of energy savings. After all investments have been reimbursed, the contract ends and the owner and/or

the tenant benefits from all energy savings (Milin and Bullier 2011). Figure 12 shows how EPC works.

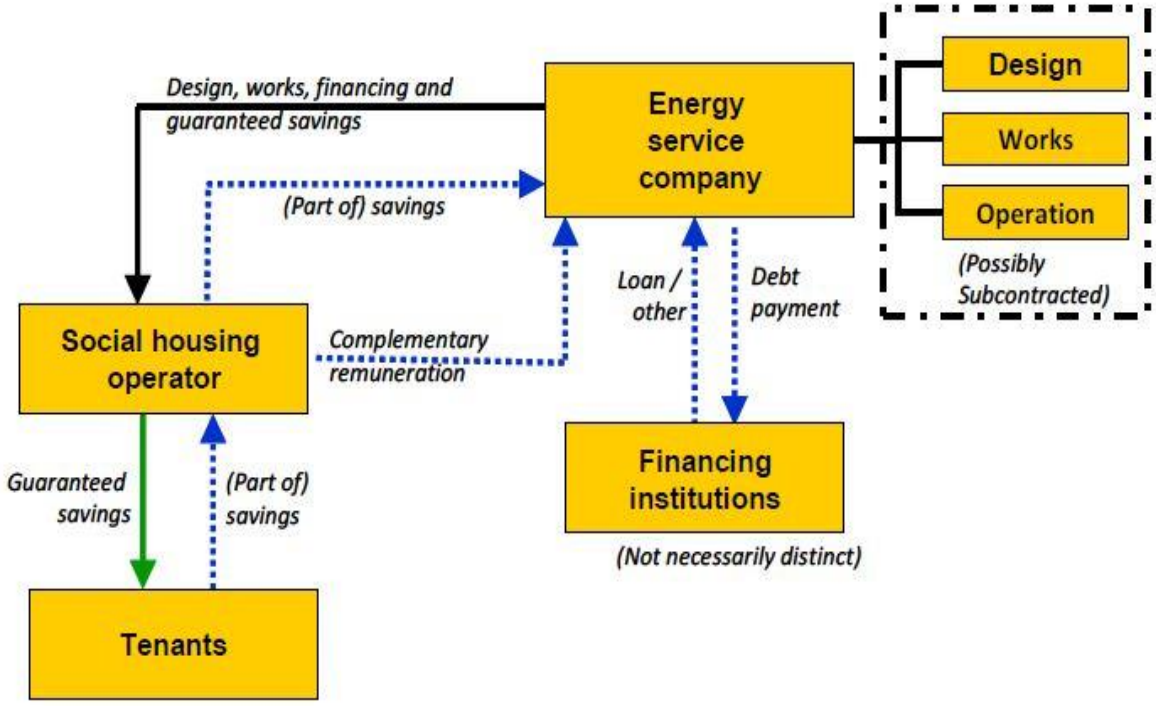


Figure 12: Energy Performance Contract (EPC), Source: Milin and Bullier (2011)

2.4.3 Transition Zero

TRANSITION ZERO aims to make Net Zero Energy (E=0) retrofits a market reality in the UK, France and The Netherlands. The coordinator of this proposal is Energiesprong, which is originally a Netherlands government funded, whole house retrofit, non-profit market development program to drive improved energy efficiency in buildings, operating in the market. Energiesprong has brokered a deal between housing associations and builders to refurbish 111,000 houses to Net Zero Energy (E=0) levels in the Netherlands. According to the TRANSITION ZERO proposal, it wants to build on the same methodology and the inspiring example, a similar innovation trajectory, will be facilitated in the UK and France through two equally ambitious deals of 100,000 houses per market (Housing Europe 2013).

Energiesprong uses the social housing sector in each market as the launching market, with a view to later scale to the private home-owner market. The independent Energiesprong market development teams aggregate mass demand for high quality in a market and create the right financing and regulatory conditions in parallel. With this in place, solution providers can go into a quick and transformative innovation process to deliver against this new standard. This project seeks both financial and regulatory solutions in parallel and delivers quick (one week) project delivery (Energiesprong UK 2015).

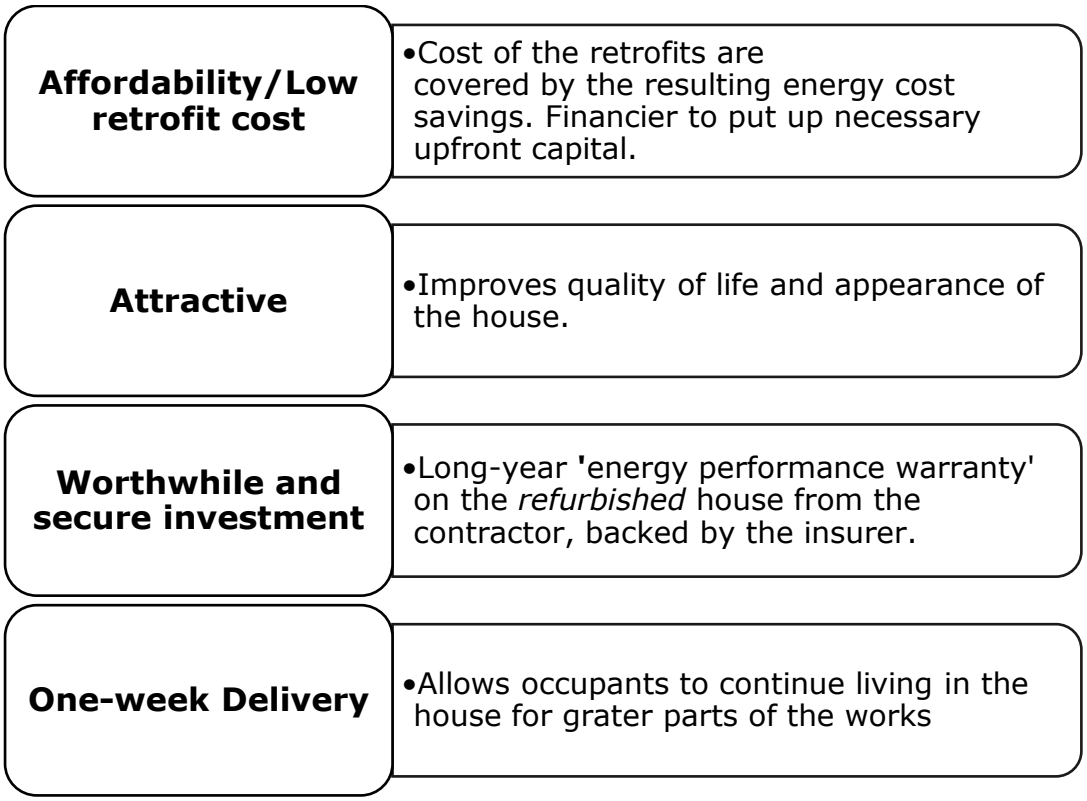


Figure 13: TRANSITION ZERO project criteria

TRANSITION ZERO program has an objective to organize mass demand for deep retrofits with the criteria as shown in Figure 13.

The proposal states that the role of TRANSITION ZERO will be to reinforce the existing Dutch Energiesprong market development team focusing on three things:

1. Further scaling of demand by housing associations for Net Zero packages.
2. Coordination of frontrunner builders to ensure a quick innovation process can take place.
3. Coordination of the demand of builders for components from suppliers to have scale advantages which creates an appetite to invest in new components by suppliers.

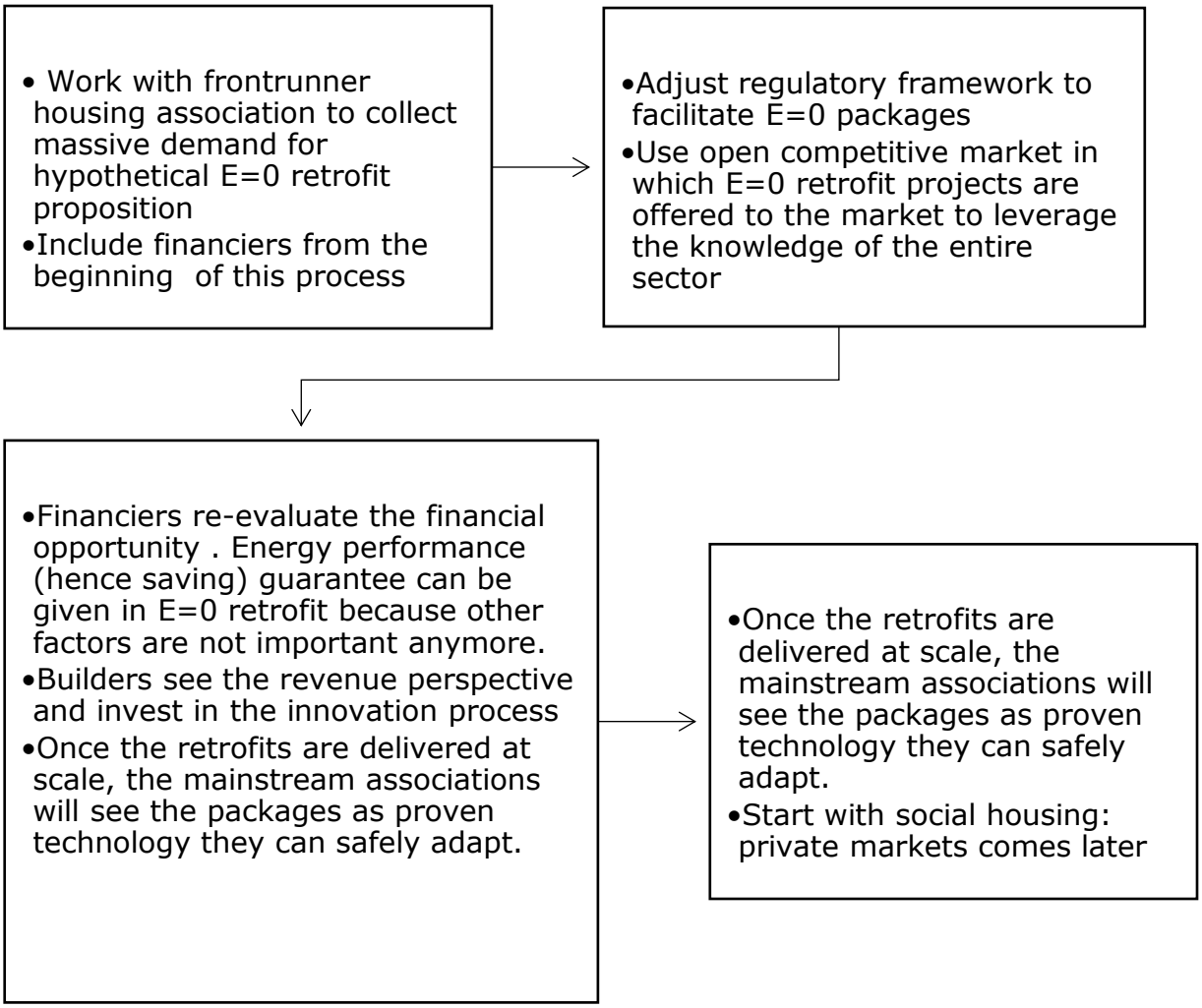


Figure 14: TRANSITION ZERO project approach

In terms of financing and project delivery time TRANSITION ZERO looks promising. However, there are challenges in terms of co-ordination and co-operation with the government to drastically change the policy of a country (i.e. UK) or region (i.e. Scotland), which is crucial to make the project

successful. An equally challenging part of this project could be convincing traditional and mainstream contractors and SHOs to embrace new and somehow 'revolutionary' challenges. In nutshell, the approach of TRANSITION ZERO project can be summarized as in figure 14.

2.4.4 Lesson Learned from EU projects

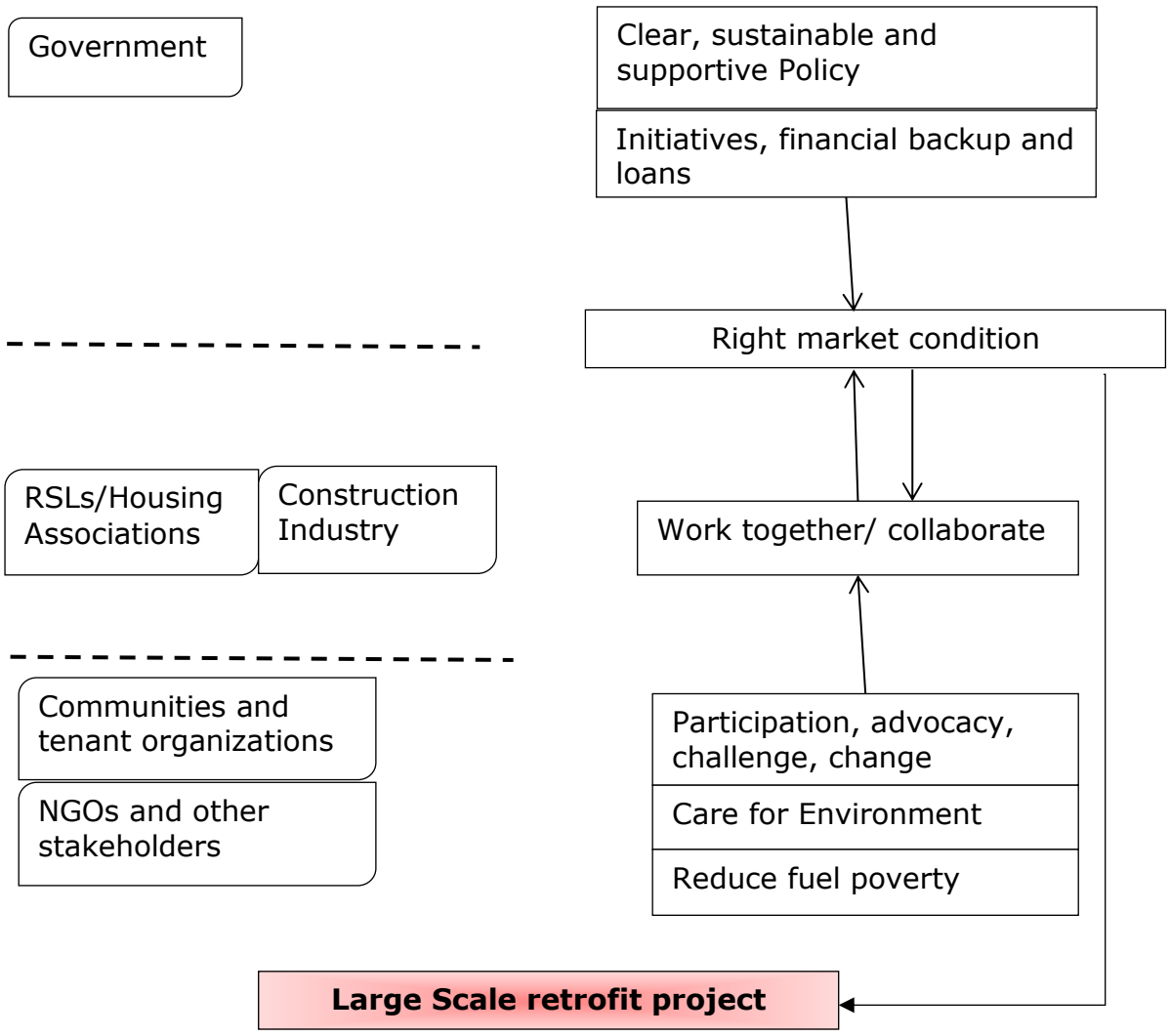


Figure 15: Lesson Learned from European Energy Efficiency Retrofit Project

As mentioned above there are both challenges and opportunities in adopting the mentioned projects. Regardless of whether adopting these projects or not,

they provide useful and valuable experiences and knowledge in the field of energy efficiency retrofit. More on the challenges and opportunities of adoption or learning from these projects is discussed in chapter 4 and Chapter 6. For now, these EU projects can be summarised as in figure 15.

2.5 Major UK Household Energy Efficiency Retrofit Incentives

This section looks at the UK and Scottish government's current legislation on energy efficiency retrofit, the different incentives initiated to support it, and the surrounding issues.

In this section from the literature review, it is concluded that UK energy efficiency incentives are heavily focused on the private sector and lack consistency. This has negatively affected the growth of energy retrofit projects and has increased fuel poverty. So, it is highlighted that there is a need for political sustainability, community involvement and social justice in energy efficiency policies. It also highlights numerous variables that influence the cost dynamics of green retrofit projects in Scotland.

The UK government's 'landmark' legislation of the 2008 Climate Change Act established statutory carbon reduction targets for greenhouse gases (GHGs) of 80% by 2050 or 34% by 2020 from the 1990 level. Emissions from buildings are to be reduced down to zero by 2050 (*Climate Change Act 2008*). The UK has fully acknowledged the carbon emission reduction potentials of the building sector from this Act. However, Lockwood (2013) states that though the 'landmark' Energy Act 2008 might appear to lock in a commitment to reducing emissions through legal means, this does not guarantee political lock-in and thus the Act itself is at risk. Lockwood argues that the lack of political sustainability challenges the effectiveness of the Act. This argument seems realistic when we look at the timeline (figure: 19 and table: 1) showing the series of changes, Acts, legislations and political announcements.

In 2010, the Feed-in Tariff (FIT) was officially launched, and the Energy Act 2010, which introduced a Carbon Reduction Commitment (CRC), came into force (GOV.UK 2010). In May 2010, the Labour government was replaced by the coalition of Conservative and Liberal Democrats. This government continued some of the major incentives such as FIT, but stopped some of the previous government's incentives, among these were the very successful Carbon Emission Reduction Target (CERT) and Community Energy Saving Programme (CESP). The coalition government introduced its flagship programme Green Deal via the Energy Act 2011, which they said, would 'revolutionise' the energy efficiency of British Properties (DECC 2015). It also introduced the Energy Company Obligation (ECO), another flagship programme intended to provide funding for hard to treat dwellings, social housing sector and to work with the Green Deal. The Home Energy Efficiency Programmes for Scotland (HEEPS), launched in April 2013 is Scotland's national incentive which is described as "the Scottish Government's flagship delivery vehicles for tackling fuel poverty and improving the energy efficiency of the domestic housing stock" (GOV.SCOT 2018a). HEEPS schemes are designed to work with other sources of funding such as ECO and Green Deal.

Below is a brief introduction to the major UK household energy efficiency incentives currently (2017) available in Scotland.

2.5.1 FITs

Feed-in Tariffs (FIT) is a UK Government scheme introduced on 1 April 2010, designed to encourage uptake of a range of small-scale renewable and low-carbon electricity generation technologies (Energy Saving Trust 2017b). The large energy suppliers such as the so-called "big six"; British Gas, EDF, npower, E. ON UK, Scottish Power and SSE) are required by law to be FITs licensees. The scheme requires participating licensed electricity suppliers to make payments on both generation and export of energy from eligible installations. An eligible installation for FIT payments is up to a capacity of 5MW, or 2kW for Combined Heat and Power (CHP) of the following technology types;

- Solar photovoltaic (solar PV)
- Wind
- Micro combined heat and power (CHP)
- Hydro
- Anaerobic digestion (AD)

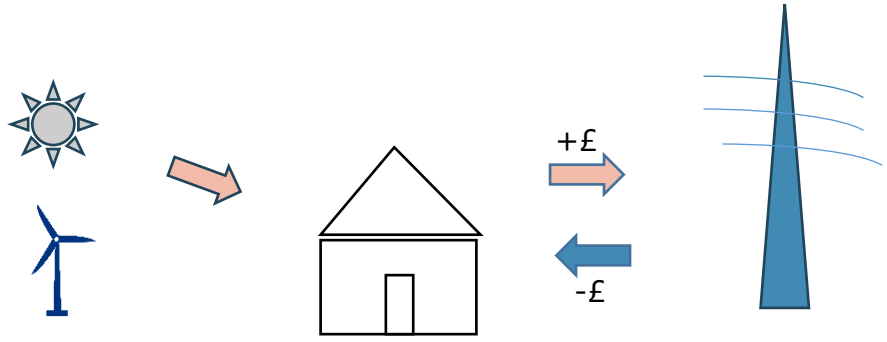


Figure 16: Feed-In Tariff Scheme (FITS)

U ey generate if they installed an eligible system such as solar PV, a wind turbine, hydro, or micro combined heat and power (CHP) technology. When the household generates more energy than their need, the extra energy is automatically transmitted to the main grid and they are paid per unit generated. When the household needs more electricity than they generate, they automatically get electricity from the main grid. Energy suppliers handle FITs scheme applications and make the FITs payments.

2.5.2 Green Deal

Green Deal is a UK government scheme through which households can pay for energy-efficient home improvements through savings on their energy bills (Energy Saving Trust 2017c). Green Deal is a Government-backed scheme to help households make cost-effective energy-saving improvements. Instead of paying for the full cost of the improvements up front, households pay over time through a charge added to their electricity bill.

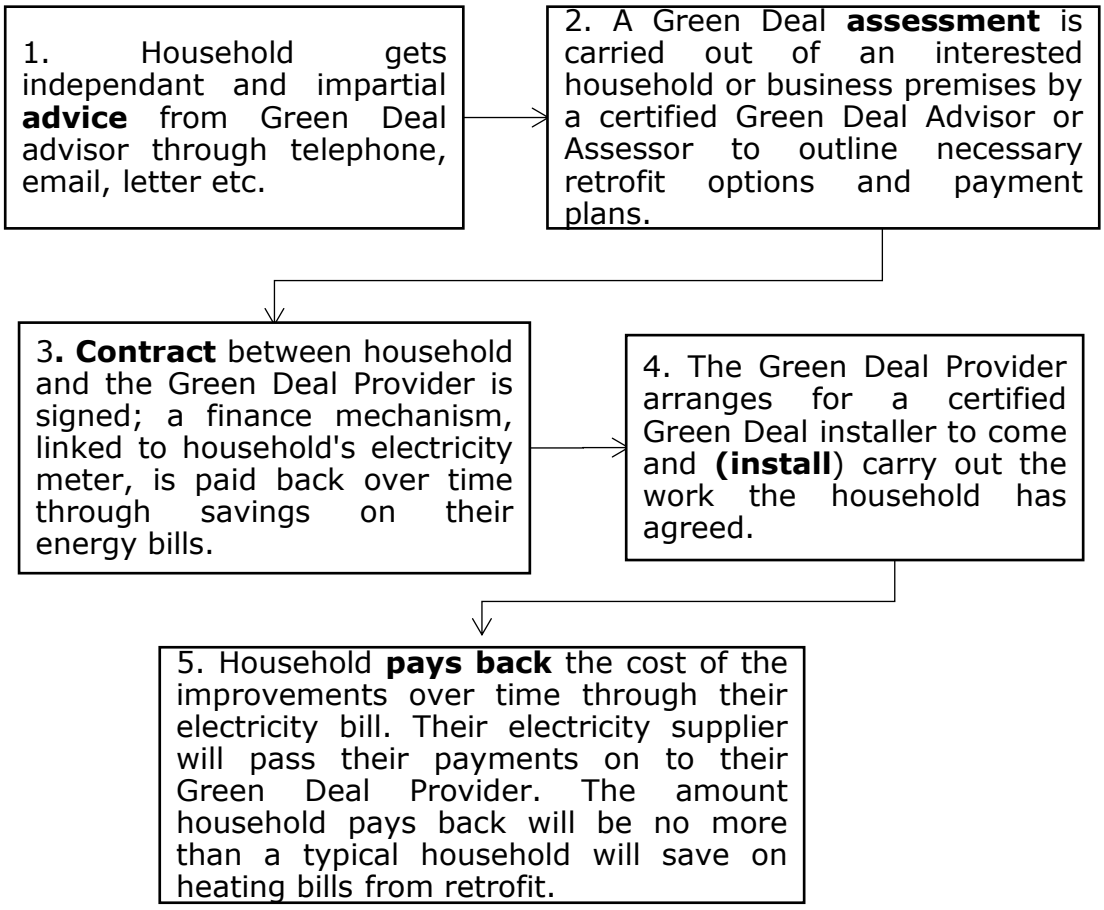


Figure 17: Green Deal

The Green Deal is said to be the "largest home improvement programme since World War II" (DECC 2015). This scheme, launched in January 2013, provides up to £10,000 for the works and the money is paid back over a period of 25 years through the savings from the energy bill. A Green Deal loan needs to meet the 'golden rule': the amount which can be borrowed is limited by the rule that loan repayments in the first year may not exceed the typically expected energy savings from the measures financed by the loan. For example, if the cavity wall insulation saves £100 per year on the energy bill the households will not pay back more than £100 a year during the first year of installation. This rule is deemed unfair as it only covers the first year, and the interest on a loan can rise significantly from the second year onward. Figure 17 summarizes how Green Deal works.

The measures eligible for Green Deal are as follows:

1. Boilers and insulation; new Boiler (high efficiency or oil condensing boiler), Cavity wall insulation, Solid Wall insulation, Draught proofing
2. Heating; Better heating controls (e.g. room thermostats), Heat pump (air or ground source), Biomass boilers and heaters, Solar water heating
3. Hot water; hot water cylinder, cylinder jacket, thermostat etc.
4. Windows and doors; Double glazing (or secondary glazing for listed properties)
5. Micro-generation and renewables
6. Lighting

2.5.3 Energy Company Obligation (ECO)

Energy Company Obligation (ECO) is an energy efficiency incentive through which eligible households get support from an energy supplier to carry out an energy efficiency retrofit (GOV.UK 2012). ECO is a funding scheme through the big six energy suppliers (British Gas, EDF Energy, Eon UK, npower, Scottish Power, SSE) to support energy improvements for people on certain benefits, for those in solid wall properties and for households in the poorest parts of the country.

The scheme is entirely focused on low income and vulnerable households where the Green Deal is less likely to work and certain property types, such as those needing Solid Wall Insulation (SWI). ECO support is expected to be integrated into the Green Deal finance combine to deliver improvements. The households are expected to meet the Golden Rule but in cases requiring solid wall insulation, the upfront cost is high and unlikely to be covered from the reduced energy bill (which is the Golden Rule), in this case, ECO subsidy will cover the full cost of installation. The combination arrangements are done behind the scene and the consumer will see one "seamless package" through their Green Deal provider. ECO is available in two parts (as in December 2017) (Energy Saving Trust 2017a);

1. Under the Home Heating Cost Reduction Obligation (HHCRO), energy companies provide insulation and heating improvements to qualifying low-income and vulnerable households in private rented or owner-occupied properties.
2. Through the Carbon Emissions Reduction Obligation (CERO), energy companies provide funding for wall and roof insulation measures and a connection to a district heating system as primary measures, along with other secondary energy efficiency measures where a primary measure is installed and is available to all tenures.

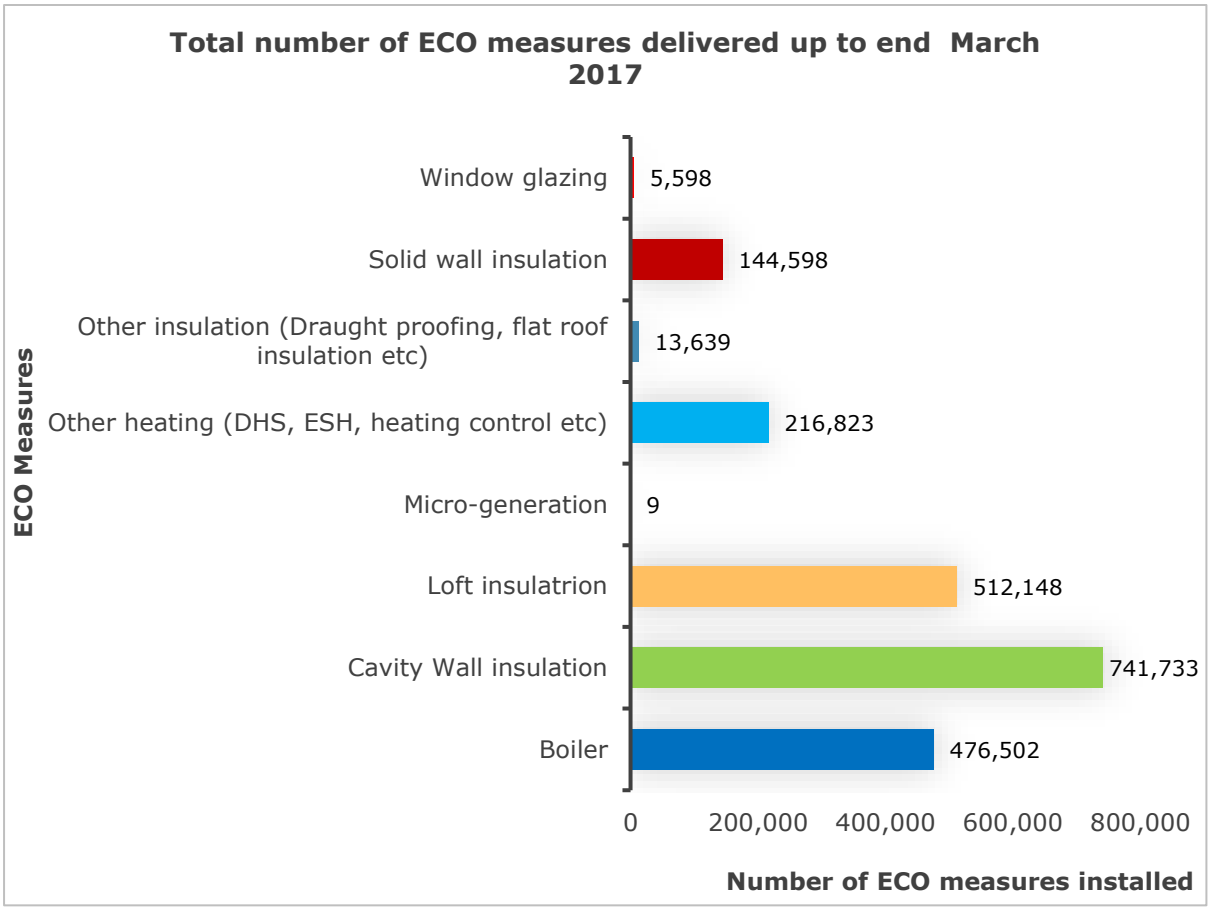


Figure 18: Total Number of ECO measures delivered up to end March 2017, Source: Department for Business, Energy and Industrial Strategies, 2017

Figure 18 shows that 'cavity wall insulation' was the most installed retrofit measure with 741,733 numbers of which accounted 35.1% of all measures

installed by ECO incentives, followed by 'loft insulation' (24.3%) and 'boiler' (22.6%). Here the installation measure 'boiler' is mainly (22.3%) a replacement of qualifying boiler and the rest implies for another boiler installation. There was 144,598 solid wall insulation which is only 6.8% of total measures installed up to end of March 2018, in the UK.

2.5.3.1 Changes in Green Deal and ECO (2010 – 2015)

After the launch of Green Deal in 2012, the initiative saw a series of changes and announcements. Along with the Green Deal, the Energy Company Obligation also a saw series of changes. Green Deal and ECO are the major household energy efficiency initiatives of the UK that focus on improving the energy efficiency of buildings via various installations and improvements. The major changes and announcements for ECO and Green Deal have been listed in figure 20. The timeframe covers one elected government's full term and launch of major energy efficiency incentives.

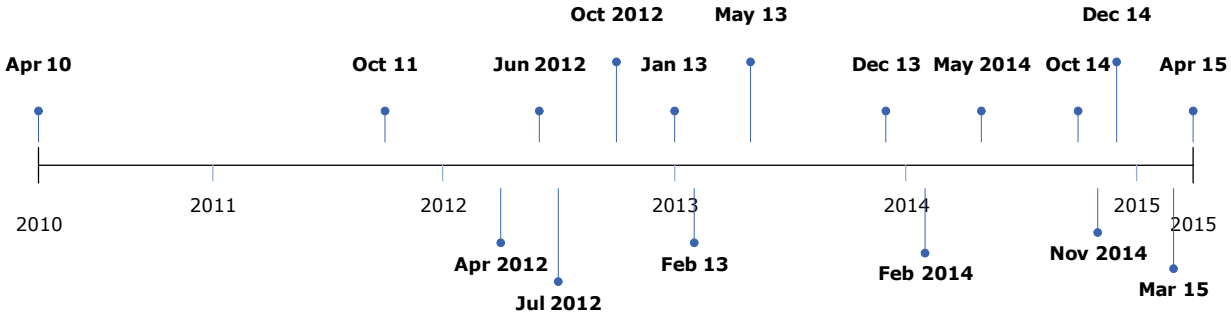


Figure 19: Timeline of major changes in ECO and Green Deal (2010-2015)

The timeline (figure 19) is useful in observing the frequency of changes in ECO and Green Deal which highlights the 'lack of political sustainability'. If observed from the SHO perspective, the changes which are too frequent to keep up with create a significant level of uncertainty and can directly impact the retrofit projects. This is further explored through the interview in Chapter 4 and discussed in Chapter 6.

Figure 19 shows that there is inconsistency in both the UK's energy policy and climate change strategies. The frequent changes can be labelled inconsistency rather than policy changes because of the frequency of change and also that the presented timeframe covers a single term of a government. The time period covers an elected government's (coalition government of Conservatives and Liberal Democrats led by David Cameron) single term (2010-2015) therefore the changes can't simply be justified as the policy change, it rather exposes the dilemma of policymakers on the issue.

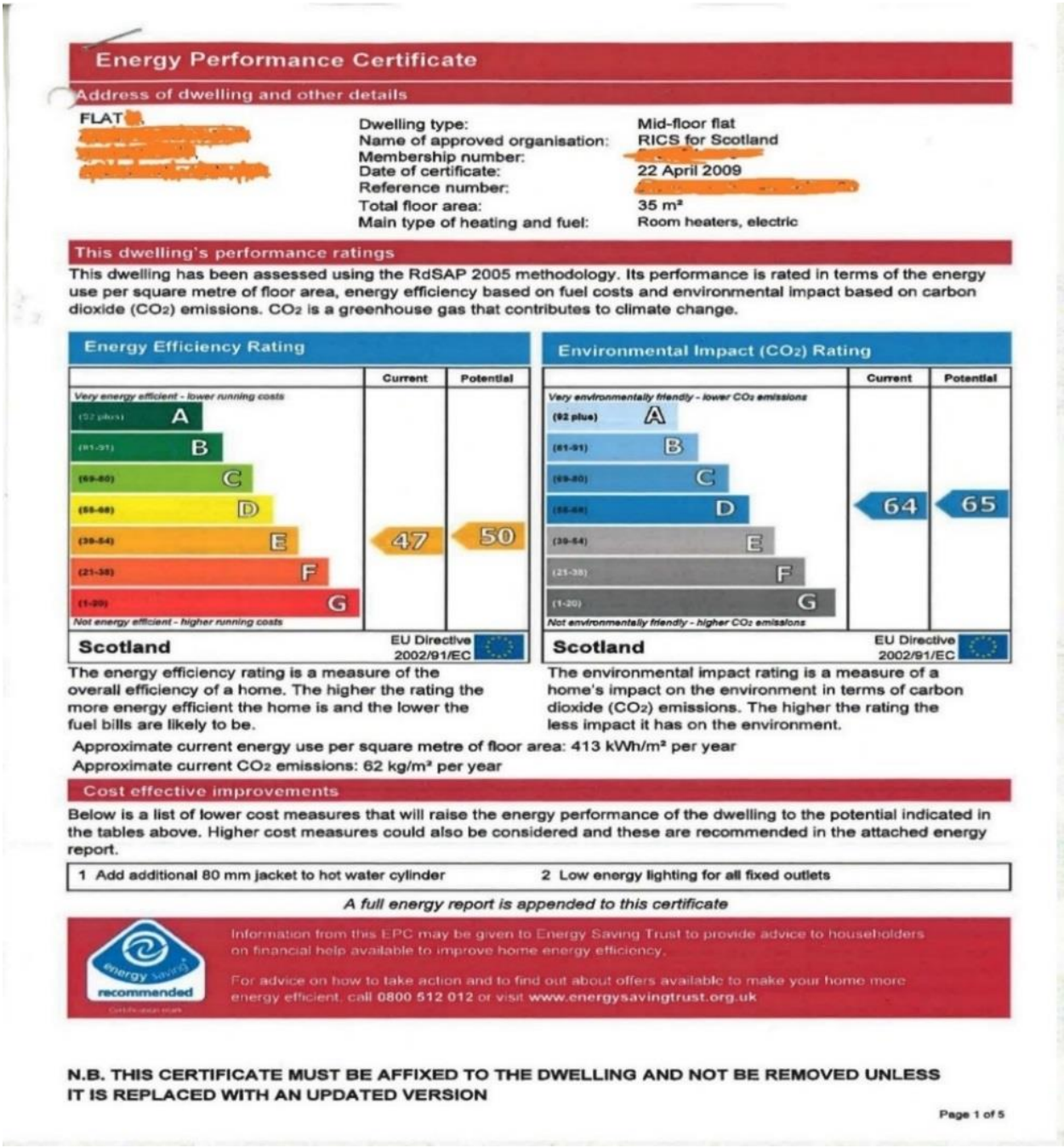
This 'lack of political sustainability' (Lockwood 2013) in energy policy and climate strategy has led to series of new energy act, energy efficiency incentives, closure of some of the incentives within a short period after launch and changes in the incentives many times a year (see figure 19 and Table 1). Policy makers and politician often consider the popularity of the initiative rather than its sustainability, which is one reason there are so many changes and confusion. Watson et al. (2015) conclude that there is a need to move beyond narrow framings of public attitudes; this frequent implementation and changes is causing uncertainty in the retrofit market, failures of the programmes and searching for new incentives or more changes in the incentives.

Table 1: Major changes and announcements in ECO and Green Deal (2010- 2015)

Year	**Month and major changes and announcement**
2010	**April:** Energy Act 2010 came into force, mandatory social price support to reduce energy bills for the most vulnerable
2011	**October** Energy Act 2011 introduced Green Deal policy
2012	**April:** DECC announced a list of pioneer Green Deal providers **July:** Electricity and Gas (Energy Company Obligation) Order 2012 introduced ECO **June:** Green Deal Oversight and Registration Body (GDORB) put into the launch **October:** Soft Launch of Green Deal
2013	**January:** Official lunch of Green Deal and ECO CERT and CESP schemes closed and replaced by ECO ECO Phase 1 delivery began **February:** Green Deal and ECO Launched in Scotland **May:** Green Deal Finance Company (GDFC) operational **December:** DECC announced the Second stage of Green Deal which was called "streamlined and improved" Green Deal. £450 million allocated to household energy efficiency for three years Energy Act 2013 came into force
2014	**February:** DECC announced changes to Green Deal scheme's cashback rates, timings and insurance backed guarantees **May:** New Green Deal Home Improvement Fund (GDIF) announced **October** £100 million for household energy efficiency announced (in addition to previous £450 million) **November:** Green Deal Finance Company bailed out; The Department of Energy and Climate Change stepped in and gave £34Million loan **December:** The Electricity and Gas (Energy Company Obligation) Order 2014 came into force, changes in ECO1 and set legislations for new obligation period (1 April 2015 to 31 March 2017)
2015	**March:** Original ECO scheme closed on 31 March **April**: The new obligation period (ECO2) started from 1 April 2015

Sources: (GOV.UK 2010), (GOV.UK 2011b), (GOV.UK 2015a), (GOV.UK 2015b), (GOV.UK 2012), (GOV.UK 2014), (Energy Act. 2013), (Ofgem 2015)

2.5.4 Energy Performance Certificate (EPC)



Energy Performance Certificate

Address of dwelling and other details

FLAT [redacted]

Dwelling type:	Mid-floor flat
Name of approved organisation:	RICS for Scotland
Membership number:	[redacted]
Date of certificate:	22 April 2009
Reference number:	[redacted]
Total floor area:	35 m²
Main type of heating and fuel:	Room heaters, electric

This dwelling's performance ratings

This dwelling has been assessed using the RdSAP 2005 methodology. Its performance is rated in terms of the energy use per square metre of floor area, energy efficiency based on fuel costs and environmental impact based on carbon dioxide (CO_2) emissions. CO_2 is a greenhouse gas that contributes to climate change.

