The impact of governance and low carbon finance on the built environment – two European case studies with a focus on regional domestic retrofitting and policy

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Author Declarations

This work has not been submitted in substance for any other degree or award at this or any other university or place of learning, nor is being submitted concurrently in candidature for any degree or other award.

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Abstract

The EU's commitment to reducing its carbon emissions by 80% by 2050 has led to an array of climate change and energy efficiency umbrella policies, some of which focused on the energy performance of the built environment. With 28 diverse member states, these policies are transposed to the national and regional level with varying degrees of efficiency and speed.

This thesis explores the financial and governance dimensions of decarbonising the European domestic building stock through the examples of two case studies in Slovenia and Germany. The study analyses qualitative data from fieldwork interviews and secondary sources. Drawing on transitions and coevolutionary theory, it employs a novel analytical framework combining Foxon's five coevolutionary systems (2011) with Geels' multi-level perspective (2005) into a versatile analytical framework.

Applying this tool, the study investigates the impact of, and coevolving interactions between governance and funding on energy efficiency in the built environment. It finds that ineffective transposition of key policies, and structural differences such as the absence of an effective regional administrative level can directly impact on low-carbon investments in the built environment. The research also finds that the effective interaction between governance and funding can have a substantial impact on domestic retrofitting.

The thesis fills an important gap in the literature, namely on the influence of institutional alignments and funding in relation to socio-technical regimes such as the built environment. It contributes to a growing body of literature and knowledge on the impact of institutional finance and governance on energy efficiency in the domestic building sector. It also adds to the growing area of coevolutionary thinking within the sustainability context and showcases a useful analytical framework within the research context of building sustainability. Finally, the thesis derives policy recommendations from the case study findings and presents these for the UK and the EU context.

Key Words

Energy efficiency; socio-technical transitions, coevolution, finance, governance, energy policy; low carbon finance; Slovenia; Germany

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1. Chapter – Introduction to the thesis

1.1. Introduction

"More than 26 million homes in the UK contribute an average 5.1 tonnes of CO_2 emissions per annum, equating to a total of 129.4 million tonnes of CO_2 per annum, which comprises 28.3 per cent of the total UK CO_2 emissions. Combined with the fact that new-build homes only contribute an extra 1 per cent to the stock every year, unless there is a deep retrofit of existing domestic buildings it is clear that reducing carbon emissions by 60 per cent and probably by 80 per cent – the targets in the Climate Change Act (2008) – will most likely be missed" (Theobald & Shaw 2014, p.88 in Dixon et al. 2014).

This quote from 2014 reflects a sense of urgency for an energy transition, in this case in the built environment. This perspective was more recently supported by the IPCC's special report on global warming, which calls for "rapid and far-reaching transitions in energy, land, urban and infrastructure (including transport and buildings), and industrial systems" with these transitions being "unprecedented in terms of scale" and implying "deep emissions reductions in all sectors, a wide portfolio of mitigation options and a significant upscaling of investments in those options" (IPCC 2018, p.20).

Complex and far-reaching challenges like anthropomorphic climate change and global warming need approaches and solutions covering a wide range of disciplines, aiming to develop sustainable pathways for a low-carbon future. Such complex challenges require the transition of multiple socio-economic and socio-technical systems towards a state of decarbonisation, globally. And these transitioning systems touch almost every aspect of everyday life. The built environment and particularly the housing sector is one of these systems. It is worth noting that for the example of a decarbonised and more energy-efficient housing system, energy efficiency efforts are not only pursued for reasons of climate protection but also to contribute to increased wellbeing and financial savings for homeowners.

This study aims to understand the possible impact of governance and finance on domestic retrofitting and the energy efficiency of buildings. The research focuses on the built environment as a transitioning socio-technical system on the path to increasing decarbonisation. The study is concerned with how governance and finance may impact the uptake of domestic retrofitting and energy efficiency measures in buildings, and how both may further or hinder the increasing energy performance of the existing building

stock. Governance and finance are explored as potentially coevolving systems in the context of two case studies, using an analytical framework to highlight interactions between the two.

After an initial introduction (section 1.1), Chapter 1 starts by presenting the research area (section 1.2) and framing the research in the literature (section 1.3). It subsequently states the research questions and moves on to the original contribution of the study (section 1.4) before introducing the research methods (1.5), including the scope of the study (1.5.1). It subsequently provides a chapter by chapter overview of the thesis structure (section 1.6) before ending in a concluding section (1.7).

1.2. The research area

This research project aims to investigate the possible transition to a decarbonisation of the built environment, principally through domestic retrofitting. In particular, it researches the role of governance and finance as a barrier or enabler to domestic retrofitting and investigates the impact of financial innovation and governance structures for domestic retrofitting in the EU. The study draws on some of the research findings to present policy recommendations for the EU as well as for the UK during its transition out of the EU.

The EU's commitment to reducing its carbon emissions by 80% by 2050 has led to an array of climate change and energy umbrella policies to create a supportive governance framework for a low carbon transition (LCT). With currently 28 diverse member states, these policies are transposed to the national and regional level with varying degrees of efficiency, speed and proactivity. As residential buildings account for approximately 10% of overall EU greenhouse gas emissions and are "the sixth largest key category of GHG emissions in the EU-15" (European Environment Agency 2014, p.256), directives and laws within this overarching policy landscape have been developed and transposed to support the decarbonisation of specifically domestic buildings. At the same time, the EU has tripled its financial commitment for climate related actions to 20% of its budget, covering, among others, aspects of energy efficiency and renewable energy generation.

This ambition is mirrored variously at the national level of EU member states. For example, the UK government committed in the 2008 Climate Change Act to reducing its carbon emissions by 80% by 2050, and decarbonising the UK economy has become a crucial task. Whilst a competing portfolio of low carbon energy technologies is currently being explored, it is widely accepted that improved energy efficiency will form a critical part of achieving the country's carbon reduction targets (Mallaburn & Eyre 2014;

Department of Energy and Climate Change 2012a; UK Green Building Council 2013). Energy policy and efficiency measures are often associated with combating climate change and its implications for future generations, but they also target various other areas of concern such as security of energy supply or increased competitiveness of the UK industry (Nilsson 2007; Kounetas et al. 2011). Rising world energy prices, and falling real incomes, have led to an increase in fuel poverty across the UK in recent years (Hannon et al. 2013). Moreover, in the longer term increasing reliance on potentially unreliable sources of imported energy can only exacerbate concerns about energy security.

This mixture of energy-related issues not only concerns policy makers but translates directly to the local and domestic level where it has implications for people's lifestyles and wellbeing. Energy end-users increasingly feel the pressures of the changing dynamics in the energy market and react in ways appropriate to their means. At the domestic level, this includes the installation of energy efficiency measures to the built environment, in the form of insulation, energy-saving devices, efficient conversion technologies, and other improvements to the building fabric and system.

To increase the chance of achieving the UK's carbon reduction targets of 80% by 2050, alleviating fuel poverty and becoming less dependent on energy imports, energy policy needs to be employed to incentivise the systemic retrofitting of domestic buildings with energy efficiency measures and decarbonise the domestic housing stock across the country. While extensive research is on-going to determine alternative transition pathways to a low carbon future, this research project focuses on retrofitting of the domestic building stock, including more ambitious retrofitting scenarios such as whole building and deep retrofits with emission reductions of 40% to 80% (Jones et al. 2013).

Currently, the UK has to manage an aging building stock, and the housing sector accounts for roughly 40% of the country's energy consumption (Dixon & Eames 2013; Jones et al. 2013). The transition to an energy-efficient housing stock could take the form of systemically retrofitting the existing properties to achieve a decarbonisation of the housing sector. Eames (2011) defines sustainable urban retrofitting as a "directed alteration of the fabric, form or systems which comprise the built environment in order to improve energy, water and waste efficiencies" (p.2). Achieving the highest possible carbon reduction, however, will likely require technology-intensive retrofit schemes which are often cost-intensive. Approaches such as deep retrofitting (meaning 40% to 80% of CO_2 reduction) rather than shallow retrofitting (meaning 10% to 30% of CO_2

reduction) have been considered elsewhere in the literature (Jones et al. 2013). Even though it was not possible to analyse examples of deep retrofitting, the research will analyse the roles of governance and finance in promoting current retrofitting which could have relevance for deep retrofitting.

Stiess and Dunkelberg (2013) found evidence in their recent empirical survey of 1000 homeowners in Germany that financing is generally perceived to be a barrier to domestic retrofit. The Institute for Fiscal Studies (IFS) (2013) describes this problem as an economic market failure for building retrofits, expressed through a credit constraint and an inability to borrow. Even in the cases where finance is available, it tends to be so restricted that it only inspires modest ambition for sustainability and energy efficiency (Building Performance Institute Europe 2011). But there are signs that the funding landscape may be changing, including at the global level since the 2015 Paris Agreement. While these changes might be less apparent in the UK market, examples of financial innovations can be found across Europe (Building Performance Institute Europe 2011) and have been shown to play a crucial role in successful retrofitting schemes.

By drawing on case studies in other European countries and the institutional funding mechanisms they have developed within the EU's overarching policy framework, the study provides insights into alternative national funding models, how these operate within different governance structures and national and regional policy landscapes. Learnings from these case studies may provide helpful pointers for the UK policy context during and after its transition out of the European Union. Finally, it may allow policymakers to learn from and potentially integrate successful funding concepts from other countries, or particularly relevant aspects thereof, in their considerations for future policies which support domestic retrofitting in the UK. Beyond Great Britain, however, some of these findings may become a source of useful recommendations for wider EU policy.

1.3. Framing the research within the literature

A critical literature review in Chapter 2 examines energy efficiency policy in the EU and how it transposes into national law and regional retrofit schemes. Furthermore, the research will investigate financial innovations for domestic retrofitting and how these innovations come about. The research will not address commercial buildings or retrofitting technology per se, but will touch upon these and related issues where relevant.

Despite its multitude of economic, environmental and societal benefits and advantages, more ambitious or deep domestic retrofitting (40 – 80% of CO_2 reduction) is still lacking support in many areas and faces many barriers and challenges (Hermelink & Mueller 2010; Building Performance Institute Europe 2012; Leicester & Stoye 2013). Probably the strongest set of barriers comes from the three main areas of the literature review – 1) policy and regulation (Dowson et al. 2012; Hepburn & Teytelboym 2017; Pollitt 2017); 2) finance and funding (Holmes 2010) and 3) the fragmentation and lack of required skills of the UK building sector (Karvonen 2013; Bonfield 2016). The thesis will examine whether improvements in these areas could greatly support the uptake of domestic retrofitting and help to scale up and out more ambitious and whole building approaches to retrofitting.

While the EU policy landscape is trying to create a supportive environment for energy efficiency projects in the built environment, its policy tools tend to focus on informative and certification approaches (Van der Heijden 2016) and lack the enforcement aspect to bring about more focused retrofit endeavours (Nugent 2003). Likewise, the transposition of the EU policies at the UK level lacks the ambition and vision to catapult deep domestic retrofitting to the top of the agenda (Ekins & Lees 2008), and rather encourages the picking of the lower hanging fruits of energy efficiency, such as individual component improvements and shallow retrofits (Hermelink & Mueller 2010). Governance is an area which can also positively impact low-carbon finance by ensuring the "effective transposition of existing EU Directives and effective local enforcement" and by creating "regulatory stability for energy efficiency [...] through the provision of long-term regulatory pathway visibility" (Energy Efficiency Financial Institutions Group 2015). This is especially relevant for energy efficiency measures which go beyond shallow domestic retrofitting. If whole-house approaches as described by Jones et al. (2013) are to thrive, they may require more incentives, e.g. funding, and control, e.g. policies. It is therefore the interplay of funding and governance which is considered in greater detail in this study.

The building sector in its currently fragmented form does not promote a uniform approach to domestic retrofitting (Karvonen 2013), let alone deep retrofits and whole-house approaches. The current small number of existing deep retrofits also limits the generation of technical expertise in this area (Hermelink & Mueller 2010) and the technologies and installation thereof remain cost-intensive and therefore often off-limits to small-scale investors and private individuals, at least unless there is substantial financial support from external sources. Buhagiar and Borg (2014) found that "there is a

broad consensus that concrete efforts need to be done to improve the energy-efficiency of buildings, thus reducing the energy demand of the sector" (p.146). However, they have also observed "the hefty capital layout often required to implement such measures" (Buhagiar & Borg 2016, p. 146).

And while there are examples of financial engineering and diversification of funding sources starting to appear throughout Europe which show the potential to fund ambitious energy efficiency projects, much like Lithuania's JESSICA funding mechanism (Buildings Performance Institute Europe 2010; Britnell & Dixon 2011), major investors still appear to be reluctant to access green investment opportunities in the built environment. More traditional forms of investments remain more attractive to larger investment funds, and it appears that the biggest opportunity to source funding for energy efficiency projects lies with public sector funding. Funding for domestic retrofitting, and low carbon finance as a topic in general largely presents a gap in the literature and will be addressed in the thesis.

While financial aspects of the transition are mentioned peripherally in most of the academic and grey literature, there are few publications which address the combined impact of governance and funding efforts on domestic retrofitting (Bolton & Foxon 2015a). The research in this thesis aims to address this important gap.

1.4. The research problem, research questions and original contributions

The research is essentially concerned with how governance and finance impact on low-carbon energy efficiency investments in domestic buildings. While energy efficiency policy and governance has received a lot of attention in the literature (Van der Heijden 2016; International Energy Agency 2010; Visscher et al. 2016; Eames et al. 2013), the financing of energy efficiency is currently an emerging area and so has received comparatively less academic attention (Lützkendorf et al. 2011; Department of Energy and Climate Change 2015). However, the interconnectedness of governance and finance, which could potentially have a considerable impact on the sustainability of the domestic building stock, has not received significant research attention.

Finance has been described as a barrier to an energy efficient domestic building sector due to its scarcity (Building Performance Institute Europe 2012) while governance and legislation are instated as enablers by the institutional sector (Tofarides 2003). Where finance is available and abundant, it might interact positively with aspects of governance and legislation to further an energy efficient built environment. In a scenario where

finance and governance form a mutually enhancing relationship, the coevolution of both might have a substantial effect on the depth and ambition of domestic retrofitting. This study seeks to address some of the gaps in the literature and bring the three areas of policy, built environment and finance together through the investigation of governance and financial innovation for domestic retrofitting.

Through empirical case study research, this thesis aims to provide an understanding of the impact of low-carbon finance as well as governance and legislation on the uptake and depth of domestic retrofitting. It applies existing theories of co-evolution and socio-technical transition to the financing of energy efficiency measures in the built environment.

The research aims to establish the types of impact that governance and low-carbon finance may have on the energy efficiency in domestic buildings. In order to address this research aim, the thesis poses the following research questions:

1. *How do different types of governance and legislation impact on energy efficiency in the built environment? Which role do governance levels play?*
2. *Does the way in which energy-efficiency policy is transposed from the supranational to the regional level affect energy efficiency in domestic buildings?*
3. *What kinds of impact do different forms of, and the availability of, low-carbon finance have on domestic retrofitting?*
4. *Does the impact of low-carbon finance and governance vary across case studies?*
5. *What policy recommendations for the EU, the UK and the respective case studies arise from addressing these questions?*

The original contribution of this research lies in two distinct areas:

- In bringing together and applying some of the theories of co-evolution, socio-technical transition and transition management to the concepts of the governance and financing of energy efficiency measures in the built environment; and
- Through qualitative case study research to create comprehensive comparisons between the regulatory and funding parameters for energy efficiency in buildings in two very different regions of the EU, Slovenia and Germany, to examine

important financial mechanisms in the EU, using the coevolutionary methodology developed for this research.

The research adds to existing knowledge particularly in the fields of governance and low-carbon finance through a comparative analysis of the interaction and co-evolution between governance and funding support for low carbon domestic retrofitting in two case study regions.

1.5.Research methods

The study's contextual framework is based on transitions theory and delineates the domestic building sector as a socio-technical sub-system. It supports the argument that the decarbonisation of this system can be considered to be a socio-technical transition and maps the various agents and artefacts across its landscape, regime and niche levels. The study's analytical framework combines the socio-technical transitions and multi-level perspective of Geels (2005b) and others with the co-evolutionary framework of Foxon (2011). This combination of a socio-technical and a coevolutionary perspective helps with the structured analysis and visualisation of patterns within the transition. In particular, this allows studying the co-development between funding mechanisms and institutional aspects such as governance and legislation and how their interactions at the landscape, regime and niche level affect domestic retrofitting in the case study regions.

This study uses comparative case study research analysing qualitative data derived from semi-structured interviews and develops a novel analytical approach to framing the research approach and extracting findings. It explores the impact of governance and low-carbon finance on two regional case studies across the EU - the city municipality of Maribor in Slovenia and the greater Chemnitz region in Saxony and translates these findings back to the EU and the UK. This study has chosen to take a regional governance viewpoint for a number of reasons. The regional focus of the two case studies is particularly relevant since it is often the regional level which strongly influences the transposition of EU law at the local level and therefore into practical programmes on the ground. Egenhofer and De Jong (2014) have found that "it is far from certain that the particulars of national situations are always considered" at the supranational level (p.2). Regional approaches have been described as "a means of taking into account country-specific circumstances and characteristics" in EU policies (Jong & Egenhofer 2014, p.2). There is also a trend that shows EU cohesion funding is increasingly being spent on projects with a more regional and even local focus. In its budget communications in

May 2018, the European Commission (2018) confirmed that "the 2021-2027 Cohesion Policy framework goes further local: it supports the development of local growth strategies by urban, local or other territorial authorities, which should now be put in charge of or involved in the selection of EU-funded projects" (p.3). This follows on from EU-funded research with an increasingly regional focus such as the Retrofit2050 project which funded the doctoral scholarship for this thesis, and the COST Action Smart Energy Regions which funded the fieldwork in one of the case studies under a Short-term scientific mission (STSM) grant. Finally, the regional approach has also been found to be useful for the analysis of example cases which if found to work well in a particular regional case study, might likely work well in other comparable regions too.

1.5.1. Scope of the study

The research looks at domestic retrofitting within two defined regions in two EU member states. It excludes industrial/commercial buildings and public sector housing due to the different nature of the retrofitting challenge for these properties. The study does not aim to achieve statistically significant numbers of responses but seeks to derive qualitative depth from semi-structured interview conversations about governance, legislation and funding impacts.

It investigates how financial incentivisation and regulatory requirements interact and impact on the uptake and intensity of domestic retrofitting. It aims to formulate recommendations for the UK and the EU as a whole from the case study findings.

1.6.Structure of the thesis

Chapter 2 critically examines the literature which is relevant to understanding and scoping the research problem and identifying gaps in the existing knowledge. Since the interconnection between finance, governance and the built environment suggests a cross-disciplinary research topic, the review covers three main areas of literature – governance, policies and legislation; finance and funding and domestic retrofitting. Each of these areas is split into a number of sub-sections. The literature review for governance is split into EU and UK energy efficiency policy landscapes; EU legislation and transposition in the member states; and governance levels. The literature review on finance is split into supranational and institutional funding; and the concept of low-carbon finance. For retrofitting, the literature review is split into technologies and approaches to domestic retrofitting, and an introduction to deep domestic retrofitting. A review of the transitions literature is further provided in Chapter 3.

Chapter 3 introduces the contextual and analytical framework. Geels' (2005b) Multi-level Perspective (MLP) is presented as the contextual framework of the research. Drawing on a review of the transitions literature, domestic retrofitting is contextualised as a socio-technical transition. Moving on from there, chapter 3 discusses coevolutionary theory as the basis of the analytical framework, and introduces Foxon's (2011) coevolutionary framework and its 5 coevolutionary systems. Chapter 3 further discusses the aim to visualise patterns of interaction between these systems in the research data and introduces the coding tree for the qualitative data analysis.

Chapter 4 is the methodology chapter and critically assesses and explains the steps taken to conduct the research. This chapter also discusses scope, limitations and ethical considerations of the research as well as temporal and geographical aspects. Following the approach set out in Chapter 4 allows for the data collection in the case study regions, and subsequent analysis thereof as described in Chapter 5.

Chapter 5 is the case study chapter, detailing how and where the data was collected for the two case studies in the European Union. The chapter is split into three parts and provides the intra-case study analysis in parts a and b and the comparative or cross-case study analysis in part c. The data is analysed in line with Foxon's coevolutionary framework to identify and visualise any patterns of interaction between the systems which might impact on the built environment and its energy performance.

Chapter 6 is the findings and discussion chapter, summarising the case study and methodology findings. Data from Chapter 5 is examined in terms of its relevance for the EU, the UK and both case study regions. Based on the findings, Chapter 6 concludes with a set of funding and governance recommendations for the EU and the UK.

Chapter 7 is the conclusion chapter of the thesis. It draws together and reflects on the main themes emerging from this thesis by reassessing the research problem and questions. It reflects on the study's contribution while also acknowledging the need for further interdisciplinary research and methodology development within different research contexts. Chapter 7 suggests areas for further research and brings the thesis to a close.

1.7. Concluding section

Chapter 1 provided an introduction to the thesis, stated the research questions and the intended contribution and then presented the research methods. Chapter 1 further set out the thesis structure and the content for each chapter. Having thus established a

research context and provided the backdrop for this thesis, a literature review across several connected research disciplines will summarise and evaluate the current state of, and any gaps in, the knowledge about finance and governance for energy efficiency in the built environment in Chapter 2.

2. Chapter - Critical Literature Review

2.1.Introduction and aim of the literature review

This literature review aims to summarise and critically evaluate key areas of literature pertinent to the research problem and questions. It combines literature from the fields of finance, governance and architecture. This serves both to establish the current extent of research and knowledge in these areas and to identify gaps in the literature and highlight the value of undertaking more focused, multi-disciplinary work.

In the field of finance, the focus will be on financial sources and financial engineering across Europe as well as the UK. The governance field will consider current energy efficiency regulation at EU and national level as well as the governance of transitions. The latter will discuss literature on socio-technical transitions, transitions management and coevolution and their applicability to the research area. Broadly, the section on architecture will look at the building renovation problem at a high level without going into inappropriate technical detail, but will also include psychological insights into the end-user decision-making process for building retrofits and potential reasons for the current lack of uptake.

The literature was identified through database searches (Web of Science, etc.), by following up references in initially identified documents, expert recommendations (particularly for industry and government reports) and conference presentations. A mixture of academic and grey literature sources was reviewed. Particularly the grey literature produced by institutional sources was very relevant for the policy and governance discussion as it details individual legislative documents as well as governmental and supranational strategies and motivations as pertaining to the energy efficient built environment in detail. These reports and articles are usually published on the online pages of the respective organisations. The importance of grey literature lies in the fact that relevant findings are often more detailed than in journals and can often be distributed ahead of academic literature (Schoepfel 2006). Grey literature "is produced on all levels of government, academics, business and industry" but not controlled by publishers (Schoepfel 2006, p.67). Academic literature on the other hand is generally peer-reviewed. Using both types of literature allowed the combination of up to date, highly detailed and often peer-reviewed information.

For the section on architecture, academic data bases such as Science Direct and Elsevier were initially searched for relevant publications using the following key words: building

performance and building components; retrofit and renovation in connection with domestic, motivation and barriers; energy efficiency in connection with UK and Europe.

For the finance literature, a similar approach for academic publications was followed using the following search terms: financing and funding mechanism in connection with energy efficiency; financial engineering; financial institutions EU; financial barriers in connection with energy efficiency; Green Deal and ECO; Energy Service Company and Energy Performance Contracting; financial instrument for domestic retrofit in connection with UK and Europe.

The documents for the policy review were searched using the following search terms: climate change policy in connection with global, EU and UK; energy efficiency policy in connection with EU and UK; energy policy and building policy; and energy and energy efficiency policy in the past.

Chapter 2 initially investigates the literature on the energy efficiency policy in the EU (section 2.2), followed by the energy efficiency policy in the UK (section 2.2.6) as well as the relevant literature on governance (section 2.2.1). It subsequently covers the literature on the architectural and technical aspects of domestic retrofitting (section 2.3) before critically examining the finance dimension in the EU context (section 2.4.2) and finally in the energy efficiency and retrofitting contexts (section 2.4.3).

2.2.Governance and policy in the EU

While policy and governance were initially not part of this research, findings from both case studies have led to the conclusion that low carbon finance for domestic retrofit cannot in fact be thoroughly and comprehensively analysed without both of these aspects. The next sections of the literature review will therefore look at governance and policy at the supranational level as well as regional governance to provide further background in which the study is set.

2.2.1. Governance at the supranational, national and regional level

Lynn, Heinrich and Hill (2001) define governance as "regimes, laws, rules, judicial decision, and administrative practices that constrain, prescribe, and enable the provision of publicly supported goals and services". This includes institutions and institutional actors on the various governance levels, such as supranational, national, regional and local which are considered in this study. Indeed, Gertler (2010) explains in his 2010 paper that there is a widespread recognition of the "premise that institutions exert an influence on the character and evolutionary trajectory of national, regional, and local economies" (p.11).

One example of governance is policy making and the implementation of policy across multiple governance levels. Tofarides (2003) discusses policy making in the EU, noting that supranational governments like the EU often have policy objectives and a budget to deliver them with but do not directly implement policies. This is done by the member states and their administrations on the national, regional and local level. Tofarides observed that there are many different actors across these different levels which are involved in the policy implementation and that these "may also act as 'gatekeepers' between the conception of the policy in Brussels and its delivery on the ground" (p.4).

The EU is working toward a "more integrated Europe" (Tofarides 2003, p. 21). "There are variations in the political systems within Member States ranging from German federalism to traditionally unitary systems such as the UK" (Tofarides 2003, p.22) which may also affect the governance structure of individual member states. Gertler (2010) reminds us that the various governance levels influence the evolution of whole economies in a way that is "often subtle, sometimes dominant, but undeniably pervasive" (p.11).

2.2.2. Policy making in the EU

In terms of the actual policy processes and policy involvement of the EU, Nugent (2003) distinguishes between regulatory (= rules which govern behaviour), redistributive (financial resources for countries, regions or groups of individuals) and distributive policies (financial resources between users appropriate to users' contributions). The EU has a strong regulatory focus in some of its policy areas, one of which is the environment (Nugent 2003). EU legislation can take three forms – regulations (binding for member states), decisions (binding for whom they are addressed) and directives (binding as to their objectives and transposed by national authorities) (Nugent 2003).

The EU has a lesser focus on redistributive policies with a small percentage of the overall EU budget allocated to these funds. There is also an increasing pattern of net contributors and net beneficiary countries whereby the net contributors would gain very little from increasing the budget percentage for redistributive funds but would have to finance a significant proportion of it (Nugent 2003). "Germany, long the major net contributor to the EU budget, has come to suffer from 'donor fatigue'" (Nugent 2003, p. 326).

EU supranational funding can be allocated as part of the EU's cohesion policies which are "designed to provide a partial counterbalance to the 'natural' effects of the internal market by promoting a more balanced distribution of resources and economic

development across the EU (Tofarides 2003, p.311). Cohesion policy has increased in importance since the mid-1980s and its main instruments are the Structural Funds (Tofarides 2003). The Funds are usually part-funded by the EU and co-financed by the member states, in line with the principle of additionality. Further, approx. 3% of the EU budget goes towards the Cohesion Fund which focuses on environmental and infrastructure schemes (Tofarides 2003).

2.2.3. The transposition process

While EU regulations and decisions come into effect directly, EU directives "do not assume legislative force until they have been transposed into national law by the appropriate national authorities" (Nugent 2003, p.355). When directives need to be transposed, member states decide the transposition process and the transposition authorities at the national level themselves. This means that "the mechanism by which directives are transposed at the national level varies between member states according to differing national legislative procedures and differing perceptions of the importance of particular directives" (Nugent 2003, p.355). Commonly, existing primary and secondary legislation at the national level needs to be adjusted with additional administrative measures, additional secondary legislation will need to be introduced or new clauses added to primary legislation which is already at the planning stage (Nugent 2003). Member states take different approaches to transposition which leads to differences in the speed and extent of the implementation of EU directives, but also "variations too in terms of the frequency with which states are subject to Commission and Court action for non/incomplete/incorrect transposition of EU" (Nugent 2003, p.355). As a result, some member states have better or worse track records of transposing directives than others (Nugent 2003).

2.2.4. The regional level policy

"The considerable national and political differences that exist in the EU make it difficult to develop coordinated and coherent policies based on shared principles and agreed objectives (Nugent 2003, p. 329). It also makes it difficult to ensure that policies fit with the cultures, identities and existing body of law of the individual member states. This is despite the fact that "the European intervention aims to complement the policies of Member States" (Tofarides 2003, p. 4).

Tofarides (2003) argues that "in certain policy areas, such as regional, there is a need for the Commission to forge coalitions with sub-national as well as national actors". Nugent (2003) observes that "regional policy, industrial policy, and environmental policy are examples of policy areas where policy responsibilities are shared between the EU and

the states, where frequently the activities of the two levels (three if subnational authorities are added) are not properly coordinated, and sometimes where they are not even mutually complementary" (p.362). Slovenia is a good example for this. Only by reaching and to some extent coordinating the municipalities at the local level, in addition to the national level administration is it possible to implement a regional approach in Slovenia. This is on account of there not existing a regional Slovenian governance level, as will be discussed in Chapter 5. This connects well with Gertler's view (2010) who showed "how locally distinctive and evolving institutional architectures, interacting with national and provincial institutions, local political dynamics, and the agency of individuals and organisations, help create particular evolutionary trajectories over time, leading to differentiated, social and economic outcomes in urban regions" (p.11).

2.2.5. Energy Efficiency policy in the European Union

With energy generation from fossil fuels and energy consumption a major contributor to anthropogenic climate change, energy efficiency has evoked increasing interest from policymakers as a solution to many a contemporary woe (Department of Energy and Climate Change 2012b). In the EU, energy efficiency has been promoted for a long time and is seen as a way of restraining energy demand, considered an instrument for meeting the carbon reduction targets of the Kyoto Protocol, as well as a key element to improve economic competitiveness of the EU member states against global competition and for energy security (Nilsson 2007, Kounetas et al. 2011). Moreover, energy efficiency in the building sector has emerged as a key focus for the EU's energy and climate policy as buildings have been increasingly perceived as a "locus of energy use with the highest cost-effective energy savings potentials" (Ekins & Lees 2008, p. 4580).

The EU policy landscape

Over time, the EU has developed a number of policies to further energy efficiencies across its member states as illustrated in Figure 1.

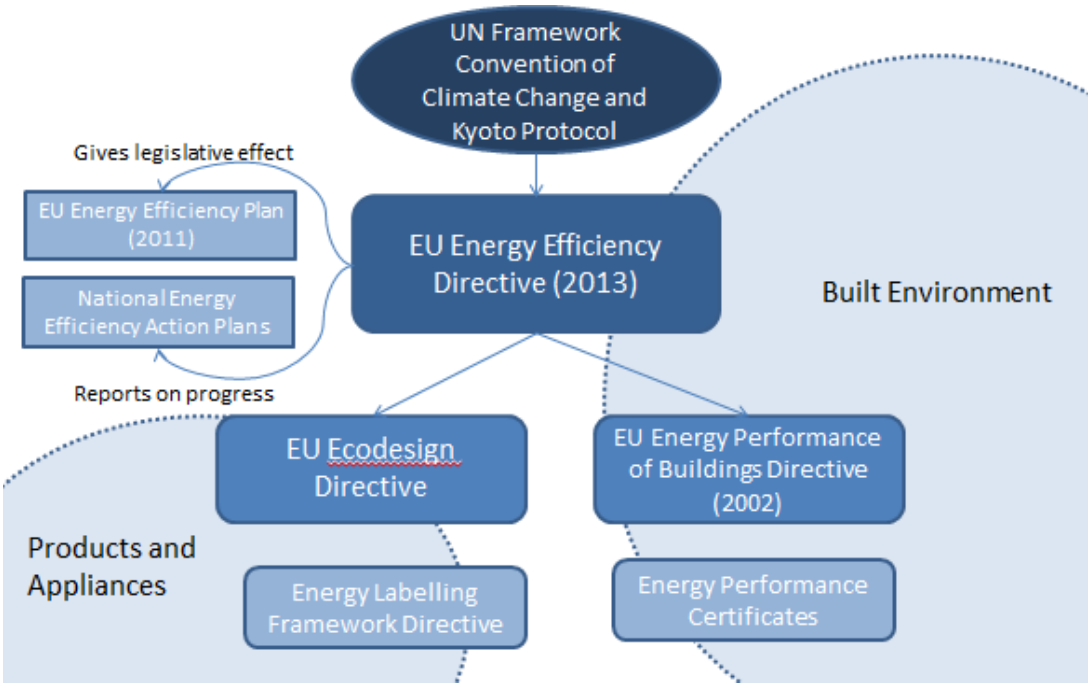

Figure 1: EU energy efficiency policy landscape (Source: Own illustration)

The policies cover a number of areas but are all based on the global commitment to combat climate change as stipulated in the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. In the past, the EU Commission set up separate pieces of legislation, such as the Co-Generation Directive and the Energy End Use and Energy Services Directive, which focused on energy efficiency in different areas of the energy market. These were integrated into the EU Energy Efficiency Directive which was legally agreed in June 2013. Overall, the Directive relies more on informational instruments, such as labelling and certification to achieve market transformation, rather than for instance on overarching fiscal measures, like taxes or charges, or command and control approaches. It does, however, oblige EU member states to:

- Set targets for their primary energy consumption by 2020;
- Meet annual targets for the renovation of buildings on government estates;
- Meet energy savings targets through supplier obligations or national policy measures;
- Require energy audits every four years for non-SME companies; and
- Report their progress regularly through National Energy Efficiency Action Plans (Department of Energy and Climate Change 2012b).

As energy efficiency can be aimed at different sectors of the economy, there are a number of policies connected to the EU Energy Efficiency Directive. These include the EU Ecodesign Directive and the EU Energy Labelling Framework Directive, focusing on minimum energy standards for products as well as their ranking for energy efficiency.

The set of policies that is most relevant for this research, however, focuses on energy efficiency in the built environment and includes the European Energy Performance of Buildings Directive (2002) (EPBD) and the Energy Performance Certificates. While the certification scheme requires the ranking of buildings on a scale of A-G, depending on age, size and fabric, the EPBD stipulates overall building performance standards in terms of CO_2 targets (Department for Communities and Local Government (DCLG) 2012). The Building Performance Institute Europe (BPIE) affirms its importance as the main policy driver for building energy use at the EU level (BPIE 2011), while Ekins and Lees (2008) highlights its significance for energy reduction in the building sector. The EPBD provides a framework or integrated methodology to achieve a number of outcomes:

- Measuring the energy performance of buildings;
- Application of minimum energy performance standards;
- Energy certification; and
- Advice on buildings renovations (Ekins and Lees 2008).

While the EPBD has been a part of EU legislation for more than a decade, its transposition into national legislation by EU member states has been much slower than anticipated, implementation has occurred in non-standardised ways and it has been generally described as patchy (Ekins & Lees 2008). The BPIE (2011) argued that the current energy efficiency policy practice in the EU is insufficient and is unlikely to trigger a much-needed wave of buildings renovations across Europe. Some of the respective barriers will be discussed in the following section.

The barriers

As the European population is predicted to increase, the need for more energy in the future becomes more and more apparent (BPIE 2011). With the trend also going towards urbanisation and decentralisation of energy supply, BPIE has stressed the need to improve the energy performance of buildings (BPIE 2011). There are, however, vast differences between the built environment across European countries, based on

climatic, cultural and economic differences as well as the approaches member states take to increase the energy efficiency of their building stocks. Without a comparable building stock across the EU, the difficulties of having a common approach to energy efficiency across the EU have become evident for some time (Ekins & Lees 2008). "While that may be relatively straightforward in the MSs with a long history of regulations to improve energy performance, it is more difficult in those that have a large legacy of buildings in poor condition and limited funding programmes" (EPBD 2018).

One issue is that the EU legislation covers only a part of the buildings sector and renovations thereof. Energy savings measures are only specified by the EPBD for deep renovation projects (BPIE 2011) and due to the issue of transposition as well as the uncertainties of enforcement, its effectiveness has been described as questionable (Ekins and Lees, 2008). In addition, energy efficiency measures have had only very limited success outside the building sector (Kounetas et al. 2011) with annual improvements in energy efficiency decreasing from 1.4% in the 1990s to 0.5% in the mid-2000s (European Commission 2005)[i]. While this overall still denotes an upwards trend for energy efficiency in the domestic sector, it could be an indication that the lower hanging fruits (such as energy efficient light bulbs) are taken up more widely and further energy efficiency measures might need more effort in the future.

This negative trend is associated with the high barriers to energy savings measures. BPIE states that these barriers are of a financial, institutional, administrative, awareness and information-related nature (BPIE 2011). Nilsson (2007) noted that policies tend to have significant transaction costs. These relate to the costs of gathering information, planning and designing of policies, collecting revenue, monitoring outcomes (Nilsson 2007, Kounetas et al. 2011). Moreover, with the number of energy efficiency policies increasing, so do the transaction costs - but so also does the risk of policy fatigue by the public (Nilsson 2007). Nilsson (2007) continues that complementary policies carry the risk of reducing credibility and confusing consumers. He argues that consumers prefer simplicity and that if carbon reduction is the issue, then this is what a policy should directly target, e.g. via carbon taxes or an emissions trading scheme (ibid). Indeed, the EU emissions trading scheme (EU ETS) is a good example of a policy with a singular focus as it is responsible for approximately 45% of the EU's greenhouse gas emissions (European Commission 2015). The problem here is that despite their overarching aim to overcome market barriers and correct market failures, the energy efficiency policies also try to achieve a number of other objectives as mentioned in the introduction. This led

Nilsson to his conclusion that the policy's "rationale is shaky" and "not the best means to achieve all of its goals" (Nilsson 2007, p. 545).

A final point of Nilsson's critique refers to the policy's failure to consider the actual carbon content of the energy which it aims to save, e.g. generated by a coal plant vs. by a wind turbine (Nilsson 2007). While this has the potential to distort the policy outcomes, it is a point that permeates the policy landscape as even "top-level EU energy and climate targets do not distinguish between particular sources of carbon or uses of energy" (Ekins & Lees 2008, p. 4581). While this can be interpreted as a shortcoming of the policy, it can also be seen as an opportunity. BPIE (2011) declared that achieving the EU's carbon reduction targets by 2050 will be determined both by actual energy savings but also by the decarbonisation of the energy supply. A combination of both would allow more flexibility in achieving the targets, as would giving carbon a commercial tangible value. The EU emissions trading scheme has done exactly that, using a 'cap and trade' principle to limit volumes of GHG emissions while reducing the maximum emissions allowances by 20% by 2020 and 40% by 2030 compared to 1990 levels (EC 2016). Emissions allowances are auctioned between sectors and organisations daily making the EU ETS "the most significant auction mechanism ever implemented for an environmental asset world-wide" (European Commission 2015, p.3).

Some positives

While there is room for improvement across the EU policy landscape for energy efficiency, it has also been noted that the regulations play an important part in confronting the EU member states with the issue and providing support as well as stringency in the form of a framework and a specified time scale to which all members are committed (Ekins & Lees 2008). Ekins and Lees (2008) stress a number of positive impacts of the EPBD, as it obliges the public sector across the member states to take on an exemplary role, while providing a forum for the exchange of experiences, which directly translates into reduced transaction costs and increased access to information.

Ekins and Lees also highlight the expectation that the EPBD may reduce 34 million t/year of carbon emissions with the potential to double this amount if the Directive were to be amended to cover the entire building stock. It currently extends to new buildings and existing buildings with a floor area greater than 1,000 m^2 while undergoing a renovation. With the EPBD for residential buildings "aimed at progressively reducing the non-renewable primary energy consumption and CO_2 emissions" some member states have been able to report progress, e.g. "Spain is on the right path" (Lopez-Ochoa

et al. 2018, p.630). Further, it has been observed that EU member states "have developed various systems of building codes, certification and inspection schemes to ensure that energy performance of buildings policies have a real impact and actually result in energy savings as well as efficiency gains" (EPBD 2018). Uihlein and Eder (2010) affirm the importance of the policy by remarking on the chronic inertia of the building sector due to the low stock turnover and argue that the policy is making a significant contribution to overcoming this.

Going forward

Overall, the EU energy efficiency policy appears to serve multiple purposes at once, turning it into a compromise rather than a focused policy tool. This could imply that the framework's signals may be weak and its incentives not direct enough. It has been suggested that the policies need to have clearer-cut goals and that transposing at the national level should be coordinated and standardised to achieve comparable and lasting results. Kounetas et al. (2011) in particular have suggested that energy efficiency policies should be increasingly linked with regional policies to achieve outcomes with the highest possible impacts. But while the EU policy landscape for energy efficiency could be improved, it provides a framework for domestic retrofitting. Its transposition onto the national levels can serve to strengthen or weaken the intention and impact of the EU policies, as illustrated by the example of Great Britain in the next section.

2.2.6. Energy Efficiency Policy in the UK

Energy efficiency historically in the UK

Mallaburn and Eyre (2014) describe the UK as a former world leader on energy efficiency:

> *"In 1994, the UK was the first EU country to use the Standards of Performance model to fund energy efficiency programmes and the first to try out carbon emissions trading. The Climate Change Act was the first of its kind anywhere in the world. The EST and Carbon Trust delivery models have been copied around the world. At some point in the last 40 years we have tried every kind of energy efficiency programme that there is." (Mallaburn & Eyre 2014, p. 38)*

Since then, energy efficiency policy in the UK has experienced significant changes and current policies rely largely on voluntary measures for end-user and mandatory ones for a select number of businesses. And while the effectiveness of the UK's current energy efficiency policy is certainly disputed, does it provide a framework for domestic retrofitting.

The UK policy landscape

Energy efficiency policy in the UK is largely driven by BEIS, the department for Business, Energy and Industrial Strategy (formerly the Department of Energy and Climate Change DECC) which was set up in July 2016. Previously, DECC had assigned the Energy Efficiency Deployment Office (EEDO) to draw up the 2012 Energy Efficiency Strategy which was subsequently updated in 2013. The document described energy efficiency as "a key strategic objective" and "fundamental to decarbonising the UK" (Department of Energy and Climate Change 2012a). The document also highlights "supporting the finance market" as "a key focus" and the need to connect the one with the other (p. 6).

Further strategic policies with a strong sustainability focus are the Planning Act 2008, the National Infrastructure Plan (2011), the Low Carbon Transition Plan (2009), the Carbon Plan (2011) as well as the Energy Act (2012) (Swan et al. 2018). Combined these documents were meant to offer a framework for longer term aspirations (ibid)

De Laurentis et al. (2018, p. 208) note that "the Climate Change Act 2008 and the setup of legally binding ambitious targets to reduce GHG emissions by 80% by 2050 and 34% by 2020 has offered a renewed focus to address the impact of the built environment on carbon emissions".

The 2011 Carbon Plan is mainly concerned with reducing UK greenhouse gas emissions (GHG) and setting up scenarios and policies on how to achieve this. Since GHG emissions are closely linked to energy supply and consumption, the Carbon Plan notes that energy efficiency is one of two key priorities which combined are "likely to have the greatest impact" (p.24)

The 2011 Energy Act paved the way for three major developments in the UK energy efficiency arena: the simplification of the Carbon Reduction Commitment (CRC) Energy Efficiency Scheme from 2010, the Green Deal (see below) and the Energy Company Obligation. With the CRC, the Energy Act turned a mechanism which had initially served as a benchmarking and reporting, financing and reputational tool into a complex form of a carbon tax.

A more recent UK policy document is the UK Clean Growth Strategy which "included an ambition to make millions of homes more energy efficient by 2030-2035" (Bergman & Foxon 2018, p. 4). A summary illustration of the UK energy efficiency policy landscape can be seen in Figure 2.

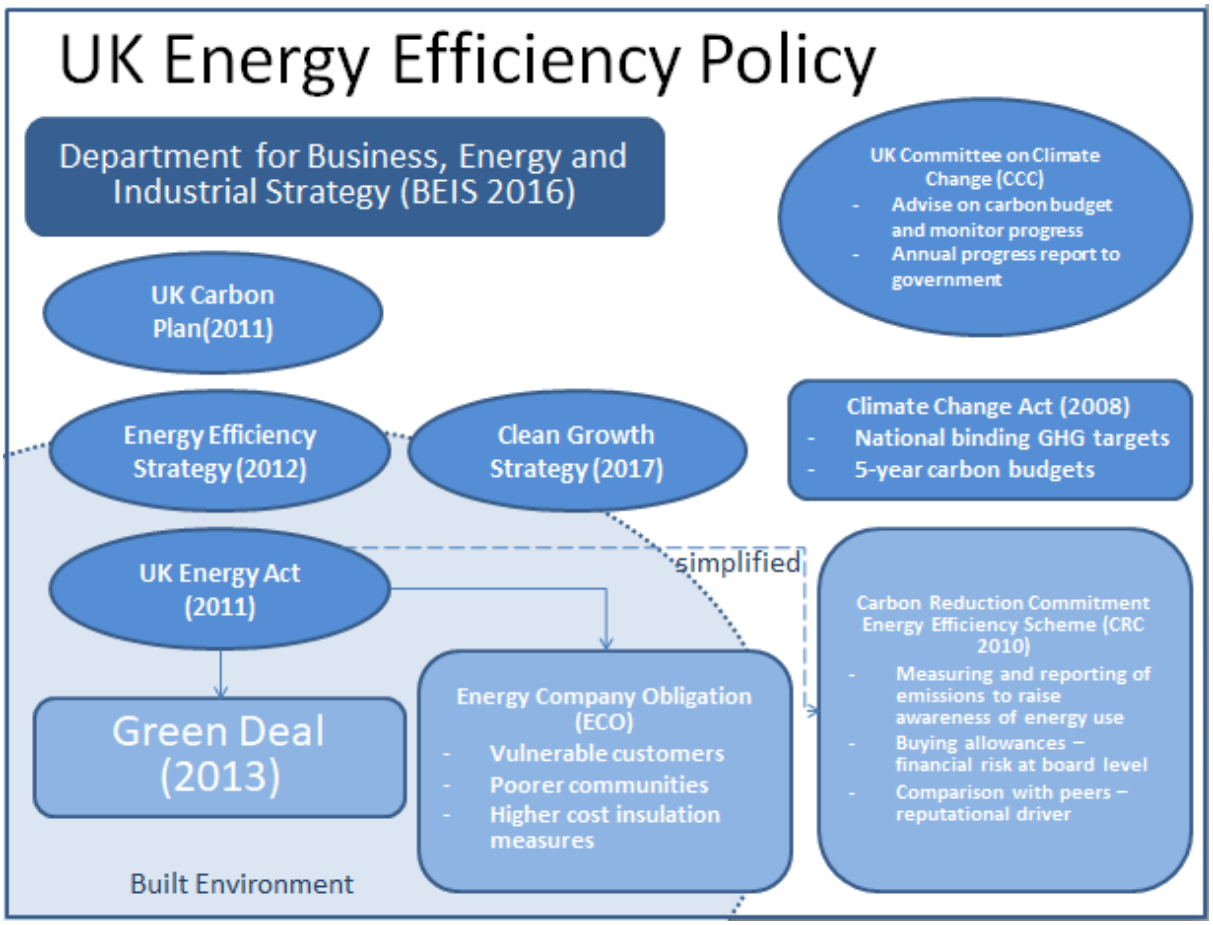

Figure 2: UK energy efficiency policy landscape (Source: Own illustration)

The UK Green Deal and the Green Investment Bank

Eames et al. (2018, p. 256) explain that the UK approach to its national energy efficiency goals has been "characterised by the creation of the Green Deal and the Green Investment Bank". The year 2012 saw the launch of the Green Investment Bank in the UK under government ownership which had the expressed aim to "strategically use public finance to secure private investment in low carbon infrastructure" (Bergman & Foxon 2018, p.16). The institution was set up to address market failures (Eames et al. 2014). The Green Investment Bank has been noteworthy for financing large scale energy efficiency and green infrastructure projects but has not been significantly involved in domestic energy efficiency. In 2017, the Green Investment Bank was sold to an Australian bank. Eames et al. (2018) describe it as "a wasted opportunity" while McLaren (2014) refers to it as a "missed opportunity in comparison with Germany's KfW" (p.154). With the disappearance of the Green Deal in 2015 (see below), there has been a funding gap for domestic and smaller scale energy efficiency projects.

The Green Deal (GD) was introduced in January 2013 as a market-based and demand-led financing instrument for energy efficiency in the domestic sector, but with an option of availability to the commercial sector. It used upfront loans which are repaid through the

energy savings on the energy bill, to overcome the initial finance barrier for energy efficiency projects. Its design avoided the expensive use of subsidies. Mallaburn and Eyre (Mallaburn & Eyre 2014, p.23) wrote that "the Green Deal represents a fundamental reorganisation of policy because it places a considerable reliance on the role of markets to deliver the required energy savings". It aimed to reduce fuel poverty as well as carbon emissions, and this focus on several goals allows questions about its ability to deliver on all fronts, therefore making it another energy efficiency policy of the kind that Nilsson (2007, p. 545) would describe as "shaky".

The Green Deal was initially described as a "British flagship policy" which would "transform the energy efficiency market" (Rosenow & Eyre 2016). The UK's 2010-2015 coalition government between the conservative and the liberal parties was touted as the greenest government ever, and the Green Deal was meant to be instrumental in delivering the coalition's sustainability ambitions. Beyond energy efficiency, the Green Deal was also designed to help "solve the landlord-tenant dilemma" and so drew a lot of internal attention from other European governments (Rosenow & Eyre 2016, p.142). It tried to overcome this barrier by ensuring that "the financial obligation is not attached to the individual: if the individual moves out of the home the financial obligation moves to the next bill payer at that property" (Theobald & Shaw 2014, p. 92).

To access the Green Deal, homeowners needed an initial assessment by a registered Green Deal assessor to calculate possible savings on their energy bills for potential improvements to their home. The assessment was followed by the homeowners choosing a Green Deal provider who set up a Green Deal plan. The plan was a contract between the provider and homeowner regarding the energy efficiency improvements to the building and their costs. The provider then commissioned a Green Deal installer to install the improvement measures as per the Green Deal plan for the property. Once the measures were installed the homeowner or tenants paid off the improvement costs through their electricity bills over an agreed timescale, up to 25 years. The Green Deal used a so-called pay-as-you-save mechanism (PAYS).

Approximately 20,000 home improvements were installed under the Green Deal (Hall & Caldecott 2016) but there are many reasons why it failed. A big issue particularly for more ambitious retrofits was the Green Deal's "Golden Rule" which stipulated that the energy savings on the energy bill should always be greater than the cost of repayments of the building improvements. "The Green Deal 'Golden Rule' is thus that the energy savings will pay for the measures over 25 years" (Theobald & Shaw 2014, p.92). This rule

effectively excluded more expensive measures such as whole building and deep retrofits which "are arguably better suited to pay-as-you-save financing" (Rosenow & Eyre 2016, p. 142). A further issue was the 7% interest rate which was fixed for the lifetime of the building improvement measure. This high interest rate was criticised for being higher than market rates. Bergman and Foxon (2018) found that the PAYS mechanism might have been more usefully employed under different parameters, such as a lower or zero % interest rate.

There were also concerns about quality standards of the Green Deal. This was due to approximately 11% of Green Deal assessors and 14% of Green Deal installers having been "suspended or withdrawn from the scheme due to non-compliance with the Green Deal scheme requirements" (Rosenow & Eyre 2016, p.143). The Green Deal was further described as "overly complex and bureaucratic" (Bergman & Foxon 2018, p.12) and received critical media coverage (Rosenow & Eyre 2016). The Green Deal's short lifespan could certainly be considered another factor for why the policy has been deemed unsuccessful. This is in light of indications that energy efficiency markets are likely to develop stronger if policies are in place long enough to create stability, meaning a decade or longer (Geller et al. 2006).

Bergman & Foxon (2018) observed that the Green Deal might have had a damaging effect on the overall retrofitting activity in the UK, as they found that retrofit measures decreased in 2013/14 compared to the previous year. They venture that this was due to the policy's unattractiveness for homeowners but also its insufficient engagement with consumers (ibid). Further, Bergman & Foxon (2018) proposed that the Green Deal might have benefitted from a different approach to demand creation, such as using different providers like high street banks.

In 2014 it became clear that the Green Deal had "failed to live up to expectations" (Rosenow & Eyre 2016, p.143). In June 2014 the Green Deal Home Improvement Fund (GDHIF) was launched providing grants up to £7,600 as energy efficiency incentives which households could claim back after installing the energy efficiency measures but capped at £120million over one year (Rosenow & Eyre 2016). The GDHIF was allocated over three funding rounds before the funding was exhausted and so only increased retrofitting demand in the short-term. Rosenow & Eyre (2016) observed that the "cash back scheme was very successful in the sense that demand for the grants far exceeded expectations" (p.143). Despite these ambitious aims, however, in the end the Green Deal was labelled as "a major setback of UK energy efficiency policy" (Rosenow & Eyre 2016,

p. 144). It was closed in July 2015 with no replacement scheme. This left the UK with only few other energy efficiency policies for domestic buildings - the Energy Company Obligation (ECO) and a national target to install smart meters in all UK homes by 2020.

Across its lifetime the Green Deal experienced slow uptake and little awareness and a general disinterest from homeowners. Rosenow & Eyre (2016) state that "the vast majority of people familiar with energy efficiency policy design were always very sceptical about the Green Deal" (p.143), which is exemplified by Eames et al. (2014, p.259) who called for a "reconfiguration of the existing architecture of the scheme" while it was still underway. There had also been criticism that the policy design team failed to review the available evidence and assumed that households would "respond rationally to economic incentives and that the major barrier to action was a lack of capital" (Rosenow & Eyre 2016, p. 144). The policy also ignored other motivations for energy efficient homes such as "comfort, well-being and health" (Rosenow & Eyre 2016, p.142).

With the benefit of hindsight, De Laurentis et al. (2018) describe the Green Deal as having proven "highly problematic, requiring significant modifications and additional incentives" (p.209). Rosenow & Eyre (2016) summarised the pitfalls of the Green Deal as poor policy design, too little engagement with consumers and limited financial appeal. Yet while the Green Deal and also the Green Investment Bank did not reach their respective potential, there is much to be learned from them for future energy efficiency policies in the UK in terms of the importance of government and leadership and regulation. With the current lack of financial incentive policies for domestic retrofitting there is "a need for intermediation between finance and energy efficiency projects. This could be a combination of national policy and regulation and local initiatives, including public private partnerships, but requires national government leadership" (Bergman & Foxon 2018, p.20). And due to recent political developments the UK might have more authority in shaping its energy efficiency policies landscape than in the last 40 years.

Brexit

It should be noted that the final two years of this thesis research have included the period after the 2016 UK referendum vote to leave the UK but before the proposed act of leaving the EU in March 2019. Since it is at the time of thesis submission still unclear whether a successful leaving agreement can be struck between the EU and the UK, this study has to consider the possible influence of Brexit on the UK energy efficiency situation and domestic retrofitting without investigating Brexit itself. Brexit and its consequences is also a topic in the academic literature. Hepburn and Teytelboym (2017)

for instance present both the optimistic and the pessimistic view for climate change policy. "An optimistic view is that Brexit is an opportunity for Britain to unilaterally improve upon the existing EU climate policies as they apply to the UK" while on the other hand "it is unlikely that ambitious policies would be put in place now if they were not before. Rather, if EU climate policies are removed, action on climate change in Britain is more likely to be weaker than stronger" (Hepburn & Teytelboym 2017, p.145). Pollitt (2017) agrees that "there are opportunities presented by leaving the EU in energy. These include rationalising the subsidy regime" (p.10). Pollitt also cautions, however, that any new energy policy the UK introduces as a result of leaving the EU should be carefully designed in light of the country's "historic capacity for adding unnecessary cost to well-intentioned EU driven policies" (ibid, p. 10). The issue of Brexit and its implications for policy will be further discussed in the thesis in Chapter 6.

Geared towards deep retrofitting?

The UK policy landscape for energy efficiency is clearly integrating building retrofits as a priority. But while the Green Deal was focused on domestic energy efficiency measures, its Golden Rule pretty much disabled it for any deep retrofit measures as the combination of technologies often proved to be too cost-intensive to be paid back through energy savings over the life time of the installed measures. While ECO focuses on domestic buildings in deprived areas, it does not usually cover deep retrofits either as the energy companies are not legally obliged and do not have a sufficient business case that would make deep retrofitting a logical choice for them. It has remained doubtful whether any financial incentive policy subsequent to the Green Deal would be strong enough and the obligation of energy companies severe enough to facilitate deep domestic retrofitting the UK. On its own, the current UK energy efficiency policy is certainly not enough to overcome the many architectural, construction and other challenges to deep domestic retrofitting.

2.3.Retrofitting and deep retrofitting in the domestic sector

The next section aims to identify and critically review some key discussion points surrounding deep energy efficiency building retrofits. It starts by looking at the different definitions of the concept, goes on to look at the main motivations for, and benefits of deep retrofits, the possible elements that could be improved and replaced in a building, and finally some of the reasons why deep retrofits have not been taken up and implemented more broadly to date.

The literature search relied heavily on the expertise of the Building Performance Institute Europe (BPIE) which seems to have done the most detailed and comprehensive

research on this topic to date. Further literature was found through database searches (Web of Science) and by following up on references in other research articles. The web tool TABULA was recommended by other researchers who are active in the area of energy efficiency retrofitting and proved useful in identifying relevant sources.

2.3.1. Definitions of the term 'deep retrofit'

What is understood by the terms "retrofit" and "deep retrofit" varies significantly across different publications and organisations. A retrofit could be understood as "a wide variety of improvements to an existing building" (BPIE 2011, p. 102) or an "upgrade to an existing house to meet contemporary norms and standards or to prepare for future conditions" (Karvonen 2013, p.564). The pursuit of energy efficiency and carbon reduction are hereby only two of many motivations, such as comfort, convenience or aesthetics that can convince a home owner to improve a building (Karvonen 2013). For this research, with its focus on environmental improvement, a retrofit is understood to have a strong environmental component, leading to a "directed alteration of the fabric, form or systems which comprise the built environment in order to improve energy, water and waste efficiencies" (Eames 2011, p.2).

Beecken and Schulze (2011) explain that the energy balance in buildings is derived from

- Energy consumption for heating and warm water
- Loss of heat through transmission and aeration
- Heat loss through the heat distribution system
- Heat gains from solar and internal heat sources (people, devices).

All of these areas of a building can be improved slightly for a "shallow retrofit" or significantly for a deeper retrofit. A deep retrofit is generally more ambitious in its environmental aspirations, and has been described as achieving energy savings of at least 40% (Curtin & Maguire 2011), at least 75% (International Energy Agency 2013) or 60% to 90% (BPIE 2011). For this research, Jones et al. (2013) illustrate the correlation of carbon emissions reduction and complexity of retrofitting in their 2013 paper and show how significant carbon savings can only be achieved through deep rather than shallow retrofitting (Figure 3) which they define as achieving between 30% to 80% of CO_2 reduction. For this research the authors decided to use of the above ranges of deep retrofit carbon emission reductions of 40% to 90% to ensure a match with the general understanding of the term in the literature.

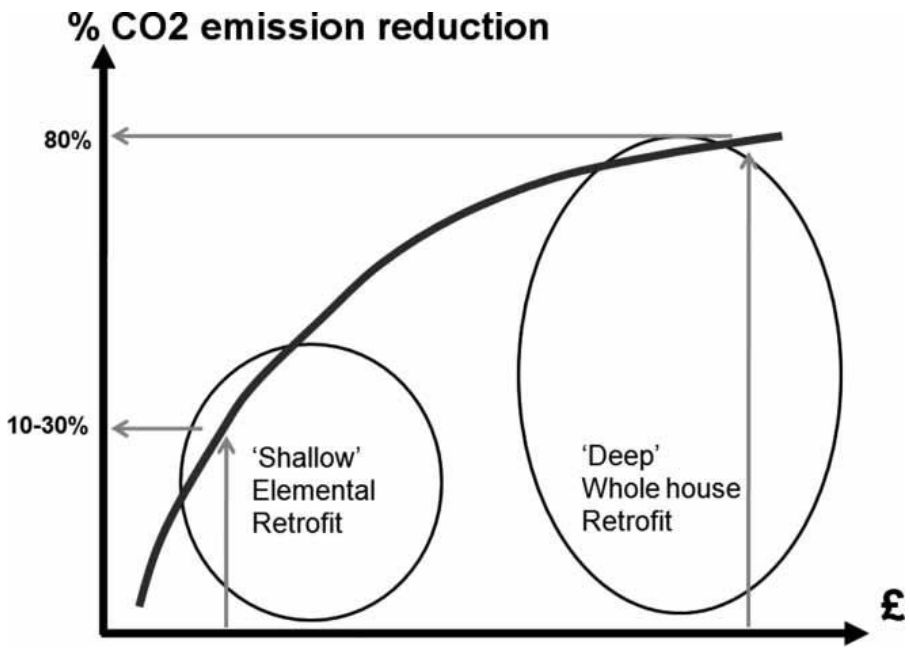

Figure 3: Correlation between cost and complexity of retrofits and % of CO2 emission reduction (Source: Jones et al.2013)

The lack of a unified definition can make the concept of deep retrofitting appear fuzzy. Sometimes it is defined in terms of energy savings, sometimes in terms of carbon emission reduction. Energy saving does not necessarily and usually distinguish between carbon-intensive or renewable energy sources, and energy saving measures might lose carbon-reducing impact through an increasing decarbonisation of the energy supply industry. Focusing on carbon emissions reduction on the other hand might provide a better way of estimating the depth of a retrofit for the long term, but is more complex to calculate. Another option could be to focus on the energy usage of individual building components or systems, such as cooling or heating, and then add this up for the whole building if required. This approach seems to be in use for instance in Bolzano, Italy, where by the end of 2019, owners of buildings will be allowed to expand the surface of their dwelling by up to 20% or up to 200m^3, only if the building achieves a heating consumption below 70kWh/m^2/yr (Building Performance Institute Europe 2013b, p.23). The most comprehensive and precise approach to measuring the impact of a retrofit and ongoing performance of a building would surely lie in a bundle of metrics that could include energy savings, carbon emission reduction and the monitoring of building components energy usage. However, since this is also the most difficult approach to achieve, requiring a multitude of data collection points and measuring equipment, it would be unlikely to become a mainstream preference.

2.3.2. Why is deep retrofitting important?

Karvonen (2013) observed that since the 1970s UK carbon emissions for domestic energy consumption have been decreasing constantly, as shown in Figure 4 – so why not just depend on this trend for achieving carbon reduction targets instead of investing money and effort into domestic energy efficiency? Not only is it a slow trend and would take significantly longer than would be required to achieve the 80% emissions reduction that the EU is aiming to achieve by 2050. Energy efficiency in domestic buildings also provides societal, economic and environmental benefits beyond just carbon savings. This could imply that deep retrofits might need to be evaluated in terms of these additional benefits also, and a truly successful deep domestic retrofit would have a tangible and proven positive impact on the health, finances and natural environment of the building occupiers. The BPIE (2013a) noted that the deep renovation of domestic buildings could lead to energy cost savings in the region of €1,300bn for EU end-users, a possible job creation of up to 1.1mn additional jobs EU-wide and cause an economic stimulus of +2.7% of the EU's GDP by 2020. Equally deep retrofits can lead to reduced fuel poverty as it provides the means to "fuel poverty-proof" homes through very low energy bills. This could positively impact up to 125mn people across Europe. Eventually, it has been argued, ambitious deep retrofitting projects have the potential to support the economic recovery and re-launch the construction sectors in many European countries (Buildings Performance Institute Europe 2010).

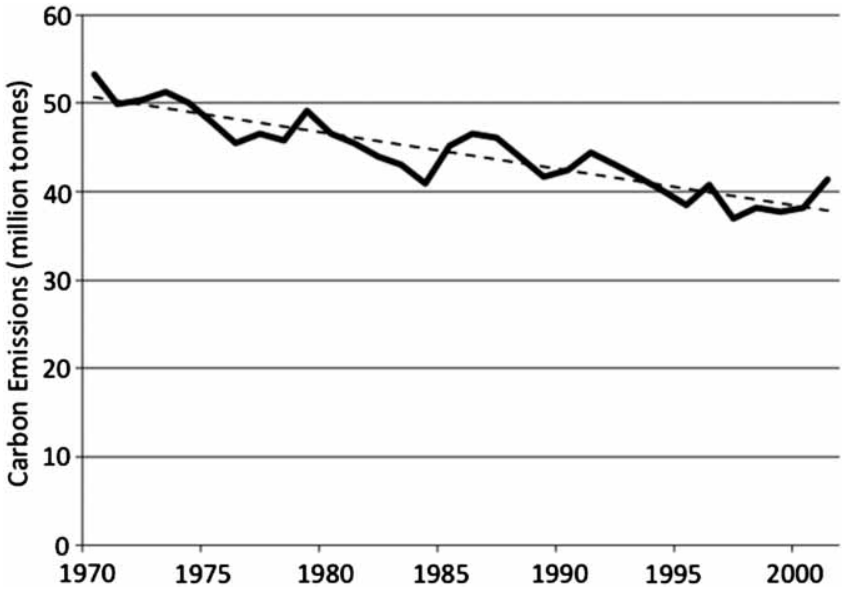

Figure 4: UK Carbon emissions from domestic energy consumption between 1970-2001 (Source: Karvonen 2013)

2.3.3. Components and measures of a deep retrofit

Curtin and Maguire (2011) observe that deep retrofits necessarily involve a combination of different energy efficiency measures which target the energy performance of the

building fabric, increase airtightness and heating efficiency and reduce energy use across the house. These measures add up to "numerous technically feasible retrofit alternatives with varying costs and different energy saving potential" that need to be tailored to each individual building (Kumbaroğlu & Madlener 2012, p.327). Beecken & Schulze (2011) list the following rough variations of building envelope and building services that could be combined for a deep retrofit:

- Insulation of external walls
- Insulation of the roof
- Insulation of the cellar ceiling
- Windows
- Doors
- Heat generation/heating system
- Means of water heating
- Controlled aeration
- Proof of thermal bridges
- Rate of air change (p.342).

Each of these measures comes in many different levels of efficiency, and the decision which measures to install into a home requires significant technical knowledge. To simplify the selection for home owners and to increase awareness among the public, the EU has established a comprehensive web tool called TABULA which provides an overview of generic building types in European countries and allows the comparison of different building components and systems on multiple levels. Below in Figure 5 is a TABULA comparison for a pre-1948 single family German building for which the primary energy demand in its initial state has been calculated as 503kWh/m²/year. A deep retrofit has the potential to reduce its primary energy demand to 78kWh/m²/year, which in CO_2 emissions would translate from 102kg/m²/year to 16kg/m²/year; a reduction of approximately 85%.

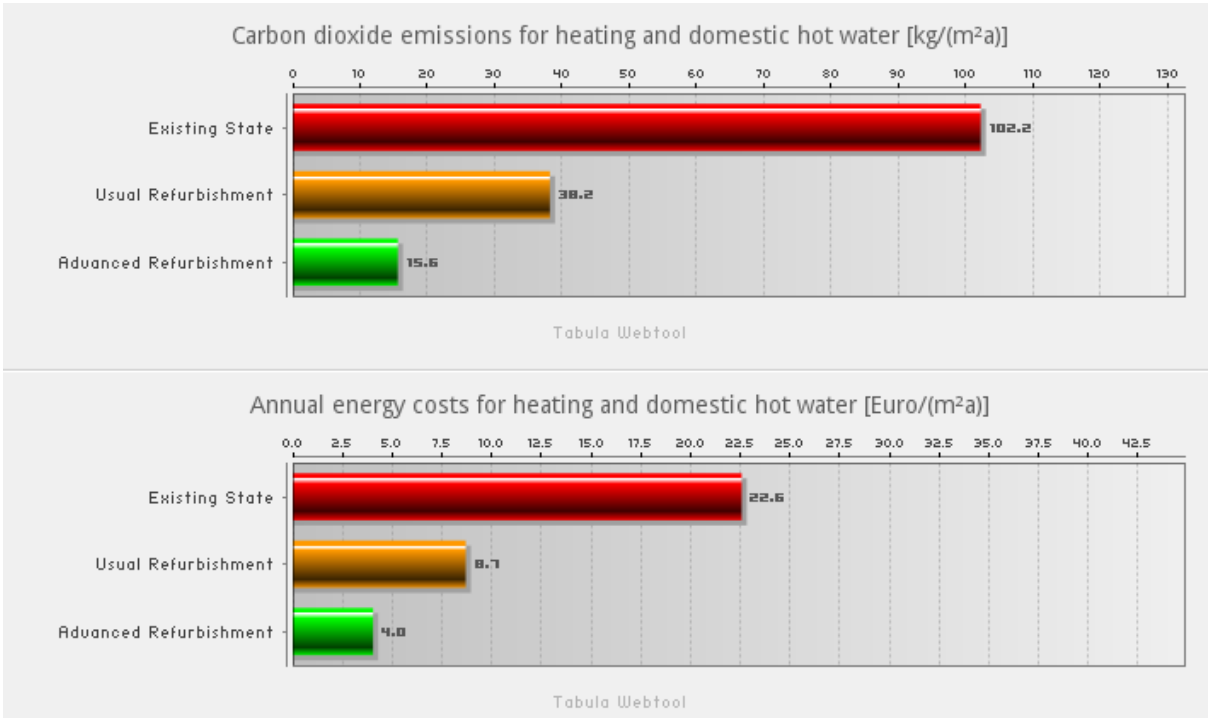

Figure 5: TABULA comparison of CO2 emissions and energy costs for different depths of retrofit for a pre-1948 German single family home (Source: TABULA http://episcope.eu/building-typology/tabula-webtool/)

Of course, these are theoretical figures based on a generic example building and need to be considered with caution. As Kumbaroğlu and Madlener (2012) pointed out, every building needs to be technically assessed with regards to its specific envelope and systems features before appropriate retrofit measures can be selected.

2.3.4. Current situation in Europe

The current situation across Europe shows a lot of room for improvement. As BPIE (2013, p.16) put it: "Most renovation activity at the moment achieves only modest energy savings, perhaps 20-30%, but this needs to increase to deep renovations of at least 60% if the full economic potential is to be realised". BPIE (2013a) also modelled some scenarios with various levels of retrofits and found that both depths (from currently up to 30% to at least 60% or even zero energy buildings) and rate (from currently around 1% to about 3% of the domestic building stock being retrofitted annually) of retrofits need to be increased to allow the current carbon reduction targets to be achieved by 2050. This would simultaneously require the energy supply system to be decarbonised over time.

There are positive signs, however, that European countries are increasingly putting into place advanced building policies. These tend to include mandatory energy retrofit requirements and support programmes. The most ambitious of these policies are being implemented in Austria, Belgium, Germany, Denmark, Finland, France, Italy, The Netherlands and the United Kingdom (BPIE 2013b). And while most of these policies

still only scratch the surface of the respective country's building retrofitting potential, there are some that cross the threshold to deep retrofitting. Germany, for instance, aims for a climate neutral building stock by 2050.

2.3.5. What are the challenges for deep retrofitting?

As discussed above, there are many benefits and reasons why deep retrofits should be a logical choice for every homeowner, and yet they are not. While it is technically demanding but possible to bring buildings close to carbon-neutral through retrofitting, it may be "prohibitively expensive" to do so to the point where one might consider demolition and new-build instead[1] (Karvonen 2013).

Financing is indeed a major barrier to deep retrofitting with issues stretching from initial access to capital, to risk exposure, a high discount rate, long payback times, lack of financier awareness and the often small size of energy efficiency projects, which can put off investors with large pots of money (BPIE 2010). Public sector investors in particular are interested in larger projects rather than piecemeal developments (Gouldson et al. 2014). This means that individual homeowners, who would profit most from deep retrofitting, often cannot afford it, and large scale and public sector investors are rarely attracted to deep retrofitting projects because they do not provide them with the necessary economy of scale and standardisation needed for a solid business case. For large scale investors, especially with connection to the financial markets, the choice to invest is all too often still based on a comparison of investment expenditure and expected cost savings (Kumbaroğlu & Madlener 2012) with little inclusion of the many long term societal and environmental benefits, which tend to be of higher importance for public sector investors. These financial issues make energy efficiency investments highly unattractive for bigger private sector investors, compared to traditional investment opportunities. Moreover, deep retrofit examples are still mostly limited to individual demonstration or pilot projects and only provide limited information on financing requirements and solutions – certainly not sufficiently for a possible rollout of deep retrofits on a larger scale (BPIE 2013a). Table 1 provides a brief overview of some investor types and their respective motivations and challenges for deep domestic retrofitting. Curtin and Maguire expressed hope in their 2011 paper that the number of deep retrofits can be increased incrementally if the "financing barrier to retrofit investment could be overcome, and if attractive financing options were made available to consumers" (p. 46). Since then, an increasing number of European countries and regions are trialling approaches to accelerate uptake of deep domestic retrofitting, such

[1] The issue of 'retrofit or destroy' opens up another area of discussion, as shown by Anne Power (2008).

as Sweden, Denmark, Alsace and Picardie in France and the Netherlands (Gupta & Gregg 2016).

Table 1: Potential investor types for deep domestic retrofitting and their motivations and challenges (Source: Own illustration)

Type of investor	Small –scale private	Large-scale public	Large-scale private
Advantages and Motivation	Long-term societal and environmental benefits	Access to finance Long-term societal and environmental benefits	Access to finance
Challenges	Access to finance High discount rate Long payback time	Risk exposure Economy of scale/ piecemeal developments	Long payback times Lack of financier awareness Economy of scale/ piecemeal developments More attractive traditional investment opportunities

Financing is not the only challenge, though. Karvonen (2013) points out the "balkanised character" of the retrofit industry. It comprises not only building owners and occupants but also a multitude of installers and manufacturers, local authorities and charities with limited communication between the different actors with their respective different aims and incentives. He adds that a building's energy performance is "locked in during design and construction activities and opportunities for upgrade only arise during infrequent refurbishment activities", creating only small windows of opportunity for deep retrofitting (ibid, p. 564). All things combined, it is neither cheap nor easy to roll out deep retrofits.

2.3.6. Where does this leave deep retrofits in the future?

While deep retrofitting could be highly beneficial for the environment, society and the economy in the long run, it is still mostly a thing of the future. Challenges start with the basic definition of the concept and the calculation of its impact, and continue with issues concerning the availability of technical expertise and the quality of communication across the retrofitting industry and the financing of the technologies and their installation. As Karvonen (2013, p.564) noted, it will "require more than conventional tools of regulations, economic incentives and information provision; instead, they will require multifaceted strategies that can leverage the diversity and

complexity of the existing housing stock and the multiple individuals and institutions that act upon it".

The building sector is a slow moving one with for instance in 2011 an annual rate of new builds of less than 0.5% and a demolition rate of less than 0.1% annually in the UK (Jones et al. 2013). Windows of opportunity for deep domestic retrofitting present themselves rarely and only briefly. During routine occupation of a building, end-users often avoid retrofitting measures due to their disruptive nature or connect them directly to the lifecycle of the technical components of a building (Stiess & Dunkelberg 2013). A change of ownership or scheduled updating of the property often present the only viable times to undertake energy efficiency improvements or a deep retrofit, both from a financial and disruptive viewpoint (Stiess & Dunkelberg 2013). While there are tools available to increase awareness and confidence to take advantage of these opportunities, they are often known only to experts or individuals in this area, and are not widely published. Meeting the retrofit challenge might require cross-sector collaborations between policy makers, financiers, builders and end-users, a concerted, long term effort of communication, education and financial support. But while most of these efforts focus on informative approaches, the financing challenge needs a lot more practical effort to provide an investment arena for energy efficiency projects, and deep domestic retrofits in particular, to turn the heads of large-scale private and public sector investors.

2.4.Finance and institutional measures

Stiess and Dunkelberg found evidence in their recent empirical survey of 1,000 German homeowners on refurbishment decision-making that financing is generally perceived to be a barrier to domestic retrofit (2013). The Institute for Fiscal Studies (IFS) describes this problem as an economic market failure for building retrofits, expressed through a credit constraint and an inability to borrow (Leicester & Stoye 2013). More precisely, financial barriers to retrofitting have been categorised as access issues, payback expectations/investment horizons, competing purchase decisions and price signals, some of which have been discussed above (Building Performance Institute Europe 2012). A more detailed discussion of these barriers as well as the problem of market failure for energy efficiency will follow with the help of case studies in the following chapters.

Even in the cases where finance is available, it tends to be so restricted in EU member states that it only inspires modest ambition for sustainability and energy efficiency (BPIE 2011). But there are examples that show that the funding landscape may be

changing. Sources of private and public finance are diversifying, e.g. through the involvement of ESCos, etc., and funding models are shifting, e.g. towards hybrid and collaborative funding (Roelich 2014). Examples of this diversification and hybridisation can be found in the UK as well as across Europe.

2.4.1. International key institutions

Institutional funders tend to hold large pots of money and are responsible for large sustainability initiatives across Europe. The BPIE (2012) report describes the European Investment Bank (EIB), the European Union and the European Bank for Reconstruction and Development (EBRD) as key multilateral financial organisations. They provide a mixture of financial instruments, such as loans, investment funds and guarantees. The findings of the report indicate that some of these sources are underused – "by the end of 2009, member states allocated less than 1% of the ERDF funding for building renovation, while they can use up to 4%" (p.29). Equally important is, however, that these institutions tend to look at investment opportunities at scale and consider opportunities in the region of several hundreds of millions more attractive investments than smaller or more fragmented ones (Gouldson et al. 2012).

2.4.2. EU financial instruments

The BPIE in their 2012 report on the use of financial instruments distinguishes between financial incentives and fiscal measures which combined are referred to as conventional instruments, and innovative instruments such as Energy Performance Contracting (EPC) or Energy Efficiency Obligations (EEO) (BPIE 2012).

Conventional instruments

Financial incentives tend to be grants, subsidies and preferential loans and in 2012 made up a majority of 77% of conventional financial instruments for energy efficiency in buildings across the EU member states (BPIE 2012). Fiscal measures include tax reductions, tax credits and reduced VAT schemes and aim to reduce the amount of taxes paid on energy efficiency investments in the built environment. Fiscal measures made up about 23% of conventional financial instruments in the EU (BPIE 2012).

Innovative instruments

BPIE (2012, p.25) considers Energy Performance Contracting (EPC) and Energy Efficiency Obligations (EEO) as the two main types of innovative financial instruments in the EU and states that "if used properly, they can provide long-term financial

support"[2] independent of government budgets. Both instruments have been in practice for decades and are included in the Energy Efficiency Directive.

EPC activity has been reported across Europe and has been valued at about €6 billion annually (BPIE 2012). EPCs often involve energy efficiency investments by an energy service company (ESCo) into a building to achieve contractually agreed energy efficiency improvements that the beneficiary pays for through their reduced energy bills. There are a number of regulatory and non-regulatory barriers, the removal of which could facilitate a faster uptake of EPC-financed retrofit programmes. Those barriers include the overall lock-in of a socio-technical system that has developed over decades based on a different business model, the resulting lack of standardised contracts and a general uncertainty about the legal issues of energy service contracting (Hannon et al. 2011). While ESCos can certainly provide the necessary technical and financial expertise, it still has to be proven whether they could play a crucial role in delivering deep retrofit projects (Hannon et al. 2011; Hannon et al. 2013; Roelich et al. 2015).

Energy Efficiency Obligations (or White Certificates) force energy suppliers to take charge of energy efficiency improvements and are common in Belgium, Denmark, France, Italy and the UK and have been focused on the residential sector, particularly on insulation, lighting, heating and appliances. As with the EPC, it is still unknown whether EEOs could deliver deep retrofits.

Other funding models

At a small- and medium-scale level, Britnell & Dixon (2011) also found that a number of other funding models were emerging, which include:

- Self-financing – whereby a company or individual borrows money to finance the retrofit;
- Service charge – whereby the landlord claims the costs of the retrofit back through a 'hard services' part of the service charge from the tenant;
- Managed energy service agreements – whereby a contractor takes on the responsibility for energy bills and utility providers (this sounds very much like an EPC);

[2] BPIE does not explain what the "proper" use of EPC and EEO would necessitate and whether both are currently used improperly.

- Investment Funds – whereby specialist funders provide the capital for a retrofit, e.g. Green Investment Bank underwrites partnership between Sustainable Development Capital and BRE;

- Green Bonds/ Climate Bonds – whereby cities/ Local Authorities issue long term bonds to finance the capital costs of retrofits upfront (examples of this can be found in the USA);

- Tax Increment Finance – whereby the borrowing is set against the value of the future uplift in order to deliver the necessary retrofit infrastructure.

2.4.3. Financing deep retrofits and "bundled" sources

Ambition, or rather the lack thereof, could pose a threat to deep retrofit schemes in Europe. Due to the high overall costs of holistic retrofitting approaches, "the level of ambition of financial programmes needs to rise in order to have greater impact and unlock further private investment for deeper renovation" (BPIE 2012, p. 5). Many financial measures currently only achieve in the region of 20% of emissions reduction per retrofit which is not enough if the EU aims to achieve its target of 80 – 95% of reductions in GHG emissions by 2050 (BPIE 2011). Subsequently, a long term vision on sustainable and deep domestic retrofitting is critical. Establishing long-term programmes may be crucial for the development of a long-term market for deep retrofit schemes, which is turn is necessary to establish deep retrofits as a common practice across the EU.

Increasingly, member states have been observed to employ a combination of fiscal and financial incentives rather than relying on either one. Since "few financial instruments target deep renovation" (BPIE 2012, p.4), one way to overcome this funding gap could be through "bundling" of several financial instruments. An interesting example of such bundling is the JESSICA model in Lithuania which pulled together EUR227 million with the aim to refurbish 24,000 domestic buildings by 2020 (BPIE 2010). The funding was sourced from the European Regional Development Fund (ERDF), the Lithuanian Ministries of Finance and Environment, the EIB and CEB as well as other private and public sector investors and banks (Figure 6) and the model is an example of sophisticated financial engineering (BPIE 2010).

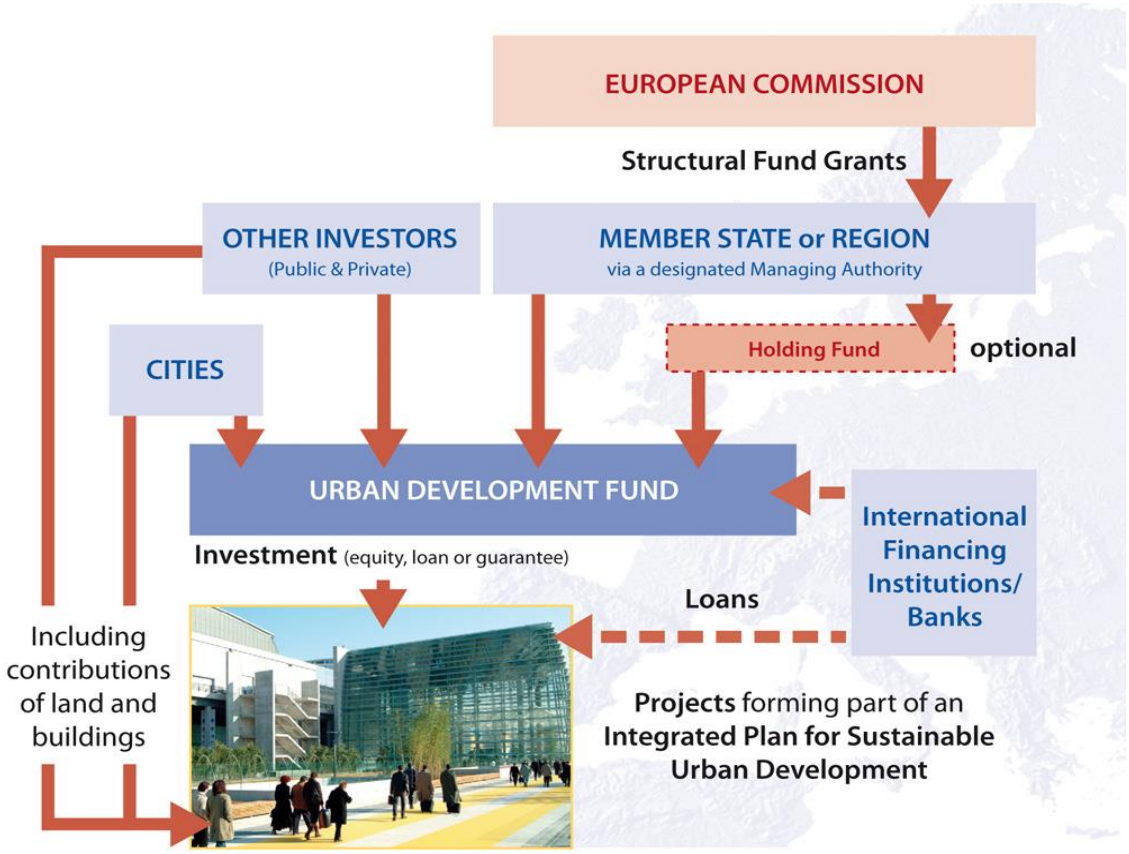

Figure 6: The JESSICA mechanism in Lithuania (Source: BPIE 2010)

While the JESSICA mechanism operated at a grand scale and a high level, the concept of financial engineering that stands behind it can be applied to a much smaller scale at a regional level. A good example for this is the Chale Community project on the Isle of Wight where a Community Interest Company (CIC), a charity, a public sector body and a business worked together successfully to retrofit a housing estate that suffered from fuel poverty. The Ellen MacArthur Foundation and Carillion joined forces to provide the funds and technology for renewable energy and building insulation which not only has improved the economic situation of the occupants but also the general outlook of the estate and, for instance, lowered the amount of vandalism in the area (Roelich 2014).

2.4.4. The financing decision-making process for domestic retrofit

While the literature discussed at the start of this review suggests that access to finance is clearly a barrier, the decision making processes on energy efficiency investment are also complex and not well understood (Dixon & Britnell 2013). Decisions on spending money on energy efficiency could be taken by a number of different parties, such as the owner or the occupier, or jointly. "Likewise, the costs will be affected if multiple parties are involved in the process. This is a classical barrier for deciding on the renovation of a building, also known in the literature as the tenant-landlord dilemma" (BPIE 2011p. 101). This, mentioned earlier in this review, is also referred to as the split-incentive problem

whereby a landlord could make energy efficiency investments which benefit the tenant who in turn might not want to carry the additional costs (Kok et al. 2012). Besides that, the decision should also be determined by "comparing investment expenditures with expected cost savings from energy conservation" to establish economically optimal choices (Kumbaroglu & Madlener 2012, p.332).

2.4.5. A closer look at low-carbon finance

This thesis explores the impact of low-carbon finance and governance on domestic retrofitting. While governance and retrofitting are clearly defined terms with a well-understood scope (apart from the identified problems with setting the boundaries of defining deep retrofitting), low-carbon finance is much vaguer and more of an emerging term and concept. This section aims to provide some background knowledge, scope and a definition for a topic that until recently has been much less well understood than the former two terms.

Low carbon finance is an emerging topic in the sustainability and transitions literature and gets featured in many recent articles (Bolton & Foxon 2015; Little et al. 2015; Jones et al. 2013; Lambe et al. 2015; Bergman & Foxon 2018). A point often made is that "ongoing low-carbon investments will be required to maintain the lower carbon intensity of economic growth" (Colenbrander et al. 2015 p. 12). And while the need for more carbon finance is frequently stressed, there is evidence that existing financing and investment mechanisms "can benefit – and sometimes even strengthen" (Lambe et al. 2015, p.64) sustainability projects and approaches. Despite a clear need and benefit for low-carbon finance, there appear to be few academic articles providing a conclusive definition or scope for the term. Rather it seems that low carbon projects are frequently treated and managed in a similar fashion as traditional projects or initiatives, and as such the required funding is often simply referred to as investment or capital.

There are many terms for what adds up to sustainability centred finance or investment. Figure 7 provides an overview of some of the terms used in the literature. While some of them have a very narrow focus, others could be used interchangeably without the risk of losing their meaning or context. Recent research has also picked up on this. Fenton (2015) stated that "a precise and universally accepted definition has [...] never existed".

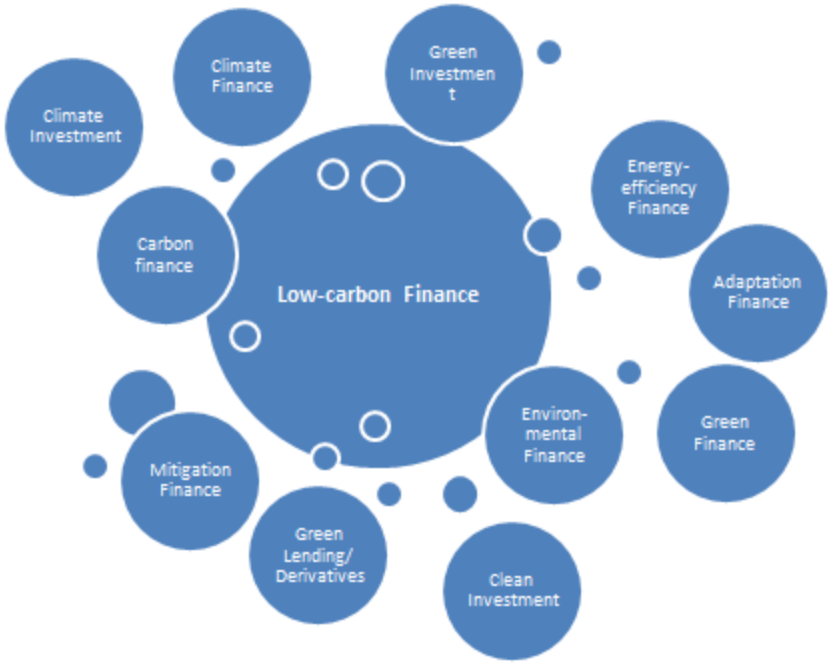

Figure 7: Selected terms for low-carbon finance, in no particular order (Source: Own illustration)

When looking into the term it materialises that most of the literature on low carbon finance is grey literature and academic publications make up a smaller proportion of the literature in this area. Nevertheless, there are a few noteworthy mentions of the issue.

So noted Pearson and Watson (2012, p.31) that "the public debate about energy has started to focus on the costs of the low carbon transition" while Eames et al. (2013) observed that finance is a big part of path-dependency and lock-in of systems with sunk investments presenting "formidable challenges for a managed transition towards sustainability" (p.513). Across the literature, there are many references to cost (Geels 2014; Smith et al. 2005) or investment (Campiglio 2015; Buchner et al. 2014) but also capital. There is an emerging understanding that finance needs to play a role in sustainability and that "ongoing low-carbon investments will be required to maintain the lower carbon intensity of economic growth" (Colenbrander et al. 2015, p.12. Nevertheless, it has been criticised that "climate related investments have fallen well short of even the most conservative needs estimates for successive years, making the requirement of 'catch up' very real" (Buchner et al. 2014, p.1).

There is broad agreement on what traditional finance is, it is defined, there are common definitions. This is different altogether for low-carbon finance. One of the reasons for this is its complexity apart from its novelty. This lack of focus on and definition of low-carbon finance makes it rather difficult to analyse what the problems are and to get a handle on them quantitatively and qualitatively.

Low carbon finance differs to traditional finance and investment in terms of the motivation behind the funding which tends to be sustainability-focused. This is likely one of the biggest points of distinction from traditional finance. Risk and return of investment are two other major points of distinction and influence significantly how easily environmentally-geared projects can access finance. Lambe et al. state that "the core purpose of carbon finance is to reduce greenhouse gas emissions" and that "the money is

Figure 8: Only finance with the primary intent of addressing climate change or also any other finance that provides meaningful climate co-benefits? (Source: Buchner et al. 2014)

"result-based", namely only paid when agreed-upon outcomes are delivered and verified – in this case, greenhouse gas emission reductions" (Lambe et al. 2015, p.56). Table 2 tries to compare some characteristics of traditional and low-carbon finance in concise form.

Characteristic	Traditional Finance	Low-carbon Finance
Investment motivation	Economic "driven by benefits to private investors" (Bolton & Foxon 2015)	Environmental and social Often "policy driven" (Bolton & Foxon 2015)
Objective	Profit – maximise return on investment	"reduce greenhouse gas emissions" (Lambe et al. 2015, p.56) "greatest environmental benefit for the largest number of people at the lowest possible cost" (Curley 2014)
Risk	Clear indication of risk level – ROI directly related to risk, All risk lies with investor	"high risk perceptions due to uncertainties about future climate policies and carbon prices, and excess upfront costs that make them unable to offer returns that are commensurate with their (perceived) risk" (Rozenberg et al. 2012) "critical to allocate investment risk […] in an equitable manner" (Bolton & Foxon 2015)
Access to capital	Institutional and private investors	Various sources, including national, regional and local government - Often challenging and administratively convoluted
Scale	Focus on larger scale investments	From domestic level to multinational collaborations (e.g. JESSICA Fund)
Timeframe	Preference for short-term	Preference for long-term
Expertise	Single focus	Multi-disciplinary
Structure	Money is invested first, profit received later	Investment activity undertaken first, funding paid out when results achieved
Issues	-	Intragenerational equity, intergenerational distributive impact (Rozenberg et al. 2012) difficult to track globally

Table 2: Traditional finance and low-carbon finance compared

A good example is the Climate Policy Initiative's (CPI) Global Landscape of Low Carbon and Climate Finance (2017) which provides a summary of funding and investment streams directly related to any form of sustainability activity worldwide. CPI states that in 2016 globally $383bn were classed as climate finance (Buchner et al. 2017). This

arguably covers many different areas of sustainability such as climate change adaptation, mitigation and emissions reduction in a social context, environmental protection and rehabilitation of ecosystems as well as green design and engineering and energy efficiency retrofitting in the built environment and a business context.

There have been voices in climate sciences warning about an underinvestment in climate and sustainability finance and the need to quantify funding needs. “Estimates of investment needs are relevant because they point qualitatively to the potential financing gap” (Buchner et al. 2014, p. 33). The financing gap is a topic which could fill a separate thesis but it should be noted that “in global terms, climate finance has fallen short of the lower bound of annualized investment needs by some hundreds of billions, for successive years.”(Buchner et al. 2014, p.33). This implies that a catch up is necessary, particularly in light of growing evidence that the world emission pathway already exceeds the often-quoted 2 degrees Celsius threshold. A second way to conceive the low-carbon financing gap is, however, as the gap between incentives for low carbon investment, and cheaper, higher carbon alternatives.

2.5.Concluding section

The literature review in Chapter 2 started with EU governance and energy efficiency policy as this provides an important legislative framework within which the research problem sits. It identified the major energy efficiency policies for the built environment and the difficulty of their transposition across different governance levels. It also identified governance as an area of considerable influence on the energy performance of buildings which creates a strong rationale to explore this impact of governance in the case studies in Chapter 5. While the EU policy landscape is trying to create a supportive environment for energy efficiency projects, its tools tend to focus on informative approaches and lack the authority to bring about deep retrofit endeavours.

It also examined the literature on the state of energy efficiency in the UK in more detail which provides a basis for a comparative analysis with the case studies in Chapter 5. The chapter further explored the concept and state of deep retrofitting in the literature as well as its opportunities and barriers for widespread adoption. As this is a very ambitious concept, there is a very limited set of example cases and the discussions in the literature are chiefly theoretical. Nevertheless, it provides a technical baseline for more ambitious whole-house approaches for domestic retrofitting which often suffer from similar barriers to uptake but also benefit from similar enablers. The transposition of the EU policies at the UK level lacks the ambition and vision to significantly promote deep

domestic retrofitting, and rather encourages the picking of the lower hanging fruits of energy efficiency, such as individual components improvements and shallow retrofits. Whole-house approaches as described by Jones et al. (2013) may require more incentives and control to thrive. The literature has shown that deep domestic retrofitting is lacking support in many areas and faces many challenges, despite its multitude of economic, environmental and societal benefits and advantages.

Further, the building sector in its balkanised and fragmented form does not allow for a uniform approach to domestic retrofitting, let alone deep retrofits and whole-house approaches. The current small number of existing deep retrofits also limits the generation of technical expertise in this area and the technologies and installation thereof remain cost-intensive and therefore often off-limits to small-scale investors and private individuals.

Besides governance, funding and low-carbon finance for energy efficiency in the built environment are a key focus of this study and so were explored in some detail in the literature review. The concept of low-carbon finance is still relative new and an emerging research area and so struggles with issues around definitions and distinctiveness from other types of finance and investment. The literature review also touched on institutional funding and sources thereof which will be explored further in the case studies in Chapter 5.

And while there are examples of financial engineering and diversification of funding sources starting to appear throughout Europe which show the potential to fund more ambitious energy efficiency projects, major investors still appear to be reluctant to invest in energy efficiency opportunities. While more traditional investments remain more attractive to larger investment funds, it appears that an important source of funding for energy efficiency projects is institutional funding, although alternative funding models and sources are emerging.

The majority of the issues which have been identified in the literature review will be further explored and tested in the case studies in Chapter 5. The literature review has explored the three areas of policy, architecture and finance and so provided some context and information on the research questions in Chapter 1. The next chapter describes how the analytical approach for the study was selected and developed.

3. Chapter - Transitions, coevolution and the analytical framework

3.1.Introduction

The research proposes to learn from socio-technical transitions by employing the multi-level perspective (MLP) (Geels 2005b) and transition management theory taking into account co-evolutionary thinking and theory in the context of domestic retrofitting. This approach aims to study the co-development between governance and finance concerning domestic retrofitting and their interactions at landscape, regime and niche level in line with Geels' multi-level perspective (MLP) (Geels 2005a) and Foxon's coevolutionary approach (2011).

Two very different regions across two European countries have been chosen for comparative analysis to investigate their respective approaches to regional governance and low-carbon finance and their combined impact on local retrofitting efforts. The case studies not only allow the analysis of the respective financing or funding structure in each region but also yield insights into the respective barriers, enablers and possible adaptation of these structures for the UK. The research also takes a closer look at EU policies which support energy efficiency measures and whether EU member states have "merely transposed" the policies or "implemented the spirit of the European legislation". Investigating these policies on a European and a national level is expected to provide insights into the development of and conditions for successful financing mechanisms for domestic retrofitting.

The literature has pointed out that "transition research encompasses a variety of approaches to study past and ongoing transitions, including the multi-level perspective, strategic niche and transition management, and technological innovation systems" (Safarzynska et al. 2012, p.1020). For the purpose of this research, however, the focus will be on socio-technical transitions, transition management and the MLP and integrating these approaches to transition research with a different analytical framework. Creating a hybrid framework between the MLP and a coevolutionary approach to analysing transitions should support the development of strong research findings.

The first part of this chapter will initially examine and discuss the transitions literature, in particular socio-technical transitions, the multi-level perspective (MLP) and transitions management. The second part of the chapter aims to discuss in some detail Foxon's co-evolutionary framework (Foxon 2011). While the initial literature review has

set the stage for this interdisciplinary research, it is also necessary to look further into transitions and coevolutionary literature to inform the manner in which data analysis is undertaken. The methodology for this will be discussed in Chapter 4 while this chapter takes a closer look at the contextual and analytical framework of the research.

3.2.Socio-technical transitions and social practices

3.2.1. Housing as a socio-technical system and its possible transition

It is argued here that the systematic decarbonisation of the domestic housing stock by means of retrofitting is part of a socio-technical transition and that the domestic housing sector itself could be regarded as a socio-technical system. Geels (2002)describes socio-technical systems (ST-systems) as "the linkages necessary to fulfil societal functions", encompassing "production, diffusion and use of technology" as sub-functions and as consisting of resources such as "artefacts, knowledge, capital, labour, cultural meaning etc. (p.900). He continues that ST-systems are based on human activities and that they focus their attention on the "co-evolution of technology and society" (p. 902)

Geels' definition of ST-systems brings to mind a domestic setting. If Geels' Figure 9 below is applied to the domestic housing sector, the buildings could be considered social artefacts, developed through the use of different technologies, by means of labour, knowledge, capital and natural resources (=production of artefacts). Buildings are then integrated into user practices in the form of occupation of domestic buildings and the development of social practices within or through the use of buildings (=use of artefacts in user practice). Buildings, particularly domestic buildings, combine a multitude of cultural meanings (family, leisure, rest, safety, nurture, etc.) and are associated with the development of numerous technologies to repair, maintain and improve the building quality and enhance the living standard of their occupants.

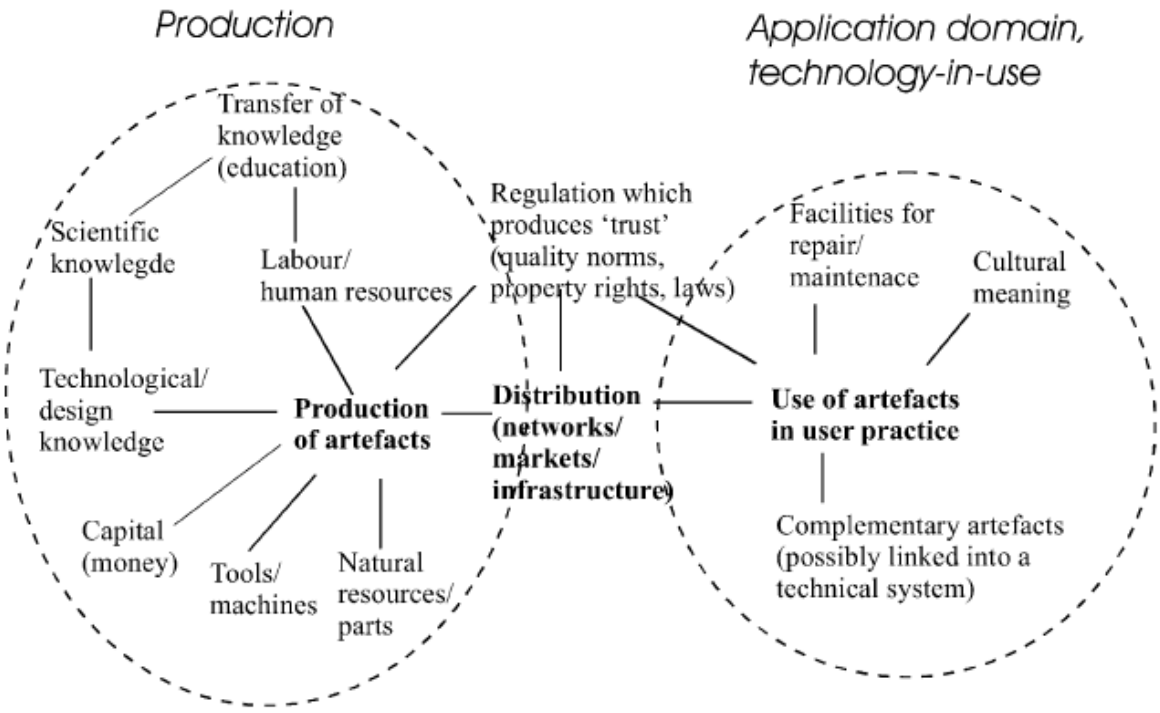

Figure 9: Basic elements and resources of ST-systems (Source: Geels 2002)

Buildings are also highly regulated, e.g. through building regulations, certification of builders' education, etc. and there are a great many actors involved in constructing, maintaining, occupying, improving and demolishing buildings, creating not only a market for buying and selling building components, materials and whole buildings, but also the infrastructure around buildings (such as routes of transport, electricity and water connections, waste disposal). While this implies that domestic buildings form a socio-technical system, it also implies that they are closely connected to a number of other socio-technical systems. They display all basic elements, features and resources of a socio-technical system as described by Geels (2002) and can therefore be considered one of many spaces where society and technology coevolve.

As discussed in the introductory chapter of this thesis, the current UK housing sector is predominantly made up of very old properties with poor energy efficiency ratings. This places the UK housing stock among the most unsustainable in Europe (Building Performance Institute Europe 2011) and means that it is responsible for roughly a quarter of the country's electricity consumption. This is in stark contrast with the UK's ambitious carbon reduction targets as well as social policies concerning fuel poverty and health, suggesting the importance of a transition of the housing ST-system towards greater sustainability. A socio-technical transition can certainly follow different pathways but for the UK housing sector one such transition path could focus on improving the existing building stock through low carbon retrofitting, particularly deep

retrofitting, as opposed to demolishing and rebuilding the most inefficient buildings (Power 2008) or in addition to focusing on decarbonising the energy supply system (Bolton & Foxon 2015a).

3.2.2. The concept of socio-technical transitions and the multi-level-perspective

Socio-technical systems have been described as heterogeneous configurations of multiple levels which include elements such as technology, regulation, user practices, markets, cultural meaning, infrastructure, maintenance networks, science and supply networks (Geels 2006a). As such, it can be argued that the majority of our lives are taking place within a multitude of overlapping socio-technical systems. These systems develop constantly, and their transitions are labelled as 'socio-technical' because they entail not only new technological developments but also changes in markets, user practices, policy and cultural meanings (Geels 2010). While there are multiple approaches to explain and analyse socio-technical systems and transitions, Geels' multi-level perspective (MLP) argues that they consist of three levels or hierarchies, creating a multi-level perspective on interactions between niche innovations and existing regimes, situated in a broader landscape environment (Verbong & Geels 2007). Those levels are called *landscape* or macro level, *regime* or meso level and *niche* or micro level.

The landscape constitutes the exogenous environment which is slowly changing and influencing the niches and regime dynamics (Verbong & Geels 2007). It encompasses various features, e.g. economic and political, which act together as 'selection pressures' for the regime (Smith et al. 2005). Landscapes are beyond the direct influence of actors and cannot be changed at will. Changes at the macro level occur either slowly (e.g. 50 year long-wave theories) or more rarely through dramatic events such as wars or crises (Geels 2006a).

The regime forms the meso-level and consists of three interlinked dimensions:

- Networks of actors and social groups (in this context, such as utility companies, DECC, industry and domestic clients); sharing
- Formative, normative and cognitive rules which guide the activities of actors (such as regulations, standards or laws); and
- Material and technical elements (such as infrastructure, power grid, power plants) (Verbong & Geels 2007; Genus & Coles 2008).

Genus & Coles (2008) describe a patchwork of regimes on the meso level, which consists of the technical/product regime, science regime, policy regime, socio-cultural regime and the users, markets and distribution networks regime, all of which are distinctive and autonomous from each other. Incumbent socio-technical regimes are characterised by path dependency and lock-in through vested interests among social networks, regulations and standards which may favour the status quo, and sunk investments into the existing structures and infrastructures (Verbong & Geels 2007; Genus & Coles 2008).

Finally, niches are the micro-level of a socio-technical system and are often considered to be the place where novelties and innovations emerge from. In this capacity, they often act as 'incubation rooms' or 'protected spaces' and may shield new technologies from the tougher market selection processes at the regime level (Verbong & Geels 2007). As with the regime level, niches rely heavily on social networks and social capital, which help to expedite learning processes.

The three levels together form the nested hierarchy of socio-technical systems (see Figure 10).

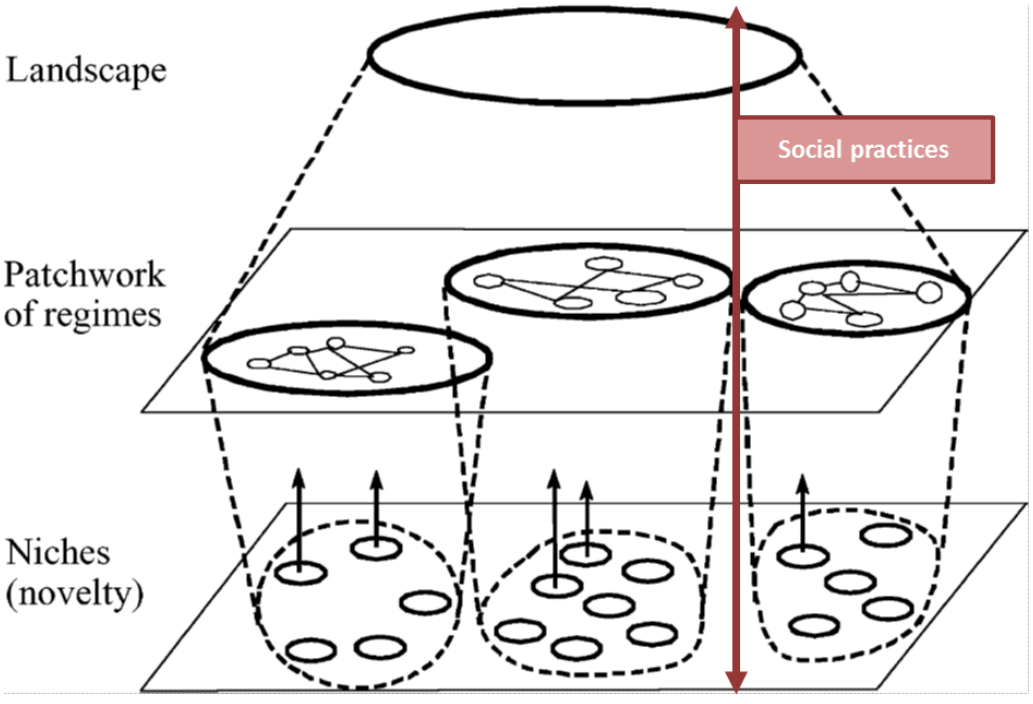

Figure 10: Multiple levels (landscape, regimes and niches) as a nested hierarchy. Integrated into the MLP are social practices, cutting across all three levels (adapted from Geels 2002)

Genus & Coles (2008) argue that socio-technical systems are most useful to analyse past transformational innovation and that the three separate levels are particularly suitable for explaining, e.g. the radical development of a novel technology, the diffusion of which

produces new sets of socio-technical relations and replaces existing social practice. Verbong & Geels (2007), however, established through historical studies that transitions tend only to come about when developments at all three levels link up and reinforce each other. Particularly the regime level accounts for the dynamic stability of socio-technical systems (Geels 2006b). For example, Unruh (2000) explains how existing socio-technical systems such as energy, transport, housing and agri-food systems are stabilised by lock-in mechanisms in the form of sunk investments, behavioural patterns, vested interests, infrastructure, subsidies and regulations. The respective industries are therefore deeply committed to the existing regimes and try to resist any destabilising changes to technologies and institutions (Turnheim & Geels 2012). This resistance can lead to inertia, which in turn may reduce an industry's ability to respond to external pressures and lead to performance problems which weaken the actors' and network's commitment to the regime. Once a socio-technical system shows signs of problems, it can trigger a transition through the emergence of innovation and the destabilisation of the incumbent regime (Genus & Coles 2008; Turnheim & Geels 2012).

Geels (2006b) differentiates between stable (closed and cold) and unstable (warm and fluid) networks and explains how stable regime networks allow for innovations to still occur. Yet these innovations are of an incremental nature, a continuation of on-going developments, and lead to deeper trajectories and path dependencies. He goes on to argue that stable networks can over time develop tensions and heat up to become unstable networks which may create windows of opportunity for the emergence and diffusion of radical innovations which are less predictable. The emergence of innovation can therefore be seen as a sign of and reaction to the problems of existing socio-technical regimes.

3.2.3. Strengths and criticisms of socio-technical transition theory

Socio-technical transitions are multi-dimensional phenomena which is why the multi-level perspective lends itself to the analysis of any number of different transitions by many different disciplines (Genus & Coles 2008). As a framework, the multi-level perspective avoids simplified causalities in the study of transitions (no simple cause or driver) (Geels 2006b). It is flexible enough to apply to many areas of transitions but unable to incorporate all social theories (Geels 2010). Smith et al.(2005) argued that the MLP should pay more attention to agency and the role of power in socio-technical transitions whereas Genus and Coles (2008) suggested a greater incorporation of constructivist approaches, such as the social construction of technology, actor-network theory and constructivist technology assessment. Furthermore, Safarzynska et al. (2012)

note that the "basic entities at each level are not clearly defined" making "their interpretation in empirical settings difficult" (p. 1020). Finally, and as discussed next, Shove and Walker took issue with the presumed dominance of MLP in the sustainable transitions discussion (2007a).

3.2.4. Social practice theory

Socio-technical transitions theory stresses the importance of social practices particularly in the regime and niche level interactions where the relations between consumers, producers and systems of provision are complex. Social practices are a combination of materials (objects, hard infrastructure), competences (skills, know-how) and images (ideas, meanings, interpretations) and are particularly useful because they bridge individual lifestyles and broader socio-technical systems of provision (Karvonen 2013). Shove and Walker (2010, p.472) also point out the value of social practice research as it considers "dynamic processes that are not much debated in the transitions literature and not adequately represented in the multi-level perspective". Social practices permeate every socio-technical system and can effectively be used to integrate the human factor into socio-technical transitions theory (see Figure 10). Treated as an isolated theory, however, social practice theory tends to look at the micro-scale and needs everyday routines of actors for its investigations. It thereby risks missing the bigger picture and struggles with problems like retrofitting as these are " often periodic and inconsistent rather than an everyday occurrence" (Karvonen 2013, p.569).

3.2.4.1. Application of social practice theory to retrofitting

Nevertheless, social practice theory is useful to understand why retrofitting does not always achieve projected outcomes in terms of carbon savings and energy reductions. Calculating carbon reductions for building retrofit activities is complex. While the numbers may seem plausible and achievable on paper, the practical application may yield less reduction than anticipated. Mostly, it has been suggested, this is to do with the way that retrofitting technologies or the retrofitted building itself is being used by its owners and occupiers. It is in such situations that social practice theory is particularly relevant if energy efficiency is to be achieved successfully. Aspects of social practices, such as competences, habits and cultural values, etc. can directly influence how people use their dwellings; and integration thereof into the design of the retrofit process may allow a higher emission reduction outcome. Karvonen (2013) explains that the social practice approach can be used as a flexible and people-centred approach in retrofit. It not only takes into consideration how a retrofit will actually be used in everyday life but

it also creates a positive association among building owners and occupiers and could therefore create support for a systemic retrofit transition.

Overall, there are several problems related to the current housing situation in the UK that need to be addressed, such as fuel poverty (Shortt & Rugkåsa 2007) and climate change (Department of Energy and Climate Change 2012b). This could imply that the socio-technical housing regime may be already heading towards a transition period. However, the system has been judged as being only in the early phases of destabilisation (Turnheim & Geels 2012). Once the social, political and economic pressures gradually increase, the incumbent system will likely start to abandon the existing inefficient housing regime and transition towards greener, more sustainable alternatives. However, without intervention, this transition might happen too slowly to feasibly achieve the 2050 sustainability targets and policy ambitions (Uihlein & Eder 2010). It might therefore be necessary to commit to a more proactive approach and aim to control and manage the low carbon transition of the UK housing sector.

3.2.5. Transitions management of socio-technical transitions

3.2.5.1. The concept

Within the area of transitions research, several branches have emerged in the last two decades – systems in transition, strategic niche and transition management and innovation systems (Safarzynska et al. 2012). In this section, we focus on transition management (TM) only, as a more active approach to domestic retrofitting seems more likely to achieve a low carbon transition of the UK housing sector within the ambitious timeframe of the country's policy framework and, more importantly, to minimise the negative impact of climate change on society and the planet in the long-term.

Smith et al. (2005) refer to processes which have been "deliberately intended and pursued from the outset to reflect an explicit set of societal expectations or interests" as purposive transitions, and observe that that these transitions are often guided by regime actors or networks of governance. Key is that the short-comings of the incumbent regime have led to a consensus about an alternative vision of the future, measures to put into place to get there and of societal objectives.

As such, TM is firmly rooted in the "traditions of system thinking which highlight the coevolution of the social and the technical and which seek to understand and analyse the emergence, transformation, and decay of sociotechnical systems" (Shove & Walker 2007a, p.763). A crucial part is the monitoring of the transition dynamics - the "different stages of a transition, the undercurrent and related seeds of transitional change, the

patterns, pathways, and mechanisms" (Rotmans & Kemp 2008), anticipating and countering risks, but also creating opportunities. While Genus and Coles (2008) observed that TM builds upon a view of transitions as a multi-level, multi-actor process, Lachman (2013) found that it is a reflexive and participative governance concept.

Rotmans and Kemp (2008, p.1006) describe TM as a "governance concept for exploring new paths in a reflexive manner, cyclical process of searching, experimenting, and learning". This is an immensely complex process and may allow for several paths to unfold simultaneously in several environments (Vergne & Durand 2010). Due to the openness of the TM governance concept, alternative paths are created and assessed against the consensus guiding vision on an ongoing basis. Lachman (2013) calls this monitoring, evaluating and improving. TM requires and allows actors' agency at every point – "giving them the capacity to do certain things and not others" – which also implies that uncertainty is inherent in the process (Garud et al. 2010). Garud explains that actors can shape an unfolding process in real-time, and while this may involve serendipitous events, this may not necessarily be considered as random but may be cultivated by the actors (ibid). TM therefore seeks to empower actors to "generate functionality and meaning from the unexpected" in pursuit of the common goal (Garud et al. 2010).

Rotmans and Kemp (2007) explain that control power is distributed over a multitude of actors with different resources and interests who are often referred to as 'transition managers'. Rather than managing the transition, however, they play a particular role in the transition process and are not all-powerful puppeteers. It is also stressed that despite the many differences of the transition actors, they are connected in many ways, not least by their common objectives. But while TM stresses the importance of non-regime and non-state actors, it has in the past often relied on robust state interventions (Smith et al. 2005). Nevertheless, TM requires the coordination of resources across a whole range of interdependent actors through processes of support and of acceptance (active or passive) to generate continuous consent to put change into practice (ibid).

3.2.5.2. Transitions Management Strengths

Rotmans and Kemp (2008, p.1006) consider the reflectiveness and openness of the concept as a major strength:

> *"By transforming the persistent problem into a visionary challenge, transition management explores a range of possible options and pathways, by carrying out a diversity of small-scale experiments. Based on what is learned from the*

transition experiments, the vision, agenda, and pathways are adjusted, if needed. Successful experiments are continued and can be scaled up; failed experiments are abandoned."