Energy Efficiency Rating

	Current	Potential
Very energy efficient - lower running costs		
(92 plus) A		
(81-91) B		
(69-80) C		
(55-68) D		
(39-54) E	47	50
(21-38) F		
(1-20) G		
Not energy efficient - higher running costs		
Scotland	EU Directive 2002/91/EC	

The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills are likely to be.

Environmental Impact (CO_2) Rating

	Current	Potential
Very environmentally friendly - lower CO_2 emissions		
(92 plus) A		
(81-91) B		
(69-80) C		
(55-68) D	64	65
(39-54) E		
(21-38) F		
(1-20) G		
Not environmentally friendly - higher CO_2 emissions		
Scotland	EU Directive 2002/91/EC	

The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO_2) emissions. The higher the rating the less impact it has on the environment.

Approximate current energy use per square metre of floor area: 413 kWh/m² per year

Approximate current CO_2 emissions: 62 kg/m² per year

Cost effective improvements

Below is a list of lower cost measures that will raise the energy performance of the dwelling to the potential indicated in the tables above. Higher cost measures could also be considered and these are recommended in the attached energy report.

1 Add additional 80 mm jacket to hot water cylinder	2 Low energy lighting for all fixed outlets

A full energy report is appended to this certificate

energy saving recommended

Information from this EPC may be given to Energy Saving Trust to provide advice to householders on financial help available to improve home energy efficiency.

For advice on how to take action and to find out about offers available to make your home more energy efficient, call 0800 512 012 or visit www.energysavingtrust.org.uk

N.B. THIS CERTIFICATE MUST BE AFFIXED TO THE DWELLING AND NOT BE REMOVED UNLESS IT IS REPLACED WITH AN UPDATED VERSION

Page 1 of 5

Figure 20: Energy Performance Certificate

An EPC contains information about a property's energy use, typical energy costs and recommendations about how to reduce energy use and save money. An EPC gives a building an energy efficiency rating from A (most efficient) to

G (least efficient) and is valid for 10 years (GOV.UK 2018a). EPC is an important certification in terms of energy efficiency of a dwelling because energy efficiency improvements for the building are identified in it. The owner, landlord or tenant can utilize this certificate to further improve the energy efficiency of their dwelling and also look for available help. Under the Energy Performance of Buildings (Scotland) Regulations 2008, landlords are required to provide a copy of a valid EPC to any prospective tenant.

In Scotland, two kinds of EPC formats are approved for use; one for dwellings and one for all other building types. Figure 20 is an EPC for a dwelling. As shown in figure 20, in addition to the information provided on the EPC, more detailed information and advice are provided in Recommendation Report which is provided with the EPC. The EPC assessment records the size and layout of the building, construction type, insulation, heating, ventilation and lighting.

An EPC is obtained using either Standard Assessment Procedure (SAP) or Reduced Data SAP (RdSAP). The EPC rating is assigned to an SAP band according to the Table 2. It applies to both the SAP rating and the Environmental Impact rating. Table 2 shows the EPC rating and the assigned SAP band. For example, if a dwelling is rated highest (band A) that means the building has an SAP (2012) rating of 92 or more.

Table 2: EPC Ratings and SAP band, Source: (GOV.UK, 2018a)

EPC Rating	SAP (2012)
A	92 or more
B	81 - 91
C	69 - 80
D	55 - 68
E	39 - 54
F	21 - 38
G	1 - 20

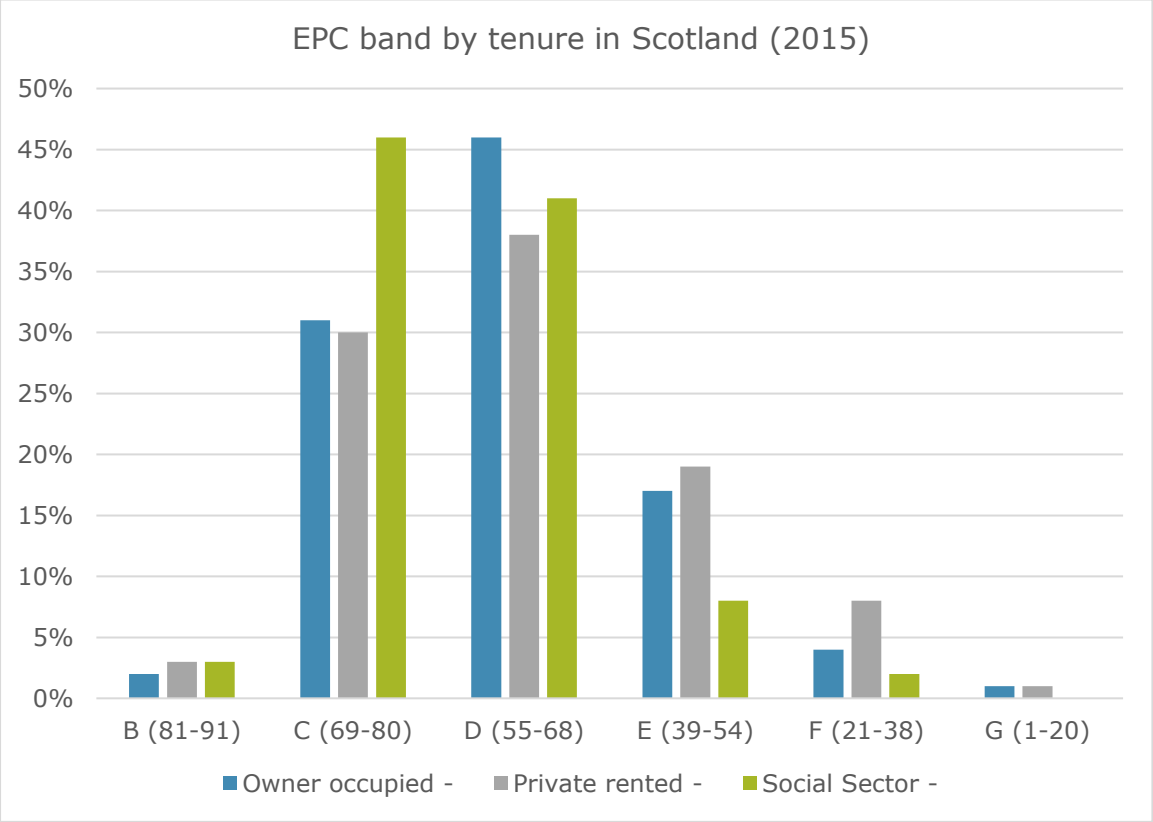


Figure 21: EPC band by broad tenure, 2015 (SAP 2012), Source: GOV.SCOT 2017b

The social housing sector has the highest energy efficiency ratings with 56% of dwellings at band C or better and only 8% below band D. According to (GOV.SCOT, 2017b). Figure 21 shows the EPC band of Scottish dwellings stock by tenure, from which, it can be concluded that the owner-occupied sector is the worst performing followed by the private rented sector. Although EPC is higher in the social sector, the prevalence of fuel poverty is higher as well, which is a contradicting fact. This simply suggests that the other factors affecting fuel poverty such as income are lesser in social housing tenants. So, while the dwelling may require less energy to heat, the cost of that energy may represent a significant proportion of a tenant's income. Therefore, the energy efficiency incentive's fixed focus on raising energy efficiency only doesn't help reduce fuel poverty.

2.5.5 Standard Assessment Procedure (SAP)

The SAP is a methodology adopted by the UK government for calculating the energy performance of dwellings (BRE 2012). SAP was developed by the Building Research Establishment (BRE) in 1992, since ten it has been updated in 2005, 2009 and the latest version is SAP 2012. Reduced Data SAP (RdSAP) was introduced in 2005 as a lower cost method of assessing the energy performance of existing dwellings. RdSAP is based on a site survey of the property when the complete data set for SAP calculation is not available.

The method of calculating the energy performance and the ratings are set out in the form of a worksheet, accompanied by a series of tables. The methodology is compliant with the Energy Performance of Buildings Directive (Recast 2010). According to BRE (2012), The SAP calculation is based on the energy balance considering the following factors;

- Materials used for the construction of the dwelling
- Thermal insulation of the building fabric
- Air leakage, ventilation characteristics of the dwelling, and ventilation equipment
- Efficiency and control of the heating system(s)
- Solar gains through openings of the dwelling
- The fuel used to provide space and water heating, ventilation and lighting
- Energy for space cooling, if applicable
- Renewable energy technologies (if any)

It is important to note that people use buildings in different ways, so the calculation is based on a standard predication of occupancy and use. For example; if it is a one bedroom flat the assessor will make a standard predication that there will be 2 people living there (children under 1 is ignored) (Shelter Scotland 2018). This suggests that the SAP considers human factor in calculating energy efficiency of a dwelling, but this use is limited to predicting

the cost of running the dwelling. The acknowledgement of the human factor in calculating energy efficiency is important however the overall success of energy efficiency retrofit largely depends on the consideration of human factor on design and delivery as well. This issue is discussed in section 4.7.3 and concluded in section 6.4.5.

2.6 Major Scottish Household Energy Efficiency Retrofit Incentives

2.6.1 Household Energy Efficiency Programme for Scotland (HEEPS)

In line with the recommendations in the Fuel Poverty Forum's 2012 interim report on its review of fuel poverty strategy, the Home Energy Efficiency Programmes for Scotland (HEEPS) (initially named the National Retrofit Programme) was launched in April 2013 (Energy Saving Trust 2018). It offers a package of support to help households who are struggling to pay their energy bills and keep their homes warm. As of March 2018, HEEPS offered the following Schemes (Energy Saving Trust 2018);

1. HEEPS: Warmer Homes Scotland Scheme
2. HEEPS: Cashback scheme
3. HEEPS: Equity Loan Scheme
4. HEEPS: Loan scheme for Registered Social Landlords

HEEPS were designed to enable funding to be levered in from the Green Deal and Energy Company Obligation (ECO). HEEPS recognised that the focus must be on measures necessary to meet both Fuel Poverty and climate change targets, which is comparatively more holistic approach than that of Green Deal and ECO measures. HEEPS aims to deliver more than ECO in terms of carbon savings and enable the long-term reduction in fuel bills.

The majority of the Scottish Government budget for fuel poverty and energy efficiency programmes is allocated to Area Based Schemes (HEEPS: ABS). Under the ABS, the Scottish government awards HEEPS funding to local

governments (councils) to develop and deliver fuel poverty programmes (mainly solid wall insulation) in areas with high levels of fuel poverty. The area-based schemes are designed and delivered by councils with local delivery partners. They target fuel-poor areas to provide energy efficiency measures for a large number of Scottish homes while delivering emission savings and helping reduce fuel poverty. The Scottish Government budget for Area Based Schemes for 2013/14 was £55m and for 2014/15 and 2015/16 the budget was £60m (GOV.SCOT 2018e).

The second element of HEEPS in 2015/16 was Warmer Homes Scotland (HEEPS: WHS), which replaced the previous Energy Assistance Scheme and went live in September 2015. For 2015/16 the WHS budget was £16m. This incentive is available to homeowners and private sector tenants who are most vulnerable to fuel poverty, struggling to heat their home, who have lived in their property for at least twelve months, and who meet one or all of mentioned qualifying criteria (GOV.SCOT 2018e).

Other HEEPS incentives included HEEPS: Cashback programme, which closed in November 2015 after the funding limit was reached. 2015/16 also saw the introduction of HEEPS: Loans; interest-free loans to households and Registered Social Landlords (RSL) to enable the installation of energy efficiency measures. Loans of up to £10 000 were available to households looking to improve their properties. In 2015/16 the HEEPS: Loans budget was £14m. Another energy efficiency incentive by the Scottish Government is Home Energy Scotland Loan, which is available to private sector landlords and owner-occupiers.

All of the HEEPS incentives are more traceable and data are conveniently available. They are also directly delivered or facilitated by local government or Scottish government. In comparison, the Green Deal and ECO incentives' data on cost is difficult to trace conveniently. UK national incentives are mostly delivered through private energy companies and data is available on bulk or approximate figures while area specific cost data is difficult to find or not

available. HEEPS focuses on both carbon emission reduction and energy bill reduction which is a more holistic approach than that of the ECO or Green Deal. As ECO and Green Deal focus mainly on carbon emission reduction it contradicts with the SHO priorities and has become problematic in achieving the overall goal of retrofitting.

2.6.2 Energy Efficiency Standard for Social Housing (EESSH)

EESSH was introduced in March 2014 and set the first milestone for dwellings owned by social landlords to meet by 31 December 2020 (GOV.SCOT 2018a). The minimum energy efficiency ratings for the 2020 milestone are set out in Table 3. The target was defined by reference to minimum ratings in the UK Government's Standard Assessment Procedure for Energy Rating of Dwellings (SAP 2009). The table also includes the equivalent ratings for SAP 2012. In terms of Energy Performance Certificates (EPCs), these ratings fall around Band-D (55-68) and Band-C (69-80).

Table 3: Minimum energy efficiency ratings required to comply with EESSH

EE Rating	SAP 2009		SAP 2012	
Dwelling Type	Gas	Electric	Gas	Electric
Flats	69	65	69	63
Four-in-a-block	65	65	65	62
Houses (other than detached)	69	65	69	62
Detached	60	60	60	57

EESSH does not prescribe specific measures needed to meet overall minimum levels of energy efficiency which leaves flexibility for the SHO to install reasonable measures to their dwelling stock. Attaining EESSH, in addition to

regulations specifying minimum energy efficiency of new boilers, is projected to provide benefits to social tenants of around £127m each year in reduced fuel bills due to improved energy efficiency. This is equivalent to an average of around £210 per year per household. For climate change carbon abatement, attainment of EESSH is projected to reduce carbon output by 760kT per annum from the social rented sector.

According to (GOV.SCOT 2018a) EESSH modelling showed that 64% of social housing would already meet the relevant EESSH rating on 1 April 2015. It was estimated that a further £310m would be needed to achieve 88% compliance using only reasonable measures (made up of £166m for local authority housing and £144m for RSLs), and that a total of £892m would be needed to achieve 99% compliance with the EESSH (made up of £478m for local authorities and £415m for RSLs).

2.7 Fuel Poverty

Energy efficiency of one's residence is strongly linked to the energy costs incurred by their household, which impacts the likelihood of being fuel poor. If a household requires a greater amount of energy to run their home, they will have higher fuel costs. Heating a household to an adequate standard of warmth is dependent on the energy efficiency of the dwelling. As expected, households with a lower energy efficiency rating have a higher likelihood of being fuel poor (Department of Business Energy and Industrial Strategy 2017). Therefore, while studying household energy efficiency, one cannot ignore the issue of fuel poverty.

Figure 22 shows that when the dwelling energy performance increases fuel poverty decreases. Although the building fabric only cannot solve the complex issue of fuel poverty, it has a direct effect on fuel poverty. To better test this hypothesis, the number of building over band C and the percentage of households in fuel poverty was compared using the data from (GOV.SCOT,

2017b). The comparison in figure 22 shows that, in general, the building EPC and household living in those building have a direct relationship. As the percentage of building over EPC band C or increases the percentage of household living under fuel poverty decreases.

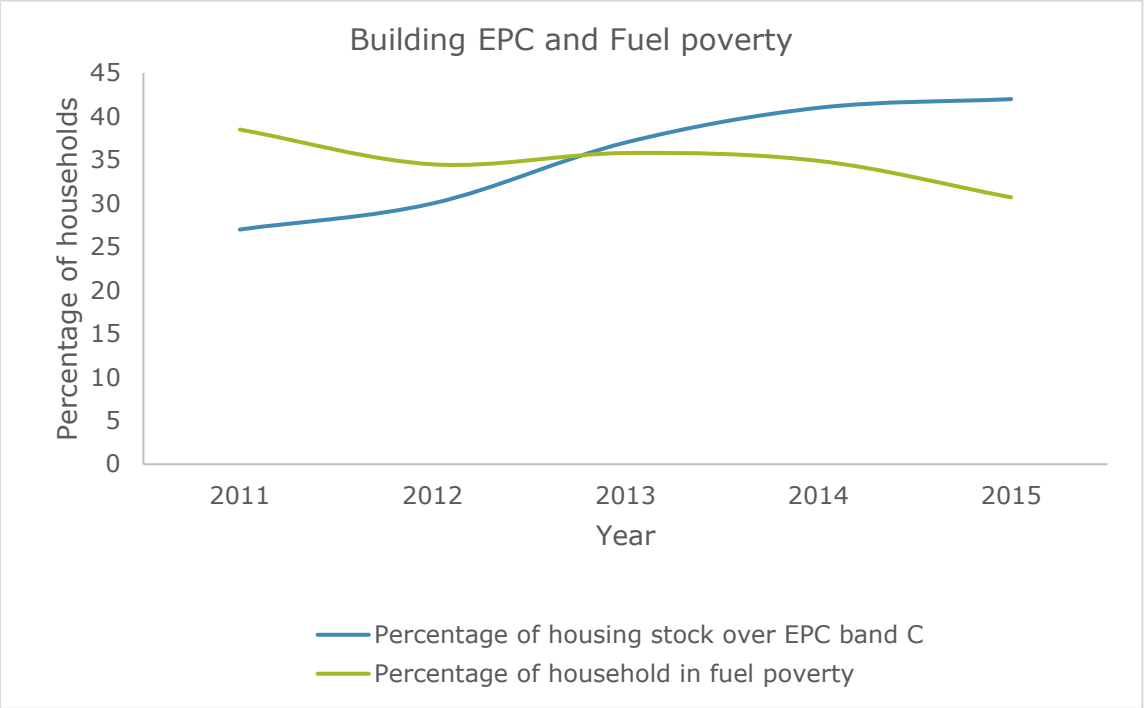


Figure 22: fuel poverty and building EPC rating, developed using data from GOV.SCOT, (2017c)

According to (GOV.SCOT 2017c), by 2015, there are 30.7% households living in fuel poverty among which 8.3% household live in extreme fuel poverty. Although the Scottish government had set ambitious plan to eradicate fuel poverty by 2016, the target has been missed and there is no sign that fuel poverty will be eradicated in the near future. Figure 23 shows that the percentage of household in fuel poverty has been constantly over 30% since 2010. There has been some progress seen from 2011 – 2015, however, the progress has not been in line with the Scottish Government's plan.

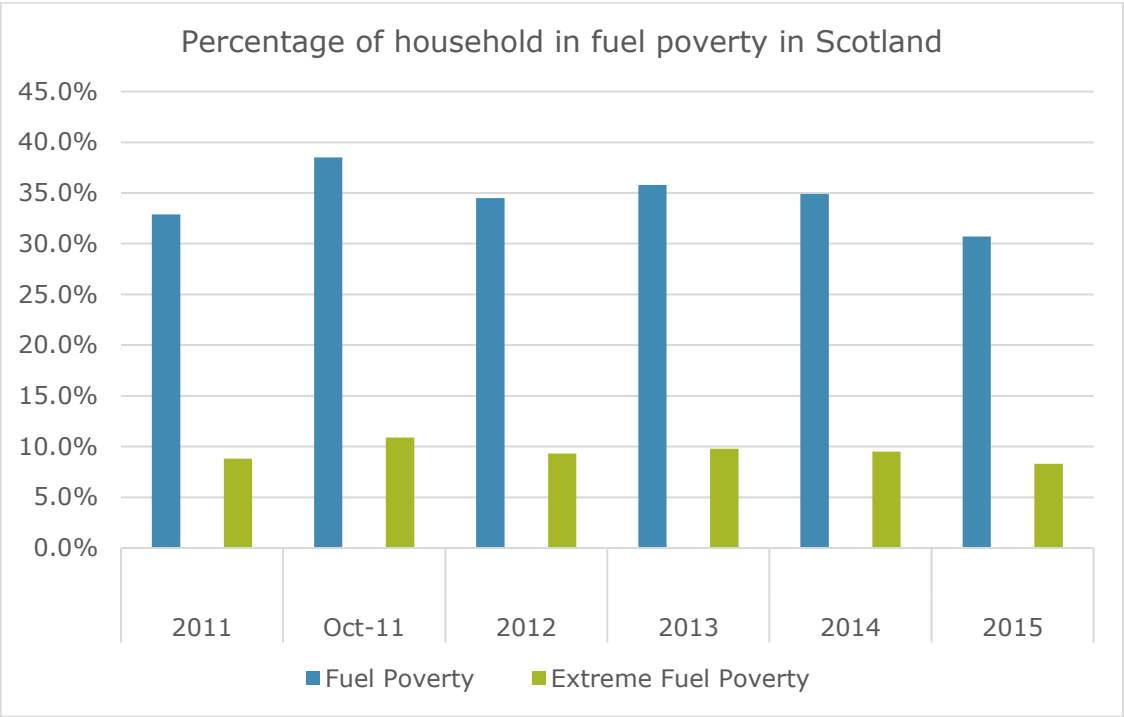


Figure 23: Percentage of household in Fuel Poverty in Scotland, *Source: GOV.SCOT, (2017c)*

2.7.1 Definition of fuel poverty in Scotland and England

In Scotland, a person is living in fuel poverty if, in order to maintain a satisfactory heating regime, they would need to spend more than 10 percent of their household income (including Housing Benefit or Income Support for Mortgage Interest) on all household fuel use (GOV.SCOT 2018c). And a household is in extreme fuel poverty if it has to spend more than 20% of its income on all household fuel (Scottish Fuel Poverty Strategic Working Group 2016).

In England, Fuel Poverty is measured using the Low-Income High Costs (LIHC) indicator (GOV.UK 2018b). Under the LIHC indicator, a household is considered to be fuel poor if:

- They have required fuel costs that are above average (the national median level)

- Were they to spend that amount, they would be left with a residual income below the official poverty line

Fuel poverty is a complicated socio-economic issue and various factors can affect whether a household is fuel poor or not. However, the Fuel Poverty status of a household depends on the interaction between four key drivers;

- Household incomes
- Dwelling's energy efficiency ratings
- Household's required fuel costs
- and how energy is used in the home

In England, instead of EPC rating, Fuel Poverty Energy Efficiency Rating (FPEER) is used to assess fuel poverty. According to (Department of Business Energy and Industrial Strategy 2017) 'an FPEER is a measure of the energy efficiency of a property based on the Standard Assessment Procedure (SAP) but accounts for policies that directly affect the cost of energy. FPEER methodology generates a rating between 1 and 100, which is then translated into an energy efficiency Band from A (highest) to G (lowest) and underpins the Government's fuel poverty target.

Scottish Fuel Poverty Strategic Working Group (2016) suggest that a wider cross-departmental approach to tackling poverty, social inclusion, health and well-being, and sustainable economic growth is needed to tackle fuel poverty. The report points at that fuel poverty is a social justice issue as one can be fuel poor just because the dwellings available in the locality are uninsulated, old or have no connection to the cheaper fuel sources. So, the fuel poverty strategy should be firmly based on the principle of social justice and creating a fairer and more equal society. The report also suggests that there is a need to review in the definition of fuel poverty in Scotland because 'a fuel poverty definition is important for setting policy objectives, targeting of resources and measurement of progresses' (Scottish Fuel Poverty Strategic Working Group 2016).

2.8 THE UK AND SCOTTISH HOUSEHOLD ENERGY EFFICIENCY INCENTIVES AND CLIMATE CHANGE STRATEGY

Some of the differences in the UK and Scottish energy efficiency incentives, policies and ambitions have been already highlighted in the previous sections. This section will discuss them in a clearer and comparative way. The research has set objective to look at the various policy levels and their interconnections so that the social housing energy efficiency retrofit can be understood as a whole. This objective is in line with the research approach based on dialectics, therefore, both problems and benefits are observed.

Scotland has its own household energy policy and climate change strategy along with the UK policies. The Housing (Scotland) Act 2001 (*Housing (Scotland) Act 2001.,* 2001), The Home Energy Assistance Scheme (Scotland) Regulations 2009 (*The Home Energy Assistance Scheme (Scotland) Amendment Regulations 2009.,* 2009), Renewables Obligation (Scotland) Order 2009 (*The Renewables Obligation (Scotland) Amendment Order 2009.,* 2009) and Climate Change (Scotland) Act 2009 (*Climate Change (Scotland) Act 2009.,* 2009) are current major pieces of legislation which create the baseline for the energy efficiency programmes that are unique to Scotland from the rest of the UK.

Scotland has its own carbon reduction targets and renewables ambitions. The Climate Change (Scotland) Act 2009 creates the statutory framework for GHG reductions in Scotland by setting an interim 42 percent reduction target for 2020, which is deeper than the UK government's 34 percent target, and an 80 percent reduction target for 2050. The ambitious Scottish renewables target requires meeting the equivalent of 100% of Scotland's electricity demand from renewables by 2020 (GOV.SCOT 2015a).

Talking about the problems of multi-levelled policy, Anandarajah and McDowall (2012) argue that 'meeting Scottish renewable electricity targets diverts investment and deployment in renewables from the rest of the UK to Scotland' and implies an additional cost to the UK. In another paper (Goulder, Stavins 2011), talking about the US context, the authors also argue that more aggressive state-level action generally leads to differing marginal abatement costs (options available to an economy to reduce pollution) across states, implying that the same reduction could have been achieved at lower cost through an increase in the in the federally established price of emissions. It is important that Scottish incentives should co-exist and not conflict or overlap, with the UK's and help to control fuel poverty, improve energy efficiency and energy security, and not add to the cost.

Although the problems discussed above are relevant, the review of the literature shows that overall the Scottish policies are more helpful than problematic. When we compare the Scottish and UK incentives by delivery model there is a very clear difference. All major UK government incentives (Green Deal, ECO and FIT) are delivered by the private companies while all the major Scottish initiatives (HEEPS, CCF, GHCB etc.) are delivered by the Scottish government or it's representing body (for example Scottish local authority). The Scottish government's biggest home energy efficiency improvement initiative is HEEPS, while the UK government's biggest home energy efficiency improvement initiative is Green Deal. The UK government's Green Deal is a 'market-led framework designed to assist individuals and businesses to make energy efficiency improvements to buildings at little upfront cost' (Ofgem 2013), while HEEPS is a Scottish government programme 'targeted at fuel poor households across Scotland and for the installation of energy efficiency measures' (GOV.SCOT 2014a).

HEEPS was announced in March 2014, ahead of Scottish Independence referendum of September 2014 with the plan of how 'ECO and Warm Homes Discount would be funded in an independent Scotland' (GOV.SCOT 2014a) suggesting it came as an alternative to the Green Deal and to work along with

the ECO. But since Scotland remains part of the UK after the September referendum, exactly how Green Deal and HEEPS will work together has not been made clear. According to Ofgem, "ECO is intended to work alongside the Green Deal to provide additional support in the domestic sector, with a particular focus on vulnerable consumer groups and hard-to-treat homes" (Ofgem 2013), and in Scotland after HEEPS is announced, which is intended to utilise ECO funding like Green Deal does, there remains obscurity regarding how HEEPS, Green Deal and ECO are going to work together without overlapping or conflicting.

Another distinct difference between the UK and Scottish incentives is about community ownership and involvement. UK government incentives are centrally launched and have been heavily privatised, while Scottish incentives are more locally distributed. Again, for example, Green Deal is a market-based framework delivered by the private companies, and FIT, which focuses on renewables, is also delivered by the private energy suppliers. Application processing, consumer selection and delivery are all done by the energy providers in FIT and Green Deal.

In contrast, Scottish incentives like Climate Challenge Fund (CCF) focus more on community involvement and community ownership of the programmes. The third and equally important difference is how they focus on renewables; Scottish incentives have a more aggressive renewables ambition which is meeting the equivalent of 100% of Scotland's electricity demand from renewables by 2020. In contrast, the UK government aims 15% of the UK's energy consumption from renewable sources by 2020(Department for Energy and Climate Change 2011). The following Table 4 shows the energy efficiency and renewable incentives run in Scotland by level and by delivery mode.

Table 4: List of Energy Efficiency Incentives available in Scotland and Delivery Model

Source: GOV.SCOT, 2014b

	Incentives	Delivered by
EU incentive	Scottish Partnership for Regeneration in Urban Centre	AMBER – as the fund manager (with the European Investment Bank acting as Holding Fund Manager
UK government Incentive	Green Deal	Certified and accredited Green Deal Finance Providers/and certified installers
	Feed in Tariff	Main energy providers
	Renewable Heat Initiative	ofgem
	Smart Meters	DECC
	District Heating Loan Fund	EST
	ECO	Main energy suppliers
	Assisted gas Connection	Scotland Gas Networks
Scottish government incentive	Climate Challenge Fund	Keep Scotland Beautiful on behalf of the Scottish Government
	Green Homes Network	Scottish Government
	Green Homes Cashback Scheme	Scottish Government
	Renewable Energy Scotland Renewable Loan Scheme	Home Energy Scotland on behalf of Scottish Government
	Community and Renewable Energy Scheme	Local Energy Scotland
	Renewable Energy Investment Fund	Scottish Enterprise – Scottish Investment Bank
	Warm Homes Fund	Scottish Government
	Home Energy Efficiency Programmes Scotland	Scottish Local Authorities on the behalf of Scottish Government
Local incentive	Scheme of assistance by Scottish local authorities	Scottish Local Authorities

2.8.1 Comparison of the key UK and Scottish household energy efficiency retrofit incentives and policies

To get the full picture of the Scottish household energy efficiency incentives, it is essential to understand the differences and similarities in the UK national and the Scottish energy efficiency policies. There are similarities and differences, and sometimes the policies and incentives overlap. Scotland having its own devolved power to decide on certain energy efficiency policy allows for the setting of good objectives but also creates complexities and a dilemma at the delivery level. In this section, the two policy levels and incentives surrounding housing retrofit are explored. Further discussion on this is covered in the interview analysis in chapter 4 and in chapter 6 Discussion and conclusion.

Table 5: Comparison of the UK and Scottish household energy efficiency incentives

Rest of the UK	**Scotland**
GHG Reduction Target	
Reduce greenhouse gas emissions by 34% by 2020 and at least 80% by 2050 compared to a 1990 and 1995 baseline (*Climate Change Act 2008.* 2008)	Reduce emissions of greenhouse gases by at least 42% by 2020, as a step towards an 80 percent reduction by 2050, compared to a 1990 and 1995 baseline (*Climate Change (Scotland) Act 2009.* 2009)
Renewables Target	
Provide for 15% of its energy need including 30% of its electricity, 12% of its heat, and 10% of its transport fuel from renewable sources by 2020. However, this target in under doubt as a result of underperformance in heat and transport sector (House of Commons Energy and Climate Change Committee 2016).	Meeting the equivalent of 100% of Scotland's electricity demand from renewables by 2020 (GOV.SCOT 2015a). This target is becoming feasible; in the first six months of 2017, enough power was generated to supply more than all of Scotland's national demand for six days (Murray 2017).

Rest of the UK	Scotland
Definition of Fuel Poverty	
Fuel poverty in rest of the UK is measured using the Low-Income High Costs (LIHC) indicator (GOV.UK 2018b). Under the LIHC indicator, A household is considered to be fuel poor if: • They have required fuel costs that are above average (the national median level) • Were they to spend that amount, they would be left with a residual income below the official poverty line	A person is living in fuel poverty if, in order to maintain a satisfactory heating regime, they would need to spend more than 10 percent of their household income (including Housing Benefit or Income Support for Mortgage Interest) on all household fuel use (GOV.SCOT 2018c).
Percentage of population under fuel poverty	
In 2015, the proportion of households in fuel poverty in England was estimated at 11.0%; approximately 2.50 million households (Department of Business Energy and Industrial Strategy 2017).	In 2015, the proportion of households in fuel poverty in Scotland were 30.7%; approximately 748,000 households were fuel poor (GOV.SCOT 2017a).
Number of households in receipt of ECO measures, up to end March 2017	
Total number of unique UK properties in receipt of ECO measures: 1,677,699 (100%)	Total number of unique Scottish properties in receipt of ECO measures: 211,820 (12.6%)
Number of households in receipt of other major home energy efficiency measures	
Households in receipt of Green Deal Home Improvement Fund (GDHIF) measures, (England and Wales); 35,347	Number of households in receipt of Home Energy Efficiency Programmes Scotland (HEEPS); 32,289
Energy Performance Certificate (EPC)	
In the UK, An EPC must be produced, when a new building has been constructed and when a building is to be sold or rented to a new tenant. (GOV.UK 2018a)	In Scotland, an EPC must be produced, when a new building has been constructed and when a building is to be sold or rented to a new tenant. And one must display the EPC somewhere in the property, such as in the meter cupboard or next to the boiler (GOV.UK 2018a).

The comparison in table 5 shows that Scotland has more ambitious carbon emission reduction and renewable energy generation target than the UK. There are far more people in fuel poverty in Scotland compared to the rest of the UK, however, there is a difference in the definition of fuel poverty, which has already been covered under section "2.6.1 Definition of fuel poverty in Scotland and England". We can also see that Scotland received more ECO measures than the UK as compared its population and dwelling number. There are also differences in regulation regarding the display of EPC of a building.

2.9 ORGANIZATION OF COSTS AND BENEFITS OF HOUSING RETROFIT

The research looked into the key aspects of social housing retrofit to determine the problems. Firstly, the 'cost' is discussed in section 2.9.1 because it is an important aspect that is interconnected with the benefit and constraints of retrofit. Without understanding how 'cost' of retrofitting interconnects with major aspects of the retrofit, social housing retrofit cannot be fully understood. Secondly, from the literature review and archival analysis, it is concluded that there are various benefits of energy efficiency retrofitting in the social housing sector then, the major benefits are summarized in section 2.9.2. The benefits summarised in this section provide the foundation for questionnaire (chapter 5).

2.9.1 Costs

The European Commission has produced a standard 'EN 15459 Energy Performance of Buildings – Economic evaluation procedure for energy systems in building' which provides a calculation method for economic aspect of systems that are involved in the energy consumption of buildings (European Committee for Standardization 2007). This methodology for calculation of energy performance of buildings is compliant with Energy performance of buildings directive (EPBD). EN 15459 provides direction for the national standards in the UK level. For example, the SAP calculation is compliant with this standard which thereby produces an EPC for the dwelling. The effectiveness of energy

efficiency retrofit measures and incentives are measured based on the result reflected on the retrofitted building's SAP or EPC band. Therefore, it is important to explore the essence of this standard and what variables are considered in the calculation method.

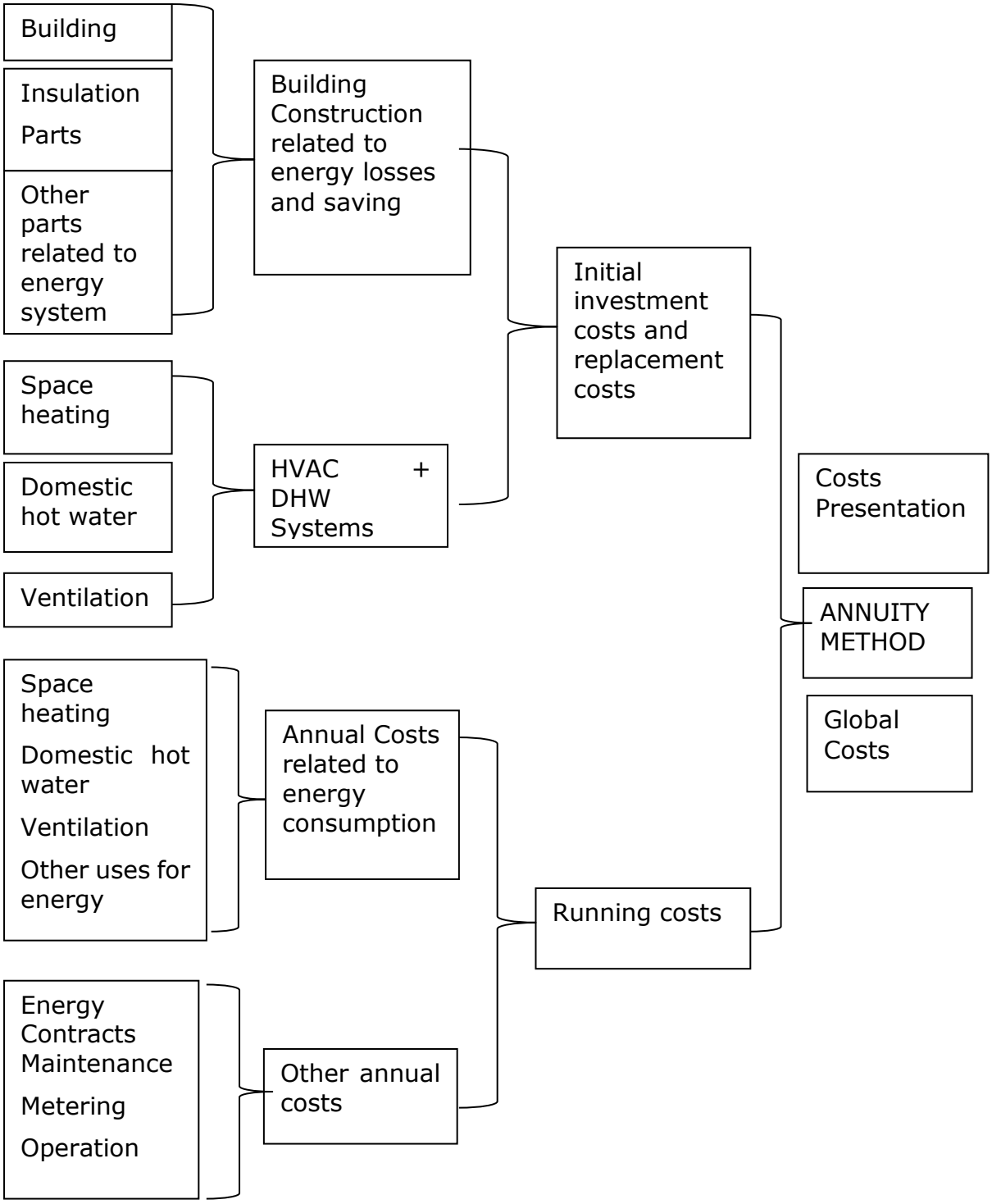


Figure 24: Organization of Costs, source: European Committee for Standardization (2007)

The main focus of EN 15459 is on the heating system, calculating the economic feasibility of retrofitting in any building, comparing different solutions of energy saving options in buildings and assess the effect of possible retrofit measures. The standard uses a global method or overall costs and the costs are separated into investment cost and running cost. Figure 24 shows the various costs used in the calculations.

In response to Directive 2010/31/EU of the European Parliament and of the EU Council of 19 May 2010 on the energy performance of buildings (recast), the UK government firstly produced "Cost optimal calculations: UK report to European Commission" in 2013 in consultation with the Scottish Government, the Welsh Government and the Northern Ireland Executive (Department for Communities and Local Government 2013). By publishing the text, the UK government fulfilled its mandatory duty and gave the EU standard the status of a national standard.

Figure 24 summarizes the organization of various costs. In Figure 24, Annuity method refers to the calculation of annuity cost and 'global cost'. Annuity cost is a distribution of the costs on an annual basis, and the 'global cost' represents the sum of the present value of all costs including investment costs. Annuity cost does not depend on the calculation period, whereas global cost is directly related to the duration of the calculation period because this method distributes the cost over a building's useful life.

The approach of the calculation method is according to a global point of view but, depending on the individual project, the calculation method may be applied considering only selected cost items. For example, calculations considering fabric improvements may be performed considering only costs for fabric improvements (insulation etc.) and other building parts related to fabric energy efficiency.

2.9.2 Benefits

Social housing retrofit is a complex issue which is correlated to many other social and economic issues such as tenant health and wellbeing, fuel poverty, local economy, climate change etc. When talking about the cost effectiveness of a retrofit project one cannot forget about the benefits and intended outcome of retrofit. Dynamic calculations consider benefits and annual variations of the discount rate and variation of any other costs considered in the annual costs.

The issue of retrofit benefit criteria is looked at from the SHO perspective in detail in chapter 5. Here, the literature review looked at the benefits of social housing retrofit from a broader perspective. In this section, the benefits of retrofit are extracted from various sources. The listed benefits are then revised, and a final list is prepared. The final list of the benefits is then used in chapter 5 Questionnaire to determine the SHO ranking of them.

According to Pennycook (2007) the benefits of retrofit are wide and can include amongst other benefits, general financial and managerial benefits, improved building services system, and improved occupant comfort and productivity.

1. General benefits
    - Provide for a change in use of the building
    - Attract higher rents
    - Produce a higher return on capital
    - Help sell or rent a building
    - Retain existing tenants
    - Create more lettable floor space
    - Compete with other new/refurbished properties in the same marketplace
    - Provide improved environmental comfort conditions

- Provide a lower-cost option than moving to a new building
- Provide better-operating characteristics

2. Improved building services system
   - Reduced energy consumption and CO2 emissions
   - Reducing heat output from equipment can correspondingly reduce the demand for cooling
   - Reduced maintenance requirement
   - Increased maintenance intervals (therefore reduced maintenance costs)
   - Greater reliability
   - Easier access for inspection and maintenance
   - Improved supply of spare parts
   - Easier to obtain suitably trained maintenance staff
   - Ability to reduce health and safety risks.
3. Improved occupant comfort and productivity
   - Thermal comfort influenced by air temperature, relative humidity, mean radiant temperature, and air velocity
   - Internal air quality influenced by ventilation rates, quality of the exterior air, building occupants and other sources of internal air pollution
   - Visual comfort influenced by illuminance levels, glare, contrast and colour rendition
   - Acoustic comfort influenced, in part, by noise from building services equipment, noise from the exterior, and noise passing from one office area to another, e.g. through walls or via ceiling voids.

Martin and Gold (1999) focus on the financial benefits to the owner and claim the principal reason or benefit of retrofit is to maximise income or asset value. The following benefits of retrofit arguably reflect this perspective;

1. Improve appearance
2. Improve efficiency
3. Utilise space
4. Meet new regulations
5. Refurbish to attract new tenants
6. Extend to increase the lettable area

Ward (1994) highlighted that landlords do not typically keep comprehensive records of management tasks dealing with tenant complaints and expenses in dealing with them. The report made clear that there is a significant management cost-saving through retrofit, but also acknowledged that to keep track of management cost-saving may be difficult. The financial benefits of retrofit to social landlords are, according to (Ward 1994), as follows;

1. Reduced condensation treatment
2. Fewer repairs following energy efficiency retrofit
3. Higher rent revenues
4. Reduced number of complaints
5. Drop in the number of transfer requests
6. Asset value increase
7. Reduction in the number of times, and in the length of time a property remains void
8. Maintenance saving
9. Management Saving

The benefits of retrofit have also been compared with demolition which is a very genuine comparison if we look at the UK and Scottish context. As has already been discussed, over 94% dwellings in Scotland are older than 53 years. So, it is economically impossible to demolish them all and replace with new dwellings. Apart from the economic issue, there is also environmental and other issues such as preservation of historical built heritage. According to (Power 2008), in contrast with the negative wider problems generated by demolition, retrofit in all but the most extreme cases is both cheaper and less damaging to the local environment than demolition and then a new build. Retrofit offers the following benefits:

1. Renovation preserves the basic structure of the property and retains existing infrastructure in an existing built environment.
2. The renewal of a single house has an immediate beneficial effect on neighbouring properties because it gives a clear signal that the neighbourhood is worth investing in.
3. Upgrading is far quicker than demolition and replacement building because in most cases it involves adaptation of the existing structure and layout of a house rather than starting from scratch.
4. It is far less disruptive to residents because even where major work is undertaken, unless a dangerous structure is involved, residents can usually stay, and the area services continue to operate. If residents have to move out temporarily, it is normally for months rather than years.
5. It involves a shorter and more continuous building process since most of the work can happen under cover in weatherproof conditions. New build involves many months of exposure to all weathers while building the foundations and main structure.
6. It has a positive impact on the wider neighbourhood, sending a signal that renewal and reinvestment will ensure the long-term value and stability of an area. This, in turn, generates other investments and a broader upgrading.

7. Older existing neighbourhoods and homes require constant upgrading. A renovation has a positive effect on street conditions, social mixing, service quality, local transport and schools since it adds value and attractiveness.

From the above literature review, it can be seen that there is a wide range of benefits of social housing retrofit. It is not feasible to discuss all these benefits and apply them to a questionnaire as an individual benefit in the research. Therefore, they are summarized into the following eight benefits.

2.9.2.1 Economic benefits to broader society

Economic benefits to the broader society can be defined as benefits of retrofit that have a positive effect on the community and the society as a whole. For example, Power (2008) argues that the retrofitting of a single house "has an immediate beneficial effect" on other dwellings in a neighbourhood "because it gives a clear signal that the neighbourhood is worth investing in". It has a positive impact on the wider neighbourhood, sending a signal that renewal and reinvestment will ensure the long-term value and stability of an area. This, in turn, generates other investments and a broader upgrading. Older existing neighbourhoods and homes require constant upgrading. A renovation has a positive effect on street conditions, social mixing, service quality, local transport and schools since it adds value and attractiveness.

Apart from that, the retrofitting activity can create new jobs which will be beneficial to the economy of the country. For example, housing repair and maintenance contributed £2349 million to construction industry output in January 2018 (GOV.UK, 2018b), of which public sector housing contributed £595 million, while private sector housing contributed £1754 million. Although this is an overall repair and maintenance figure, it is correct to say that this is a significant figure for the UK economy, and energy efficiency retrofit is a significant sub-sector in terms of its contribution.

2.9.2.2 Environmental and climate change benefits

Pennycook (2007) mentioned that retrofitting improves building services system which reduces energy consumption and CO2 emissions in the dwelling. Similarly, Martin, Gold (1999) and Power (2008) have mentioned about the improved energy efficiency and other environmental benefits of retrofit.

It has previously been discussed in the section "1.1 background of the research" that there are tangible and significant benefits of retrofit on reducing carbon emissions from dwellings with respect to climate change risks mitigation. According to the 2017 Department for Business, Energy and Industrial Strategies report (Waters 2017), the domestic sector accounted for 29% of final energy consumption in the UK in 2016 which is the second biggest contribution after transportation sector (40%). Energy efficiency retrofit is therefore very important environmentally; the provisional estimated lifetime carbon savings of retrofit measures installed by the end of September 2017, under ECO (excluding Affordable Warmth), Cashback, GDHIF and GD was between 31.8 - 33.2 MtCO2 with provisional estimated lifetime energy savings between 127,614 – 133,996 GWh (GOV.UK 2018a).

2.9.2.3 Financial benefits to the landlord

Financial benefits of retrofit have been discussed elsewhere by authors such as Martin, Gold (1999) and Ward (1994). They explore various financial benefits including reduced condensation treatment, fewer repairs following energy efficiency retrofit, higher rent revenues, asset value increase, maintenance saving and management saving. Retrofit helps to improve the appearance and efficiency of the dwelling, which in turn helps attract new tenants. (Power, 2008) highlights that retrofit is far less disruptive to residents than demolition because even where major work is undertaken, unless a dangerous structure is involved, residents can usually stay, and the area services continue to operate. If residents have to move out temporarily, it is normally for months

rather than years and decanting tenants can be a significantly big cost to the SHO. By retrofitting, such cost may be avoided.

In the social housing sector, this benefit may be not a major priority however this can save a significant amount to the SHO, which can then allocate to other useful work such as helping out tenants who are in fuel poverty. This benefit is one of the least explored in literature and is subject to further research. This issue has also been highlighted by interviewees as well.

2.9.2.4 Fuel poverty reduction

One of the most important benefits from energy efficiency retrofit is fuel poverty reduction or eradication due to reduced energy consumption and reduced energy bill. This topic has been already discussed in detail in section 2.6 where it is looked as a problem. Here, 'fuel poverty reduction' is looked as a benefit of retrofit because as a result of improved energy efficiency and reduced bill, retrofitting help reduce fuel poverty. The interconnection between energy efficiency retrofit and fuel poverty reduction has been discussed in the previous sections.

In contrast to the significance of issue, it is revealed from the communication with leading Scottish SHO that they don't keep financial record of their fuel poverty-related expenditure (Dundee City Council, personal communication by email, 2016), (Edinburgh City Council, personal communication by email, 2016), (Aberdeen City Council, personal communication by email, 2016). The communication with some of the biggest social landlords in Scotland reveals that they have the record of overall maintenance cost but don't keep the record so as to distinguish whether the maintenance was related to fuel poverty and energy efficiency issue or it was a regular maintenance.

The benefit from fuel poverty reduction, therefore, interconnects with the 'financial benefits to the landlord' because both benefits are related to direct

benefit to SHO. As the communication reveals that the social landlords typically don't keep the record of the financial impact of tenant transfer, maintenance cost related to cold/dampness and fuel poverty-related expenses, SHO have not been able to realise the benefits of solving those issues, to full extent. If the SHO were able to have tangible statistics on such benefits this can help them attract more funding for retrofitting.

2.9.2.5 Preservation of historic buildings and built heritage

Power (2008) mentioned that one of the benefits of retrofitting is it preserves the basic structure of the property. To retain the existing structure of a dwelling really important in terms of historical and preservation values. There are many social sector buildings with historical and other value, therefore, retrofitting them is very important.

According to Historic Environment Scotland (2017), in Scotland the buildings are considered 'listed' in terms of their importance as assessed by the following;

1. Age and rarity
2. Architectural and historical interest
3. Historical association

The preservation of historical buildings and built heritage is very important for historical, architectural, political, cultural, tourism and economic reasons. These dwellings reflect the identity of a community and a country and add to the value of that community and country. Retrofit is fundamental to protect these dwellings whether that are houses or other types of buildings. For example, it was discussed earlier that the pre- 1919 dwellings account for 1% of all social sector dwellings in Scotland, a lot of these dwellings are listed dwellings and carry historical, political, architectural, scientific, and religious or other significance. Retrofit helps preserve such dwellings.

According to Historic Environment Scotland (2017), there are around 47,000 listed buildings in Scotland. These buildings are managed through the planning system's listed building consent process, so that any changes to them have to be carefully considered because they carry historical, architectural or other 'special' significance nationally, internationally or locally. Among the listed buildings in Scotland, the simple traditional buildings category accounts for around 42% (19,740) of the total.

2.9.2.6 Meeting government regulation

Martin, Gold (1999) mentioned that retrofit is necessary in many dwellings to meet new regulations, with failure to having to do so having possible legal consequences. Most interviewees stated that one of the main reasons for doing retrofit is to meet government regulations and to bring the dwellings to the current standard. For example, The EESSH was introduced in March 2014 and set the first milestone for social landlords to meet for social rented homes by 31 December 2020 (GOV.SCOT 2018a). EESSH has been discussed in section 2.5 which discusses details on the requirements set by EESSH.

2.9.2.7 Tenant health

In section 2.2 it was discussed that many social tenants are from the population in society those considered as vulnerable. The housing for tenants, including those regarded as vulnerable needs to be suitable for healthy living whether in relation to the movement of tenants inside a dwelling, internal air quality or the ability to achieve a warm home. Thermal comfort plays an important role in tenant health, especially those with certain conditions, while the elderly and children need adequate thermal comfort. Pennycook (2007) state that retrofit increases thermal comfort as influenced by air temperature, relative humidity, mean radiant temperature, and air velocity. The paper further states that retrofit can improve internal air quality as influenced by ventilation rates, quality of the exterior air, building occupants and other sources of internal air pollution.

Energy efficiency retrofit can help improve tenant health by keeping their homes warmer and reducing energy bills. Therefore, the reduction of the energy bill and tenant health interconnects with fuel poverty. If the dwelling uses less energy, the tenant will be able to heat the house adequately which will help maintain healthy temperature while the risk of tenant falling in fuel poverty is reduced. The research questionnaire found out that fuel poverty reduction, the improvement and taking care of tenant health is a very high priority for the SHO which is discussed in detail in chapter 5.

According to GOV.SCOT (2017b), when asked: "Does Your Heating Keep You Warm Enough in the winter?" 22% of the social tenants said, "Only sometimes" and 9% of said, "No, never". This survey shows there is a significant number of social tenants who live in cold homes. The problem of not heating a home adequately is related to fuel poverty as well as a house being not retrofitted to the current standard. Whatever the reason, this has direct consequences on tenant health which can be widely avoided by retrofitting.

2.9.2.8 Tenant satisfaction

Tenant satisfaction can largely be considered in the context of the benefit regarding tenant health, however, there are other factors that can improve tenant satisfaction. By retrofitting visual comfort measures, illuminance levels, glare, contrast and colour rendition can be improved. Similarly, acoustic comfort influenced, in part, by noise from building services equipment, noise from the exterior, and noise passing from one office area to another, e.g. through walls or via ceiling voids, can also be improved (Pennycook 2007).

Improving tenant satisfaction has an indirect but significant benefit to social landlords. Ward (1994) state that retrofit can lead to a reduced number of complaints and a drop in the number of transfer (move from one dwelling to other) requests, which reduces in the number of times, and the length of time

a property remains void. Therefore, improved tenant satisfaction increases rent revenue and also saves management cost to the SHO. Such a saving can be significant, but as revealed by the communication (Dundee City Council, personal communication by email, 2016), (Edinburgh City Council, personal communication by email, 2016), (Aberdeen City Council, personal communication by email, 2016) the social landlords don't typically keep record of the cost arising from voids, transfers, dealing with complains etc. Therefore, the financial benefit of tenant satisfaction is unexplored although a significant benefit can be seen.

2.10 CONSTRAINTS OF SOCIAL HOUSING ENERGY EFFICIENCY RETROFIT

The research looked into the key aspects of social housing retrofit to determine the problems. From the literature review and archival analysis, it is concluded that there are various problems in the social housing energy efficiency retrofit in Scotland, among them the following listed are the major problems. These constraints are interconnected with the cost and benefits discussed in section 2.9 and provide the foundation for the interview (chapter 4).

2.10.1 Cost of retrofitting

It is important to acknowledge that 'cost of retrofitting' as a constraint does not necessarily mean 'lack of funding' but 'adapted funding'. Social housing is charity or social non-for–profit organization. Along with the basic duty of providing home to people it also runs various complex operations such as assisting people to pay their rent, repairs and maintenance, fuel poverty, health and wellbeing, helping to deal with antisocial behaviour, help with universal credit, benefits and money etc. And a lot of these operations such as fuel poverty, maintenance and repair, health and wellbeing are related to dwelling's energy efficiency along with other social and economic factors. The above discussed incentives such as ECO only focus on the dwelling's energy efficiency while ignoring associated social issues like fuel poverty. This leads to projects not meeting the desired outcome.

From the review of the literature, it can be concluded that the lack of adapted funding (Milin and Bullier 2011) is the major problem in the social housing energy efficiency sector. Firstly, there is not enough funding secondly the available funding is not adapted to the need of social landlord. There are various funding sources available through EU, UK government and Scottish government (see Table 4) but these findings come under certain conditions such as timeframe, type of building, the location of a project, size etc. Meeting those targets for social housing organizations challenging, in that sense, available findings are not adapted to the need of SHO.

The main source of funding for retrofitting social housing is ECO. And the other sources of funding are HEEPS Loan scheme, The Green Network for Social Housing and District Heating Loans scheme (GOV.SCOT 2014b). The main source of funding ECO is designed more suitably for private sector due to its focus on reducing carbon emission rather than on energy efficiency. The resource implications attached to applying for, and complying with, the Energy Company Obligation (ECO) are not always justified in terms of returns. As a result, SHO are not being able to utilise the incentives to cover the cost of retrofitting their dwelling stock.

Table 6 Investment in the first two years of EESSH, source: (The Scottish Government 2017)

	2015/16		**2016/17**		
	Local authority	**RSL**	**Local authority**	**RSL**	**Total by SHO (LA +RSL)**
Investment from subsidy	£6.15m	£11.61m	£11.12m	£4.86m	15.98m
Investment from own resources	£64.37m	£28.05m	£49.29m	£30.41m	79.7m
Investment from other sources	£0.95m	£0.72m	£1.17m	£3.05m	4.22m
Total	£71.47m	£40.38m	£61.60m	£38.33m	99.9m

Table 6 shows data on investment from the performance returns made by social landlords to the Scottish Housing Regulator for the business years 2015/16 and 2016/17- 2016/17.

The chart below shows SHO investment on retrofitting in year 2016/17. Among £100 million spent only £15.98 million was investment from incentives such as ECO. This shows heavy reliance on social landlords' own resources to achieve EESSH target for 2020. Suggesting that the SHO are unable to fully exploit the funding from incentives such as ECO.

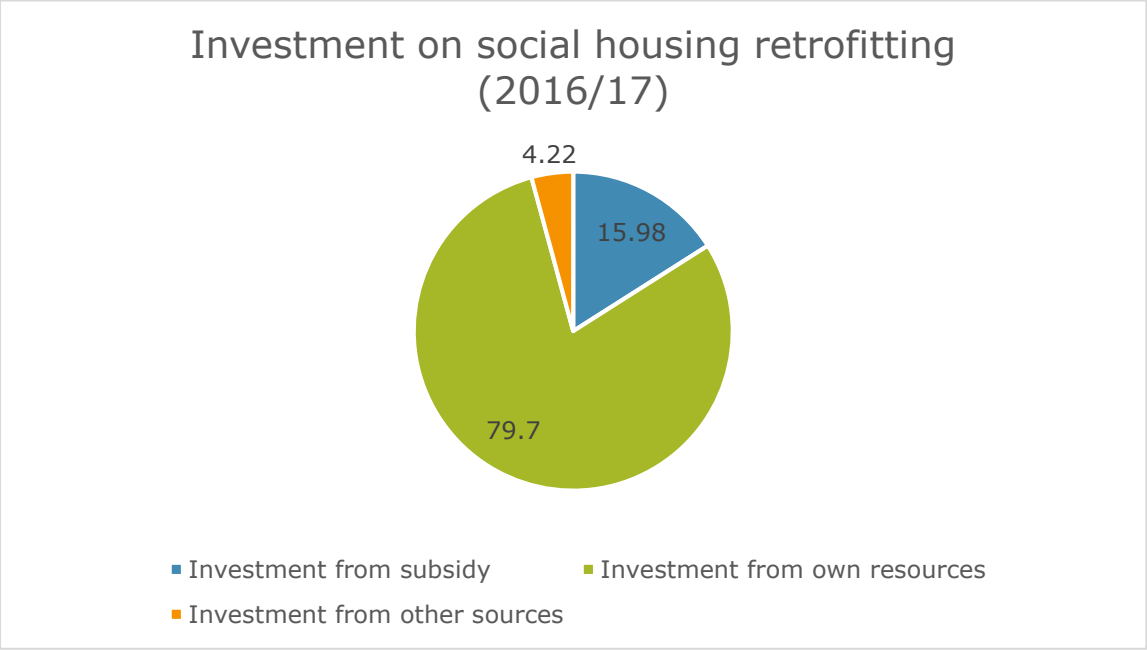


Figure 25 Investment in year 2016/17 on social housing retrofitting, Source: (The Scottish Government 2017)

2.10.2 Prevalence of fuel poverty

High prevalence of fuel poverty in Scotland has forced the conversation around energy efficiency retrofit towards many socioeconomic issues such as income, economy, social justice, fuel price etc. This diversion of conversation is a problem and needs a holistic approach to deal with both retrofit and fuel poverty issues.

Energy efficiency of a building is not just an environmental issue, but, has a direct relationship with wider economic and social issues including fuel poverty and social justice. According to GOV.SCOT (2017c), by 2015, there are 30.7% households living in fuel poverty in Scotland. This is comparatively a higher number than in England. The issue of fuel poverty is interconnected with the issue of energy efficiency retrofit (see section 2.7) therefore these two issues have to be addressed in combination. But there are problems in defining and dealing with fuel poverty which leads to a problem in trying to conjointly address fuel poverty and energy efficiency retrofit.

2.10.3 Incentives are heavily market-oriented

UK government energy efficiency incentives are heavily market focused which creates the problem of clarity and accountability on who is responsible for the social housing retrofit. If looked at Table 4, there are the majority of incentives delivered by private energy companies including three major incentives; ECO, Green Deal and FIT. This looks problematic as the private energy companies' interest (of selling energy) and responsibility of delivering retrofit incentives (for reducing energy demand). The issue is further discussed in Chapter 4. For now, the review of literature can conclude that the market-oriented solutions of energy efficient housing retrofit focus more on effectiveness and less on social justice (Schaffrin 2013). And since social housing exists on the belief of social justice, the delivery mechanism of retrofit incentives itself become a problem.

2.10.4 Lack user behaviour and “human factor based retrofit”

The access of people to the information about the initiative, the way people heat and light and use appliance has a big impact on the issue of energy efficiency and fuel poverty. Major UK government's energy efficiency incentives lack user behaviour or "human factor based retrofit". If we look at Table 4, apart from Smart Meters incentives, the other retrofit incentives lack human factor or user behaviour. The UK government initiatives also lack the involvement of the people, the tenants or the group who are considered fuel

poor. If the user behaviour is wasting a lot of energy or the user doesn't understand the ways of using retrofitted energy efficient appliances or retrofitted house, even the comparatively high-income people can become fuel poor as well (Wilson et al. 2012). Apart from that, the lack of stakeholder involvement in the delivery of retrofit incentives can make the delivery difficult and success of incentives may be limited. If we look at the delivery mechanism of ECO and Green Deal, the tenants or SHO involvement is limited.

Study by Elsharkawy and Rutherford (2018) show that, although a retrofit scheme through Community Energy Saving Programme (CESP) in Nottingham may have succeeded in providing people with warmer homes, it did not actually achieve the energy and carbon savings anticipated partially due to the variable energy consumption behaviour of tenants noted in pre-implementation and post-implementation phase of the retrofit. They conclude that with the rapid increase in energy prices combined with variable energy consumption trends in households, a significant part of the savings had not been realised, resulting in the unresolved issue of fuel poverty.

2.10.5 Lack political sustainability in retrofit policies

One of the prompting occurrences on the review of the literature was the frequent changes in the energy efficiency incentives and policies. When looked at Figure 19 and Table 1, the major changes and announcement in ECO and Green Deal incentives are presented. It shows that there is inconsistency in UK's household energy efficiency policy and climate change strategies. This 'lack of political sustainability' (Lockwood 2013) in energy policy and climate strategy has led to significant uncertainty on the projects funded by those incentives and SHO have difficulties dealing with those uncertainties.

2.10.6 Scottish and UK incentives are overlapping

The other prompting occurrence observed from the review of the literature was that the various policy levels that exist in energy efficiency retrofit. Among the retrofit incentives some of the Scottish and UK initiatives are overlapping and there are obscurities on how similar programmes work together. Many incentives deliver similar measures with slightly different aims and there no clarity whether they can work combine or separately. This can be problematic because of confusion it can create. The different policy levels and funding incentives also cause breaking up of funding and limit the scale of a retrofit project. See section 2.8 for more detail on how the Scottish and UK incentives interconnect.

2.11 RESEARCH GAP

To understand the existing knowledge in the field and find out the research gap, a thorough search of literatures was carried out (Please also refer to section 3.1 for the research gap with focus on research method). From the review of literature, it can be concluded that most of the research in the field of social housing retrofit is focused either in particular case-study/studies; for example (Elsharkawy, Rutherford 2015), (MILIN AND BULLIER 2011), (Gagliano, Nocera et al., 2013) all focus on case studies. Or there are the reports from the governments; for example (GOV.SCOT 2018a), (GOV.SCOT 2018c), (GOV.SCOT 2018b), (DTI, 2007) are all government reports. The research which focus on particular case-study focus on particular problem such as 'user behaviour after retrofit' or particular location such as 'Nottingham', therefore cannot be generalised. On the other hand, the government reports tend to highlight the plans and best projects such as case study of Cairn Housing Association presented in (GOV.SCOT 2018b). Therefore, such reports lack neutrality.

From the review of literature, it can be concluded that there is a gap in the knowledge; there is lack of academic research which looks at social housing retrofitting as a whole. There is not any independent academic research carried out in the field of social housing retrofit in a holistic way and from the perspective of SHO in Scotland. This research looks at the overall issues and determines benefits and constraints of social housing retrofit in Scotland. The objectives this research covers three key elements of social housing retrofit; policies, problems and benefits from SHO's perspective. The previous research in this field cover either policies or benefits or problems. They don't cover all of the three elements in holistic study as this research does.

3 RESEARCH METHODOLOGY

The theoretical aspects of the research methodology are discussed in this chapter with reference to related literature. Overall research methodology applied in the research, which are identified in this chapter, feed to the research aim, objective, questions, framework and phases identified in chapter 1. Section 3.1 explores the methods used by previous researchers in the field of social housing retrofit. The next sections lead to determining the research method and factors that made to choose particular method and approach to generalisation from the findings.

According to Oxford Dictionary, research methodology is a 'system of method' (Oxford Dictionaries 2018b). The research method; as a 'procedure for accomplishing something' (Oxford Dictionaries 2018a), for interview and questionnaire, is explained in detail in chapter 4 and chapter 5 respectively. Apart from research methodology, this chapter also identifies the limitation and ethical consideration of the research.

3.1 REVIEW OF THE RESEARCH METHODS

As mentioned in section 2.11, most of the research in the field of social housing retrofit adopted case-study, review of literatures and archival analysis methods. The aim of this research is "to determine the problems and benefit criteria of energy efficiency retrofit in the social housing sector, in Scotland, from the social housing organizations' perspective" which has some similarity to Dowson, Poole et al. (2012) 's aim to "…review the key outcomes of the various fabric efficiency incentives and understand the key barriers to obtaining deep energy and CO_2 savings throughout the stock".

In their article Dowson, Poole et al. (2012) review the thermal performance of the existing UK housing stock and the main fabric efficiency incentive schemes to understand the barriers to obtaining deep energy and CO_2 savings throughout the stock. The research used method of reviewing literature and various reports (for example: survey reports from Building Research Establishment, history of UK building regulations), analysis of archival statistics (for example: survey of English house conditions), and energy efficiency incentives (for example: Green Deal). The research presents strong argument in terms of reviewing barriers of energy efficiency incentives such as Green Deal. However, the conclusion is purely based on the archival analysis and reviews of literature, policies, incentives and reports, therefore, it does not necessarily represent the stakeholder's view on the incentive. The research further recommends more transparency regarding the benefits and disruption of different retrofit packages and more information about the wider implications of schemes such as how it impacts fuel poverty, household value and re-saleability.

Santangelo, Tondelli (2017) aims "to provide an insight on the role of occupant behaviour in the social housing sector and to make recommendations to support successful delivery of current and future policy instruments towards the energy efficiency in the residential sector". Similar to Dowson, Poole et al. (2012) the research also uses literature review and analysis of various incentives and policies as research method. Although the research comes up with significant conclusions, there are issues with research method. Under the section "strategies of to promote energy efficient behaviour" the authors come up with benefits of energy efficiency retrofit which comes from "author's elaboration". Although typical benefits of retrofit such as; i) improved comfort, health, safety and education; ii) preserve affordability etc are mentioned, the research fails to connect those conclusions with valid source, instead, it states "author's elaboration" as source.

Another recurring method used in the research of social housing retrofit is case study usually with interviews and/or questionnaires. Elsharkawy, Rutherford

(2015) used questionnaire based on a scenario-building strategy 'to map the personal constructs of a broad group of respondents. The sample were households eligible for one of the energy efficiency schemes that did not receive official information about the scheme. The households were selected and approached in a door-to-door survey approach. The strength of this approach is that it has high response rate, accurate sampling and minimum interviewer bias, while offering the benefit of a degree of direct contact. But as the questionnaire survey was carried out in small area of specific location, the method may be limited to representing that specific geographical location. From the strength and weakness of this research method, it can be concluded that direct contact during filling up questionnaire has significant benefits such as high response rate and accurate sampling therefore it can be adopted in this research. However, the case study and door to door surveying limits the implication of research into smaller geographical location. For example, Reeves, Taylor et al. (2010) also present a case study of Peabody, England on social housing retrofit which focused only on carbon emissions that result from direct and indirect energy use in the home. Their finding implied that there is a need for a substantial deployment of carbon reduction measures to achieve deep cuts in carbon emissions for all stock types considered which is likely to be required for other social landlords. However, the research also concludes "...though the particular measures that will be appropriate will differ according to each particular landlord's stock profile".

3.2 RATIONALE FOR THE RESEARCH METHOD

It can be concluded from the review of research methodologies that both qualitative and quantitative methods are used in the study of social housing retrofit and among them review of literature, archival analysis, interviews and questionnaires are most common. For this research, it is determined that mixed method (qualitative and quantitative) will be used.

In the first phase of the research, qualitative method of archival analysis, review of literatures, policy documents and various literatures regarding social housing retrofit will be done. Specific focus is given to the literature regarding Scotland to meet research aim "to determine the problems and benefit criteria of energy efficiency retrofit in the social housing sector, in Scotland...". From the research method used by Dowson, Poole et al. (2012) it can be seen that the review of literature and archival analysis are important methods for understanding the barriers/problems and benefits of retrofit. But for the wider validity of the research, the stakeholders' opinions should be included. Therefore, for the validity of the conclusions drawn from the review of literature and archival analysis and to answer questions such as the benefits and disruption of different retrofit packages and wider implications of incentives such as how it impacts fuel poverty, this research includes stakeholder's opinion using semi-structured interview and fully-structured interviews methods.

Similar to Santangelo, Tondelli (2017), this research first takes 'desktop approach' to identify the benefits of retrofit in first phase and then takes those results to the stakeholders for ranking through fully structured interview in the second phase. Taking the results of literature review and archival analysis to interview gives the results more connection to the valid source and reliability is established. At this stage, semi-structured interview is carried out. This gives a chance to revise and determine the results from literature review and archival analysis. Fully structured interview is more suited for this research because the exploratory part of research is already done in archival analysis and literature reviewed. The fully structured interview is important as it gives chance to validate and rank those result with the stakeholders. More on the sample size, questionnaire design, are described sections below. More on data analysis techniques and the reason for selectin those techniques are discussed in chapter 4 and 5.

3.3 Research Design

Figure 26 shows the design of the research in nutshell.

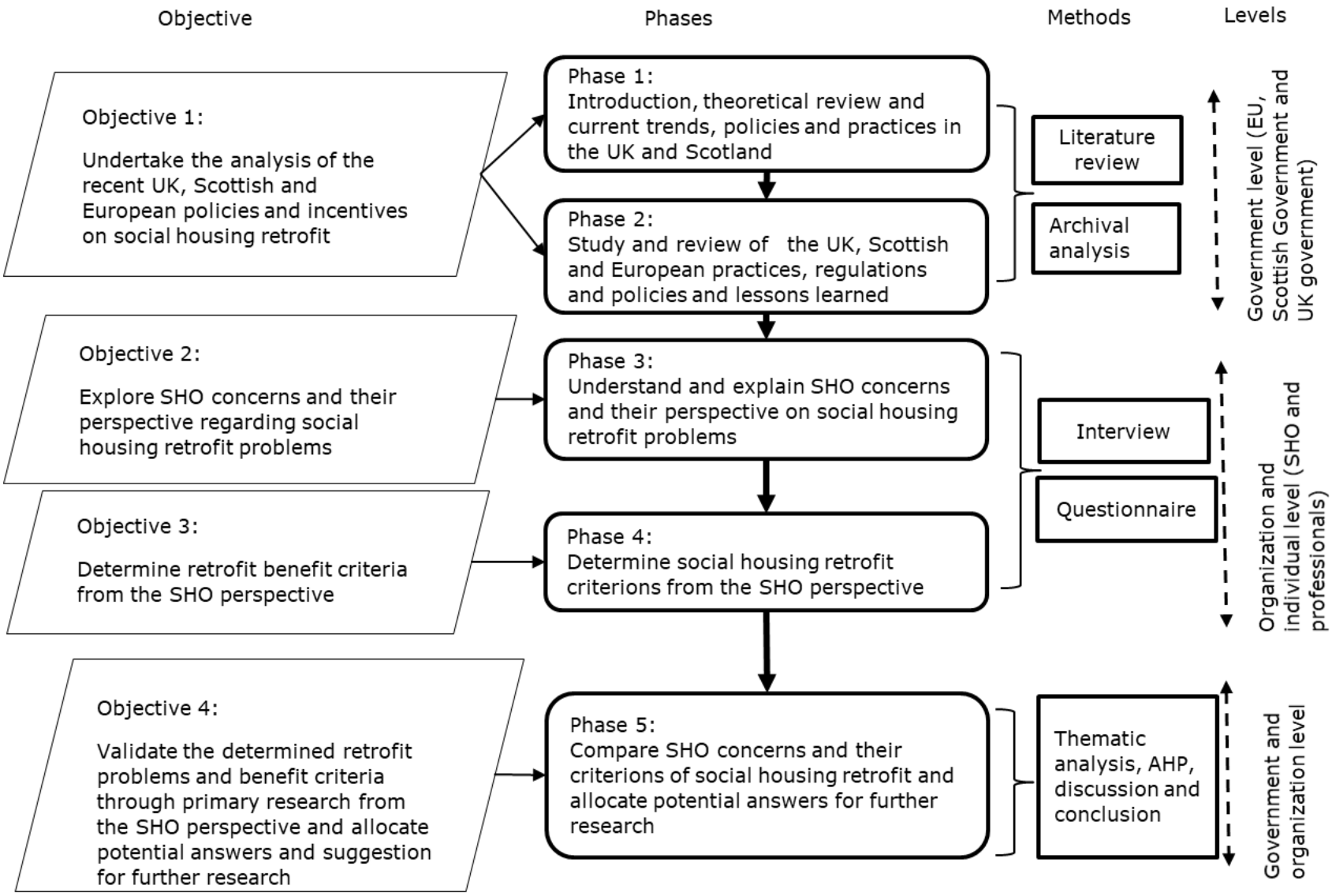


Figure 26: Research design in nutshell

The aim of this research was to determine, from the social housing organizations' perspective, the problems and benefit criteria of energy efficiency retrofit in the social housing sector in Scotland. To achieve this aim four objectives were set. To achieve the aims and objectives of the research, a number of questions were identified; i) What are the problems of social housing retrofit? ii) How can the social housing sector become the recipient of more energy efficiency measures? iii) What are the questions that need to be answered in order to maximize energy efficiency retrofits in the social housing sector?

Then the 5 phases of research were developed. Each phase answering the research questions relevant to a research objective and then finally meeting the research aim. In various phases various research method is used. The first and second phase used a desktop approach of research. The first phase was introduction, theoretical review and current trends, policies and practices in the UK and Scotland. In this phase, archival analysis and literature review was used as the research method. Similarly, in the second phase, literature review and archival analysis was used to study and review of the UK, Scottish and European practices, regulations and policies. At the end of this phase, lessons learned from previous projects and literatures, and benefits and constraints of social housing retrofit were identified.

The third and fourth phase of research tested the conclusions derived from the second phase. At this stage, semi-structured interview method is used to understand and explain SHO concerns and their perspective on social housing retrofit Problems. Inductive Thematic Analysis is used as data analysis method to analyse interview data. Fifth phase of the interview used fully-structured interview or face-to-face questionnaire method to determine social housing retrofit benefit criteria from the SHO perspective. The interview at this phase used Analytical Hierarchy Process (AHP) matrix to rank the benefit criteria. This stage completed the final task of validating the conclusions gathered through literature review and archival analysis in phase 2. Finally, discussion and

conclusions section compare SHO concerns and their benefit criteria and allocate potential questions for further research.

3.4 RESEARCH MODES

Table 7: Research Modes

Key research modes	What type of research is this?
1. Research application	
Applied research	√
Pure research	
2. Research objective	
Exploratory research	
Explanatory research	√
Descriptive research	
Correlational research	√
3. Inquiry mode	
Qualitative method research	
Quantitative method research	
Mixed method research	√
4. Data sources	
Documentation	√
Interviews	√
Direct Observation	
Participant Observation	
Archival records	√
Physical artefacts	
5. Data analysis	
Analytical	√
Logical	
6. Reliability	
Stability	√
Equivalence	√
Representative	√
7. Validity	
Internal validity	√
External validity	√
Statistical validity	√

Before determining a research method, it is important to understand the nature or type of the research as a whole. Scholars have explained different types of research based on key research modes. The research modes mentioned in table 7 indicate the way research methodology is expressed in relation to research application, research objective, inquiry mode, data sources, data analysis, reliability and validity. From the review of the literature Kumar (2014) and Bryman and Bell (2015) the above research modes (Table 7) can be listed.

3.5 APPLICATION OF THE RESEARCH

Research can be categorized as applied research or pure research on the basis of the application of the research. "Applied research refers to an investigation undertaken to discover the applications and uses of theories, knowledge and principles in actual work or in solving problems (Sreejesh, Mohapatra et al. 2014)." The research aims to 'determine the problems and benefit criteria of energy efficiency retrofit in the social housing sector, in Scotland, from the social housing organizations' perspective'. In other words, the research aims to determine the retrofit benefit criteria from the SHO perspective and allocate potential answers to the retrofit problems. The research aims to determine the problems and criterions of social housing retrofit from existing literature, archival analysis, interviews and questionnaires using an existing method such as Inductive Thematic Analysis (ITA) and Analytical Hierarchy Process (AHP). Since research is aiming to use existing principle/knowledge in solving the problem in social housing retrofit it is categorised as an applied research.

3.6 RESEARCH OBJECTIVES

From the point of view of the objectives, the research can be categorized as both correlational and explanatory research. Correlational research means to discover or establish the existence of the relationship, association or interdependence between two or more aspects of a situation. Explanatory research means to clarify why and how there is the relationship between two

aspects of the situation (Kumar 2014). It is useful to restate the objectives of this research:

1. Undertake the analysis of the recent UK national, Scottish and European policies and incentives on social housing retrofit
2. Explore SHO concerns and their perspective regarding social housing retrofit *problems*
3. Determine retrofit benefit criteria from the SHO perspective
4. Validate the determined retrofit benefit criteria through primary research from the SHO perspective and allocate potential answers and suggestion for further research

The objectives are mainly focused on discovering relationships and interconnections between various aspects; mainly benefit criterion and problems of retrofit. Objective one is to look at the interaction, interdependencies, etc. between UK, Scottish and EU retrofit policies, incentives and regulation. It is to explain or clarify the relationship between these three levels of policies, incentives and regulations, and how the outcomes are going to influence the overall aspects of the Scottish social housing retrofit.

The project regarding the second and third objectives together, this is again looking at the interconnection between problems and benefit criterions of energy efficiency retrofit. And the fourth objective is more concerned with explaining why and how these relationships, interactions and influences can are gathered in an understanding to produce some tangible object such as framework model to help decision-making process s in SHO green retrofit project.

3.7 RESEARCH STRATEGY

A combination of archival analysis, history, interviews and questionnaires sum up the research strategy used in this research. The archival analysis in this research is focused mainly on the public sector records and documents stored in various sources. The data or resources for archival and historical analysis are mentioned in section 'Data sources' below.