Finding a consensus guiding vision for a multitude of actors has to be the most attractive trait of TM, albeit also the most complex aspect to achieve. However, by exploring a number of transitional options at every step of the way, TM is not constrained by either the preferences of regime or niche actors but can focus on finding the most sustainable options and paths based on experimental learning. As it is a forward-looking and adaptive governance model for interactions between market, state and civil society (Kemp et al. 2007), it aims to take account of cultural, demographic, economic, environmental and technological aspects and is inclusive of many actors and groups, which in other forms of governance may be neglected (Genus & Coles 2008). TM also combines short-term action with long-term planning and is as such a complementation to conventional policy (Lachman 2013).

3.2.5.3. Transitions Management Criticism

There have been a number of concerns and criticisms voiced about TM. Lachman (2013) notes that TM may be very difficult to apply to practical examples and that there is so far no conclusive proof that the concept works as well as it promises. She continues that the focus seems to be on the management of the niche-regime dynamics rather than the actual transition and that there appears to be a bias towards incumbent regime actors in comparison to niche actors. This is also represented by a "lack of practices, models" which could help niche actors in their development.

Shove and Walker highlight a collection of issues in their 2007 commentary:

- The politics of various actors involved in TM may easily be obscured, conflicts and inequalities with the transition neglected, passiveness can be mistaken for consensus;
- The inclusion of all important agents of change is very difficult and actors change constantly along the transition pathway;
- There is a strong focus on the multi-level model, possibly at the expense of other theories of change;

- "outcomes of actions are unknowable, the system unsteerable, and the effects of deliberate intervention inherently unpredictable, and, ironically, it is this that sustains concepts of agency and management";
- TM does not sufficiently take into account actual social behaviour or patterns of demand;
- While TM aims to be inclusive and reflective, participatory measures and multi-stakeholder involvement are rarely unbiased but shaped by the incumbent system – the same applies to visions of the future that the incumbent regime should be transitioning towards;
- Politics can play a big role, knowingly or not;
- Opposing interests might be too much of an obstacle to successfully negotiate common goals and objectives (Shove & Walker 2007b).

Genus and Coles (2008) add that transition managers may not necessarily improve a transition – their intervention may in fact make things worse. This concurs with Vergne and Durand's observation that the selection of transition paths may lead to a transition trajectory, but it may not necessarily be an optimal one (2010). Shove and Walker (2007b) take this thought one step further and question how "those transitions which appear to be heading in exactly the opposite direction… `managed' by actors whose interests are not part of the consensus vision and whose `malignant' priorities lie elsewhere" are to be managed. Dealing with unsustainable transitions might require the engineering of the "death of undesirable systems", or as Garud (2010) puts it, their 'creative destruction'. TM literature, however, does not give any information on how this may be accomplished but notes that "every transition will involve winners and losers" (Rotmans & Kemp 2008, p.1008).

3.2.5.4. The Practical Application of Transitions Management

Particularly in Belgium and the Netherlands, transition management has been taken out of academic discussions and applied to a practical context in policy, e.g. in the areas of energy and water, meaning that some government-sponsored programmes have adopted methods of transition management (Rotmans & Kemp 2008; Shove & Walker 2007a). Loorbach and Rotmans (2010) investigated several case studies covering regional examples related to social services, citizen participation, unemployment, health and ageing, mobility, economic infrastructure, and ecosystem services, and that illustrate

”both the advantages and the difficulties of actually trying to manage transitions” (Loorbach & Rotmans 2010, p. 237).

3.2.6. Concluding section

With strong arguments both from proponents and disputants but with very few practical examples, the effectiveness and applicability of transition management for socio-technical systems changes has yet to be proven. “We still cannot answer unequivocally the question whether transition management really works” and yet there appears to be a continuing interest in the concept as “an attractive and useful model for governance towards sustainable development”(Rotmans & Kemp 2008, p.1010). Finally, it’s worth noting that “past transitions were not managed and modern transitions could be faster, but it still takes time to build new enthusiasm, infrastructure and institutions; to escape the shackles of path dependence; and to overcome ‘lock-in’ and turn over old capital stock” (Foxon et al. 2013, p.198).

3.3.The coevolutionary approach

While the MLP provides a good framework to analyse the context and setting within which a transition to a decarbonised domestic housing stock may occur, it has been criticised as retrospective and not precise enough (Lachman 2013). At the same time, it has significant potential to create an analytical link with other disciplines (ibid). As such, it can be usefully expanded by means of an additional framework which allows for more analytical precision as well as the option to take into account more immediate events and co-developments.

As already discussed earlier in this chapter, the socio-technical system of domestic buildings is a space where coevolution of society and technology occurs. Roelich (2014, p.30) explains co-evolution as "the pattern of evolutionary change of two systems interacting". As a coevolutionary socio-technical space, it may be useful to analyse the transition of the UK domestic building sector not only through a socio-technical model but also by means of a coevolutionary framework.

For the purpose of this research, it is felt that coevolution in socio-technical transitions is a valuable approach for looking at interactions between the system of governance and institutions and the system of finance and investment in the context of transitioning to a decarbonised domestic building stock. Safarzynska et al. argue that "evolutionary thinking [...] can offer a useful contribution to the emerging research on sustainability transitions" and provides a "framework for dealing with complex dynamic systems" (2012, p.1020). While governance and economic aspects of the low-carbon transition have been analysed independently in the academic and grey literature, a thorough analysis of the coevolutionary dynamic between the two has not found its place in the literature yet. Accordingly, and because the decarbonisation of the building stock is of long-term importance for achieving the UK and EU carbon reduction targets, this thesis focuses on the interactions between governance and finance and their combined impact on the low-carbon potential of the existing built environment. It suggests the combination of Geels' MLP and Foxon's coevolutionary framework, described below, to allow for the exploration of the current state of the transition as well as how governance and finance may coevolve as the transition progresses.

3.3.1. Evolution in transitions

Simmie and Martin (2010) see "adaptation and change" as key processes of the evolutionary perspective (p. 41). Safarzynska et al. add that evolutionary theories "can provide insight into the dynamics of transitions and their management" (Safarzynska et al., 2012, p.1011). They move on to explain that evolution in transition sees change as

brought about by variation, selection and differential replication. These three change processes are explained as "innovation leading to diversity in practices and technologies in the economy, competition, regulation and institutions as the main driver of selection reducing diversity in practices and technologies, and imitation as the main way practices and technologies are selectively replicated among actors" (ibid, p. 1012). In terms of the transition to a decarbonised domestic building stock, as set out earlier in this chapter, it can be argued that much of the niche-level innovation which created technological diversity, and as such variety, for domestic retrofitting has already taken place in previous decades. For a successful transition to a low-carbon housing stock it is now increasingly necessary to incentivise selection and replication of existing technologies to encourage wide-spread and systematic retrofitting across the existing building stock.

3.3.2. Foxon's coevolutionary framework

Foxon (2011) saw the lack of "economic variables that can significantly influence transitions and which are central to policy analyses" as a shortcoming of Geels' MLP (p. 2261.) At the same time, however, the problem of sustainable transitions cannot be examined purely from an economic perspective as mainstream economics tends to ignore the "complexity of systemic interactions and behavioural factors" as well as the "dependence of economies on natural resources and ecosystem services" (Foxon 2013, pp.126–127). Its focus tends to be more on markets, their equilibrium and stability of offer and demand (Dasgupta 2007) There are cases of 'market failure' which present themselves in the form of 'externalities' and knowledge-based flaws, i.e. insufficient knowledge to make efficient economic decisions or failure to sufficiently benefit from the creation of knowledge (Foxon & Pearson 2008). According to Foxon and Pearson (2008), these market failures are being responded to with innovation policy and environmental policy but without being able to "address adequately the challenge of promoting a transition to more sustainable systems" (p. 149).

Evolutionary economics then goes one step further and looks at incremental "economic change" (Geels 2005), seeing economies as dynamic systems rather than equilibriums. But investigating a complex transition such as the decarbonisation of the housing sector requires more complex methods and cannot be reduced to only economic factors. As discussed in an earlier chapter, transitions develop through the interactions or co-evolution of multiple actors, systems and levels; or, as Geels puts it, the "interplay between dynamics at multiple levels" (2006, p. 1004). Foxon et al. (2013) concur:

"Understanding and analysing transition pathways to a low-carbon economy requires a coevolutionary approach, combined with a multilevel framework, addressing interactions between macro, meso and micro levels." (p. 196)

Foxon identified the five "key coevolving systems relevant for analysis of a transition to a sustainable low carbon economy" as ecosystems, institutions, technologies, user practices and business strategies" (Foxon 2011, p. 2261).

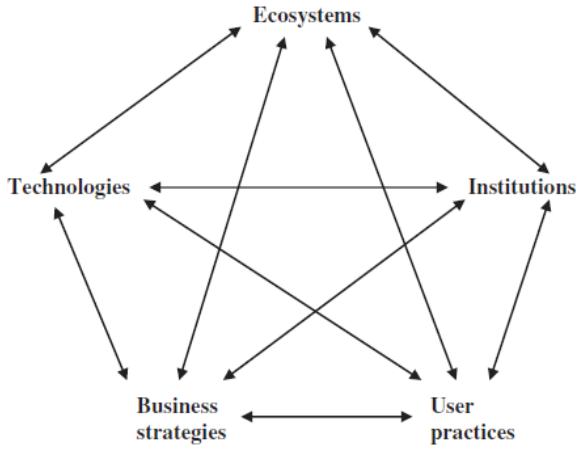

Figure 11: Foxon's coevolutionary framework (Foxon 2011)

He defined these systems as follows:

- Ecosystems: "systems of natural flows and interactions that maintain and enhance living systems";
- Technological systems: "systems of methods and designs for transforming matter, energy and information from one state to another in pursuit of a goal";
- Institutions: "ways of structuring human interactions";
- Business strategies: "means and processes by which firms organise their activities so as to fulfil their socio-economic purposes";
- User practices: "routinised, culturally embedded patterns of behaviour relating to fulfulling human needs and wants" (Foxon 2011, pp.2262–2263).

Foxon stresses that "any transition analysis should examine the evolution of each of these systems and their causal interactions" (p.2261). This supports Safarzynska et al.'s thinking who note the usefulness of evolutionary theories to rethink changes in transitions "in a more precise manner" (Safarzynska et al. 2012, p. 1020). The coevolutionary framework appears flexible enough to be applied to a multitude of socio-technical transitions while also providing the necessary precision and clear focus on the five most important systems that form part of a socio-technical transition in line with Geels' definition discussed earlier in the chapter. As Foxon (2011, p. 2262) points out, the framework "focuses attention on the causal influences between systems, and hence may give greater insight into how decisions made by policy-makers or other actors could

affect these influences, so as to promote evolution towards more sustainable, low-carbon systems".

The applicability of the coevolutionary approach has already been demonstrated elsewhere in the literature. Foxon's framework has been applied to various other fields of transitions research such as energy storage (Taylor et al. 2013), energy service companies (Hannon 2012), utility and infrastructure (Roelich 2014) and energy distribution networks (Bolton & Foxon 2015b). Moreover, it has also been usefully combined with other analytical frameworks (Hannon 2012, Roelich 2014). Most recently, the author has applied and tested the approach in the interdisciplinary area of fuel poverty (Grey et al. 2017).

Co-evolution has been described as a "seamless web" and "co-construction [...] emerging as an important concept in a range of disciplines" (Geels 2005, p. 60). The socio-technical system of domestic buildings is a space where not only coevolution of society and technology occurs but also of institutions. As a coevolutionary socio-technical space, it may be useful to analyse the transition of the UK domestic building sector not only through a socio-technical model such as the MLP, but also by means of a coevolutionary framework. Foxon (2011) saw the lack of "economic variables that can significantly influence transitions and which are central to policy analyses" as a shortcoming of Geels' MLP (p. 2261.) He identified the five "key coevolving systems relevant for analysis of a transition to a sustainable low carbon economy" as ecosystems, institutions, technologies, user practices and business strategies (p. 2261).

Foxon et al. (2013) go on to explain that "from a complexity perspective it is not necessary to understand the full extent of economic complexity; just sufficient insight is needed to design policies and remove barriers" (p. 201). This study analyses the coevolution of systems, namely ecosystem, business models, institutions and technology particularly for institutions (policy and regulations), ecosystems (sustainability) and end-users (domestic retrofitting) interactions.

3.3.3. The coevolutionary systems in this study

Foxon's framework was designed to be applicable to coevolution in a broad range of contexts and this study aims to apply it to the transition towards a decarbonised building stock. While Foxon provides definitions for the five coevolutionary systems in his framework, he cautions that "these are not definitive, but provide a starting point" (Foxon 2011, p.2262). Since this study is using Foxon's framework for a specific context, that of energy efficiency in the built environment, it makes sense to specify the

definitions of the five systems for the study context. The next section will go through each of Foxon's guideline definitions of the coevolutionary dimensions and explain how these have been adjusted for the study.

Foxon explains that natural *environments* are constrained by human techno-economic systems which directly rely on and draw from ecosystems. In the case of the built environment, the energy demand for heating, cooling, appliances etc., so essentially the use and functionality of the built environment still largely depends on high-carbon fossil fuels but is increasingly moving towards low carbon energy production such as from renewable energy sources. This meant that this system was most closely aligned with topics of carbon reduction and sustainability which helped code the interview transcripts. When applying the coevolutionary ecosystem dimension to the study, it meant that those sections of the interview transcripts were allocated the ecosystem dimension or parent coding node which have a strong sustainability and environment focus. In the transition to a decarbonised built environment, the ecosystem nodes would frequently cover topics of energy efficiency, carbon reduction and general sustainability.

A similar logic was applied to the *technology* system. Technologies which pursue the goal of decarbonising the built environment consist of building components as well as retrofitting approaches, with varying degrees of energy efficiency. It was also decided that technologies in the context of the study would cover building types such as new-built vs existing and different building structures such as detached, single dwelling vs multi-apartment blocks or private vs publicly owned buildings. As such, any sections of the interview transcripts from the case studies which fall under the above themes have been coded under the technology coding parent node and therefore the technology system of the coevolutionary framework.

Further, Foxon (2011) mentions that the coevolutionary system of *institutions* is often seen to include regulatory frameworks, property rights but also ways of organising human interactions. He brings up North's definition of institutions as "the rules of the game" which makes the institutions system rather difficult to frame. For the purpose of this study and the context of financial innovation in the built environment, the coding nodes referring to the institutions system cover two major areas of focus - policies and legislation, and governance. Governance in turn is allocated a number of child nodes around governance at the EU-level (supranational) as well as national, regional and local level governance. Choosing two case studies with different governance structures

highlighted the importance of these distinct governance levels for the understanding of low-carbon finance in the built environment, and will be further discussed in Chapter 5.

Foxon's framework also covers *business strategies* as a coevolutionary system. This system covers business aspects such as the delivery of goods and services to consumers but also profit and financial return. It is for this coevolutionary system that the thesis deviates most from Foxon's suggested definition of coevolutionary systems. While funding, particularly institutional funding could well have been allocated to the coevolutionary system of institutions, it seemed important to keep funding and finance separate from governance and policies to allow for a distinction and comparison of the two. Albeit not explicitly described by Foxon in such terms, finance and funding are logically related to profit and financial return and intuitively fits with the business strategies system. Low-carbon finance was therefore allocated to the business system which is also often referred to as the finance system throughout the thesis. As an illustration, in the coding tree in **Error! Reference source not found.**, the business strategies system is encompassed in the parent coding node of business which has two child nodes, business models and finance. There are two more layers of child nodes under the finance node which allows the distinction between private vs public funding as well as public funding from the supranational, national, regional and local level. The coding nodes relating to the business strategies system are the most diversified among the five coevolutionary systems.

The last of the coevolutionary systems in Foxon's framework are *user practices* which are also referred to as "culturally embedded patterns of behaviour" or "ways of meeting social needs" (p. 2263). Foxon makes the connection to the "study of sustainable consumption patterns" as mentioned by Ropke (2009, p.2463). In the thesis context of an energy efficient building stock, it was perceived that a great many social and societal factors influence sustainable consumption patterns and it was decided to broaden the systems definition to one that envelops societal aspects as a whole. As a consequence, the user practices system manifests in the transcript coding as the society parent coding node with child nodes such as education and information, political factors, and socio-economic factors. It was felt that these nodes would allow the coding of most factors which influence user practices towards or away from sustainable consumption patterns relating to the built environment. With the systems definitions of Foxon's coevolutionary framework adjusted to the study's research context, it becomes necessary to explore its fit with Geels' multi-level perspective.

3.3.4. A coevolutionary multi-level framework

Having ascertained the standing of both the MLP and the coevolutionary framework in the transitions literature, the next section aims to bring together Foxon's coevolutionary framework for analysing a transition to a sustainable low carbon economy (Foxon 2011) with the multi-level perspective (Geels 2002) to explore the inter-development between governance and finance within the overarching socio-technical system of the domestic built environment. It is argued that this approach could lead to insights into the mutual dynamics of both systems, which might usefully inform policies for an accelerated decarbonisation of the built environment. This analytical framework is deemed appropriate because coevolutionary models are considered "crucial for a complete understanding of transitions" (Safarzynska et al. 2012, p.1012) and, in combination with other approaches to sustainability transitions such as the multi-level perspective, "could be used to explore investment uncertainty in a more structured and coherent way" (Bolton & Foxon 2015a). This latter point is of course of high importance for a study with a focus on low carbon finance.

Complex systems can coevolve in a multitude of different ways and dynamics of inter-developments can emerge involving a multitude of different actors. As an example, Figure 12 shows the major actors operating within the domestic sector in the UK in line with the MLP's landscape, regime and niche level.

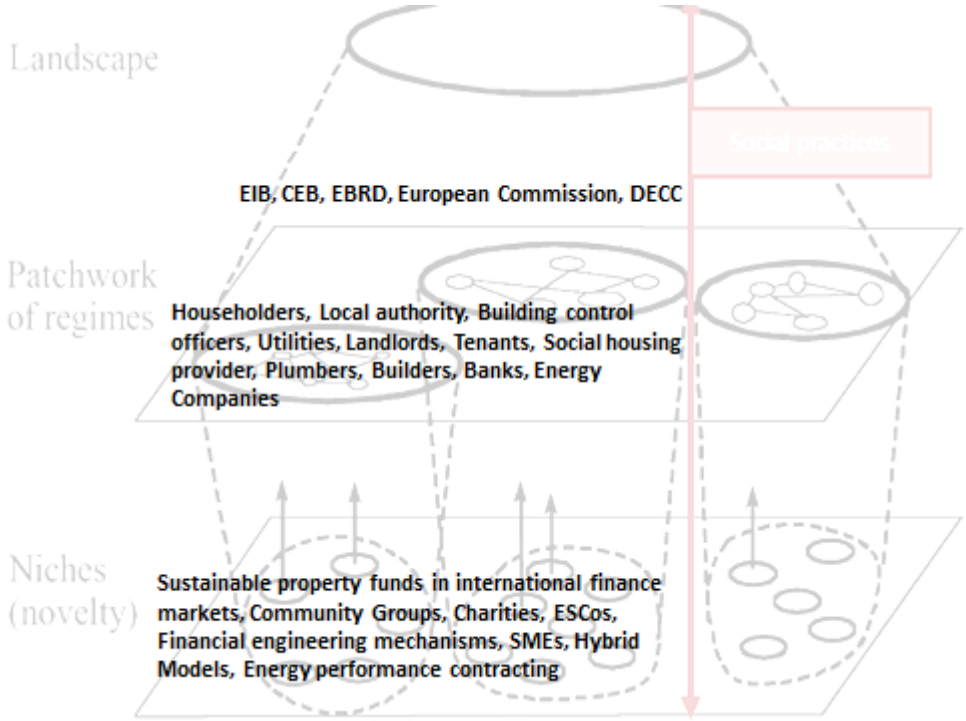

Figure 12: Actors allocated to each of the levels of the MLP for the UK domestic retrofitting context (Source: Own illustration, adapted from Geels 2002)

These cover a wide range of institutional, industry as well as private actors with varying degrees of direct and indirect impact on the transition to a decarbonised domestic building stock. Within the MLP, it is predominantly the regime and landscape level which impact technology selection for domestic retrofitting by means of policies and regulations but any number of actors across all three levels can interact and create a coevolving dynamic, supporting or hindering the transition.

According to Foxon et al. (2013), "understanding analysing transition pathways to a low-carbon economy requires a coevolutionary approach, combined with a multi-level framework, addressing interactions between macro, and micro levels" (p. 196). Figure 13 illustrates how this sentiment could be applied, integrating both concepts of socio-technical transitions and coevolution usefully into a grid. This would allow the researcher to allocate emerging patterns for case study drivers and barriers, aspects and features to the MLP's landscape, regime or niche level as well as the five coevolutionary systems; and as such show interactions of multiple systems across multiple levels, as well as the potential hindrance thereof.

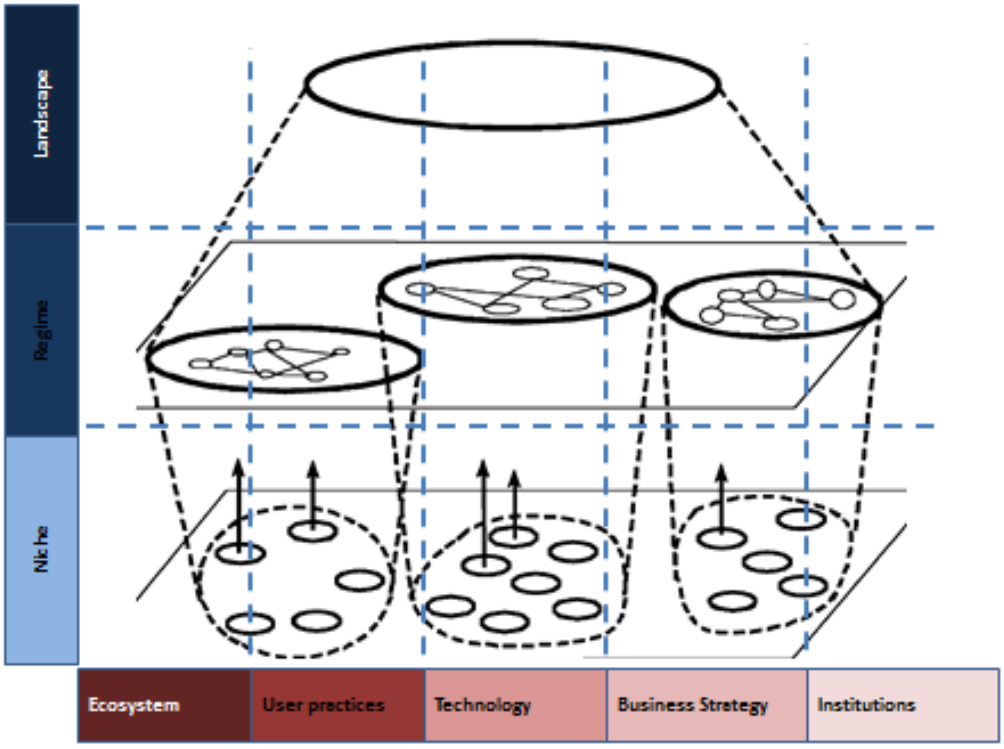

Figure 13: Combining the MLP with Foxon's five coevolutionary systems (Source: Own illustration based on Geels 2002 and Foxon 2011)

It should be noted that a related approach to the above hybrid framework features in Roelich's work (2014). The application of the above hybrid framework for analysis of the

qualitative data is discussed in more detail in Chapter 5 where it is applied to the qualitative data from the regional case study interviews.

In brief, once the semi-structured interviews have been transcribed, each is coded using Foxon's coevolutionary systems as coding nodes to identify and group together relevant actors and coevolving aspects of the respective case studies, in line with the levels of the MLP. This highlights dynamics within the socio-technical system of domestic retrofitting which directly or indirectly impact the transition to a low-carbon housing stock. This illustrates the value of integrating the approaches to create a grid of systems on the landscape, regime and niche levels, and allows for a visualisation of coevolving dynamics.

Not only does this approach highlight key actors which support and carry the transition forward, more importantly it allows for a visualisation of the interaction between governance (institutions, policies, regulations, etc.) and finance (funding, investment, organisations, etc.) within this socio-technical system. Once coding patterns emerge from the qualitative data, these can be emphasised and further explored within the hybrid framework, to determine trends and dominant factors for the transition. The hybrid framework is initially applied to each regional case study individually to draw out coevolving aspects within each region for in-depth intra case study analysis (K.M. Eisenhardt 1989). Once these patterns have been analysed for each case study, they are visualised within the framework to allow for inter case study analysis of these coevolving dynamics. This allows for a discussion of the coevolutionary dynamics initially within each individual case study and subsequently across all three case studies in the discussion chapter later on.

3.4.Concluding section

This chapter has established the context of the study within the field of sustainable transitions. It has also aimed to understand how both the multi-level perspective and the coevolutionary framework are positioned in the transitions literature. Initially the chapter framed domestic buildings and domestic retrofitting as a socio-technical system which is transitioning towards a low-carbon, sustainable building stock.

It has looked critically at socio-technical transitions and transitions management and how they can usefully complement each other if combined in a coevolutionary multi-level framework. This hybrid framework has proven itself to be a useful tool to analyse the transition to a low-carbon built environment. It can help with a structured analysis

of said socio-technical system and visualises patterns and factors which influence a transition at various levels.

Finally, the application of this hybrid framework for analysing the regional case studies has been described and illustrated. Its usefulness for visualising, drawing out patterns and coevolving dynamics has been established and will be further substantiated in the following chapter on data analysis.

4. Chapter - Method and data analysis

4.1.Chapter Overview

The research addresses low-carbon finance for energy efficiency measures in domestic retrofitting. More specifically, the research aims to provide an understanding of the impact of low-carbon finance as well as governance and legislation on the uptake and depth of domestic retrofitting. It explores both of these factors on two regional case studies in the EU: the city municipality of Maribor in Slovenia and the greater Chemnitz region in Saxony. It draws on these studies to offer recommendations for the UK.

This chapter explains the steps taken and the rationale of the research design for the study. It explains the research hypothesis (section 4.2), population and sampling (section 4.4), the data collection procedure (section 4.5) and instrumentation (section 4.7). It also discusses interdisciplinarity (section 4.3), limitations (section 4.8), assumptions (section 4.9) and the ethical assurances for the study (section 4.10).

4.2.Research Question, Hypotheses and Rationale

The nature of the research suggests a research question which is exploratory (open-ended) and ontological (capturing knowledge about participants' realities). The research started with the hypothesis that the availability of low-carbon funding increases the occurrence and depth of domestic retrofitting. The data collected during the first part of the study has since disproved part of this assumption but led to the strengthening of another. While the connection between governance and finance for the occurrence of domestic retrofitting has been obvious early on in this research, it has become clearer in the course of the study that this connection does not increase or decrease the uptake of domestic retrofitting but directly affects the depth of retrofitting achieved and thus the carbon-saving potential and the lifetime sustainability of the housing stock. This appears to be a significant finding.

4.2.1. Relevance of the hypothesis

The research fits into the overarching field of sustainability and climate change research. Within these are enormous fields of knowledge, some areas of which have received more focus and exploration than others. While low-carbon finance is an emerging and increasingly important area it has historically been underexplored and is only now starting to catch up with other areas such as renewable technologies or carbon trading schemes. Section 2.4 of the literature review chapter, "Finance and Institutional Measures" examines this developing area in more detail. The field of energy transitions

in itself is a mature and steadily progressing area of research and covers dimensions such as society, technology, governance, economics and a diverse set of others.

However, the majority of the opportunities connected to energy transitions is predicated on there being finance or funding. Often, this aspect is so obvious as to be overlooked. Finance is a basic part of the overarching transitions infrastructure, and increasingly a topic in the transitions literature (Lambe et al. 2015; Jones et al. 2013; Little et al. 2014; Bolton & Foxon 2015a). From the literature it also becomes obvious that "ongoing low-carbon investments will be required to maintain the lower carbon intensity of economic growth" (Colenbrander et al. 2015, p. 12). There is also somewhat of a consensus developing around the understanding that in order to sustainably transition to a low-carbon economy, a synergy of a multitude of factors is necessary, some of them being governance, funding, technology and information (BPIE 2011, BPIE 2013; Karvonen 2013). While all of these factors are important in themselves, it is fundamental to understand how they interact with each other and how this interaction progresses, or potentially hinders, a low-carbon transition. As Bolton & Foxon (2015) point out "questions of finance and investment have **not been an explicit focus** of this field of research to date" (p.166). As a direct consequence, the interrelation between finance and governance in low-carbon transitions, and more specifically in the transition to a low-carbon building stock has not been explicitly explored and presents an important research gap as has been concluded in the literature review chapter. This thesis aims to address this research gap.

4.3.Research Design

4.3.1. Interdisciplinarity

As the critical literature review has shown, low carbon finance for domestic retrofit is a complex topic touching on economics and governance, on energy efficiency, social practices and socio-technical transitions. Due to this varied and multi-faceted nature of the research topic, a methodology was chosen which can accommodate interdisciplinarity and allow exploration of the topic from various angles. Klein & Newell described interdisciplinarity as

> *"a process of answering a question, solving a problem, or addressing a topic that is too broad or complex to be dealt with adequately by a single discipline or profession and draws on disciplinary perspectives and integrates their insights through construction of a more comprehensive perspective"* (Klein & Newell 1997, pp.393–394).

Interdisciplinary work allows the researcher to "make connections and integrate information from multiple sources, and engage in effective ways of making decisions and solving complex problems" (Repko et al. 2014, p.3). It is an increasingly important approach for its "integration or synthesis of ideas and methods" (National Academy of Sciences et al. 2005, p.27), true to the idea that complex problems may require complex solutions.

4.3.2. Specific research method and appropriateness

For this project, is was decided to follow Perry and Bellamy's (2012) approach to "choose data collection methods that will enable us to collect data in a more open-ended fashion, to find out if any other factors are important" (p. 105). Consequently, the research is an empirical, inductive case-based study and "concerned with the generation rather than the testing of theories" (Bryman 2001, p.21).

The study uses case studies as the centre of its research design as described by Yin (1984) and Eisenhardt (1989). It adopts Eisenhardt's approach of "analysing within-case data" and "search for cross-case patterns" to make the findings stronger (pp.539-540).

Bryman (2001) explains empiricism as an approach in which ideas must be rigorously tested before they can be considered to have become knowledge. Qualitative research is seen as inductive and "concerned with the generation rather than the testing of theories" (Bryman 2001, p.21). The study followed a qualitative research design in the form of case studies, supplemented by a range of quantitative data. The research findings are based on data mostly derived from a combination of semi-structured interviews, visual illustrations of financing mechanisms and academic as well as grey literature.

Semi-structured interview refers to "a context in which the interviewer has a series of questions that are in the general form of an interview schedule but is able to vary the sequence of questions […] has some latitude to ask further questions in response to what are seen as significant replies" (Bryman 2001, p. 110).

Bryman describes semi-structured interviews as follows:

- An interview guide covers a list of questions or specific topics, the order of which is flexible;
- Interviewees have a lot of flexibility in how to respond;
- Additional questions can be asked on new things emerging in the interviews;

- "the emphasis must be on the how the interviewee frames and understands issues and events – that is, what the interviewee views as important in explaining and understanding events, patterns, and forms in behaviour" (Bryman 2001, p. 314).

Bryman points out that particularly for multiple-case study research, as is the case for this study, "some structure to ensure cross-case study comparability" is necessary (2001, p.315)

For an interdisciplinary study such as this one the research design must be flexible yet robust enough to generate reliable and repeatable data. Semi-structured interviews provide a guiding framework of questions which ensure that the same topics are covered in each interview. At the same time, the researcher is encouraged and free to expand on certain questions and increase the depth of answers provided if the opportunity presents itself in an interview context. Some interview participants have a much stronger knowledge and background in specific aspects/topics covered by the interview questions and can be explored with follow-up enquiries as the discussion unfolds. Often these situations present themselves unexpectedly and a flexible interview design allows the researcher to react to these ad-hoc. While there might be other suitable methods available, the researcher has significant experience with qualitative case study research and coding of qualitative interview data and transcripts. From past experiences, the applied method of qualitative case study research produces solid data sets with an often unexpected range and depth of information. This data can then be analysed using the approach described in the analytical framework chapter (Chapter 3) and the data analysis chapter (Chapter 5).

4.4.Population and Sample

The study aimed to collect data from a range of institutional and private interviewees which had either specific knowledge of low-carbon finance and governance in relation to domestic retrofitting, or previously benefitted from either in a personal capacity. Governance, legislation and funding were key criteria when finding and selecting institutional interviewees and have also been explored in the interviews with householders, albeit householders were not chosen based on their perceived knowledge or expertise in these areas. Table 3 shows the interviews for both case studies.

Table 3: Interviewees by case study

Case study		Interviewees	Date	Quotation key
Slovenia	1.	Senior Manager Energy Agency Podravje (Energap)	18/08/2014 In person	**1**
	2.	Regulatory and Legal Specialist Energap	19/08/2014 In person	**12**
	3.	Sustainable Transport Specialist Energap	20/08/2014 In person	Not quoted
	4.	Senior staff member Energap	21/08/2014 In person	**4**
	5.	Senior staff member Energap	22/08/2014 In person	**7**
	6.	Manager European Projects Office Municipality of Maribor	25/08/2014 In person	Not quoted
	7.	3 Planning specialists, 1 Manager Spatial Planning Department, Municipality of Maribor	26/08/2014 In person	**10**
	8.	Leading manager EKO Sklad	27/08/2014 In person	Not quoted
	9.	2 Senior Analysts EKO Sklad	27/08/2014 In person	**2**
	10.	Senior lecturer Architecture department, University of Maribor	28/08/2014 In person	**5**
	11.	Senior Manager Energap	28/08/2014 In person	**9**
Germany	12.	Senior energy specialist SAENA Energy Agency of Saxony	18/12/2014 In person	**1**
	13.	Department head Macro Economy and honorary professor Kreditbank fuer Wiederaufbau KFW	06/11/2015 By phone	**3**
	14.	Department head energy policy Deutsche Umwelthilfe - German environmental charity	09/11/2015 By phone	**2**
	15.	2 policy advisor, division energy efficiency Umweltbundesamt - German Ministry of the environment	10/11/2015 By phone	**5**
	16.	Department Passive house sales FASA AG	10/11/2015 By phone	**4**
	17.	Energy and policy advisor, division Promotion of Energy Efficiency in the Building Sector, German Ministry of Economy and Energy	12/11/2015 By phone	**6**
Germany		*Homeowner interviews for back ground information – recorded but not analysed*		
	18.	*2 private homeowners, married couple* *Chemnitz*	*02/01/2015* *In person*	
	19.	*2 private homeowners, married couple* *Chemnitz*	*02/01/2015* *In person*	
	20.	*Private homeowner* *Chemnitz*	*05/01/2015* *In person*	
	21.	*Private homeowner* *Frankenberg*	*06/01/2015* *In person*	
	22.	*Private tenant, aspiring homeowner* *Chemnitz*	*12/01/2015* *In person*	
	23.	*Private homeowner* *Dresden*	*24/01/2016* *In person*	
United Kingdom	24.	Professor of Sustainable Futures in the Built Environment, University of Reading	13/11/2013 In person	

Where interview respondents have been directly quoted, this is indicated in the quotation key column in Table 3. It should be noted that not all interviewees have been quoted in the thesis and so only the quoted interviewees have been given a number. While some interviews made pertinent comments which would have been ideal for inclusion in the thesis, some of these had previously featured in a published conference paper which led to their exclusion from the relevant thesis chapters. However, the content of these quotes went into the data analysis and case study narratives. The quotation key numbers for the interviewees are in order of analysis of the interviews and so are not chronologically aligned with the dates of data collection. The quotation key for the Slovenian interviewees run from 1 to 12, despite there having been conducted only 11 interviews. This is due to the researcher having recorded and analysed, but not quoted, a brief interview snippet with an interviewee after the original interview took place which had been counted in the analysis software and so takes the quotation key number above the 11 interviews for Slovenia. The quotation key numbers for the German interviewees run from 1 to 6.

For the purpose of this study, a representative set of members of the general population was not needed. Participants were rather chosen based on their particular knowledge, expertise or experience around low-carbon funding, energy efficiency and retrofitting or homeownership. Initially, participation was split between employees of institutional organisations and private homeowners, namely the providers and infrastructure and the beneficiaries of low-carbon finance. An overview of all study participants is provided in Table 3. No further personal data about the participants is captured in the data analysis tool although additional details may be included in the respective transcripts if provided during the recording.

While the researcher strived for a balance in interview participants in terms of home owners and institutional participants, this has proven difficult across the two case studies. Mainly this has been down to language barriers and time limitations for the Slovenia case study where it was not possible to find homeowners to interview within the 2 week data collection period. Instead, the researcher made use of the network of contacts of the regional energy agency which was hosting the research visit to access a number of institutional organisations. As shown in Table 3, these institutions included the regional energy agency itself, the national eco-fund, the departments for spatial planning and the European projects office of the Municipality and the architecture department of the University of Maribor. While no recorded interviews were conducted with homeowners in Slovenia, the 2 week stay in the country provided many

opportunities to connect with colleagues in the host organisation and learn more about life and culture in the region in an informal way as well as connect with a small number of inhabitants of Maribor. Hospitality is an important part of the Slovenians' culture and the researcher benefitted from this through social weekend activities and after-hour dinners, the conversations of which contributed to the tacit and explicit background information for the study, albeit none of it being formally recorded. These informal conversation covered topics ranging from the importance of property ownership and the financial burden to achieve this to inertia towards energy efficiency in the population and institutions to the problem of black market activities and institutional corruption. Despite the lack of Slovenian homeowner interviews, it is felt that these informal conversations went some way to fill this gap.

In the Germany case study, contacting homeowners turned out to be much simpler, mostly because the researcher was able to use their own pre-existing network of contacts in the area. It should be noted, however, that the German homeowner interviews did not form part of the data analysis. This was due to there not being an equivalent set of homeowner interviews for the Slovenia case study and therefore a lack of comparable data. Nevertheless, the German homeowner data provided invaluable background information for the research and some of the findings from the German homeowner interviews are summarised in Appendix 3 for information.

Contacting institutional participants, however, proved much harder since any potential interviewees had to be contacted individually which often led to being 'handed around' departments and institutions, taking up a lot of time and resource with frequently no interview outcome. Germany's institutions have a strong culture of gate-keeping and it is often only possible to successfully access relevant interviewees by means of introduction through a mutually known third party.

4.4.1. Interview protocol

The study established two interview protocols – one for institutional and non-homeowner interviewees and one for homeowners. The interviews were structured into a number of questions. These were adapted to the case studies and whether the interviews where focused on gathering institutional or non-institutional data.

The interview protocol contained an initial question on the interviewee's background and connection to energy efficiency in the built environment. It covered a set of question around energy efficiency policy in the respective case study country and the interviewee's knowledge thereof. This included some reflection on the regional and local

government levels' involvement. The list of questions also covered a set of questions around perceived barriers to and enablers for energy efficiency in domestic buildings. This led on to a number of questions around institutional funding for energy efficiency in buildings. The interviews were brought to a close with a snowball question on recommended relevant organisations or persons which might contribute to the data collection.

The institutional interview protocols for the Slovenia and Germany case studies are attached as Appendix 4.

4.4.2. Interview participation

The number of interviews per case study ranged initially between 10 and 15. This number was chosen because it was seen to be sufficient to deliver a manageable data set that achieves the aim of the study while being commensurate with the resources available for the study. The study does not aim to achieve statistically significant numbers of responses but seeks to derive a qualitative depth from the semi-structured interview conversations in terms of governance, legislation and funding impacts.

The number of interviews conducted generated more than 20 recording hours and a wealth of qualitative data. This data was analysed and coded in NVivo, specialist software for analysing qualitative data. It is a useful tool for transcribing audio files and coding interview text. It allows the researcher to work on several steps of the analysis process in parallel, keep mental notes and thoughts in the same file and mark and comment on text freely. It offers code selection on existing nodes, increasing coding consistency, or in vivo, allowing the definition of new nodes if a new theme emerges. It can be used for separate coding of the same text for greater robustness of the analysis. "A reliable system of measurement of coding is *consistent* in that, each time it is used on the same data, it yields the same measure or code"(Perry 6 & Bellamy 2012, p.21). Once the interviews have been transcribed and coded, NVivo enables the researcher to compare and contrast coding nodes easily. As such, it facilitates the process of qualitative interview analysis throughout the research.

The data was coded to show where areas of several predefined themes or parent nodes, namely in finance, governance and technology interact or co-evolve. The coding tree for the data analysis with the coding themes based on Foxon's coevolutionary framework has been discussed in the analytical framework chapter 4 of this thesis under section 4.4.3 "Making coevolution visible".

The data collected during this study has successfully highlighted areas of such interdevelopment, often showing similar co-evolution across slightly different contexts. It is judged likely that further data collection would only solidify these findings but not generate any new observations and as such would need a large amount of resources for very little additional benefits to the study. Increasing the number of participants would likely provide repetitive responses and repetitive coding themes that have already been explored. Thus, the existing number of interviews and interviewees for each case study is deemed sufficient and adequate.

4.4.3. Making coevolution visible

As this study investigates the interactions between Foxon's coevolutionary systems, a useful approach to take may be to make coevolution visible in the interview data. To this end an important first step for a coevolutionary analysis of the case study data was finding a suitable tool to draw out any patterns in the data. While this could have been done manually, it was found that specialised software applications offer significant time savings and some analytical advantages for data analysis. The next section discusses the software which was chosen for the data analysis and its application in the study.

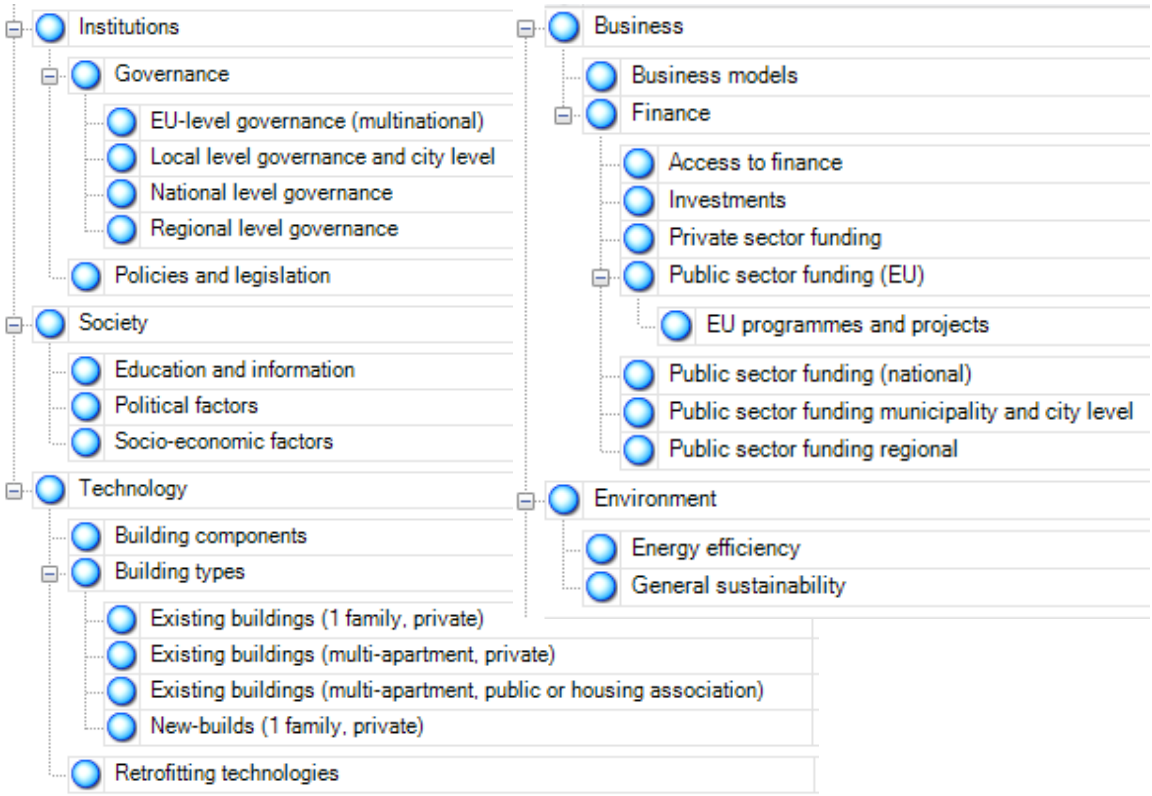

Figure 14: NVivo coding tree (Source: Own image in NVivo)

NVivo, a qualitative data analysis software, was used for transcribing and coding the interview data. Drawing on qualitative data from fieldwork interviews, local documents

and other secondary sources concerned with the socio-technical system of the built environment, an initial coding tree with a number of parent and child nodes was set up in NVivo. Figure 14 shows the structure of the analytical framework applied to the interview data, forming the coding tree.

The coding tree is the practical application of the five coevolutionary systems in the analysis of the data. It guides the thinking and analysis of the case study research. In Figure 15 the coevolutionary systems were used to inform the coding of the qualitative data collected in the Slovenia case study. An in vivo coding approach was used to allow for relevant and major themes to emerge from the text during the coding process, and subsequently become integrated as new coding nodes. Whenever new nodes of coding emerged in the text, these were allocated to a particular coevolutionary parent node. Upon completion of coding, each parent and child node was then analysed in terms of coded sections of text and emerging patterns which were cross-compared and formulated into research findings.

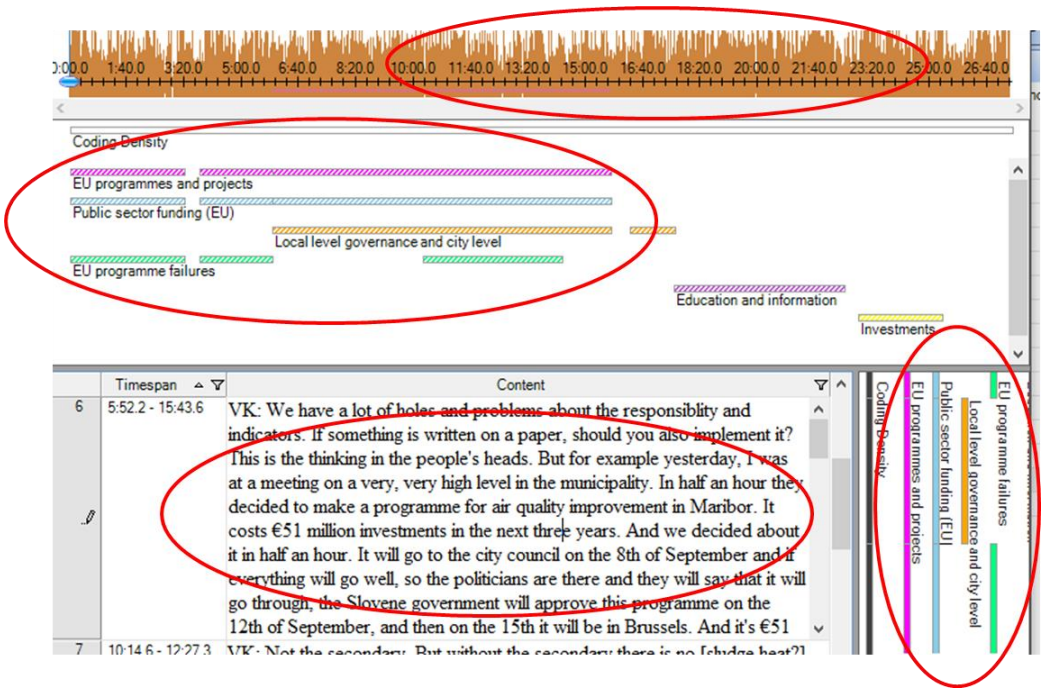

Figure 15: Example of in vivo coding of case study interview data. The audio recording is at the top of the image and the transcription on the bottom. The coloured bars show the coding themes and can highlight possible patterns of coevolution emerging.

Figure 15 illustrates the coding process with NVivo. On the top of the image, it shows the audio data from the recorded interviews. At the bottom it shows the transcribed interview text. The red circles across the image show the coding. When progressing through the text during the coding process, the nodes in the coding tree provide the

coding structure. The coding then leads to parts of the text being coded in different nodes, showing different strands of coding emerging in parallel. This step shows themes and patterns emerging from the text and illustrates how different themes, such as governance and finance for instance, might be influencing and coevolving with each other.

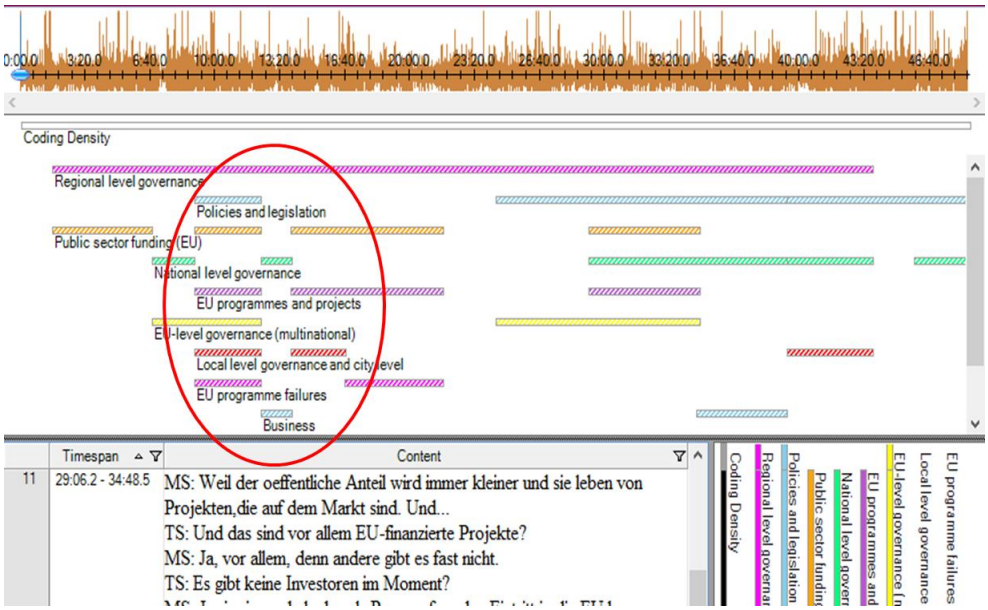

Figure 16: Further illustration of multiple coding themes and possible patterns emerging from the text (Source: Own image from NVivo)

Figure 16 is an example of a part of an interview with a number of coding topics or themes overlapping. The coevolutionary approach makes the coding of information-dense pieces of text much more structured and allows identification of themes and possible patterns which are emerging from the text, such as governance and finance in the above example. While not all the nodes imply coevolving systems, it can be an indication of such if the same pattern repeats consistently.

Applying this framework to the case study data has helped develop a deeper understanding of the case studies and has shown the emergence of governance, finance and technology as key factors impacting on the decarbonisation of the built environment in Slovenia and Germany. Applying a coevolutionary multi-level perspective has illustrated how governance and finance interact across different levels and have a direct impact on the sustainability performance of domestic retrofits. The emerging results also show that the lack of an administrative regional governance level can be an obstacle for the effective transposition of EU energy efficiency policy and its translation to useful energy efficiency programmes in the built environment at the local level. As will be seen in Chapter 5, not only does the absence of a regional administrative

level appear to have an impact on Slovenia accessing and allocating funding from EU programmes, but also on the quality and energy efficiency performance of the projects which are built through the support of this funding. An in-depth discussion of the case study findings is provided in the data analysis chapter, Chapter 6.

As mentioned earlier in the chapter, the hybrid analytical hybrid framework has been usefully applied by the author to research on fuel poverty (Grey et al., 2017) and has been published in a conference paper presenting initial findings of the Slovenia case study (Schmieder-Gaite 2016).

4.4.4. Case study methodology in Slovenia

A 12-day fieldtrip to the municipality of Maribor in Slovenia allowed the recording of semi-structured interviews with a number of energy experts, academics, civil servants and senior public sector managers (see Table 3). All of the interviewees were national and regional actors who are directly involved with energy efficiency and spatial planning in Maribor and sustainability funding in Slovenia. The interviews were based on a predefined starting list of open-ended questions on energy efficiency, retrofitting, legislation and governance as well as funding and investment. As noted in Chapter 4.10, the project and data collection were approved by the Research Ethics Committee of the Welsh School of Architecture at Cardiff University and all respondents were asked to sign a consent form before the interviews.

The audio recordings of the interviews were transcribed into text, which was analysed with the NVivo software for qualitative data analysis. NVivo allowed coding the transcripts in line with Foxon's five co-evolutionary systems of environment, institutions, technology, business and society (Foxon 2011).

The study benefitted from an EU-funded COST Action Short-term Scientific Mission (STSM) Award which funded the field work and data collection in Slovenia. The COST Action STSM also provided the initial contact with the regional energy agency of the Podravje in the municipality of Maribor (Energap) which acted as the host organisation for the STSM and the data collection. Energap is a "generator of development, ideas and projects in the area of efficient use of energy, renewable energy sources and sustainable mobility in the Podravje region" (Energap 2018) and a strong promoter of energy efficiency in the build environment in Maribor. Energap facilitated the majority of the data collection in Slovenia by providing access to its network of institutional contacts and by sharing its expertise, experience and time for the benefit of this study.

Several practical challenges were encountered during the STSM, one of which was the language barrier in both written and spoken communication. While the national language is Slovene, the majority of the population speaks English and several other European languages. This allowed for all interviews to be recorded in either the English or German language of which all interviewees had an exceptional command. However, many of the Slovenian government websites and official documents as well as academic and grey literature articles are only available in Slovene or occasionally partially translated into English. The articles and chapters available in English are often related to, and focus on, particular EU-funded programmes and there are a limited number of academic articles published in international journals. The findings in chapter 5.1 are therefore predominantly based on the qualitative data extracted from the interviews.

4.4.5. Case study methodology in Germany

The data collection in Germany took place between November 2014 and January 2016 in several stages. Apart from the length of time spent in this case study region, the Germany data collection also differed from the Slovenia data collection in that it aimed to collect data both from institutional respondents as well as private homeowners. Beyond this, it followed the same research procedures including the consent process as described in Chapter 4.4.2, similar to the Slovenia fieldwork. The German interviews were transcribed and analysed as set out in Chapter 3 using Foxon's coevolutionary framework (2011) . The Germany case study was not affected by any language challenges as the data was collected in German language of which the author of this thesis is a native speaker. All research documents including the introduction to the research, the research questions and the consent forms were translated from English into German before the start of the Germany fieldwork. All German interviews were recorded in German language and then transcribed and translated by the researcher. The researcher does not claim professional translation skills and the translation therefore needs to be highlighted as a limitation of the study as inaccuracies are possible. It is unlikely, though, that the researcher has erroneously and grossly mistranslated the original phrasing due to a decade of bilingual academic and professional language competencies. All of the original German wording is copied into the footnotes.

The German case study was based on primary data from six in-depth semi-structured institutional interviews and secondary data from published sources in journals, books and newspapers, etc. The interviews covered one non-governmental organisation (NGO), one business, one institutional funding body and two ministries over a combined 182 minutes or just over 3 hours. All of the interviewed parties have strong

competencies relating to energy efficiency policy and legislation, low-carbon finance or domestic retrofitting and kindly agreed to share their knowledge and expertise for the study. The interviewees were selected based on their knowledge and experience and expertise around energy efficiency, governance and low-carbon finance in the built environment in Germany and Saxony and as members of institutional organisations which influence the energy efficiency in the build environment. An initial conversation was held with a supervisor's institutional contact in Germany who recommended a number of institutions and individuals within these institutions as potential interview partners. These organisations and individuals were then contacted and either interviewed when available and appropriate for the study, or used as a starting point for snowballing the selection of further individuals within these organisations.

4.4.6. Sampling technique and recruitment

This study uses the convenience sampling technique. In Bryman's Social Research Methods (2004) convenience sampling is defined as "a sample that is selected because of its availability to the researcher. It is a form of non-probability sample" (p.538). While this implies that "some units in the population are more likely to be selected than others" (ibid, p. 541) this in fact is beneficial to the overall research since it is concerned with a distinctive set of research participants. While this sampling technique does not allow for a generalisation of findings across a population as would a form of probability sampling, this is also not the aim of the research.

In addition to convenience sampling, the study also applied snowball sampling where possible. Once a relevant interview participant had been identified and questioned, the last part of the interview included a question about any other individuals or organisations which the interviewee felt might provide useful information for the study. As Bryman (2004) describes it, "the researcher makes initial contact with a small group of people who are relevant to the research topic and then uses these to establish contacts with other" (p. 100). This approach was very useful in both the Slovenia and Germany case study since it often alleviated the 'gate keeper' problem of accessing experts and organisations. Being able to give the name of the person who recommended a potential interviewee often made them more amenable to spending some of their time answering interview questions and strengthened the research's perceived credibility for future interviewees.

Both the convenience and the snowball sampling were judged appropriate for the available time and resources and relative size of this study. The have proved a time-

economic and cost-effective way of accessing an appropriate number of interviewees and have been successful across two separate case study geographies and cultures.

If resources and time had been more generous, the researcher would also have considered a questionnaire for homeowners across both regions, and in the future this might be a useful approach to gather statistically relevant data on the topic. It might also be a useful addition to the existing data to triangulate and make the findings more robust.

4.5.Data Processing and Procedure

Details on the data processing, data analysis, coding and themes are explained in detail in Chapter 3 on the analytical framework.

In chronological order, the data collection followed the procedural steps set out below.

Table 4: Data collection procedure in chronological order

Identification
• Web search • Discussion with supervisors and other academics • Check of researcher's own social network
Contact
• Send email • Call • Explain research • Request participation • Arrange interview time and date • If not inclined, ask for substitute contact
Interview
• Introductions • Information about the research • Consent form • Recording - Questions and responses • Snowball contacts • Thank you and goodbye
Follow-up
• Thanks for participation • Follow-up and clarification questions where necessary
Data storage
Transcription and analysis

4.6.Quality Assurance

4.6.1. Credibility, dependability and confirmability

The data collected from the interviews seem to be supported by the existing literature, where available. Beyond published literature, there is also the factor of personal conversations. Neither in Slovenia nor in Germany did the researcher encounter any

individuals with significantly contradictory experiences or stories. The researcher acknowledges, however, that personal interactions would be limited to a small circle of non-representative individuals. Beyond literature and personal observations, it becomes exceedingly difficult to determine whether data and findings truly reflect participants' experiences.

The research methods and procedures of this study are robust enough to allow a replication of the study with similar findings and results. The strongest changing variable is time since political, economic and regulatory situations within case study regions can change significantly inside of a few years. The study was undertaken at a point when the impacts of the financial crisis were strongly felt particularly in the Slovenian region of Podravje. It is expected that the region would recover particularly economically over the next decade.

Findings from this research would be confirmable by talking to other participants in the same case study regions and by cross-checking with secondary literature which focused on the issues of energy efficiency, regional governance and policies and low-carbon finance. There are also broader trends within each of these research areas individually which would allow other researchers to reach similar conclusions to the findings of this study.