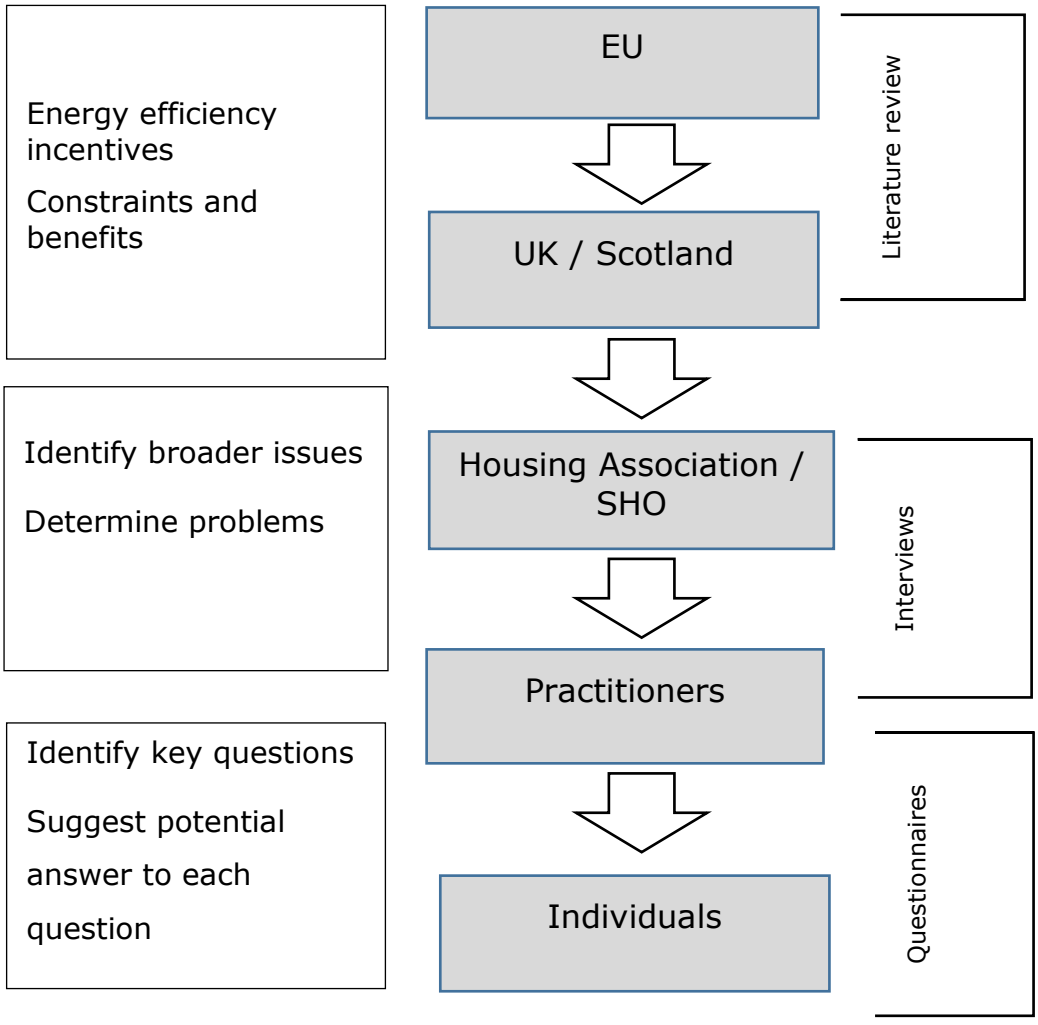


Figure 27: Research Strategy

3.8 DATA SOURCES

The main data sources for this research are documentation, government and public sector archival records, building data from the reference dwellings, interviews and questionnaires. The data is collected in both quantitative and qualitative forms. The qualitative data comes from the literature review, interviews and archives and the quantitative data comes from the quantitative data is derived from questionnaire and various archival sources such as Office for National Statistics (ONS), Department of Energy and Climate Change (DECC), RSLs, LA, Department for Communities and Local, Government (DCLG), Consumer Price Index (CPI), European Commission etc. Some specific data are also obtained from the personal communication such as email conversation.

The details on how data acquired from interview and questionnaire is analysed are discussed in section 3.10 and 3.11 The different data sets from the archive or government statistics are used to compare two or more interconnecting issues. For example, the fuel poverty data and EPC ratings of dwelling are compared in section 2.7. Various data tables available from government websites have been analysed and presented in a graphical way to support or against the argument. Some data are simply presented in a graphic, for example, see figures 5, 6, 7, 8 and 9 where data from archives are simply presented in graphics. Some qualitative data derived from various sources are analysed, summarised, and synthesised in table or charts to support for or against an argument. For example, see figures 22, 23, 24 and Tables 4 and 5 where a big number of qualitative data is summarized and synthesised.

3.9 Enquiry Mode

The research has taken both qualitative and quantitative approaches. According to Hammersley (2013) qualitative research means "a form of social inquiry that tends to adopt a flexible and data-driven research design, to use relatively unstructured data, to emphasize the essential role of subjectivity in the research process, to study a small number of naturally occurring cases in detail, and to use verbal rather than statistical forms of analysis". The quantitative research is defined as 'entailing the collection of numerical data and exhibiting the view of the relationship between theory and research as deductive, a predilection for natural science approach, and as having an objectivist conception of social reality' (Bryman, Bell 2015). Since the research "aims to determine the problems and benefit criteria of energy efficiency retrofit…" it will require both statistical and theoretical data and approaches. The quantitative approach is used to rank the benefit criterion of social housing retrofit whereas the qualitative approach is used to describe the various relations, interconnections between problems and benefit criterions.

3.10 Semi-Structured Interviews

Semi-structured interviews with limited individuals of interest were carried out. The interviews used both predefined questions and an open-ended exploration. The reasons behind this method were to have direct interaction with the key people in the field and explore new and beyond the pre-fixed questions, then revise the problems of social housing energy efficiency retrofit. The interview also establishes a base for the questionnaire which is more limited and focused on a certain group of people. As Lazar, Feng et al. (2017) states, 'direct conversations with fewer participants can provide perspectives and useful data that surveys might miss'. For this reason, this interview was significant and laid the foundation for the research to progress into next stage. There are some limitations of interview method used in this research which is discussed in section 3.13.

3.10.1 Method of interview (Semi-structured)

According to Wilson (2014) interviewers using the semi-structured interview approach generally, follow a document called an interview guide or interview schedule that includes the following:

- An introduction to the purpose and topic of the interview
- A list of topics and questions to ask about each topic
- Suggested probes and prompts
- Closing comments

Based on the above guide Wilson (2014) and Mann (2016), the interview guide was developed which is summarized in the following figure 28.

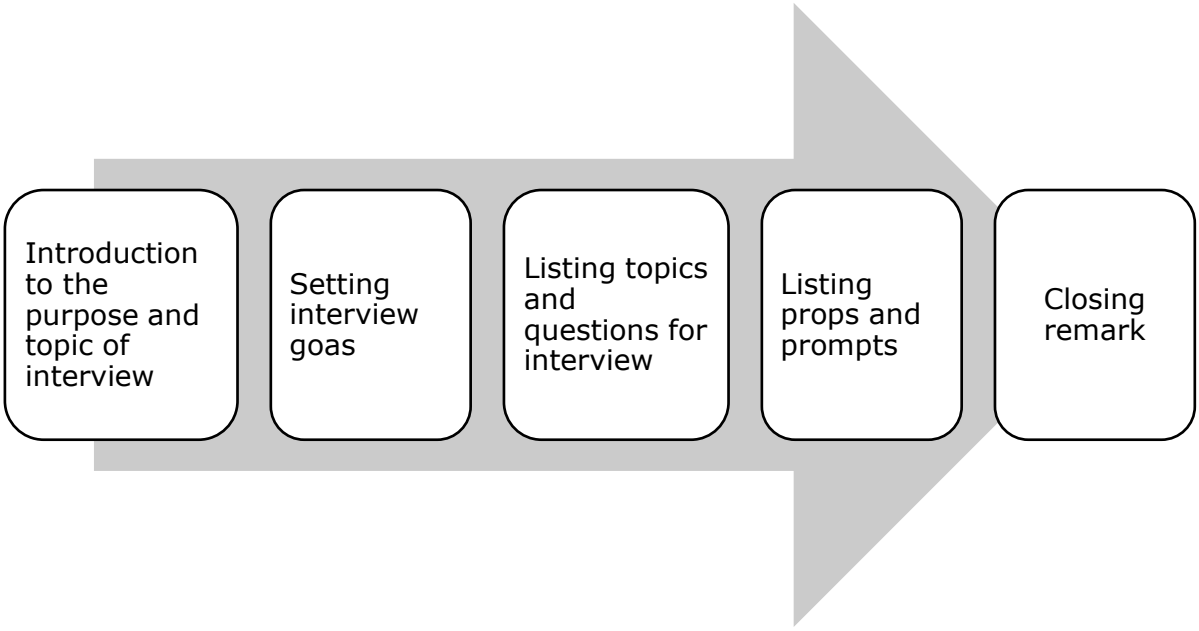


Figure 28: Method of Interview

In this research, the introduction to the purpose and topic of the interview was sent in the form of an email letter which is available in the appendix. The email also included a consent form and explained how the data is to be used, and a permission for data recordings. More about the consent is explained in detail later in section 'Ethical Considerations'.

The main goal of the interview was to gather systematic information about energy efficiency retrofit in the social housing sector in Scotland to determine and explain SHO concerns and their perspective on social housing retrofit problems. The interview preliminary, had the following sub-topics;

- Importance/need of energy efficiency retrofit in the social housing sector in Scotland
- Cost dynamics and budget
- Carbon emissions reductions
- Policy issues; Scottish and UK policies, initiatives, EESSH, Green Deal etc.
- Collaboration/ co-operation between the construction industry and social landlords for large-scale retrofit projects
- Partnership approaches at a strategic level, knowledge sharing platforms, community engagements
- Fuel poverty
- Renewables and micro generations, technologies, market etc
- Stakeholder problems

A list of general questions that the researcher wanted to ask during the interview was developed. The questions and answers are discussed in detail in chapter 4. The questions were accompanied by possible one-word answers for the purpose of notes (Lazar, Feng et al. 2017). These possible answers were in the interviewer's document and not shown to the interviewee. For example;

Question: Why do you think retrofitting old housing stock is a priority? Or why do you think retrofitting old housing stock is not a priority?

- ☐ *Because it's the law*
- ☐ *To reduce CO_2 Emission*
- ☐ *To reduce fuel poverty*
- ☐ *To maintain the property*

- ☐ *To create job*
- ☐ *Other*

Then the question topics along with suggested probes and prompts (Wilson, 2014) were listed in the diary which was not given to the interviewee. For example;

- *I have got the list of my questions; can I start by asking you...?*
- *I don't quite understand that…*
- *Can you spell that out for me, please...?*
- *How did you cope with that?*
- *What makes you feel like that?*
- *Now, I want to close this interview by asking one final question...*

And finally, the interview was closed with a final question and a thank you remark. For example;

I am very grateful for your time and knowledge you have shared with me. Thank you very much.

3.10.2 Outcome of interview

The interview mainly had the following outcome;

1. Build an understanding of the needs, practices, and attitudes of the people
2. Explore new issues
3. Further clarification and backing for the research
4. Understanding problems and complex issues
5. Understanding stakeholders' intention

The interview helped to build an understanding of the needs, practices, concerns, preferences, and attitudes of the people who were involved in key positions for household energy efficiency retrofit in Scotland, while also

allowing some exploration when new issues or topics emerged (Gubrium 2012; Lazar, Feng et al. 2017). For example, the interviewee suggested a new area of interest for the research at the end of the interview;

Question: *Finally, is there anything I missed, and you would like to say?*

Answer: *No, no I don't think so. I think the topic has been thoroughly covered in the main areas. I don't know… Do you know about network organization for European social landlords? They have a website and, large network. Maybe it is useful to look at the schemes (energy efficiency incentives) that have been developed in other areas of Europe.* (Stewart 2016)

Another outcome of the interview was that it provided further clarification and backing to the issues on which research was almost certain. For example, 'lack of political sustainability' was one of the *problem*s the researcher had found challenging to claim and needed a clarification from the SHO regarding whether they found this to be a real problem.

Question: *Do you think the UK and Scottish household energy initiatives are stable or changing? Are these changes needed? What is going on? Are these changes making it easier for the social landlords or difficult?*

Answer: *Yeah, I think, there has been a problem, over the time the schemes have been developed, altered and they have been closed and another one opens. And I think that lack of continuity and there is not confidence sometimes in the schemes, for example, the housing association might have proposal on schemes funded by ECO and there is change in ECO or they might have developed plans to install solar PV there were changes in the cost of the FIT to the solar PV. So, I think for the landlords and also for the supply chain contractors making these constant changes is a problem. Needs to plan and develop a sustainable system.*

The interview also helped gather an understanding of complex issues which cannot be observed (Lazar, Feng et al. 2017). The complexity of the Scottish and UK governments working together cannot often be observed, with only the result of the complexity can being seen. For example, it is not possible to understand the internal complexity of the two administrations (or governments) working together. However, asking directly the people involved in the process can help understand the issue more clearly;

Question: *You mentioned that EESSH aims to use funding from ECO, do you think there will be any intervention from the UK government because initially, ECO is UK initiative. How would it work, is there any kind of body to mediate between the two governments?*

Answer: *They have a discussion, I know the people in Scottish government who work on the home energy efficiency programme have the discussion with their counterparts which is really helpful. But you know, they really two different administrations and sometimes things can't progress, you know the Scottish Government were not able to do anything when the ECO was cut down in an attempt to reduce the energy bills. It can be a problem, different administrations, working for the different parts of energy programmes.*

Another important outcome of the interview was to be able to understand the stakeholders' intention. For example, energy efficiency incentives like Green Deal being seen as an incentive to be used by landlords and householders. Talking directly to SHO representatives gave insights to their opinion on those incentives and what they want to use them to achieve.

3.11 FULLY-STRUCTURED INTERVIEW

According to Wilson (2013) a questionnaire is a written, online or verbal tool for collecting data from individuals or groups that can be analysed using qualitative and quantitative techniques. Schnall, Wolkin et al. (2018) state that, a well-structured and effective questionnaire is an objective means of collecting data from people. Fully-structured interview using AHP matrix in the research will be referred to as questionnaire throughout this thesis to avoid confusion with semi-structured interview.

3.11.1 Method of Interview (Fully-structured)

Figure 29 summarizes the method used from start to the end of the questionnaire in the research. At first, general information about the subject area was gathered from the stakeholders via the review of the literature and interviews. Then the data sample was determined; questionnaire data sample has been discussed in the section 'Sample Size'. In this research, the questionnaire was designed mainly for the following two reasons;

- To complement interview by adding breadth to the data.
- To collect a subjective judgement of SHO professionals about benefits of energy efficiency retrofit and give them a ranking.

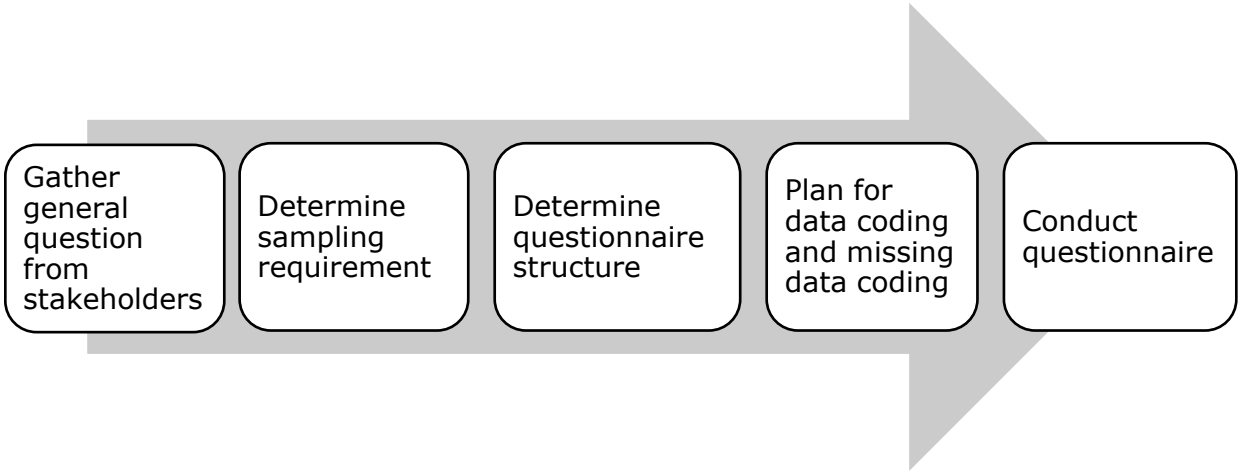


Figure 29: Method of Questionnaire

The questionnaire was obtained from the participant in face to face meeting, therefore it can also be categorized as a fully structured interview. Lazar, Feng et al. (2017) state that 'Fully-structured interviews use a rigid script to present questions in a well-defined order. Although some questions may be skipped, based on answers to previous questions, there is no room for asking questions out of order or for adding questions not found in the predefined interview script'. However, the process involved strictly in comparing and giving scales based on AHP scale and there was no room for skipping any questions, it is categorised as the questionnaire. At the beginning of the session, the introduction to the purpose and topic of the questionnaire was explained verbally. Then the participants were informed about consent and how the data will be used, and permission for data recordings was obtained. This is explained in detail a later section.

After that, the questionnaire structure was determined. For the purpose of this research closed question questionnaire was selected. As already mentioned, the aim of the questionnaire was to compare and rank the benefits of retrofit, hence if the respondents were given open-ended questionnaires, it would be difficult to get the complete comparison matrix; for that reason, the closed question questionnaire was used. Questionnaire design, structure and comparison matrix has been discussed below in detail.

3.11.2 Use of Scale

For the purpose of quantifying participant's qualitative thinking process, the fundamental Analytical Hierarchy Process (AHP) scale (Saaty, Vargas 2012) was used as shown in table 8.

Based on the principle of the Analytic Hierarchy Process (AHP) method the questionnaire was designed to generate the average weighting/ranking of various benefits/criteria of energy efficiency retrofit. In AHP, the decision

maker carries out simple pairwise comparison judgments which are then used to develop overall priorities for ranking the alternatives (Saaty, Vargas 2012). By adopting this method, the research is able to identify the priorities of energy efficiency retrofit benefit/criteria within SHO.

Table 8: AHP Scales used in the questionnaire

INTENSITY OF IMPORTANCE	**DEFINITION**	**EXPLANATION**
1	Equal importance	Two criteria contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favour one criterion over another
5	Strong importance	Experience and judgment strongly favour one criterion over another
7	Very strong or demonstrated importance	A criterion is favoured very strongly over another; its dominance demonstrated in practice
9	Extreme importance	The evidence favouring one criterion over another is of the highest possible order of affirmation
2,4,6,8	These are intermediate scales between adjacent judgements	These are intermediate scales between adjacent judgements
Reciprocals of Above	If criteria i has one of the above nonzero numbers assigned to it when compared with criteria j, then j has the reciprocal value when compared with i	If the criteria have a lower value than compared criteria

3.11.3 Questionnaire Design

The questionnaire for this research was designed based on the literature review and the Interview. The following eight benefits of retrofit were listed on the table both on row and column and the participants were asked to compare one benefit over other.

- Economic benefits to broader society
- Environmental and climate change benefits
- Financial benefits to the landlord
- Fuel poverty reduction
- Historical and preservation
- Meeting government regulation
- Tenant health
- Tenant satisfaction

The participants were briefed that their goal was to carry out an energy efficiency retrofit project within their housing stock. The eight benefits on the table were presented as the benefit criteria they have to choose over other according to the goal of their project. And they were asked to compare each pair of benefit criteria with rest and give it scale between 1-9, where, 1 is - two benefits being of equal importance and 9 is - one being extremely important than other benefits. This was continued until every benefit was compared with rest.

During the period that the participant was filling the questionnaire, the researcher was present there and answered any queries with use of scale and comparison. The presence of the researcher worked as a catalyst to transform

the participant's qualitative measurement and comparison of two benefits into a quantitative scale and weighting. Table 9 shows the questionnaire design. The process, scale and comparison are further discussed in detail in Chapter 5 (section 5.3 – 5.5).

Table 9: Questionnaire Design

	Economic benefits to broader society	Environmental and Climate Change	Financial benefits to the landlord	Fuel poverty reduction	Historical value and Preservation	Meeting Government regulation	Tenant health	Tenant satisfaction
Economic benefits to broader society	1							
Environmental and Climate Change		1						
Financial benefits to the landlord			1					
Fuel poverty reduction				1				
Historical and Preservation					1			
Meeting Government regulation						1		
Tenant health							1	
Tenant satisfaction								1

3.11.4 Data Coding and Missing Data Coding

The pairwise comparisons determined the priorities of a set of elements (criteria or alternatives) and are made by means of a value scale (Karanik, Wanderer et al. 2016). The pairwise comparison matrix was used to generate the average weighting of each of the benefits of energy efficiency retrofit. After the questionnaire was completed, the scale given to each criterion was summed at the end of each column.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_n
C_1	1							
C_2		1						
C_3			1					
C_4				1				
C_5					1			
C_6						1		
C_7							1	
C_n								1
Σ	$\Sigma C_1 : C_n$							

Figure 30 Pairwise comparison matrix

$$\sum(AA:AH) = AA + AB + AC + AD + AE + AF + AG + AH$$

Then each scale given by the participant was divided by the sum to get standardized a matrix;

$$Std\ Matrix = \frac{C_1C_1}{\sum(C_1C_1 : C_1C_n)}$$

Where C= criteria

Then from the standardized matrix, the average weighting given by an individual participant was calculated at the end of each row.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_n	Av. (%)
C_1	1								AVERAGE (C_1C_1: C_1C_n)
C_2		1							
C_3			1						
C_4				1					
C_5					1				
C_6						1			
C_7							1		
C_n								1	

Figure 31: Standardized Matrix

Finally, the weighting for each criterion was derived using average weighting given by each participant to the particular criteria.

$$Weighting = Average(SP_1 : SP_n)$$

Where SP= scale given by participant to each criterion

Sometimes the participants don't fill all the questionnaire as expected and some data go missing. In such a case, the participant was helped to translate qualitative judgement into scale. For example, if the participant said Criterion 1 (C_1) was of very strong importance over Criterion 2 (C_2) but was not sure about the scale, then scale 7 was suggested (see table 7 for explanation). Once the upper triangular matrix is complete the lower triangular matrix was filled with reciprocal of the scale on the upper triangular matrix for the same comparison. This is described in detail in section 5.3. For example; if the

participant gave scale 7 to compare Criteria1 (C_1) over Criteria2 (C_2) and didn't give any scale to compare C_2 over C_1 the missing data was filled with 1/7.

3.12 SAMPLE SIZE

3.12.1 Interview sample

The interview was carried out with one representative from each of the four focused sectors; academic, practitioner, policymaker and advocacy organization.

Figure 32: Interviewee representation

The four interviewees represented the following;

1. Academic and Practitioner, Senior Lecturer and business development manager at a Scottish University
2. Director, Leader of Scottish government's fuel poverty charity organization

3. Policy Maker, Member of Scottish Parliament. Member of the Economy, Energy and Tourism Committee at Scottish parliament.
4. Social Housing Organization Leader, Scottish Federation of Housing Association (SFHA)

Initially 5 interviews were carried out, but one interview was dropped because it was a pilot interview. These carefully chosen interviewees represent the major drivers of social housing energy efficiency retrofit in Scotland. The interviewees were also from higher positions in their field, which helps in deriving expert opinion. As the interview forms the base for the questionnaire, which has a larger representation, there is arguably a scaling aspect applicable. Hence, the interview leads to the questionnaire which completes the process of identifying the benefit criteria and values to be addressed by social housing retrofit projects which is one of the objectives of this data collection.

3.12.2 Questionnaire sample

The data sample was selected randomly from professionals within Scottish SHOs. The questionnaire consisted of 12 SHO representatives' responses. The job titles of the participants are: Director, Housing Officer, Board Member, General Manager and Tenancy Support Officer. The research, therefore, has the representation of not just decision makers but also the operators who have everyday, face to face interaction with the tenants and building stock.

These participants are representative of different Housing Associations, housing, care and property-management groups which own and/or manage over 63,000 properties in Scotland. As the participants range from the highest level to operational level, this sample is arguably a quality representation of the SHOs in Scotland.

3.13 LIMITATIONS OF ADOPTED RESEARCH METHOD

The research data is not entirely derived from the interview and questionnaire for the data, rather the research uses the interview to test and validate and conclude the arguments drawn from the literature review and various archival and historical data. However, there were limitations in interview and questionnaire data, in particular, quantity. According to (Lazar, Feng et al. 2017) the higher effort requirements of interviewing limit interview-based studies to relatively small numbers of participants. This is applied in this research as well. Due to the effort and time required for each interview, the size of the interview sample is small. Not only the interview (4), but the 'questionnaire' (12) in the research is also as time-consuming as interviews. The four interviews took approximately 1 hour 20 minutes on average.

Similarly, the questionnaires took approximately 40 minutes on average because each respondent was asked to make 28 different comparisons. The majority of respondents were not familiar with the AHP method, so they had to be assisted throughout the answering session by the researcher. Apart from that, the personnel resources such as travelling, and management of time also significantly contributed to limit the size.

Some data were also collected from communications such as email, especially to get the official views and data from city councils. It took more than 2 months to get a reply from a city council in some cases. Apart from trying to contact them, there is nothing a lot a researcher can do to get fast reply as most of the data requested fell under the Freedom of Information (Scotland) Act 2002 which allows the organization 28 days to reply and they are allowed another 28 days to give the requested information/data.

Along with many advantages and appropriateness, there were some disadvantages of the chosen methods. (Braun and Clarke 2006) mention that thematic analysis has the following limitations;

- Makes developing specific guidelines for higher-phase analysis difficult, and can be potentially paralysing to the researcher trying to decide what aspects of their data to focus on
- Difficult to retain a sense of continuity and contradiction through any one individual account
- Limited interpretative power beyond mere description
- Difficult to retain a sense of continuity and contradiction through any one individual account

To overcome these limitations of the thematic analysis, it was used as a part of the research, not wholly depending on it. To capture all the aspects of data and for continuity, the analysis in the research was carried out using an existing theoretical framework based on Braun and Clarke (2006) which anchors the analytic claims that are made.

The AHP method is also not without difficulties or limitations. The major limitation issue with AHP was regarding consistency of ratio scale. The measures taken to address this is discussed in section 5.6. The second issue with AHP was that there were challenges in interpreting people's personal judgements into AHP scales and coding missing data. This issues and measures taken has been discussed previously.

Apart from that, the research doesn't complete the 3 layers of hierarchy originally presented in the AHP by (Saaty and Vargas 2012). This is because the set aim and objective of research does not require it. The research is not entirely dependent on AHP analysis alone, rather it is a part of the whole. In the research, AHP is used as well-structured and established comparison tool to get the ranking of benefits criterion. The implementation of all three layers of AHP is used for project appraisal such as cost-benefit analysis. But the

research is concerned only with the ranking of benefits criterion, therefore, AHP is used to get the ranking of benefits criterion.

3.14 Ethical Considerations of the Research

The full consideration of ethical conduct is applied in the research by following university rules and guidance and also by developing a considered, flexible and thoughtful practice. In this research, there is no use of individual human objects, animals or genetically modified organisms.

The 'group' and 'organizations' involved in the research are social housing organization such as city council and housing association regarding interviews, filling up questionnaires and answering emails and indirectly involves social housing tenants. The research does not involve any sensitive, private and confidential information. The research however does involve some important data related to the social housing stock, energy performance, fuel poverty etc. which fall into the public sphere. Therefore, no consent or ethical consideration is required regarding their use for the purpose of this research.

In the process of doing the research, there was no potential for harm to the research participants, research subject, researcher or any other third party. The research mainly impacts on the social housing organization and tenants if applied in the real world. The research outcome can be used to determine energy efficiency retrofit options and then help decision making by the social housing organization and policymakers. There is no physical or other harm from the research if applied in the real world. The research will not have any negative consequences on the research subject or research or in the society after its completion.

The research includes interview recordings and questionnaire from the participants. For that, the interviewees were informed beforehand about the

research and that their opinions are to be recorded and used in the research. Since pre informed-consent is acquired from the participants before an interview, it is safe to use in research. The required permission or consent is obtained from the participating individuals. The consent form is attached in the appendix 2 of this thesis.

4 THEMATIC ANALYSIS OF SOCIAL HOUSING RETROFIT ISSUES; INTERVIEWS

4.1 AIMS AND OBJECTIVES OF THE INTERVIEW

Interview aim: The aim of the interview method was to gather systematic information about energy efficiency retrofit in the social housing sector in Scotland to determine and explain SHO concerns and their perspective on social housing retrofit problems. The aim of interview directly feeds into research objective 2.

- Explore SHO concerns and their perspective regarding social housing retrofit problems

And then, the discussion and conclusion section of the interview validates and determine the retrofit problems which compliments research objective 4.

- Validate the determined retrofit problems and benefit criteria through primary research from the SHO perspective and allocate potential answers and suggestion for further research

The interview is essentially shaped by the literature review and answers the following research questions to meet the above research objectives.

- What are the *problems* of social housing retrofit incentives?
- How are can the social housing sector become the recipient of more energy efficiency incentive measures?

The interview took an exploratory approach where the responder was asked a certain question but was also allowed to add information thought to be more useful or skip any question thought not to be relevant. The method of the

interview has been discussed in chapter 3. In this section, the method of interview data analysis is described.

4.2 Introduction To Inductive Thematic Analysis (ITA)

The inductive thematic analysis (ITA) is being used in the analysis to gather the most occurring theme in the interview then to produce a report. ITA is one of the most common analytic approaches used in qualitative inquiry. In-depth interviews and focus groups are the most common data collection techniques associated with ITA (Braun and Clarke 2006 cited in Mann 2016). The phases of ITA applied in this research, based on Braun and Clarke (2006) are summarized in figure 33.

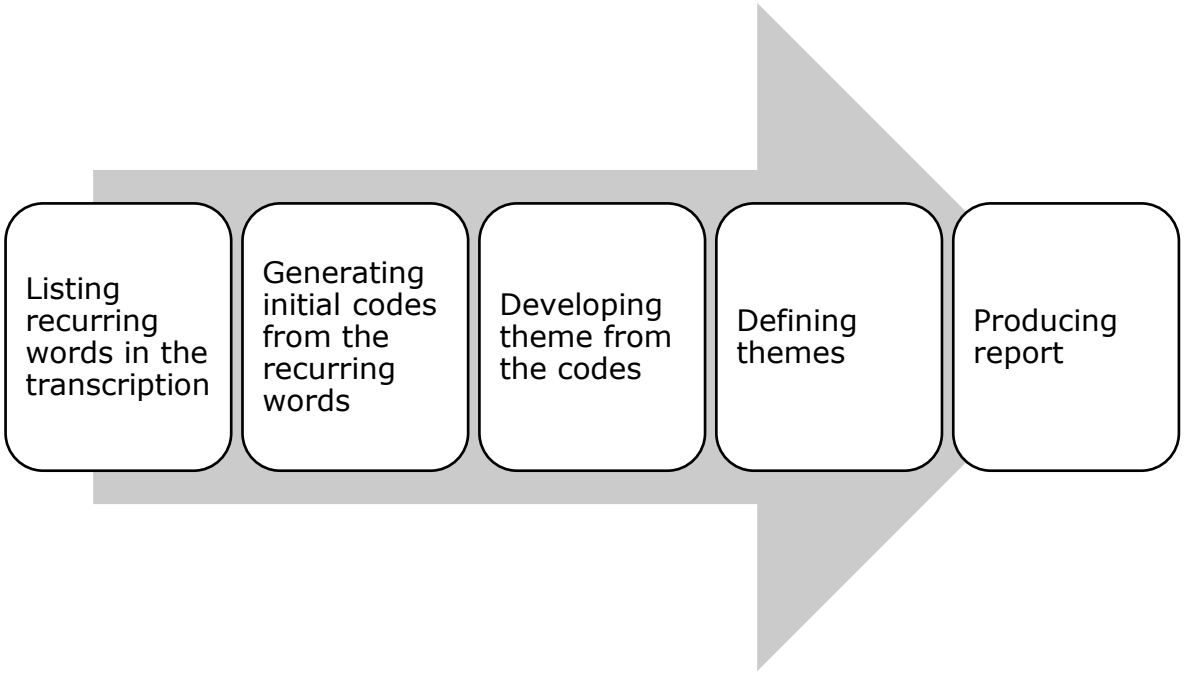


Figure 33: Phases of inductive thematic analysis

An inductive approach was applied in this research and this means the themes identified are strongly linked to the data themselves (Patton 1990 cited in Mann 2016). The technique mainly involved identifying and coding emergent themes within interview data. All of the interviews were transcribed in authentic form. Then the repeating words within the text, along with the number of times they were repeated, were listed. The number of repetitions by the interviewee

excluded the words in the question itself. In some cases, different interviewees used different synonymous words to indicate the exact same thing. For example, Person-1 used the word "scheme" while Person-2 used "incentives" to indicate the government energy efficiency stimulus programmes such as Green Deal. In such cases, both words were counted as the same in terms of repetition by different interviewees.

4.3 RECURRING WORDS AND PHRASES

The table shows the words that were most repeated and number of times each interviewee (P_n) repeated those words.

Table 10: Recurring words and phrases

		Number of repetitions			
Words/phrases		P_1	P_2	P_3	P_4
	Scheme/incentives	36	6	4	3
	Funding	25	22	5	3
	ECO	18	15	-	3
	Energy efficiency	13	9	8	19
	Energy bills /price	10	4	3	2
	Fuel poverty	7	11	7	16
	Scottish Government	7	18	6	6
	UK government	5	2	4	1
	Green Deal	5	9	-	-
	Landlord / social landlord	9	23	2	3
	Tenant	3	-	1	7
	Total words	3391	5964	2826	5842

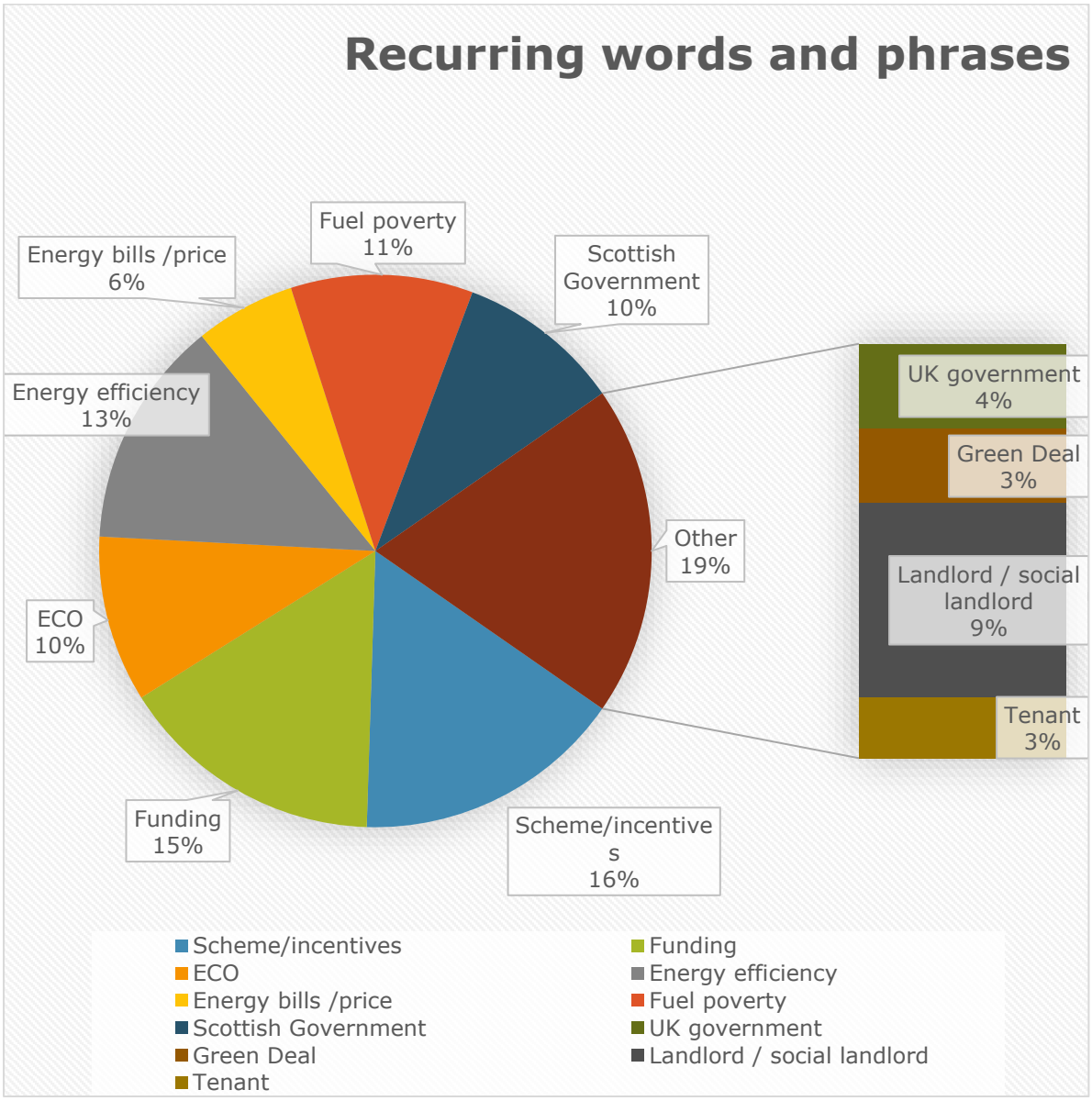


Figure 34: Recurring words and phrases

There was a mathematical problem in giving all the repetition the same importance because the length of interview transcription varied from 2826 words to 5964 words. Therefore, the numbers of repetitions were converted into the percentage with compared to the total number of words for each transcription. For example, if the word Scheme and/or incentives were repeated n times and there were W words in transcription P_1 the value of Scheme/incentive would be;

$\frac{n}{W} \times 100$

The repetition value of the words was calculated for each transcription, then the average of all four transcriptions was calculated to get the final value of the word. For example, if the value of Scheme/incentive is P1 in transcription 1, P2 in Transcription 2, P3 in Transcription 3 and P4 in Transcription 4 then the final value of word 'Scheme/incentive' is calculated as follows;

$Average(P1, P2, P3, P4)$

Finally, the value for all the words/phrases were calculated and ranked accordingly.

4.4 GENERATING THE INITIAL CODES

Figure 34 shows that the most repeated word in all of the interview is 'scheme/incentive' followed 'funding' and 'energy efficiency'. From the analysis, the following ranking of words can be derived where number 1 is the most repeated while number 11 is the least repeated among the recurring words. These words are referred to as codes in this stage of the research.

1. Scheme/incentive
2. Funding
3. Energy efficiency
4. Fuel poverty
5. ECO
6. Scottish Government
7. Landlord / social landlord
8. Energy bills /price
9. UK government
10. Green Deal
11. Tenant

These codes are not being driven by the researcher's theoretical interest in the area or topic. Use of inductive analysis means, therefore, a process of coding the data without trying to fit it into a pre-existing coding frame, or the researcher's analytic preconceptions (Mann 2016).

According to (Weston, Gandell et al. 2001) coding is a mechanism for understanding the phenomenon of the process of reflection. The interview process began with the big picture; an overall conception of energy efficiency retrofit in social housing sector, then moved in to focus on details through analysing transcriptions and coding and moved out again to see how the details might have changed the interpretation of the larger picture; in the next step as theme.

In the next step, from the list of the eleven recurring words/phrases, the words/phrases with a common theme are arranged together to create five themes that occurred in the interview data.

4.5 DEVELOPMENT OF THE THEMES

Braun and Clarke (2006) argue that a theme captures something important about the data in relation to the research question and represents some level of patterned response or meaning within the data set. It is not necessarily about how many times it is repeated or if it is quantifiable, rather it is about whether it captures something important about the overall research question.

The aim of this interview was to gather systematic information about energy efficiency retrofit in the social housing sector in Scotland within the following sub-topics;

1. Importance/need for energy efficiency retrofit in the social housing sector in Scotland

2. Cost dynamics and budget
3. Carbon emissions reductions
4. Policy issues; Scottish and UK policies, initiatives, EESSH, Green Deal etc.
5. Collaboration/co-operation between the construction industry and social landlords for large-scale retrofit projects
6. Partnership approaches at the strategic level, knowledge sharing platforms, community engagements
7. Fuel poverty
8. Renewables and micro generations, technologies, market etc.
9. Stakeholder problems

In other words, initially, the semi-structured interview question had the above mentioned nine themes. In the process of developing themes, while keeping the interview question sub-topic (or theme) in mind, the development of theme mainly focused on the recurring words in transcription.

There were some words that were associated with the recurring words but not yet mentioned often by the interviewees. The theme would not be complete without such less or hardly recurring words but directly associated with the frequently recurring words. For example, when the interviewee P-4 talked about the incentives, he mentioned renewable heat incentive (RHI) just twice, however, gave a high importance while saying it by giving an example of RHI funded project. Similarly, when the interviewees talk about different levels of policies they focus mainly on Scottish and UK scenario and rarely mention the EU. However, the literature review prior to the interviews interview suggests that most of the major UK and Scottish energy efficiency policies exist to comply with the EU legislation; therefore, including the EU is actually important to complete the theme fully.

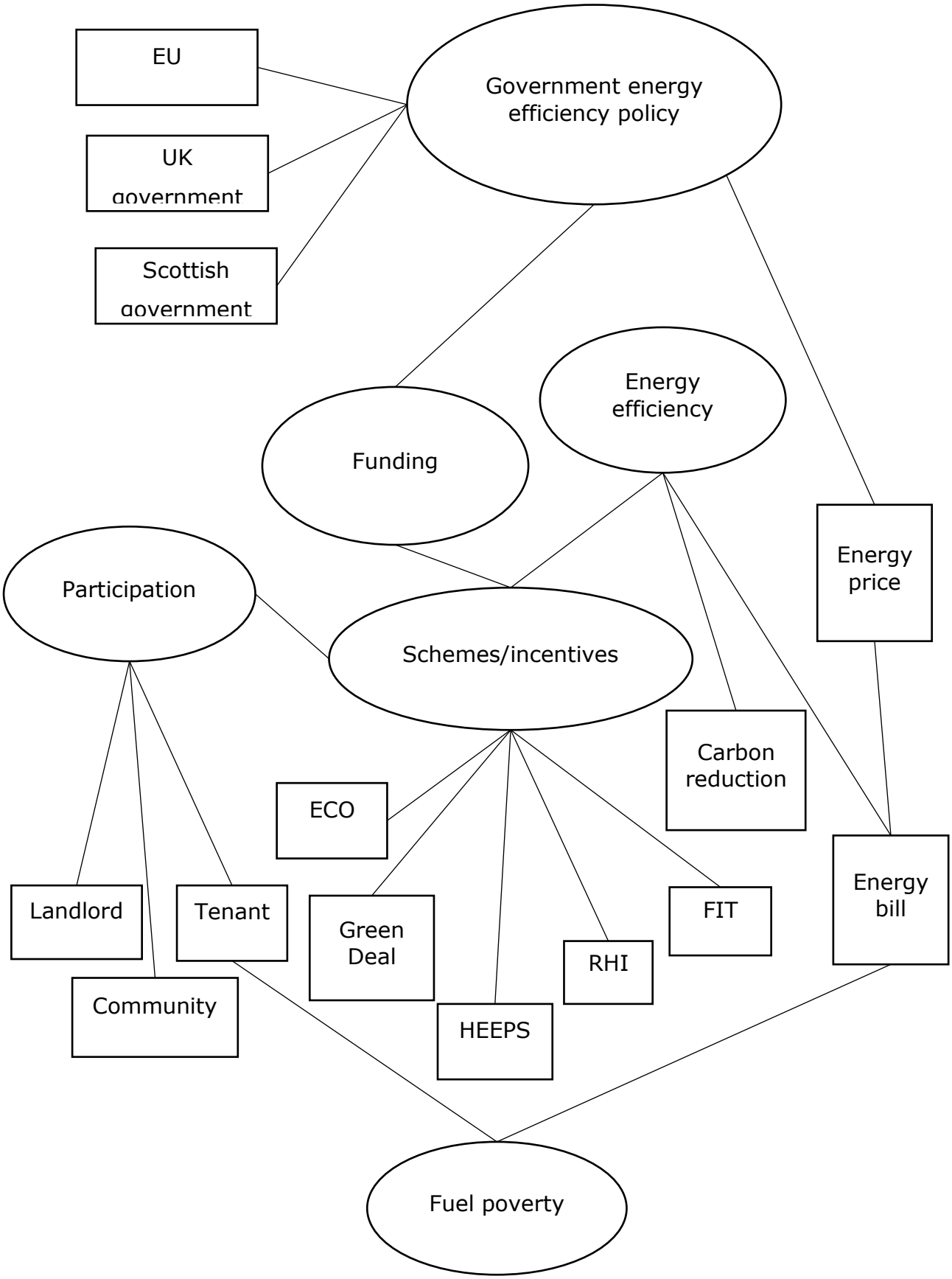


Figure 35: Thematic map showing initial main six themes

Figure 35 shows the initial thematic map. Initially, there are six themes emerging directly from the codes. These six themes are in raw form coming from the codes which will be analysed in the next step to get the final theme. There are themes which are strongly connected to other themes and themes which are copied from single code. Section 4.6 will explain these issues.

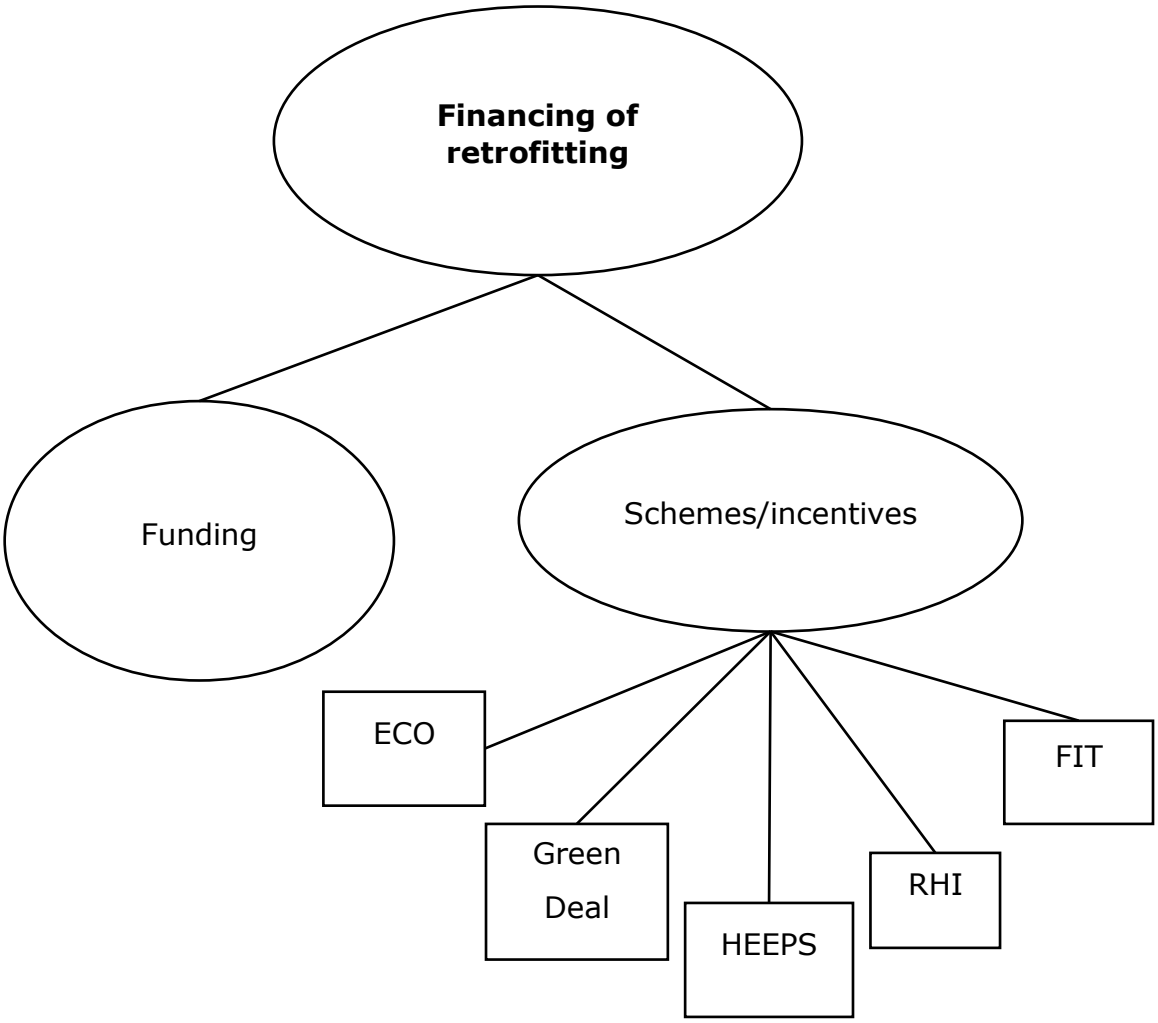


Figure 36: Theme 1 - Financing of retrofitting

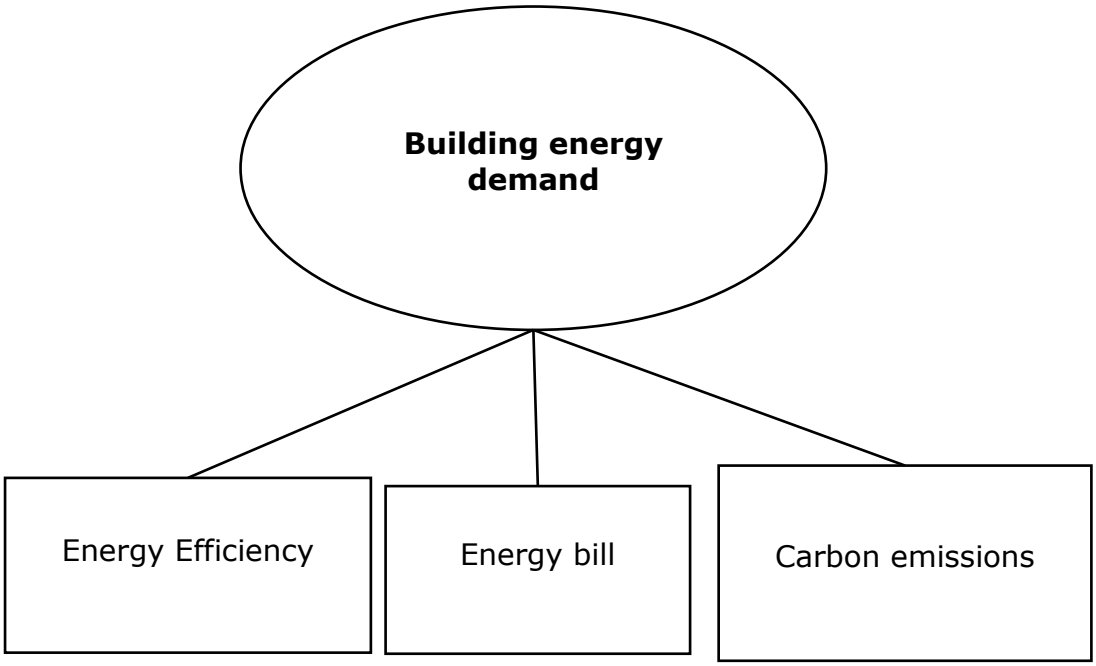


Figure 37: Theme 2 - Building Energy Demand

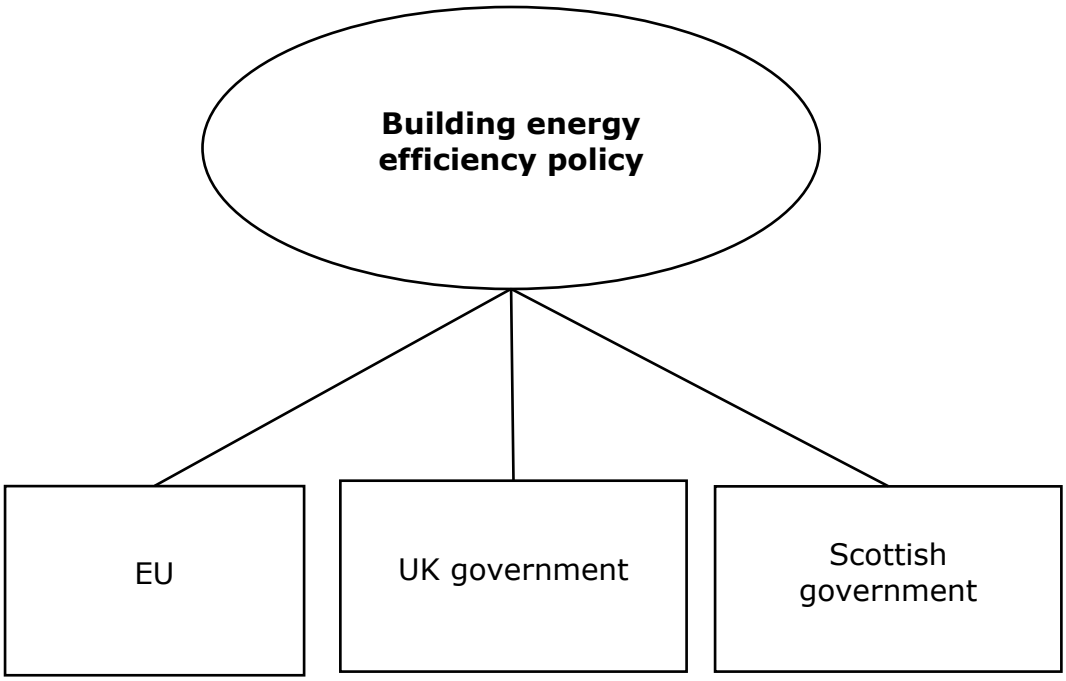


Figure 38: Theme 3 - Building energy efficiency policy

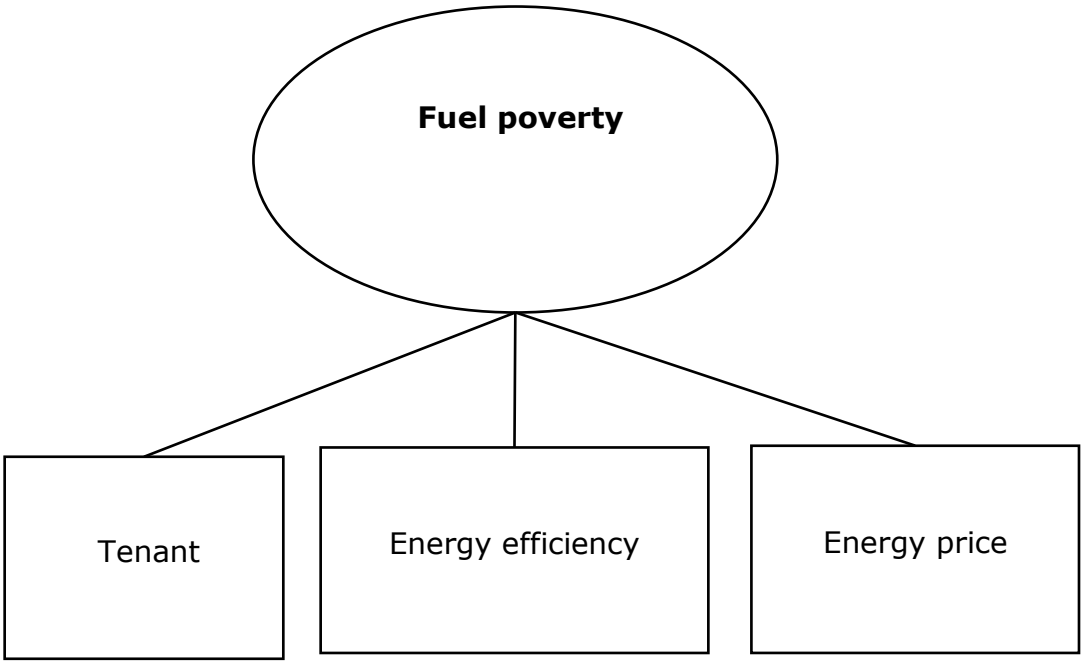


Figure 39: Theme 4 - Fuel poverty

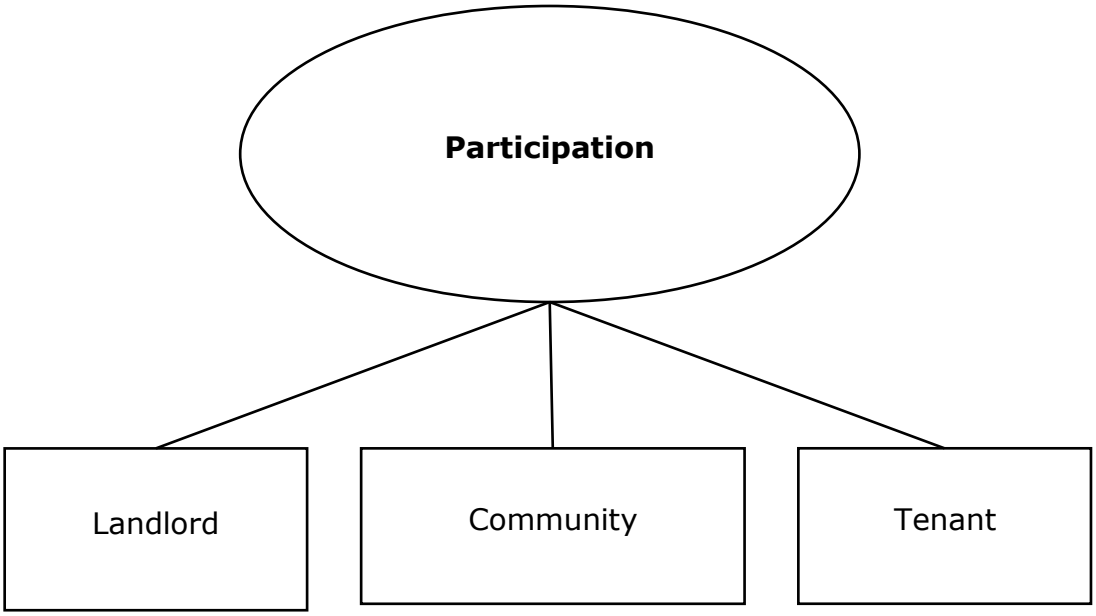


Figure 40: Theme 5 – Participation

Finally, the themes (figure 36-40) are developed through combining both recurring words and associated words. In this phase, the two themes "funding" and "scheme/incentive" are arranged as a sub-theme under the single theme "Financing of retrofitting". Naming theme ‘Government energy efficiency policy' would imply only the UK and the Scottish government, therefore, it is renamed

as "building energy efficiency policy" to adjust code 'EU'. "Tenant", "Energy efficiency" and "energy price" are brought under the single theme "Fuel poverty". The final theme participation is left in its original (figure 40).

4.6 DEFINITION OF THEMES

In this section, the chosen themes have been defined in terms of how the interview participants and their fellow professionals construct these themes themselves when talking about energy efficiency retrofit in the social housing sector. Defining a theme means identifying the 'essence' of what each theme is about and determining what aspect of the data each theme captures (Braun and Clarke 2006). The theme defined below are derived completely from transcription. The analysis, revision and final themes are presented in section 4.7.

4.6.1 Theme 1: Financing of retrofitting

Financing of retrofitting in social housing refers to the amount of money needed to complete any retrofit project. In Scotland, the social housing sector's cost of the retrofit is covered by government funding and SHO's income from rental. The government funding for retrofit comes through various energy efficiency incentives. The major energy efficiency incentives currently run in Scotland are Energy Company Obligation (ECO), Green Deal, (Renewable Heat Incentives (RHI), Feed-in Tariff (FIT) and Household Energy Efficiency Programme for Scotland (HEEPS). In this theme, the positives and negatives of energy efficiency incentives have been covered. As seen in Figure 36, this theme is the biggest in terms of scope and this is the most important of all the themes, which basically determines everything about the energy efficiency retrofit in the Scottish social housing sector.

4.6.1.1 The main source of funding

When asked about the source of funding for energy efficiency retrofit in the social housing sector, all of the respondents mentioned government funding as the main source of funding. Also, Energy Company Obligation (ECO) was mentioned as the major scheme that provides funding for social housing retrofit. Another source of funding mentioned was rentals.

4.6.1.2 Complex funding stream

The financing of social housing retrofit is not a straightforward as the respondent (P2) said "So the amount of money they (SHO) have been given to fund (retrofit project) from the Scottish government, and there is a unit price to that, now that restricted the money which comes from the Scottish government, by Westminster government (UK government). So, it's a.... you know, it's a complex financial stream I guess". It is the issue of the UK and Scottish government's budgeting mechanism and their area of interest. For example, the UK government may have different funding priorities than that of the Scottish government. Once funding is moved forward from a budgeting mechanism it does not go to the SHO, instead, the funding comes through the energy companies, through a scheme such as ECO. This puts extra uncertainty and complexity into the funding stream. As another respondent (p1) put it, "…And they also don't have the flexibility over the cost and value for money because they (SHO) were not receiving money/funding (directly) and then procuring a project but they were being offered to fund by ECO for example, so which is not very easy to procure what's (already determined in a way)."

Some clarity is needed around this. At first the UK government designs the scheme then determines for the funding Scottish government is to receive. Secondly, the Scottish government indicates measures that they prioritise. Finally, the energy companies come to deliver the measures in SHO properties through the schemes which are designed by the UK government. In between this process SHO "search" for funding that they are eligible for. As P1 put,

“there are just too many different funds available…” and getting them is a complex process.

4.6.1.3 The ownership of energy efficiency retrofit

From the literature reviews and interviews, it is clear that the energy efficiency retrofits are important and necessary. However, if this is important and needs to be done, who is going to drive the mission? Or it is worth asking who is going to be the responsible point of contact? Here, the funding complexity doesn't just stop on being "complex" but also creates a situation where is hard to figure out where the ownership of whole energy efficiency retrofit lies.

One of the respondents (P1) from a body representing Housing Associations in Scotland, was asked if the funding has created the situation where the energy companies are more in control of the projects than the SHO, the reply was "Yeah, Certainly." But the role of energy companies in energy efficiency retrofit has not always been positive, they have been repeatedly fined millions of pounds by the government regulator Ofgem (Office of Gas and Electricity Markets) during the period of 2010-2018 for not fulfilling their obligations (ECO) (Ofgem 2018). This issue was raised to P1 and his answer was following; "I think that happens, erm… I don't think the energy companies are the best place to invest in energy efficiency or to develop the schemes, that would have been better if the schemes were led by the organizations related to the housing, like local authority housing department or housing associations, they do know their homes, they do have the expertise and ability in procuring contracts, and could be much more trusted. And the energy companies in terms of consumers or tenants’ issues and also, Erm I don't know, probably it is not a priority for energy companies to reduce carbon, reduce fuel bills." When the same issue was raised to respondent P3, who is an elected member of the Scottish parliament, he put it this way; "Well clearly, the companies have an obligation which they should clearly understand that they should fulfil. But some of them are not fulfilling an obligation as you said, and Ofgem are right to hammer them so they do enough and not violate the obligation again."

4.6.1.4 Energy Company Obligation could have been better

In terms of the funding, it is now clear that the Energy Company Obligation (ECO) is the major scheme to fund social housing energy efficiency retrofit in Scotland. The respondents were asked if they think the incentives are achieving what they should be achieving, and the response was mainly positive but also highlighted the issues with the overall delivery mechanism. P1 said, "There are complicated areas like ECO funded by the UK government, there is Scottish Scheme and there is potential for EU scheme. So, I think there is problem…" Here respondent P1 is highlighting the fact that the Scottish incentives under HEEPS aim to get funding through ECO at the same time ECO itself is a funding incentive.

Respondent P2 mentioned that ECO has been "pretty successful or was pretty successful". Here, the interviewee is suggesting that the ECO was better before the changes made over the time of the interview (January 2016). For the changes in ECO please refer to literature review (chapter 2). P2 further elaborated that "it is easy to be critical about the ECO obligation, but if some of these initiatives had been supported better and now if some of these had not been abandoned". When some of the incentives work well the government runs out of the allocated budget and then the incentive is abandoned, which affects many other projects which were planned under the scheme.

Respondent P4 thought "ECO in its various formats has been effective to a certain extent …it's been effective because it's been about saving carbon. It's not necessarily about making homes more energy efficient". P4, who is also a director in a fuel poverty advocacy charity tried to throw light on another side of the issue, that ECO is solely focused on saving carbon, rather than making homes energy efficient. It is an important issue to understand that carbon reduction and energy efficiency are directly related but not exactly the same issue. Energy efficiency refers to both carbon emission reduction and running

cost, whereas carbon reduction is solely about reducing greenhouse gases emissions.

Respondent P4 gave an example, "If you are off the gas grid, and they (Energy Company) come along and they say you have an electric heating system, and the deemed efficiency of that system is 100%, how can you put up a system that is more than 100% efficient? You can't…there would be no theoretical carbon saving, because you are replacing a system that is 100% efficient with a system that is 100% efficient." His example tells a crucial story; in the rural context, where there is no gas grid, the priority should be connecting them to a gas grid to make homes cheaper to run but that won't necessarily save carbon. And if a retrofit does not save carbon theoretically, the energy companies who deliver ECO are not interested. P4 further commented that "ECO hasn't been a good delivery mechanism but it could be a better mechanism." This reflects the same issue raised by P1. Their answers clearly suggest although ECO has been a good scheme the delivery mechanism is fallacious.

4.6.1.5 The area-based approach is relatively successful, Green Deal is a failure

All respondents referred to HEEPS-ABS (HEEPS area-based scheme) as a relatively successful incentive when asked which incentive they thought was more effective. The area-based scheme is a scheme under HEEPS, which are designed and delivered by Scottish councils with local delivery partners. They target area with higher fuel poverty rate to provide energy efficiency measures to a large number of Scottish homes while delivering emission savings and helping reduce fuel poverty (GOV.SCOT 2018d). P3 said "I agree on an area-based approach", P2 revealed the fact that organizations like Scottish Federation of Housing Association (SFHA), Chartered Institute of Housing (CIH) and other organizations like Energy Action Scotland (EAS) lobbied for area-based schemes. P3 added the scheme is "more efficient", "participatory" and gives results. The respondents have the similar view that the HEEPS has been successful in delivering. But as P4 noted, they have not seen from the Scottish

government reports how effective HEEPS has been in terms of reducing carbon emission, reducing fuel poverty and addressing tenant concerns.

One of the UK government's flagship energy efficiency incentives is Green Deal. But this has also been a very controversial and unsuccessful incentive, and yet it has not been dropped. The basic idea behind Green Deal is that if anyone wants their home retrofitted or make energy efficient, they can apply for a loan and if they fall within the criteria the Green Deal providers (energy companies again!) will install measures in the building. The amount of energy bills the household saves from new measures will pay back to the Green Deal provider over time, and the so-called golden rule means a household won't pay more for any measures than what is saved from them. For detailed information on Green Deal please refer to literature review section (chapter 2).

When asked about Green Deal, P1 said that "really, it was never a lot of chances with the social housing sector, and I think there is a problem" because it is primarily designed for private homeowners. P1 added that the Green Deal is "very much designed for an individual home" and "doesn't really comply with the fact that the housing associations have long-term ownership of the properties" and they want to focus on measures improving their stocks rather than focusing on single units.

P2 said "Well, I don't think the Green Deal has been effective. Again, from constantly reading stuff from the press, the take-up of the green deal has been minimum. So ... I… my thought would be that it has been a failure." P2's concern was "There are limited items/products you can get from the Green Deal… have to have these approved products… that restricts the market." Apart from the limitation in products you can choose from, Green Deal also has a long payback period as well, P2 added. P1 noted another problem of Green Deal that it "ended up with a high rate of interest" which eventually made it "a lot harder" for Green Deal to work.

4.6.2 Theme 2: Building energy efficiency policy

Building energy efficiency policy are the Acts, directives, legislation, announcements or any strategy and action that government takes with regards to building energy efficiency. In the case of social housing, building energy efficiency policy is absolutely crucial for retrofit projects because it determines the main source of funding for energy efficiency retrofit. From the codes, three levels of policies can be identified. EU policy stays at the top which directs UK policy and the UK policy directs Scottish policy. In some cases, there are policies which are particular to the UK only. And in some cases, the Scottish policies are either derived straight from EU policy or different than rest of the UK.

4.6.2.1 Contradictions, overlaps and lack of political sustainability in energy efficiency policy

Talking about the EU, the UK government and Scottish government roles, P1 said, "There are complicated areas like ECO funded by the UK government, there is Scottish Scheme and there are potential for EU scheme. So, I think there is a problem, there are schemes that have slightly different objectives and they run in slightly different periods. So, I think there is a problem." The interviewee also said that "schemes have been developed, altered, closed and opened new" and the process still continues which leads to confusion and uncertainty in the retrofit industry and SHOs.

Referring to the change of government in the UK, P2 said that "ECO obligation is in a real state of flux". P2 predicted in his "personal view" that the fate of schemes like ECO depends on which political party is in Westminster rather than the need of SHO. The interviewee added, "From the Scottish perspective, that ECO obligation, there is not only desire to retain, but actually strengthen that, to actually make sure that there should be more money coming from there." P2's argument suggests that there is, sometimes, a clear contradiction in views of the UK and Scottish governments.

When the member of Scottish parliament (P3) was asked if he was aware of such contradicting situation, he said: "I think that's the nature of a devolved government." His view suggests that the contradictions or overlaps are inevitable "because in the UK we chose to have different levels of governments to do differently". However, P3 also suggested that in his personal view, "when you have a mechanism that is successful, you should focus on it rather than changing it and changing it again." He closed his remark on the contradictions and overlap issue by saying "you cannot have a division of power between governments and not have some difficulties… more joint work is desirable but that's never going to be completely perfect, we can only try to achieve perfection."

The EU legislation on household energy efficiency plays decisive role in shaping the UK and Scottish policies. But again, as highlighted above Scotland already has three level of governments (the UK, Scotland and city councils) who sometimes contradict and overlap; adjusting EU legislation can be a challenge. For example, when asked if there is any support available from the EU in energy efficiency retrofit, P1 replied "Scottish government has been taking advice on it but they have breached the eligibility in HEEPS and because UK governments FIT has breached the terms and conditions for European Regional Growth Fund (ERGF) unfortunately, we have been lobbying for the ERGF fund to be able to use in energy efficiency but we aren't able to meet the term". According to the interviewee P1 ERGF couldn't be used in retrofit because the UK and Scottish government hadn't met the terms and conditions to be eligible for the funding.

4.6.2.2 Funding priorities and funding mechanism target low hanging fruits

Apart from the administrative issues, the interviewees also shed light on other important policy issues surrounding energy efficiency retrofit. P4 highlighted that in Scotland the rural area has not benefitted that much from ECO as urban areas. If we go back to the theme: 1 financing of retrofitting, we see the example of how energy companies only prioritise funding carbon reduction through ECO and not necessarily towards energy efficiency. This has diverted the focus of the scheme from the most needed area to the areas where high achievement can be shown in numbers of tonnes of carbon emission reduction, which is highlighted by P4.

The interviewee also mentioned that there is a tendency of looking at the figures of how many measures have been installed and how much is spent rather than how effective the scheme has been. P4 gave an example of HEEPS, "This area-based scheme, HEEPS has been successful in delivering, I think what we have not seen from the Scottish government is from reporting in just how effective it's been… we have not seen is what's the impact on people's bills".

As mentioned under "theme: 1 financing of retrofitting", the funding mechanism is also a problem. P1, who represents the Housing Associations, says "the UK government set up schemes rather than being based on direct taxation, but through energy bills, I don't think it is a good way to run a programme". P1's comment points to our sub-theme "the ownership of energy efficiency retrofit". As a result of government not directly funding the schemes, the energy companies become somehow determinant force in social housing retrofit; who clearly have a conflict of interest about selling energy and reducing energy demand through energy efficiency retrofit.

Although the HEEPS-ABS was regarded as successful scheme, P2 noted that the policy priority has an important point to address; the hard to treat homes

such as granite dwellings. He blamed that the HEEPS is "to some extent" picking the "low hanging fruit" such as; cavity wall insulation, focusing in cities rather than rural areas, retrofitting easier homes, leaving one property in a terrace while retrofitting the rest etc. Why the "low hanging fruits" are being picked is discussed in the theme "participation".

4.6.3 Theme 3: Fuel poverty and building energy demand

In Scotland, if a household is spending 10% or more of their income on fuel bill, the household is considered fuel poor. The codes; Tenant's household income, the energy efficiency of the dwelling and energy price are responsible factors determining fuel poverty. The thematic map (figure 38 and 39) also shows that the tenant and fuel poverty have reciprocal relationship meaning; fuel poverty can affect tenant or vice versa. And the amount of energy required to run a building can be defined as building energy demand. From our codes, it can be seen that energy efficiency of a building is directly responsible for the energy demand of a building while energy bill and carbon emission are the consequences of building energy demand. As the interview was mainly focused on social housing retrofit, the social and economic aspects of fuel poverty are not amply covered in this theme.

All of the interviewees were asked about the significance of the fuel poverty as an issue, the following was the answer;

- P1: "It's a significant issue"
- P2: "There is no question or doubt that it's a serious issue"
- P3: "It's very significant indeed"
- P4: "…what we know is that 35% of all homes in Scotland are fuel poor, and that is a very high proportion."

4.6.3.1 Impartial definition and focus on carbon reduction are amiss

Although all the interviewees responded almost exactly by taking fuel poverty as a very significant issue, they also seem not convinced the way Scottish

government has defined fuel poverty. As P2 said, "… without any question or doubt but my brain still tells me much more people that are in fuel poverty could have been helped if the system was means tested right. If you have income over a certain level, if you are retired or not working but you got a big pot of money sitting in the bank account; sorry you will not get that freebie or whatever else." Here, P2 is referring the fact that just because someone is elderly or falls under certain criteria they are regarded as "vulnerable" to fuel poverty and aided from fuel poverty scheme such as Warm Homes Discount. P1 also acknowledged issues around the definition of fuel poverty; "It's difficult to measure against other countries, so for example in Scandinavian countries, they may not necessarily recognize the term fuel poverty, but they will talk about the affordability of fuel."

It has already been discussed that energy companies focusing solely on carbon reduction means picking low hanging fruits and not necessarily increasing the energy efficiency of a building. Without improving the building energy efficiency, the energy bill remains higher and higher energy bill means the risk of fuel poverty. Another flaw in fuel poverty reduction campaign was that the definition directed money towards all individual over certain age or individual under certain benefits who are not necessarily fuel poor. Therefore, P1 suggests that the focus should be to "invest the money in retrofit rather than just give money to the individual."

4.6.3.2 Incentives like ECO come at a price

The issue of fuel poverty and trying to help people come out of fuel poverty through schemes delivered by energy companies are contravening ideas. Interviewee P2 suggests "there has to be a balance because the ECO comes from out of the energy bills that consumers pay to the energy companies." In his view, "to some extent, the energy cost is artificially increased because for the need for the ECO", and the increase in energy bill means more households falling into fuel poverty rather than coming out of it. This is not simply a speculation from the interviewee, the energy companies have been accused of,

found guilty of and fined for artificial energy increase and unlawful charges to consumers. However, this act of energy companies has not been established as connected to the ECO funding. But from common sense, it is not hard to understand that the private business pass on any additional cost to the consumers.

This argument leads to previous sub-theme "taking ownership of energy efficiency retrofit". Now, the question is, if the energy efficiency retrofit is governments or SHO's duty, energy companies are right to pass on the cost to consumers. The participants expressed the view that if the government thinks it's everyone's duty, it is natural to impose direct taxation on the energy companies and fund energy efficiency retrofit or fuel poverty incentives directly.

When talking about fuel poverty the interviewees were also asked about Scottish government's ambition to eradicate fuel poverty by 2016 as far as reasonable, all of them said that ambition was not achievable, and they were right as the ambition hasn't been achieved or seem near achievable until March 2018.

4.6.4 Theme 4: Participation

In the interview transcription, participation means the engagement of stakeholders in various levels and stages of the social housing energy efficiency retrofit project. In the transcription, social landlords, tenants and community have been repeated mostly in terms of participation and collaboration. The interviewees were also asked if they know about any collaboration or participation from the construction industry in the delivery of the retrofit project and all of them replied with no.

The theme participation could be mainly on two levels. Firstly, at the government level where the tenants, landlords and communities talk to the

government and influence the energy efficiency retrofit policy. Or at the delivery level where the tenants, landlords and communities can contribute to the delivery of the retrofit project.

In terms of participation in policy-making level, P1 mentioned that in his opinion, "there has been some success" for example; the idea of HEEPS and area-based schemes, "to large extent", were from the lobbying of organizations like SFHA, Chartered Association of Housing and other organizations like Energy Action Scotland. The interviewee added that such schemes are more participatory and relatively successful.

4.6.4.1 There is not enough tenant and community participation on the policy level and on project delivery

P1 said that there are "quite a lot of examples (of community involvement) of schemes in the UK and from Europe from district heating, smart meter, area-based interventions" and community participation is "really important" to achieve the desired results of retrofit such as carbon emission reduction and fuel poverty reduction.

P2 also said that there are "fantastic" examples of "really good community engagement in energy efficiency improvements and lowering carbon" and he provided two examples of community-driven projects where he was directly involved. But as for community involvement in delivering national schemes such as ECO P2 shed light on an important challenge that successful and meaningful delivery of scheme depends on active participation of private owners, tenants and community as a whole;

"If you look at upon the … housing estate, you know the last few weeks … one of the companies who do cavity wall injection, is running about sporadically as far as I can see. Now, that's easy to do, why not do that sporadically if you can. Some of the houses have been bought by the people and some of the

houses are still the council estate. They have been doing RSL houses in a Terrace as a four or five, and there's another one in the middle that has been done and there is another private one in the middle which has not been done. Or maybe they have already been done but they did it privately. I don't know, but it just looks like a piecemeal approach to that. Yes? Which could under ECO and if the rules have been put rightly on the place, there should be a means testing, if you got a terrace of 5-6-9 or 10 houses in that terrace, what's the point of doing 3 out of 10?"

P3 also said that community involvement is very important and gave an example of on community-led project to install combined heat and power. P4 said that 'when it comes to local delivery, then whoever is the delivery agent, it is very important for them to have a good link to local communities or tenant organizations'. P4 further highlighted that if the tenant doesn't understand how a new installation/system works, and there is a difficulty. He gave an example on how spent a long time working with the council, working with the local resident groups, to engage them and explain what measures are planned to be undertaken and that it is important to involve 'with people rather than to people'.

4.6.4.2 Private sector participation is an uncharted territory

When asked about the participation and collaboration with the private construction industry, the interviewees mentioned the following;

- P1: "There hasn't been really much done on that"
- P2: "Not sure" how that collaboration works
- P3: "There has to be a spending of public money"
- P4: "We don't have a strong link"

P1 mentioned that there are "few challenges". He mentioned three major "challenges";

1. Funding tends to be in different packages; there is no funding which allows large-scale retrofitting.
2. People (SHO) aren’t always clear what they want to do,
3. There is no clear guidance on what the best approach to is take for the different types of housing.