4.7.Instrumentation

4.7.1. Content, number and adequacy of questions

It was decided during the course of the data collection to have two sets of interview questions – one for institutional interviewees and one for private homeowners. The reasoning was that institutions as the providers of low-carbon funding would have a very different knowledge about policy and governance than homeowners who would be able to provide much stronger input into practical issues around receiving and benefitting from such funding for domestic retrofitting. There was still a large overlap between both sets of questions around regional policies and energy efficiency as a whole.

Each interview started with the same list of questions. These questions were, however, starting points and varying amounts of time were spent on different questions depending on the expertise and inclination of the interviewee. Frequently, a number of questions were comprehensively answered within one response and so those already answered questions were not brought up in that particular interview.

Either set of interviews would start with an introductory question about the interviewee covering their background and involvement with low-carbon finance and domestic retrofitting. Other common questions covered the perceived barriers and enablers for domestic retrofitting and the availability and efficacy of low-carbon finance for domestic retrofitting.

The initial set of interview questions was developed in English for the institutional interviews in Slovenia and covered 13 questions. These were directly translated into German for the institutional interviews in Germany. All of the Slovenian interviews were done in English apart from one which used German. All the German interviews were held in German. Following the preparation of the interview questions for institutional respondents, a separate set of interview questions for homeowners was compiled in German covering 17 questions. In both sets of interview questions the most important 'must-get' questions were marked in bold script and the researcher took great care to cover these early on in the conversation to avoid the risk of incomplete interviews in case the meeting ended prematurely. This level of risk management seemed prudent considering that some of the institutional interviewees were working towards tight schedules and prone to ad-hoc meetings on urgent issues. Luckily, none of these interruptions happened during face-to-face meetings. However, phone interviews generally were completed much more quickly and with less verbal meandering of the interviewees than the interviews which were conducted in person, and so this strategy was particularly useful for these circumstances.

The choice of using semi-structured interviews with open-ended questions and prompters where needed proved invaluable in generating large sets of qualitative data. Once they had agreed to have an interview, the interviewees were often happy to talk at length about the topic and area and frequently shared information beyond what was asked in the interview questions. While this was hugely helpful in broadening the researcher's background knowledge in the research topic it also led to lengthy interview recordings of up to 2 hours per session. This seemed to be particularly the case for the interviews with homeowners who, due to the convenience sampling technique where the researcher already knew most of the interviewees personally, were happy to respond at length. In hindsight, a more stringent approach to avoiding interviewees going off topic might have been helpful in limiting the effort which was subsequently needed for transcriptions and data analysis.

4.8.Limitations

Some of the limitations of this study are methodological and some are environmental. In terms of the methodology, choosing convenience sampling was not necessarily a strategic but rather an opportunistic decision. Some of the issues with this have been mentioned above. In addition, convenience sampling which was used both for the Slovenia as well as for the German homeowner interviews may limit the research participants mostly to those who are readily accessible for the study, such as direct acquaintances or indirect acquaintances, e.g. friends or colleagues of friends or colleagues. This might hold the risk of never accessing specific holders of expertise or experience who may be outside the reach of the study's network. While this risk is particularly big for convenience sampling, it must be said that this is also a risk in any other form of sampling since inertia to respond to research invitations and information gaps as to where to find and how to access said knowledge holders may also lead to gaps in the participants landscape.

Another methodology-related limitation could be that semi-structured interviews have a unique structure and dynamic each time. Transcripts of interviews are therefore not directly comparable and it would be difficult to test repeatability of the study by undertaking the same interviews with the same participants based on the same questions template – the interviews are likely to take a different dynamic and yield slightly different responses, although overall information and data should be similar.

In terms of environmental limitations, meaning limitations caused by the research environment, one of the disadvantages of collecting data abroad might be that foreign populations are difficult to follow up with if there are ever any questions about specific responses. There are also language barriers and possible translation errors, particularly if the research is conducted in an intermediary foreign language like English if that is a second language to both the interviewee and the interviewer. For this particular study, the researcher was a native speaker of German and proficient in English. While this simplified the data collection in Germany, it also meant that many of the interviews were conducted and analysed in German and a significant part of the data had to be translated into English. It also meant that most interviews in Slovenia were conducted in a second language to both the interviewees and the interviewer. Particularly for the Slovenian interviewees this occasionally led to initial inhibition and a 'warming-up' stage at the start of the interviews. While the majority of the Slovenian interviewees have an outstanding command of English, the study terminology was quite specific and it was felt that this in rare instances put a strain on communication.

One final limitation specific to this study was the limited funding for the Slovenia case study. While the researcher is grateful for the generous COST Action Short-term scientific research grant, the funding did not allow for a data collection period longer than 2 weeks which would have been immensely valuable to generate further interviews through snowball sampling. Timeframes sadly did not allow for this.

4.9.Assumptions

Assumptions made for this study to be valid include truthful and honest participants' response and a fairly stable governance and legislative regime in both case study countries. At the time of writing this is still the case both for the governance and funding landscape in either country as both countries are still EU members and as such operate under the EU's policy umbrella. On the issue of participants' responses no obvious falsehoods or exaggerations have been detected in the data and it is unlikely that any of the respondents had any reason to falsify any of their responses. In the case of the German institutional interviews, this is because much of the information provided would be possible to cross-check with the institution's own publications and with public media. In terms of the German householder interviews, the respondents were mostly known to the interviewer before the time of recording and so were their energy efficiency situations and opinions. The Slovenian interviewees mentioned several times that they seldom felt heard, that their experiences and opinions mattered since Slovenia is such a small country, and they wanted to share their experiences and opinions for the study.

4.10. Ethical Assurances

The research proposal was assessed and approved by the Ethical Approval Committee at the Welsh School of Architecture at Cardiff University. Risk assessments were completed and approved before each round of data collection. The researcher prepared a consent form in English (Slovenia) and German (Germany + 1 interview in Slovenia) which explained the research and requested permission to interview and record the participants. These consent forms were signed by participants before the interviews. A copy of a consent form is shown in Appendix 1. Whenever interviews were conducted via telephone, consent forms were previously sent to the interviewee and permission to interview and record was requested before the interview started and again at the beginning of the interview to capture the response on the audio recording.

The consent form agrees to treat all responses anonymously. Anonymity is created through the coding process. While all interviews are stored in the qualitative data

analysis under the name and organisation of the participant, it is only the researcher who can access this data. Further analysis of the transcription is undertaken without names or identifiers beyond generic terms, e.g. 'senior manager in a public funding body' or 'energy expert at an NGO' for instance.

Wherever participants have explicitly given information to the researcher in confidence, which happened surprisingly frequently, this information is only used to inform the background knowledge of the researcher and will not be cited in this research. It should be mentioned that the nature of the semi-structured interviews gave complete control to the participants over their narrative and the amount and depth of information they wished to disclose. They have the option to void any of the information provided and withdraw from the study at any point as stated on the consent form.

The level of care taken regarding data protection, confidentiality and anonymity concerns seemed very beneficial for the study. Most of the participants seemed to feel at ease to disclose information much beyond what was asked in the questions, including even some commercially and personally sensitive information which the researcher agreed to not include in the study.

4.11. Concluding section

The methodology chapter provided further insight into the rationale and relevance for addressing the research gap of governance and funding in the transition to a low-carbon building stock. It explained the approach, how and why the interview participants were chosen and gave further insight into the case study design, including sampling. The research steps and procedures are listed in chronological order. Ethical issues and quality assurance matters were equally addressed in this chapter as the possible limitations and assumptions to the study.

In conclusion, Chapter 4 of this thesis has described the hypothesis, the main rationale, research methods, interview participants, means and approach to data collection, quality assurance, limitations as well as the approach to data processing of this research study. Chapter 5 follows on from there by examining the research findings through *within-case* and *cross-case* analysis.

5. Chapter – Case study research

This chapter provides details and findings from the case study research in Germany and Slovenia. It is divided into three sections. Section 1 discusses the Slovenia case study and analyses the respective within-case data, section 2 discusses the Germany case study and its intra-case analysis, and section 3 presents the findings of the cross-case analysis between the case studies.

Concerning why Slovenia and Germany have been chosen for this comparative case study research, there are several reasons, some of these very practical ones. Both case studies allowed for the data to be collected in languages familiar to the researcher. They present a mixture of familiar and unfamiliar environments for the researcher as well as an element of serendipity in available research funding for the Slovenia case study under the COST Action Smart Energy Regions. Both countries are member states of the EU and therefore subject to the same supranational policies. Both member states have administrative systems which are distinctly different to each other. They joined the EU in different decades and are at different points in their respective sustainability journey. The case study regions Podravje and Saxony are different in size, demography and located in different parts of the European continent which suggests that they have different climatic situations also. Particularly because of their differences in governance they can serve as examples and comparisons of how EU policies are transposed in different member states. They offer examples of the regional and local dimensions of EU energy efficiency policy but also of the funding structures which are in place to support policy objectives. Overall, the case studies are alike yet different enough to make for an interesting and moreover robust comparison of a number of factors relevant for an energy efficient built environment.

5.1. Case Study 1 - Local governance and low-carbon investment in the built environment in Slovenia

This case study chapter discusses the first of the two case studies in the thesis. After a general introduction to the case study country, it focuses in more detail on the case study region before presenting the major findings from the interview data. The data is structured along the coevolutionary systems of the analytical framework as set out in Chapter 3. Initially, the qualitative data is presented through quotes taken from the interview transcripts complemented by commentary. Latterly, the coevolutionary systems are visualised through parallel coding themes, complemented by further commentary, before the first case study is concluded in the final part of this chapter.

5.1.1. Introduction to the Slovenia case study

Since the 2015 UN Framework Conference on Climate Change in Paris, low carbon finance and investment has been given a prominent place within the suite of strategies and mechanisms to minimise climate change. It is no surprise then that the study of governance and climate finance interactions is an emerging area in the literature (Rozenberg et al. 2012; Bolton & Foxon 2015a; Buchner et al. 2014). Despite this, the research area has as until recently received little attention with regards to describing its characteristics, boundaries and outline nor giving it a clear definition (Fenton 2015).

The recent Paris Agreement adds another significant layer to the international policy framework on climate change. At the European level, these kinds of policies are developed into directives, such as on carbon reduction, renewable energy and energy efficiency, forming an umbrella policy landscape which member states proceed to transpose into national law and align with their own climate change targets (EC 2015). An illustration of this policy umbrella is shown in Chapter 2. As such, these European policies aim to achieve a standardised approach to energy efficiency in the built environment across Europe but need to be flexible enough to work around a diverse range of member states with their own unique governance settings and structures. Standardisation, while well intended, is difficult to make compatible with diversity.

The Municipality of Maribor (MOM) in Slovenia was chosen as the first case study for this thesis The Podravje region in Slovenia works as an example of how local governance structures can have an impact on a country's potential to achieve its own and European climate change targets. The focus of this case study is on low carbon funding to decarbonise the built environment and the transposition of European policies in Slovenia to the local level.

5.1.2. Slovenia and the Podravje region

Slovenia is a former part of Yugoslavia and became an independent nation state in 1991. It is officially known as the Republic of Slovenia. In 2004, it was the first transition country to join the European Union (EU) and it subsequently joined the Eurozone in 2007, replacing the Slovene currency Tolar with the Euro. Slovenia is one of the smallest member states in the EU, with a population of only 2 million inhabitants of which approximately 75% live in urban areas (Lindstrom 2005). It is also an economically well-developed country and per capita the richest nation of the Slavic countries. Since its independence, Slovenia's governance structure has been described as "highly centralized, with no pre-existing regional administrative level" (Lindstrom, 2005, p. 1). The country is divided in 211 municipalities which act as "basic administrative units of

local autonomy" and this municipality-focused approach has led to a "tradition of regionalism and local self-government" (Sitar & Krmelj 2014, p.241) but is also "often described as highly polycentric" (Peterlin & Kreitmayer McKenzie 2007, p.456).

In 2013, Slovenia imported 47% of its total energy needs and met 22% with renewables (StatSlovenia 2014). Its domestic electricity production stems mainly from nuclear, thermal and hydro sources (International Energy Agency 2012) but with large rivers running through its abundant woodland landscapes, it could cover much of its demand through hydro power and has a significant potential for wooden biomass as an energy source (Sitar & Krmelj 2014). The 2013 energy demand for domestic space heating was in fact sourced at 52% from wood fuel, followed by 17% from fuel oil and 13% natural gas (StatSlovenia 2014).

According to the National Statistics Office of Slovenia, the country's debt more than tripled to 70% of its GDP between 2007 and 2013 (StatSlovenia, 2014). At the time of the data collection in 2014 many EU member states were starting to recover from the financial crisis of 2008. Slovenia, however, was still "struggling, both economically with a lack of investments and budget cuts in the public sector, a high rate of bankruptcy in the private sector and high unemployment figures" (Schmieder-Gaite 2016).

5.1.3. The Podravje region and the Municipality of Maribor

After the capital Ljubljana, the Municipality of Maribor is the second-biggest city in Slovenia with approx. 115,000 inhabitants. Maribor lies north-east in the statistical region Podravje at the foot of the southern-most Alps. One of Slovenia's major rivers, the Drava, runs through it. With a long heating period of on average 227 days annually, energy consumption is of a high concern to the municipality (Sitar and Krmelj 2014, p. 242).

Most buildings in the municipality are domestic buildings (**Error! Reference source not found.**) which means that particularly the residential sector takes up the highest share of 40% of the municipality's energy consumption in comparison to 24% on average in the rest of the EU. This could indicate that energy efficiency in domestic buildings should be a high priority in Maribor. While 47.5% of the

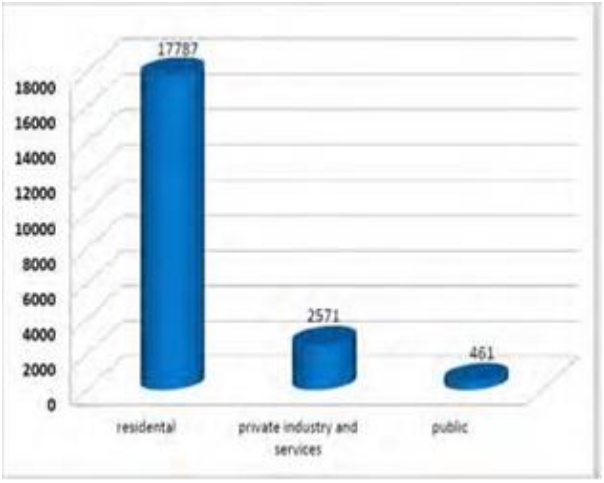

Figure 17: Number and type of buildings in the Municipality of Maribor 2010 (Source: Sitar and Krmelj 2014, p. 246)

municipality's electricity stems from thermal power plants, 24.2% from nuclear, 20.9% from hydro and 1.7% from photovoltaic energy sources (International Energy Agency, 2012), the municipality has a significant "additional potential for solar and wooden biomass energy as well as geothermal energy" (Sitar and Krmelj 2014, p. 243). As a result, the municipality has taken significant steps to embed sustainability and energy efficiency into its governance and policy framework (Schmieder-Gaite 2016).

5.1.4. Slovenia's housing stock

Most of Slovenia's building stock was erected before the year 2000. There are a total of 857,000 domestic buildings in Slovenia in 2013. As **Error! Reference source not found.** shows, most of these buildings were built between 1961-1970 (14%), 1971-1980 (21%) and 1981-1990 (17%) (StatSlovenia 2014). A large proportion of the domestic buildings in Slovenia are therefore older than 30 years and would likely benefit from energy efficiency improvements to reduce carbon. Cirman et al. (2012) found that the large majority of these buildings, namely 71%, have never been retrofitted. In addition, the general trend in the country goes towards private homeownership with 92% of dwellings owned by natural persons, and only 5.6% of dwellings owned by the public sector in 2011 (StatSlovenia 2013). Sitar et al. (2009) observed similarly an increase of privately-owned homes between 1991 and 2002 from 67% to 92% (2009) with 78% of these privately-owned properties owner-occupied (StatSlovenia 2013).

	Number	%
Total	**844,656**	**100.0**
Before 1919	121,955	14.4
1919–1945	57,973	6.9
1946–1960	80,827	9.6
1961–1970	122,353	14.5
1971–1980	176,521	20.8
1981–1990	146,825	17.4
1991–2000	64,743	7.7
2001–2005	31,500	3.7
2006+	41,959	5.0

Figure 18: Dwellings by period of construction in 2011 (Source: StatSlovenia 2013, p.44)

The neglect of retrofitting of the existing building stock is visible in Slovenia's construction sector. While the majority of all construction activity in Slovenia is on residential buildings rather than non-housing, 75% of this activity focuses on new-builds and only 10% on the retrofitting and maintenance of existing buildings (Sitar et al. 2009). This is a relatively small proportion compared to other countries. Germany, for instance focused 25% of its residential construction activity on new construction volume and 75% on existing residential buildings in 2011 (Gornig et al. 2018, p.6). In the same year, "refurbishing and improving the existing built stock accounts for about half of this

total", meaning 50% of overall construction activity in the UK (Cabinet Office 2011, p.5). The reason Slovenia's construction sector is not more active in existing buildings could be due to a range of barriers and obstacles to retrofitting. Most of these barriers are not unique to Slovenia, but prevalent; notably a lack of evaluable data on housing issues (Sitar and Krmelj 2014), issues of mixed or fragmented ownership and housing management problems in multi-dwelling buildings (Sitar and Krmelj 2014, Cirman et al. 2012, Nieboer et al. 2011), insufficient awareness and information on retrofitting (Sitar and Krmelj 2014) as well as a lack of funding and a limited financial capacity of owners and tenants (Sitar and Krmelj 2014, Cirman et al. 2012, Nieboer et al. 2011). Both the fragmented ownership and the lack of finance have been described as the main barriers to domestic retrofit in Slovenia (Cirman et al. 2012, Nieboer et al. 2011) and pose "serious obstacles to implementing an energy efficiency policy" (Nieboer et al. 2011, p.4)

As discussed in the literature review in Chapter 2, issues of finance and funding can be seen as a more general obstacle to energy efficiency and retrofitting. In Slovenia, however, this financial barrier is presented most strongly in "the difficulty to cover upfront costs (Nieboer et al.2011, p. 11). The issue of fragmented ownership on the other hand is predominant in Slovenia due to the large proportion of multi-dwelling buildings. The management of these requires all tenants and owners to mutually agree to any measures done to the building but the often high number of actors involved frequently causes significant transaction costs to reach a consensus (Olson, 1965). Nieboer et al. agree that the "mobilisation of stakeholders" and "collective action of individual tenants is crucial" (Nieboer et al. 2011, pp. 4 and 8) but also that it requires "intensive communication to get commitment" (Nieboer et al. 2011, p. 8). However, it is important that this communication is continued "throughout and after the improvements have taken place to prevent counter-effective behaviour of individuals" (Nieboer et al. 2011, p. 10).

5.1.5. Case study methodology

A 12-day fieldtrip to the municipality of Maribor in Slovenia allowed the recording of semi-structured interviews with 14 energy experts, academics, civil servants and senior public sector managers. All of the interviewees were national and regional actors who are directly involved with energy efficiency and spatial planning in Maribor and sustainability funding in Slovenia. The interviews were based on a predefined starting list of open-ended questions on energy efficiency, retrofitting, legislation and governance as well as funding and investment. As noted in Chapter 4, the project and data collection were approved by the Research Ethics Committee of the Welsh School of

Architecture at Cardiff University and all respondents were asked to sign a consent form before the interviews.

The audio recordings of the interviews were transcribed into text, which was analysed with the NVivo software for qualitative data analysis. NVivo allowed coding the transcripts in line with Foxon's five co-evolutionary systems of environment, institutions, technology, business and society (Foxon 2011). As explained earlier in this thesis, Foxon's coevolutionary framework serves as the analytical framework for this research and led to the development of a coding tree with parent and child nodes. The coding illustrated the presence of patterns across the co-evolutionary systems in the parent nodes and made visible the mutual development and interaction of seemingly unconnected issues and topics across the interview transcripts. The coding visualisations are discussed in a later part of this chapter.

The study benefitted from a COST Action Short-term Scientific Mission (STSM) Award which funded the field work and data collection in Slovenia. The COST Action STSM also provided the initial contact with the regional energy agency of the Podravje in the municipality of Maribor (Energap) which acted as the host organisation for the STSM and the data collection. Energap is a "generator of development, ideas and projects in the area of efficient use of energy, renewable energy sources and sustainable mobility in the Podravje region" (Energap 2018) and a strong promoter of energy efficiency in the build environment in Maribor. Energap facilitated the majority of the data collection in Slovenia by providing access to its network of institutional contacts and by sharing its expertise, experience and time for the benefit of this study.

Several practical challenges were encountered during the STSM, one of which was the language barrier in both written and spoken communication. While the national language is Slovene, the majority of the population speaks English and several other European languages. This allowed for all interviews to be recorded in either the English or German language of which all interviewees had an exceptional command. However, many of the Slovenian government websites and official documents as well as academic and grey literature articles are only available in Slovene or occasionally partially translated into English. The articles and chapters available in English are often related to, and focus on, particular EU-funded programmes and there are a limited number of academic articles published in international journals. The findings in this chapter are therefore predominantly based on the qualitative data extracted from the interviews.

5.1.6. Word frequency analysis in the interview transcripts

While having in-depth interviews around the topic of low-carbon finance and governance in domestic retrofitting has helped identifying a number of themes and issues in this field, it can also be illuminating to look at the words that are used most frequently in these conversations. Figure 19 illustrates these.

Figure 19: Word cloud of the most frequently used words in the Slovenia case study data (Source: Own illustration)

The Slovenian interviewees focused their discussion a lot around energy which is the most frequently used word in the transcripts. Energy is followed by the terms people and public. The transcripts also show a frequent use of the terms buildings, money, municipality and government which follow close behind. There are also strong occurrences of words such as efficiency, households, investments, improvement, national and European and Maribor. Further, respondents spoke about problems, consumptions, different and special, ministry and state, loans and heating, funds, system, directive. It is a positive indication that the most frequently used words include energy, people, buildings and money, implying that the interviewees understood the research topic and provided relevant responses.

The Slovenian word frequencies will be compared to the most frequently used words of German respondents in the case study comparison chapter.

5.1.7. Coevolutionary themes in the case study data

As mentioned in the analytical framework discussion in Chapter 3 and the methodology section of this case study in section 5.1.5 above, the data analysis is based on Foxon's coevolutionary systems as previously described. Since these five systems which double as parent nodes, provide only a broad way of categorising topics and issues, it made

sense to develop child nodes under each parent node. These child nodes emerged naturally during the data analysis process as themes and conversation topics and were in vivo allocated to the parent nodes. Some child nodes have child nodes of their own. All the parent nodes and child nodes together create the coding tree. For the purpose of this next section, the child nodes are referred to as themes since some of them can be child nodes of child nodes. It is important to note that child nodes have no varying degrees of importance. They are simply connected by logic. The next section of this chapter discusses the most relevant themes that have emerged from the data of the Maribor case study.

5.1.8. Low-carbon Funding

This theme falls under the business and finance coevolutionary system. It covers finance and funding at the private and public level. For the latter it considers funding at various governance levels such as the European, the national, the regional and the local level. It is also concerned with the impact of funding and finance on the built environment in general and domestic retrofitting in particular. More technical aspects of both are discussed in more detail under the Technology system and its child nodes and themes.

5.1.8.1. Low carbon funding at European and the national level

In 2016, Slovenia contributed 0.32% to the overall European Union budget (Statista 2018). This translated to a contribution of EUR339.52 million to EU budget (European Commission 2017). As a point of reference, Slovenia's overall GDP was EUR40.4 billion in 2016. In the same year, Slovenia received EUR544.88 million in funding from the European Union. Overall, this means that the EU is a significant funding provider for the country through its Structural and Investment Funds[3] Particularly during its recovery from the financial crisis, these funds were important for Slovenia as national institutional funding was significantly reduced during this period as part of the government's austerity measures. During and in the aftermath of the global financial crisis and at the time of data collection in 2014, Slovenia was struggling with high numbers of bankruptcy in the private sector, leading to high levels of unemployment. The government's austerity measures not only affected the national government but also municipalities on the local level which were also unable to provide funding for energy efficiency.

[3] The European Structural and Investment Funds combine 5 EU funds – European Regional Development Fund (ERDF), European Social Fund (ESF), Cohesion Fund (CF), European Agricultural Fund for Rural Development (EAFRD) and the European Maritime and Fisheries Fund (EMFF).

"We need to source money from other sources, not just from our country or the municipality, because the municipality is also not in good standing for money." 1

This emphasised the EU's importance as a funder for energy efficiency in the country. Ironically, Slovenia could be eligible for even bigger amounts of EU money from the ERDF funds for low income housing but since it had "no well-defined national housing strategy" it makes itself ineligible for these (Cirman et al. 2012, p. 203). Nevertheless, Slovenia has benefitted from EU funding for sustainability and energy efficiency-related programmes and projects some of which were very ambitious. It became apparent that some of those projects were not reaching their predicted potential or were failing to achieve the agreed funding targets in terms of energy efficiency, carbon reductions or economic growth. Unsuccessful programme results carry a risk of being seen as failure and an inappropriate use of EU funding by the funding body. As was explained by an interviewee, were the EU programme audits to find fault with those projects, this could lead the EU to withholding further funding and even potentially claw-back some of the funding:

"We've already lost €200 million! Because of bad reporting and not achieving what we promised. They stopped paying out €405 million and now after 7 months only €185 million was left to Slovenia and they are saying that the other €200 million will not reach Slovenia anymore, so we will have to pay ourselves. But it is even worse because we will have to pay back I think. I know the EU rules very well, and it is not a systems that says "if you have not worked well, just leave it, you won't get more money but we will forget about your faults." No, they won't. We will have to report and give the money back." 1

Beyond the European funding, Slovenia has set up a dedicated sustainability focused national funding body. The EKO Sklad (ECO Fund) with its headquarters in Ljubljana is the most important financial institution for the funding of energy efficiency measures in Slovenia. EKO Sklad describes itself as:

"...a public fund which means that we are state-owned but we are also the largest state-owned institution that specialises in financing environmental projects. We do that with various mechanisms such as granting soft loans with favourable subsidised interest rates, we grant non-repayable subsidies, we also raise awareness in the area of environment as well as financing of

energy counselling offices that are spread throughout Slovenia which are free of charge for households. And this is all done with the aim of financing investments in environmental projects, energy efficiency, renewable energy projects in private-public companies as well as municipalities and primarily households." 2

EKO Sklad reports directly to the Ministry of Agriculture and Environment and is governed by a supervisory board consisting of the Ministries of Agriculture and the Environment, of Infrastructure and Spatial Planning and of Finance as shown in Figure 20.

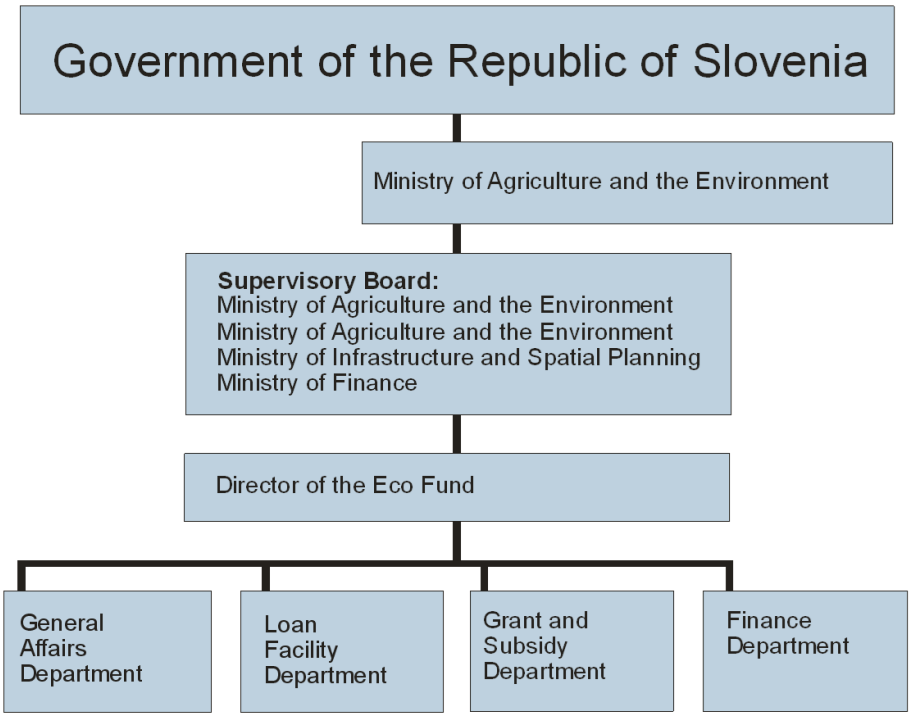

Figure 20: Governance and organisation chart of EKO Sklad (Source: EKO Sklad 2014)

The two main funding giving departments of the EKO Sklad are the Loan Facility Department and the Grant and Subsidy Department. Funding is allocated in the form of preferential loans and grants and new funding calls are published annually.

Being a national funding body, EKO Sklad is active throughout Slovenia but residential applications for grants and responding approvals are disproportionally distributed across the country.

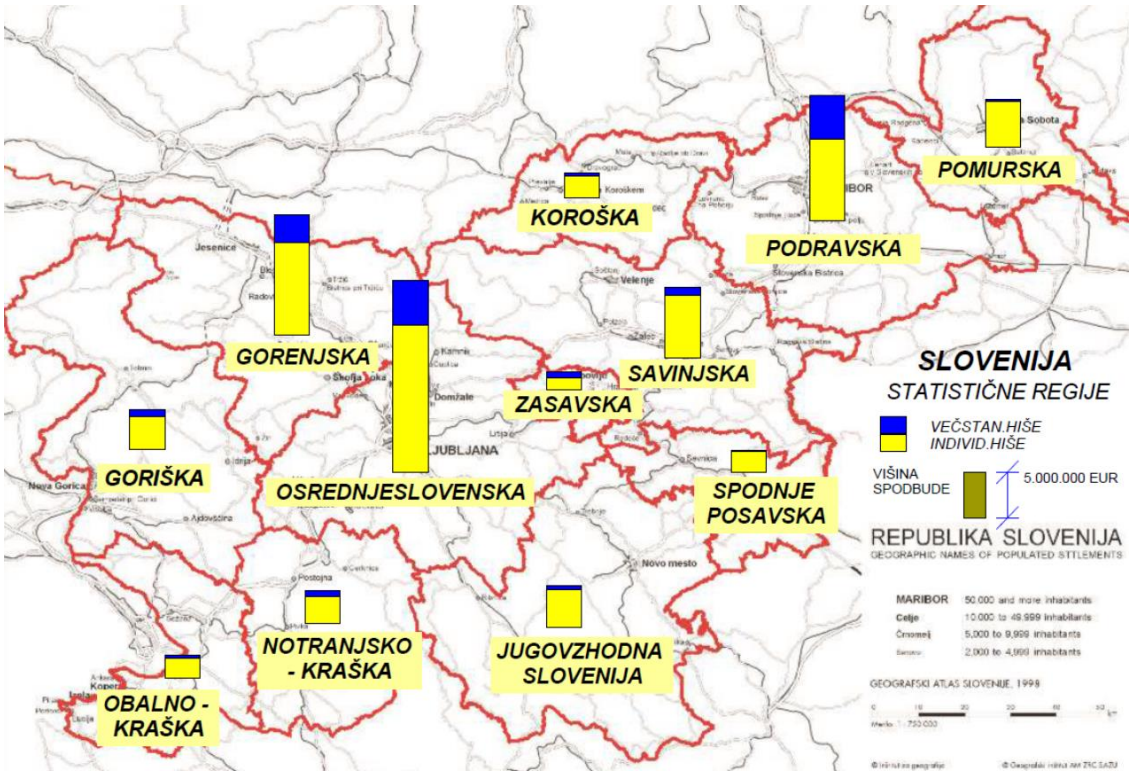

Figure 21: Regional distribution of EKO Sklad grants approved 2008-2013 for residential buildings (Source: EKO Sklad 2014)

As becomes apparent from Figure 21, the majority of grants go to the capital Ljubljana and surrounding region which counts as the most affluent part of the country. The case study region Podravska with Maribor is receiving the second largest grant funding but with a markedly higher proportion for multi-apartment buildings (blue part of bar) than single dwelling properties (yellow part of the bar).

According to their own statements, EKO Sklad granted approx. 16,500 loans from 1995-2013 with a total value of approx. EUR 459 million for the purposes of air pollution reduction, efficient use of energy, use of renewable energy sources, waste and waste water management, water supply and noise reduction. Most of the loans went towards corporate bodies but of the proportion of loans going to households are split up in Figure 22.

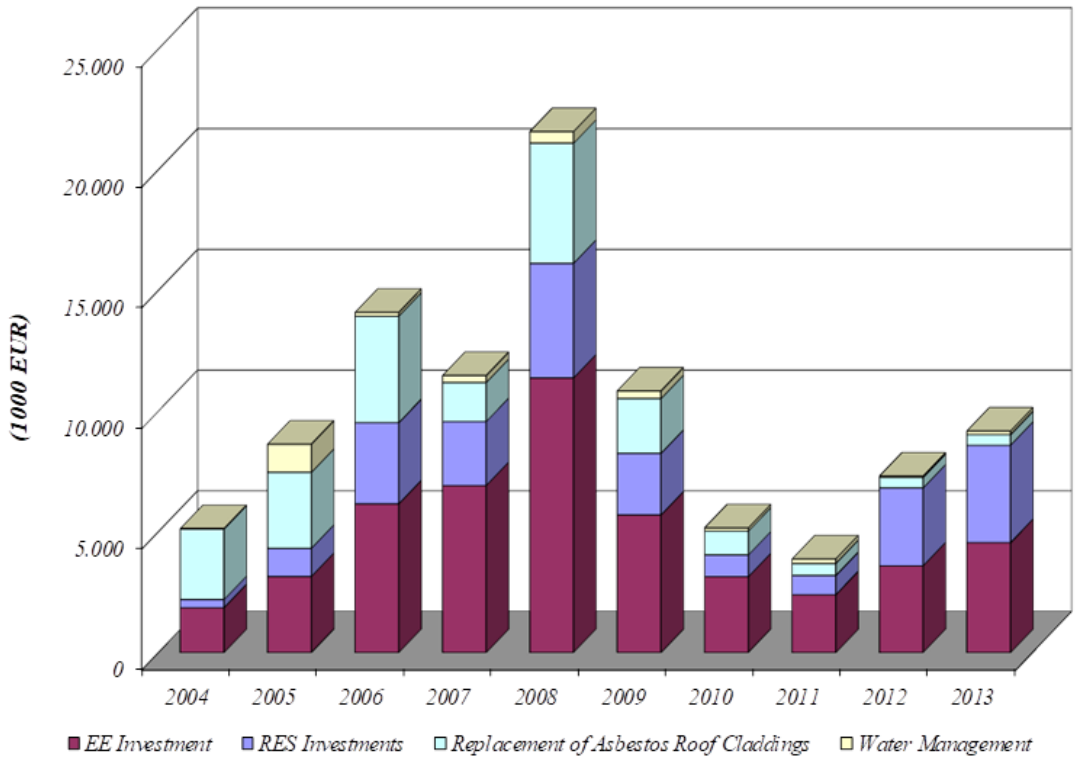

Figure 22: Structure of EKO Sklad loans for households 2004-2013 in the value of EUR96 million

The largest amount of loans was requested in 2008, just before the onset of the financial crisis as illustrated by Figure 22. Since 2006, energy efficiency investments was the main reason households requested loan from EKO Sklad followed by renewable energy resources and replacement of asbestos contaminated roof cladding. Much more interesting for households than loans were grants, however. The below pie chart (Figure 23) shows the split of grants for domestic buildings according to funded technology.

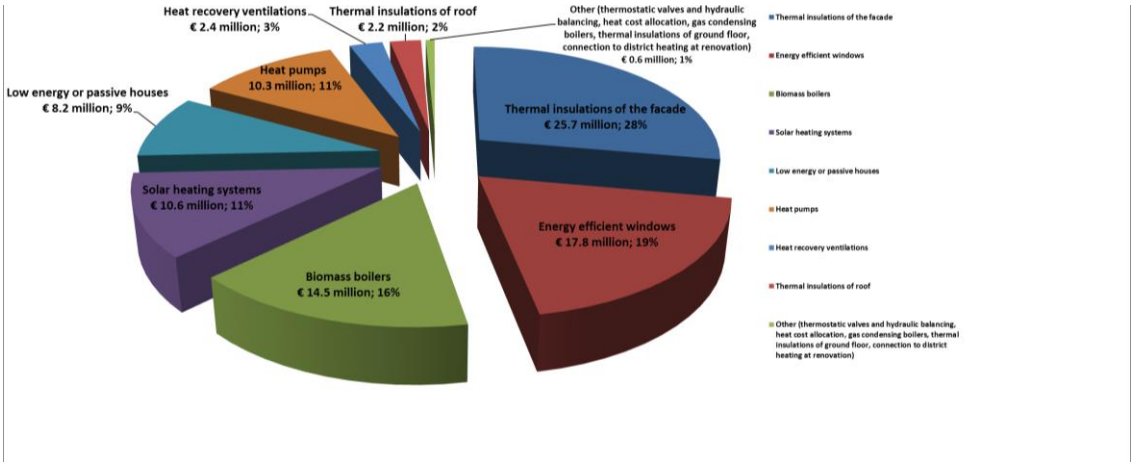

Figure 23: EKO Sklad analysis of grants for residential buildings between 2008 and 2013 (Source: EKO Sklad 2014)

According to their own statement, EKO Sklad approved 62,500 investments for residential buildings (households) with a value of EUR 92.3 million in the period between 2008 and 2013. Figure 23 shows the split of technologies these grants were

allocated for. The biggest proportion of grants with 28% or EUR25.7 million went towards thermal insulation of facades, followed by energy efficient windows (19% or EUR17.8 million) and biomass boilers (16% or EUR14.5 million). According to EKO Sklad's calculations, however, thermal building insulation in the grant period up to 2013 alone caused 173,323 MWh/a in energy savings and 25,998,415 kg/a in CO_2 emissions reductions. It should be noted that not all of these grants went towards domestic retrofitting as for instance 9% or EUR8.2 million went into funding low energy or passive houses which tend to be new-builds.

It is worth noting that for private individuals and householders in Slovenia, EKO Sklad is currently the only source of public sector financial support which can be applied to energy efficiency measures in new and existing buildings and domestic retrofitting:

> *"For the municipalities, for public buildings there were other calls, two or three other calls in the frame of the cohesion fund. But for the individuals it's the only subsidy scheme in Slovenia." 1*

Sitar and Krmelj observed that a "high number of privately owned residential buildings have recently intensively improved the energy efficiency by renovation processes, financially supported by national subsidy schemes introduced by Eco Fund" (Sitar and Krmelj 2014, p.246). EKO Sklad's financial incentives have been found to be a strong stimulus for energy-efficiency refurbishments in Slovenia (Nieboer et al. 2011, Cirman et al. 2012) and in 2012 its "subsidies of €23.6 million resulted in the investment in energy efficient renovations of nearly €132mn" (Sitar and Krmelj, 2014, p.247). EKO Sklad runs regular annual public calls for their subsidies but has repeatedly run out of money due to the high interest in the population.

> *"For instance this year we had this public call for households and there were 15 million Euros and we received around 9500 applications on that. So we had to close it at the beginning of July which means that we are not covered by the end of the year and now that's the building season. We are expecting that people will be investing in the summer in facades and stuff. I think this is the problem. We would be more influential if we could guarantee the money throughout the whole year. If this could be a non-stop process, that would be great." 2*

This enthusiastic response from the population which the EKO Sklad is experiencing stands in direct contrast with the passiveness regarding energy efficiency which a

respondent from Energap had described. One obvious reason could be that free money, e.g. in the form of subsidies as provided by the EKO Sklad, is a much stronger motivator for domestic retrofitting than information and advice which the energy agencies are limited to. As such, a closer collaboration between the energy agencies and the EKO Sklad could be a useful impetus to increase the rate of retrofitting in the municipalities. As of yet, however, both institutions operate separately:

> *"EKO Sklad is an institution which is established by the state and we are cooperating during different conferences or things like that and they are also giving us some information about their funding on our region because we need it for our report about what's done, for example in the last year in Maribor about retrofitting the buildings. In that way we are cooperating, otherwise we all have our own tasks." 7*

And while the EKO Sklad approach seems to be effective in increasing investment into energy efficiency at the household level, it also aims to strengthen the country's construction sector and economy. For domestic retrofitting, however, EKO Sklad is effectively competing with Slovenia's grey economy which is costing the state millions in taxes each year:

> *"Because the subsidy is really only covering the taxes. They are 22% and the 25% is the subsidy. But you have to pay the tax on your own so if you calculate and if I count, for example, I have a €10,000 investment and 22% is taxes, so it's really €7,800. So EKO Sklad is giving me back 25% from this €8,000, so that's €2,000. So the investment is €10,000 and EKO Sklad is paying me €2,000. So I have to have €8,000. And in the grey economy people come and say 'I will do it for €7,500', and people are doing it for €7,500 without a bill. And we already… We have a consortium of the Slovene energy agencies and we already wrote an official letter to EKO Sklad to increase the subsidy to 30% because this will then make a little bit of a change. With the 25% it will only cover the taxes for you. But if they increased it to 30% it would be a little bit different in the field." 1*

Generally, the trend towards energy efficiency investments in Slovenia is positive as Al-Mansour (2011) illustrates in Figure 24 on energy efficiency funding in the public sector. While the Ministry of the environment played a significant role in the 2000s in allocating public funds towards energy efficiency and renewables, this role has

increasingly been taken over by the EKO Sklad which now manages the majority of the public funds in these areas.

	In [1000 EUR]		
	Public Financing (from budget)[a]	Soft loans Eco-fund[b]	Total
2000	1196	705	1901
2001	1297	320	1617
2002	1103	3054	4157
2003	1142	2150	3292
2004	1127	237	1364
2005	885	7510	8395
2006	833	10 083	10 916
2007	956	10 772	11 728

[a] Source: Ministry of the Environment and Spatial Planning.
[b] Source: Eko Fund.Sources: Ministry of the Environment and Spatial Planning and Eco Fund

Figure 24: Public sector funding for energy efficiency and renewables between 2000 and 2007 (Source: Al-Mansour 2011, p. 1872)

5.1.8.2. Low carbon funding at the local level

The municipality level in Maribor provides very limited funding for domestic retrofitting, and exclusively for historical buildings. Regular attempts by Energap to establish a municipality fund for subsidising energy efficiency and renewables at the domestic level with a similar approach as the EKO Sklad grants or even linked to the applications for EKO Sklad subsidies were discarded repeatedly by the city council due to budget constraints.

> *"The special municipal fund for the subsidies of such activities was proposed but wasn't accepted because there is no money. Each year we have this report about the energy use in the municipality, especially in Maribor which is the biggest one, about how to force households a bit to cooperate, and there the councillors are discussing about the possibility of such a financial fund. But in the end they decided that there is no money. But we wanted to start with only €50,000, so it's not really a lot. Only with €20,000 would be good just to start the system, maybe for 10 households and that's all but they haven't funded this money." 1*

Private home-owners in the MOM with the intention of retrofitting their homes tend to come up against a barrier when it comes to access to money. When asked whether they felt that funding for domestic retrofitting was available, one interviewee replied:

"Yes, it is accessible but it is not under better conditions than other loans if you are deciding to seek a loan from the bank, you will get the same interest as for buying a car." 7

Local banks and also international chains in the MOM do not currently have any inclination to offer specialised energy efficiency financial products. In 2009, Energap organised a dedicated conference on this issue and experienced a very low attendance from representatives of Slovenian and international banks, the intended target audience.

"Our banks are not educated about giving loans or helping individuals or companies with energy efficiency projects. A few years ago, we had a conference at the finishing of the -3% project. We invited all the banks in our region to contribute to this conference just about this issue to help companies and individuals with loans for energy efficiency but only one bank came. And they said that this is not part of their problem and they are not doing this." 7

5.1.9. Institutions and Governance

5.1.9.1. The lack of regional governance in all but statistics

Governance levels emerged as an important discussion topic with the Slovenian interviewees. This is due to Slovenia's two-level governance structure. The country is effectively governed on the national level by the elected government and on the local level by the municipalities with their elected mayors. The majority of EU member states have a third governance level at the regional level. Often this can be a county level, or in the case of Germany the federal state level. The reason why Slovenia lacks this intermediate governance level between the state and the municipalities is due to its socialist history. In most other EU member state the regional level plays a role in facilitating policies and programmes from the supranational and national level to the communities and municipalities on the local governance level. Slovenia however used to be a part of the former Yugoslavian socialist regime and as such was divided into a series of statistical regions used for economic planning, as explained by an interviewee:

"Regional planning in the 60s in Old-Yugoslavia, of which we used to be part, was confirmed on the basis of the republics and Slovenia as a republic back then had its own regional governance. That was very important. In the general planning which applied to all socialist states, the 5-year planning, the base was actually of an economic nature." 5

Lindstrom described the process of regional governance in Yugoslavia as one whereby special measures promoted the growth of less-developed sub-national regions without handing over any actual administrative power to these regions (Lindstrom 2005, p. 4). This was legislated in 1971 in the law on the Promotion of Balanced Regional Development. This meant that the regional level in Slovenia had predominantly an economic function, with no change to this until 1991. Since it became independent in the early 1990s, Slovenia has "seen a high degree of centralization in resources and decision-making at the national level" (Lindstrom 2005, p. 4). Lindstrom (2005) suggested that it effectively made a step backwards by reducing the function of the regional level to a statistical one. Not only did this mean that a functional regional governance level was not developed in Slovenia, but the existing economic significance of the regional level also disappeared. When Slovenia joined the European Union during the 2004 accession period, the lack of a regional governance level turned out to have some draw-backs for the country.

> *"This regional level does not formally exist in reality. There is only the state and the municipality. And that is a big problem since the funding for various structural and cohesion funds etc. are allocated based on regional programmes and the harmonisation of the national and the local level. That is why a compromise has been developed in Slovenia. […] This was a must; Slovenia had to have the regional programmes to even gain access to this financial environment."* 5

As the above quote indicates, EU programmes and policies are designed in such a way as to rely on the national and the regional governance levels of EU member states for their effective implementation and delivery. EU programmes and policies thereby promote a decentralised governance structure in member states. This approach is standardised across the EU, regardless of the actual governance structures of individual member states. Whether or not a member state chooses to establish a regional governance level is however up to the sovereign states and the EU has little to no input or control over this, as explained by an interviewee.

> *"Regional planning is essentially not within the competency of the EU. Because that is the state, the national level."* 5

In the case of Slovenia, however, "the Slovenian constitution made no provision for politically institutionalized regional bodies. Yet it did allow for voluntary cooperation among municipalities to unite as regions" (Lindstrom 2005, p. 6). As indicated by the

interviewees, however, the Slovenian municipalities see little incentive in organising themselves into functioning regional level structures and the Slovenian government favours a centralised governance approach and does little to encourage regional level collaboration. Further, Lindstrom (2005) found a competitive element also prevents the establishing of a regional governance level as municipalities "were more concerned with gaining competencies and resources than promoting development on the regional level" (p. 6).

Since there is no functioning regional level in Slovenia other than for statistical purposes, the municipal or local governance level becomes all the more important. Each municipality in Slovenia democratically elects a municipal council and a mayor. For the duration of their term, it was explained by interviewees, mayors have close to universal decision-making power for their municipality. This makes them the highest authority at the local level, as one interviewee elaborated:

> *"By the law the mayors have too much power. They are the most powerful person in Slovenia by the law. If the mayor doesn't say that it is a good idea, no changes will happen." 1*

This strong legislative role of the mayor is further strengthened by the fact that Slovene municipalities may establish their own legislation, as long it complies with and remains within the parameters of the national law of Slovenia. An interviewee described how this municipal autonomy might have a possible detrimental effect on the adoption of EU programmes as some municipalities might comply while other would not.

> *„Because Slovenia has only two administrative levels - the national with the ministries and the local with the municipalities and there are 210 municipalities, it means they don't have to cooperate. They really have autonomy. And it is difficult because some of them are very small. […] And it's very difficult to make some bigger development projects and take care of the regional development, as it is called from a EU position." 1*

As indicated earlier in the chapter, Slovenia receives a net benefit from EU structural funds. A lot of this EU funding takes the form of programmes and project which need to be implemented by a number of delivery bodies within the country. A good example for this at the local level is the Municipality of Maribor's EU project office which has been active since 2004 but was officially established in 2010. The EU project office is responsible for the management of EU projects which can be as diverse as energy-

efficiency in public sector buildings, sustainable and barrier-free mobility, energy book-keeping projects, eco-tourism and many more, as explained by an interviewee:

> *"The local municipalities and local entities, they get funding for lots of projects regarding infrastructure, traffic, energy efficiency, renewable of city centres regeneration, cultural infrastructure, cultural heritage." 9*

And while the variety and breath of the funding can be tremendously important for a country which is struggling through a recession, the administrative requirements can be arduous and potentially ruinous as one interviewee points out:

> *"In the new member states like also Poland and for example Hungary they're afraid of making any mistakes so they would like to make Slovenia also stricter controls to have to be sure they don't have to... they don't want to make mistakes and don't have to give money back because it will be impossible." 9*

The steep learning curve which is needed for newer member states to fully comply with EU funding requirements is addressed somewhat by the knowledge sharing and multi-actor structure of many European projects. It was mentioned by an interviewee that EU funding comes with a strong collaborative elements which can be particularly beneficial for newer member states in their learning of the ropes:

> *"So we learn in the European projects how to make the procedure in the best way already from the partners in the European Union who already have done it. They show us their best and also practices which perhaps are not so good so we don't repeat the same mistakes. "9*

Coming back to the significance of a regional governance level, it should be noted that not all municipalities benefit from an EU project office like Maribor. Many are simply too small and not inclined to work with neighbouring municipality to set up a joint office. The role of a regional governance level carries a supervisory element which could support the local level in their efforts to apply for funding, deliver project and report back to the national and supranational level. Without a regional level, Slovenia is hampered in its ability and efficacy to strategically apply for and deliver EU programmes. Several interviewees pointed out examples at the local level where EU funding was used inappropriately or not in line with EU requirements:

"You have many controls. First you have the first control at the ministry, then the second control from the finance ministry, then you can have the control from the European Commission. And right now Slovenia has problems because there were too many mistakes in public procurement and we don't get all the money back. So this is also a lack of money in the budget, and Slovenia has now not enough money because we have spent and we don't get the money back from Brussels." 9

"For example in Silnice up there, there is a wastewater treatment plant for 5000 units. The whole municipality doesn't have 5000 units. But it is only for the agglomeration in the centre because you have seen a lot of small houses around, so we have only 1800 units connected to the sewage system but they have planned it for 5000. And the indicator in the agreement is 5000, so I would like to see this money coming from the European Commission because they have to get it back this year because only 1800 people will be connected in the future, not at the moment because there is only a primary line and the wastewater treatment plant." 9

Funds for such misaligned projects are at risk of claw-back from the EU. This leads to an interesting hypothesis, namely that the absence of an intermediate body between the local and national level could be a barrier to the effective evaluation and supervision of the appropriate use of EU funds.

A regional administration and governance level could not only provide more strategic oversight and shape and facilitate access to supranational and national funding at the local level. It could also be instrumental in the efficient distribution, use and supervision of energy efficiency funds. It could guide and facilitate effective reporting mechanisms with funders and beyond this support the local level with the effective transposition and monitoring of supranational law into the legislative frameworks of individual municipalities. While adding this additional regional level would likely increase decentralisation in Slovenia, regional governance bodies could generally have a positive impact on the transposition of energy efficiency policy, use of energy efficiency funding and subsequently the energy efficiency of the built environment.

5.1.9.2. Governance and the transposition of EU law into Slovenian law

The importance of multiple governance levels has been confirmed by a number of EU member states, as covered in a 2011 international study on energy efficiency in housing management. Almost all of the 11 surveyed member states in the study stressed "the

combination of national, regional and municipality activities" (Nieboer et al., 2011, p. 3). Slovenia was a part of this study, having to harmonise EU legislation with its own national body of law as part of its EU membership.

As mentioned earlier in this chapter, Slovenia tends to be on top of adopting and transposing EU legislation and policy as swiftly as needed. A more problematic point for it is keeping pace with EU strategies when it comes to sustainability and energy efficiency policies (Sitar et al. 2009). The practical implementation of these is sometimes met with resistance, as illustrated by the below interview quote:

> *"For example, we already talked about the energy certificates for buildings in 2006 and 2007, and they only came into force in the last year, in July 2013. So 7 years we were talking about the energy certificates that were already in the energy law in Slovenia in 2006. So then if I'm a citizen I will say "Ah, they are ten years ahead of the things. So if they are now talking about some inspection of the boilers they will think, maybe it will come into force in Slovenia in 10 years because we are so many years behind the European practice."1*

When Slovenia started the transposition of EU directives "with the intention of harmonising national legislation" (Sitar and Krmelj 2014, p. 243), the process led to some fragmentation. "Some of these laws were transposed into national energy law but others were assimilated into a range of other ministerial documents and sectors." (Schmieder-Gaite 2016) This meant for instance that the responsibilities for some policies and directives were split up over a number of ministries and government department. The EU Energy Performance of Buildings Directive (2002) (EPBD) is a good example for this fragmentation. The policy was transposed as four separate Slovenian laws under three different areas of jurisdiction. As illustrated in Figure 25, the EPBD was transposed into the Building Construction Act, the Spatial Planning Act, the Environmental Protection Act and the Energy Act under the Ministries of Infrastructure, Spatial Planning and the Environment.

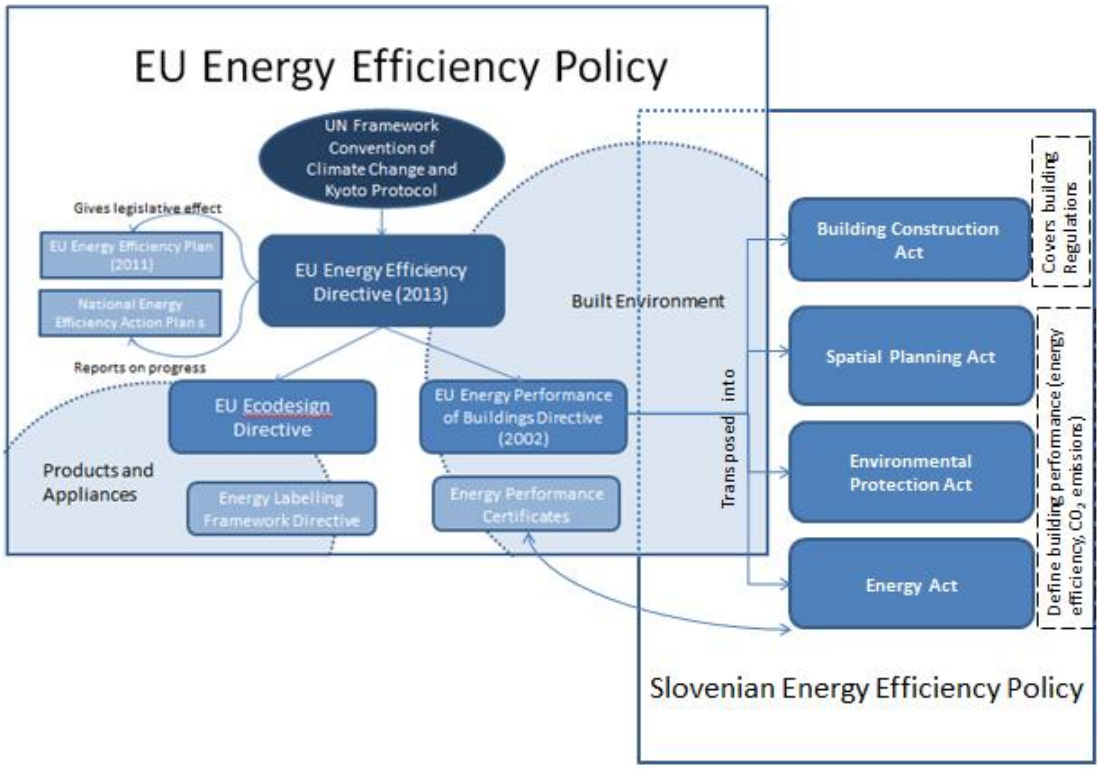

Figure 25: Main EU and Slovenian Energy Efficiency Policy (Source: Schmieder-Gaite (2016) based on Sitar and Krmelj in Jones, P., Lang, W., Patterson, J. & Geyer, P 2014)

Since the early 2000s, sustainability and energy have grown in importance in Slovenia's legislation. This is illustrated in Figure 26 which shows an adoption timeline for a range of important energy-centric policies and legislation. Sitar and Krmelj (2014) mention Slovenia's National Energy Programme (2004), Energy Act (2005) and Development Strategy (2005) as being particularly noteworthy for their emphasis on sustainability and energy, especially energy-savings.

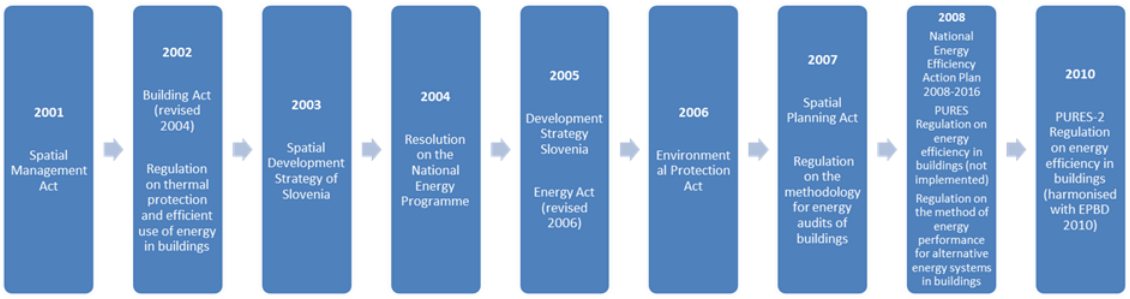

Figure 26: Slovenian Sustainability and Energy Efficiency Policy (Source: Own image in Schmieder-Gaite 2016 based on Sijanec 2009)

In 2006, this energy focus led to the formation of energy agencies at the local municipality level. These agencies were co-financed by the EU and were a response to the increasingly urgent need to increase energy-savings and energy efficiency as well as the requirement for facilitating bodies which could support the transposition of energy

policies in the municipalities. The year 2008 saw a strong focus on energy efficiency in the Slovene legislation, including the National Energy Efficiency Action Plan (Sitar et al. 2009). The Action Plan 2008-2016 established the requirement for energy efficiency in buildings. The energy agencies became a crucial part of implementing those policies into initiatives and programmes at the local level and supported the adoption of Local Energy Concepts. In the Slovenian case study region Podravje for instance, the local energy agency was heavily involved in setting up and launching Maribor's Local Energy Concept (Schmieder-Gaite 2016).

Slovenia had no unified energy efficiency strategy for buildings until 2008. Until this point, the responsibility for retrofitting existing buildings was entirely with the owners, be it private homeowners or the municipalities (Sitar et al. 2009). The missing regional governance level posed again a barrier for a more joint up approach. A regional governance body could otherwise have acted as a bridge between the national and the local municipality level and facilitated the translation of the existing national building laws into tangible local projects (Schmieder-Gaite 2016). The statistical regional level in Slovenia did not allow for this.

The energy efficiency of Slovenia's built environment has benefitted significantly from EU legislation and policies which have supported the country's sustainability agenda during its 15 years of EU membership. However, EU energy efficiency law is often perceived to be implemented to ambitious timeframes and to force change more rapidly on the country than it can necessarily adjust to. As one interviewee explained, sustainability objectives changed too fast for end-users to internalise the inert advantages of sustainability and instead caused irritation and confusion as both the media and the public sector struggled to keep up and align their messages to the public:

> *"The priorities some years ago were different; there was nobody to explain that renewable energy is important and that it is the future. The marketing was just for fossil fuels and in favour to pollution, everything in favour to pollution, not energy efficiency. And so the public is now confused and doesn't want to accept the new European legislation about this." 3*

What is more, since certainly at the point of its accession Slovenia had not been able to input into existing EU law, EU policies were sometimes perceived to be inflicted on the country. As Sadakata (2006) observed, EU policies are not usually seen as a "product of dialogue" in Slovenia (p. 45). Legislation is generally a difficult topic in Slovenia, as one interviewee remarked. Slovenia's adoption of national law and the additional

transposition of EU legislation into this body of law tends to be adopted into the Slovenian legal system swiftly. This is to satisfy the obligations and requirements of European Commission but does not necessarily imply an equally prompt and efficient application and enforcement of this law.

> *"I have to be familiar with the EU legislation and our Slovene legislation because we are in the European Union and this must be implemented. But the Slovene legislation is tricky; everything works on paper but nothing in reality. It is very, very hard to deal with it." 12*

EU law and policies have to be implemented and enforced by EU member states. While all member states benefit from a transposition period to allow them to appropriately harmonise EU law with their national body of law, some member states may transpose these more promptly and with more resoluteness than others. As mentioned by interviewees, the Slovene government tends to transpose EU law promptly but is then dragging its feet when it comes to enforcing these laws and policies. Of course this lack of conviction does not go unnoticed by the general public which respond with apathy at the end-user level. As one interviewee observed, EU law is perceived to be a burden and adds an additional level of complexity to an already administratively challenging body of national law.

> *"We have too much legislation on paper and it's a chaos because one is for that and another is for that and if you wanted to do something you must look for this and this and that legislation, and if you use this one then you cannot use that one and it's as I said chaos in some areas." 12*

When asked about its growing landscape of energy efficiency legislation, some interviewees responded that they perceived it to be "too hard". It was also noted by interviewees that this likely often led to indifference towards energy efficiency among end-users.

5.1.9.3. Local governance and its impact on energy efficiency investments

On the national level, Slovenia has a track-record of frequently unstable governments which changed on average every two years at time of data collection. Interviewees also suggested that the Slovenian government and public sector might portray high levels of corruption. It should be noted that at the time of data collection in 2014, Slovenia was ranked 39 in the corruption index by Transparency International, compared to Germany ranked 12 and the UK ranked 14 (Transparency International 2014). Interviewees further

suggested that this perception of corruption might be seen to encourage an attitude of economic self-interest in the population and a strong grey market economy. It was noted by an interviewee that this mind-set, unfortunately, is common across the country:

> *"Everyone is doing something for themselves or alone. There is no cooperation between the actors and it's hard to arrange some cooperation between the municipality and the companies, even the bank - it's not possible." 1*

Corruption has been observed by several interviewees as a big problem across Slovenia's public sector, particularly at the local level, and has come up as a topic in the interviews several times. This in connection with the frequently changing national government causes distrust among the Slovenian population, not just of the political system but also extending to public sector programmes and initiatives at the local level.

> *"So then we had a new mayor election in March 2013, and the new one is also making some strange things. And for the last two months the regional newspapers everyday write something about what is wrong with the organisation, with the money and other things." 1*

Slovenian municipalities democratically elect their mayor and municipality councils. Once elected, however, some respondents perceive that mayors have universal decision-making power for the entire community and therefore represent the highest authority at the local level.

> *"By the law the mayors have too much power. They are the most powerful person in Slovenia by the law. If the mayor doesn't say that it is a good idea, no changes will happen." 1*

Furthermore, as explained earlier in the chapter, each municipality can adopt its own legislation within the parameters of the Slovenian national law. This can complicate the implementation of specific EU programmes and makes them applicable to some municipalities but not to others.

> *"So we must search for other municipalities that are smaller and don't have this legislation on the municipality-level." 4*

> *„Because Slovenia has only two administrative levels - the national with the ministries and the local with the municipalities and there are 210*

municipalities, it means they don't have to cooperate. They really have autonomy. And it is difficult because some of them are very small, for example the municipality of [Loare] has only 1700 inhabitants, but it's a municipality. […] And it's very difficult to make some bigger development projects and take care of the regional development, as it is called from a EU position." 1

But there have also been cases where public sector departments, whether from confusion or resistance to transposed EU policies, have attempted to counteract these at the local level.

"The special planning sector in the municipality wanted some special plans but didn't want to include this energy efficiency and renewable energy in their plans. So they thought that because in the previous legislation, energy legislation was written that way that the special planning legislation and special planning act are above the energy topics, energy efficiency priority. But now in this energy act in Slovenia the priority has changed in that energy on paper is more important than special planning and they don't want to accept that. It is difficult to do something because they didn't want to do that and the covering act is written not very precisely, very detailed, just very generally. Everyone interprets it differently." 10

5.1.10. Society

5.1.10.1. Information and awareness issues

While the collected data is certainly not representative of the entire Slovenian population, it was a recurring theme that sustainability and environmental consciousness were secondary reasons for energy efficiency. Slovenians are mostly motivated to consider energy efficiency measures and retrofitting for the cost-savings it generates.

Information and education about energetic renovation, low-energy houses and passive houses have also been mentioned as an important issue. Since particularly the EU-funded programmes promote low-carbon living, this frequently means that the EU-funded public sector new-builds and retrofits tend to be to the highest sustainability standard, for example in compliance with the passivhaus standard etc. These building also tend to have a strong design component due to their desired reputational and exemplary effect. Once the buildings are operational and in use, however, the building

users are often left with the problem of how to operate the building for its maximum efficiency.

Energap recounts an example of an EU-funded new-built passivhaus kindergarten in which case the insufficient training of the building users resulted in the property becoming very inefficient and the energy use increased by 205%.

> *"Each year we have 10 of those workshops where we explain how to use the passive house kindergarten, how to ventilate, how to open the door and close the door, how the system is slowly working up and down and how the outside temperature is coming inside in the 3 days after and again. But they were just laughing! Because you know, "we know how we ventilate the house. We open the window and just let the air in." If there are windows which are closed, then they say that there is not enough fresh air." 1*

This reflects the general perception that since energy efficiency is a relatively simple concept, there is no need for further information, education or training on the subject.

> *"And also in Slovenia we have a consortium of local energy agencies and we discuss this, and everyone has the same problem. There is the same all over Slovenia. Not public sector, not private, not individuals, they're not interested to come to some education activities, to some workshops, to some presentation conferences." 1*

Furthermore, a more direct approach taken by the energy agency by inquiring into the passiveness and apathy towards energy efficiency among the population of Maribor has highlighted economic strain and trust issues as well as inactivity at the municipality level.

> *"We have asked all the people around the municipalities and all of them are saying "we don't have the time and we don't have any money for energy so why should I attend something if I don't have any money to do something on the municipality level?" Or maybe "I would understand, but my mayor or my department, they wouldn't understand that there are different things." 1*

> *"We are trying to get some companies involved in the projects but the economic crisis is still here in Slovenia and it looks like it is even deeper than it was and companies are not deciding usually to go with a project in the public sector." 7*

There is also a widespread mistrust among the population that energy efficiency programmes could be scams and therefore disadvantage the participating individuals. This implies that even the most direct approach towards awareness-raising by means of a door-to-door campaign in Maribor's population might at this point not yield the desired outcome.

> *"No, they don't want that, they wouldn't like that and they would be afraid. They wouldn't let us in, they are quite afraid of everything." 1*

There was also a perception of a direct correlation between the troubled economic situation of the country and the energy efficiency apathy of the population, meaning that as soon as the economic situation of Slovenia would improve, so would the openness and pro-activeness of its population towards sustainability and energy efficiency.

> *"You're seeing that in the feelings of the people. I think that if things improve and there are more jobs, it will be better. I think so." 4*

Some of the respondents' statements indicated a preoccupation with the lingering impacts of the European economic crisis in the Maribor if not the Slovene population, as illustrated by the following quote:

> *"A lot of companies also closed their doors because they're bankrupt, because they have financial problems. And this is a problem, a big problem. And also just a few companies have stayed and are still working. Maribor at the moment is not in a good position." 4*

This sense is of course supported by official statistics of this period, showing high unemployment and public sector funding cuts due to investors and investments having pulled out of the country.

5.1.11. Coevolution of Themes

The coevolutionary systems have just been discussed by means of quotes from the interview transcripts and respective commentary, but an additional way of highlighting the interconnectedness of the systems is through visualisation of their child nodes or coding themes. This approach demonstrates that coding themes emerge and re-emerge in parallel throughout the interview conversations. Some coding stripes emerge frequently in parallel with the same or related themes, indicating a strong relationship between these themes. The following section will go through a number of interview illustrations to demonstrate the approach and illustrate the findings.

Figure 27: Coding stripes in Slovenia interview transcript 1

The most prominent coding stripes are EU public sector funding, EU programmes and projects as well as public sector funding at municipality and city level. These coding themes reappeared throughout the interview, often emerging in parallel with each other. All of these fall under the coevolutionary system of business/funding. In two sections, these strong themes were complimented by the coevolutionary system of environment, namely energy

efficiency and environment in sections 2 and 3. Other coevolutionary systems interacting with finance in this interview are society with the themes of education and information and socio-economic factors, and institutions with the themes national and regional level governance and policies and legislation, although each of these themes only occurring once throughout the interview.

Figure 28: Coding stripes in Slovenia interview 2

This interview shows a strong connection between no less than five coding themes in section 1. These represent three different coevolutionary systems. The strongest system appears to be finance with national public sector funding being the strongest coding stripe in the interview. Finance is followed by the coevolutionary systems of institutions and technology, represented by the retrofitting and policies and legislation theme respectively. And the coevolutionary system of environment is represented by the coding themes energy efficiency and environment. It is worth noting that other coding

stripes related to the technology system appear sporadically throughout the interview with the themes building components, building types and retrofitting technologies.

Figure 29: Coding stripes in Slovenia interview 3

This interview was largely dominated by the coevolutionary business/finance system. National public sector funding is the dominant theme and an almost constant topic during the recording. Access to finance, business models and private sector funding are also strong themes and parallel coding stripes throughout the interview. Other systems such as society, technology and institutions feature but don't indicate a strong interaction with business/finance.

Figure 30: Coding stripes in Slovenia interview 4

The dominant theme in this interview is national public sector funding combined with retrofitting, see parallel coding stripes #1. These are connected to the coevolutionary systems of business/finance and technology. Another noteworthy observation is that socio-economic factors emerge as a topic three times during the conversation in connection with national public sector funding, and each time in connection with other coding themes. In section 2, it interacts with national level governance and business levels which fall under the coevolutionary systems of institutions and business/finance respectively. In section 3, socio-economic factors are discussed in connection with retrofitting technologies, private sector funding and investments, which are part of the coevolutionary systems of technology as well as business/finance. And in the fourth section, they are considered in combination with retrofitting and access to finance, again themes belonging to the coevolutionary systems of technology and business/finance. The interview finishes with a discussion around purely socio-economic factors.

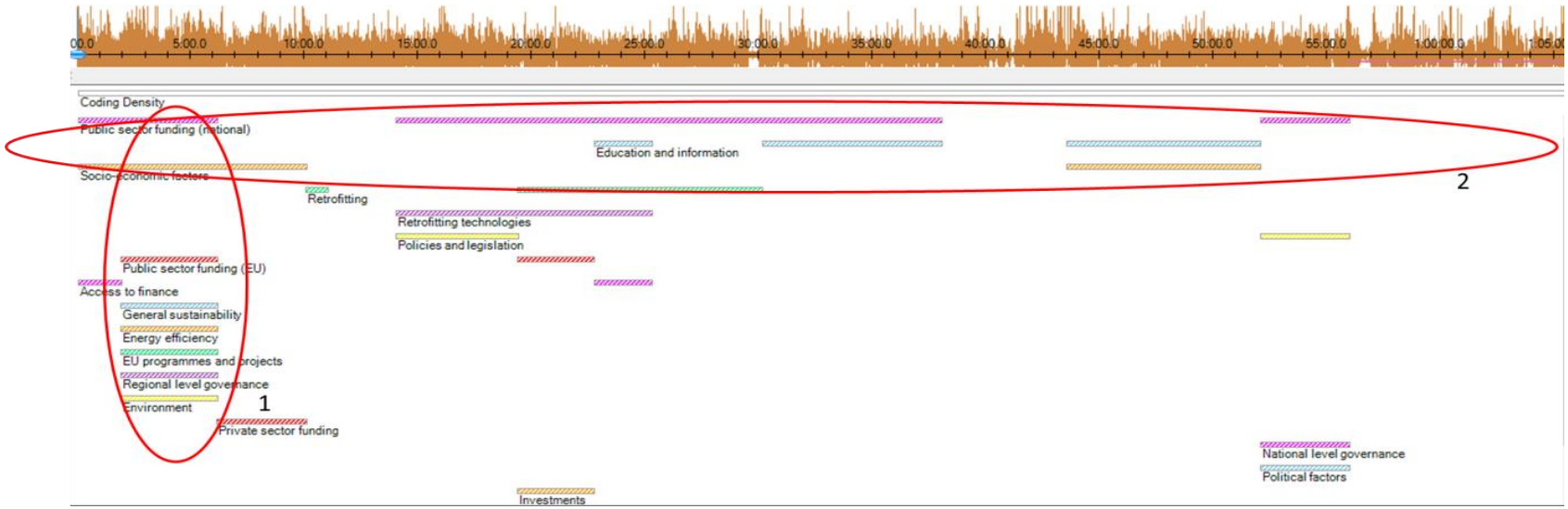

Figure 31: Parallel coding stripes in Slovenia interview 5

This interview starts broadly with a discussion around socio-economic, funding and environmental aspects, touching also on governance (section #1). There is a diversity of coding stripes in the recording. The prevalent one is national public sector funding, part of the coevolutionary system of business/finance. Other frequent coding themes are education and information as well as socio-economic factors which both form part of the society system. Retrofitting and retrofitting technologies feature as part of the coevolutionary system of technology; and policies and legislation as well as national and regional level governance are presenting aspects of the coevolutionary system institutions. Section #2 highlights the strongest area of interaction which is between national public sector funding and socio-economic factors and education and information, representing the interaction between the coevolutionary systems of business/finance and society.

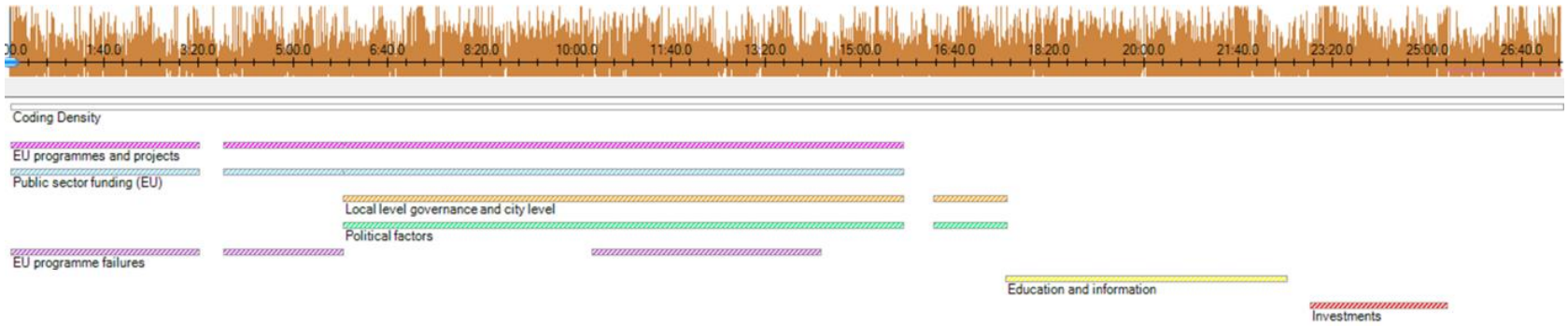

Figure 32: Parallel coding stripes in Slovenia interview 6

This interview transcript focuses on only 7 different coding themes, most of which are being discussed in the first half of the conversation. The two strongest themes are EU programmes and projects and EU public sector funding, both part of the coevolutionary system of business/finance. These are on three occasions complemented by the coding theme EU programme failures, again a business/finance theme. Local level governance and city level enters the conversation slightly later, together with political factors, these being aspects of the institutions and society coevolutionary systems respectively. The interview ends with the themes education and information and investments.

As mentioned previously, the interview transcripts from the Slovenia recording had been coded using Foxon's coevolutionary systems as a basis for the coding nodes. The Slovenia case study used interview data from institutional interviews to illustrate the interconnectedness between coevolutionary systems. The connected coding stripes from the interview transcripts illustrate this interactivity between the systems. Coding stripes which run in parallel across parts of the interview recording indicated that these sections touch upon more than one of the coevolutionary systems which might in turn be an indication that these systems might be interacting. Recurring parallel coding stripes can highlight key issues and relationships of relevance to the case study. The illustrations for the Slovenia case study show the main dominating coevolutionary systems to be business/finance, technology and institutions with a strong focus on business/finance. For the coevolutionary system of business/finance, the strongest links were with the coevolutionary systems of institutions, society and technology, all in relatively equal measure. Finance/business also interacted with the coevolutionary environmental system, but to a lesser extent than with the other coevolutionary systems. The data for these results can be directly taken from the illustrations of the coding nodes in Figure 27 to Figure 32.

While it is possible to code qualitative interview data in many different ways, it was Foxon's coevolutionary approach which has been valuable in drawing out a number of key issues from the interview data and which allowed to identify business/finance as the major area of importance for energy efficiency in the Slovenian built environment.

5.1.12. Concluding section

The case study of Slovenia and the Podravje region has highlighted a number of interesting findings, some of which are specific to the country and region while others might be of wider relevance for the EU. At the time of data collection in 2014, Slovenia was struggling to emerge from the global financial crisis from which it had suffered significant economic damage. With this as the case study context, the interview data highlighted a range of issues which might negatively impact the country from achieving a more energy-efficient and sustainable building stock. Areas of importance are related to funding and governance, particularly administrative governance structures and the transposition of law.

In terms of coevolving systems, Slovenia portrays a strong dominance of the business/finance system which strongly interacted with the institutions, technology and society systems. The business/finance system having significant importance for energy efficiency in the Slovenian built environment implies that funding bodies, be it domestically or supranationally, have an

opportunity but also potentially a responsibility to influence and shape the energetic performance of the building stock in Slovenia. While there is institutional funding in place that is focused on supporting and increasing the uptake of energy efficiency technologies and domestic retrofitting, private finance and banks have yet to enter the low-carbon funding space.

The interaction between the finance and technology systems in the interview data highlights the interviewees' perception that energy efficiency and retrofit technologies come at a price. This is important in light of the finance/society connection, since nodes related to the finance system have most frequently been associated with socio-economic factors in Slovenia. In light of the recent financial crisis, this connection often highlighted a shortage or lack of funds in Slovenia at the time of data collection, be it in the government, the population or businesses. This shortage or lack of funds directly affected the uptake of technologies and approaches for energy efficiency in Slovenian buildings.

The data clearly shows that these systems are strongly interacting and coevolving. Indeed, the data shows that a positive change to the dominant system of finance, i.e. increased availability of funding, is more than likely to impact on the other coevolving system, e.g. increased uptake of retrofit and energy efficiency technologies and availability of more institutional funding for this.

Issues relating to governance appear to impact the country in a number of ways. An important aspect is the integration of sustainability themes into Slovenia's legislation, leading to gaps in the law around the concepts of energy efficiency in buildings. There are also issues around the national body of law being convoluted and unwieldy making it difficult to apply, but also increasing the complexity of integrating emerging EU policies and regulations into national law. While these tend to be transposed into the documentation quickly, their integration into national law may lead to fragmentation across unconnected ministries and government department. This in turn leads to inefficiencies in their application and confusion and resistance across institutional actors and the general public.

Unlike most other EU member state, Slovenia is governed through a two-level administrative structure on the national and the local level. Effective EU programmes and policy transposition is however dependant on a functioning administrative regional governance level. The lack thereof in Slovene governance structures is an impediment to how impactful EU mechanisms can be at the local level. In particular, EU energy efficiency policy and the

development of schemes promoting building energy efficiency have been hampered by this lack of an intermediate governance level.

The impact of this can be seen on the example of EU funding programmes and how these are delivered in Slovenia. Accessing and allocating financial support is difficult and necessitated the establishing of statistical regions to ensure Slovenia's eligibility for many programmes. But without a supervising intermediary governance body the quality assurance of these programmes was difficult and led to a number of funded projects and buildings under-delivering on their energy efficiency potential. An ambitious local level without a supervising regional level could make decisions on funding allocation to projects which are disproportionate in size and cost-intense compared to actual usage and performance potential of the buildings once delivered. Funding misallocation and unsuccessful projects carry the risk of financial claw-back by the funder, negatively impact the country's reputation and can impact on the motivation with which the population engages with sustainability and energy efficiency. "With a history of regions based only on statistical and economic considerations, current expectations of governance standardisation by the EU, and a local governance level which fosters competition rather than cooperation between the municipalities, it appears that a strengthening of the regional governance through the establishment of a supervisory or administrative body might enhance Slovenia's efforts towards a more energy efficient and sustainable built environment" (Schmieder-Gaite 2016, p. 7). This also carries implications at the supranational level where the one size fits all approach towards governance might benefit from some reflection on the diversity of EU member states. The current dependency of the overall governance chain on the regional governance level might pose an obstacle when it comes to achieving overarching sustainability and carbon targets.

This chapter discussed the first of two case studies, namely the Podravje region in Slovenia. Major findings were highlight through quotes of interviewees with commentary throughout the text. The interview data was then analysed through the lens of Foxon's coevolutionary systems and interacting systems were presented through parallel coding themes in the interview recordings. The Slovenia case study is complemented by a second case study in Saxony, Germany. The Germany case study will be discussed in the following chapter.

5.2. Case Study 2 – Regional and local governance and low-carbon investment in the built environment in Germany

The aim of this study is to investigate the interconnection between governance and low carbon finance on energy efficiency investments in the built environment on the example of two case study regions. The previous chapter analysed and discussed the first case study, the Podravje region in Slovenia. The current chapter will focus on the second case study, the county of Saxony in Germany. While the Podravje region served as an example of how local governance structures can have an impact on a country's potential to achieve its own and European climate change targets, Saxony is an example of an efficient interplay between the national and the regional governance level. As with the first case study, the focus is on low carbon investments and the transposition of European policies to the national and regional level.

After a general introduction to the case study country (section 5.2.1 and 5.2.2), the chapter focuses in more detail on the case study region (section 5.2.3) before presenting the major findings from the interview data (section 5.2.3 to 5.2.7). The data is structured along the five coevolutionary systems of the analytical framework. Initially, the qualitative data is presented through quotes taken from the interview transcripts complemented by commentary. Later, the coevolutionary systems are visualised through parallel coding themes, complemented by further commentary (section 5.2.8), before the first case study is concluded in the final part of this chapter (section 5.2.9).

5.2.1. Introduction to the case study

Germany is a federal republic which became an independent nation state in 1871 and united into the present Federal Republic of Germany in 1990. Germany is one of the six founding countries of the European Union and joined the Eurozone in 1999 as one of the first countries to adopt the Euro, replacing the German currency Deutsche Mark. Germany is one of the biggest member states in the EU, with a population of 82.5 million inhabitants (Destatis 2018). It is an economically developed country and with EUR3.3 billion the highest GDP in the EU (Destatis 2018).

The Federal Republic of Germany consists of 16 federal states with Saxony being one of them. Germany's federal states have a lot of autonomy in terms of legislation, taxation and an input into some areas of federal policy (EC2018). Improving thermal standards in the housing stock became mandatory in Germany in 1977 under the Thermal Retention Regulations (Waermeschutzverordnung WSVO 1977, 1984, 1995) which was later replaced by the Energy Savings Ordinance (Energieeinsparverordnung EnEV 2002 and 2009) (Gavin 2014). While the Thermal Retention Regulations applied only to new-

builds, the 2002 EnEV introduced thermal standards for domestic retrofitting in Germany (Gavin 2014). Amecke and Neuhoff (2011) succinctly summarise the German ambition for the building sector. "By 2050, the sector is prescribed to decrease primary energy demand by 80% by:

- reducing heating demand by 20% until 2020;
- ensuring all new buildings are climate neutral by 2020; and
- increasing the thermal retrofit rate from 0.8% to 2%." (p.6)

5.2.2. Sustainability and energy efficiency in Germany

Germany has developed a detailed roadmap towards a low-carbon economy and future and has expressed its energy goals up to 2050 in the strategy called Energiewende (energy transition). While the Energiewende covers a range of sustainability areas such as increased uptake of renewable energy sources, one of the biggest areas of transition is the building stock. About 40% of the energy in the EU is consumed by buildings and the building sector (IEA 2012). Germany's building stock aligns with this pattern perfectly and has so been identified as a priority area to increase energy efficiency and reduce energy consumption. The means by which this can be achieved include energy efficiency retrofitting and renovation of domestic buildings. While the German energy transition also aims to increase adoption of renewable energies in the buildings sector, these are out of scope for this thesis.

The German government has calculated that to achieve the goals of the Energiewende by 2050, there is a need to retrofit on average 2% of the existing building stock annually, as was explained by an interviewee. This is an ambitious goal compared to the reality of the current annual retrofitting rate of just 1%. An additional factor is the age of the existing building stock in Germany, two thirds of which was built before 1978 (BPIE 2015) and would likely require extensive and holistic energy efficiency retrofitting rather than just replacement of individual components. There is a clear gap between vision and reality and the challenge is to find approaches to close it in time to achieve the goals. From the interviews a general picture of the situation of domestic retrofitting in Germany could be gleaned. It was stated by an interviewee that there "is a relatively strong need to renovate and retrofit."[4] This is the context in which the political decision had been taken to implement the Energiewende until 2050. "The government has calculated that until 2050 on average 2% of the building stock needs to be

[4] "Da besteht schon ein relativ starker Renovierungs- und Sanierungsbedarf." (3)

fundamentally retrofitted annually to achieve the target."[5] In light of the current annual rate building retrofitting of 1% in Germany, there was a general sentiment amongst interviewees that more needs to be done.

The TABULA web tool which was introduced in the literature review chapter provides more detail on the energy efficiency rating of the majority of German buildings and has been a helpful referencing tool for the German residential building stock.

5.2.3. The Federal State of Saxony

The Free State of Saxony is located in Eastern Germany and as such used to be part of the former German Democratic Republic (GDR) until the German Reunion in 1989. Since the almost 30 years since then, Saxony like the rest of the former GDR has undergone dramatic structural and economic changes but is one of the few new federal states which has established itself as a region of strong industrial heritage and innovation. It is the sixth biggest federal state in Germany with a surface of 18,400 sq km and approx. 4 million inhabitants. The state capital of Saxony is Dresden which is a city of national cultural and architectural importance. Saxony borders on the Czech Republic and Poland. The three major cities are Dresden, Leipzig and Chemnitz. Saxony comprises 10 counties and 427 municipalities (see map in Figure 33).

The backbones of Saxony's economy are small and medium sized businesses which are also a source of constant industrial innovation. In 2016, Saxony's GDP was around EUR27,500 per capita and the employment rate was 4.4% as of 2017 (EC 2018).

[5] "Die Bundesregierung hat ausgerechnet, dass bis 2050 im Schnitt jedes Jahr 2% des Gebaeudebestandes grundlegend saniert werden muessen um das Ziel zu erreichen." (3)

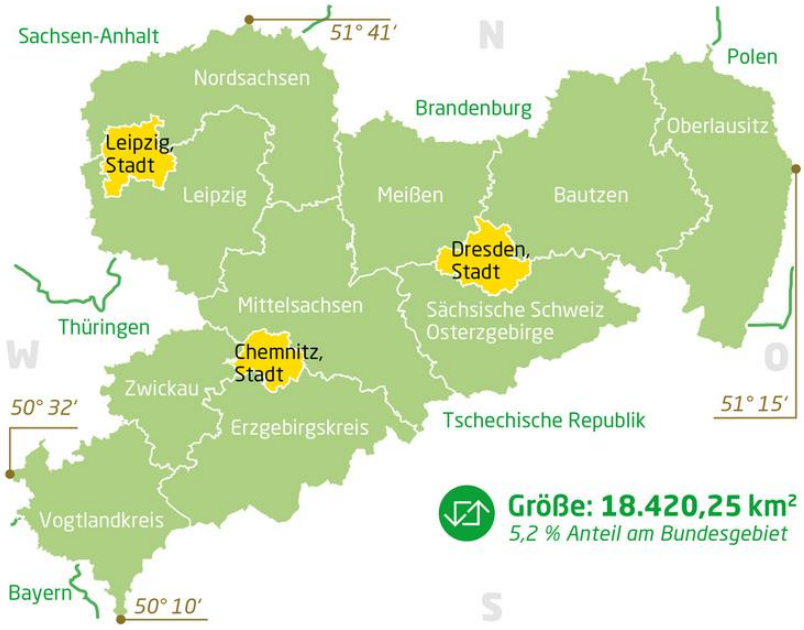

Figure 33: The federal state of Saxony with its major cities and ten counties (Source https://www.freistaat.sachsen.de/index.html)

In 2016, there were 2,173,000 private households in Saxony in 818,992 domestic buildings. 21% of households were in detached single household buildings, 12% were in semi-detached buildings and 66% were in multi-apartment buildings (Saechsische Staatskanzlei 2018). "Due to the federal organisation, every state has a sovereign constitution and is able to shape its own areas of legislation. This is particularly true for the energy sector, where local regulations for buildings and incentives for renewable energies have been established locally" (Lang & Geyer 2014, p.85). Saxony's CO_2 emissions in 2012 were 47.5 million t/a(Sachsen.de 2015). By 2020, the federal state hopes to have reduced its emissions to 43.8 million t/a (Biedermann 2011).

5.2.4. Word frequency analysis in the interview transcripts

Figure 34: Word frequency analysis in the Germany interview transcripts (Source: Own illustration via NVivo)

While having in-depth interviews around the topic of low-carbon finance, governance and technology in domestic retrofitting has helped identifying a number of themes and issues in the Germany case study, it was considered worthwhile to undertake a word frequency analysis, similarly to the Slovenia case study. The word cloud in Figure 34 illustrates the words that were used most frequently in the interviews. The German interviewees focused their discussion a lot around funding (Foerderung) which is the most frequently used word. There are a number of words important to the sentence structure, such as modal verbs and qualifiers which are included in the word cloud. Funding is followed by building (Gebaeude) and measures (Massnahmen). Energy efficiency (Energieeffizienz), Germany (Deutschland), government (Bundesregierung) and funding programme (Foerderprogramm) follow close behind. There are also strong occurrences of words such as energetic (energetisch), funding (Foerdermittel), retrofit (sanieren and Sanierung) and legislation (Gesetzgebung). Further, respondents spoke about regional (regional), preferential interest rate (Zinsverbilligung), requirements

(Anforderungen), together (zusammen), funded (gefoerdert), Energy Savings Ordinance (Energieeinsparverordnung) and federal states (Bundeslaender). It is a positive indication that the most frequently used words include funding, building, measures and energy efficiency, which is an indication that the interviewees understood the research topic and provided responses relevant to the research questions.

The German word frequencies will be compared to the most frequent words used by Slovenian respondents in the case study comparison chapter.

From the Germany interview data a number of sub-themes emerged for each of Foxon's systems of the coevolutionary framework. These are discussed in the following sections of this chapter. It is worth noting that some of the themes interact with two or more systems. It is also worth noting that the content of the below themes is entirely drawn from the German interview data.

5.2.5. Themes

The co-evolutionary systems as per Foxon's framework are mirrored in the parent nodes from the coding tree as detailed in the analytical framework chapter. The themes under each of the systems have emerged as a result of data coding with the child nodes.

5.2.6. Low-carbon Funding

This theme covers aspects of low-carbon funding at the national and regional governance levels but also the impact of finance of domestic retrofitting either as a barrier or an enabler. The German government has a budget for energy efficiency measures in the built environment. These are allocated to the KfW, the Kreditbank fuer Wiederaufbau (Bank for Reconstruction). The KfW provides low-carbon funding through its energy efficiency funding programmes to incentivise building retrofits but also renewable energy in the built environment. "We know that approximately 35 – 40 % of all retrofitting measures are funded via KfW programmes on average"6 and "we cover a majority of measures which then by far exceed regulatory requirements"7 as explained by an institutional interviewee. As an indication of the magnitude of allocated low-carbon funding the interviewee stated that in 2013, the KfW funded more than 400,000 residential units which were either new-builds or retrofits.

[6] "Wir wissen, dass rund 35-40% aller Sanierungsmassnahmen auch KfW-gefoerdert werden, so im groben Durchschnitt." (6)
[7] „Wir decken damit einen Grossteil der Massnahmen mit ab, die dann weit ueber ordnungsrechtliche Anforderungen hinausgehen." (6)

5.2.6.1. New-builds

While this research looks predominantly at retrofitting existing buildings, it is worth noting that the KfW is also an important player in the funding of new-builds. One interview participant estimates that it provides low-carbon finance to approximately 50% of new-built domestic buildings in Germany[8].

5.2.6.2. Increasing the number of retrofits through finance

Throughout the interviews the question was raised whether increased funding might increase retrofitting in Germany: "And the question which arises next is whether this is predominantly a financial question and do I need to provide people with an easier loan or do I need to give them a grant, or does it depend on something else."[9] The responses to whether the low retrofitting rates are essentially a financial problem were answered relatively consistently by interviewees with a no. At the institutional level there is a view that "at the moment there are enough for this funding area… are the provided funds currently available for these targets"[10] to support and achieve the 2020 climate change goals in the built environment. This view extends to an understanding that these climate change goals cannot be achieved by simply providing more money. The focus at an institution level is around establishing and maintaining continuity to create a state of planning reliability which will be discussed as a separate theme at a later point in this chapter. Providing more funding support is perceived to be a limited option and according to one interviewee, the building industry shares the above institutional view and even beyond that appears to believe that an increase or even doubling of retrofit measures [as would be needed to annually retrofit 2% of the existing building stock] is simply not feasible: "The second barrier is that the sector cannot deliver twice the volume within a year."[11] An approach for systemic retrofitting, it was felt by the interviewee, would simply overwhelm the state since even the current execution of retrofitting was perceived to be relatively bad: "The current delivery is already very bad and if this was widely increased to a much higher number of cases, then they would probably be completely overwhelmed."[12] This view is explored further in the interview

[8] "Bei den Neubaufinanzierungen gemessen an den Baugenehmingungen schaetzen wir unseren langfristigen Anteil bei etwa 50%."
[9] "Und die Frage, die sich als naechstes stellt, ist das in erster Linie eine finanzielle Frage und muss ich den Leuten irgendwie einen leichteren Kredit geben oder muss ich ihnen einen Zuschuss geben, oder haengt es nicht vielleicht woanders dran." (3)
[10] "Momentan reichen sie fuer diesen Foerderbereich...stehen die ausgereichten Foerdermittel fuer diese Ziele jetzt zur Verfuegung." (6)
[11] "Die zweite Huerde ist, dass die Branche das doppelte Volumen innerhalb eines Jahres auszutauschen nicht leisten kann." (2)
[12] "Der jetzige Vollzug ist ja schon sehr schlecht und wenn man das jetzt flaechendeckend auf eine sehr viele groessere Zahl von Faellen ausweiten wollte, dann waeren die [...] wahrscheinlich voellig ueberfordert." (5)

data in one of the following sections. Nevertheless, low-carbon institutional funding is considered an important part of the picture and new funding approaches are being considered.

A possible climate change levy

One of these approaches, which is already part of Germany's NAPE (National Action Plan Energy Efficiency) is a climate levy the exact amount of which, for instance, would depend on the sustainability index of a building beyond a set threshold for CO_2 emissions or energy consumption levels. This levy could be an additional incentive for homeowners to retrofit their buildings. It could be integrated with existing mechanisms such as taxation and depending on the energy efficiency status of a building would incentivise homeowners to reduce or avoid said levy by retrofitting or maintaining their building at a high energy efficiency level: "Then homeowners would have an additional financial incentive to retrofit their building because their climate levy would be removed."[13] The onus would be on the homeowners to provide evidence of any improved energy efficiency of their buildings. "And vice-versa, the levy could also be used to more reliably design and set up the funding programmes than is currently the case, because this currently only happens a few years ahead of time and then it tends to be uncertain what will happen to the funding programmes."[14] A climate levy would therefore also be a way to increase planning reliability. One aspect that should be mentioned refers to the nature of tax measures like a levy: "Although fiscal measures are always an intervention in the fiscal authority of the federal states so the national government has very little room to manoeuvre."[15] So while retrofitting is already funded nationwide across Germany, the real challenge might be to provide incentives to retrofit more buildings beyond funding.

5.2.6.3. National funding in Germany via the KfW

There are a number of funding bodies across Germany. The focus of this research, however, is the KfW. The main national vehicle of low-carbon funding for the building sector is the KfW. "The KfW is active nationwide and complemented by federal funding banks"16 such as the SAB. While various federal states are running their own funding programmes for the building sector, these vary widely as discussed under the Regional

[13] "Dann wuerden Gebaeudeeigentuemer einen zusaetzlichen finanziellen Anreiz bekommen Ihr Gebaeude zu sanieren, weil dann Ihre Klimaabgabe wieder wegfallen wuerde." (5)
[14] "Und im Umkehrschluss koennte man mit so einer Abgabe die Foerderprogramme verlaesslicher ausgestalten, als es bisher der Fall ist, weil das immer nur einige Jahre im Voraus geschieht und dann immer wieder unsicher ist, was denn dann mit den Foerderprogrammen geschieht." (5)
[15] „Wobei Steuermassnahmen auch immer ein Eingriff sind in die Steuerhoheit der Laender, weshalb der Bund da wenig Spielraum hat." (6)
[16] "Die KfW ist bundesweit taetig, komplementaer dazu haben wir die Landesfoerderbanken." (3)

funding theme. Also active nationwide is the BAFA which is funding renewable energy through grants rather than loans. However, "funding through the KfW has been the only constant funding source in recent years"17 in the built environment. KfW funding programmes are financed by the national government but allocated by the federal states. This means that the federal states draw from the funding of the national budget, in this case the energy and climate fund. This funding is used for preferential interest rates and repayment or investment grants to support homeowners in achieving certain energy standards. "This is used a lot because they are trying to design their programmes fairly profitably; they tend to have a commitment period of only 10 years."[18] KfW low-carbon funding is generally seen as reliable and stable. While smaller adjustments to the funding have occurred, "there is planning reliability. Of course there are always small differentiated changes but it is usually the case that in the last years, since I have been involved in the task, fundamental changes have not taken place."[19] This is an important aspect of maintaining planning reliability for the building sector. KfW funding with a longer term repayment period and a preferential interest rate bring a similar effect as a conventional market loan but allow homeowners to consider a number of additional components to retrofit without a higher financial burden: "I mean for instance the Energetic Retrofitting Programme which has the same impact as a market loan but I can consider a few other measure which I can add instead of doing it without the requirements. Because with this I have financially more possibilities but without the higher burden; that's exactly the point."[20] An alternative to taking out a KfW loan is for homeowners to apply for a grant. KfW grants are available for detached and semi-detached buildings but also for homeowner associations.

How KfW funding works

KfW funding programmes are a combination of loans and/or repayment grants and/or interest subsidies. For instance a homeowner could take out a KfW loan with an interest subsidy of 1% on what otherwise would have been a 1.75% interest rate on this loan. This leads to a preferential interest rate of 0.75%. The KfW funding contract requires the

[17] "Die einzige Konstante ist in den letzten Jahren die KfW-Foerderung." (5)
[18] "Was viel auch genutzt wird, weil die versuchen ja ihre Programme auch recht lukrativ aufzubauen, haben ja nur Bindungsfristen von 10 Jahren." (1)
[19] "Und das gibt halt auch Planungssicherheit. Natuerlich gibt es immer noch kleine differenzierte Unterschiede, aber das ist eigentlich immer so, dass jetzt in den letzten Jahren seitdem ich auch diese Aufgabe mache, nie dazu gekommen ist, dass es da einen grundlegenden Wandel gab." (6)
[20] "Das ist dann... ich meine, gerade jetzt beispielsweise dieses Energetisch-Sanieren-Programm, der bringt ja jetzt auch eigentlich so viel Effekt, als wuerde ich ein Marktdarlehen nehmen dafuer, dass ich mir dann schon das eine oder andere nochmal ueberlegen kann, das ich doch mitmache, als wuerde ich jetzt einfach so ohne jegliche Anforderung was machen, weil ich einfach dann mehr Moeglichkeiten habe finanziell dann auch, ohne mehr Belastung zu haben, das ist ja dann genau der Punkt." (1)

homeowner to implement or retrofit energy efficiency measures on components of the domestic building to achieve a specified energy efficiency standard. “Once you then provide evidence of having achieved this energy efficiency standard to a technical appraiser, the repayment grants directly reduce a part of your loan. And this repayment grants can be for up to 30% of the loan balance, meaning you could be repaid up to 30% of the initial KfW loan.”[21] This partial remission of the loan debt is available for various KfW energy efficiency building standards as per the KfW’s definition for comprehensive building retrofitting but equally for the retrofitting of individual building components. The prevailing principle of the KfW’s energy efficiency support is, the higher the achieved energy standard, the higher the funding.

Most of the KfW’s funding programmes are loan programmes which are not perceived to be as attractive to private homeowners as the grant programmes of which there are fewer: “The private homeowner is not as interested in loan programmes. He usually wants the grant programmes of which there are less on the ground”[22] A regional energy agency noted that “experience over recent years has shown that the grant programmes are more wanted and successful in take-up than the loans. Even though loans are frequently required in addition, the grants have a much higher appeal.”[23]

Beyond energy efficiency, the KfW also provided funding for age-appropriate retrofitting and other funding for retrofitting for special needs. These separate funding streams are compatible. “This programme funding for retrofitting a building appropriately for elderly people can be combined with energy efficiency retrofitting of external components.”[24] Age-appropriate retrofitting usually involves open spaces, minimising the use of walls and doors as well as small enclosed rooms to allow freedom of movement with assistive equipment such as wheel chairs or walkers. Combining the two funding types allows for barrier-free, open plan domestic energy efficiency retrofitting.

[21] “Wenn Sie einen bestimmten energetischen Standard erreichen und dieses nachweisen, dass Sie das erreicht haben ueber einen Sachverstaendigen, dass Sie dann einen Teil dieser Darlehensschuld die Sie haben, direkt erlassen bekommen. Und dieser Tilgungszuschuss betraegt zum Teil bis zu 30%, so dass Sie 30% der Kosten der Darlehensschuld erstattet bekommen.“ (6)

[22] “Der private Bauherr interessiert sich nicht so fuer Kreditprogramme. Der moechte immer die sogenannten Zuschussprogramme und die sind ja eher duenner gesaet.“ (1)

[23] “Und es hat so die Erfahrung gezeigt in den letzten Jahren, dass diese Zuschussprogramme natuerlich ganz anders gewollt sind und dass die auch offensichtlich durchschlagender sind als jetzt Darlehensprogramme. Auch wenn ein Darlehen manchmal trotzdem gebraucht wird, aber irgendwie dieser Zuschuss, das lockt anders.“ (1)

[24] „Dieses Alterngerecht-Sanieren-Programm dazu, also Altengerecht-Umbauen heisst das, das man dann quasi koppeln kann mit zum Beispiel mit der energetischen Sanierung der Aussenbauteile...“ (1)

How KfW funding is accessed

Germany's banking system features house banks for private and business clients which specific to the German and a number of other countries' economy. "House bank is a bank with which a company conducts most of its financial business. This kind of close business relationship is common in Germany, Japan and Austria in particular, which is why the banking system in these countries is often called the relationship banking system." (Deutsche Bundesbank 2018)

> *"And the KfW in Germany works in such a way that you will usually request a loan from your local or house bank directly where you generally also want to finance the retrofit or the purchase of a building. This has the advantage for us as the government and for the KfW that local or house banks can sell their own real estate or retrofitting loan products and add KfW funding into their product catalogue as well. This means that the mandatory bank check and bank security of the loan applicant by the bank applies not only to the bank's financial products but extends to the KfW's. This means that funds are being used in an economical way."*[25]

This approach saves resources, costs and time for the KfW not just for the financial background checks and loan securities. "This has the enormous advantage that time and resources to calculate the loan opportunities for the applicant are not wasted. And the applicant when applying for a loan is informed about the funding decision via an online response in the shortest possible timeframe,"[26] making administrative efforts for allocating national low-carbon funding minimal and eliminating the need for a bespoke KfW infrastructure.

Uptake of KfW funding

An institutional interviewee declared that "up until 2013 all available KfW funding pots were regularly exhausted."[27] The annual funding amount at this point was approx. EUR 2 billion per year. The complete allocation of KfW funds changed from 2014 due to the

[25] "Und die KfW-Foerderung funktioniert in Deutschland halt so, dass wenn Sie einen Kredit beantragen moechten, dieser ueber die Hausbanken gestellt werden muss, also ueber Ihre eigene Bank oder die Bank, wo Sie generell auch Ihre Finanzierung fuer eine Sanierung oder einen Kauf eines Gebaeudes machen wollen. Und das hat fuer uns als Staat und auch als KfW den Vorteil, dass erstmal die Bank ihre eigenen Produkte, die sie im Bereich Wohneigentum fuer Sie haben, oder Gebaeudemodernisierung mitverkaufen koennen, es zusaetzlich in ihre Produktpalette einbringen koennen, und wir aber auch eine Bankensicherheit, eine Bankenueberpruefung des Kreditnehmers durchfuehren, damit auch einfach Mittel so verwendet werden oder dort ankommen, wo sie auch wirtschaftlich eingesetzt werden." (6)

[26] "Das hat einfach den enormen Vorteil, dass dafuer viele Zeiterfordernisse und so weiter zur Kalkulierung der Kreditmoeglichkeiten eines Foerdermittelnehmers einfach nicht vergeudet werden. Und er kann auch insgesamt, wenn er einen Kredit beantragt, bekommt er sehr schnell innerhalb von kuerzester Zeit ueber ein Onlinesystem eine Zusage, dass er Mittel beantragen kann." (6)

[27] "Bis zum Jahr 2013 wurden alle Mittel ausgeschoepft, die zur Verfuegung standen." (6)

developments in capital markets. In the first half of 2014, funding was not made available to the same extent as in previous years because the interest rate subsidy could not be applied. This was due to the market interest rates being so low.

> *"Before then, up to 3% interest rate subsidy had been available to KfW loan applicants. We found that up until then, a large part of the KfW funding was used for loan funding in connection with the repayment grants because most homeowners tended to need a loan to retrofit and implement the measures. And due to the lower interest rate subsidy the repayment grants were subsequently increased to still be able to provide the same amounts of overall funding as in previous years."*[28]

This decision also encouraged continued uptake and exhaustion of funding pots in the years following 2014. KfW energy efficiency funding has generally been a successful programme since its inception. There may be an element of homeowners taking funding despite perhaps not being reliant on it for their retrofitting activity, though the windfall gain is unknown and can only be estimated and will not be further explored in this study.

Target assessment

Issues have arisen in the past when some retrofitters only see the reduced interest rate or the higher loan value without fully considering the funding requirements and retrofit depth. To satisfy the loan requirements evidence of achieved sustainability levels must be provided as part of the loan agreement. Once evidence needs to be submitted for the achieved standard some retrofitters then run into difficulties with producing said evidence. Monies can be clawed back by the funding bodies if they are not satisfied with the achieved retrofit standard. An additional measure to ensure validity of this evidence is the need for an appraiser. "An external appraiser always needs to countersign the documentation, so it is not just the homeowner who feels that he has done everything as requested but an additional person."[29] Failure to retrofit to a sufficient standard or lack of evidence might mean that "if the funding was used for a preferential loan then it may

[28] "Frueher hatten wir bis zu 3% Zinsverbilligung und wir haben daher auch die Feststellung gemacht ein Grossteil der Foerdermittel wird auch fuer die Kreditfoerderung in Verbindung mit den Tilgungszuschuessen verwendet, weil die meisten Gebaeudeeigentuemer auch einen Kredit brauchen um diese Massnahmen durchzufuehren. Und wegen dieser geringeren Zinsverbilligung wurden dementsprechend auch nochmal die Tilgungszuschuesse nach oben angepasst um hier entsprechend den Vorjahren die Foerdermittelsummen hier gleich anbieten zu koennen." (6)

[29] Beziehungsweise ist es ja auch so, dass immer ein Sachverstaendiger mit unterschreiben muss und damit ist es jetzt nicht nur der Bauherr, der sich vielleicht traut zu unterschreiben, ich hab alles so gemacht, wie ich es gesagt hab, sondern da ist noch ein zweiter." (1)

be transferred into a market loan"[30], thus removing any financial advantages of the low-carbon funding.

Governance of KfW funding

The KfW funding programmes are complex and require intricate instruments of governance and a collaborative institutional approach. For instance, the Ministry of Industry, Trade and the Environment (BMWi) is working closely with the KfW and meetings between both institutions are held every two weeks. Those meetings ensure that "every two weeks suggestions from either side are being discussed to highlight mutually practicable funding pathways and how to integrate these within the existing funding structures."[31] If potential changes to the funding programmes "may have financial implications or require integration with for instance new energy techniques, technologies or standards, then as a consequence the necessary approach will be coordinated and discussed between the respective departments of the BMDI and the KfW as well as with any other parties of the respective departments."[32] These departments usually include the environment and building department or agriculture (if funding changes impact on and involves biomass). An institution which is always part of the discussions is the Ministry of Finance since the financial sovereignty over the funding lies with them. "This discourse between various ministries and departments ensures a balanced agreement between the various institutional actors so that different perspectives are considered and that the discussion is not one-sided. Because we have to avoid that measures may only be valid for one legislative period and instead follow the guideline that these are sensible measures which everyone can agree on."[33] As explained by an institutional interviewee, this collaborative decision-making minimises the risk of divesting or changes in certain technologies and approaches after one legislative period. "Because this causes uncertainty for homeowners, among the actual responsible owners of the properties. These people need to be able to rely on that they can get a certain

[30] „Und beziehungsweise wenn es ein Kredit war, dann wird da bestimmt dann geschaut, wie es in ein Marktdarlehen umgewandelt wird. (1)

[31] "Also wir arbeiten konkret so, dass wir uns zweiwoechentlich zusammensetzen, Vorschlaege die von der einen oder andern Seite kommen miteinander diskutiert werden um die gemeinsamen praktikablen Foerderhandlungswege aufzuzeigen, wie man das so in die Foerderung integrieren kann." (6)

[32] "Wenn Aenderungen in diesen Foerderprogrammen anstehen, die auch finanzwirksame Auswirkungen haben, und die auch in bestimmte neue energetische Techniken, neue energetische Technologien oder Standards eingefuehrt werden sollen, werden diese nachdem diese zwischen uns im BMDI auf der Arbeitsebene, also wir als das zustaendige Referat das bearbeitet haben mit den Kollegen von der KfW, mit den Kollegen der andern Fachresorts abgestimmt." (6)

[33] "Nur das hier eine ausgewogene Abstimmung zwischen den verschiedenen Resorts auch stattfindet, damit unterschiedliche Interessen auch sichergestellt werden, dass es nicht nur in eine Richtung geht. Weil wir eben auch verhindern muessen, dass bestimmte Massnahmen vielleicht nur fuer eine Legislaturperiode gelten, sondern wir immer den Ansatz auch haben, dass das vernuenftige Massnahmen sind, die von jedem mitgetragen werden koennen." (6)

amount of funding and this won't be repeatedly changed. And this creates planning reliability."[34]

5.2.6.4. Regional funding in Germany

Low-carbon funding at the regional level varies significantly. Some German federal states have no such funding while others have had significant success running their own regional funding programmes. The overarching principle here is that national funding from the KfW always forms the base funding to which the regional funding or "the federal funding programmes are additional, complementary and supporting."[35] Regional funding can be added on top of national funding. The individual federal states are very diverse and range in demographics, type of building stock and federal budget. "It is the interest of the national government to provide national funding programmes for everyone across the whole nation"[36], and then the individual regional programmes are seen as good practice while not being mandatory. Any expectation to have funding programmes in the federal states could delay funding activities, particularly since the federal states do not have the same financial opportunities.

According to one interviewee regional funding has often been connected with EU funding over the last years and "what you often find is that regional funding bodies, such as the Saxon Bank for Reconstruction (SAB), regularly top up the KfW's national programmes with their own regional programme. We currently have an interest rate on the KfW loan from 0.5% and a possibility would be to give additional funding of 0.25% and the difference would be paid from the Saxon federal budget"[37] Energy agencies in particular often encourage such a combination of funding programmes where feasible. Often the approach is to retrofit a building holistically and a combination of national and regional funding programmes facilitates this approach. Interviewees mentioned a number of regional funding programmes including in Hamburg, Bavaria, Saxony and Baden-Wuertemberg. The latter example has "the same energy efficiency requirements

[34] "...weil man dadurch auch eine gewisse Verunsicherung gegenueber den Gebaeudeeigentuemern, gegenueber den eigentlichen Verantwortlichen fuer ihr eigenes Hause, fuer ihr eigenes Eigentum auch darstellt. Die Leute muessen sich darauf verlassen koennen, dass sie eine bestimmte Foerderung bekommen und das dies nicht immer wieder umgedreht wird. Und das gibt halt auch Planungssicherheit." (6)

[35] „Die Programme der Bundeslaender sind insofern zusaetzlich und ergaenzen und unterstuetzen." (5)

[36] „Das ist auch das Bundesinteresse, oder das Interesse der Bundesregierung, dass man sagt sie muessen die Bundesfoerderprogramme fuer jeden in der ganzen Bundesrepublik zur Verfuegung stellen." (6)

[37] "Was Sie regelmaessig haben, ist dass die Landesfoerderbanken, zum Beispiel die SAB, nochmal auf die KfW-Programme eigene Programme aufsetzen und hier nochmal extra foerdern. Wir haben momentan einen Zins von 0,5%, und eine Moeglichkeit waere, dass die dann sagen, okay wir geben euch das Geld fuer 0,25% und die Differenz wuerde aus dem saechsischen Landeshaushalt gezahlt werden." (3)

as the national funding programme and adds a small financial incentive on top."[38] This is an indication of the importance of separate funding measures working together and not against each other, "it is an interplay of the funding that is important, so that funding measures are easily combined with each other."[39] While this lowers administrative barriers, it is also a consideration for homeowners in the respective federal state to see and trust that the regional funding body provides funding for them. Regional funding for the case study region Saxony is discussed in a separate section below.

5.2.6.5. Regional funding in Saxony

Saxony is one of Germany's federal states which have set up a regional low-carbon funding body – the Saxon Bank for Reconstruction (Saechsische Aufbaubank – SAB). "I would say that in Saxony, funding is only available through the SAB in an effort to centralise funding options to one source."[40]

Saxony also has a regional energy agency, the SAENA (Saechsische Energie Agentur) which describes itself as the "Saxon competency centre for energy" (Saechsisches Kompetenzzentrum Energy). SAENA is a well-established source of energy-related information and received 2,000 to 3,000 phone requests each year. Regional energy agencies tend to be very aware of regional funding opportunities and advising the public on low-carbon funding is one of their core competencies. Specifically in Saxony, there have been the Landeswohnungsbauprogramme (federal domestic building programmes) and Energiespardarlehen/Darlehen energetische Sanierung (loans for energy efficient retrofitting) with 1% interest over 25 years which have been allocated through the SAB.

A point of criticism has been that "energy agencies for instance are only partially focused"[41] on an integrated and comprehensive retrofit approach. They promote individual building component retrofits and funding thereof equally as comprehensive whole-building approaches. Similar criticisms have been raised by some institutional interviewees for KfW funding programmes. "The KfW provides funding for individual component retrofits but I believe it does not require or demand a whole-house view to

[38] "die gleichen energetischen Anforderungen hat wie die Bundesfoerderung und hier einen kleinen zusaetzlichen Schmankerl oder Sahnehaeubchen oben drauf gibt." (6)
[39] „...es ist ein Zusammenspiel der Foerderung, dass sehr wichtig ist, damit Massnahmen miteinander kombiniert werden." (6)
[40] "Ich sag mal so, in Sachsen ist es ja so geregelt, dass es inzwischen eigentlich nahezu nur noch Programme ueber die Saechsische Aufbaubank gibt, weil man das ja zentralisiert hat." (1)
[41] "Und die Energieberatungen beispielsweise sind darauf erst teilweise ausgerichtet." (5)

ensure that the funded component fits with an integrated whole-house concept, to ensure that building parts have not been chosen randomly."[42]

5.2.6.6. Market situation and uptake of low-carbon finance

As discussed in the literature review, windows of opportunity for comprehensive domestic retrofitting are few and far between. An interviewee from a regional energy agency observed that "once something is broken and the need to retrofit arises, to then take available funding for something that would be done or had to be done anyway, that is simply a normal or logical case."[43] While this windfall gain approach suggests that low-carbon funding is not crucial to encourage domestic retrofits, it facilitates retrofitting in a way recommended by the funders. Conversely, it was described as "rather an exception that someone would say that their building is not in need of retrofitting and retrofits anyway to access energetic funding."[44] On the other hand, other interviewees observed that financing of energy efficiency technology, particularly in new-builds, is increasingly done without funding support.

Applications for low-carbon funding can vary depending on market situations. Periods of low interest rates can cause funding pots to not get completely exhausted. "We are experiencing this at the moment because of the low interest period that funding is not completely used up. This would completely change again with an interest rate increase by half a percentage."[45] Once the market interest rate is approximately the same as the preferential interest rates, low-carbon funding is no longer a focus for retrofitting and loses its attraction. At this point, "funding is not always attractive because of the administrative effort if conservative funding options are similarly attractive"[46]. Low-carbon funding can be challenging in terms of complex forms to complete and the stress of providing target evidence. Low interest rate situations then add to existing barriers of uptake for low-carbon funding, such as low awareness of funding opportunities.

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[42] " Es werden ja Einzelmassnahmen von der KfW gefoerdert, aber ich glaube dass die KfW eben noch nicht jetzt fordert, dass mal jemand sich das Gebaeude in der Gesamtheit angeschaut hat, um sicher zu stellen, dass das, was gefoerdert wird, auch in so ein Gesamtkonzept passt und nicht eine mehr oder weniger willkuerlich nach dem Zufallsprinzip ausgewaehlte Massnahme ist."