Further, on the issue of collaboration with the private sector for a large-scale retrofit project, P1 further added that "There hasn't been really much done on that. That is the area to develop."

In terms of construction industry's participation to make large-scale retrofit viable, P2 suspected that he was "not sure" how that collaboration works unless there is a middle conjoint to bring (construction sector and retrofit) them together". He gave a reason for that; "most of construction companies are of course commercial companies, they are there doing business to make money unless they make money they don't exist" and as P1 said, there isn't funding which supports large-scale retrofitting.

P3 also echoed P1 and P2 that "because they are private businesses and they need to make money", if there is not enough funding from the government there is no money and if there is no money the private companies won't participate whether that is for collaboration or innovation in the retrofit industry.

P4 admitted that they "don't have a strong link" with the private sector, therefore, they "attempt to influence them (private sector) through talking to government building regulation". This exposes a clear lack of connection between the private sector and SHO regarding retrofit. P4 referred to "a research by existing homes alliance” that the selling pitch for any home is, close the amenities such as good school, transport link and nice interior such as kitchen and bathroom etc. But the energy efficiency and what appliances are inside the building is not a selling pitch or probably doesn't attract the potential buyers/tenants. To solve this issue P4 suggested that builders should

be encouraged to talk about energy efficiency; "until we get house builders to innovate and say this home is a B rated and it has built in the full energy efficiency features, this is a home that will cost you pennies a year to run."

4.7 Interview results, Discussion and conclusions

In this section, the themes are analysed and discussed in a broader holistic picture of social housing retrofit and examined whether the responders covered all aspects or not. To examine how the responses fit into the broader context of social housing retrofit and if they bear essence the original themes which were in question itself, we also look at the following questions;

1. What is the most commonly raised issue with regards to social housing retrofit by interviewees?
2. What is the most important aspect of social housing retrofit according to the interviewees?
3. What does the holistic picture of social housing retrofit look like when the literature review and interviewees' answer is combined?

The answer to question one and two in sum; the most commonly raised issue with regards to the social housing retrofit was the financing of retrofitting; funding and the most important aspect of social housing retrofit was tenant/community concern; fuel poverty.

To answer the third question regarding the holistic picture of social housing retrofit, it can be summarized under the following theme from the interview;

1. Financing of retrofitting
2. Building energy efficiency policy
3. Fuel poverty and building energy demand
4. Participation

Now, after we know the summary of the interview result, the essence of SHO retrofit is discussed in the next section. The four themes that are drawn from above analysis are heavily interrelated. They can't be separately discussed. For example, building energy efficiency determines financing for SHO retrofitting which then impact on fuel poverty and energy demand. On the other side, the participation from all stakeholders can only lead to the desired goal of energy efficiency retrofitting. So, to understand the essence, the question of the purpose of energy efficiency retrofit needs to be asked then the holistic picture should be drawn. On this process, the themes are being discussed but from the angle of seeking reason and motive behind those four themes.

4.7.1 The tenant at the heart of social housing energy efficiency retrofit

From the interview, it can be concluded that the interviewees put tenant at the very centre of energy efficiency retrofit, however, this logic comes with an irony that the word tenant was one of the words that were mentioned the least among the codes. The section below discusses this.

4.7.1.1 Why retrofitting social housing?

The first question asked to interviewees was; "why do you think social housing is important if it is important and why do you think it is not important if it is not?"

The question was asked to see what will come up in the mind of the interviewees as soon as they think about the reason behind retrofit. Later in the interview, the other question followed the same theme and sequence but evolved in wording as the interviewee responded. So, the first question is the only question asked to all interviewees in exactly the same wording and format and right at the beginning of the interview.

In the first section of the question when asked in a positive tone that the interviewee thinks retrofit is important "because...". Here The interrogative adverb "Why" means; for what reason or purpose. In the second section of the interrogative adverb "Why" is used to make or agree with a suggestion that retrofit is not important "because…" (Oxford Living Dictionaries 2018). P1, P2 and P4 gave a straight answer to the question while P3 had a more explanatory answer. The interviewees were followed carefully during the interview and in transcription after the interview in search of the first question to see if they will have a different tone or give an additional reason for retrofit.

The following table shows the answer. The primary reason is the direct answer following the question. The other reason is the additional reason interviewees gave during the course of the interview.

Table 11: Reasons for doing energy efficiency retrofit in the social housing sector

	P_1	P_2	P_3	P_4
Primary reason	To eradicate or control fuel poverty	To comply with current regulation and standard	To raise the standard of energy efficiency to current standards	To reduce the energy demand and cost of energy
Other reason	Carbon reduction	Energy efficiency	The benefit to the tenant and community	Health benefits

The table (11) shows that the primary reason for energy efficiency retrofit is to eradicate or control fuel poverty, compline with current standards, increase building energy efficiency and decrease the cost of energy to run a house. The peripheral reason is carbon emission reduction, increase the energy efficiency of building, health benefits to the tenant and other benefits to the tenant and community.

4.7.1.2 Many reasons point to tenant welfare

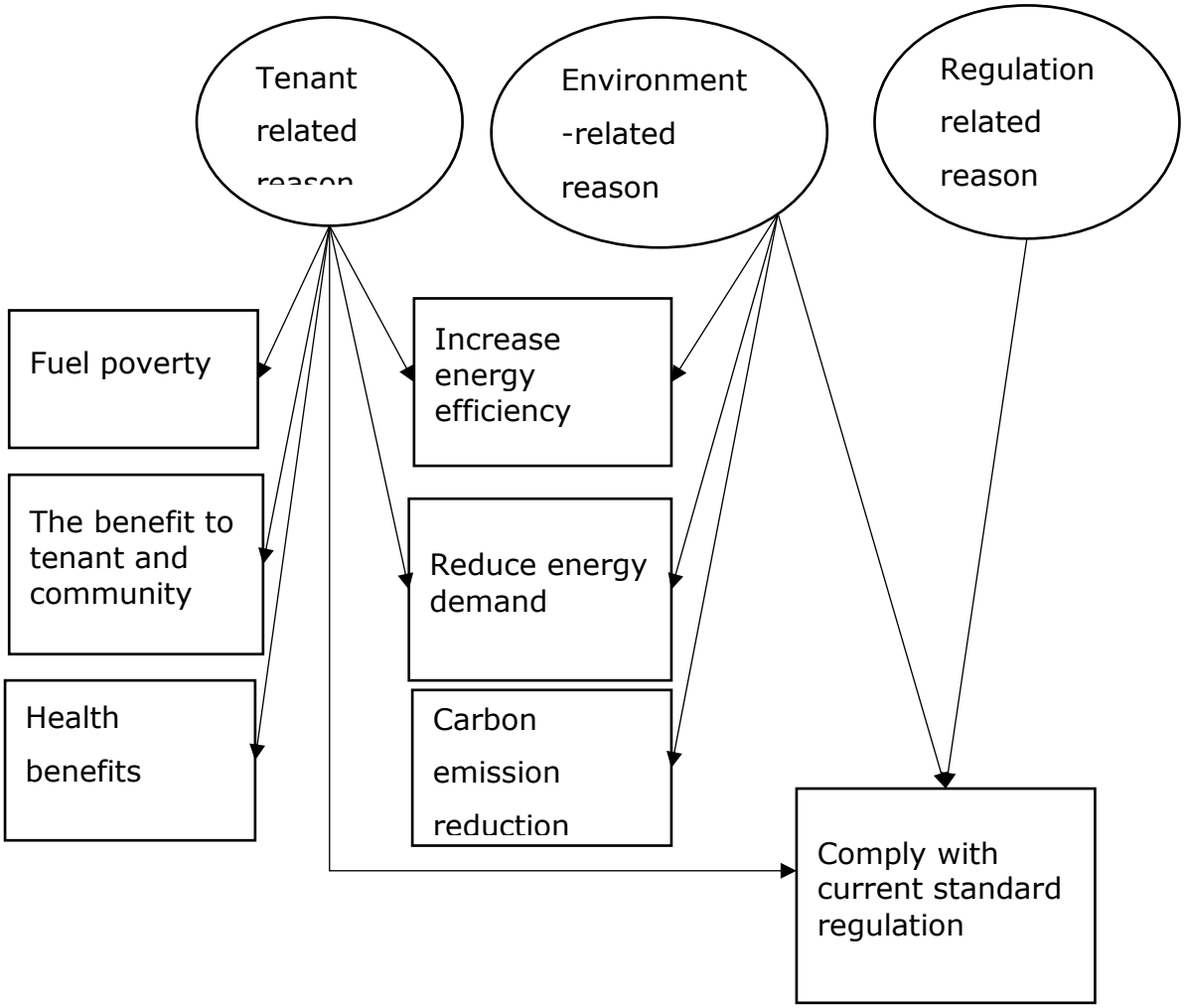


Figure 41: Reasons for doing energy efficiency retrofit in the social housing sector

If looked closely at, these reasons are related to tenant, environment and regulation. And if looked closer to the relationship between them, it is found that six out of seven reasons are directly related to tenant welfare while one reason, "carbon emission reduction" is indirectly related to tenant welfare. Fuel poverty reduction or eradication, health benefit and other benefits to tenant and community are directly related to tenant welfare.

Increase in energy efficiency and reducing energy demand are primarily environmental reasons however they are equally related to tenant welfare as well. As the energy efficiency of dwelling helps tenants to reduce energy bill that also helps reduce fuel poverty. Similarly, complying with current standards means an overall improvement of building such as energy efficiency and health and safety which is also related to tenant welfare. The last reason, carbon emission is more related to environmental benefit and benefit to overall society and humankind. However, the benefit to overall society certainly means benefit to the tenant as well.

4.7.2 Building energy efficiency policy and financing mechanism of retrofit schemes

Previously it was discussed that the tenant welfare is the main reason or the purpose behind energy efficiency retrofit in the social housing sector. But the building energy efficiency policy and financing mechanism of energy efficiency retrofit tell a different story. In the thematic analysis the following sub-theme was discussed under building energy efficiency policy and financing of retrofitting;

1. Financing of retrofitting
    a. The main source of funding is ECO
    b. Complex funding stream
    c. The ownership of energy efficiency retrofit
    d. Energy Company Obligation could have been better
    e. The area-based approach is relatively successful, Green Deal is a failure
2. Building energy efficiency policy
    a. Contradictions, overlaps and lack of political sustainability in energy efficiency policy
    b. Funding priorities and funding mechanism target low hanging fruits

4.7.2.1 SHO should have outright control over social housing retrofitting, not energy companies

It was discussed that the main source of funding for energy efficiency retrofit in the social housing sector is ECO, but the ECO mechanism is complex, and it places energy companies at the centre of delivering the measures. This is the point where the problem starts; if the tenant welfare is the main purpose and SHO are responsible for that where does the energy companies' role as delivering retrofitting fit? As raised by our interviewee P1, why can't energy companies be taxed directly and funding for ECO or whatever incentive is proposed come through government or local government? If all the purpose of retrofitting social housing points towards tenant welfare and SHO own the buildings, should the measures not be delivered by SHO with the active tenant and community participation? SHO own their building and they know the necessities of tenants and what is the best retrofitting solution for the building. They have the expertise and manpower to deliver. So SHO is best-placed among stakeholders to drive retrofit, not energy companies.

Another problem raised by the interviewees was that "there has to be a balance" on what is expected from the energy companies through ECO and realizing the energy companies' actual purpose; that they exist to sell energy not to reduce energy consumption. It is obvious that the money for ECO "comes from out of the energy bills that consumers pay to the energy companies." In this view, "to some extent, the energy cost is artificially increased because for the need for the ECO", and the increase in energy bill means more households falling into fuel poverty rather than coming out of it. And this argument is backed by the evidence that the energy companies have been found hiking price unfairly and not fulfilling ECO repeatedly over years. All the evidence and argument suggest that the whole idea of putting energy companies at the forefront of delivering energy efficiency incentives is paradoxical. As one interviewee said the direct taxation and funding through the government and delivery by the SHO is a solution to this problem. The issue of ownership and control in relation to SHO, tenant and energy companies is discussed further in next section.

4.7.3 Tenant participation; fundamental to social housing retrofit

Although the complexity of funding stream was raised as the main concern by the interviewees the complexity around delivering the retrofit measures are equally challenging. All of the interviewees said that tenant and community participation in social housing retrofitting was very important to them. But this didn't come without a problem. Similarly, tenant participation is very important in fuel poverty reduction. As fuel poverty is not just about building energy efficiency but also involve tenants overall social economic and behavioural bearings, tenant participation before and after retrofit is equally crucial.

4.7.3.1 Tenant participation is decisive in the success of delivering measures

As P2 mentioned, without proper consultation and participation from the tenant and community, retrofitting in mixed tenancy dwelling becomes complex. P2 gave an example that an insulation company was carrying out retrofit activity in a terrace in an unplanned manner; leaving some buildings as it is and insulating others. The effectiveness of insulating a certain building in a terrace and leaving some without insulation is questionable. It is obvious that if all the building in the same terrace is insulated the terrace has better chance of being warmer and garnering better result, if some building in a terrace are left without insulating, they act like cold bridge and the heat escapes from them, making the adjoining (insulated) building colder as well.

In this scenario, the question we should be asking is "why certain dwelling was left uninsulated?" Again, as P2 said, that could have been a private tenant and didn't want to insulate. Or the owner didn't qualify, and the energy company didn't want to insulate. Or the owner was never asked. Or was asked and couldn't agree to the terms. Or had already insulated the property. If the in incentive was more participatory and all of the dwelling owners or landlords and SHO had reached an agreement to carry out insulation at the same time the effectiveness and outcome of the measure would have been better.

4.7.3.2 Ownership and control of retrofitting project matters

From the analysis of the themes earlier, it is observed that the SHO have ownership of the dwelling and thereby the ownership of the retrofit incentives but the energy companies by implication, control the retrofitting project. And the tenant is at the receiving end of retrofit. This puts ownership and control in different places. By putting ownership and on the SHO and control on the energy companies, the complexity is added to the energy efficiency retrofitting. Talking about the corporate firms and financial sector, Coffee, J.C.J. (2001) argue that such separation of ownership and control "should not naturally evolve, absent the prior satisfaction of special legal or political preconditions". This is a matter of further research whether the UK government have implemented enough legal or political preconditions to protect the interest of SHO and Tenants over the energy companies who deliver the measures and. If the separation of ownership and control of retrofitting social housing has evolved without any pre-condition, it should be further researched from both legal and ethical point of view.

The issue of ownership and control doesn't just add complexity but also has an influence on public perception towards retrofitting. It is said that a dwelling can be seen as an expression of identity. (Hauge, Kolstad 2007) argue that our own dwellings and neighbourhoods create self-concepts about who we are. Lyons, & Twigger-Ross, 2002 as cited in Hauge, Kolstad (2007) document that "people's identities are affected by changes in their spatial environment". Now, when an average length of time social tenants stay in the current address is 11 years (GOV.SCOT 2018f), it wouldn't be exaggerating to say that the rented house becomes moulded to tenant's identity as well. So, for the social tenant, it is natural and legitimate to have an interest and be part of the decision making while retrofitting the property they reside. The control of ownership of energy efficiency retrofit has to be shared between the tenant and SHO, not between energy companies and SHO. This can add a huge potential for participation and lead to the success of the overall social housing retrofit

Apart from the awareness or feelings such as expression of identity, the tenant participation leading to community participation has often been proved successful in Scotland. All of our interviewees were able to recall and give examples of successful projects where tenants and communities were directly involved. In their paper, which is claimed to be the "first empirical evidence from a Scottish context" (Warren, McFadyen 2010) have concluded that "public attitudes are more positive towards windfarm developments in areas where local communities have a direct involvement in them than in areas where they do not". This conclusion can be justly transferred to the context of social housing retrofit as well that if the public attitude is more positive to the wind farm where local communities have direct involvement, the attitude towards the retrofitting of the dwelling they live in will also be more positive if they have direct involvement and ownership.

4.7.3.3 Tenant participation may affix funding gap

In terms of tenants and community participation, the successful examples have been discussed earlier. In this section characteristics of social tenants have been analysed to see if this can indicate that the tenants can actually affix the funding gap.

The characteristics of social tenants are changing, according to (GOV.SCOT 2018f). According to the figures in key findings, the household income of social tenant is increasing, there is the more working adult in social housing than in 1999 and 2007, and more household is reporting that they are doing well. The percentage of household staying more than 10 years at the current address was decreasing from 1999 until 2007, but it is increasing again in 2016.

According to (GOV.SCOT 2018f) an estimated 1.17 million people were living in social rented housing in Scotland in 2016, 30% of whom were single working-age adults. The social rented housing stock in 2016 totalled 594,458 units which are 23% of total housing stock in Scotland.

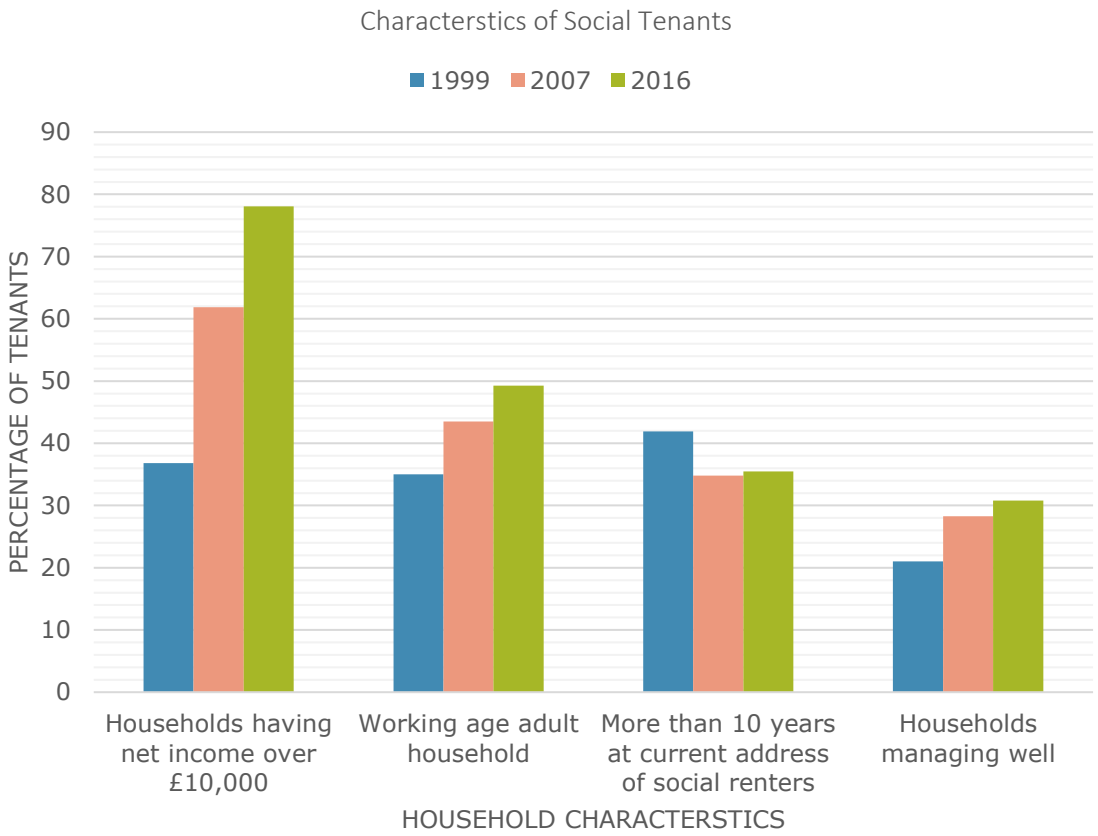


Figure 42: characteristics of Social Tenants, source: (GOV.SCOT 2018f)

The above-mentioned characteristics of social tenants can actually be a positive thing for social housing retrofitting. The working-age adults can possess useful skills needed for retrofitting which can be utilized through active participation. The increasing net income of household suggests tenants might actually be able to contribute towards retrofitting cost. And if tenants are living longer in the dwelling, as we discussed earlier, they have moulded into the dwelling and the dwelling becomes related to the tenant's identity. This can actually be a positive thing and tenants might be more willing to contribute towards retrofitting whether that is financially or by skills or another form of participation.

The question of how social tenants, especially the growing number of working age social tenants can be promoted to social housing energy efficiency retrofit is a matter of further research. For the moment it won't be an overstatement to say that tenants can potentially affix the big issue of funding through the financial contribution or through their skills and knowledge.

4.7.3.4 Tenant participation can reduce dwelling energy demand and help eradicate fuel poverty

According to GOV.SCOT (2017c), 33% of social tenants are under fuel poverty in 2015 which is more than overall Scottish household under fuel poverty (30.03%) in the same year. But if we look at the EPC band, 49% dwellings in the social rented sector are EPC (SAP 2012) band C or above while only 33% private rented dwellings and the same percentage of owner-occupied dwellings are EPC band C or above in 2015. This figure suggests that apart from building energy efficiency other factors such as household income and fuel price also equally influence fuel poverty.

Fuel price and household income fall under a broader social and political issue, however, the management of energy demand within a dwelling can only be achieved through active tenant participation. Having active tenant participation before, during and after dwelling retrofit means tenant will understand how to use the newly fitted appliances or make use of retrofitted dwelling more efficiently and reduce energy use. This not only helps reduce energy use but also helps reduce energy bill hence reduce fuel poverty and carbon emissions. For example, if only tenants can be made aware of their energy use from monitoring such as smart meter and be advised of potential energy saving, there can be a huge energy saving (GOV.SCOT 2017c). The latest data (GOV.SCOT 2017c) shows that 32% households in Scotland don’t monitor their energy use at all. The social sector specific data is not available for this. However, if we assume the same percentage of social tenants don’t monitor their energy use, this shows that there is a big potential to decrease energy demand from awareness and active tenant participation.

The latest data from GOV.SCOT (2018f) shows that 28.96% social tenants of working age are employed part time, looking after the home or family or unemployed and seeking work. Among which 8.94% are fully unemployed and seeking work. This demography can potentially be promoted for energy efficiency retrofit. The energy efficiency incentive can encourage the suitable social tenants to take part in volunteering or paid internship. These tenants can become the ambassador to their families and teach how to make use of retrofitted building and energy efficient technologies. Promoting social tenants in retrofitting can help generate income and learn employable skills in future. This can help reducing fuel poverty by uplifting the household income. Therefore, tenants can prove to be a resource for the social housing sector. Tenant participation can not only help reduce energy demand and help eradicate fuel poverty but also promote the feeling of ownership in social tenant which may then lead to better looking after of the property.

There are many pieces of evidence that community involved, or community-based renewables projects are very successful (Community Energy Scotland 2018), this can justly be applied to housing retrofit as well however the extent of community participation should be explored in scientifically and credible methodology should be established.

4.7.4 Private construction industry participation in large-scale retrofitting must be explored promptly

When asked about the collaboration with private construction firms who have enough resources to invest in an innovative retrofit solution, all of the interviewees mentioned that there is a possibility but "there hasn't been really much done on that". This allied language of the interviewees suggests that the field is an unchartered territory as we discussed earlier. The interviewees, however, mentioned that there are some examples of small-scale or "pilot" projects with collaboration with the construction companies. The interviewees were asked more specifically about the possibility of collaboration on a larger scale with the bigger construction companies who have sizeable resources and

can potentially invest in innovative solutions. The answer was again very much alike that the private companies exist because there is profit if they don't make a profit they don't exist. And, to make a profit in social housing retrofit there needs investment from the government. This allied language suggests there is the same understanding about private sector at all different social housing stakeholders. This can be a result of experience or a general conception.

From the interview it can be concluded that to collaborate with the private sector construction companies there is need to think out of the box and find a solution that works for all; SHO have their dwelling stock retrofitted, tenants have their home modernized and construction company has profit. The government can facilitate this process through funding and policy intervention such as they have developer contributions to affordable housing (GOV.SCOT 2018b) for new built. Apart from that as P4 suggested, there is a need for a "strong a link" between SHO, Private sector and researchers through which regular exchange of ideas and design of the innovative project can be facilitated. P2 suggested that the organizations such as Construction Scotland Innovation Centre (CSIC) (Construction Scotland Innovation Centre, 2018) can be that missing link but CSIC oversees overall construction industry and focus is more towards the new built. P2 further mentioned that he was personally involved in a CSIC funded small-scale pilot retrofit project but there were funding and continuity issues from government side for the continuation of it. From this experience, it can be observed that government can facilitate similar organization like CSIC, which is solely focused on retrofit independently or under CSIC. However, again the political sustainability of commitment towards such innovative projects remains a challenge as previously discussed.

5 BENEFIT CRITERIA OF ENERGY EFFICIENCY RETROFIT; QUESTIONNAIRES

Although it was clear from the interview that the tenants are considered the most important stakeholders of social housing retrofit projects, in order to more confidently understand what SHO truly prioritise when undertaking retrofit projects (what for them is at the heart of an SHO retrofit), the research implemented a questionnaire based on the AHP decision-making method.

Reflecting back to the research objectives, the questionnaire directly feeds to the research objective 3:

- Determine retrofit benefit criteria from the SHO perspective

The questionnaire discussion and conclusion further support and validates the determined benefit criteria as stated in research objective 4.

- Validate the determined retrofit problems and benefit criteria through primary research from the SHO perspective and allocate potential answers and suggestion(s) for further research

The SHO priority of benefits criterion helps understand 'why' social housing sector is receiving comparatively fewer incentive measures. Understanding the 'why' question then leads to the answer to the following research question;

- How can the social housing sector become the recipient of more energy efficiency incentive measures?

5.1 RATIONALE FOR USING AHP

Saaty and Vargas (2012) have defined rationality in AHP as focusing on the goal of solving the problem, through knowing enough about a problem to develop a thorough structure of relations and influences. Within such a structure, through having enough knowledge and experience, along with access to the knowledge and experience of others, it becomes possible to assess the priority of influence and dominance (importance, preference or likelihood) of the goal as appropriate amongst the relations within the structure. The literature review has determined the benefits of retrofit, which in this case are the importance, preference or likelihood to the energy efficiency retrofit. The interview provided sufficient further insights to know about the *Problems* in social housing retrofit, and the structure of *Problems* and their relations and influences. Therefore, using AHP at this stage to determine the SHO priorities is a coherent and reasonable action.

5.2 THE GOAL OF THE QUESTIONNAIRE

In AHP, the hierarchic synthesis is obtained by a process of weighting and adding that progresses down the hierarchy, thereby leading to a multilinear form (Saaty and Vargas 2012). This process starts from the identifying of a goal. The goal is basically set by answering questions such as "what is it that we are trying to accomplish?" and "what is the main question?" It then becomes possible to identify the criteria that must be satisfied in order to fulfil the overall goal.

Therefore, in context of the term 'goal' as used by (Saaty and Vargas 2012), the goal of the questionnaire is to find out the priority vector which shows relative weights among the retrofit criteria that are being compared. Or in other words, the objective of the questionnaire is to determine what benefits SHO prioritise when carrying out retrofit projects, or what is at the heart of an SHO retrofit.

As previously mentioned, the goals, policies and options or outcomes of stakeholders involved in social housing retrofit, are discussed in chapter 2 and 4. In this chapter, the research is focused solely to determine the views and priorities of SHO professionals on benefit criteria of energy efficiency retrofit projects.

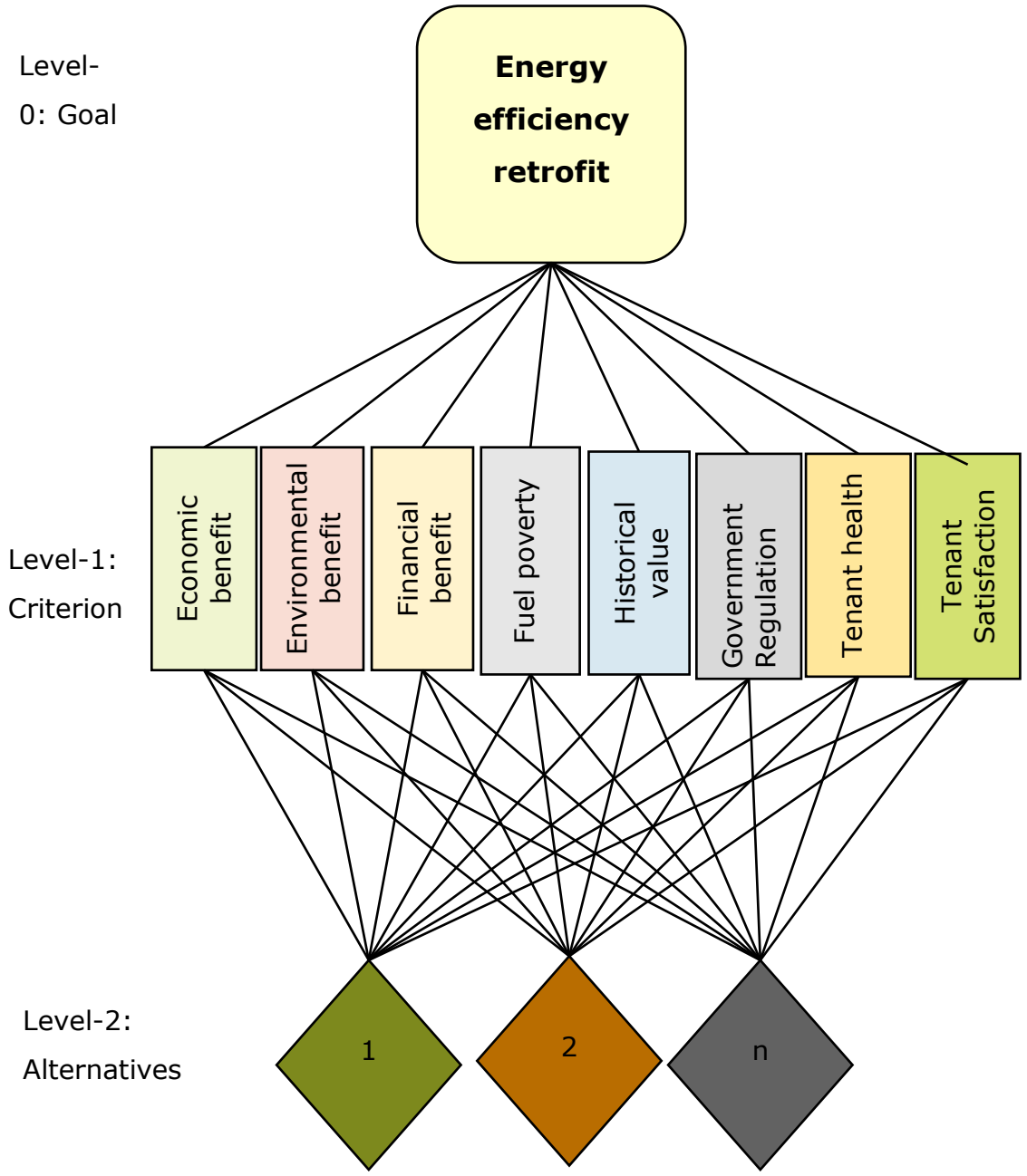


Figure 43: two levels of AHP decision making

The participants were given a scenario where their goal was to carry out an energy efficiency retrofit project within their housing stock. Eight benefit criteria were presented to the SHO professional to compare. The benefit criteria were arranged in alphabetical order to randomize and remove any influence of researcher or respondent such as having a particular criterion as the first on the list might have had.

The participants were asked to compare each criterion over every other according to the attributes of their project. After they gave their subjective judgement of the criteria, AHP scales were used to fill in the questionnaire matrix to get the priority vector. Please refer to chapter 3, section 3.11 for the scales and their definition in detail.

In Figure 43 we can see the hierarchy of goal, benefit criteria and alternatives in AHP decision making. In the initial phase, the goal is determined. Secondly, the multi-criteria are listed, and they are given a ranking. Finally, alternatives are chosen according to the priority/priorities or the benefit criteria the SHO value the most. The goal of the questionnaire is up to level Level-1, which is to identify the priority vector for multi-criteria decision making that consists of 8 factors. This opens the door to the next stage of decision making; to select the various alternatives and compare them to achieve the preferred benefit criteria(s).

The last level or Level-2 is the alternative choices of type of energy efficiency project which is not a type covered in this research. The reason for not covering this level is due to the aims and objective of research: "determine the social housing organizations' perspective on problems and benefit criteria of energy efficiency retrofit in the social housing sector". There were also other practical issues, such as time and resources that meant Level 2 projects could not be included. In more practical as the final level is about selecting which project is the best in terms of value for SHO which is more of an implementation phase. This requires the development of a project and determination of what

benefit(s) the different projects bear and, finally, choosing one from them based on those benefit criteria the SHO values the most.

5.3 THE BENEFIT CRITERIA

Benefit criteria are defined as "principle or standard by which something may be judged or decided" (Oxford Dictionaries 2018). In previous section the aim of the questionnaire is given as being to determine the views and priorities of SHO professionals regarding benefit criteria of energy efficiency retrofit. Therefore, the questionnaire is aimed at determining what benefits or standard the SHOs value when they undertake retrofit of their housing stock. In other words, the benefit criteria are the benefits an SHO seeks from a potential retrofit and based on which they decide whether to implement the project or not.

It was previously concluded from the literature review that there are many benefits of retrofitting. In addition, the interview then concluded that those benefits that are linked to tenant health and wellbeing are most valued. However, the finding was not deemed sufficiently robust in terms of the sample size. Therefore, taking into consideration both the literature review and the interview, allows the benefit criteria to be finalized. Conclusions from the literature review are regarded as the potential benefit criteria an SHO may value for social housing retrofit projects. These benefit criteria are then compared individually with each other by SHO and their ranking is determined. Here within the text, the benefit criteria are given the labels of benefit criteria 1 – benefit criteria 8 (C_1 – C_8) for workability.

1. Economic benefits to broader society (C_1)
2. Environmental and climate change benefits (C_2)
3. Financial benefits to the landlord (C_3)
4. Fuel poverty reduction (C_4)

5. Historical and preservation (C_5)
6. Meeting government regulation (C_6)
7. Tenant health (C_7)
8. Tenant satisfaction (C_8)

5.4 PAIRWISE COMPARISON MATRIX

Pairwise comparison matrix can be defined as where "decision makers compare two criteria or two alternatives at a time and judge which one is more important or better" (Bozóki and Fülöp 2018). The pairwise comparison matrix (PCM) is composed of elements expressed on a numerical scale and the values of elements are given by decision makers based on their experiences and expertise in order to transform the qualitative attribute or criteria into measurable numbers (Kou, Ergu et al. 2012). Saaty and Vargas (2012) suggested a 1–9 fundamental scale to compare two elements with respect to the criteria, and n(n-1)/2 comparisons are needed to complete a comparison matrix. Where *n* is the number criteria.

In the research, the questionnaire respondents were asked to compare each pair of criteria with the reminder and give it a scale between 1-9, where, 1 indicates two benefits being of equal importance, and 9 indicates one being extremely more important than the other benefit. All the elements in the comparison matrix are positive, $c \geq 0$. The participants were asked to give a reciprocal of the scale in order to indicate those criteria with a negative importance for one criterion over another.

To get the quantitative scale, firstly the respondents were asked to compare two criteria at a time. For example, in Table 12, Row 2; respondent 1 is asked to compare the importance of "economic benefits to the society (C_1)" over "economic benefits to the society (C_1)". In cell 2B, the scale given is 1 because C_1 is compared with C_1. After that in the cell 2C, the scale given is 7. Here

benefit criteria C_1 (economic benefits to the society) is compared with C_2 "environmental and climate change benefits". Given scale 7 is given because the respondent said that for him while retrofitting dwelling stock the criterion "economic benefits to the society" is "very important" compared to "environmental and climate change benefits". According to the AHP scale the qualitative scale "very important" is converted to quantitative scale 7. Similarly, in cell 2D, the scale 9 means the respondent said that for him while retrofitting a dwelling stock "economic benefits to the society" is "extremely important" compared over C_3 "financial benefits to the landlord". In this way, every other benefit criterion is compared with "economic benefits to the society (C_1)" in row 2.

Looking at row 3, cell 3B is left empty because the comparison between C_2 "environmental and climate change benefits" and C_1 economic benefits to the society" is already done in cell 2C. Therefore, cell 3B is filled with the reciprocal of scale in cell 2C (see Table 14). Then the benefit criteria C_2 "environmental and climate change benefits" is compared with C_3 "financial benefits to the landlord" in cell 3D. The scale given in cell 3D is 9 which means the respondent said criterion C_2 "environmental and climate change benefits" is "extremely important" compared with C_3 "financial benefits to the landlord". In this way, all the other cells are filled with the AHP scale based on the respondent's comparison. The following is the complete comparison matrix from Participant-1.

Table 12: Matrix showing upper triangular comparison matrix

	A	B	C	D	E	F	G	H	I
1		C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
2	C_1	1	7	9	1	1	5	1	1
3	C_2		1	9	1/9	1	1	1	1
4	C_3			1	1/9	1/9	1/9	1/9	1/9
5	C_4				1	9	9	1/9	5
6	C_5					1	1	1/9	1/9
7	C_6						1	1/9	1/9
8	C_7							1	9
9	C_8								1

The comparison of each horizontal (row) benefit criterion over the vertical (on the column) benefit criterion was scaled on the upper triangular matrix (above the diagonal line) shown in Table 12. Here there are eight criteria to compare. The total number of comparisons will be the combination of the criteria to compare.

$$Nc = \frac{n(n-1)}{2}$$

Where n is the number of benefit criteria and N_c is the number of comparisons. Hence, the total number of comparisons to make in the matrix is 28. These comparisons are basically the number of comparisons an interviewee would made during the interview. For example, we had 8 criteria to compare, if we compare each criterion with the rest the total comparison would be total of 28 comparison in the upper triangular matrix.

$$Nc = \frac{8(8-1)}{2} = 28$$

5.5 RATIO SCALE

Campbell (1957), as cited in Rossi and Crenna (2013) stated that a ratio scale "enables measurement with a minimum degree of arbitrariness, since once a conventional unit has been chosen, the scale is entirely fixed". As the ratio scales are all derived from the same fundamental scale, it is invariant and produces homogeneous comparisons. Table 13 is an example of a completed comparison matrix where the comparison scale in the lower triangular matrix is a reciprocal of the scales in the upper triangular matrix.

Once the comparison of benefit criteria (C) on the row over benefit criteria on the column is done (in order to fill the lower triangular matrix) the reciprocal values of the upper diagonal are used. Thus, the result is a complete comparison matrix. If the first comparison 2C is the element of row 2 column C of the matrix, then the lower diagonal is filled using this formula;

$$2C = \frac{1}{2C}$$

Table 13 Matrix showing lower triangular comparison matrix

	A	B	C	D	E	F	G	H	I
1		C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
2	C_1	1	7	9	1	1	5	1	1
3	C_2	1/7	1	9	1/9	1	1	1	1
4	C_3	1/9	1/9	1	1/9	1/9	1/9	1/9	1/9
5	C_4	1	9	9	1	9	9	1/9	5
6	C_5	1	1	9	1/9	1	1	1/9	1/9
7	C_6	1/5	1	9	1/9	1	1	1/9	1/9
8	C_7	1	1	9	1/9	9	9	1	9
9	C_8	1	1	9	1/5	9	9	1/9	1

A ratio is the relative value, or quotient C_1/C_n, of two quantities C_1 and C_n of the same kind. The reciprocal value suggests that the two quantities C_1 and C_n are related to another so that their product is unity. Considering the matrix (Table 13), C_1 and C_2 represent the same kind of quality; 'the benefit of energy efficiency retrofit', so they are comparable to each other. As a comparison between C_1 and C_2 is already carried out in the upper triangular matrix, the reciprocal value in the lower triangular matrix suggests that the comparison between C_1 and C_2 there is related to their comparison in the upper triangular matrix. For example, in Table 14 the scale for comparison of C_1 over C_2 is given scale 7 in the upper triangular matrix (cell 2C). This means when C_2 is compared over C_1 in the lower triangular matrix (cell 3B) it is reciprocal to the comparison made in the upper triangular matrix, therefore it is scale 1/7.