[43] "Und wenn etwas ohnehin dran ist, weil dort was kaputt ist und man etwas tun muss, dann diesen Mitnahmeeffekt zu nutzen, das ist einfach auch der Normalfall und der logischere Fall." (1)

[44] "Aber dass jemand sagt, eigentlich ist mein Haus in Ordnung, aber die geben da jetzt Geld und jetzt mach ich da mit - hm, ich glaube, das ist eher der Ausnahmefall." (1)

[45] „Das erleben wir so zur Zeit einfach mit dieser Niedrigzinsphase, dass die Foerdermittel nicht komplett ausgeschoepft werden, was sich aber einfach durch einen Anstieg von einem halben Prozent der Zinsen wieder komplett aendern wuerde." (6)

[46] „Daher sind Foerdergelder nicht immer attraktiv aufgrund des administrativen Aufwands, wenn konservativere Finanzierungsoptionen aehnlich attraktiv sind." (2)

Nevertheless, funding still needs to be made available and accessible irrespective of market interest rates to maintain planning reliability even when interest rates increase again. As one institutional interviewee explained, "it would have disastrous consequences if funding was to be cut because it is temporarily not being exhausted."[47] Once interest rates were to rise again by even just 0.5% demand would pick up again and funding would be requested as previously. This highlights the importance of stringent funding policies irrespective of temporary demand changes.

5.2.6.7. Finance and planning reliability

Opinions about the planning reliability provided by Germany's low-carbon funding structure are divided. From the interview data it emerged that while institutions aim to create as much planning reliability through their funding programmes as possible, this does not necessarily translate to homeowners. One interviewee criticised that "there is not enough planning reliability for funding instruments because funding is not separate from the domestic budget"[48]. It was explained that this sentiment was echoed by the building industry: "The industry has repeatedly expressed the need for more planning reliability."[49] Another interviewee argued that while the current low carbon funding depends on the national budget, it should arguably be a legal entitlement: "Funding happens in line with budget situations, and we are calling for a legal right to funding. Especially since planning reliability is very important in the building sector."[50] While individual homeowners certainly need to have funding stability to plan ahead, this is more important for housing associations and even more so owners associations which need a stable planning period of several years to plan and implement building retrofits. It was suggested that under the current situation this is near impossible and housing and home owners associations have to deal with a lot of uncertainty as a consequence. From the institutional side it was stressed that while establishing continuity is important, a public ongoing discussion of the issue is not helpful and only creates more uncertainty for homeowners. There is a view that "discussing the issue of fiscal funding measures will eventually lead to people discussing, awaiting the outcomes of such

[47] „Es waere ganz schlimm, wenn die Mittel auf einmal wieder zusammengekuerzt wuerden, weil eventuell diese Mittel im Moment nicht benoetigt werden." (6)
[48] "Insgesamt fehlt auch die Planungssicherheit ueber die Foerderinstrumente, da keine haushaltsunabhaengige Foerderung existiert." (2)
[49] "Auch die Industry betont wiederholt, dass es mehr Planungssicherheit geben muss." (2)
[50] "Es wird praktisch gefoerdert nach Kassenlage, kann man sagen, und wir plaedieren dafuer, dass es einen gesetzlichen Anspruch auf die Foerderung geben sollte. Gerade eben weil Planungssicherheit im Gebaeudebereich sehr wichtig ist." (5)

discussions and doing *nothing*."[51] Therefore any institutional discussions run in the background and are not to be made a public display.

5.2.6.8. Finance and the building sector – architecture, building components and retrofitting

An interviewee from the building sector stressed that they only recommend funding support in the form of loans with preferential interest rates from the KfW although there used to be a historic funding connection with BAFA (Bundesamt fuer Wirtschaft and Ausfuhrkontrolle) and SAB. Despite the limited recommended sources, it was expressed that more funding for low-carbon technologies and more support in the uptake of such technologies was desirable: "No, we would much rather wish for instance for similar treatment of PV and solar thermal energy, since there is no support for solar thermal energy – in multi-apartment buildings occasionally but in single dwellings nothing at all"[52] An example suggestion of the interviewee was for instance to treat photovoltaic technologies and solar heating technologies equally preferentially in funding decisions.

It was generally considered that while institutional impact on energy efficiency in the built environment is significant, it still largely depends on the homeowner's interest and self-accountability if any retrofitting and subsequent funding thereof takes place. "If there is no apparent interest in this, then the guiding effect [of information and funding] cannot be felt by which homeowners decide to apply a more ambitious building standard than they normally would have done without funding support."[53]

One interviewee from the third sector criticised the need for a more stringent policy for sustainability funding and financial support. They explained that there are currently three major barriers to domestic retrofitting in Germany – "because they are not known enough and because the funding process can be complex and because of the current interest rate situation"[54] (at the time of recording). These issues led in their view to not all available funding being used up. Interestingly, a similar set of barriers was observed by institutional interviewees. Among the issues mentioned were "foremost a problem

[51] " Deshalb auch jede Diskussion darueber, dass es eine steuerliche Foerderung geben sollte und so weiter sorgt eigentlich nur mehr dafuer, dass die Leute wieder mehr diskutieren, abwarten und nichts machen." (6)
[52] "Nein, wir wuerden uns viel mehr wuenschen, zum Beispiel eine Gleichbehandlung von PV und Solarthermie, da es fuer Solarthermie im Moment gar nichts gibt – im Mehrfamilienbereich vereinzeltes aber im Einfamilienhausbereich nichts." (4)
[53] „Wer sich nicht dafuer interessiert, wird dann die Lenkungswirkung auch nicht zu spueren bekommen indem sich solche Gebaeudeeigentuemer fuer einen besseren Gebaeudestandard entscheiden als sie das normalerweise gemacht haetten ohne Foerdermittel in Anspruch zu nehmen." (5)
[54] „weil sie nicht bekannt genug sind und weil der Foerderungsprozess sehr komplex sein kann und aufgrund der derzeitigen Zinssituation." (2)

with publicity"[55], "knowledge gap with the consumers who should use the funding, and builders who are often approached about funding opportunities"[56], "complexity of the funding process and a lack of awareness-raising for specific funding possibilities."[57] According to them, "funds are not being fully used up."[58] These statements are in contrast with other interviewees' insights, as above.

Finally it was divulged that "through examinations the funding programmes are evaluated annually to avoid undesirable developments and to understand how funding can be improved further as well as the actual impact of the funding."[59] These funding evaluations are published and publically available.

5.2.7. Institutions and Governance

The governance section covers aspects of special governance but also policy and legislation in the area of energy efficiency in the built environment.

5.2.7.1. Energy efficiency trinity

In Germany there is a trinity of laws and policies, funding and information – and these are complementary and mutually supportive. While regulatory requirements make energy efficiency increasingly mandatory, the national funding body KfW provides the funding for the development of energy efficiency measures and technologies and the information aspect then assures that there is demand and a market for these technologies. All three columns - policy, funding and information - are needed. This is a sentiment that was echoed across the majority of the interviews for the Germany case study. Beyond the established need for the three columns of energy efficiency, it was also stressed that information, legislation and funding are all of comparatively equal importance for building retrofits. As one interviewee stated, "I would weigh them as comparatively equal. You cannot remove any one of the three columns. All things considered, there are probably some minor differences between them but I wouldn't want to differentiate them in percentages."[60] The interviewee continued: "One thing is certain; we are dependent on a bundle of instruments. It doesn't work with one

[55] „...vorallem ein Problem mit der Bekanntheit..." (2)
[56] „...Informationsluecken bei Verbrauchern, die die Foerdermittel in Anspruch nehmen sollen und Handwerkern, die zumeist zu Foerdermitteln angesprochen werden..." (2)
[57] „...Komplexitaet der Foerderungsablaeufe, fehlendes Aufmerksammachen auf bestimmte Foerdermoeglichkeiten." (2)
[58] „Teilweise werden diese Mittel aber anscheinend gar nicht abgerufen." (2)
[59] „Und durch diese Untersuchung, wir lassen diese Programme jaehrlich evaluieren, um Fehlentwicklungen auch zu vermeiden und rauszufinden, wo kann man die Foerderung nochmal wieder verbessern und was kann man da machen, was bringt diese Foerderung auch." (6)
[60] „Ich wuerde die schon vergleichsweise aehnlich gewichten. Also man kann jetzt nicht auf eine von den drei Saeulen verzichten. Unterm Stich koennen die sich sicherlich nochmal unterscheiden, aber so prozentuale Unterscheidungen wuerde ich da jetzt nicht anstellen wollen." (5)

instrument or one measure but with a bundle. This is a complex task that we need to deliver."[61]

The interviews included a question around the interconnection between funding and policy. As one interviewee observed, "promoting funding through legislation would be difficult apart from ensuring a legal right to funding which ensures reliability and availability of funding pots"[62]. He went on to explain that this already exists for renewable energy in the building sector through market incentive programmes, such as the heat from renewable energy directive (erneuerbare Energienwaermegesetz). According to the interviewee, this directive involves a right to accessible funding for renewable energy at a specified amount. While this funding pot could be used up by high demand, it nevertheless guarantees a base pot of annual funding and thereby creates improved planning reliability for heat from renewable energy technologies.

5.2.7.2. Planning reliability

Planning reliability has emerged as a major theme throughout the institutional interviews in Germany. Its importance for energy efficiency retrofitting was stressed again and again by various interviewees in light of homeowners, housing associations and homeowner collectives investing in energy efficiency in the built environment. Planning reliability is seen as an institutional task but one that is not consistently done satisfyingly. It was noted that beyond homeowners, planning reliability is also necessary on a policy level. Furthermore, "the building sector has also stressed repeatedly that more planning reliability is necessary."[63]. Interviews were recorded during the legislative period 2015 and "within this legislative period should have taken place the updating of the EnEff and EWaermeG which now can definitely not be completed although it is stated in the coalition agreement."[64] A third sector interviewee claimed that "these policies might need a fundamental make-over. Some of their requirements are contradicting each other or being duplicated with regards to similar situations"[65].

[61] „Also eins ist klar, wir sind angewiesen auf ein Instrumentenbuendel. Es geht nicht mit einem Instrument oder einer Massnahme sondern mit einem Buendel. Das ist eine recht komplexe Aufgabe, die da zu bewaeltigen ist." (5)

[62] „Foerderung ueber die Gesetzgebung voranbringen koennte schwierig sein, also abgesehen von einem gesetzlichen Foerderanspruch, der die Verlaesslichkeit von Foerdermitteln sicherstellt." (5)

[63] „Auch die Industry betont wiederholt, dass es mehr Planungssicherheit geben muss." (2)

[64] „Innerhalb dieser Legislaturperiode haette die Novelierung EnEff und EWaermeG bzw deren Abgleich und die Weiterentwicklung stattfinden sollen, was nun definitiv nicht mehr abgeschlossen werden kann, obwohl es im Koalitionsvertrag steht." (2)

[65] „ Diese Regelwerke beduerfen einer fundamentalen Weiterentwicklung - teilweise widersprechen oder ueberschneiden sich Bedingungen innerhalb dieser beiden Gesetze bezogen auf die selben Situationen." (2)

Planning reliability can hereby be seen as 'good policy maintenance' and maximised policy efficiency.

5.2.7.3. Governance levels

Some of the interviewees criticised that the interaction between the national and local level could be improved as "both levels complain about the lack of linking up between each other"[66].

An institutional interviewee observed that "good models are already implemented on the federal level which could be a template to establish sensible national policy"[67]. These approaches are of particular importance since many responsibilities lie with the federal states at the regional level, such as fiscal and tax deductibility. The idea of a climate change levy for instance would fall into the tax sovereignty of the federal state. When this levy was discussed for implementation, this federal sovereignty became a barrier. The levy or in fact any tax-related funding would apply at regional level so it failed.

According to an institutional interviewee, "a more intensely linked up approach between the national and regional level would be good to allow data collection of activity in the federal states level to see what is happening and understand which models are working well and these could then be much more integrated into national policy."[68]

5.2.7.4. Policies

There was a general acknowledgement amongst the interviewees that energy efficiency in buildings is playing an important role in Germany's sustainability agenda. "We have great goals and so on until 2050 for the building sector, but the Ministry of Economic Affairs and Energy is the decision-maker in this case, and they want to achieve these with funding rather than regulations"[69], according to the Department of trade and industry. However, some doubt was expressed: "We have our doubts if all this can be achieved through funding alone."[70]

[66] „Beide Ebenen beklagen, dass es zu wenige Verknuepfungen gibt." (2)
[67] „Auf Landesebene finden oft bereits gute Modelle statt, die moeglicherweise als Vorlage dienen koennten um eine sinnvolle Bundesgesetzgebung zu etablieren." (2)
[68] „Es waere schoen, wenn es eine intensivere Zusammenarbeit gebe, dass man Daten zur Aktivitaet in den Laendern sammelt um zu sehen, was passiert und welche Modelle gut funktionieren und diese staerker in die Bundespolitik einfliessen zu lassen." (2)
[69] "Wir haben zwar schon tolle Ziele bis 2050 und so weiter, was alles im Gebaeudebereich getan werden muss, aber das Sagen hat das Wirtschaftsministerium in diesem Fall und die sind der Meinung wir wollen das nicht mit Ordnungsrecht erreichen sondern eher mit Foerderung." (5)
[70] „Und ob das gelingt, das bezweifeln wir so ein bisschen, ob das allein mit Foerderung klappen koennte." (5)

Generally it was perceived that "for energy efficiency we have a much differentiated policy landscape."[71] As shown in Figure 35, there are a number of institutions, policies and funding approaches in this space that were discussed in the interviews during the data collection. It should be noted that the below is not a complete list and illustrates the differentiation as per the previous quote. The next section will explore some of these policies through data from the interviews.

Figure 35: Germany's 'differentiated policy landscape' - selected institutions, policies and funding discussed during data collection (Source: Own illustration)

Energy Efficiency Directive

A third sector respondent remarked "that the EED is not performing as well in Germany as it may seem. Germany is still seen as a pioneer but the remaining problems must be highlighted at the European level."[72] The same interviewee sees the most important pieces of regulation for energy efficiency as Energieeinsparverordnung and Erneuerbare Energienwaermegesetz as well as Mindestwaermeschutz.

A respondent from the building sector perceived that "at the moment the focus of policy-makers is on other topics, like the tightening up of the EnEff next year"[73] when it should be on creating a level playing field for energy efficiency technologies, according to him.

[71] "Fuer Energieeffizienz an sich haben wir ja eine sehr ausdifferenzierte Gesetzgebung [...]."(5)
[72] „dass die Umsetzung der EED in Deutschland nicht so gut funktioniert wie es vielleicht den Anschein hat. Deutschland wird noch immer als Vorreiter betrachtet, aber es muessen auf europaeischer Ebene die Probleme deutlich gemacht werden, die es noch gibt." (2)
[73] „Im Moment stehen andere Themen auf der Tagesliste, wie die Verschaerfung der Energieeffizienzverordnung naechstes Jahr." (4)

It was mentioned that "it would be supported to combine several policies in to one efficiency policy. The EnEff is constantly being developed which makes the standards harder and harder to achieve."[74] Seeing as the EnEff is constantly being developed and achieving the required standards is increasingly difficult it was ventured that the current standards might also not be logical or practical enough. Another critical point about the EnEff was raised: "Further, a holistic approach towards building retrofits is also not considered since technology can for instance compensate for the insulation and vice-versa. Individual components can be added up whereas a holistic view of the building would be decisive"[75].

Energy Savings Ordinance

Another important piece of legislation is the Energy Savings Ordinance. "The Energy Savings Ordinance is key; it limits the primary energy consumption of buildings both new-built and retrofit"[76]. One of its major criticisms is "that the difficulty is due to federal states being responsible for its enforcement and enforce in various levels of intensity"[77] This might be due to factors such as costs since monitoring and control are very cost intensive. It was suggested that "we could expect an improvement through financial support from the national state [...] The national state could motivate the federal states to be more engaged in the matter."[78]

It was further elaborated that whether enough funding is available to achieve the energy efficiency goals "is depending on the regulatory basis on which the funding rests."[79] With a view of current regulatory requirements "based on the current Energy Savings Ordinance it may even be necessary to provide a lot more money to achieve a carbon

[74] „...befuerwortet die Zusammenfuehrung in einem Gesetz, einem Effizienzgesetz. EnEff wird staendig weiterentwickelt, wodurch die Standards nur noch schwer zu erfuellen sind." (2)
[75] „Zudem wird der ganzheitliche Blick bei der Gebaeudesanierung dadurch ausser Acht gelassen, da die Technik z. Bsp. die Daemmung und anders herum kompensieren kann. Die einzelnen Elemente werden gegeneinander aufgewogen, wohingegen ein ganzheitlicher Blick auf das Gebaeude entscheidend waere." (2)
[76] „Da ist ausschlaggebend die Energieeinsparverordnung, die den Primaerenergiebedarf von Gebaeuden begrenzt, sowohl Neubau als auch Sanierung." (5)
[77] „Schwierigkeit besteht darin, dass die Bundeslaender fuer den Vollzug zustaendig sind und die Vollzugsaufgaben in unterschiedlicher Intensitaet wahrnehmen." (5)
[78] „Und wir koennten uns eine Verbesserung dadurch erwarten, dass der Bund vielleicht finanziell unterstuetzt. [...] Er koennte die Bundeslaender vielleicht motivieren, engagierter an die Sache heranzugehen." (5)
[79] "Das haengt natuerlich damit zusammen, wie die gesetztlichen Grundlagen sind, auf denen die Foerderung beruht." (5)

neutral building stock without relying on the massive expansion of renewable energies."[80] Uptake of available funding also depends on the availability of information.

It should be noted that KfW funding "is only provided for measures which exceed the regulative law, meaning the Energy Savings Ordinance"[81]. An institutional interviewee explained that this is part of the Federal Budgetary Regulations. "The Federal Budgetary Regulations in clause 44 in Germany states that funding money may only be spent for measures which exceed requirements of the regulative law."[82]

The Energy Savings Ordinance is the main vehicle for transposing the Energy Performance of Buildings Directive (EPBD) from the EU level to the German national body of law. Figure 36 illustrates the transposition of the EPBD into the Energy Savings Ordinance under jurisdiction of two German federal ministries. This minimises fragmentation of the policy and increases clarity around responsibilities and competencies within government institutions. This in turn causes less resistance and inefficiencies in the implementation of the policy at the national level.

[80] „Wenn man von der jetztigen Energieeinsparverordnung beispielsweise ausgeht, kann es sogar sein, dass man sehr viel mer Geld in die Hand nehmen muss um Richtung klimaneutralen Gebaeudebestand zu kommen, ohne erneuerbare Energien im riesigen Umfang ausbauen zu muessen." (5)

[81] „Weil die Foerderung wird immer nur ausgereicht bei Massnahmen, die ueber das Ordnungsrecht, also ueber die Energieeinsparverordnung hinausgehen." (6)

[82] Die Bundeshaushaltsordnung im Paragraph 44 in Deutschland regelt, dass man Foerdergelder nur ausgeben darf, wenn Massnahmen, die vorgeschrieben sind... wenn man nur Massnahmen foerdert, die ueber das Vorgeschriebene hinausgehen." (6)

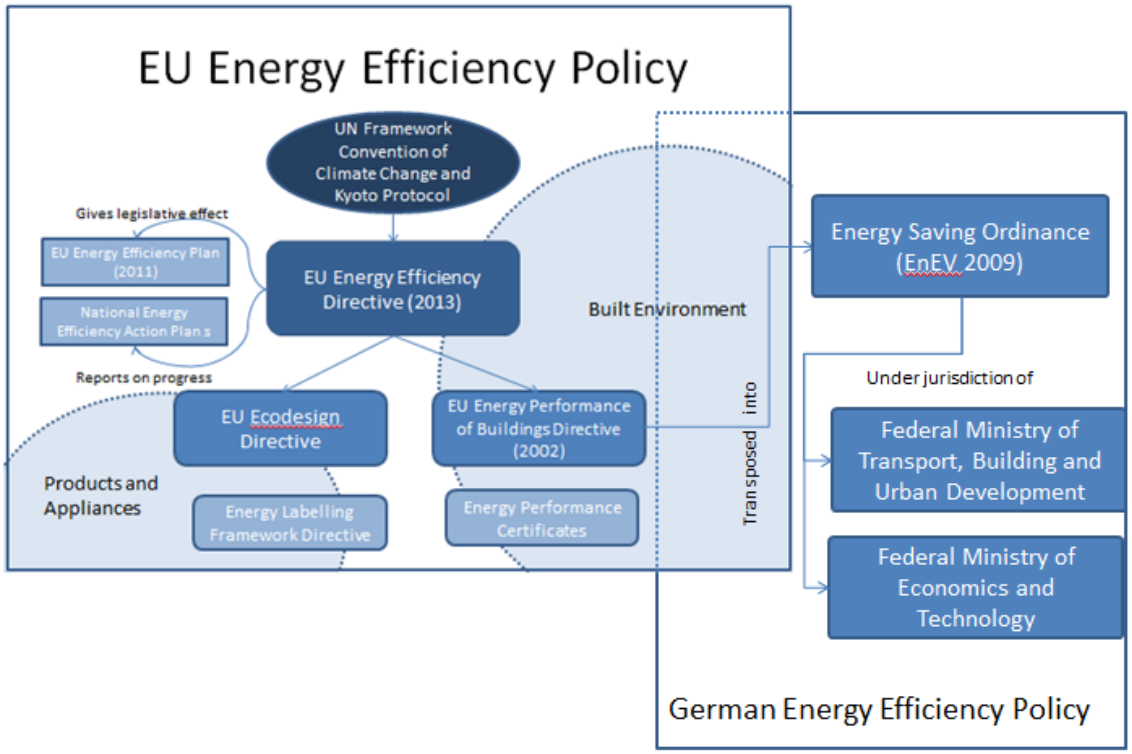

Figure 36: Main EU and German Energy Efficiency Policy (Source: Own illustration)

It was also mentioned during the interviews that the Energy Savings Ordinance is due to be further developed. "Findings from model projects and the funding are used to examine how to further develop the Energy Savings Ordinance"[83] as an institutional interviewee explained. "This happens via neutral scientific organisations in Germany such as the Frauenhofer Institut or Institut fuer Wohnen und Umwelt Darmstadt which have built up expertise over the last years"[84] to ensure academic rigour and unbiasedness. These findings are then "analysed by my colleagues in the ministries of economy, environment and construction who examine it further with the scientists and the politicians to understand how the regulatory law can be further tightened."[85]

Energy Conservation Act

The Energy Conservation Act was described as "this is the enabling provision for the Energy Savings Ordinance meaning it states that such an ordinance should exist and that it should be implemented. But the Energy Conservation Act also includes a

[83] „Und dann gehen auch Erkenntnisse aus dem Modellvorhaben, aus der Foerderung generall auch wiederum in Untersuchung zur Weiterentwicklung der Energieeinsparverordnung." (6)
[84] „...was wiederum durch neutrale wissenschaftliche Einrichtungen hier in Deutschland geschieht - Frauenhofer Institut, Institut fuer Wohnen und Umwelt Darmstadt etc. Verschiedene Bereiche, die hier Expertisen auch aufgebaut haben, in den vergangenen Jahren." (6)
[85] "Die Energieeinsparverordnung wird von meinen Kollegen hier im Haus im Wirtschaftsministerium wie auch durch die Kollegen im Umwelt- und Bauministerium mit untersucht und mit den Wissenschaftlern zusammen und mit der Politik gemeinsam halt entdeckt, wie kann man das Ordnungsrecht weiter verschaerfen." (6)

principle of economic feasibility which can be interpreted in various ways."[86] It was stated that the act can be interpreted conservatively or progressively. It was further said that "at the moment, and in the past, it has been interpreted very conservatively with the consequence that the Energy Savings Ordinance has not been developed or tightened up progressively, like we would have wanted it"[87].

National Action Plan on Energy Efficiency (NAPE)

Each member state of the EU develops a mandatory NAPE. As one interview described it, "the document was written at the start of the new legislative period and includes certain measures in part B which shall be taken to further energy efficiency in the building sector."[88]

During the interviews, however, some of the respondents elaborated on some aspects of the German NAPE. So it was mentioned that the NAPE also includes the introduction of a funding standard 'Efficiency House Plus' for domestic buildings. According to a respondent, "homeowner associations which are reluctant to retrofit are being targeted to become more active in terms of retrofitting"[89] through this standard.

An interesting comment from one of the institutional interviews was around low-carbon funding volumes. According to him, "one aspect of [the NAPE] is the further development, consolidation and increase of the CO2 building retrofit programme, meaning the funding programmes of the KfW. This led to a decision to increase funding for the CO2 building retrofit programme by EUR2.5million."[90] Part of this increase from EUR1.8bn to EUR2bn is meant to allow for the development of certain building areas. He further stated that "a certain part of the EUR2bn funding will be provided for grant funding."[91]

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[86] „Das ist die Ermaechtigungsgrundlage fuer die Energieeinsparverordnung, also darin wird festgehalten, dass es solch eine Verordnung geben sollte und das ist ja umgesetzt wurden. Aber das Energieeinspargesetz enthaelt auch einen Wirtschaftlichkeitsgrundsatz, der so oder so interpretiert werden kann." (5)

[87] „Zur Zeit ist das noch so, und in den vergangenen Jahren war es noch so, dass er sehr konservativ interpretiert wird mit der Folge, dass die Energieeinsparverordnung nicht so progressiv weiterentwickelt und verschaerft wurde, wie wir das gerne gehabt haetten." (5)

[88] " Also das Papier ist geschrieben worden zu Beginn der neuen Legislaturperiode und da gibt es in dem Teil B bestimmte Massnahmen, die ergriffen werden sollen um gerade auch Energieeffizienz im Gebaeudebereich voranzubringen." (6)

[89] "Man moechte es erreichen, dass Wohnungeigentuemergemeinschaften, die eher zurueckhaltender sanieren, staerker aktiviert werden um Sanierungen durchzufuehren." (6)

[90] „Und darin ist eben auch ein Aspekt die Weiterentwicklung, Verstetigung und Aufstockung des CO2-Gebaeudesanierungsprogramms, also dieser KfW-Foerderprogramme. Und damit wurde beschlossen, dass man das CO2-Gebaeudesanierungsprogramm um EUR2,5 Millionen aufstockt." (6)

[91] „Und dass man einen gewissen Teil dieser EUR2Mrd fuer eine Zuschussfoerderung zur Verfuegung stellt." (6)

Beyond the above funding standard, the NAPE has further provisions which are relevant for low-carbon funding in the domestic building sector. ”It includes a point on immediate measures in the shape of tax funding of retrofitting to support homeowners. This was included for homeowners which may not want to apply for KfW funding. These are opportunities for tax deduction for private homeowners”[92] as an institutional interviewee explained. Under the current legislation, “landlords can use tax deductions anyway. But private homeowners weren’t able to do this in Germany”[93] he continued. However, financing this law was contentious at the regional level which led to a failure of this law: “Which is why in politics the wish arose to do this. But no consensus was found on how to finance it. And finally in February earlier this year it failed because no agreement could be found with the federal states.”[94] The interviewee further explained that talks are ongoing to resolve the funding issue. As became evident throughout the interviews, the institutional level is aiming to provide seamless funding support for energy efficiency measures in the built-environment in Germany and this is an example of closing gaps in funding: “Through this, gaps in the existing funding are being closed.”[95]

Other

A very separate aspect unrelated to previous governance themes but nevertheless interesting is the mention of clause 559 AGW in one of the interviews which relates to profits from properties that have benefitted from KfW funding. According to one respondent it stipulates that “The landlord does not profit twice. He cannot receive funding support and simultaneously increase the rent, although he has received funding for the retrofit. This would be tax fraud.”[96]

[92] „Unter sogenannten Sofortmassnahmen gibt es eine steuerliche Foerderung von energetischen Sanierungen, die ist genannt worden um auch die Bandbreite fuer Foerdermoeglichkeiten fuer bestimmte Gebaeudeeingentuemer, die vielleicht keine Foerderung in Anspruch nehmen wollen ueber die KfW, dass diese auch Foerdermoeglichkeiten erhalten. Das sind steuerliche Abschreibungsmoeglichkeiten eigentlich fuer private Gebaeudeeigentuemer.“ (6)

[93] „Jeder der im vermieteten Wohnbereich vor Ort ist kann eh Massnahmen immer steuerlich abschreiben. Aber private Gebaeudeeigentuemer konnten dies oder koennen das nicht in Deutschland.“ (6)

[94] „Deshalb ist da jetzt aus der Politik der Wunsch daraus entstanden, das zu machen. Wo man sich allerdings nicht einigen konnte, wie man dieses Ganze finanzieren soll. Und das ist dann letztendlich im Februar diesen Jahres gescheitert, das man sich nicht geeinigt hat mit den Laendern gemeinsam. (6)

[95] „Damit wird dann nochmal eine Luecke geschlossen, die in der bestehenden Foerderung besteht.“ (6)

[96] „Dass also der Vermieter nicht doppelt davon profitiert. Er kann nicht eine Foerderung erhalten und dann gleichzeitig eine hoehere Miete dafuer nehmen, obwohl er eine Foerderung dafuer erhalten hat. Das waere ein Steuerbetrug.” (6)

5.2.8. Technology

5.2.8.1. Increasing retrofitting

As mentioned in the introduction of the Germany case study, increasing the occurrence of domestic retrofitting annually is a strong focus of the national energy efficiency efforts in the built-environment. It was thus one of the interview questions whether in the opinion of the interviewees increased energy efficiency funding from the KfW would lead to more domestic retrofits per year in Germany. As previously mentioned, to achieve national energy efficiency targets by 2050 the rate of domestic retrofitting would need to double annually. As one interviewee explained, while KfW sees the need to do more to increase retrofitting from 1% to 2% annually, it sees the question as to whether enough is being done in the sector as one to be posed to the national government. This is partly due to the assumption that it is unlikely that energy efficiency funding increases the uptake of retrofitting: "I believe that that the decision to retrofit has probably already been made but the availability of the funding increases the ambition of the homeowner for the retrofit, and so they might achieve a higher energy efficiency level than they would otherwise."[97]

Another interviewee questioned the logic behind the 'increased funding equals increased retrofitting' idea. One interview illustrated this on the topic of retrofitting heat pumps. "Normally 1 million heat pumps are replaced annually which the government would like to increase to 2 million to reduce energy costs and carbon emissions. Practically speaking this raises the question why 2 million households should want to replace their heat pumps."[98] They added. "the second barrier is that the construction industry might not be able to replace twice the volume per year"[99] and ventured to mention another doubt about increased retrofit uptake: "In addition, this approach might consolidate current technologies, such as oil heating. This might prolong the use duration of technologies which aren't necessarily desirable any

[97] "Ich glaube, dass die Entscheidung zu sanieren, das zu machen, wahrscheinlich schon getroffen ist, dass die Foerdermittel aber dazu fuehren, dass die Leute vielleicht mehr machen und vielleicht ein hoeheres Effizienzniveau erreichen als sie sonst erreichen wuerden." (3)

[98] "Normalerweise werden 1 mio/Jahr Heizungspumpen ausgetauscht, was die Bundesregierung auf 2 Millionen steigern moechte um Energiekosten zu senken und CO2 einzusparen. Praktisch gesehen stellt sich jedoch die Frage, warum 2 Millionen Leute ihre Heizungspumpe austauschen wollen sollten." (2)

[99] "Die zweite Huerde ist, dass die Branche das doppelte Volumen innerhalb eines Jahres auszutauschen nicht leisten kann." (2)

longer"[100], making it harder for innovation to expand in the market over the next few years.

It appeared that "generally, these actions are seen as short-termist and all agents and associations in the industry show little enthusiasm for such activities. In their view, these activities only serve to provide proof in numbers that something is done to achieve the targets"[101] and they receive little support from industry and business. In fact, there was some doubt regarding the industry's capability to keep up with demand if twice as many retrofits ever materialised. "...doubling the funding amounts does not lead to an automatic doubling of the retrofitting rate because order need to be completed and take a lot of time"[102], as one interviewee rightly stated.

5.2.8.2. Depth of retrofitting

Increased uptake of retrofitting does not of course guarantee the quality of the delivered energy efficiency measures. But there is increasing evidence that funding plays a crucial role in ensuring that the achieved depth of the retrofits complies with or surpasses national regulatory requirements. This supports the argument that there is a role to play for energy efficiency funding in the transition to a decarbonised domestic building stock. Interviewees generally agreed that funding is necessary to achieve better standards of energy efficiency. The concern of one institutional respondent was that "Building retrofits are often done without use of funding support but to a lower level. These often turn into the problem cases, if you so want, which make it difficult for us to achieve the goal of a carbon neutral building stock by 2050."[103] He advised that "These would have to be repeated at a later point. Either that or at the least insulation would need to be topped up which either way will cause additional costs that could have been done at much, much lower costs during the first time the insulation what applied."[104] This means that any retrofits which are currently undertaken without the use of energy

[100] "Ausserdem manifestiert man damit die derzeitigen Technologien, was teilweise noch Oelkessel etc. sind. Dadurch koennen moeglicherweise Lebensdauern von Technologien verlaengert werden, die nicht unbedingt mehr wuenschenswert sind." (2)
[101] "Diese Massnahmen sind recht kurzfristig gedacht und alle Akteure aus der Industie und den Verbaenden zeigen wenig Begeisterung fuer solche Aktionen. Aus Sicht der [...] dienen diese Aktionen nur dazu rein rechnerisch zu belegen, dass etwas getan wird um die Ziele zu erreichen." (2)
[102] "...eine Verdopplung von Foerdermitteln fuehrt ja nicht dazu, dass automatisch der Sanierungsmarkt sich verdoppelt, weil Auftraege ja auch einfach abgearbeitet werden muessen und Zeit benoetigt wird dafuer." (6)
[103] "Es werden ja auch viele Gebaeude ohne Inanspruchnahme von Foerdermitteln gedaemmt, aber halt auf einem anderen Niveau. Das sind dann letztlich die Problemfaelle, wenn man so moechte, die uns das Ziel im Jahr 2050 einen klimaneutralen oder nahezu klimaneutralen Gebaeudebestand zu erreichen erschweren." (5)
[104] "Das muesste man dann glatt nochmal machen. Entweder das oder Daemmung aufdoppeln und das sind dann Zusatzkosten, die entstehen und die man am Anfang beim ersten Aufbringen der Waermedaemmung mit viel, viel geringeren Zusatzkosten haette erledigen koennen." (5)

efficiency funding create a tremendous opportunity cost. As one interviewee put it, "And this is essentially a point around which the funding programmes or legislation should be centred if the 2050 goals are taken seriously."[105]

During the interviews this topic became a very interesting area to explore. An institutional interviewee stated bluntly that "it is the case, we see it clearly in statistics, that homeowners are more ambitious with those funded [retrofits]"[106] than unfunded ones. He continued that "Especially the homeowners who aim for the energy efficiency house standards which receive the higher level of funding retrofit more holistically [...] but from what we can observe, homeowners would achieve a higher energy efficiency level with the funding support."[107]

This was also explained as the reason why specific energy standards are required for funding which have to be complied with. As one interviewee explained "it is not the CO_2 savings that are funded because homeowners who have neglected their building's energy efficiency would then benefit from the highest possible funding advantage"[108] whereas homeowners who have consistently maintained and retrofitted their building would be disadvantaged. He continued that "we support the homeowners which are proactive. And that is the important thing, rather than the pure CO_2 reduction."[109]

Another interviewee stressed that "the message here isn't a digital yes/no, to retrofit or not retrofit; this is not what this is decided on. But it the question when I retrofit which energy efficiency level am I aiming for."[110] And while it is possible that there is an element of the bandwagon or free-rider effect in the uptake of energy efficiency funding, these is almost impossible to measure and also not relevant as it only increases the energetic robustness of retrofits. Another interviewee agreed, saying that "I have to say honestly I am not certain if there are homeowners who will retrofit due to available funding rather than due to the need to change building components. I haven't come

[105] "Und das ist letztendlich ein Punkt, an dem die Foerderprogramme oder gesetzlichen Vorschriften ausgerichtet werden muessten, wenn man das mit dem Ziel 2050 ernst meint." (5)
[106] "Da ist es auch so, dass wir relative klar in den Statistiken sehen, dass das was gefoerdert wird, dass die Leute da ehrgeiziger sind." (3)
[107] "Gerade die Leute, die auf Effizienzhausstandards gehen, wo es nachher auch einen groesseren Zuschuss fuer gibt, machen in der Regel eine wesentlich gruendlichere Sanierung. [...], aber nachdem was wir sehen, wuerden die Leute auch auf ein hoeheres Energieeffizienzniveau mit Foerderung kommen. (3)
[108] „Wir foerdern ja nicht die erreichte CO2-Einsparung, weil Gebaeudeeigentuemer, die jahrelang nichts gemacht haben, dann halt die groesstmoeglichen Foerdervorteile davon ziehen wuerden" (6)
[109] "Wie unterstuetzen die Leute, die halt auch was machen. Und das ist eben das wichtige und nicht die reine CO2-Einsparung." (6)
[110] "Hier ist die Botschaft, dass es eben nicht dieses digitale ja/nein, saniere ich oder nicht, da entscheidet sich das nicht dran. Sondern es ist die Frage, wenn ich saniere, was fuer ein Energieeffizienzniveau strebe ich an." (3)

across this in my observations."[111] The view here was since the retrofit decision has already been taken "this would be just common economic sense"[112] on the part of the homeowner.

A related but separate consideration of homeowners could be an anticipation of greater sales values of properties after home retrofitting. After all, increased energy efficiency results in lower energy bills and higher disposable income and recent home improvements are likely to reduce home maintenance costs (Fuerst et al.2016). Recent studies (Fuerst et al. 2015; Fuerst et al. 2016)estimated significant positive premiums for energy efficiency in England and Wales and finds a positive association between dwelling price and energy performance. The studies however highlighted a split-incentive problem between owner-occupiers and buy-to-let investors. "Buy-to-let investors may not apply the same discounts to low-EPC dwellings that owner-occupiers would because energy costs are passed on to tenants" (Fuerst et al.2016, p. 29).

5.2.8.3. Construction sector and homeowners

There seemed to be some agreement among institutional and third sector interviewees about the need for education in energy efficiency technology and innovation in the building sector. In fact, a lack of understanding of and therefore support for energy efficiency seems to be perceived at a significant barrier to effective upscaling of domestic retrofitting.

It was stressed by an institutional interviewee that there is a need to educate and upskill builders in terms of funding and technologies. "This is a difficult area because many skills would be necessary to implement the legally by the Energy Savings Ordinance required new technologies. Builders often recommend only what they have been familiar with for a long time. But there are new products and materials with a diverse range of features."[113]

There was further a perception that the construction sector "on the other hand is also sceptical of innovation."[114] This uncertainty about new technologies means that "be it

[111] "Also ich muss ganz ehrlich sagen, ich bin mir immer nicht so sicher, ob es tatsaechlich Bauherren gibt, die, weil es die Foerderung gibt, jetzt eine Massnahme angehen, wo sie sonst noch keinen Leidensdruck hatten. Da bin ich einfach noch nicht so ganz... Also es ist mir in den Beobachtungen noch nicht aufgefallen." (1)
[112] "Und das waere dann volkswirtschaftlich schon sinnvoll." (3)
[113] "Das ist ein schwieriger Bereich da eigentlich viele Schulungen und Kenntnisse notwendig waeren um permanent auch gesetzlich durch die Energieeinsparungsverordnung vorgeschriebene Neuerungen umzusetzen. Handwerker empfehlen oft nur, womit sie sich seit langer Zeit auskennen. Es gibt jedoch neue Produkte und Materialien mit unterschiedlichen Eigenschaften." (2)
[114] "Andererseits auch eine gewisse Skepsis gegenueber Neuerungen." (5)

higher depths of insulation, ventilation system or heating system – all of it struggles to disseminate through the building sector"[115], as one institutional interviewee put it.

This sentiment, however, was not seconded by an industry respondent. When asked whether specialist technical knowledge was needed and if they struggled with recruiting such technically skilled labour they responded: "No, not really. Two solar engineers work in-house who design everything and everything else is common building work. Special training is not necessary."[116]

But while most of the criticism was aimed towards the building sector, it was noted that "this also applies to architects. It is also about the quality of energy consultants because energy consultant is not a protected title. There is a need to improve the quality of energy advice in terms of funding possibilities and options, e.g. for insulation."[117] One of the interviewees suggested that a central information centre be set up. This is a role, it should be noted, that is already being carried out by national and regional energy agencies.

5.2.8.4. Components vs whole-building approach

Energy efficiency funding in Germany supports both a whole building approach as well as individual component retrofits. Loans are more likely to be taken out for whole building retrofits while grants often support component retrofits. The energy agencies are an information provider for both and receive questions on "predominantly technical things. Questions on funding are usually more of a side issue."[118] One interviewee is critical about grants as she believes that "it is somehow a little crazy because they discourage homeowners from looking at the retrofit holistically and whether everything fits together."[119] Funders however agree with individual component grants seeing as homeowners often follow a piecemeal retrofit approach as and when monies become available for this purpose. While a whole building retrofit is therefore an ideal scenario, the component retrofit approach takes into account the realistic needs of homeowners. One institutional interviewee therefore supports "a holistic and comprehensive pathway

[115] "Und sei es jetzt eine groessere Daemmstaerke, sei es eine Lueftungsanlage, sei es eine bestimmte Heiztechnik, das hat es alles vergleichsweise schwer sich im Gebaeudebestand zu verbreiten." (5)
[116] "Nein, eigentlich nicht. Zwei Solaringenieure arbeiten im Hause, die alles konzipieren und der Rest handelt sich um ganz normale Handwerksarbeiten. Spezielle Schulungen sind nicht noetig." (4)
[117] "... geht es da auch um die Architekten. Dann geht es auch um die Qualitaet der Energieberatung, denn Energieberater ist kein geschuetzter Begriff [...] Es gibt Bedarf, dass die Energieberatung noch besser wird auch in Richtung Foerdermoeglichkeiten und Optionen, z.Bsp. bei der Daemmung." (2)
[118] "Also es sind schon eher so die technischen Sachen. Foerderung, die faellt so nebenbei immer mit ab." (1)
[119] "Ja, es ist ja irgendwie ein bisschen verrueckt, weil dann auch weniger darueber nachgedacht wird, ob das jetzt alles zusammenpasst und so." (1)

to a carbon neutral building stock beyond the existing instruments."[120] He explained the need to devise a retrofitting roadmap for a single unit detached house. This is "because most homeowners do not to retrofit the entire building in one step but rather whenever monies become available."[121] It is for such situations that one institution proposed a roadmap that provides guidance on necessary specifications of building components to be goal compatible to achieve an effective master plan or integrated concept. He explained, "And that is the moment when they would need to know the ideal specification of the currently faulty component in order to ensure this component will be goal compatible. So that means windows, facade, loft insulation or heating or similar, to create a coherent and integrated concept in the end."[122]

Among interviewees there were various opinions about which approach should be supported, though.

5.2.8.5. Systemic retrofitting

Since this thesis research was part of an overarching research programme on systemic urban retrofitting, questions around systemically retrofitting the domestic building sector were a consistent part of the data collection in Germany. It emerged from the interview data that a systemic energetic retrofit across Germany is considered to be very difficult due to the different structures across individual federal states. A valid point was that "A model that works in Berlin or Hamburg (city states) may not make sense in territorial states due to different demographics, housing stock, income structure, age structure - all of these play a decisive role for retrofitters"[123]. It was further established that "A cookie-cutter approach for all federal states is not very logical in a diverse space such as Germany"[124]. Other responses echoed similar sentiments.

One interviewee stated that "Systemic retrofitting does not make sense. A retrofit is only economical for the homeowner, the asset owner and the landlord who lets the home

[120] "...der Weg zum klimaneutralen Gebaeudebestand, wo eben ein umfassendes Konzept auf den Weg gebracht werden muesste ueber die bestehenden Instrumente hinaus." (5)
[121] "[...] weil die meisten Gebaeudeeigentuemer eben nicht in einem Schritt das ganze Gebaeude umsanieren, sondern wenn mal wieder ein bisschen Geld verfuegbar ist." (5)
[122] "Und das ist der Moment, in dem die wissen muessten, was ist die ideale Ausfuehrung des gerade faelligen Bauteils waere um dann dieses Bauteil zumindest erstmal zielkompatibel zu machen. Also Fenster, Aussenwand, oberstes Geschoss Decke oder Heizung oder ahnliches, damit am Ende ein stimmiges Gesamtkonzept steht." (5)
[123] "Ein Model, dass in Stadtstaaten wie Berlin oder Hamburg funktioniert, muss nicht unbedingt in einem Flaechenstaat sinnvoll sein aufgrund unterschiedlicher Demographie, unterschiedlichem Gebaeudebestand, Einkommensstruktur, Altersstruktur - all dies spielt eine entscheidende Rolle fuer Sanierer." (2)
[124] "Eine Schablone fuer alle Bundeslaender ist bei der Uneinheitlichkeit in Deutschland wenig sinnvoll." (2)

out"[125]. The interviewee explained that according to their experiences "measures are being implemented when the time has come for them, meaning when something needs to happen on the building or when something needs replacing"[126], and that "Otherwise, this is not sustainability"[127]. An example they gave was that "Changing roofs or windows when they're only 5 or 10 years old doesn't serve anyone"[128]. They declared that "the timing has to be awaited until the measures need to be implemented. But at that point the measures need to be implemented so they are energetically and sustainably good enough. And then deliver a high standard."[129]

This thought was repeated by an interviewee saying that systemic retrofitting "is unlikely to be realistically executable since nobody knows which standard any individual building has at any one point in time. And this would need to be checked before deciding the order of building retrofits, which building's turn it is."[130]

Another interviewee followed a similar train of thought and focused on the practicalities of a potential systemic retrofitting approach; musing that systemic retrofitting "would require the entire building stock to somehow be recorded"[131] which means "This is of course a gigantic volume of data without which the concept would be unworkable"[132]. They further questioned whether this would need to be centrally recorded or could be locally with the respective financial authority locally or regionally. They concluded the necessity that "The trigger and incentive would need to come from the national level to achieve a unified implementation. But the delivery would happen on the regional level.

[125] "Es hat keinen Sinn es systematisch durchzufuehren. Eine Gebaeudesanierung ist nur wirtschaftlich darstellbar fuer den Eigentuemer, fuer den Wertbesitzer, wie auch fuer den Eigentuemer, der sein Wohngebaeude vermietet. (6)

[126] „...wenn er diese Massnahmen durchfuehrt, wenn die Zeit dafuer da ist, also wenn etwas geschehen muss an diesem Gebaeude oder wenn etwas erneuert werden muss." (6)

[127] „Ansonsten ist es auch nicht Nachhaltigkeit." (6)

[128] „Es ist niemandem damit gedient, die Fenster oder das Dach komplett auszutauschen oder zu erneuern, wenn diese Massnahmen erst 5 oder 10 Jahre alt sind." (6)

[129] "Sondern man muss einfach den Zeitpunkt abwarten, wann Massnahmen durchgefuehrt werden muessen. Aber dann soll man diese Massnahmen so durchfuehren, dass sie auch energetisch nachhaltig und gut genug sind. Und dann einen hohen Standard auch durchzufuehren." (6)

[130] "so realistisch wird das auch wahrscheinlich einfach nicht vollziehbar sein, weil niemand weiss, welchen Standard ein individuelles Gebaeude gerade hat. Und das muesste man ja erstmal kontrollieren, bevor man dann feststellen kann, welches Gebaeude ist jetzt dran, woran man jetzt etwas tun muesste." (5)

[131] „Das erfordert natuerlich, dass der gesamte Gebaeudebestand irgendwie erfasst wird." (5)

[132] „Das ist natuerlich auch ein riesen Datenvolumen, aber ohne solche Daten geht es letztlich nicht." (5)

By the regional level financial authorities which would then deliver a nationally unified regulation."[133]

During a different interview it was cautioned that systemic retrofitting is in principle possible. "Basically yes, but it is important to increase capacity slowly, not abruptly."[134] This interviewee considered that "it would principally involve funding requirements which aren't currently in place such as a timeframe to have buildings of a specified type comply with a certain insulation standard."[135] He concluded that "this is of course a discussion which would likely lead to rejection, I think."[136]

This objection to a more uniform strategy to national domestic retrofitting begs the question as to the usefulness of the much standardised EU energy efficiency policy approach. That being said, the EU policies seem to be flexible enough to be interpreted, transposed and applied at a national and regional level as required by the respective countries and regions in a way that works best for the respective environment. While it is a point of contention, this might indicated that EU policies and building standards are currently sufficiently concise yet flexible enough to promote the transition to a low-carbon domestic building sector.

5.2.8.6. Future vision and longevity of building retrofits

Looking forward, some interviewees have expressed concern that "there is still a lack of knowledge or understanding of what buildings should look like in 30 years. Although the basic features are comparatively certain. On the one hand good thermal insulation plus much renewable energy, in most cases a ventilation system with heat recovery system to save more heat, and these are the key components in various different shapes. Perhaps further additional concepts might be added in the future, for instance that PV will be added on the roof and a solar heat system, and that is basically it."[137] One of the

[133] „Also der Anstoss muss schon natuerlich von der Bundesebene kommen, damit das einheitlich geschieht. Aber die Umsetzung wuerde dann auf regionaler Ebene geschehen. Durch die Finanzaemter, die aber eben eine bundesweit einheitliche Regelung umsetzen." (5)
[134] „Grundsaetzlich ja. Es geht darum, die Kapazitaeten langsam aufzubauen, das geht nicht sprunghaft."(5)
[135] „Aber im Prinzip dann muessten ja sagen wir mal Massnahmen gefordert werden, nicht wie die heute gefordert werden, also dass zu einem gewissen Zeitpunkt die Gebaeude eines bestimmten Typen meinetwegen einen bestimmten Waermedaemmstandard einhalten muessten." (5)
[136] „Das ist natuerlich eine Diskussion, das wuerde zu Verwerfungen fuehren, denke ich mal." (5)
[137] „Daher wissen wir eigentlich auch noch gar nicht ganz genau, wie die Gebaeude eigentlich aussehen sollten in 30 Jahren oder so. Wobei eigentlich die Grundzuege vergleichsweise klar sind. Einerseits moeglichst guter Waermeschutz und dann in der Waermestoffversorgung moeglichst viele erneuerbare Energien nutzen. Dazu in den Faellen, wo es moeglich ist, also wahrscheinlich in den allermeisten Faellen noch ein Lueftungsanlage mit Waermerueckgewinnung um noch mehr Waerme zu sparen und das sind dann diese Schluesselkomponenten, auf die es hinauslaeuft und die dann vermutlich in unterschiedlicher Auspraegung. Kann sein, dass dann noch unterschiedliche Konzepte zukuenftig

issues that has been remarked on is building component durability: “But of course there is a dilemma when retrofitting that the funded building components are very durable. Any mistakes now or in the next 10 years will remain manifest for the next decades which makes it extraordinarily difficult. As such, future-proofing becomes essential now or in the next few years.”[138]

This was seconded as a concern which was expressed relating to the construction sector: “Add to this that the whole building sector or construction sector has an inherent inertia or resistance with regards to new innovations.”[139] It has a history of it being slow to take up innovation. “This may be due to the durability of the components, insulation and render which lasts 30 – 40 years in which period nothing new will be commissioned.”[140]

5.2.9. Society

The social practice system was not a strong focus throughout any of the interviews. While it was understood that domestic retrofitting touches many aspects of society and social life since it relates directly to a social hub meaning the home, the interviews were largely focused on the financial and policy systems, and the technology system to a lesser extent.

5.2.9.1. Stakeholders in this sphere

Energy efficiency in the built environment involves a broad range of stakeholders, from homeowners and building professionals, non-governmental and public sector actors to financial institutions. Stakeholder communication seems to be most relevant for the institutional sector which aims to engage with a number of stakeholders on a regular basis.

NGOs

As part of the interviews, the researcher spoke to an environmental charity which defines energy efficiency as part of their energy and climate change remit. They described the building sector and energy efficiency retrofitting as a main ingredient to achieving the EU climate change goals. However, they lamented that “the current

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dazukommen, dass noch ein Fotovoltaikanlage aufs Dach oder Solarthermieanlage und dann ist das das im Wesentlichen. (5)

[138] „Aber jetzt sind natuerlich bei der Gebaeudesanierung, auch die gefoerderten Gebaeudesanierungen in dem Dilemma, dass die Bauteile halt sehr langlebig sind. Alle Fehler, die wir jetzt machen, oder die wir in den naechsten 10 Jahren machen, die sind manifest dann im Grunde fuer die naechsten Jahrzehnte und das wird dann ausserordentlich schwierig. Das heisst, wir muessten jetzt in den naechsten Jahren mal die Kurve bekommen und uns tatsaechlich auf die Zukunft ausrichten.“ (5)

[139] „Dazu kommt, dass sich der gesamte Gebaeudebereich oder die Baubranche eine gewisse Traegheit hat oder ein Beharrungsvermoegen, was neue Innovationen angeht.“ (5)

[140]“ Das kommt einerseits sicherlich von der Langlebigkeit der Massnahmen, Waermedaemmung oder Aussenwandputz, das haelt halt alles 30-40 Jahre und solange wird da nichts gemacht.“(5)

activity in the area of building retrofitting is not sufficient to achieve the targets." [141] The charity sees it as part of its responsibility to raise these concerns to the relevant institutions both at the German national level but also at the EU level.

At an institutional level, an interviewee stressed the efforts to engage with NGOs: "naturally, certain NGOs complain about certain developments. That's why they need to be given a chance to grow into it and follow certain processes."[142] He also included housing associations in these engagement efforts, stating that "occasionally smaller model projects are being trialled, e.g. with housing associations to get an understanding of what is already being implemented on the ground and how to help struggling housing associations with possible solutions. That change can also mean opportunities to improve their building stocks which might lead to better rentals for their buildings and apartments."[143] He explained that data on any such trialled solutions which may already see increasing uptake and implementation are published and disseminated, showcasing various solutions for various building types. These studies and publications are carried out in partnerships with independent scientific organisations throughout to ensure academic rigor.

The same institutional respondent stressed that "there is always an interest in hearing the various involved parties and so follow a consolidated path."[144]

Institutions

The Bundesministerium fuer Wirtschaft und Umwelt (BMWi = State ministry of economy and energy) is a major German institution responsible for low-carbon funding in the built environment. "Being responsible for development, adjustment and maintenance of funding programmes in the built environment, meaning the KfW funding programmes, is an aspect"[145] of the BMWi's competencies.

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[141] „Die derzeitige Aktivitaet im Bereich der Gebaeudesanierung reicht nicht aus um die Ziele zu erreichen."(3)

[142] „... natuerlich beschweren sich bestimmte Interessenverbaende bei bestimmten Entwicklungen. Darum muss man ihnen eben eine Moeglichkeit geben, da mit reinzuwachsen und bestimmte Prozesse auch mitgehen zu koennen." (6)

[143] "...dass man dann auch einfach gemeinsam [...] mit der Wohnungswirtschaft hier einfach Modellvorhaben auch durchgefuehrt um zu schauen, was wird denn dort ueberhaupt schon gemacht und wie kann man auch Wohnungsunternehmen, die sich vielleicht eher schwer tun damit auch Loesungsmoeglichkeiten aufzeigen. Das Veraenderungen auch Moeglichkeiten sind, ihren Gebaeudebestand zu verbessern, dass sie dadurch auch ihre Gebaeude und ihre Wohnungen teilweise besser vermieten koennen. (6)

[144] "Also es besteht immer das Interesse daran, dass man halt die verschiedenen Seiten hoert und dadurch auch einen konsolidierten Weg zu gehen." (6)

[145] "Und darin ist eben auch ein Aspekt die Weiterentwicklung, Verstetigung und Aufstockung des CO2-Gebaeudesanierungsprogramms, also dieser KfW-Foerderprogramme." (6)

Inter-institutional communication was identified by one interviewee as integral to successful low-carbon funding in Germany, saying "Yes, we are in regular communication with the relevant ministries of state as well as with the working committees of residential funding and of city planning and of the conference of ministers of economy."[146] He continued that advice from federal states is often received retroactively and then integrated with existing funding structures. He ventured that "It is not as if we are secluded in our offices; the exchange certainly takes place"[147], but that "it always depends on the individuals in the federal ministries and what they want to do there. With some it works better, with others less well."[148] When inquiring about any transcripts of these inter-ministerial interactions, it was explained that these exchanges between the working committees are internal only and no publications or minutes are available.

5.2.10. Environment

The environmental system is an overarching system for the research area. In the interview discussions, environmental sustainability was more implied than openly discussed, what with energy efficiency targets largely set within global climate change targets. Energy efficiency was specifically coded a number of times throughout the interviews, though.

5.2.11. Coevolution of Themes

The coevolutionary systems that come out strongest in the coding and analysis of the interview transcripts are low-carbon funding and governance, followed by technology. The society and environment systems are present but were a lesser focus of the conversations.

As an example, the coding stripes in the below interview recording (Figure 37) show how different themes emerge and re-emerge in parallel in the conversation with several themes seemingly connected to each other.

[146] „Ja, wir haben ja auch einen regelmaessigen Austausch mit den zustaendigen Landesministerien, mit dem Arbeitskreis der Wohnraumfoerderung und auch der Staedtebaufoerderung und auch der Arbeitskreis aus der Wirtschaftsministerkonferenz heraus." (6)

[147] „Es ist nicht so, also ob wir da allein in unserem Kaemmerlein sitzen, sondern dieser Austausch findet statt." (6)

[148] "Es ist aber immer abhaengig von den einzelnen handelnden Personen in den Landesministerien, was man dort machen will. Mit den einen funktioniert das besser, mit den anderen weniger gut." (6)

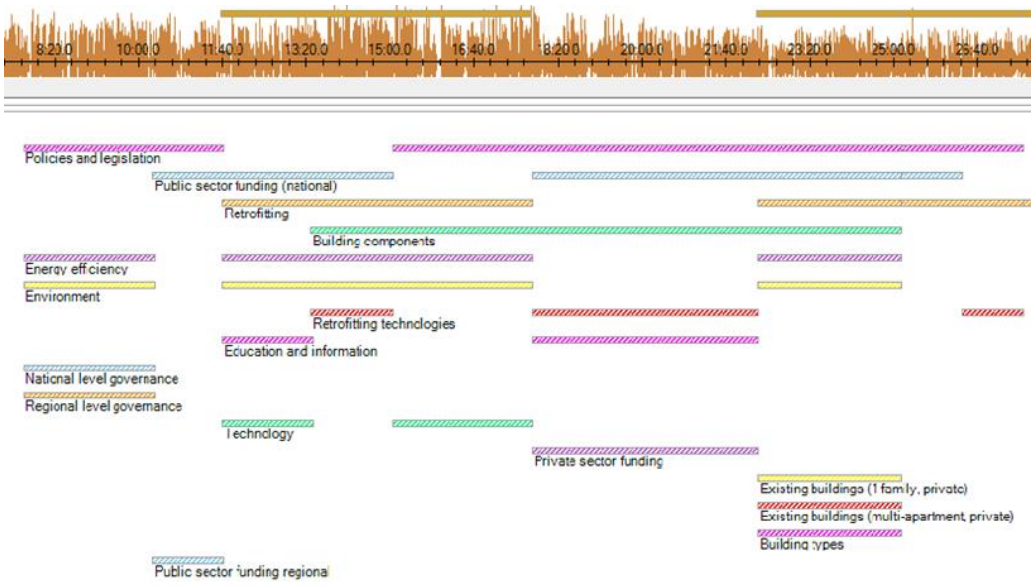

Figure 37 Illustration of parallel coding nodes in recording transcript

Frequently connected themes are funding and policy or policy and retrofit, with many of their related themes intertwined. These are child nodes in the coding tree under the coevolutionary systems of business, governance and technology. The more the child nodes of a coevolutionary system are present in parallel with child nodes of other coevolutionary systems, the more likely it is that these systems are interconnected and coevolve with each other.