5.6 BRINGING VARIOUS JUDGMENTS INTO ONE SINGLE MATRIX

The questionnaire is aimed at determining the SHO view on energy efficiency retrofit criteria as directly as possible. Hence, the data has been carefully analysed using a mathematically correct procedure. It is not the aim to find out the judgements from the point of view of qualities such as experience, knowledge, and power of each respondent, but simply to generate a collective overall view of SHO.

To bring various judgements together and generate a single matrix, a complete comparison matrix from each respondent was obtained. In total 12 comparison matrixes were obtained from 12 respondents. From the twelve comparison matrixes, the element from each comparison matrix was added and divided by 12 to get the single element which is the average of all participants. For example, If the element of a final single matrix is E, the formula to obtain E is;

$$E = \frac{\sum(EM1: EM12)}{12}$$

Where, EM1 is an element of matrix 1, and EM12 is an element of matrix 12.

Table 14: Single comparison matrix obtained from 12 different comparison matrixes

	A	B	C	D	E	F	G	H	I
1		C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
2	C_1	1	2.7944	5.3333	0.9155	2.8333	4.2500	0.2842	1.5286
3	C_2	0.9855	1	5.2917	1.3935	3.5000	3.4167	0.4361	1.6528
4	C_3	0.2264	0.3646	1	0.1706	2.3426	2.5556	0.2794	0.5287
5	C_4	2.2292	2.1667	5.8333	1	5.2778	5.5000	0.9259	3.3333
6	C_5	0.4731	0.3612	1.1944	0.4183	1	2.2712	0.1425	0.6790
7	C_6	0.3679	0.5169	2.7044	0.2994	1.6667	1	0.2108	1.3287
8	C_7	5.0000	2.2778	6.5417	1.1759	6.5833	5.9167	1	4.6667
9	C_8	1.3958	0.8333	4.7778	0.5861	5.2708	3.4778	0.3433	1
10	Sum	11.5946	10.2316	32.5933	5.8760	28.3912	28.3045	3.5389	14.6345

Note: The table shows the single comparison matrix which are the average of 12 matrixes. To avoid confusion the middle diagonal comparison line are left as single decimal (1 instead of 0.9167). This does not have any effect on the sum in excel.

5.7 PRIORITY VECTOR AND RANKING

According to Kwiesielewicz and van Uden (2004), the main aim of the pairwise comparison method in the AHP is to provide a ranking of given factors or alternatives. At this stage of the research, a priority vector is calculated to provide the ranking of criteria derived from the personal judgement of respondents. The priority vector is derived from the single pairwise comparison matrix (Table 14).

After producing the single comparison matrix in section 5.4, the normalized relative weight is computed in this section. The matrix is showing normalized relative weight, which is also called the standardized matrix. Each column of the reciprocal is summed, then each element of the column is divided with the sum of its column to get a normalized relative weight. If the element in Table 15 is E, the formula is;

$$E(T15) = \frac{E\ Cn\ (T14)}{\sum E\ Cn\ (T14)}$$

Where C_n is Column n and T14 is Table 14.

For example, the element E of table 15 is obtained by dividing the elements of column n in table 15 by sum of column *n* in table 14. Table 15 shows the standardized matrix and the related priority vector.

Table 15: standardised matrix showing normalized relative weight and priority vector

	A	B	C	D	E	F	G	H	I	J
1		C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	PV
2	C_1	0.0791	0.2731	0.1636	0.1558	0.0998	0.1502	0.0803	0.1045	0.1383
3	C_2	0.0850	0.0896	0.1624	0.2372	0.1233	0.1207	0.1232	0.1129	0.1318
4	C_3	0.0195	0.0356	0.0281	0.0290	0.0825	0.0903	0.0789	0.0361	0.0500
5	C_4	0.1923	0.2118	0.1790	0.1560	0.1859	0.1943	0.2616	0.2278	0.2011
6	C_5	0.0408	0.0353	0.0366	0.0712	0.0323	0.0802	0.0403	0.0464	0.0479
7	C_6	0.0317	0.0505	0.0830	0.0510	0.0587	0.0324	0.0596	0.0908	0.0572
8	C_7	0.4312	0.2226	0.2007	0.2001	0.2319	0.2090	0.2590	0.3189	0.2592
9	C_8	0.1204	0.0814	0.1466	0.0997	0.1857	0.1229	0.0970	0.0626	0.1145
10	Sum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.000

Finally, the priority vector is obtained by averaging across the rows. If, in Table 15, row 2, the average of elements is 0.1383 (cell 2J), then the priority vector (PV) can be found using the formula:

$$PV = Average(Rn)$$

Where R_n is Row *n*.

The priority vector shows relative weights among the benefit criteria of energy efficiency retrofit that were compared. So, these comparisons started with the subjective judgements of respondents, which was then translated into a

quantity using AHP scales to produce an individual pairwise comparison matrix for each respondent. Then the individual matrixes were merged into one single pairwise comparison matrix. The merged matrix was transformed into the standardized matrix and finally, the priority vector was derived from the standardized matrix. The following table 16 shows the final priority vector or ranking of energy efficiency benefit criteria.

Table 16: Benefit criteria and their ranking

Criteria	**Weighting**
C_1 Economic benefits to broader society	**13.83%**
C_2 Environmental and climate change benefits	**13.18%**
C_3 Financial benefits to the landlord	**5.00%**
C_4 Fuel poverty reduction	**20.11%**
C_5 Historical and preservation	**4.79%**
C_6 Meeting government regulation	**5.72%**
C_7 Tenant health	**25.92%**
C_8 Tenant satisfaction	**11.45%**
Sum	**100%**

5.8 CONSISTENCY INDEX AND CONSISTENCY RATIO

To measure the Consistency Ratio (CR) of a reciprocal matrix, Saaty and Vargas (2012) gave a measure of consistency, called the Consistency Index (CI), as being the deviation or degree of consistency using the following formula:

$$CI = \frac{\lambda max - n}{n-1}$$

Where, (λmax) = largest Eigen value and (n) = number of comparisons.

It was proposed that this index be used by comparing it with the Random Consistency Index (RI) developed by the same researchers;

$$CR = \frac{CI}{RI}$$

But there have been new developments since that original proposal. Donegan, Dodd (1991) presented a large set of Critical Indexes for use in AHP, arguing, in doing so, about the significance of RI. Saaty himself argued that the Consistency Index (CI)'s improving the consistency of a judgment matrix does not necessarily also improve the validity of the outcome. Instead, he stated that, with better consistency, the outcome is arithmetically worse (Saaty, Tran 2007). In his paper, (Cavallo 2017) also state that the Consistency Index has been widely criticized in the literature 'because it is defined in a non-intuitive way, has no clear algebraic and geometric interpretation and there is not an analogous consistency index for the other kinds of pairwise comparison matrix'. The paper further argues that consistency is very hard to reach in real situations.

As this research is not entirely based on AHP, neither does it demand the completion of all levels of the AHP decision-making hierarchy. Thus, the decision to drop Consistency Ratio calculation then adjustment on the reciprocal matrix. Apart from that, it has been discussed in the previous paragraphs that improving the consistency of a judgment matrix does not necessarily improve the validity of the outcome.

5.9 Questionnaire Results, Discussion and conclusion

The questionnaire discussed in this chapter is a continuation of the inquiry (from the interview) commenced in chapter 4. However, the inquiry has increased in terms of the size of the sample and also narrowed in terms of the scope of inquiry (from overall retrofit issue to focus solely on benefits of energy efficiency). At this stage of research, the questions are determined, well defined and ranked according to their importance.

5.10 Ranking the benefits of social housing retrofit

The questionnaire has produced benefits hierarchies based on the SHO perspective. According to Kou, Ergu et al. (2012), how one prioritizes the criteria and sub-criteria is even more important than how one identifies the alternatives, which are themselves composites of criteria. Therefore, these rankings of benefit are highly significant for decision making in the context of energy efficiency retrofit.

To sum up, the ranking given by the respondents of the questionnaire, the following list shows that the first benefit criteria are the highest ranked while the last benefit criteria are the lowest ranked. In other words, the first benefit criteria "tenant health" is the highest ranked benefit criteria of all, followed by "fuel poverty reduction" and "economic benefit to the society", whereas the benefit criteria "historical and preservation" is ranked the lowest.

1. Tenant health (26%)
2. Fuel poverty reduction (20%)
3. Economic benefits to broader society (14%)
4. Environmental and Climate Change (13%)
5. Tenant satisfaction (11%)
6. Meeting government regulations (6%)
7. Financial benefits to the landlord (5%)
8. Historical and Preservation (5%)

The ranking above explains an important question, "what the highest priorities for SHO is" and the answer is tenant health and wellbeing. As already mentioned, it was clear from the interview results that the tenants are considered the most important stakeholders of social housing retrofit. However, it was also not clear what benefits of the retrofit are the highest priority for SHO and what is the lowest priority. The result of the questionnaire has helped to clarify really what criteria SHO prioritise when carrying out retrofit projects.

5.10.1 Tenant health and wellbeing is the top priority

From the ranking of the benefits, it is clear that SHO prioritises 'tenant health' above all other criteria. The second most prioritised benefit criterion is tackling or eradicating 'fuel poverty'. This is followed by the 'economic benefits to the broader society' and contribution to mitigating the 'environmental and climate change' issues.

Looking back to the interview results, the interviewees said that that the primary reasons for energy efficiency retrofit were as follows;

- Eradicate or control fuel poverty,
- Comply with current standards,

- Increase building energy efficiency
- Decrease cost of energy to run a house

These criteria cannot be ranked because these answers came from the different interviewees in a qualitative form. However, from these four primary benefit criteria, it can be seen that two priorities; 'eradicate or control fuel poverty' and 'decrease cost of energy to run a house' are about the tenant (and in particular about fuel poverty). The other two reasons were less focused on the tenant: 'comply with current standards' and 'increase building energy efficiency'.

Apart from those primary reasons, the other reasons for undertaking retrofit projects as mentioned by interviewees were:

- Carbon emission reduction
- Health benefits to the tenant
- Other benefits to the tenant and community

When the interview result is compared to the questionnaire result, there is a similarity; both results reveal that the SHO value tenant or tenant related retrofit benefits the most. In fact, from the questionnaire, it is revealed that SHO prioritises 'tenant satisfaction' more, over 'meeting government regulation' which are ranked 5th and 6th respectively. 'Financial benefits to the landlord' are ranked sixth among the eight criteria compared, which is natural for SHO as non-profit making organizations. The SHO ranking of 'historical and preservation' as the lowest (8th) is a curious scenario. According to Historic Environment Scotland (2017) there are around 47,000 listed buildings in Scotland, among which the traditional buildings category accounts for around 42% (19,740), which may be a smaller number compared to overall SHO stock (595,547). This could be a subject of future research with regard to how historical and preservation issues are viewed in the social housing sector.

5.10.2 Economic benefit & environmental benefit

Apart from the similarity in prioritising benefit to the tenant, there is also a difference in the results of the interview and the questionnaire. After tenants, the interview results suggested that the environmental benefits such as building energy efficiency and carbon emission reduction were said to be the main reason of doing the retrofit, but the questionnaire result suggests that the SHO prioritise 'economic benefits to broader society' more than the 'environmental and climate change' benefits. The interviewees did not mention 'economic benefits to society' when asked about the reasons for carrying out retrofit projects.

Regarding the contrasting opinion obtained regarding the benefit criteria 'environmental and climate change' and 'economic benefits to society' in the interview and the questionnaire, there can be two legitimate reasons identifies for this contrast. Firstly, in terms of method, the questionnaire could be more impartial and have achieved an unbiased result because the respondents of the questionnaire didn't directly rank the criteria. The ranking comes from the systemic and holistic analysis of 28 different comparisons. Secondly, this contrast may be due to the difference in expertise, experiences and numbers of respondents to the interview and the questionnaire. The interviewee represented the SHO, academic, experts in fuel poverty and lawmaker functions, whereas the questionnaire answers were solely obtained from the SHO leaders and professionals. Therefore, the interview captured an 'overall' or general view, whereas the questionnaire captured the on-the-ground reality or a solely SHO view.

If the first reason is accurate then it can be concluded that a pairwise comparison matrix method, such as AHP, produces an unbiased result and therefore such a method should be used for decision making in social housing retrofit. If the second reason is accurate, it can be concluded that the decision or policy-making regarding social housing retrofit must consult SHOs

thoroughly, because the overall or general assumption of what is preferred or what should be prioritized in social housing retrofit can be different (or wrong) to the actual preference. If both reasons are accurate, it can be concluded that any retrofit incentives and decisions, whether in policy making or in delivery phase, should establish retrofit priorities using an unbiased method and the priorities should primarily include the SHO leaders and professionals who know the on-the-ground realities first hand.

6 DISCUSSION AND CONCLUSION

This chapter summarizes, discusses and synthesizes the results of the literature review, archival analysis and primary research (interview and questionnaire) in relation to research aims and objectives, research framework and research method. Section 6.1 looks back at the research in relation to research aim, research objectives, research questions, phases and method used in the research. Section 6.2 and 6.3 deal with the structuring of problems and benefits which gathers together the summary of problems and benefit criterion from Literature review, interviews and questionnaire. Finally, section 6.4 determine and synthesise the problems and benefit criteria to develop 'a single well-defined question for which there is a single correct solution' which feed directly to the research aim 'to determine the problems and benefit criteria of energy efficiency retrofit in the social housing sector'. The final section provides recommendation for future research.

6.1 LOOKING BACK AT RESEARCH AIM AND OBJECTIVES

The aim of this research was to determine, from the social housing organizations' perspective, the problems and benefit criteria of energy efficiency retrofit in the social housing sector in Scotland. To achieve the aim the following objectives were set;

1. Undertake the analysis of the recent UK national, Scottish and European policies and incentives on social housing retrofit.
2. Explore SHO concerns and their perspective regarding social housing retrofit problems.
3. Determine retrofit benefit criteria from the SHO perspective.

4. Validate the determined retrofit benefit criteria through primary research from the SHO perspective and allocate potential answers and suggestions for further research

To achieve the aims and objectives of the research, a number of questions were identified prior to the research framework being developed and defined. The questions addressed in this research are as follows:

1. What are the problems of social housing retrofit?
2. How can the social housing sector become the recipient of more energy efficiency measures?
3. What are the questions that need to be answered in order to maximize energy efficiency retrofits in the social housing sector?

The research had 5 phases, with each phase answering the research questions relevant to a research objective and then finally meeting the research aim.

1. Introduction, theoretical review and current trends, policies and practices in the UK and Scotland.
2. Literature review: Study and review of the UK, Scottish and European practices, regulations and policies and lessons learned.
3. Interview: Understand and explain SHO concerns and their perspective on social housing retrofit.
4. Questionnaire: Determine social housing retrofit benefit criteria from the SHO perspective.
5. Discussion and conclusions: Compare SHO concerns and their benefit criteria of social housing retrofit and allocate potential answers for further research.

In a nutshell, figure 26 in chapter 3 shows the overall construction of the thesis.

6.2 PROBLEM STRUCTURING: SUMMARY OF THE PROBLEMS OF THE SOCIAL HOUSING RETROFIT

By applying a process of problem structuring, the real-world dilemma around social housing energy efficiency retrofit is arranged in a pattern and defined. According to Oxford Dictionaries (2018b), structuring means to construct or arrange according to a plan; give a pattern or organization. To structure the problem, Phase: 1, Phase: 2 and Phase: 3 of the research are brought together in an analysis in this section.

In Phase: 1 and Phase: 2 of the research the theoretical concepts, definitions and the real-world situation were discussed through a combination of literature review, archival analysis and interview (see chapters 2 and 4). Chapter 2 was backed by relevant literature, examples, data and facts from government archives. The second phase of this division was Chapter 4, which represented opinions of individuals from the arrays of social housing-related professionals. The pattern of the problem was finally arranged and defined in this phase.

The literature review looked at the major acts and legislation on EU, UK and Scottish levels. It was concluded that the UK and Scottish policies are directed by the EU directives and legislation. Also, the UK and Scottish policies and regulations set the methodologies of calculating energy efficiency of a dwelling and benchmarking practices such as EPC and SAP. The methodologies were analysed and discovered that they mainly focus on the measure of cost-effectiveness. In Scotland, the EPC and SAP calculations determine a building's energy efficiency rating and, based on that, energy efficiency measures are designed and installed in a building.

From the literature review, it was concluded that the major problem in delivering energy efficiency measures in the social housing sector is ‘lack of funding’. This was further investigated using the archival data and other literature and the wording then revised to ‘lack of adapted funding’. This meant

that there is funding available for social housing retrofit but that it is either not enough or not adapted to the needs of social housing organizations.

This led to an examination of the major sources of funding in the social housing sector. The energy efficiency incentives; ECO, Green Deal, FIT, and HEEPS were identified as the major energy efficiency incentives that provide funding for social housing retrofit in Scotland. Among these incentives, ECO was the major source of funding for the social housing sector and Green Deal was identified as the major source of funding for the private sector. But in contrast to the purpose of ECO, from figure 7 it was highlighted that the majority of the ECO measures (71.9%) were installed in the private sector, mainly in the owner-occupied sector, while the Social housing sector received the least support (13.4%). The statistics were also compared with the proportion of social housing in Scotland and found that the measures received by social housing sector are less.

In the next stage of the research, ECO and Green Deal were further researched; how they work, what measures they install, what is the role of stakeholders (SHO, government, tenant, energy companies) in installing measures etc. It was seen that there were a series of changes and announcements in the incentives and major policy changes and announcements occurred, which in turn created uncertainty. The analysis concluded there was a lack of 'political sustainability' within the approach to the use of energy efficiency incentives, and the delivery of the incentives was heavily focused on the private sector. In terms of the government levels of delivery, in particular, it was found that the Scottish Government and the UK government incentives overlapped, contradicted, and stated ambitions were not always mutual. It was also seen that there was very little or no tenant participation in policy making and the delivery of the incentives. The SHO role in delivering retrofit measures was limited; energy companies had the bigger say. Another most important realization of this phase was that the energy efficiency incentives are mainly focused on carbon emission reduction and meeting government regulations, such as meeting certain EPC rating, but there

is an equally or more important issue associated with this; fuel poverty. The archival analysis showed that fuel poverty in Scotland is a serious issue, as over a quarter of the population is living in fuel poverty.

These problems were further explored in Phase: 2, the interviews. In Chapter 4 the previously identified problems were explored, determined and defined using thematic analysis of the interview material. From both archival analysis in Chapter 2 and the thematic analysis of interviews in Chapter 4, a homogeneous pattern within the result was obtained regarding the problems of social housing retrofit. At the end of Chapter 4 the following problems of social housing energy efficiency retrofit were determined and divided into the following themes and sub-themes:

1. Theme 1: Financing of retrofitting
    - The main source of funding
    - Complex funding stream
    - The ownership of energy efficiency retrofit project
    - Energy Company Obligation could have been better
    - Area-based approach is relatively successful, Green Deal is a failure
2. Theme 2: Building energy efficiency policy
    - Contradictions, overlaps and lack of political sustainability in energy efficiency policy
    - Funding priorities and funding mechanism target low hanging fruits
3. Theme 3: Fuel poverty and building energy demand
    - Impartial definition and focus on carbon reduction are out of right course
    - Incentives like ECO come at a price
4. Theme 4: Participation

- There is not enough tenant and community participation on a policy level and on project delivery
- Private sector participation is an uncharted territory

Chapter 4 provides definitions of the above themes.

6.3 BENEFIT STRUCTURING: SUMMARY OF THE BENEFITS OF SOCIAL HOUSING RETROFIT

Along with determining the problem, the research also looked at the benefits of social housing energy efficiency retrofit. Careful consideration of the aim makes clear that the research is trying to 'determine the problems and benefit criteria of energy efficiency retrofit in the social housing sector, in Scotland, from the social housing organizations' perspective'. This clearly gives an indication that the research is about the appraisal of retrofit decision making from the SHO perspective. In order to achieve the aim, the research has conducted a parallel inquiry into both problems and benefits.

As with the determining of benefit, the research took a similar approach to determining the benefits. The first phase (Phase: 1) looked into situation where there is the realization of retrofit benefits, but they are not well defined and various literature takes different approaches to their definition. Some looked at the financial benefit, some environmental, and some looked at the SHO benefit. After the literature review, the benefits were identified and defined. After that, the interviewees were asked why they do retrofit and what their priority is. From the interview it was clear that the tenants are considered the most important stakeholders of social housing retrofit, hence benefits related to tenant health and wellbeing were found to be the top SHO priority. However, it was still not well-founded for the purpose of the research due to a small but diverse sample size for the interview.

Unlike problems, the benefits needed to be ranked to be clearer about the SHO perspective. The prioritising of benefits determines what type of retrofit

measures an SHO needs, therefore it is important to rank them. To fully understand what SHO prioritise when doing the retrofit, or what is at the heart of an SHO retrofit project, the research implemented a questionnaire based on an AHP decision-making method. By determining the SHO priorities or benefit hierarchy, as stated by Saaty and Vargas (2012), the research is focussing on the goal of solving the problems that were previously determined. At this stage the importance, preference and priorities of SHO are assessed which will help to develop a thorough structure of relations and the influences they have on social housing retrofit projects.

The literature review determined the benefits of retrofit, which in this case are the importance, preference or likelihood to the energy efficiency retrofit. The interview in Chapter 4 was helpful in providing insight about the problems in social housing retrofit and the structure of problems and their relations and influences. Therefore, using AHP at this stage, the research determines SHO priorities. From the literature review in Chapter 2 the following benefits of retrofit were determined;

1. Economic benefits to broader society
2. Environmental and climate change benefits
3. Financial benefits to the landlord
4. Fuel poverty reduction
5. Preservation of historic buildings and built heritage
6. Meeting government regulation
7. Tenant health
8. Tenant satisfaction

For the definition of the benefits, please refer to section 2.9.2. After that, from the AHP method, the following ranking of benefits of social housing was determined, with 1 being the highest ranked, and 8 being the lowest ranked.

1. Tenant health
2. Fuel poverty reduction

3. Economic benefits to broader society
4. Environmental and Climate Change
5. Tenant satisfaction
6. Meeting government regulations
7. Financial benefits to the landlord
8. Historical and Preservation

With contrast to the focus of incentives such as ECO and Green Deal (on reducing carbon emission and meeting government regulations/targets such as certain EPC rating through retrofitting cost-effective measures), the SHO prioritise tenant health and welling the most, and meeting government are ranked low among their priorities. This result from the questionnaire exposed the approach of incentives such as ECO and Green Deal as being erroneous and fundamentally contrasting to the SHO needs.

6.4 Appraisal of problems and benefit Criteria

An appraisal is defined as 'an act of assessing something' (Oxford Dictionaries 2018a). In a real-world scenario, an appraisal is usually done in areas such as the assessment of an investment opportunity or assessing the performance of a person or organization etc. In the case of this research, the appraisal of social housing retrofit is done to assess the problems and benefits. According to Lester (2017) an investment appraisal, if properly structured, improves the decision-making process regarding the desirability or viability of a project. Similarly, the appraisal of problems and benefits of energy efficiency retrofit is also aimed at improving the decision-making process regarding the desirability or viability of a proposed retrofit project.

6.4.1 Key stakeholders and driver of investment on the social housing retrofit

The key stakeholders of social housing retrofit are the SHO, government, energy companies, tenants and communities. Among them the SHO, government and energy companies are the stakeholders who initiate and invest on the social housing retrofit. At this stage of research, understanding the 'why' question or 'why the key stakeholders want to invest in social housing retrofit' holds the key to achieving the research aim of 'determine the problems and benefit criteria of energy efficiency retrofit in the social housing sector'.

The investment on social housing retrofit is literally a social investment. However, from the review of the literature and archival analysis it can be concluded that the drivers of the investment on the social housing retrofit are different for the SHO, government and the energy companies. Figure 46 is developed from European Venture Philanthropy Association (EVPA)'s classification of organizations (Cummings, Hehenberger 2011). Figure 44 shows the position of key stakeholders and key drivers of social housing retrofit investment.

The government incentives such as Green Deal is structured into a 'socially driven business' model with 'impact first' strategy where tangible financial return is required. Therefore, for the government the blend of social and financial value is the key driver of the investment on the social housing retrofit. The SHO on other hand, is solely focused on the 'social value' such as 'tenant health' and 'fuel poverty', therefore, the social value is the driver of the investment on social housing retrofit for the SHO. In contrast, the energy companies are traditional businesses whose key driver of investment on social housing is financial value.

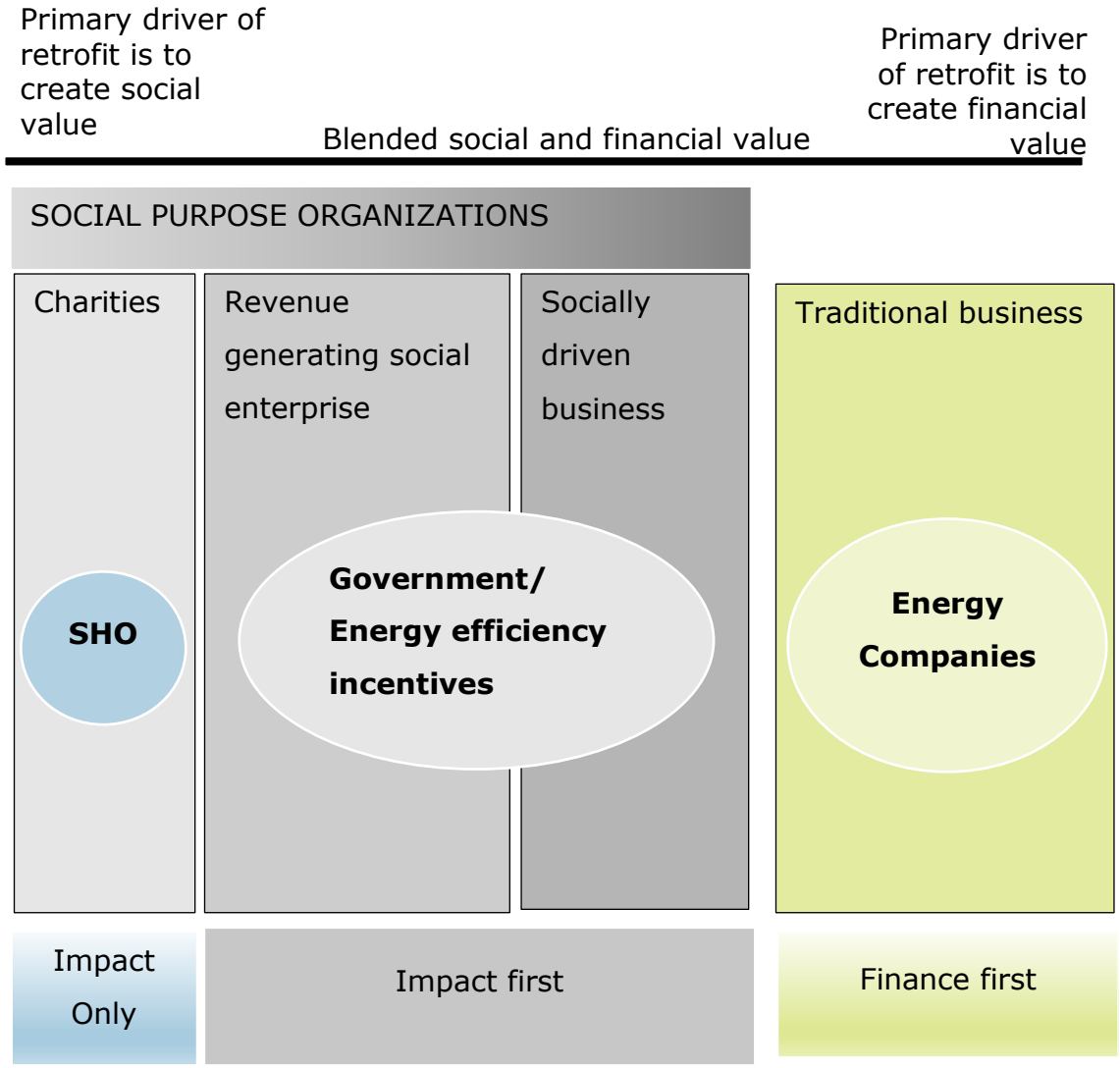


Figure 44: Key stakeholders and drivers of the social housing energy efficiency retrofit investment, developed from Cummings and Hehenberger (2011)

Cummings and Hehenberger (2011) state that European Venture Philanthropy Association EVPA's definition of social investment refers to funding that may generate a financial return, but where the societal impact comes first; so-called 'Impact First' strategies. If followed the Green deal and ECO funding mechanism and looked how they work (section 2.5.2 and 2.5.3) it is clear that the incentives' purpose is to invest in energy efficiency retrofit for social good such as to reduce carbon emissions and fuel poverty, with requirement of financial gain from the investment. For example, the so-called 'golden rule' requires financial saving from reduced energy demand to pay for the retrofit cost, similarly, in the FIT incentives, the energy generated from the

microgeneration is expected to pay for the installation cost. Therefore, the incentives can be defined as 'socially driven business' model.

On the other hand, from the review of literature and interviews, it was clear that the social housing retrofit is depended fully on government funding. "Grant funding" is defined by EVPA as the provision of non-repayable donations to the social purpose organisation supported; an "Impact Only" strategy (Cummings and Hehenberger 2011). If looked back to the main purpose of the SHO it is clear that they exist to provide housing for the needy in the society (see section 2.2), therefore, their primary driver to retrofitting is to create social value using the 'grant funding'. For example, the SHO ranked 'tenant's health' the top priority while 'financial benefit' was ranked second to the last among eight benefit criteria which proves that they are 'impact only' organizations whose retrofit interest is derived from social good only.

6.4.2 Synthesis of the problem and the benefit criteria

As already mentioned, social housing retrofit is a very complex issue, therefore, it has to be looked at a holistic approach. A firm understanding of problems and benefits of overall social housing retrofit is necessary before going into a real-life project. Therefore, the research took an approach to look at the overall problem and benefits of social housing retrofit rather than doing an appraisal of an individual project. As the aim of the research was to determine the problems and benefit criteria of energy efficiency retrofit in the social housing sector in Scotland from the social housing organizations' perspective, looking at the specific project would have had limited the scope then the aim would not have been met.

Once a complete list of problem and benefits are determined, it is important to understand how the problems and benefits are related and how they influence the decision of SHO and eventually the success of energy efficiency retrofit in social housing retrofit. And by understanding the problems and benefits in a

structured and well-defined way, the decision-making process can be improved.

When we look at section chapter 6.2, it outlines the problems which are the summary of findings from Chapter 2 and Chapter 4. And section 6.3 outlines the benefits which are the summary of findings from Chapter 2 and Chapter 5. If looked together at the problems and benefits they are linked and influence each other. All the benefits and problems are linked with each other in general, however, the more directly related benefits and problems can be linked together to form a cluster.

From the questionnaire analysis in Chapter 5, it was determined that the SHO ranked tenant health and fuel poverty reduction first and second respectively. But when we go back to Chapter 4, it is concluded that along with underfunding the Scottish government's impartial definition of fuel poverty and not enough tenant participation has become an obstacle in controlling or eradicating fuel poverty. Without active tenant participation, the SHO top priority tenant health and fuel poverty reduction cannot be met because the user behavior is equally responsible for building energy demand and on energy bill which then have effect on fuel poverty status of a household.

Similarly, the SHO ranked ‘economic benefit to the broader society' as the third most important benefit, but the problem determined in Chapter 4 suggest that there is very few or no community participation in policy-making and delivery of measures although it is realized that the projects with community involvement have been highly successful. Instead of the community and tenant involvement, the incentives are financed and delivered through private companies. In this way the problem related to ‘financing of retrofitting' influences the SHO priority.

The SHO ranked ‘environmental and climate change benefit fourth which was, in contrast, the major policy focus. Therefore, the problem related to ‘building energy efficiency' is linked with this priority. The government policy should realize that the SHO priorities carbon emission reduction the fourth compared to benefits related to the tenant and overall society. This result also suggests that the SHO prioritizes tenant health and wellbeing over carbon emission reduction. Here the government priorities and SHO priorities contrast which leads to the need for SHO participation and involvement in policymaking. The result also concluded that SHO prioritizes ‘tenant satisfaction' more than ‘meeting government regulation' and ‘historical and preservation' issues. All these comparisons between SHO ranking of benefits and overall problems of social housing retrofit show that they are interlinked and must be looked holistically.

Another important finding can be stated as the revelation that there is a contrast between the policy focus (which is energy efficiency through cost-effective measures) and SHO focus (which is tenant health and wellbeing). The identification, determination and defining of the problems of social housing retrofit under four themes is another important finding of the research which can now be further analyzed with bigger sample and step can be taken to solve those problems. Another important finding of the research is the identification, defining and the ranking of the retrofit benefit criteria. This can be used by the decision makers to improve the project outcome. Again, this finding can be tested on the national scale to generate a robust result that can help policymakers decide and improve energy efficiency retrofit in the social housing sector. The problem and benefit criteria can be synthesized into the following three topics:

1. A contrast in Government's policy focus and SHO's priority for housing retrofit
2. Ownership and Control of energy efficiency retrofit
3. Participation in energy efficiency retrofit

6.4.3 A contrast in Government's policy focus and SHO's priority for housing retrofit

The most important finding from the research is that there is a contrast between the policy focus and SHO priorities for housing retrofit. The ultimate focus of the UK government's household energy efficiency incentives is carbon emission reduction through cost-effective measures. Whereas the SHO rank tenant health and wellbeing along with fuel poverty reduction as the top priority. Since the current energy incentives don't acknowledge the SHO priorities the incentives are not efficient.

6.4.3.1 The Problem

In contrast to both the government incentives and SHO, the energy companies who are one of the main stakeholders and deliverer of the social housing retrofit measures is a traditional business. Cummings and Hehenberger (2011) define 'traditional businesses' as 'finance first' organizations whose primary driver is 'to create financial value'. Again, looking back to the interview and literature review (see section 2.10), it is proven that the energy companies are 'finance first' organizations and don't fit into the 'social purpose organization' framework to deliver 'impact only' or 'impact first' retrofit incentives (also see section 4.6.1.3). Therefore, there is a need for an innovative social purpose organization/ construction companies deliver the incentives in association with SHO and tenants.

Although the major incentives such as ECO and Green Deal are stated as "household energy efficiency incentives", their focus is more into carbon emission reduction and 'economic energy efficiency' rather than overall efficiency from the householder's perspective. So, the main goal of these incentives is a reduction in carbon emission and increase in energy efficiency by installing cost-effective retrofit measures. The 'reduction in carbon emission' simply means reducing the emission of greenhouse gases such as carbon dioxide, methane, nitrous oxide, and ozone (Easterbrook 2016). And Brookes (2000) cite Thompson, Karaganis et al. (1981) that economic energy efficiency

is the substitution of lower cost forms of energy for those of higher cost in defining raised efficiency. This makes raising energy efficiency simply part of economic optimization. Therefore, the easier way of achieving the goal of government incentives is by installing renewable energy measures in building (such as solar PV) or replacing old appliances with new appliances which use less energy. But this type of 'efficiency' does not guarantee that the raised energy efficiency will benefit the householder because there are two problems;

1. It does not guarantee that the house will be warmer and healthier for the tenant
2. It does not guarantee that there will be a financial benefit to the tenant.

Firstly, if the incentive measures are focused on 'economic energy efficiency' the priority is cost effective measure than the measure that addresses the household need and SHO priority. For example, if an old electric heater is replaced with a new 'efficient' gas heater that will be substituting the higher cost electric heater with lower cost gas heater because electricity is more expensive than the gas in the UK. This will be cost-effective because technically the new heater uses lower cost form of energy (gas) than the previous heater (electricity). However, the new gas heater does not guarantee that the house will be warmer and healthier for the tenant. From the behavioural side, the tenant may not know how to operate it or. From the building perspective, the house may still have other issues not addressed by the retrofit such as a poorly glazed window, uninsulated wall etc. Now, there is the duty for SHO to try to help their tenants come out of fuel poverty and make the rented property warm and healthy to live in. But by simply putting the focus on incentive measures on the 'economic energy efficiency' the major SHO priority is simply overlooked.

Secondly, if the incentive measures are focused on 'carbon emission reduction' the priority will simply be on reducing the carbon emission not reducing the energy demand. Reducing carbon emission does not guarantee that there will

be a reduction in energy demand and there could be no financial benefit to the tenant. As already discussed, there is a fundamental difference between 'energy efficiency' and 'carbon emission reduction'. Energy efficiency can contribute to carbon emission reduction but not all carbon emission reduction is necessarily energy efficiency. For example, if a household installs a solar panel using fund from ECO or Green Deal, this could truly reduce the carbon emission of that building. But if we look at the point of view from the tenant, he could still be paying the same or even more amount of money as he used to pay before (the measure was installed) towards the Green Deal plan.

Even if looked at the so-called 'golden rule' in green deal guarantees the tenant will pay 'no more than before the green deal plan' on fuel bill, but 'golden rule' doesn't guarantee about the years after the first year, which simply mean that tenant may pay even more on energy bill after the first year! Here, in terms of energy efficiency of the overall building such as window and wall, the house could still be equally inefficient as before installing the solar panel. Now, Energy Company can benefit from installing the solar panel because it helps the company towards fulfilling its obligation (ECO) whereas the tenant/householder will not benefit financially. Again, as mentioned earlier there is the duty for SHO to try to help their tenants come out of fuel poverty and make the rented property warm and healthy to live in. But by simply putting the focus of incentive measures on the carbon emissions reduction the major SHO priority is simply overlooked.

6.4.3.2 The root causes

The foundation upon which the UK government's retrofit incentives like ECO focus on 'economic energy efficiency' lies within the EU regulation. EN 15459 is an EU methodology for calculation of energy performance of building which is compliant to the Energy performance of buildings directive (EPBD) that provides direction for the mandatory national standards in the UK level. For example, the SAP calculation is compliant with this standard. An SAP is used to produce EPC for the dwelling. And the effectiveness of energy efficiency

retrofit measures or energy efficiency of a building is measured based on the result/ratings reflected on the retrofitted building's SAP or EPC band. Since the EU standard and methodology upon which the UK energy efficiency are based are focused mainly on 'economic energy efficiency' that is reflected in the UK and Scottish energy efficiency incentives such as ECO.

6.4.3.3 Recommendation - 1

The incentives such as Scottish government's HEEPS-ABS are comparatively successful (GOV.SCOT 2018a), and they try to address SHO priorities by localizing the delivery of incentives. However, there are barriers as the energy companies who fund and deliver the incentives measures focus on the things that help them quickly achieve their obligation. For example, there is highest portion of cavity wall insulation carried out in the cities and on private or owner-occupied dwellings because it is cheaper (cost effective!), easier and quicker than doing external wall insulation on a hard to treat traditional building in outskirts or rural areas. So, there is a tendency of picking the low hanging fruits which technically give a bigger figure of carbon emission reduction rather than installing the measures that are more effective and needed. Again, this is the result of the funding mechanism which fundamentally focuses on carbon emission reduction with cost-effective measures. This highlights the need for a holistic approach to retrofitting where priorities of tenants, SHO, energy companies, government and all the stakeholders are addressed at the design phase and delivery is localized. Linking the human factor and holistic consideration retrofit measures into the energy efficiency calculation of a dwelling resolves the root cause at the policy level. In terms of delivery level, holistic approach of retrofitting where priorities of tenants, SHO, energy companies, government and all other stakeholders are addressed at the design phase and delivery of the incentive measures is localized is necessary.