The next section will look at parallel child nodes in the German transcripts analysis.

The below image highlights three different types of parallel child nodes.

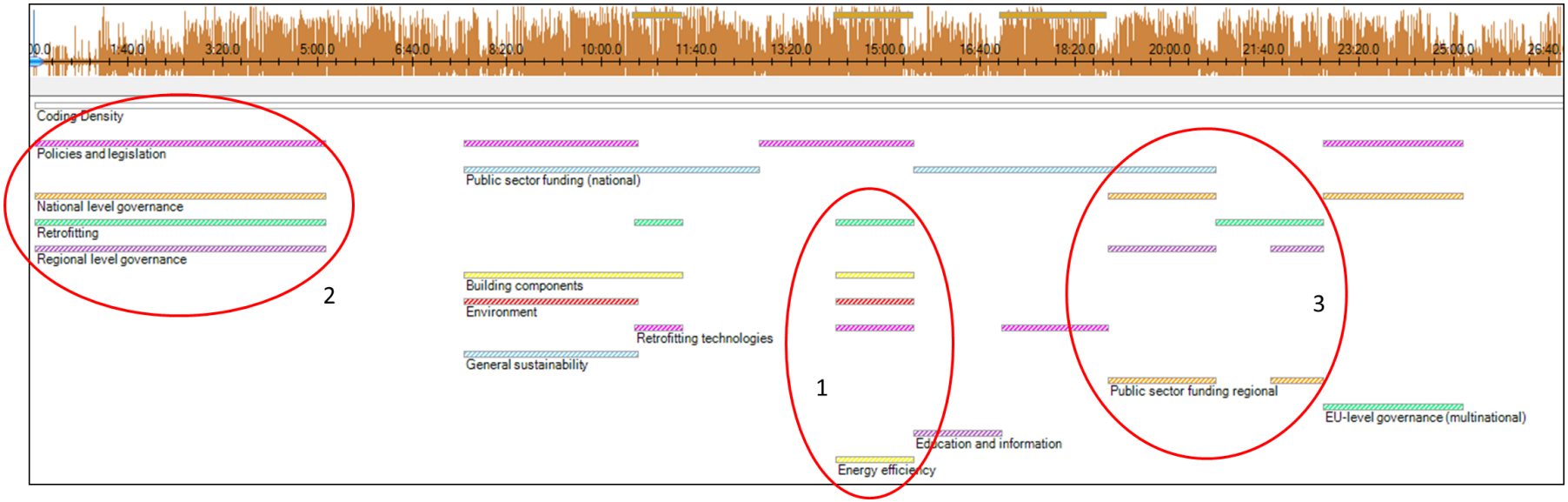

Figure 38 Parallel coding nodes in a German recording transcript

Parallel coding stripes #1 refer to the themes and sub-themes of retrofitting, building components, environment, retrofitting technology and energy efficiency. This means they cross the coevolutionary systems of technology and environment. Parallel coding stripes # 2 refer to policies and legislation, national and regional governance as well as retrofitting, meaning that this part of the interview addresses the coevolutionary themes of institutions and technology. #3 refers to coding stripes related to national and regional public-sector funding, national level governance, retrofitting and regional level governance. #3 links the coevolutionary systems of business/finance, technology and institutions.

Figure 39 Parallel coding nodes in a German recording transcript

The coding stripes for this interview show that it was very data heavy. It was also an interview with two interviewees who added to and followed up on each other's statements throughout the recording. The parallel coding stripes in #1 cover themes referring to national public-sector funding, retrofitting, building components, energy efficiency, environment, retrofitting technologies, education and information and technology. This section of the recording interlinks the coevolutionary systems of business/finance, technology, environment and society. Section #2 illustrates an even bigger spread of coding nodes, ranging from policy and legislation, national public-sector funding to retrofitting, building components and energy efficiency and environment to building types such as one family and multi-apartment buildings. As such, this section covers the coevolutionary systems of institutions, business/finance, technology and environment.

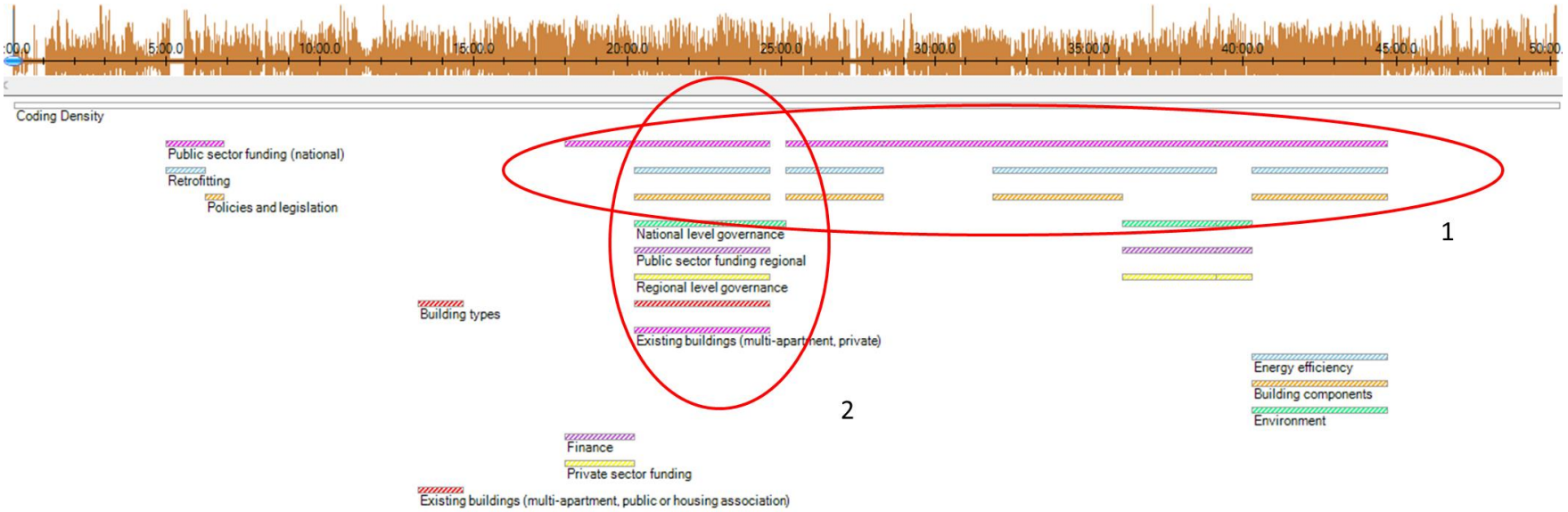

Figure 40 Parallel coding nodes in a German recording transcript

Parallel coding stripes #1 refer to the themes of national public sector funding, retrofitting and policies and legislation. This means they show a link in the interview with the coevolutionary systems of technology, institutions and business/finance. The mid-interview section with the parallel coding stripes #2 highlights a link in the recorded conversation between the themes of national and regional public sector funding, retrofitting and private multi-apartment buildings as well as national and regional level governance and policies and legislation. This implies that this part of the interview addresses the coevolutionary systems of institutions, technology and business/finance.

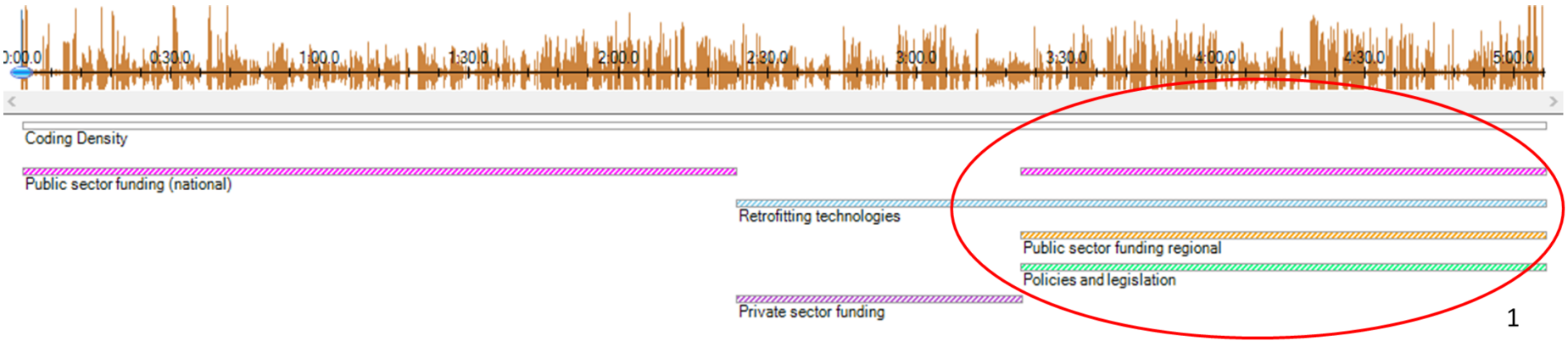

Figure 41 Parallel coding nodes in a German recording transcript

This brief industry interview covered the themes of public and private sector funding, retrofitting technologies and policies and legislation. The parallel coding stripes in #1 address the coevolutionary systems of business/finance, institutions and technology.

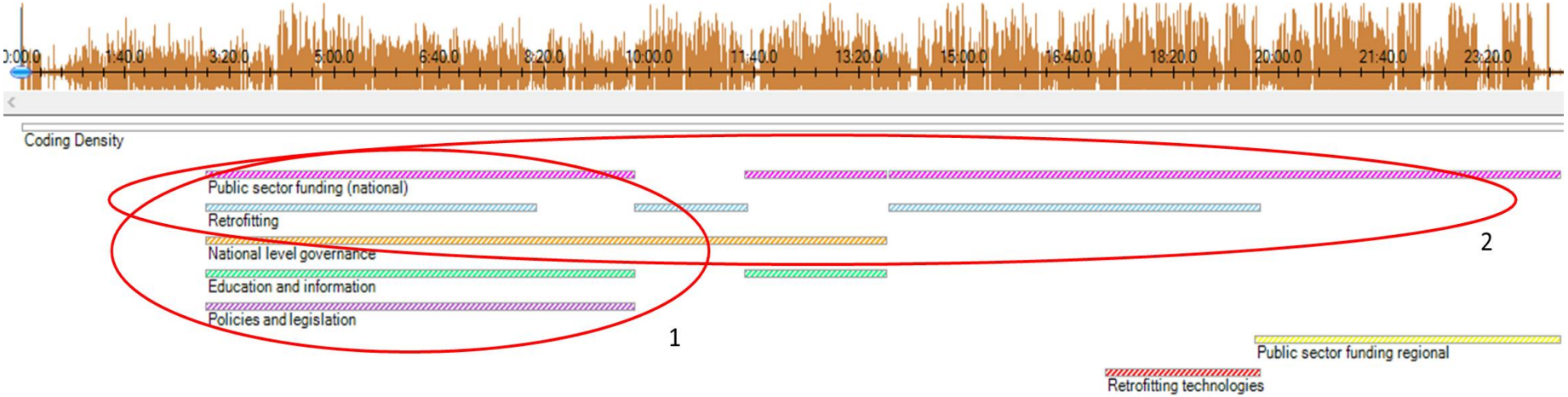

Figure 42 Parallel coding nodes in a German recording transcript

The parallel coding stripes in #1 show how the first part of the interview recording focused on themes such as national public sector funding, policies and legislation, national level governance as well as retrofitting and education and information. The themes show a link between the coevolutionary systems of business/finance, institutions, technology and society. A large section throughout the interview (#2) however kept its focus on the themes of national public sector funding, retrofitting and to some extend on national level governance. This shows the strong connection between the coevolutionary systems of business/funding, technology and institutions.

Figure 43 Parallel coding nodes in a German recording transcript

This interview shows how throughout the recording certain themes emerge and re-emerge, often in connection with other linked themes. In #1 for instance, the themes national public sector funding and building components seem to be linked and emerge together three times during the interview, highlighting the link between the coevolutionary systems of business/finance and technology. National public sector funding is the leading theme in this interview and is connected twice with regional public sector funding as well as access to finance. The three latter ones are all themes of the coevolutionary system of business/finance.

The Germany case study used interview data from predominantly institutional interviews to illustrate the interconnectedness between several coevolutionary systems for the funding of domestic retrofits. It illustrated this interactivity through connected coding stripes from the transcript analysis. Parallel coding stripes, especially if recurring, can point towards key issues and relationships which are relevant to the research questions. The illustrations show that the three dominating coevolutionary systems in this case study are business/finance, institutions and technology. For the coevolutionary system business/finance, the strongest links were with the coevolutionary systems of institutions and technology. For the coevolutionary system institutions the closest links were with business/finance and technology. This comes out of the interaction between coding nodes in Figure 38 to Figure 43.

5.2.12. Concluding section

The Germany case study explored the importance and impact of low-carbon funding on domestic retrofitting in Germany. It analysed six semi-structured interviews with respondents from the institutional, third and business sector, all of them experts in either low-carbon funding, governance or retrofitting. During the analysis a set of themes emerged which were explored in individual sections throughout the chapter as part of the intra-case study analysis. The interview recordings were also systematically coded with qualitative data analysis software which allowed for parallel coding stripes to be made visible and thus patterns of connected topics and issues to emerge.

In terms of coevolving systems, the Germany case study portrays a strong dominance of the business/finance system which interacted with the institutions and technology systems. The business/finance system having significant importance for energy efficiency in the German building stock implies that funding bodies such as the KfW have a strong role to play in shaping the energy performance of German homes. Finance and funding has been perceived by the interviewees as an enabler in several ways, particularly due to the abundance and accessibility of institutional funding. The enabling function of finance applies to achieving national and supranational energy efficiency and sustainability targets as well as to increased comfort and wellbeing derived from the German building stock. This is highlighted in the interaction between the business/finance and institutional systems.

A second strong coevolutionary system in Germany, albeit not as dominant as business/finance, is technology. The most important interacting systems with technology are business/finance and institutions. The interaction between the finance,

institutions and technology systems in the interview data highlights the interviewees' perception that particularly institutional funding is an enabler for energy efficiency and retrofit technologies in the German building stock. Germany also benefits from a strong policy landscape which also supports the uptake of these technologies. Interestingly, the society and environment systems only feature as minor but interacting systems in the interview data.

The data clearly shows that the business/finance, technology and institutions systems are strongly interacting and coevolving in the Germany case study.

The findings from the Germany and Slovenia case studies will be discussed in Chapter 6. Following the case study research methodology as set out in Chapter 4, the research is moving from intra case study analysis to cross case analysis in the next and final section of this chapter.

5.3.Cross-case study analysis

This chapter aims to compare and contrast the two case studies and the case study findings. It is divided into a section comparing the countries and case study regions and also includes a word frequency analysis for the interview transcripts, followed by a more detailed comparison providing information about economy, governance and building stocks and the data comparison in line with the systems of the analytical framework.

The cross case study analysis is important for understanding the impact of a series of factors on the energy performance of domestic buildings. The findings from both case studies may be combined and provide learning for the wider context. So does the analysis across the case studies inform on the importance of policy transposition or of governance levels on the energy efficiency of the wider built environment which feeds into research questions 1 and 2. Additionally, the findings on the different mechanisms of institutional funding feed into research questions 3 and 4. And ultimately, the findings from Chapter 5 contribute to a set of recommendations in Chapter 6, which serve to serve to answer research question 5.

5.3.1. Introduction

The case study areas are very dissimilar in their political, social and economic situations. The two case studies provided two different sets of content based on the same topic and questions. The interviewees in each case study explained their respective sets of priorities which means that there were very different issues discussed in Slovenia than in Germany.

The cross case study analysis is part of the overall theory building methodology as described by Eisenhardt (1989). It facilitates "cross-case patterns search" and "forces investigators to look beyond initial impressions and see evidence thru multiple lenses" (Eisenhardt 1989, p.533). Ravenswood supports cross-case analysis, elaborating that "when the researcher identifies similarities this strengthens the findings, and when they discover contradictions the process of reconciling the contradictions often leads to a deeper questioning of the data" (2011, p.681).

Before this chapter delves into the cross-case analysis, it is worth comparing the two case study countries and regions with each other as shown below in Table 5. The table combines country facts with qualitative impressions from the data collection to compare and contrast. Both countries had a strong sustainability focus but a very different economic situation at the time of the data collection. They are also very different in terms of population and size but both are governed by a parliamentary republic.

Despite, their political systems differ significantly, particularly regarding their governance levels.

	Slovenia (Podravje)	Germany (Saxony)
Inhabitants	2.065 million (322,545 in 2015)	82.67 million (4.055 million in 2015)
Size	20,273 km2 (2,170 km2)	357,030 km2 (18,416 km2)
Economy in 2017	$23,597 GDP per capita	$44,470 GDP per capita
EU membership	2004	EU founding member
Governance	Democratic parliamentary republic	Democratic federal parliamentary republic
State in 2014/15	Transition country, stricken by financial crisis (at time of data collection in 2014)	Industrial country, strong economy and low unemployment (at time of data collection in 2014/15)
State of sustainability	Sustainability agenda stronger at regional level than at national level	Strong sustainability agenda both at national and regional level
Incentivisation	Financial incentives seem effective	Regulatory incentives seem effective
Building stock	Interview responses indicate that the region prioritised economic growth over sustainability and as a consequence was left with substandard real estate projects which are difficult to maintain	Interview responses indicate that energy efficient building standards are strong and widely accepted as a baseline for new-builds and retrofits, supported by funding and information initiatives at national and regional level

Table 5: Comparing country parameters between Slovenia and Germany

5.3.2. Data collection in both case study regions

Initially the research proposed three regional case studies in Slovenia, Germany and the UK. After completion of the data collection in the first two case study regions in Slovenia and Germany, initial findings indicated that the third case study in the UK which would have focused on the Green Deal in the Cardiff region in South Wales would be unlikely to be a) successful since the Green Deal has been described as a failure in achieving its energy efficiency targets in domestic retrofitting and funding ended in 2015 (see Chapter 2), and b) the economic and political future of the UK and its energy efficiency policies and standards became highly unpredictable after the outcome of the Brexit referendum in 2016 and the subsequent protracted negotiations. It was therefore felt to be more useful to provide some of the learnings from the two case studies as recommendations for the UK as well as for the wider EU and the two case study countries Slovenia and Germany. It is possible to draw recommendations for the UK from either case study since the UK is currently a country in flux.

5.3.2.1. Interviewees

The data collection experiences were in stark contrast to each other in the case study regions (a list of the interviews for both case studies is provided in Chapter 4). In Slovenia, the data collection took place over a time span of two weeks and was therefore relatively time-constrained. The researcher was hosted by the regional energy agency in Maribor. The data collection in Slovenia was predominantly undertaken with institutional interviewees which was a result of the researcher being able to access the regional energy agency's extensive network of contacts in the municipality and the national environmental funding mechanism. This access yielded a number of interviews with high-level civil servants and employees of the local authority, national ECO fund and the university. However, no interviews with private homeowners could be recorded in Slovenia.

Data collection in Germany did not benefit from access to an existing mature network of institutional contacts like in Slovenia but was undertaken over a longer time period. The researcher sent out numerous invitations to potential institutional interviewees in the hope that a number of them would respond. Any interviews undertaken aimed to use a snowball approach of further interviews whereby the current interviewee was asked to point out two or more contacts which they thought would be useful for the researcher to get in touch with. While gaining access to a number of home-owners turned out to be easier in Germany and the snow-balling technique yielded a number of new potential

interviewees which were not formerly known to the researcher, it was a bigger challenge to obtain interviews with some public institutions.

An example of this is the regional development bank with which the researcher was unable to arrange an interview. A phone call on their public hotline yielded the information that personal meetings can only be arranged for private prospecting or existing homeowners as per the mission of the organisation. After sending the interview request and a list of questions via email and following this up multiple times over a period of several months with different staff members, a response to the interview request was never received. On the other hand, the regional energy agency SAENA helpfully provided much information via a phone interview, access to which had been achieved by calling SAENA's public hotline and then being transferred to an expert architect of the agency who happened to be available at the time. Serendipity certainly played a role here.

5.3.3. Word frequency comparison between both case studies

The case study analysis for Slovenia and Germany included a word cloud illustrating the most frequently used words in each case study. These visualisations of the relative word frequencies gives an indication of a hierarchy of issues that came out in the interview transcripts. While each word cloud by itself is insightful, it is also useful to compare the two case studies with each other (see Table 6).

Slovenia	**Germany**
Energy (technology)	Funding (finance)
People (social)	Retrofit (technology)
Public (institutional)	Building (technology)
Buildings (technology)	Energy efficiency (environmental/technology)
Money (finance)	Measures (technology)
Municipality (institutional)	Government (institutional)
Government (institutional)	Funding programme (finance)
Investment (finance)	Legislation (institutional)
Funding (finance)	

Table 6: Order of word frequency in the interview transcripts for the Slovenia and Germany case studies with the most frequently cited words at the top.

A full table with the most frequent words used in the Slovenia and Germany case study is available in Appendix 2. A closer look at the word frequency table revealed that many of the German words could be further combined but this was unfortunately not picked up by the software as the analysis language is English. The analysis revealed the word

frequency order as shown in Table 6 for both case studies with the corresponding coevolutionary system in brackets.

The Slovenia interviewees appeared particularly focused on energy but also on people and their willingness to undertake energy efficiency improvement, which frames the retrofitting problem in Slovenia as one of technology and social systems. The Slovene respondents further focused on public, buildings and money which are coded under the institutions, technology and finance systems respectively.

In the German interviews the two top terms are funding and retrofit which frames the problem in the context of the finance and technology systems. These terms are followed by building and energy efficiency which are both coded under the technology system. Overall, terms related to funding, retrofitting and buildings dominated the conversation while words related to governance and legislation were slightly less frequently used.

5.3.4. Comparing the coevolutionary systems in both case studies

In the Slovenian data, the coevolutionary system of business/finance is dominating and interacting most strongly with the institutions system and the society system. It is perceived that the interaction between finance/institutions is stronger than the interaction between finance/society. The focus in the society system was frequently on socio-economic factors relating to the impacts of the financial crisis so it appears that the significance of this system is depending on economic factors unrelated to the socio-technical system of building decarbonisation. There was also interaction with the systems of technology and environment. It is worth mentioning that environmental aspects were mentioned more frequently in the Slovenia case study than in the Germany case study where environmentalism and sustainability were more implied as part of the 2050 national policy targets.

In the Germany data, the coevolutionary system of business/finance dominates and interacts most strongly with the institutions system and the technology system. It is perceived that the interaction between finance/institutions is as strong as the interactions between finance/technology. There is a notable level of detail in the German data around technical details of retrofitting, architecture and building components which is largely absent in the Slovene data. This preoccupation with technologies is also evident in secondary literature in the German language. There were also interactions with the coevolutionary systems of society and environment. It is worth mentioning that in the Germany case study aspects relating to the society system

were often around stakeholder management and consensus building, which did not feature at all in the Slovenian data.

5.3.4.1. Business and Finance in both case studies

At the national level

Both case studies benefit from national funding bodies which receive an annual budget from their respective national government. Neither funding body benefits from EU funding however. In Slovenia, this body is the EKO Sklad, which is the most important financial institution for the funding of sustainability in Slovenian funding areas such as air pollution reduction, energy usage, renewables, waste and waste water management, water supply, noise reduction and energy efficiency. It is also the only source of public sector financial support for domestic retrofitting. This is in stark contrast to Germany, where the KfW is the main national vehicle for low-carbon funding but not the only actor in this space. The KfW also sets standards for and focuses on support for particularly energy efficient houses, both for construction but also for refurbishment. While the KfW works directly with house banks in the lending process and closes financing gaps, the EKO Sklad is a stand-alone loan or grant provider and homeowners have to submit applications to it. Both the EKO Sklad and the KfW are active nationwide but the KfW's funding is frequently complemented by regional funding banks. In this sense, KfW funding programmes are financed nationally but allocated regionally or even locally, whereas the EKO Sklad funding is financed nationally and allocated nationally.

EKO Sklad provides their funding in the form of preferential loans and grants and their funding calls open annually. KfW provides preferential loans and repayment and investment grants on a rolling basis without annual funding calls. For both organisations it can be said that the grants are more attractive to homeowners than loans, but the loans are frequently needed in addition. While the EKO Sklad receives an enthusiastic response from the public so that funds run out prematurely, the KfW funding is also largely used but sufficient across the entire year.

At the regional and local level

While both Slovenia and Germany have some kind of low-carbon funding at the national level, only Germany has significant low-carbon funding at the regional level with the reason for the lack of it in Slovenia being that it simply does not have a regional governance level. It has however a strong local governance level which might be thought to make up for this lack of regional governance and provide low-carbon funding for

energy efficiency at the municipal level. However, as the study has found, there is very limited funding accessible at the local level and most of it is focused on specific building types, particularly historic buildings. It is up to each municipality to set up municipal energy efficiency funds and certainly in the case study region this objective has been promoted by the regional energy agency for years and repeatedly rejected by the municipal council. This leads to several negative outcomes for Slovenia's building stock; one of the most impactful for housing is likely inertia to retrofit domestic buildings by homeowners. One of the most impactful for the communal building stock is misallocation and ineffective use of EU funding, leading to underuse and poor energetic performance of the funded buildings.

In fact, the lack of regional funding in Slovenia has shown that homeowners' first choice for accessing funding for domestic retrofits are private banks. The study has also shown that these banks make no accommodation for sustainability or energy efficiency in their finance products. They do not provide retrofit focused loans or are connected to the EKO Sklad. How much of a positive impact the regional level can have on domestic retrofitting is however illustrated by the findings of the German case study. While the national level funding from the KfW forms the base funding which is being drawn down and potentially topped up by the regional development banks, this national funding is then accessed by the homeowners through their local or house banks which handle all administration. The regional funding from the development banks of the individual federal states can vary greatly as there is no standardised approach due to individual federal budgets and constitutions. Regional federal banks also often team up with EU funding to provide further incentives for energy efficiency measures in the domestic sector. It is this interaction and combination of national and regional low-carbon funding which appears to facilitate holistic and whole-house retrofitting thereby increasing the ambition, quality and depth of retrofits. It also improves the availability and accessibility of low-carbon funding significantly relative to that in Slovenia.

5.3.4.2. Governance and legislation in both case study regions

The basic governance and legislation level is relatively similar for both case study countries seeing as they are both democratic member states of the European Union and the EU requires all member states to harmonize their legislation and transpose EU legislation into their own existing national legislative framework. However, it should not be fore forgotten that EU policy first needs to be transposed or "processed, adapted, and implemented at the domestic level" (Steunenberg & Rhinard 2018, p.515). These transposition processes "are influenced by conflicts and negotiations that took place at

the European level, but also display their own configuration of actors with different interests, degrees of experience, and proclivities toward conflict" (Steunenberg & Rhinard 2010, p.516). Transposition of law is often subject to necessary adaptation which can take time, involving parliamentary and political actors but also lower-level administrative actors, sometimes even situations where transposition is "solely decided in an administrative context" by "individual units deep within ministries" (ibid, p.517).

While the transposition process can follow different timelines and take different forms for different EU members, involving decision-makers in different ministries and hierarchical levels, the end result is a relatively uniform supranational policy landscape. For the energy efficiency policy in Germany and Slovenia, the EU policy umbrella provides a common baseline from which to analyse both country's governance efforts and their translation from the national to the regional and local level. It also allows any additional efforts by either country to legislate above and beyond the EU baseline to be distinguished.

At the national and regional level

Both countries have democratically elected governments but different governance structures which manifests in different ways.

Slovenia's governance structure is different to that of most EU member states in that it essentially has a two layer governance structure. The country is governed on the national and the local or municipal level which is a result of its socialist heritage. Because of the missing regional level there is no supervision of the implementation and transposition of supranational and national programmes and policies to the local level. Particularly for the EU this is a problem as its programmes and initiatives rely on decentralised governance structures as is the case in most of its member states. Slovenia's governance structure however is much more centralised and its constitution makes no provision for regional institutional bodies. Any level of regionalisation is left to the municipal level. Each municipality can set up its own legislation and constitution within the parameters of the Slovenian national law. The democratically elected mayors have the highest level of authority and ultimate decision-making power within their community. Since the strategic thinking ends at the boundaries of each municipality, there are multiple examples where EU funds have been allocated at the local level and were then either wasted or misused without achieving the intended purpose or impact. Municipalities also tend to foster a sense of competition for resources and competencies with other municipalities which prevents a more collaborative approach between

regional municipalities. Nevertheless, the only level of regionalisation is up to the municipal level.

Germany on the other hand has a much decentralised governance structure with three governance layers - the national government layer, the 16 federal states at the regional level and the local or municipal level. The German federal organisation allows each federal state the right to a sovereign constitution within the bounds of the national constitution and law, and to shape its own areas of legislation. This means that regulations for buildings and incentives for energy efficiency are established, supervised and accounted for regionally in terms of the implementation and operation at the local level.

As a result of the cross-case study analysis, it has been found that more decentralisation and the existence of an administratively competent regional level furthers access to energy efficiency funds and increases the efficacy of those funds. It also increases trust in investment due to the additional supervisory and accountability layer between the local and national levels.

Further, on the national governance level Slovenia is struggling with a frequently unstable government with elections taking place approximately every 2 years on average over the last decade. This is due to the higher level of institutional corruption compared to other EU member states (Transparency International 2014). This sets a negative example at the institutional level which leads to mistrust in the governance layers and fosters economic self-interest in the population and a reliance on the grey market economy.

Focusing on similarities, both case studies rely on a three-pronged approach to tackle sustainability challenges. This approach acknowledges the need for a bundle of instruments for complex tasks such as domestic retrofitting. These instruments relate to legislation, information and finance. In Germany, these are described as complementary, mutually supportive and equally important. In both case studies, the information function is largely fulfilled by the energy agencies, the legislation function is fulfilled by the EU and the national government in Slovenia and by the EU, the national government and the regional governments in Germany. And the finance function is fulfilled by the national body EKO Sklad in Slovenia and the national body KfW in Germany, plus the development banks of the federal states. How these functions are handled differently is in the way they interact. In Slovenia, the finance and information functions operate largely separately with little cross-over and energy agencies that are

information providers are frequently met with passiveness and inertia by the public. In Germany the information and finance functions are very joined up, down to federal states having federal energy agencies whose remit it is to educate about legislation, technologies and the national and federal funding opportunities. In both case studies, certainly the institutional impact on energy efficiency through policies and legislation is noticeable but the actual depth and ambition of domestic retrofitting depends largely on the homeowner's interest in the topic and self-accountability. In the case of Germany it was expressed by institutional interviewees that without this interest from homeowners, neither funding nor information has much effect on domestic retrofitting.

At the local level

In Slovenia, there is a possibility that the level of corruption in the public sector, particularly at the local level in the municipal administrations could lead to distrust in the population towards the programmes and initiatives that are set up at the local level. There is a sense among interviewees of inappropriate ultimate decision-making power in the role of mayors at the local level which has led in the past to some EU funding being misappropriated for projects or buildings without a clear business case for the need for it or the benefits it would provide. This is possibly due to the lack of a supervisory regional administrative body as explained in the Slovenia case study.

In Germany, there is also a sense that the national and the regional level could be better interlinked. Interviewees of the national and regional level both agree that interactions could be improved and both levels are critical of the lack of linking up. More and better coordination would allow more data gathering of approaches and activity at the regional level and create a basis where regional level models could become templates for national policy.

Governance and legislation

In both case studies, energy efficiency in buildings is an important part of the respective sustainability agenda. In both case studies, the role of legislation and policies was acknowledged by interviewees as an important instrument on the path to sustainability. But while Slovenia suffers from a convoluted and fragmented policy landscape, Germany's has been described as much differentiated. Slovenia is working towards increased retrofitting by strengthening its policy base with a financial incentive, but relies mostly on the impact of legislative and policy requirements. Germany which has a strong policy base is aiming to achieve increased and more ambitious retrofitting with funding rather than regulation. There are however doubts among interviewees whether these goals can be achieved mostly through funding.

Generally, Germany puts a lot of emphasis on planning reliability and sees this as a major institutional task. Planning reliability and thereby peace of mind for homeowners to retrofit within very transparent parameters of risk, is achieved both through a stable policy and legislation landscape and stable funding levels. Planning reliability is considered by institutional interviewees as good policy maintenance and perceived to maximise policy efficiency.

It takes a fairly comprehensive body of subject law and legislation to start concentrating on fine-tuning it. Slovenia had not got such a body of law and legislation in place for the domestic building sector at the time of data collection. The existing body of law was described as written in vague wording leading to confusion and resistance in local planning departments. In addition, there were gaps in the legislation around housing and housing strategy which also exempted the country for certain tranches of supranational funding for the built environment.

So while the Slovenia case study highlights the need for completeness and conciseness of energy efficiency and building policies, in the Germany case study interviewees were more concerned with the fact that legislation can be interpreted conservatively or progressively. There was a sense in Germany that more could certainly be done. Part of Germany's energy efficiency legislation was thought to be due further development and refinement. While changes to the law often focus on closing gaps for instance in the existing low-carbon funding, there were some concerns that some of the legislation did not sufficiently consider holistic building retrofits.

A big difference can be found between the two case study regions in the way EU law is transposed in to national law. Germany as one of the founding states of the EU transposed any laws over time as timescales required and integrated them into the national body of law. For Slovenia, this process was very sudden as a new member state in 2004 in a rush to comply with EU objectives. At the time of data collection, EU energy efficiency policy had been transposed for approximately a decade, leaving little time for the country, public sector and media to adapt and leading to conflicting messages. At this point, there was a disconnection between the integration of EU law into Slovenian law which happened very promptly, and the actual practical application of this law. After the swift transposition on paper, EU policies were often seen by interviewees as imposed rather than a result of dialogue and therefore met with resistance from the administration and the population, but also with incapacity and irritation as they were seen to add to an already cumbersome and chaotic body of national law.

Efforts to harmonise EU and Slovene national legislation led to a fragmentation of laws and responsibilities across separate government departments, as in the case of the EPBD which has been discussed in Chapter 4. Efforts to harmonise EU and Slovene national law have also brought benefits to the country. So Slovenia had no national strategy on energy efficiency in buildings, which was introduced in 2008 as a result of said harmonisation. Until then, this area had been left to homeowners.

In terms of practical enforcement of energy efficiency, the regional governance level plays an important role certainly in the case of Germany. The responsibility to enforce legislation lies with the federal states which enforce it in various degrees of intensity. In Slovenia, this enforcement function lies with the municipalities. A regional governance body in Slovenia, however, could facilitate the translation of national energy efficiency and building laws into local initiatives and projects. It was found that the current lack of such an intermediary governance level however provides not many options to support the transposition of EU legislation around sustainability which is largely met with passiveness by homeowners and municipalities.

5.3.4.3. Technology and Retrofitting in both case studies

There is a notable lack of focus on the technology-side of retrofitting in the Slovenia case study. Throughout the interviews, there was only the occasional mention of difficulties with proper operation of passive houses and the technical specification of the EKO Sklad funding requirements which touched on this coevolutionary system. This limited the data collection around Slovenia's technical approach to decarbonising the domestic building sector and implies that the country's focus is less on engineering. Indeed, it suggests that Slovenia is focusing more on the rationale of retrofitting – the 'if' and the 'yes or no', rather than on the 'how'.

This is in stark contrast to the Germany case study for which the rationale seems to have been established and agreed and the focus has moved on to the 'how' of retrofitting. With this in mind, it is interesting to see where the discussion in the Germany case study centred on retrofitting and technology for energy efficiency in the built environment. The message in the Germany case study was not whether to retrofit but when to retrofit and which energy efficiency level should be aimed at.

The Germany case study adds to the evidence and understanding that the availability of low-carbon funding appears to increase the energetic ambition of the retrofit and the energy performance level that is achieved. It does not, however, appear to increase the actual number of retrofits. The decision to retrofit is a complex one that extends beyond

the availability of finance, and follows a case-by-case approach where homeowners make very individual decisions whether they perceive their buildings to still sufficiently meet their needs or require updating. Once the decision to retrofit has been taken, it becomes evident that low-carbon funding plays a crucial role in ensuring that the depth of the retrofit complies with or surpasses national legislative requirements. Low-carbon funding is needed to achieve better standards of energy efficiency and the evidence suggests that the availability of low-carbon funding usually leads to more robust retrofits.

This message has been understood and taken forward in Germany where more low-carbon funding becomes available for more ambitious retrofits. The aim here is not for the highest reduction of carbon emissions but for increased energy efficiency. This prevents sustainable and progressive homeowners who incrementally or regularly improve their buildings being penalised against homeowners who have let their houses fall into disrepair and would reduce carbon emissions significantly through even basic retrofitting attempts. This approach aims to communicate that progressive homeowners can receive more funding because their buildings achieve deeper, more ambitious and more comprehensive and sustainable retrofits.

This is a conscious effort to increase uptake of low-carbon funding and therefore conformity with higher energy efficiency standards in the built environment. There is an understanding that not communicating the benefits and preferred outcomes of applying low-carbon funding to domestic retrofits runs the risk of increased numbers of shallow retrofitting. Where retrofits are undertaken without low-carbon funding support, these are often to a much lower and much less ambitious energy efficiency standard and frequently turn into future problem cases. There is also an understanding that, while whole building approaches are an ideal scenario, for many homeowners these tend to not be feasible. Component retrofits seem to be more realistic as many homeowners retrofit parts of their homes whenever capital becomes available. It is for this purpose that the German institutional sector has developed a retrofitting roadmap for single unit detached houses. This roadmap provides guidance on the technical specifics of buildings components and the proper order of their retrofitting to reach goal compatibility with ambitious energy efficiency levels. The aim hereby is to achieve an integrated and holistic concept by means of a piecemeal, component retrofitting approach. While the journey may take longer, it is hoped that this roadmap may yield similarly ambitious energy efficient domestic retrofits as whole buildings approaches.

Despite this forward thinking approach for whole-building and component retrofits as well as the availability of low-carbon funding thereof, according to two institutional interviewees there is still a lack of knowledge, clarity or vision what sustainable buildings should look like in the future. While basic features are relatively certain, it is felt that more work on future-proofing buildings is needed.

The Germany case study has also shown that the construction sector might hope for more support with low-carbon retrofitting technologies and increasing uptake thereof. This is an important issue for the sector as it may prevent a consolidation of outdated and increasingly inefficient technologies. Once these often durable components are implemented, they might remain manifest for decades until the next window of retrofitting opportunity arrives for individual buildings and they can be replaced or updated to next generation components and technologies. Beyond that, it is thought unlikely that the construction sector could accommodate a significant increase in retrofit numbers, let alone a doubling as envisaged by the German government.

5.3.4.4. Society in both case studies

The case study data which was coded under the coevolutionary society system can roughly be divided into information and stakeholders. Information and education on energetic renovation are considered important issues in Slovenia and Germany. In the Slovenia case study it was highlighted that information and education do not only focus on the various benefits of energy efficiency but also promote the correct operation of energy efficient buildings or passive houses. This matters as it might help to avoid disappointment and frustration with the technology among users and homeowners and a general disenchantment with energy efficiency and sustainability in Slovenia.

The information function in both case studies is held by the regional energy agencies which act as information hubs. In the Germany case study it was pointed out that the energy agencies are very aware of national and regional low-carbon funding. It was also explained that being advisors to the public in this area was one of their core competencies, which is different to the energy agencies in Slovenia. Despite this sign-posting role of the German energy agencies, they received some criticism in some more technology-focused institutional interviews for their impartiality in the matter of component vs whole-house retrofitting. While they are promoting and informing about domestic retrofitting, they are said to be only partially focused on comprehensive retrofits and equally endorse the piecemeal approach of retrofitting individual components.

But despite the energy agencies spreading the gospel of low-carbon funding by the KfW together with the local banks which promote it alongside their range of financial products, it was perceived that there is still room for improvement in Germany for raising awareness of funding opportunities for energy efficiency in domestic buildings. In Slovenia on the other hand, any issues with information spreading were attributed by interviewees to the passiveness and apathy and mistrust of the population, and particularly any suspicions or concerns by citizens that the energy efficiency programmes might be scams and could damage already economically struggling families. There was a sense of hope among the interviewees of the Slovenia case study, however, that once the country's economic situation improves, so would the population's proactiveness towards energy efficiency in their properties.

This highlights that the differences in the two case studies in terms of stakeholder engagement could not be bigger. While Slovenia is working on reducing barriers to interact with stakeholders in this space at all, Germany's focus is on mutual understanding among stakeholders and consensus-building to map and follow a consolidated plan towards a sustainable and energy efficient domestic building stock. There is much awareness of the fact that energy efficiency in domestic buildings involves a range of stakeholders – from homeowners, buildings professionals and NGOs to institutional actors and financial institutions – and that intra- and extra-institutional communication is integral to a successful and sustainable low-carbon funding concept.

5.3.4.5. Environment and sustainability in both case studies

The case study data which was coded under the coevolutionary system of the environment differed significantly between the two case studies. Neither case study had a significant amount of interview data coded to the environment system but both sets of data showed that environmental considerations around carbon reduction, climate change and environmental protection were a strong and recurring focus. In both case studies, environmental sustainability was more implied since energy efficiency targets are largely set within global climate change targets. In the Slovenia case study, however, it was perceived that cost savings and economic considerations were the bigger motivating factor for energy efficiency in domestic buildings. Environmental concerns were secondary to this among the Slovene population.

5.3.4.6. The development of coevolutionary nodes between both case studies

This is an important part of the analysis as it shows which areas are directly interacting with each other, at least in the respondents' perception. Where there is a clear and

repetitive interconnection between two coevolutionary systems, it would be worth considering these when further developing funding programmes or policy and legislation, or indeed new retrofit technologies.

Coevolution in the Slovenia data

For the Slovenia case study, when looking at the coded transcripts, the following themes emerge in order of dominance:

Coevolutionary systems	Dominant	Minor but interacting
Finance	6	0
Institutions	2	4
Technology	2	2
Society	1	3
Environment	0	2

Table 7: Hierarchy of coevolutionary systems in the Slovenia data

This means that in six of the Slovenian interviews finance was a dominant topic, in two the focus was predominantly on institutions and on technology whereas only one focused mostly on topics directly related to society. When finance was a topic in the interviews it was exclusively the main focus in the discussion and did not interact significantly with any other systems in a minor role. This was very different for the other coevolutionary systems. Institutions, for instance, were discussed in connection with other systems and are therefore shown as minor but interacting in four interviews. The environment system only played a minor role in the interviews. The dominant coevolutionary system was business/finance throughout. It should be noted that the dominant or minor system does not imply an actively interacting system. There may be interviews where the respondent kept their focus on one dominating system and touched upon other systems without there being any connection between these in the interview data, such as sudden topic changes. It should also be considered that the coding nodes included in Table 7 are the most prevalent ones in each interview. There were also a multitude of nodes that were mentioned either in passing, as a stand-alone non-interacting comment or as a tertiary discussion without receiving as much attention and discussion focus as the dominant and minor systems in Table 7

While it is relevant to understand the perceived hierarchy of the systems, this does not reveal which systems are directly interacting. Indeed, the results shown in Table 8 are equally interesting:

Interacting pair	Occurrences
Finance with institutions	3
Finance with society	3
Finance with technology	3
Finance with environment	1

Table 8: Significant interacting coevolutionary systems in the Slovenia case study

These interactions cover dominant systems interacting with other dominant systems and interactions between dominant and minor systems. The difference between the total number of dominant and minor systems in Table 7 and the interacting pairs in Table 8 is due to a number of minor evolutionary systems interacting with other minor systems but also individual dominant systems interacting with one or more other dominant systems in the individual interviews.

While there are a number of dominant and minor systems within the transcripts, the majority of these are interacting with the finance system, making it the dominant coevolutionary system in the Slovenia case study.

Coevolution in the Germany data

A similar approach to the Slovenia data was taken for the Germany case study. When looking at the coded transcripts, the following themes in Table 9 emerge in order of dominance:

Coevolutionary systems	Dominant	Minor but interacting
Finance	5	0
Technology	4	2
Institutions	3	3
Society	0	1
Environment	0	1

Table 9: Hierarchy of coevolutionary systems in the Germany data

The most prevalent coevolutionary systems in the Germany case study are business/finance, technology and institutions as shown in Table 9. The business/finance system is the most dominant coevolutionary system in the Germany interview data, followed by technology and institutions. This means that these systems dominated or came up more frequently in the transcripts derived from the fieldwork in Germany. The society and environment systems were also discussed but not to the same extent.

Interacting pair	Occurrences
Finance with technology	4
Finance with Institutions	2
Institutions with technology	2
Institutions with finance	1
Institutions with environment	1

Table 10: Significant interacting coevolutionary systems in the Germany case study

While technology is one of the dominant themes discussed by German respondents, it also interacts directly with the business/finance system and the institutions system. Compared to business/finance and institutions it is a minor interacting system, however. Finance/business interacted most strongly with technology and with institutions as illustrated in Table 10. This could imply while developing new funding programmes or further developing existing ones, it would be advisable to consider the state and trends of retrofitting technologies and approaches to ensure long-term impact. It could also imply that when designing funding programmes, it would be advisable to match these to existing or developing legislative requirements and objectives for domestic retrofitting targets.

The coevolutionary system of institutions interacted significantly with technology and business/finance, and to a lesser extent with environment. This could imply that any design and development of legislation should equally take into consideration the status quo and any trends in technologies and approaches domestic retrofitting, as well as existing and needed funding mechanisms.

Coevolution across the case study data

Combining the data from the coevolution analysis from both case studies provides insights into similarities and differences (see Table 11).

Dominant coevolutionary systems	Slovenia	Germany
Finance	6	5
Technology	2	4
Institutions	2	3
Society	1	0
Environment	0	0

Table 11: Hierarchy of coevolutionary systems in the case study data

Table 11 shows the strongest coevolutionary systems in the Slovenia and Germany interview transcripts. Dominating the interview conversations in both case studies was the theme of business/finance to an almost similar extent. In Slovenia, the interview respondents focused on themes related to technology and institutions in similar measure while German respondents focused slightly more on technology than on institutions. While in the Slovenia case, society related themes were certainly a topic these featured relatively little in the Germany case study. The coevolutionary system of environment was not presented strongly in either case study.

Interacting pairs Slovenia		Interacting pairs Germany	
Finance with institutions	3	Finance with technology	4
Finance with society	3	Finance with Institutions	2
Finance with technology	3	Institutions with technology	2

Finance with environment 1	Institutions with finance	1
	Institutions with environment	1

Table 12: Significant interacting coevolutionary systems in the case studies

Nodes that seem to emerge together again and again are business/finance and institutions, and business/finance and technology. There may be various interchangeable sub-nodes connected but these are two strong areas of perceived interrelation and interconnectivity in both case studies. While business/finance interacted to a similar extent with the coevolutionary systems of institutions, society and technology in the Slovenia case study, there was more variation in the Germany case study. Business/finance showed the strongest level of interaction there, followed by business/finance and institutions and institutions and technology in equal measure.

In the Slovenia case study it appeared that only finance/business interacted with other systems since it was consistently the most dominant system. In the Germany case study, the business/finance system and the institutions system interacted with other systems as per Table 12

5.3.5. Concluding section

The cross case study analysis chapter summarised the major similarities and differences of the Slovenia and Germany case studies, drawing the most relevant findings for each from the respective case study chapters. It started with a direct country and region comparison, followed by a word frequency analysis for the interview transcripts and then by a systematic comparison of the major similarities and disparities of the case study findings for each of Foxon's coevolutionary systems. Finally, the chapter compared occurrence and interconnectedness of the coevolutionary systems across the two case studies. This has provided some insights into patterns of occurrence and therefore connection between some of the coevolutionary systems, pointing towards a possible interdevelopment between some of them.

The next chapter aims to present the findings and recommendations derived from the intra- and cross case analysis of the Slovenia and Germany interview data as analysed through Foxon's coevolutionary framework.

6. Chapter - Discussion of Findings

6.1. Introduction to the chapter

Subsequent to Chapter 5 which discussed the Slovenia and Germany case studies and then analysed their findings across both case studies, Chapter 6 follows on from this by adding further discussion to the case study and methodology findings. Chapter 6 is the penultimate chapter of the thesis before Chapter 7 concludes it and brings it to a close. Chapter 6 aims to present and discuss all major findings from the previous chapters and join these up to align with the research topic and its main aims and questions. The chapter will also include a number of recommendations for the EU, UK and both case study regions.

As this is an interdisciplinary piece of research, the findings chapter covers a range of topics. First, it will be useful to place the research outcomes within the literature (section 6.4) and discuss if and how it has contributed to filling a gap in the literature, or added to existing transitions publications. Since the research goes beyond transitions literature and draws on energy efficiency and sustainability research as well, this chapter also considers how the study adds to these areas of literature.

Then this chapter discusses the learning and findings on the impact of governance (section 6.2) and funding (section 6.3) on the energy efficiency of the built environment. The chapter will further focus on coevolutionary interactions between finance and governance in the context of energy efficiency in the built environment (section 6.6). It is important to consider how the case study findings might be relevant for the EU and an UK setting. This means that these findings might be important to consider when expressing recommendations for future policy and funding strategies for all geographies covered in this study.

6.2. The governance findings

From the case study data, this study highlights a number of interesting findings relating to governance and policy for energy efficiency in the built environment. While not all of these are new and original findings, they aim to strengthen previous research and add to an existing body of knowledge.

6.2.1. Supranational one size fits all

One of the most striking observations of the study was that while the EU policies and laws are progressive and seeking equity in their goals, they may also in themselves pose

a barrier to EU member states achieving the EU's goals due to their one-size-fits-all approach.

This understanding is increasingly being verbalised in other areas of EU policies such as in the agriculture sector. So said EU agriculture commissioner Phil Hogan in 2017:

> *"We have concluded that a one-size-fits-all approach to implementation is not always appropriate for a union of 500 million citizens" (EU Observer 2017).*

In its official communication from the Commission to the European Parliament it was stated that "in the Union's highly diversified farming and climatic environment, however, neither top-down nor one-size-fits-all approaches are suitable to delivering the desired results and EU added value" (EC 2017, p.9). This changing approach towards policies in the agriculture sector is equally relevant for other sectors such as for energy efficiency policies. While most EU member states are actively working towards a more energy-efficient building stock, it is fair to say that they are on varying stages on the path towards this goal, dealing with different building stocks in various climatic systems, working for varying demographics within a range of different economies and political systems. It should therefore be acknowledged that implementing and adhering to the EU energy efficiency policies and regulations might put more pressures on some member states than on others and also might feature differently in the list of priorities for different countries. In the case of Germany and Slovenia, it was found that Germany has a better foundation and administrative structure to realise said policies than Slovenia has, not least because Slovenia is operating with one less administrative governance level than Germany as described in the previous chapter.

6.2.2. Policy and transposition

While this has previously been found elsewhere in the literature, the study confirms that there exists a prevailing top-down approach to the transposition of European law into member countries. This is an effort to achieve policy and governance harmony for the greater good of the many. Lohse (2012) discussed the various aspects and considerations of harmonisation of EU law. She arrived at the following succinct definition:

> *"Harmonisation can thus be defined as a conscious process that has the aim to lead to the insertion of a concept into the national legal orders, which triggers a process of adaptation to form a European concept as uniform as required to serve the objectives of the European Union" (Lohse 2012 p.28).*

As Lohse notes, the overall objectives of the EU are key but these are not necessarily aligned with all of the objectives of its diverse cohort of members. Coming back to the laws and regulations relating to energy efficiency, creating a level playing field is difficult if each participant starts from a different level of progress – for some members the unified policies will be ambitious while others may be ahead of the game already. Equally, depending on the level of or lack of involvement of particular member states in the design of the EU law, some might be put at a disadvantage while others might be benefitting disproportionately. As an example, Germany was involved in the debate and shaping of many of the energy efficiency policies yet the implementation and updating of these is still a matter of contention among German law-makers. Slovenia on the other hand joined the EU too late to be involved in the discussion and received these laws and policies as an obligation to implement as part of its accession process. As Lohse notes, "Member States are 'forced' to adopt all harmonising measures regardless of whether they like the particular objective or deem it suitable for their own national policies" (2012, p.4). While this approach aims to achieve an overall efficient and standardised policy landscape for the European Union as a whole, this is achieved in various degrees, of success, and it should be said despite various degrees of resistance, across the individual member states. The harmonisation of these supranational laws at the national level can significantly impact the efficacy of these laws within individual member countries. Slightly more flexible approaches to transposition, beyond the flexibility which already exists for each member state, could be considered by the EU in the future.

6.2.3. Regional governance

Regional governance is an important level in the way EU support functions are meant to operate. However, since not all EU member states have historically and economically developed in a similar fashion, not all of them actually have a regional governance level. This makes accessing these support functions disproportionately more difficult for those member states, like Slovenia, which operate through the national and local governance level only.

In the case of Slovenia, an artificial statistical intermediary level at the regional level was put in place which serves no governance purpose but makes the country eligible to access EU programmes and incentive schemes. Still, Slovenia struggles with its lack of an administrative regional governance level which not only appears to be an obstacle to the transposition of EU energy efficiency policy but is also reflected in a lack of the necessary translation into energy efficiency programmes at the local level. The EU's one size fits all approach does not fit Slovenia.

Slovenia is also struggling with the required harmonisation of EU policy and law with its national body of laws and regulations. Implementing these supranational energy efficiency laws into a national policy landscape which has historically not had a role for energy efficiency was a challenge. Slovenia's policy landscape was also patchy at best for the housing sector. These factors have led to a fragmentation of EU policies at the national level causing inefficiencies and the transposition of law on paper only.

With no sense of ownership regarding its swiftly changing policy landscape, EU laws have been considered a burden and a nuisance and their implementation on the local level has caused confusion and inefficiencies. In the future, EU considerations could move towards making allowances in the way legislation is harmonised, particularly for very small states like Slovenia. These findings are directly derived from the Slovenia case study but the findings are likely applicable to other European countries.

6.3.The finance findings

There have also emerged a number of interesting findings around finance and funding. Some of these strengthen the existing body of knowledge while other aspects can be considered new and original.

6.3.1. Working premises

The research started with the working hypothesis that the availability of low-carbon funding increases the occurrence and depth of domestic retrofitting. The data collected during the study has since questioned this assumption but led to the development of another observation. While the connection between governance and finance for the occurrence of domestic retrofitting was obvious early on, it has now become clearer that this connection may not in fact increase or decrease the uptake of domestic retrofitting in the case study regions but rather tends to directly affect the depth of retrofitting achieved and thus the lifetime sustainability of the housing stock.

A second initial premise that low-carbon finance impacts on the depth and ambition of domestic retrofits, however, was early supported by the data and the analysis. Throughout the data collection a number of sources confirmed that low-carbon funding stimulates the choice of retrofits that go beyond regulatory requirements.

Beyond that, the data provided evidence that low-carbon finance supports the uptake of multiple applications at once rather than a piece-by-piece approach, thereby promoting a more holistic or whole-house approach rather than individual building components. All three premises are further addressed in this chapter.

6.3.2. Supranational funding at the local level

The case studies showed that supranational funding such as EU funding can play a strong supporting role in enabling economically weaker member states to pursue national and supranational sustainability and carbon reduction targets. This makes supranational funding, be it structural funds or otherwise, an important facilitator for sustainability and sustainable infrastructure projects. It also means that supranational funding can positively impact a country's sustainability profile, particularly in cases where an individual state might not have been able to act on its own. The resulting energy efficient or low-carbon projects can play a role in raising awareness among institutional stakeholders and the population, and can so potentially leverage further national institutional, private or third party funding for further sustainability initiatives and projects.

Notwithstanding this positive intention and impact of supranational funding on energy efficiency in the built environment, it also presents a number of constraints to the structurally and economically weaker EU member states. EU funding is designed with a particular governance structure in mind and to be effective, requires a functioning national, regional local governance level within a member states. Not all EU member states are structured in such a way. As the example of Slovenia has shown, smaller EU member states mind have a national administrative level and a local one but not necessarily a regional one, be it for historical reasons or that the size in terms of population or landmass just does not require it. Since the regional level is crucial in interfacing allocation, decision making and accountability between the national and the local level where a supranational strategy is concerned, those EU member states without a regional administrative level are at a disadvantage. The issues that might arise stem from misallocation of funds, accountability issues as to how decisions are taken at a local level and potential claw-back of funds where funded projects do not align with scope or target metrics of the funding, as illustrated in the Slovenia case study.

This means that the lack of a regional administrative level can be a direct obstacle to access and allocation of EU programme funding. Where funding has been successfully accessed and allocated, the lack of a regional level can still be an obstacle to the performance potential of funded projects as there is no administrative oversight body beyond the municipalities at the local level which largely act in self-interest and not in pursuit of a wider national or supranational strategy. Again, as shown by the example of Slovenia, this can lead to those funded projects being considered failures once they get audited by the EU administrators. This carries a high financial and reputational risk for

the recipient countries, in this case the Slovenian public sector. Besides the immediate threat of financial clawback of project funds in frequently less than affluent countries, there is also a risk that repeated perceived misallocation of funds may lead to a loss of trust that the recipient country can capably implement sustainability projects, and therefore withholding of future funding.

6.3.3. National and regional funding

Low-carbon funding at the national and regional level can vary widely across EU member states. National low-carbon finance is relatively common across EU member states (BPIE 2012), albeit by no means guaranteed. 77% of institutional funding for energy efficiency comes in the forms of grants, subsidies and preferential loans, whereas the other 23% took the form of fiscal measures (BPIE 2012). In both case studies, institutional low-carbon funding was provided by national funding bodies which have a wider funding remit than energy efficiency in the built environment. These funding bodies apply different funding approaches, one engaging directly with the individual homeowners while the other uses an existing banking network which handles applications and funding administration for the funding body. There is also a difference in the availability of funding. Where grants, subsidies and preferential loan funding is generously available and funding calls are continuous, energy efficiency measures in retrofits can be more ambitious. Where national low-carbon funding is limited and funding calls regularly run out of funds and funding success relies on a first-come-first-served system, energy efficiency measures are likely to be more conservative and stay within the means of the individual homeowners.

Regional low-carbon funding was found in one of the two case studies, in Germany, but inconsistently so. Not all German federal states provide regional low-carbon funding which is mostly dependent on the budget situation of each federal state. In Slovenia, regional low-carbon funding was also not found since Slovenia lacks a regional governance level. Local level funding appears to be rare in both case studies and also depending on the economic situation of the municipalities. Some restricted municipality funding was identified in one of the two case studies.

Based on the case study data, it can be observed that there is no standardised approach to institutional low-carbon finance in EU member states at the national, regional or local level and availability of funding is dependent on the respective economic and budget situation.

6.4.Backtrack to the literature and gap in the literature

In Chapter 2, the literature review looked at key areas of literature relevant to the research problem. It covered governance, particularly energy efficiency policy in the EU and the UK and policy transposition across the national and regional governance levels. In terms of the EU energy efficiency, the literature review identified a differentiated supranational policy landscape relevant to a range of sectors as set out in Figure 1 (section 2.3.1). The literature review further identified the EU Energy Performance of Buildings Directive (EPBD 2002) as directly impacting buildings performance standards in EU member states. The EPBD was found to the main policy driver for energy use and energy reduction in the building sector.

The literature review also identified issues relating to policy transposition as particularly significant for EU directives as transposition processes and transposition authorities are decided by member states directly. This leads to EU directives such as the EPBD being implemented into various national laws under various ministerial jurisdictions in various EU member states. In the case of the EPBD, the transposition of the directive was investigated for the case study in Slovenia and the case study in Germany, finding different levels of fragmentation into national legislation, under the jurisdiction of several ministries, leading to higher or lesser levels of impact on the national building stock. It became apparent that the transposition of EU energy efficiency directives, as indicated in the literature review, can therefore have a significant impact on the energy performance of the building stock of member states. This is particularly the case in member states with a weaker regional governance level. While the EU energy efficiency policy landscape provides a useful framework to move member states towards a higher energy performance of buildings, policy transposition would benefit from a more coordinated approach across member states.

The literature review identified finance as a barrier or restriction to energy efficiency in the built environment. While the funding and investment landscape is diversifying and shifting towards more collaborative funding approaches, low-carbon finance is currently largely dominated by institutional funding. More diverse funding models are emerging at the small and medium-scale level, yet this study focused on two institutional low-carbon funding schemes in two case study regions. The most common forms of energy efficiency funding for the built environment are grants, subsidies and preferential loans but also fiscal measures such as tax reductions or tax credits. The thesis investigated institutional low-carbon funding in two case studies at the national, regional and local governance levels. The literature review also identified low-carbon finance as an

emerging area in the sustainability and transitions literature and distinguished it as different from traditional finance. The literature review found that low-carbon finance is distinct in its motivation and result-focus. It is result-based finance rather than return of investment –focused, which affects its risk perception by potential investors. As an emerging research area, the concept of low-carbon finance would benefit from further efforts of definition and recognition of the significant role it plays in low-carbon transitions.

6.5.Interpreting the case study findings for the UK and the EU

The next section will look at how some of the findings from this study could be relevant for the EU and the UK. It starts by applying the study's finding to the EU in section 6.5.1. It looks further at the UK's current shape of its policy landscape and how it could develop in section 6.5.2. It provides some comparative analyses between the case studies in Slovenia and Germany as well as the UK and it considers these findings in light of the UK's proposed and much-contested decoupling from the EU. All three of these topics are closely interlinked.

6.5.1. Applying the findings to the EU

Ringel and Knodt (2018) describe the EU as a "sui generis" organisation which applies to its "unique mix of different modes of governance referring to the broad categories of hierarchy, network and markets". They explain further that the EU operates through a "range of governance modes [that] reaches from supranational hierarchical governance, as in ordinary legislation that allows for the adoption of legally binding decisions, up to forms of soft governance that are intended to steer behaviour without legally binding action. (ibid., p.210). Despite this variety of governance modes, the EU is working towards unity through standardisation, particularly for its policy landscape which is transposed into domestic law by the EU member states.

This causes a one-size-fits-all policy and transposition situation which requires all member states to adhere to similar governance structures and policy approaches. The case study on Slovenia however has shown that this approach can be problematic for some member states which can then become disadvantaged compared to their more aligned fellow member states.

One such alignment issue is the need to operate via a number of administrative governance levels which include a national and a regional level. Slovenia operates via national and local administrative governance levels without a regional intermediary level which hampers its access to some of the EU's programmes and schemes. It could

be argued that rather than requiring Slovenia to instate an artificial statistical regional level to comply with the eligibility criteria for said programmes, the EU could respond to Slovenia's problem by having funding mechanisms which they could access without the need for a regional governance level. Instead the EU required the country to comply with the governance structure which benefits the country in no other way beyond eligibility to access a number of EU programmes. In light of the recent increase in nationalist movements within EU member states, there is a political argument to be made. If the EU would like to foster a strong union and essentially survive for decades to come, it should carefully consider which requirements to impose on the member states. A change in governance structure might be considered too big of an ask and lead to increasing anti-EU friction within member states. Creating a standardisation approach with an accommodating level of flexibility might be preferable to creating expectations among member states to change historic governance structures in order to align with most other EU member states.

Another potential source of problems is the level of input into policy making as well as the burden of transposing a large number of supranational policies when new member states are joining. On the example of Slovenia, it was seen that the integration of supranational law into the national body of law was far from straightforward and caused confusion and resistance among ministries and institutional bodies but also the wider public. This also could be a potential cause of anti-EU sentiments in more recently joined or accession states and could be explored as an area for improvements.

6.5.2. Lack of UK follow-up policies

As discussed in Chapter 2, the UK is currently suffering from something like a policy vacuum for energy efficiency in buildings resulting from the Green Deal being abandoned as the panacea for domestic energy efficiency and the Green Investment Bank being sold abroad. "The Green Deal is widely regarded as a failure, with original intentions of refurbishing millions of homes by 2020 failing to materialise, as only around 20,000 home energy improvements were funded between 2013-2015" (Hall & Caldecott 2016 in Bergman & Foxon 2018, p.12). It appears that the lack of success of and continuing commitment to recent UK energy efficiency policies has left the UK government without effective policies in this policy area. Since then, the UK energy efficiency policy landscape has entered a hiatus with no new energy efficiency policy having been designed in recent years. As mentioned in Chapter 2, only a small number of policies are still actively promoting energy efficiency in the built environment, such as ECO and the problematic national smart energy meter rollout. "The lack of continuity

and changes in policy direction and agenda are damaging to the energy efficiency sector as investments in skills are not rewarded, and confidence in policy drops" (Bergman and Foxon 2018, p. 18).

The UK might benefit from looking at previous policy measures. While the main Green Deal offering of the PAYS scheme is worth revisiting under different parameters as mentioned in chapter 2, it was the Green Deal Home Improvement Fund (GDHIF) which attracted interested much beyond its intended funding cap. As found in both case studies in this study, grant funding appears to be very attractive to homeowners, often exceeding demand expectations as in the case of Slovenia or providing stable demand as in the case of Germany in economically challenging situations. Both the EKO Sklad and KfW provide grant funds which are deemed successful so a funding offering of this kind might provide a strong approach to creating and maintaining an energy efficiency market beyond governance and economic parameters. As such, a scheme which resembles the GDHIF might pose a good approach to revisit in the UK's future beyond Brexit.

On the other hand, this policy vacuum could be seen as a space of opportunity where, with careful consideration of previous policies and by taking learnings from other countries working on achieving similar targeting, the UK policy landscape could be redesigned to more successfully work towards national and global sustainability targets.

6.5.3. Learnings from elsewhere

The case study research provides a very interesting comparative element. Both case study regions are strikingly different and so provide for interesting approaches to energy efficiency incentive policies. One focuses on the (im-)potence of the regional and local level while the other benefits from a joined up approach across all governance levels under central supervision.

So has it been said that the energy efficiency of the UK housing stock could surely benefit from institutional interventions in terms of "regulation, leveraging private finance, or even more central programmes to improve the housing stock" (Bergman & Foxon 2018, p. 18). Theobald & Shaw (2014) concur, saying that "the 'immature' market for sustainable retrofit still requires more extensive (and effective) regulation and support, and that managing retrofit at scale is a complex process" (p.95). These arguments support the approach of the Germany case study.

For instance, in the absence of financial incentives policies in the UK Bergman and Foxon (2018) point towards decentralised, regional and local solutions. These could take the form of public development banks such as the German KfW, a role which in the UK could be centrally managed by the now privately-owned Green Investment Bank or a body like that. There is also an opportunity at the local level for cities and municipalities to step in and invest in domestic retrofitting schemes as successfully done by the Warm Zone programme in Kirklees, West Yorkshire or even by third sector organisations like the Ellen McArthur Foundation in the Chale Green Housing Trust on the Isle of Wight. Bergman and Foxon (2018) stressed the importance of local and regional level capacity for the effectiveness of policy, stating that "local delivery of energy efficiency measures can be more effective, as local institutions and businesses, as well as community groups, are more widely trusted than central government and large energy corporations" (p.5) However, the case of Slovenia also shows how leaving the responsibility for major energy efficiency strategies and programmes purely to the local level can cause more harm than good, resulting at the least in disjointed approaches or at the most in little to no retrofitting activity at all if the local level fails to rise to the challenge.

When looking at the two case studies in this thesis it appears that the UK closely resembles neither but fits somewhere in between them. It has strong governance structures at the national, devolved and local level and in this respect resembles more Germany. However, in terms of energy efficiency incentives or limitation thereof it is much closer to Slovenia. If the UK took an approach more aligned with Germany and its federal states, its strong governance structure would allow it to provide energy efficiency incentive schemes not only at the national level, very much like Slovenia, but also provide regional and even local level low-carbon funding. In fact, the German three pillar approach of funding, regulation and information is considered to be an example of good practice (Schroeder et al. 2011, Bergman & Foxon 2018) which could be reflected in future UK energy efficiency approaches.

6.5.4. The opportunities and disadvantages of Brexit

Another aspect to consider is how the impending Brexit might shape or allow shaping the UK energy efficiency policy in the future. At the time of writing the UK government has struck some sort of compromise with the EU which leaves both parties unhappy and the UK government in pieces following a string of resignations of ministers. Nevertheless and without analysing the current amended Chequers Brexit deal in any great detail, it might be worth understanding in which approximate position the current agreement would leave the UK. What is currently being experienced might leave the UK

in a situation close to the Slovenian policy landscape after it had joined the EU – with no input into the policy design yet still expected to make the policies work somehow with its own national body of law. This would be a new and likely uncomfortable situation for the UK which has until recently had significant influence in shaping EU policy, albeit the extent of its influence on EU energy efficiency policy is not known.

There appears to be a sense in approximately 50% of the UK population that the UK has been constrained or held back by the EU and its membership. There is no doubt that some EU policies and programmes are more beneficial to individual member states than other but it might be interesting to consider some of the areas which the UK might perceive as a loss after Brexit despite the extra degrees of freedom which would come with leaving the EU. The UK might lose finance and financing mechanisms such as from the structural, cohesion and research funds which it would need to substitute with internal spending. On the other hand, in the case of a hard Brexit the UK would not need to adhere to state aid regulations any longer as this is an EU policy, and could potentially increase energy efficiency funding to up to 100%. "EU State Aid regulations constrain public funding for energy efficiency measures to 30-50% of total costs, although energy infrastructure is allowed support of a full 100% of eligible costs" (Bergman and Foxon 2018, p.8). While this would count as an opportunity of Brexit, it remains to be seen if the UK would be inclined to maximise energy efficiency funding in areas like the built environment. Of course, in the case of a soft Brexit State Aid might still apply and no such funding freedom might apply to the UK after leaving the EU.

6.6. Coevolution - combining governance and finance leads to increased retrofit potential

The coevolutionary analysis of this thesis has shown that it is important to consider the impact of governance and finance in tandem but also in connection with some of Foxon's other coevolutionary systems. This section will show that some of the linkages between these systems are indeed important. The individual systems highlight many similarities between the two case study regions, but it is only once they are considered in combination with other coevolutionary systems that some striking differences between the two case studies become fully apparent. The technologies system is a good example for this. The analysis with Foxon's coevolutionary framework has shown that actors in Slovenia are not as concerned about and engaged with, or rather are more grappling with technology. Slovenia appears to be still transitioning into an emerging landscape of low-carbon technologies for an energy efficient building stock. Germany has overcome this challenge in the past and has developed a building sector which

decarbonises existing buildings with confidence and experience. Both case study regions are at different stages in the retrofitting debate and are therefore facing different challenges.

From the outset of the research, there had been an understanding that low-carbon finance or governance, in fact both, are likely to have an impact on domestic retrofitting, either the rate of uptake or the depth of it. From the interview data for Slovenia and Germany it then emerged that neither low-carbon finance nor governance in the form of policies or the various administrative levels are directly influencing the uptake of domestic retrofitting to significant levels. This is not to say that neither have any impact on increasing domestic retrofitting. Instead, the data shows that governance and low-carbon finance by themselves are struggling to significantly raise domestic retrofitting rates, such as the German target of doubling the retrofits rate of the domestic building stock from currently 1% to 2% annually. From the interviews there is a sense that the number of retrofits in any given year in either case study does not significantly increase or decrease depending on the amount of low-carbon funding available or the rigorousness of the institutional and policy aspects concerned with domestic retrofitting. While in Slovenia the annual funding call for institutional funding might run out of funding due to oversubscription, the resulting lack of funding until the next funding call does not significantly negatively impact Slovenia's overall retrofitting rate. Neither does Germany's retrofitting activity significantly increase due to a possible abundancy of low-carbon funding. Whether or not domestic retrofitting occurs depends on a multitude of factors, including windows of opportunity which provide a need to replace or improve building components while coinciding with beneficial and supporting personal circumstances of homeowners, availability of disposable cash at that point, prioritisation of the home over other factors or needs and many more considerations.

While neither governance nor finance might significantly impact on retrofitting occurrence, there is, however, a sense that when domestic retrofitting does occur, low-carbon finance and governance have an impact on the depth and ambition of the home improvements. Legislation and policies can enforce a minimum level of energy efficiency or carbon reduction for building components and demand a signalling requirement which ensures the comparability of buildings in terms of their energy efficiency, heating/cooling costs or carbon footprint that is easily understood by homeowners. Both of these support a minimum energy efficiency standard for domestic retrofitting. While this might only cover the lower hanging fruit of energetic

improvements to a building, it nevertheless assures that any money spent on the building is unlikely to be just cosmetic. Such governance provides a minimum level of domestic retrofitting.

Funding, on the other hand, plays a role in maximising the depth of the retrofit. While it does not appear to increase the overall number of energetic renovations of buildings, it does provide financial incentives to implement more efficient and advanced buildings components for the same or slightly higher amount of investment.

Beyond this, interviewees had a sense that both low-carbon finance and governance impact each other in their pursuit to improve domestic retrofitting, at least in the direction of governance correlating with low-carbon finance. In an instance where there is a strong legislative basis for sustainability, be it in the form of strong supranational umbrella policies which enforce energy efficiency in the built environment, rigid national legislative requirements on building components or supportive regional initiatives that increase awareness and understanding of domestic retrofitting, and indeed all of these combined, there is a higher likelihood and abundance of low-carbon funding that supports the policy objective. Vice versa, in an environment where energy efficiency in the built environment is part of the legislative framework but only features rather than is actively pursued or has a strong focus, there appears to be a lower likelihood and fewer occurrences of low-carbon finance for domestic retrofitting.

As noted, some of the results from the Slovenia interview data show that the lack of an administrative regional governance level is an obstacle for the effective transposition of EU energy efficiency policy and its translation to useful energy efficiency programmes in the built environment at the local level. This weakens the country's governance and also appears to limit funding for energy efficiency in the built environment. Not only does the absence of a regional administrative level appear to have an impact on Slovenia accessing and allocating funding from EU programmes, but also on the quality and energy efficiency performance of the projects which are built through the support of this funding.

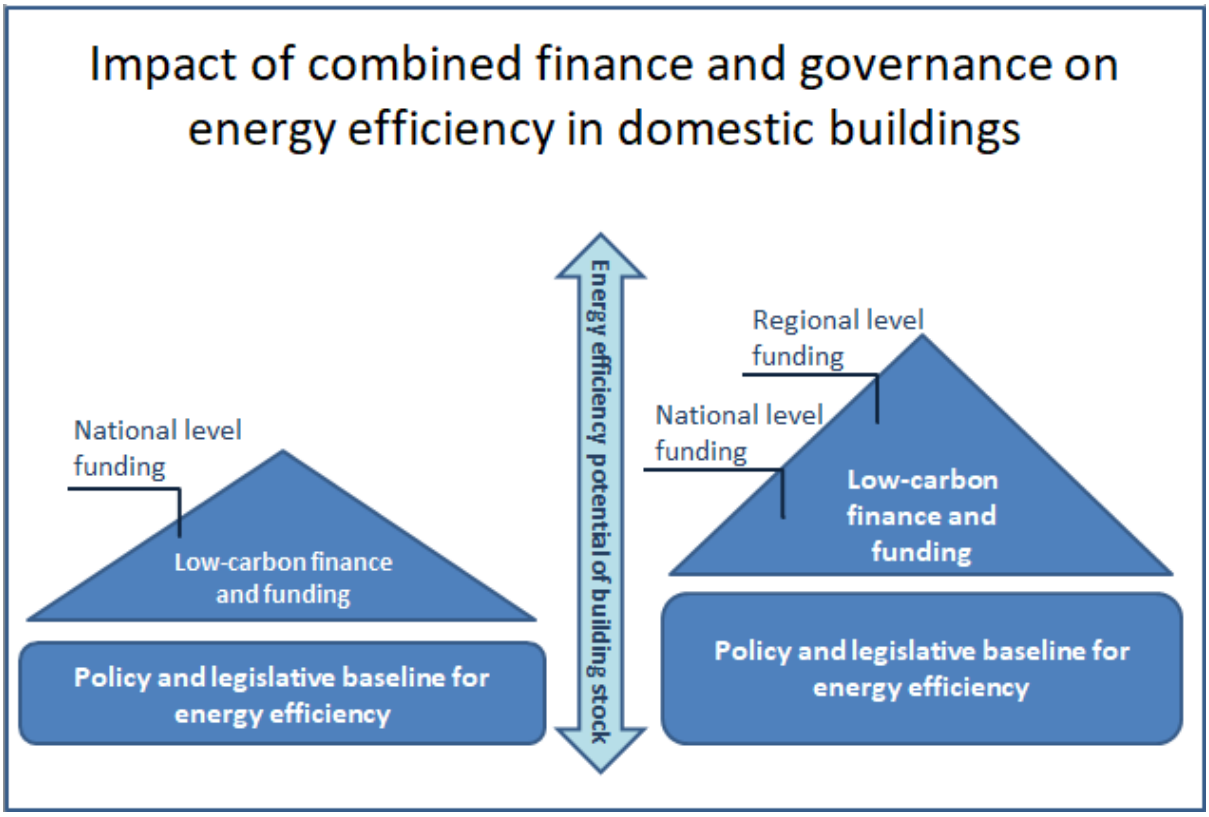

Figure 44: Impact of combined funding and governance on energy efficiency in domestic buildings in Slovenia (left) and Germany (right) (Source: Own illustration)

Figure 44 illustrates the interconnectedness between finance and legislation and governance in the domestic retrofitting space. The figure shows pyramids on a base for Slovenia on the left and Germany on the right. The bases signify the legislative and policy landscape. If the policy landscape or governance base is more structured and prescriptive in terms of the legislative requirements and governance targets for energy efficiency in the built environment, domestic retrofits will have a higher likelihood of achieving depth and ambition in terms of energy reduction and carbon savings. This is because the basic regulatory requirements demand a higher energy efficiency level. This is amplified by a number of factors. If policy and regulations are not sufficiently transposed and enforced, they are less likely to achieve as much impact as tight and well-defined regulation would. Equally, if policy and regulatory requirements are fairly unambitious, retrofits might only aspire to integrate the lower hanging fruits of energy efficiency. More aspiring and ambitious regulations with higher research efficiency targets will promote uptake of more sophisticated and future-proof retrofitting technologies which achieve more sustainable retrofits. Other factors which can determine the efficacy of the policy base is whether targets are being achieved within a specified timeframe or whether there are no timescales stipulated. Similarly, if an effective level of enforcement is in place and non-compliance is penalised, retrofit

outcomes might be better than if the quality control and assessment is left uncontrolled or to the discretion of individual homeowners. This means that the rectangle in Figure 44 which denotes the legislative basis for domestic retrofitting depends on a multitude of factors which create a combined level policy and governance impact on domestic retrofitting.

The triangle in Figure 44 symbolises the potential impact of funding on domestic retrofitting. Where there is no low-carbon funding available, the depth of retrofits will depend on policy requirements and the level of ambition of individual homeowners to retrofit their homes as sustainably as possible. Any additional level of low-carbon funding has the potential to increase the sustainability of the retrofitted building stock by attaching technological or carbon-saving requirements in exchange for a monetary contribution. This contribution could come from different governance levels, such as a national funding body, a regional level funder or a local or municipal contribution. The more low-carbon funding sources are available on different governance levels, the higher the combined impact on the final retrofit since each funding contribution allows the integration of increasingly ambitious retrofitting technologies. Each contribution is usually subjected to rigorous technical assessments by independent surveyors before the funding is paid out, increasing the motivation of homeowners to deliver an ambitious retrofits that stands up to scrutiny.

The connection between governance and funding is interesting. The availability of funding might not provide further insights into the legislative and policy basis for energy efficiency in the built environment – but the policy landscape might provide an indication regarding the availability or intensity of low-carbon funding. The stronger the legislative basis for sustainable retrofitting the greater is the likelihood of abundance of low-carbon finance to foster energetic ambition of domestic retrofits. Combined, the policy basis and the abundance of low-carbon finance impact the depth or energetic ambition of domestic retrofits. A denser and more demanding policy layer combined with abundant low-carbon funding, while not increasing the overall number of retrofits, play a crucial role in maximising the energetic potential of the domestic retrofits which do take place. Those two linked factors create and increase the opportunity for deep and ambitious retrofits.

The transitions in both case studies are institutionally-led which means that governance and policy are driving forces for the decarbonisation of the built environment. This might imply that they need a similar steering approach for the decarbonisation

transition. Yet the nuances of both countries' transitions are different which might counteract the above statement. Both share institutions as their dominant coevolutionary system but feature different minor but interacting systems. They are likely to require separate transition management approaches.

An interesting finding from the coevolution of systems relates to society. Both case studies are very different in this respect. In the Germany data, the society system as defined in this study does not feature a lot. The focus seems to be rather on technology and function which could imply that Germany is undergoing a transition which is more technology-led than Slovenia's. In the Slovenia case study, however, points about socio-economic and social issues feature relatively often, certainly more frequently than in the Germany case study. While this focus on societal issues is an important point of consideration since it highlights what was an important driver for the transition at the time of data collection, it also highlights that technology was perceived to be a less important driver at the time. This could provide insights for institutional decision-makers whether or not there is a need to increase their focus more on technology as this might be a system in need of intervention.

This might provide interesting insights for transition management approaches and could imply that the transition to a decarbonised built environment would benefit from different approaches in both countries rather than a standardised one-size-fits-all approach. While a managed transition might benefit from taking into consideration factors like national culture and national preferences as well as the governance and economic situation and sustainability ambition, analysis through Foxon's coevolutionary framework might provide a sense of prioritisation among these factors. This could help provide transition pathways of least resistance for specified geographic boundaries. The Germany data implies that particularly the institutional actors focus a lot on technology and governance and might therefore be more inclined towards a transition which is communicated around these aspects. Slovene institutional actors, however, might not prefer a similar approach. Their buy-in might more likely be secured by highlighting the long-term economic and societal benefits which not only addresses some of the region's hardships at the time of data collection, but also highlights a potentially sustainable pathway to preventing their reoccurrence in the future.

Extrapolating a set of relevant focus points for positioning a sustainability transition in the public eye and that of decision-makers can help secure high buy-in and reduce resistance. While this might help address just one of many factors which need to be

considered for transitioning countries towards energy efficient buildings, analysing a socio-technical transition using Foxon's coevolutionary framework can certainly play role in developing sustainable pathways.

6.7.Wider relevance

6.7.1. Technology and deep retrofitting

The study initially ambitiously was hoping to target occurrences of deep domestic retrofitting in the two case study regions. As became apparent during the case study research, access to such examples was unattainable because there had not been many practical cases of deep domestic retrofitting. While deep retrofitting was occasionally mentioned in the literature, at the time of data collection is remained an aspiration rather than a reality and so the study's focus is on energy efficiency in the existing building stock rather than a defined range of energy reduction as a result of component or whole house retrofitting. Within this area, however, it focuses on more ambitious whole-house retrofits rather than the replacement of individual building components.

6.7.2. Relevance for Brexit

It is useful to consider the findings of this study in light of the UK's Brexit preparations. Brexit presents the UK with a number of opportunities in that it may have more independence in developing and structuring its policy framework for energy efficiency and the housing sector once it operates outside the European Union's policy framework. Indeed, it may find itself in a position where it could 'pick and choose' individual legislation and policies and/or financial instruments to create a bespoke policy and funding landscape for the UK. One of the issues which have come out of the study was that the EU policy framework might not be suitable for all EU member states in equal measure. It aims to provide a standardised approach, a 'one-size fits all' for a diverse set of countries in terms of economies, politics, demographics and cultures. A post-Brexit UK might potentially be able more freely to shape its policy landscape according to the needs of the British economy, politics, demography and culture. This might perhaps provide an opportunity to take pointers from the case studies which were discussed in the study in where it wants to position itself in terms of regulations and funding. This thesis has been submitted before March 2019 and while there is no certainty at the time of writing it is likely that whatever it will shape into, the UK will be different to EU once Brexit is concluded.

This study looks at different types of governance and regulation. Particularly the cross-case comparison in the previous chapter shows differences in the way policy is reflected

at the regional and national level and there may be learnings for the UK to prepare for the transition away from EU law. So could the UK exercise a much stronger energy efficiency policy framework or develop its own bespoke funding landscape for its national sustainability arena in the case of a hard Brexit. The UK has a national carbon budget to achieve emissions reductions of at least 80% of 1990 level by 2050, in accordance with the UK Climate Change Act (Committee on Climate Change 2018). This target has been set by the UK Parliament and the UK, while currently on track, "will need to reduce emissions by at least 3% a year" (Committee on Climate Change 2018). Since this carbon reduction target needs to be delivered by UK law, Brexit could be seen as an opportunity to encourage and enforce this change by means other than EU policy. On the other hand, the UK carbon budget would likely remain one of the only drivers for climate change and energy efficiency policy in case the UK leaves the EU with no deal. Since Brexit will involve a change of governance for the UK, it presents a window of opportunity to change or improve upon already transposed EU acts in such a way that it not only acknowledges but also makes provision for the design and implementation of effective funding mechanisms which are easily accessible by the wider public and provide a measurable positive impact on the British housing sector. This is because policy areas which had previously been a compromise between all member states could be fully explored without the balancing influence of the EU, to the extent that the outcome could be bespoke to the UK's demographic, political and economic needs and the climatic characteristics of an island nation without any of the additional legislation that serve the country only marginally and might cause disproportionate administrative effort and dissatisfaction among the population.

Since at the time of writing the terms at which the UK is leaving the EU are not clear, it is useful to look at different scenarios. In terms of the availability of low-carbon finance for domestic retrofitting and the governance of domestic retrofitting, the UK could be seen as positioned between the Slovenia and Germany case study. Regulatory and financial support in the UK is more established than in Slovenia but not as supportive as in Germany. An example of this is the previous Green Deal incentive scheme which while providing a framework including funding in the form of loans and grants for domestic retrofitting (as set out in Chapter 2) ran out of money for the home improvement grants, much like the Slovenian EKO Sklad with its annual funding calls for energetic home improvements. Due to its relatively late accession to the EU, Slovenia was faced with a large body of supranational energy efficiency law to transpose into its national law. At the point of accession it had had no input into these policies on

account of it joining after the point of policy decision making by the existing EU member states. In case of a soft Brexit deal, the UK might find itself in a position much like Slovenia at the point of its accession. It might be subject to policies and laws which it has no control over or input in. Much like Slovenia before it joined the EU, the UK would lose its policy-making power after leaving the EU. It is likely that such a Brexit deal might be a cause for resistance and further anti-EU sentiment in the UK.

Of course, at the point of writing the UK also has the option of rejecting Brexit altogether and remain as a full member state in the EU. However, this comes with compromises as the UK knows well and as the German case study has shown. Even when fully involved and considered in the EU policy making process, there are still compromises to be made between the often conflicting demands of all member states. Full EU membership allows for full input in the policy shaping process but also requires full compliance with any compromises. A hard Brexit would require neither compromises nor compliance for the UK.

6.8. Recommendations

While this study's focus is on the impact of low-carbon finance and governance on domestic retrofitting, some of the findings from the two case studies can be formulated into recommendations for the UK, particularly in light of its changing relationship with the EU, the Slovenian case study region, the German case study region and the wider EU. This section briefly summarises these recommendations.

Recommendations for the UK – In light of the current vacuum of energy efficiency policy and incentive scheme for the built environment in the UK, the country could take learnings from the two case studies discussed. It could for instance employ a three-pronged approach featuring policy, funding and information as in the case of Germany. It could also take learnings from Slovenia and its own experiences with the Green Deal Housing Improvement Fund and ensure sufficient long-term low-carbon funding is put in place without an annual call structure but rather an ongoing open call such as in the example of the KfW in Germany. As in both case studies, the funding body providing such low-carbon finance does not need to have a retrofitting-only or even a built environment-only focus but could be a vehicle to fund, supervise and implement wider sustainability schemes across the UK. The introduction of such an organisation, while taking learnings from the previous public-sector Green Investment Bank, could go hand in hand with the design and implementation of energy efficiency policy in the UK. Again, this could take learnings from both case studies and ensure that the policies fall

into the mandate of as few ministries and government departments as possible so that there is a clear focus among the administrative bodies on the implementation of these policies and no ambiguity, and thus inefficiency, in terms of administrative competencies across departments.

Recommendations for Slovenia – Slovenia appears to be facing the big challenges in governance but also finance. It would benefit from more local level collaboration and goal setting, leading into the establishing of regional level administrative bodies which can maintain an oversight and guiding function across and beyond the often conflicting local level ambitions and competitions of the municipalities. Not only would this allow for more stringent implementation and tracking of sustainability and energy efficiency policy on the local level as well as more coordinated messaging, information and sign-posting across regions in Slovenia, it would also facilitate the use of supranational and national low-carbon funding in the most impactful way and for the strongest sustainability outcomes. While funding may be a problem for a country emerging from economic hardship, the revolving fund model that is already being used for the EKO Sklad, similar to the one used for the KfW in Germany, is a useful approach for such situations. It enables the country to increase the budget of the fund whenever public monies become available.

Recommendations for Germany – Germany is using its federal governance approach to strengthen national level low-carbon finance where possible at the regional level of the federal states. However, as the Bundeslaender differ in their affluence, it would be useful if the national government could provide baseline regional level funding beyond the national level KfW funding to even the odds for increased energy efficiency retrofitting across the country and across affluence levels of the population. Germany's three pillar approach of policy, funding and information is providing good results and should be continued. Having a dedicated sustainability funding body like the KfW is considered best-practice and should also be continued.

Recommendations for the EU – EU policy makers and programme designers could consider either reframing the eligibility requirements of some of the EU's programmes and incentive schemes to fit with the governance structures of all its member states. This is particularly relevant for some of the smaller countries or city states which do not necessarily require a regional or local governance level to operate effectively and which are currently forced to implement artificial statistical level to comply with EU needs. If this approach is for some reason unworkable for the EU, it should consider making a

specific governance structure with set levels which fit its governance approach a joining requirement for the new accession states and a transformation requirement for existing member states. While this might foster more standardisation across the EU, it is likely that this might also increase anti-EU sentiment as this could be seen as a major intervention into national political and cultural pillars of the countries.

6.9. Concluding section

This chapter discussed the case study findings and investigated their applicability for the UK, the EU and both case study regions. The learnings from the interview data cover a wide range of topics, a selected set of which were mentioned in this chapter. It covered the literature gap as relevant to energy efficient retrofitting, the study's contributions in terms of methodology, governance and low-carbon finance and its relevance to coevolutionary research in sustainability transitions. From these learnings, a number of recommendations were drawn up for the benefit of the future shaping of energy efficiency policy and incentives scheme in the UK and potentially the EU. This thesis is brought to a conclusion in Chapter 7 with a summary of the study, its findings, useful learnings and any recommendations for further research.

7. Chapter- Conclusions

This study set out to understand the impact, if any, of governance and finance on domestic retrofitting and the energy efficiency of buildings. The different stages of the research are described in the seven chapters of this thesis.

Chapter 1 introduced the study topic and provided some background to the research area. It also framed the research problem and explained how this was split into a number of research questions. After presenting the research questions and the original contributions that the study aimed to complete, the first chapter gave a brief overview of the scope of the research and an overview of the thesis structure.

This was followed by a critical literature review in Chapter 2. The second chapter was split into three major areas of literature – governance, retrofitting and finance. The governance section reviewed aspects of governance at the EU supranational and UK national level, and looked at energy efficiency policy in particular. The retrofitting section introduced the technology approach of deep domestic retrofitting and its benefits but also existing barriers. And the section on finance reviewed the literature relating to supranational and institutional funding in the EU as well as the concept of and challenges around low-carbon finance and low-carbon funding. The literature review chapter identified governance levels and the transposition of energy efficiency policy as areas with substantial influence on the energy performance of the building sector, and particularly for domestic buildings. It further identified low-carbon funding and the way it interacts with governance as a gap in the literature.

Chapter 3 framed the decarbonisation of the built environment as a socio-technical transition and introduced the contextual and the analytical frameworks for the study. The contextual framework is Geels' Multi-Level Perspective (MLP) and the third chapter provided an overview of its three levels. It also framed domestic retrofitting as a socio-technical system. The analytical framework for the study is Foxon's coevolutionary framework with its five coevolutionary systems. This chapter elaborated in some detail how the study aimed to make coevolution of some of the coevolutionary systems visible in the case study data. It introduced the coding tree for the qualitative data analysis and provided some illustrative examples of how aspects of coevolution could emerge from the interview data.

Chapter 4 laid out in some detail the methodology and analytical approach which was applied and yielded the case study data as described in Chapter 5. Initially providing

findings for the individual case studies from the intra case analysis, it also presented a comparative analysis of both case studies through the cross-case analysis. The case study sections followed Foxon's five coevolutionary systems to present the findings. The interview transcripts were then evaluated in terms of the occurrence of any coevolutionary systems in the data, represented by coding nodes which are allocated to the respective systems. Presence of multiple systems in parallel in the transcripts could indicate a meaningful interaction and were analysed, and where possible quantified, to highlight any systems which might impact on energy efficiency in the built environment through their interactions or coevolution.

The findings for governance and finance and the possible coevolution of both systems from Chapter 5 were further discussed in Chapter 6. The discussion focused particularly on the relevance of the findings for the EU, the UK and both case study regions before concluding with a number of recommendations for all four geographies.

7.1. Reassessing the research problem

The overall problem this thesis addressed was the need for efficient and ambitious domestic retrofitting and a high energy performance in the built environment in general, and whether governance and financing could enable this. Accelerating the decarbonisation of the housing sector through domestic retrofitting not only refers to the increased uptake but also to an increase in energy performance ambition of the retrofits, i.e. their energy efficiency. The study was mainly concerned with how governance and finance can impact, be it to further or hinder, domestic retrofitting. Moreover, the study explored the interaction between governance and finance as coevolving systems and whether their coevolution might already be underway. It was also interested in ways to increase their combined impact on domestic retrofitting beyond the sum of their respective areas of influence.

The study's overarching aims were broken down into smaller research questions which are repeated below. The case study data provided some insights for these which are discussed in greater detail in Chapter 6 and summarised below.

1. *How do different types of governance and legislation impact on energy efficiency in the built environment? Which role do governance levels play?*

   The case study data revealed that that governance and legislation can have a significant impact on the built environment. The importance of governance levels was demonstrated in the Slovenia case study where a lack of the regional governance level leads to inefficiencies in how low-carbon finance is

allocated at the local level. Germany serves as a counter example whereby an efficient regional administrative level ensures a more efficient use of low-carbon finance from national to local level into buildings with a strong energy performance. In terms of the regional level governance level, Germany benefits from a federal political system which means that the regional governance level of the Laender has a lot of authority and is an effective intermediary level between the national and local governance levels.

2. *Does the way in which energy-efficiency policy is transposed from the supranational to the regional level affect energy efficiency in domestic buildings?*

   The importance of policy transposition was illustrated through the example of the EPBD which was fragmented and transposed as four separate Slovenian laws across three administrative departments in Slovenia. This led to confusion and resistance to implement the Directive more efficiently. In Germany, the EPBD is transposed mainly into one German law under the jurisdiction of two ministries. This leads to less fragmentation of the Directive and so causes less resistance and inefficiencies in its implementation.

3. *What kinds of impact do different forms of, and the availability of, low-carbon finance have on domestic retrofitting?*

   This study looked at institutional forms of funding for energy efficiency in the built environment. The Slovenian example was the EKO Sklad, the Slovenian Eco Fund, and the German example of institutional funding was the KfW. Both funding mechanisms provide finance for sustainability measures beyond domestic retrofitting and both attach a set of technology requirements to the funding, such as minimum levels of insulation or double glazing. Through these requirements, both finance mechanisms ensure that the funded retrofits achieve higher than legally required energetic performance of the buildings. The availability of institutional low-carbon funding has not been found to affect the overall number of retrofits in the case study regions. Its effectiveness, however, has been linked to the existence of a strong energy efficiency policy base.

4. *Does the impact of low-carbon finance and governance vary across case studies?*

   The study found that legislation provides national minimum baseline requirements for the energetic performance of buildings. As such, it also serves as the base for how impactful low-carbon finance can be for the built environment, as it directly builds on and improves on legal energy performance requirements. This means that where legislation was transposed less to comply with EU administration, and more to achieve EU energy efficiency objectives, better results could be achieved through the interplay of governance and finance. This means that the combined impact of low-carbon finance and governance did indeed vary across the case study regions with the German case study showing a stronger sustainability and energy efficiency potential for their domestic building stock than the Slovenia case study.

5. *What policy recommendations for the EU, the UK and the respective case studies arise from addressing these questions?*

   The study highlights some interesting recommendations around policy and programme flexibility for the EU, some policy and funding design learning for the UK and some recommendations for the case study regions. These were set out in Chapter 6.

7.2. The study's contribution

One of the more complex parts of the study was establishing an analytical framework for an interdisciplinary piece of research. The study was placed in the context of transitions research, so it was a logical step to consider applying an analytical framework that had been well established in this particular research area. Geels' multi-level perspective (MLP) is such a framework and was thoroughly discussed earlier in the thesis in the transitions chapter 3. It proved exceedingly helpful to ascertain the transition context for the study, in particular the socio-technical transition to a decarbonised domestic housing stock. As such, the MLP played a role in identifying the transition landscape in terms of institutional actors and policy activity, the regime and the niche levels as pertaining to the domestic retrofitting sector. It helped to define energy-efficient building retrofitting as a socio-technical system with important agents and artefacts and practices. Since it is difficult to identify a transition without a clearly defined system which is moving from a potentially path-dependent, locked-in status quo to a more

sustainable and progressive and future-proof version of itself, framing domestic retrofitting as a socio-technical system was a necessary starting point for the research. This also adds to the existing transitions literature that highlights domestic retrofitting as a socio-technical system with specific actors and artefacts.

Once the parameters of the transition and the socio-technical system had been identified, the research then aimed to understand those aspects of the system which might interact in such a way as to shape and progress the transition. It became evident that to understand the interconnectedness and interdependencies between the individual transition layers, agents and resources an additional analytical structure was needed besides that of the MLP.

It should be noted that the three major frameworks and theories applied to this study being Geels' multi-level perspective, transition management and Foxon's coevolutionary framework worked well in complementing each other and therefore strengthening the research. Foxon's coevolutionary framework, which formed the analytical framework of the research, was the backbone of the data analysis. The MLP and TM formed the conceptual background for the analysis and added to the coevolutionary framework in several ways. The MLP provides a deeper understanding of the slow-moving landscape level which includes economic and policy development but also sheds light on the constraints of incumbent systems on the regime level, for instance through sunk investment, behavioural patterns, regulation and vested interests. It allows the identification of important actors on the regime level who may help or hinder progress towards a decarbonised low-carbon building stock.

Transition management on the other hand is a proactive, consensus-building and practical governance approach that aims to bring together systems and actors of a transition. While one of its criticisms has been a lack of practical examples of TM in action, it serves well as an approach to identify various complex factors and aspects which interact in a transition which might otherwise get missed. For this research, this included interactions between society, technology and economic factors but also culture and demographics which might otherwise have taken a backseat as the research initially focused on funding and low-carbon finance. As such, TM formed an important part of, and broadened the contextual framework for the research and provided a deeper understanding of the transition spaces and systems in the respective case studies. Its flexible and adaptive approach also meant that it encompassed many of the interacting systems, such as society and technology, which form an integral part of Foxon's

coevolutionary framework, and so built an easy bridge between the contextual and analytical frameworks of the research.

Foxon's coevolutionary framework was chosen to strengthen the analytical methodology by complementing the MLP in order to usefully analyse the transition to a low-carbon built environment. It should be noted that Foxon's framework had previously been usefully applied to other areas of sustainability research for analysis of the utility and energy sectors (Roelich 2014; Bolton & Foxon 2015), which gave some confidence in applying it to domestic retrofitting. Previous results as mentioned in Chapter 3 as well as this study have shown that the coevolutionary framework adds value to the analysis of sustainability topics in connection with case study research. Applying this framework to the case study data has helped develop a deeper understanding of the case studies (see Chapter 5) and has shown the emergence of governance and finance as key factors impacting on the decarbonisation of the built environment in Slovenia and Germany.

This study provides evidence that combining a multi-level perspective and a coevolutionary framework creates a structured approach to the analysis of the socio-technical system of domestic retrofitting and helps to identify patterns and factors which influence the system's transition at various levels. This finding combined with other research applying the coevolutionary framework provides useful insights into the transferability of the analytical methodology as described in Chapter 3.

Beyond technology alterations within the transition to a decarbonised building stock, the analytical framework is also inclusive of geographies and politics. In the same way that the methodology has enabled researchers to apply this method to different contexts, sectors and industries, the case study analysis for Slovenia and Germany has demonstrated that it is similarly applicable to various governance contexts including ones as changing as the UK's. This is of particular relevance in light of Brexit and could potentially ensure that studies of a similar nature and on a similar context can be repeated or followed up with strong comparable research findings for changing political systems.

Having earlier examined the literature on transitions management and its potential to strategically drive socio-technical transitions, the study's analytical framework might also be a useful addition here. This is because the understanding about coevolutionary dynamics between the different transition layers it produces could be directly fed back into a transitions management approach. In the case of this particular study, the data would help shape a transition management approach towards the decarbonisation of the

built environment in both case study countries, but also provide learnings for actively managing the transition in other countries. It could be argued that the data derived from applying the analytical framework could be usefully employed to illustrate the respective stages of decarbonisation of a case study.

This study added to existing literature and research around socio-technical transitions on the example of domestic retrofitting. It has also added to the literature on the coevolutionary approaches, in particular as an analytical framework. The research applied Foxon's coevolutionary framework to a new context of transitions research, namely domestic retrofitting and the transition of the decarbonisation of the built environment.

The study has identified a gap in the transitions literature relating to the role of finance in socio-technical transitions. By addressing this gap, the research further identified a lack of understanding of the combined impact of funding and governance on energy efficiency in the built environment on the example of two country case studies.

The findings and recommendations from this study are relevant for policy makers at the supranational EU level who might reconsider eligibility and access criteria for energy efficiency programmes and funding. They might also be of interest for policy makers in the UK who could take learnings from more successful energy efficiency policy incentive schemes in other countries, particularly in light of the UK's impending exit from the EU, and use these to strategically plan to fill the current policy void in this field. The Slovenian government might find some of the data from the Slovenia case study relevant for strengthening its governance levels, perhaps by supporting a regional administrative governance level with a supervisory role towards the local level municipalities. And finally, German policy makers might find some of the learnings interesting in order to consolidate the efficacy of governance levels and the impact of energy efficiency incentive schemes, like the KfW.

7.3. Further work

The combined coevolutionary multi-level analytical approach was applied to energy efficiency in the existing buildings stock but may be just as useful for analysing renewable energy sources for the existing building stock in a bid for decarbonisation. It might indeed be similarly effective in the analysis of new-builds and the various forms of sustainable technologies which can be applied to minimise their carbon footprints.

The combination of Geels' multi-level perspective with Foxon's coevolutionary framework as an analytical framework is just as applicable to qualitative data from institutional actors as well as data from private homeowners. A brief pilot study of the latter was undertaken as part of the research project but did not feature in the analysis of the study. This is because while homeowner interviews were relatively easily accessible for the researcher in the Germany case study, there was no such access in the Slovenia case study. This was due partly individuals in Slovenia, although friendly and helpful, proved very reserved when asked about their personal life of which their homes are a part, and partly because the fieldwork funding only allowed for two weeks of stay in Slovenia, which was not long enough to try to find ways through such reticence. Nevertheless, the German homeowner interviews suggested that the framework could be fruitfully applied in future to the potential and actual recipients of finance for domestic retrofits, as well to the provision and uptake of such finance. The preliminary data from the German homeowner interviews indicated for instance that interviewees were positive about the availability of institutional funding for energy efficiency measure but found the policy requirements somewhat constraining. The administrative complexity to obtain funding was perceived to be manageable due to the involvement of banks, particularly for the grant funding. Selected findings from the homeowner interviews in Germany can be found in Appendix 3.

The potential versatility and unbiasedness is a strong feature of the analytical coevolutionary framework. It is this feature which deserves further investigation. It would be useful to understand the potential and limits of the analytical framework's applicability in other interdisciplinary research areas either in other sustainability transitions or beyond transitions and indeed sustainability research. While it could be argued that the framework is inherently inter- and multidisciplinary in nature, it might be useful to try to apply it to single discipline research within a more focused and defined research project, to identify how well it might perform within the limits of a disciplinary boundary and perhaps help to extend beyond it.

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Appendices

Appendix 1 Consent Forms in English and German

Building Retrofit and Financial Innovation – Decarbonising the UK Domestic Building Stock

Consent Form

- I understand that my participation in this project will involve a recorded interview which will require approximately 45 minutes of my time.
- I understand that participation in this study is entirely voluntary and that I can withdraw from the study at any time without giving a reason.
- I understand that I am free to ask any questions at any time. I am free to withdraw or discuss my concerns with the project researcher Tina Schmieder.
- I understand that the information provided by me will be held confidentially, such that only the project researcher Tina Schmieder can trace this information back to me individually. My information will be anonymised for any reports or publications. My information will only be used for research purposes by the researcher Tina Schmieder.
- I understand that I can ask for the information I provide to be deleted/destroyed at any time and, in accordance with the Data Protection Act, I can have access to the information at any time.

Questions and Contact

For any questions regarding the project before or after the interview, please feel free to contact us via schmiedert@cardiff.ac.uk. You may also find additional information on the project and our research on http://www.cardiff.ac.uk/archi/asg/tina-schmieder.

I, _____, **[PRINT NAME]** consent to participate in the study conducted by Tina Schmieder, Welsh School of Architecture, Cardiff University under the supervision of Professor Malcolm Eames.

Signed: Date:

Forschungsstudie zur Gesetzgebung und innovativen Finanzierung von Gebäudesanierungen

Einverständniserklärung

- Ich verstehe, dass meine Teilnahme an diesem Projekt ein etwa 30-minütiges Interview einschließt, welches aufgenommen wird.
- Ich verstehe, dass die Teilnahme an dieser Studie vollkommen freiwillig ist und dass ich meine Teilnahme jederzeit und ohne Begründung widerrufen kann.
- Mir ist bewusst, dass ich jederzeit studienbezogenen Fragen stellen und Bedenken mitteilen kann.
- Ich verstehe, dass jegliche Informationen, die ich im Laufe des Interviews bereitgestellt habe, vertraulich behandelt und ausschließlich zu Forschungszwecken verwendet werden. Nur Frau Tina Schmieder-Gaite hat Zugang zu diesen Daten und für eventuelle Berichte oder Veröffentlichungen werden meine Daten anonymisiert.
- Ich kann jederzeit die Löschung meiner Daten und Informationen veranlassen und entsprechend dem Datenschutzgesetz (Data Protection Act) Zugang zu meinen Daten und Informationen erhalten.

Fragen und Kontakt

Für Fragen zur Studie können Sie uns jederzeit kontaktieren unter schmiedert@cardiff.ac.uk. Zusätzliche Informationen zum Projekt und dieser Studie finden Sie auf den folgenden Webseiten: www.retrofit2050.org.uk und http://www.cardiff.ac.uk/archi/asg/tina-schmieder.

Ich, _____, **[Name in Druckschrift]** bestätige hiermit meine Teilnahme an der o. g. Studie, die von Frau Tina Schmieder-Gaite unter Aufsicht von Professor Malcolm Eames und Professor Peter Pearson an der Welsh School of Architecture, Cardiff University durchgeführt wird.

Unterschrift: Datum:

Appendix 2 Word frequency table

Word	Slovenia	Germany	Word
Energy	279	87	**Funding**
People	271	54	**Retrofit**
Public	262	49	**Building**
Money	199	46	**Energy efficiency**
Municipality	191	29	**Measures**
Buildings	214	24	**Government**
Government	177	18	**Funding programme**
Investment	93	14	**Legislation**
Funding	92		

Figure 45: Word frequency analysis with numbers

Appendix 3 Homeowner interviews in Germany

Selected examples of additional knowledge

Homeowners appeared to finance energy efficiency measures in their buildings with the most cost-saving options. These often included building loans or private loans from the banks or private loans from family members, such as parents. One homeowner couple used conventional finance as at the time of their building works, the interest rates for KfW funding were higher than from high street banks. Where additional low-carbon technologies or components were installed separately, these were often funded privately. Generally, low-carbon funding options were not normally considered separately but in conjunction with other financial products from banks and house banks. Often, homeowners who had accessed KfW funding felt that traditional banks did not put any great weight on energy efficiency measures, saying that even if the building had no insulation whatsoever, the bank would still have provided a loan. For further retrofitting works and component replacements, homeowner interviewees indicated that they would consider KfW funding alongside other funding options. Usually, retrofitting activities were done all at once such as after purchase of a property. The focus thereafter appeared to be on maintenance of the building and the components without a clear roadmap towards regularly increasing the energy efficiency of the building.

Homeowners were generally positive about energy efficiency in buildings but also low-carbon technologies such as renewable energy sources. There was an understanding among the interviewees that energy efficiency is 'common sense'. When asked about their motivation for energy efficiency one respondent stated: "Cost reduction. The ecological consciousness is rather in the background. Foremost, this is about financial aspects."[149] This perspective was echoed among several interviewees, with one clarifying that there was no such thing as a born environmentalist: "There might be individual ones but you can only really motivate people with finances."[150] So enthusiasm for energy efficiency and low carbon technologies was mostly based around cost-savings, comfort and occasionally interest in technological progress.

Homeowners felt that there was sufficient focus on energy efficiency in Saxony and in Germany: "Overall I get the impression that a lot is being done and that there are many options."[151] One homeowner felt unsure if the wider population was sufficiently informed about these options, though.

Homeowners appeared to be generally aware of increasing energy efficiency requirements in regulations and policies for their buildings. This was often due to conversations with friends and acquaintances that had retrofitted their homes earlier or later and so provided a comparison in terms of energy efficiency requirements over time. Homeowners were also aware of the different energy efficiency requirements for domestic retrofits and domestic new-builds. Energy efficiency policy was often seen critically, as a means of enforcing compulsory energetic requirements for the building stock. As one homeowner explained: "There are of course clearly stricter regulations over

[149] Kosteneinsparung. Das oekologische Gewissen ist was, was man nochmal im Hinterkopf behalten kann. Zuallererst geht es um finanzielle Aspekte.
[150] Da gibt es vielleicht vereinzelte, aber du kannst die Leute nur mit Finanzen motivieren.
[151] Ich habe insgesamt then Eindruck, dass sehr viel getan wird, bzw. dass es viele Moeglichkeiten gibt.

the last years or decades which force you to build more energy efficiently."[152] Some interviewees voiced their opinion that incentives should be preferred over mandatory regulations: "Like I said, I view the obligation as a difficult approach. Rather develop useful incentives than introduce compulsory measures."[153] Financial grants or tax rebates were mentioned as possible incentives. One interview stated that if the institutional sector wanted to promote energy efficiency, then more funding should be provided, and if more funding was provided homeowners would retrofit more.

When asked how they felt about energy efficiency policy and its transposition to the regional or local level, one respondent clarified: "Since the issue with the climate is not limited to individual federal states but is rather a global topic, the national level is the minimum. It should really be considered at the European level"[154] When asked further about the concept they would see as a useful approach, they said "that for energy efficiency building measures suitable funding is available, that needs to be stipulated at EU-level and on the regional level the respective solution as these can differ between countries and between regions."[155]

While awareness of funding institutions such as the KfW or the SAB and the availability of energy assessors is high, there is also a perception amongst home and property owners that the main source of finance for retrofits are banks and private loans. While the KfW approach to allocating funding is cost-effective and practical, it appears that whether homeowners use these funds depends on the financial products of the banks that they are attached to. If the banks are unable to provide attractive interest rates, homeowners might not investigate additional low-carbon funding. The interview data showed also a specific approach to information gathering from unofficial sources. There is a reliance on gathering information based on other people's experiences. Acquaintances who have retrofitted their properties and have dealt with other companies and certain ways of financing, are sharing their knowledge either directly or via the internet by means of forums. Other sources of energy efficiency information were the construction sector. The energy agency was not explicitly stated as an information source.

[152] Es gibt natuerlich gesetzlich ueber die letzten Jahre und Jahrzente deutlich strengere Regelungen, die einen sozusagen noch dazu zwingen energieeffizienter zu bauen.
[153] Wie gesagt, das verpflichtend halte ich fuer eine schwierige Geschichte. Eher sinnvolle Anreize schaffen, als wirklich zwingende Massnahmen einzufuehren.
[154] Da die Geschichte mit dem Klima jetzt nicht auf einzelne Bundeslaender beschraenkt, sondern eher so eine globale Sache ist, ist es auf Landesebene schon das Mindeste. Eigentlich muesste man aber auf europaeischer Ebene darueber nachdenken.
[155] Dass fuer energieeffiziente Baumassnahmen entsprechende Foerderungen vorhanden sind, das muss auf EU-Ebene sozusagen gegeben sein, und auf regionaler Ebene dann die entsprechende Loesung, weil das eben von Land zu Land bzw. von Region zu Region unterschiedlich ist.

Appendix 4 Interview protocols

Fragenliste zur Foerderung von Energieeffizienzmassnahmen in Gebaeuden

Guten Tag – vielen Dank, dass Sie sich die Zeit fuer ein Gespraech mit mir nehmen – vielleicht erzaehle ich Ihnen als erstes kurz etwas zur Studie – Teilstudie eines groesseren Forschungsprojektes, das von Cardiff aus geleitet wird und wofuer mehrere britische Unis zusammenarbeiten – Retrofit2050 zur systematischen energieeffizienten Gebaeudesanierung, link in Uebersichtsdokument – meine Arbeit ist eine Vergleichsstudie zwischen Slowenien und Deutschland – untersucht das Zusammenspiel von Gesetzgebung und Foerderung fuer Energieeffizienz in Bestandsgebaeuden – sowohl EU-, Bundes- und Landesebene - dadurch eben die Gebaeudesanierung.

Falls einverstanden – gern aufnehmen damit ich beim Mitschreiben nichts verpasse

1. Vielleicht koennten Sie zu Beginn kurz etwas zu Ihrem Aufgabenbereich beim Bundesministerium sagen?
2. **Fuer wie effektiv halten Sie die derzeitige Gesetzgebung zur Energieeffizienz in Deutschland? Wie effektiv koennen die EU-Gesetze Ihrer Meinung nach auf Bundes- und Laenderebene umgesetzt werden? Wo sehen Sie moegliche Probleme oder Barrieren fuer deren Umsetzung?**
3. **Halten Sie die derzeitigen Foerderungen fuer einen effektiven Weg zur Erreichung der deutschen Klimaziele? Foerdermittel haben oft die groesstmoegliche Nachhaltigkeit des Foerderprojektes zum Ziel. Halten Sie die derzeitige Gesetzgebung dafuer fuer eine Unterstuetzung oder stellt die Gesetzgebung eher ein Hindernis dar? Was koennte verbessert werden?**

Die deutsche Gesetzgebung stellt bereits Mindestanfordungen an Gebaeudesanierungen, aber die Foerderbanken gehen oft darueber hinaus. Wie werden die energetischen Anforderungen von den Antragstellern aufgenommen?

4. **Sollten sich Bund oder Laender staerker in die Foerdung von Energieeffizienz in Gebaeuden einbringen? Falls ja, wie koennte dies Ihrer Meinung nach aussehen?**
5. **Koennten Ihrer Meinung nach energetische Sanierungen systematisch ueber das ganze Bundesland ausgeweitet und gefoerdert werden? Falls ja, welche Rolle koennte die Gesetzgebung hierbei spielen?**
6. **Glauben Sie, dass es in den Bundeslaendern genuegend Foerdermittel fuer Energieeffizienz und energetische Sanierungen gibt? Und halten Sie diese Optionen fuer zugaenglich?**

Gibt es ausser den KfW Foerderprogrammen weitere Finanzierungs- oder Foerderoptionen, die Sie empfehlen? Falls ja, welche?

Fallen Ihnen weitere Personen oder Organisationen ein, die ich zu diesem Thema befragen sollte?

Interview protocol Slovenia - Semi-structured interview

1. Firstly, are you happy for this interview to be recorded?

2. Could you describe briefly your research background/work please?

3. Could you please describe briefly how you are involved with any energy efficiency work and retrofitting work in the Podravjie region/Maribor?

4. What do you think are the main barriers for retrofitting in Slovenia, and for domestic deep retrofitting in particular?

5. Do you think that governance could or should play a role in removing these barriers? How?

6. In your opinion, could retrofit schemes be scaled up across Slovenia and what could be promising approaches to do that? What about deep retrofitting schemes?

7. How significant do you think finance is to domestic retrofitting, both as a barrier and an enabler?

8. Does your organisation work directly or indirectly with any financial institutions or other funders (like NGOs, charities, private funders)? (If so, how was contact established?)

9. Which funding options for domestic retrofitting are you aware of or involved with? Could you describe these in a bit more detail please?

10. What do you think are the short-comings and/or advantages of these finance options?

11. Are you aware of any approaches to funding for retrofits, or of any deep retrofit case studies in Slovenia which might be relevant for this research?

12. Are there any people that come to your mind who it might be beneficial for this research to speak to?

13. Would you be happy to be contacted again in the future with further questions or to clarify aspects of this interview?

Thank you very much for your time.

[i] The Green Paper on Energy Efficiency does not explain whether these numbers apply globally or to the EU, nor does it offer a source. The author assumes that these numbers relate to the EU.