6.4.4 Ownership and Control of energy efficiency retrofit

The second finding of the research is that current government funding mechanism allows energy companies to have control over the retrofit measures to be installed but don't have ownership of the building they install retrofit measures. Whereas the SHO have ownership of the building but they don't effectively have the control over the retrofit measures. Since the ownership and control are in different places there is a conflict of interests on retrofit measures.

6.4.4.1 The problem

The funding mechanism of energy efficiency incentives in the UK is heavily focused on the private sector. When looked closely the UK government energy efficiency incentives such as Green Deal, FITS and ECO, they are heavily market based and focus on stimulating private sector growth and delivered by the private energy companies. These market-based solutions focus more on cost-effectiveness and less on social justice (Schaffrin 2013). Scottish government's flagship initiative HEEPS-ABS is not entirely private sector oriented and delivery is more localized but again dependent on UK government incentives which are market-based.

Depending completely on the market-based mechanism for delivery of retrofit measures can't be justified. Firstly, it transfers the responsibility of serious social issue to the private sector. For example, Fuel poverty is the serious issue and influences people's physical and mental health, the wellbeing of a community; costs elderly, children and other vulnerable people live and has larger impacts in the population of the country (Marmot Review Team 2011). Retrofitting of the housing stock is directly related to fuel poverty and tenant health and wellbeing which makes it a serious issue. In such serious issue, the government is in practice, passing responsibility to the private sector, which is not justifiable.

Firstly, delivering the initiatives by private sector shifts control of installing measures for tackling housing related energy vulnerability away from the SHO and government into the private sector, where cost efficiency will be a greater imperative and accountability likely reduced (compared to the public sector) regarding how vulnerable households are selected, treated or passed over (Walker, Day 2012). The idea that the private energy companies are not best placed to deliver energy efficiency retrofit can be supported by the fact that the energy companies have been repeatedly found not fulfilling their obligation, creating artificial energy price rise and been fined by Ofgem (Ofgem 2018).

Secondly, as raised by the interviewees "there has to be a balance" on what is expected from the energy companies through ECO and realizing the energy companies' actual purpose; that they exist to sell energy not to reduce energy consumption. It is obvious that the money for ECO comes from out of the energy bills that consumers pay to the energy companies. In this view, 'to some extent, the energy cost is artificially increased because for the need for the ECO', and the increase in energy bill means more households falling into fuel poverty rather than coming out of it. This speculation is proven to be true by the fact that the National Audit Office published a report in April 2016 criticizing the Green Deal for "not only failed to deliver any meaningful benefit, it increased suppliers' costs – and therefore energy bills" (The National Audit Office 2016).

6.4.4.2 The root causes

The funding mechanism of ECO allows Energy Company to have the control over the retrofit measures to be installed but they don't have ownership of the building. SHO own the building but don't have control over the retrofit incentive measures. There is clearly a conflict of interest that whether the energy companies are expected to sell more energy or help reduce energy demand.

Although the ownership and control over different places is a practice in big corporations and in Stock Market, that happens with the government putting on firm legislation and political stint behind it. Coffee (2001) argue that such separation of ownership and control "should not naturally evolve, absent the prior satisfaction of special legal or political preconditions". Now, this is a matter of further research that whether the government is aware of the separation of ownership and control in social housing energy efficiency incentive existing in social housing retrofit and if the government is aware, whether it has taken enough legal and political measures on it. Because putting energy companies in control of installing energy efficiency measures in the dwellings SHO own could, in fact, be unethical if not illegal on the government side.

6.4.4.3 Recommendation - 2

Energy companies are not right placed to deliver energy efficiency incentive measures. The retrofit incentives should be funded directly by the government or local government through SHO. Energy companies should be made to be taxed directly as a part of their obligation rather than government putting them at the forefront of delivering energy efficiency incentives. It was also evidenced in 4.6.1.5 that the schemes directly funded by local/national government was successful compared to the one funded through energy companies.

The SHO own the property, they know the property, they know the tenant need, have a responsibility towards their tenants, and they have resources and people power employed for the job. Therefore, they should rightfully have the outright control over the incentive measures to be installed in their properties. And the SHO should be able to set the priorities themselves. This will increase the accountability and effectiveness of retrofit incentives.

6.4.5 Participation in social housing retrofit

The third finding of the research is that the participation of all stakeholders in social housing energy efficiency retrofit is not acknowledged in the holistic sense of conception, design, delivery and post-project running phases of the retrofit incentives. The three major stakeholders; tenants, communities and private construction companies are not involved in the process of conception and design phase and even in delivery stage in some cases. The research highlighted the following;

1. Tenant and community participation are decisive in the success of energy efficiency retrofit
2. Private construction companies must be attracted and involved in retrofit project innovation and design
3. Tenant participation and private construction company's participation can actually fill the big funding gap prevalent in social housing retrofit

6.4.5.1 The problem

The lack of adapted funding was concluded as the biggest constraint of social housing retrofit project. The government funding mechanism focused on funding the retrofit incentives through energy companies, which is itself very problematic as discussed earlier. Other sources of funding such as private construction companies and the tenants themselves are not explored. The biggest irony of social housing retrofit is that the tenants and community's health, wellbeing and economic benefit are considered the top priority by the SHO but their role in retrofitting is very limited.

From the archival analysis and the interview, it was concluded that tenant and community participation in social housing retrofitting was very important for the success of the incentive. Similarly, tenant participation is very important in fuel poverty reduction. As fuel poverty is not just about building energy efficiency but also involve tenants overall social economic and behavioural

bearings, tenant participation before after retrofit is equally crucial. Without the tenant and the community of the area where the retrofit measures are to be installed the incentive cannot be successful. As mentioned by one of the interviewees, there are cases where some houses of a terrace are left uninsulated, tenants not familiar with the use of retrofitted appliance or heating system, other issues such as de-canting tenants etc causing delay etc. If the retrofitting is all about tenant and communities, they should be involved in the process right from the beginning rather than them being told about the decision made. Without the tenants and community including private landlords and owner occupiers' active participation, there can't be significant progress towards retrofitting old dwellings and reducing fuel poverty.

It was noted from the EU project such as Energiesprong that there is a potential of filling the funding gap through private sector involvement, especially the participation of private construction companies who have resources to innovate and implement a noble retrofitting solution. However, the literature review and interview conclude that there is very few or no progress made on how to bring private sector funding into energy efficiency retrofitting in the UK and Scotland's context. The research participant stated 'there is no strong link'... 'there hasn't been really much done on that" when asked about collaboration and participation of private sector. This is, in fact, a surprising fact that the incentives are designed to be delivered by the private energy companies and market-based approach is taken but the actual private sector; the construction industry who are there for the job has been left out.

6.4.5.2 Root Cause

It can be seen from the literature review and interview that the tenant and community participation has been proved to be very successful in delivering retrofit incentives and renewables generation. But this participation is usually at delivery phase or these success stories are one-off isolated projects. There is not a consistent platform for knowledge sharing and learning from these projects and these successful projects are not transformed and adopted on a

national scale. Similarly, there are some successful EU projects which use private sector funding and resources to fund large-scale project. This is again not explored in the UK context. There have been some pilot projects and some attempts on private sector participation but not on a national scale to materialize the concept in Scottish concept.

6.4.5.3 Recommendation - 3

Both tenant and community including private owners' participation in retrofit incentive should be guaranteed from conception to post retrofitting through localized and area-based approach. Apart from retrofitting, the focus should be equally on behaviour and other human-based retrofitting options. The role of private homeowners and social tenants in funding retrofitting should be explored. The archival analysis shows that there is the significant percentage of working age unemployed social tenants which can potentially be diverted into retrofitting projects. The archival analysis also shows that there is the significant percentage of social tenants who are economically well off, their involvement in filling the funding gap can be subject to future research.

Regarding the private construction companies' participation and utilizing their resources in filling the funding gap, the organizations such as Construction Scotland Innovation Centre (CSIC) can bridge that missing link. The government can facilitate similar organization like CSIC, which is solely focused on retrofit to materialize the participation of private construction companies and filling the funding gap in social housing energy efficiency retrofit.

6.5 RECOMMENDATION FOR FUTURE RESEARCH

The limitation of research regarding research method and the sample size is already discussed in section Chapter 3, the limitation of the result is discussed in this section and general recommendation for future research is presented. The results from interview and questionnaire in this research represent a general SHO view. In particular, the questionnaire didn't look into the respondent's professional experience, knowledge of the field, influences in decision making, organization etc to compare the result, instead, it represents a collective general view. If looked at the SHO, there are differences in them as well. Most of the SHO fall into the category that they provide housing for comparatively 'vulnerable' and people of society at the need of assistance to fulfil their housing needs. But some of the SHO is more specific and provide housing for a specific group such as elderly people. And their need may be different than that of the need of the SHO providing housing to others, therefore, their retrofit priority can be very different.

From the literature review and questionnaires, it was concluded that "tenant health" is the highest ranked benefit criteria of all, followed by "fuel poverty reduction" and "economic benefit to the society", whereas the benefit criteria "historical and preservation" is ranked the lowest. This conclusion is drawn from the questionnaire asked to 12 professionals (from Director to tenancy support officer) who were the representative of majority of the biggest SHOs in Scotland. However, sometimes the needs of the SHO may largely vary from place to place. For example, the SHO operating in the area with high level of fuel poverty may have a different priority than that of the SHO operating in an area with less or no fuel poverty. For example, the same SHO may have different priorities in different areas as depending on the type of the tenant. Another factor that could influence SHO priority is the building construction type and age as well. For example, some old dwelling may fall into the listed category and have historical importance, therefore, the SHO may prioritise the benefit from historical and preservation over the benefit from carbon emission reduction.

Therefore, it is recommended that the ranking of priorities of SHO for real-world retrofit project appraisal should be carried out separately on the basis of the area (location) of the project. Taking the location of a project, or area-based approach of ranking of the priority can be combined with the already existing incentive such as HEEPS-ABS.

From the research (see section 4.7.2.1 and section 4.7.3.2) it is observed that the ownership and control of social housing retrofit project are separated; the SHO have ownership of the dwelling and thereby the ownership of the retrofit incentives but the energy companies by implication, control the retrofitting project. Placing ownership and control in a different place without enough legal and policy protection can be in fact illegal and unethical from the government. This issue is a very important issue and needs further research from the legal and procurement perspective.

Finally, the research also concluded that there is potentially a huge opportunity to fill up the big funding gap in social housing retrofit through private sector partnership and active tenant participation. This can be further researched and a model of tenant participation in retrofitting including funding can be developed. Similarly, a model of private sector participation such as Energiesprong model can be developed. There have been important developments in private sector participation in some European projects which can be developed in the Scottish context.

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APPENDICES

APPENDIX 1 – EXAMPLE OF A LETTER SENT TO PARTICIPANTS PRIOR TO INTERVIEW/QUESTIONNAIRE

ROBERT GORDON UNIVERSITY ABERDEEN

THE SCOTT SUTHERLAND SCHOOL OF ARCHITECTURE AND BUILT ENVIRONMENT
Robert Gordon University
The Sir Ian Wood Building
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United Kingdom
Tel: 01224 263700
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11/12/2015

The_____

Mr Suraj Paneru is a PhD student at the Robert Gordon University and undertaking a research topic related to housing and sustainability in various aspects.

At this stage of his research Suraj is gathering data where interviews are his main source of information and data.

We will be very thankful if you can collaborate by accepting to be interviewed by Suraj during his research.

At your own preference, your name or the organisation you are representing won't be mentioned in this PhD thesis.

Please feel free to contact me if there is any question regarding the interview.

Kind regards

Dr Amar Bennadji
Lecturer, Researcher
Robert Gordon University
Scott Sutherland School of Architecture and Built Environment
Tel:+441224263609

INVESTOR IN PEOPLE

Head of School
Professor David McClean
PhD MBA ARB RIBA FRIAS SFHEA

APPENDIX 2 – EXAMPLE OF THE CONSENT FORM (INTERVIEW)

The purpose of the interview is to gather systematic information about energy efficiency retrofit in the social housing sector in Scotland to determine and explain SHO concerns and their perspective on social housing retrofit problems. The data obtained will be recorded and used as a part of PhD Thesis.

The data obtained from the participants shall be;

- Used anonymously in the research.
- Processed fairly and lawfully.
- Used only for one above specified purpose.
- Kept for no longer than is absolutely necessary.
- Kept safe and secure.

☐ I agree to above statement and take part in the questionnaire.

APPENDIX 3 - EXAMPLE OF THE QUESTIONNAIRE FORM

Question No. 1 (of 2): How do you compare the following benefits of energy efficiency/thermal retrofit? Please compare them pairwise. Mark them 1-9, where, 1 is - two being of equal importance and 9 is - one is extremely important than other. Above the diagonal line you are comparing row with column so put the importance of row over column. And below the diagonal you are comparing the column with row so put the importance of the column over row.

	Economic benefits to broader society	Environmental and Climate Change	Financial benefits to the landlord	Fuel poverty reduction	Historical value and Preservation	Meeting Government regulation	Tenant health	Tenant satisfaction
Economic benefits to broader society	1							
Environmental and Climate Change		1						
Financial benefits to the landlord			1					
Fuel poverty reduction				1				
Historical and Preservation					1			
Meeting Government regulation						1		
Tenant health							1	
Tenant satisfaction								1

Scale Guidelines (See page 4 for bigger font size)

INTENSITY OF IMPORTANCE	DEFINITION	EXPLANATION
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favour one activity over another
5	Strong importance	Experience and judgment strongly favour one activity over another
7	Very strong or demonstrated importance	An activity is favoured very strongly over another; its dominance demonstrated in practice
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
2,4,6,8	These are intermediate scales between adjacent judgements	
RECIPROCALS OF ABOVE	If activity i has one of the above nonzero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	If the objective has lower value than compared objective

Consent Form

The purpose of research: The purpose of the questionnaire is to ask professionals and individuals how do they rank the objectives/benefits of retrofit; for example, what is more important to them; reducing carbon emission or meeting government regulation? The data obtained will be used as a part of PhD Thesis.

The data obtained from the participants shall be;

- Used anonymously in the research.
- Processed fairly and lawfully.
- Used only for above specified purpose.
- Kept for no longer than is absolutely necessary.
- Kept safe and secure.

☐ I agree to above statement and take part in the questionnaire.

Please add any comments below:

Scale Guidelines

INTENSITY OF IMPORTANCE	DEFINITION	EXPLANATION
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favour one activity over another
5	Strong importance	Experience and judgment strongly favour one activity over another
7	Very strong or demonstrated importance	An activity is favoured very strongly over another; its dominance demonstrated in practice
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
2,4,6,8	These are intermediate scales between adjacent judgements	
RECIPROCALS OF ABOVE	If activity i has one of the above nonzero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	If the objective has lower value than compared objective
RATIONALS	Ratios arising from the scale	If consistency were to be forced by obtaining n numerical values to span the matrix

APPENDIX 4 – EXAMPLE OF A FILLED-UP QUESTIONNAIRE FORM

Participant
Job Title: _____

(Optional) Name: _____
(Optional) Email: _____

Question No. 1 (of 2): How do you compare the following benefits of energy efficiency/thermal retrofit? Please compare them pairwise. Mark them 1-9, where, 1 is - two being of equal importance and 9 is - one is extremely important than other. Above the diagonal line you are comparing row with column so put the importance of row over column. And below the diagonal you are comparing the column with row so put the importance of the column over row.

	Economic benefits to broader society	Environmental and Climate Change	Financial benefits to the landlord	Fuel poverty reduction	Historical value and Preservation	Meeting Government regulation	Tenant health	Tenant satisfaction
Economic benefits to broader society	1	7	9	1	1	5	1	1
Environmental and Climate Change		1	9	1	1	1	1	1
Financial benefits to the landlord			1	1/9	1/9	1/9	1/9	1/9
Fuel poverty reduction				1	9	9	9	5
Historical and Preservation					1	1	1/9	1/9
Meeting Government regulation						1	1/9	1/9
Tenant health							1	9
Tenant satisfaction								1

Scale Guidelines (See page 4 for bigger font size)

INTENSITY OF IMPORTANCE	DEFINITION	EXPLANATION
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favour one activity over another
5	Strong importance	Experience and judgment strongly favour one activity over another
7	Very strong or demonstrated importance	An activity is favoured very strongly over another; its dominance demonstrated in practice
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
2,4,6,8	These are intermediate scales between adjacent judgements	
RECIPROCALS OF ABOVE	If activity i has one of the above nonzero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	If the objective has lower value than compared objective

Researcher: SURAJ PANERU, PhD Student, Robert Gordon University, Aberdeen. Email: s.paneru@rgu.ac.uk m: 07403531983

QUESTION: Why do you think retrofitting old housing is an important priority for you, if it is?

ANSWER: Well, retrofit is really important because, number 1, the majority of the houses that exist now are varying in age from, I guess 18th century right up to housing that are recently completed. So, you have got pretty much small number of the houses that compline with the current regulation and standards. But housing even that might even be 15 years old doesn't comply with current standards. So, you got the huge variance of the energy efficiency of the houses as you see, from 18 century to now. But if you look the majority of the houses that require energy efficiency retrofit are the houses built around the time of industrial revolution where there was a mass migration from the countryside that they were working on the land to moving to the town because of the industrial revolution. That brought huge number of hoses building therefore you got large number of housing stock which are really poorly insulated and to try managing or to comply or come near to current standard requires huge amount of money to put into that.

In terms of what's sexy for government is to build new affordable housing, new lo carbon low energy housing. The Scottish government has just made as this SNP party said that if they are re-elected in the next election, they plan to build 50 thousand new affordable housings for the social sector. And, now is very eye catching you know, that is really good thing to do. Erm, but because of that concentrates on new build, there is almost a disregarding for retrofit. So, they need to continue to keep the retrofit in the pipeline both politically and economically. It is really important and people like RGU, try chipping that, whether that is Scottish government or national (UK) government we try representing that view for overall (social) interest.

QUESTION: Ok thank you for your view, second question is what will make construction industry and RSL / SHO work together, as is seems at the moment that construction industry is not fully prepared for retrofit as they are for new

build. And it seems that government have their own political issues, housing association have their own issues and construction have their issues as well, how they all can come together?

ANSWER: Well, there's a few things in that. Firstly, the old housing stock obviously is in the social domain, which is the social landlord if you like to say. But there are also private landlords who also have a considerable stock of old properties. And there are individuals like me and Bruce and whoever else who own our own houses and they require work to be done to be more energy efficiency. Now regarding the contractors and how there can be a better collaboration, between them? The government role has been up to now is to have an ECO system; to have an ECO fund or the energy company obligation yes? So there has been a fund of money which have come to… I guess they have been trying to alleviate the problems of EE through the energy companies and through the obligation that have been put upon them by government to try and improve the energy efficiency. Now that ECO obligation is really state of flux at the moment because of the change in the government at Westminster where the conservative government was to some extent restricted to its belief by coalition that existed with the liberal democrat. Since that's gone away, there is not the thing of the strain put on the belief (negative) of the government of the Westminster. This is my view, this is not necessarily the view of the university (laughs). Erm, from the Scottish perspective, that ECO obligation, there is not only desire to retain, but actually strengthen that, to actually make sure that there should be more money coming from there. But there has to be balance because the ECO comes from out of the energy bills that you pay to the energy companies. So, to some extent the energy cost is artificially increased because for the need for the ECO. So, from the economic perspective if you like, the more energy companies increase the price of energy the more money you have to invest into retrofit through the ECO. But in fact, you are making the energy price up for the people who are less able to afford it, because of fuel poverty, which we will come to. So, it's a really difficult thing.

Now where the contractor come, ultimately, they are doing the job. Large companies like everworm which are doing cavity insulation, and or likes of the companies who generate insulation products, rather than actually install those

products. Most of these companies are of course commercial companies. They are there doing business to make money, unless they make money they don't exist. And now, how there can be a closer collaboration; between retrofit and contractors; I am not exactly sure how that collaboration works unless there is a middle conjoint to bring them together. They are coming from different perspectives and I am not sure how that could happen. Again, from the Scottish perspective there is Construction Scotland Innovation Centre which Bruce is working on a job, that's been funded through them. Now, that CSIC is there to fund particularly contractor organizations, to do work that are innovative for construction industry not just for EE but other things as well. So that is certainly a right direction, so how that may go on, I am not sure, but it is a good step.

QUESTION: ok. This is a similar question but more from contractor's point of view, how large-scale retrofitting can be made more profitable so that the businesses can take off themselves without the funding like ECO.? Like you said the funding like ECO are changing depending on the government and policies around. So, do you there is some natural process, particularly in social housing that the retrofitting can take off by themselves without funding?

ANSWER: That's going to be really difficult for contractors to do that. Because of the economics of that situation. Contractors need to make money. RSL don't have money. You know, there is severe restrictions on the amount of money RSL have. The main income of course is through rental they are bringing in money. But by the very nature the social housing sector there is level of rental, there is unexpected level of rental in terms of normal social housing, right which is for good quality houses for people who are in lower wages and it's a proper political thing we should be doing absolutely without any question or doubt, but what RSL are doing is where they can find, they have been going to the mid-market level rental, building small scale, in small scale, nonetheless there is building happening. So, the amount of money they have been given to fund from the Scottish government, and there is a unit price to that, now that restricted from the money which comes from the Scottish government by Westminster government. So, it's a... you know, it's a complex financial stream I guess, but from the RSL perspectives, how contractors could make money if

there is not this support of the funding, because the RSL don't have money to pay let's say the full economic cost of doing work themselves. And in most cases, the only way the RSLs can if the cost of the work, contractor price is supported by some governmental type organization or wherever that money comes from. So, if the contractor is going to RSL and there are works to be done in terms of retrofitting and energy efficiency and RSL don't have the supported funding, then I don't think the RSL will be able to do that. So, it's a really difficult dilemma about how that might happen. Now for that process to become more active, I would think, quite possibly the funding stream are under real pressure, because of the austerity and all these, business and reducing the deficit and all that. Funding for everything is reducing, it's not increasing. Now, it's ok for the Scottish government to say we are going to find the funding for the 50,000 new social houses, and if they do that the funding has to come from that total pot and something else has to suffer in terms of funding. I mean at the moment, you can only the bigger economic situation is really restricting I guess; what RSLs can do because they don't have much funding other than rental they are bringing in. From the rentals RSL bringing in, they have got all other expenses they have got to pay for staffing and upgrading and other whatever expenses they require to do anyway. And you have got an issue of course which is the burden that is coming down on the RSL; you must compline with the energy efficiency standards by 2020, and they have been restricted to the funding that is going to them. You know it's a really complex kind of situation I would say, now.

QUESTION: the next one is about budget, which is mostly covered already. But still I was wondering where the rent and the government subsidies does? Is there any other sources of funding RSL can have and is there any cases where the project has been abandoned or been forced to change due to the funding?

ANSWER: Err, well I guess there is a couple of examples I can give you there. RSLs are allowed to enter into private development. Grampian housing for example, they have a private development company, I don't know if they have taken any development/building work, but I know they have got a private development company. And I know they have actually looked at the particular

sites where they think there is the possibility of doing private development. For housing, that they would sell and the profit they would make from that would then go back to the social housing. Housing associations are allowed to do that. What the extent of that development is, I don't know. It would be worthwhile you try to find that out. Guess in term of your interview, you can extend that question ask that question. So that's one aspect of trying to supplement their budget. The other example if can give you is again the Grampian housing association budget through work that Bruce and I and Amar did, where particular house type, where concrete houses at Heatheryford, so small scale pilot scheme about how to insulate these economically. So that we can draw some sort of conclusion about how we can do that more economically and get cost-benefit coming out of that. So out of that small pilot study we did, Grampian housing association were supported by us, the Scottish government said there are 240 houses of that same construction type at Heatheryford and in Aberdeen. And ok, on the basis of the work that we have one at the pilot study, I don't remember what the figures are, but they needed financial support from Scottish government to do actually larger scale project on the basis of what we did in the pilot study. Scottish government said, yep we will fund that, and they agreed to fund that and the money was, and there were two difficulties on that, number 1 was as you be aware, government runs on financial cycle, a yearly cycle; what the government does is allocate an intermediate budget to say that there is a need for that, But, this Heatheryford thing went into the process from the Scottish government about the point of this interim budgetary review, so there was money available, Scottish government had allowed budget for different projects, some of them had and some of them didn't have but there was a money in the pot. So, the Scottish government said, ok we allocate the money, but it got to be spent before the end of the year which was April, or whatever point it was. So, from the point Scottish government funded this, GHA had then need to effectively go to tender, get prices from the contractors to actually do that work, which one issue. But by the time you prepare a detailed specification, get your bills ready, go through the valuing system in terms of achieving the best value that takes time. So that was one issue, it is very time hungry, that bit of the process. And the other thing was, the RSL were tied, their procurement processes were

changed again by the government. To make them more transparent and effective so the competitiveness of the tendering process had to me much more transparent and much wider, so ultimately what happened was it took so long to get paperwork together, go through this new procurement process to actually to allow the money could be funded, that it couldn't be spent before April then the project never happened. So, in terms of budget, there are couple of examples which make life difficult because bring together the political process as in funding from government. The RSL are which are kind of candled and the private domain the contractors as you mentioned, you have to employ to actually the work to be done, so it becomes really complicated to actually get project to happen, because of all these bits, not because of money is not there, but because the process is so complex and takes so much time.

QUESTION: Let's go the next section, it's about fuel poverty. As you mentioned social tenants mostly low income and they are supported by the government. DO you think the fuel poverty is really a serious issue in social housing sector? How serious is it if it is serious?

ANSWER: Well, as issue, there is no question or doubt that it's a serious issue. The basic definition which says, its minimum of your ten percent income is spent on fuel bill then you are in fuel poverty. Now it's a seriously a big issue but the way to get people out of fuel poverty, you know there can be number of things, but one of them of course is getting improved fabric energy efficiency of a building so there isn't as required as much energy to heat, particularly. And that a way to trying to take people out of fuel poverty. There are other ways of doing that; politically, economically, whatever else you know, everybody should have a higher wage for example, moving from minimum wage to living wage, but I am not completely agreed the way they look at living wage and minimum wage. But if you look at the labour party and the SNP are looking at the living wage and the Tories and Lib Dem looking the living wage, they were looking much higher so that's political thing trying to raise the standards and level of employment. But is a really serious issue which is as you look at particular examples, again in examples of we have been involved, when you look at the data of the temperatures that the people are living in,

they are not healthy particularly in the cold weather period. Because people cannot afford to run the heating systems. Now, heating systems in themselves again in the older properties tend to be older and inefficient. So, because the heating systems are less efficient, they require more energy to run them. If you can invest in them and get more efficient heating system, then that is a possibility in combination with other things. But the big thing about fuel poverty is people are living under houses, much lower than healthy temperatures, then there is the illness issue that puts burden on the NHS, so it's really complex kind of issue as well.

QUESTION: So, what about the government incentives, there are incentives which are particularly focused to the fuel poor families? Are these incentives helpful enough? How these incentives are doing?

Well again, Scottish government had had this strapline, last time they were elected, that they are going to eradicate fuel poverty by 2016, they are nowhere near there that they will eradicate the fuel poverty by 2016. What incentives are there, I don't know? If you can give me an example?

QUESTION: like the ECO they give money to hard to treat houses, they give money towards fuel bill from warm homes discount, they have started pilot incentive in England like NHS can prescribe boiler/heating systems to the patients who are actually suffering from the cold related diseases. They sometimes subsidise the energy bills to old age people, are these types of incentives effective or there is something you can think of?

ANSWER: Some of the things you mentioned are I am not aware of to be honest, But what I do know in terms of your boiler and, there was a scheme where people disabled or if they had particular type of illness, could apply to get more efficient boiler and now, I think that particular incentive which had a fund of money I think that was exhausted. Yes , that's definitively beneficial, the problem with some of these blanket initiatives, some of them are really good, yes they are going to affect the people who are, fuel poor but other bit is that some of these initiatives, for example disabled person , actually no

problem if whatever people who need these things get them yes, but I think from my perspective there should be some sort of means testing, Just because I am a disabled person I can get a free boiler, under that old system , I don't know if that still exists. You know I might have a healthy bank account and I can afford to pay for that myself. Well there is two things I guess, one thing there should be means testing because this pot of money is limited and is targeted to the person who cannot afford, where the people who can afford, they should be doing that themselves. The second thing is that if you are replacing a very highly inefficient heating system with very efficient heating system, you are reducing the CO2 by putting that sort of stuff, so that is a good thing without any question or doubt but my brain still tells me much more people that are in fuel poverty could have been helped, if the system was means tested right. If you have income over a certain level, if you are retired or not working but you got a big pot of money sitting in the bank account; sorry you will not get that freebee or whatever else. I was watching to Paris (COP), we need to reduce CO2 and that stuff yes, I agree totally, that is a very worthwhile thing to do. Yes, we need to do more there again it sits within a complex system of things which, is so difficult to try and see what you do is right thing or not. I am sorry if that was question.

QUESTION: that's fine. Some of these have been covered already, but let's go back to the policy again; We mentioned about ECO and Green Deal, how could they be made effective, or are they doing good in their current position?

ANSWER: Well, I don't think the Green Deal have been effective. Again, from constantly reading stuff from the press, the take up of the green deal have been minimum. So, I… my thought would be that has been a failure. It's been a failure, again it's a personal opinion but it's been a failure because of the way it has been set up. There are limited items/products you can get from the green deal, you have to get this green deal inspection, you going to have to these approved products, then you set up, that restricts the market. And I think this payback period as well. So, I don't think the green deal has been particularly successful. In terms of the ECO obligation I think that has been pretty successful or was pretty successful. These things come in a wave of success an erm... And I think it was successful with unbalance with trying to improve

existing housing. The downside is as we said, we have got this artificial increase in fuel price that allows this ECO funding. That's downside in terms of fuel poverty issue. But the bigger issue in terms of ECO, in a way there is market place of buying it and selling it to the consumer, the structure of how this works is severely flawed. I think we need the energy in cheaper prices, I think other development in terms of green energy was really good again, ok... It's the UK government have nonetheless changed that system in the recent past and I think, there is determinant how the energy works. I think the nuclear question is that huge issue that has been debated and gone round and round for years and years in circles, In terms of the UK going with the partnership with Chinese company, again personal view is in the climate of what, economic cycle we are in to make that investment and that commitment to contract to providing energy at a very high cost, over a long period of time I think it's fundamentally flawed against the energy that is produced here in home in Scotland. There is a lot money to put that into the grid, again that's hugely flawed. I think Scotland also has the experimental things in Peterhead... Carbon capture experiment again that's been abandoned in terms of funding from government. Again, a fundamental flaw in terms of energy capture from tidal and wave... I think it is easy to be critical about the ECO obligation, but if some of these initiatives had been supported better and now if some of these had not been abandoned, I think the UK as a whole have got a huge amount of innovative thinking. All of these things can't always be successful, there will be failures. But unless you are prepared to take that risk, they can never happen. But you are prepared to put all of your money in the nuclear basket? And put the population at risk, I think that is a flaw.

QUESTION: Ok, lets come back to Scotland from the UK, in terms of EESSH energy efficiency standard for social housing, 2020, do you think it is achievable?

ANSWER: It is achievable, everything is achievable if you put money on it. The problem of achieving these, particularly in the difficult housings. And to some extent you know it's pressing the low hanging fruit. You know that expression? The low hanging fruits. The thing that are easy to achieve, a lot of that low

hanging fruit have been done, right, external insulation, cavity wall insulation, whatever. Now, a lot of that stuff has been done, if you look at upon the Garthdee housing estate, you know the last few weeks, everwarm, one of the companies who do cavity wall injection, is running about sporadically as far as I can see. Now, that's easy to do, why not do that sporadically if you can. Some of the houses have been bought by the people and some of the houses are still the council estate. They have been doing RSL houses in a Terrace as a four or five, and there's another one in the middle that has been done and there is another private one in the middle which has not been done. Or maybe they have already been done but they did it privately. I don't know, but it just looks like a piece meal approach to that. Yes? Which could under ECO and if the rules have been put rightly on the place, there should be a means testing, if you got a terrace of 5-6-9 or 10 houses in that terrace, what's the point of doing 3 out of 10? Do them all, and if there is the contribution required from the owner, because of means testing, then you go there and say, this has to be done, if you can afford to pay 10 pound a week or if you can pay a 100 pounds a week towards the cost of doing that. The system at the moment, to that particular cases, in my opinion is broken. But these are the easy ones, right, the ones that are left are the difficult houses. A lot of difficult housings are still left to be done. The kind of houses we are looking at are the houses granite housings that around here, these are the difficult things to do. The traditional building sign restricts and limits what you can do, a lot of that stuff are proper and right and other estimates. But there are other things like of granite projects, where we have done some limited pilot studies, you know we gather lots of information and this process we are advocating at the moment, for this bigger pilot study, this process wouldn't compline with this Green Deal or ECO or any other incentives. So, whilst meanwhile be successful and we are very hopeful, it will be successful, it does not fit into any of those systems at the moment. So, whiles it doesn't compline with incentives, to funding this at the moment is going to be difficult. But I do think EESSH is achievable. Yes?

QUESTION: Yes, that was my question, if the past Green Deal has been unsuccessful and Scottish government's promise to eradicate fuel poverty by

2016 looks completely impossible. So, again I was wondering how are they going to achieve EESSH?

ANSWER: I don't think it's completely unachievable, I mean I am sorry, I want to change that word (about Fuel poverty), As I say nothing is impossible if you put enough money on it. But it's not just about money, it's about the ingenuity, the incentives of doing things differently. To be able to look at things without having blankets on but being able to look at the bigger approach. So, to produce a bunch of number and say you will have a minimum level of as SAP 60 or 70 or whatever else by a particular period of time, I think that is achievable, only if the funding is available and the processes are available to allow that to happen. And there are restrains and limitations at the moment on what are allowed, and those restrains, will definitely be a challenge, there is no question or doubt about that. But if you see, is this achievable at the base level, yes, it is. But how much is it going to cost to achieve that? And to achieve that, the bigger picture is we are going to build more new houses that are going to comply with, really up to date standards of zero carbon or below carbon. If that is where the emphasis is, then this won't have enough money to achieve it. So, you have got really complex dilemma in terms of limitations on funding and regulations like EESSH that is saying as an RSL you have got to achieve this by 2020 and if you don't achieve it, what is the penalty? And there is a penalty, the penalty is, ultimately, if you don't achieve this, you cannot have the stock within your portfolio that does not achieve this. So, if you are not allowed to have the stock, the alternative is you have to sell the stock in the private market, you have got to dispose of that stock. Which then transfers the problem from one place to another. It doesn't resolve the problem. Yes? So just to look at numbers and say this is what you got to achieve, there's is a but to that and the but to that is if you don't achieve this, you cannot have the stock within your portfolio.

QUESTION: Ok thank you very much. Let's talk about the partnership in the strategic level. How influential are the RSL/city councils in making policies or incentives like green deal or ECO, or EESSH?

ANSWER: Well, from Scottish perspective, the Green Deal there was not much consultation on Green deal in Scotland. I have been in few meetings and conferences in last few years where that was a topic of conversation you know, where the national government went ahead and generated this process without consultation with us. The view was, that might be right for England but not certainly right here. Erm so how influential they were in terms of that? I don't think they were consulted in any meaningful way. EESSH that have been ran and set up by a conglomerate people from Scottish government and also RSL and local authorities who own social housing. They were at the committee who were looking at the EESSH and set up that system, so I think, again from your perspective, Green Deal is a national UK thing, EESSH is a Scottish thing, and I believe, and again this is a personal opinion but, I believe the Scottish government is much better listening organization than the UK government is. And I also think, because of the devolution thing the specific Scottish incentives can be looked much more closely than that of national, in terms of the bigger entity. So, there is a process or political thing that allow local issues are to be considered by the people who actually know what the problem are. So, I think RSL are influential in that perspective. Again, another example is, a chap, a Scottish government guy who we dealt with, in terms of our studies, I mean he was really easy to deal with and he was quite knowledgeable about funding a quite knowledgeable about what we are trying to do, and he asked us some really difficult questions. But he ultimately as a civil servant he was able to see yes ok we can put this project for funding and we were successful, we got funding for that. And there were we put to the guy and he said sorry there are no chance of these things. So, in terms of universities, work we have been doing, RSLs, Scottish Federation of Housing Association, there is other organization as well, these bodies represented the housing committee at Hollyrood and so there is very right to the means to these people, So I think they do have an influence.

QUESTION: So, you talked about Housing committee in Holyrood, are you talking about this Joint Housing Policy and Delivery Group?

ANSWER: Aye, Yes.

QUESTION: So that have been helpful in terms of...

ANSWER: I believe it has been. I believe it has been. I went to an event about housing a few weeks ago now, Erm there was some really interesting ideas there, provided that, that sat above everything was there was a limitation there in terms of funding.

In a meeting about the retrofit, which is a policy meeting with Scottish government in Edinburgh. So now, err here, we are being invited to go to these kinds of meetings because of the work we have done, and our name is kind of known, RSL are the same now, they're invited to these meetings.

QUESTION: Yes, when you talk about this board, the RICS they proposed in 2014 that they should include the academics and other stakeholders from private sector as well. Has that been done?

ANSWER: Erm, I am RICS member, but I am pretty disillusioned with what they do, they come up with policy statements and there is nothing very much that happens behind that, erm... the RICS have contributed to various Scottish Government policy stuff, I used to sit on RICS committee for many years, and as we were asked as we were consulting, through Scottish government for relevant things that applied to the institution, and you know I made comments to the things like changing to the planning act, new building regulations, whether or not we should be looking for tighter standards and all that sort of stuff. But in the recent past while the RICS are asked to comment on stuffs directly to the government there is no policy person in place who tries to gather information from relevant people in the institution and then feed that into government but, personally I don't think that has been very successful. I went to a meeting in Hollyrood probably five or six years ago, I was invited there because I was the member of the RICS and sit in the committee and actually made a submission regarding the building regulation and, invited to sit in the committee room and there was debate going on. There was a huge debate about contractors who didn't want higher regulated standards because that would reduce the profit so there were people like RSL who said we need better energy efficiency, fuel poverty. All the things you have discussed, and

regulation is the way to deal with because if you leave it in the market place nothing will happen

QUESTION: when talking about the policies and partnerships, what about the community's alike tenant organisation, are they involved? Is it important to have them in the policy making platforms? Will it make positive difference?

ANSWER: Again, there is number of examples of really good community engagement in energy efficiency improvements, lowering carbon and all that sorts of stuff throughout the UK. There's a fantastic examples of community engagement. To the extent of some communities they have been raising funding from EU for projects to work in their communities. There's been energy... I don't remember the title but the communities who can apply for funding to put up a small turbines or wind energy generation. So, there are good examples, I find it difficult just now to give you some names, but I have a document over there somewhere, if you remind me when we are finished, there are some examples. I went to a RICS conference a few months ago where the RSLs gave an example of things that were driven by community engagement. One of the projects we are doing at the moment is the Abertay housing association in Dundee. They are very fantastic in community engagement in that project, but that is not driven by the community, it's initially driven by the housing associations.

QUESTION: you mentioned about the EU earlier, do you know about any projects from EU and that have been very successful, and we can learn from them? The EU projects that could be copied in Scottish context.

ANSWER: Well…… well it's a huge potential, how much collaboration erm. I am not entirely aware of those success or the other ways that things could happen. Again we looked at a thing couple of years ago which was meant to be collaborative project, EU funding between Scotland Holland and Germany if I remember right, And invited academic institutions to put in .. Essentially it was a bit a request to be involved in a project and we certainly didn't get beyond the first cut on that. So no, I don't really know, I am sorry.