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German Efficiency?

Analysing the Policy Mix for Energy Efficiency in Existing Buildings in Germany

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Abstract

Energy efficiency improvements have not yet been developed to their full potential. Further improvements are necessary to tap into the full potential of reducing greenhouse gas emissions by decreasing energy consumption. This challenge is particularly relevant in buildings, a sector that consumes substantial amounts of energy. Despite numerous public policies to increase the energy efficiency performance of existing buildings in Germany, achieving short and mid-term objectives remains highly uncertain. The effect of multiple policies in a topic like building energy efficiency is still largely unknown. This research draws on emerging concepts of policy mix analysis to describe the design of objectives and instruments as well as interactions between them and assess the combination of policy instruments for existing buildings. As assessment criteria, the policy mix characteristics coherence of objectives; consistency of instruments; and comprehensiveness of solutions to market challenges are used. In document review and stakeholder interviews, design features of the policy mix and perceptions of practitioners have been collected and analysed through qualitative content analysis. The German policy mix is found to be coherent in respect to climate targets but less in respect to social policy targets. However, key problems remain. First, a mismatch between the ambition of objectives and the ability of instruments to achieve them is found. Second, stakeholders perceive it as difficult to work with the numerous funding programmes in practice. And third, market failures and barriers of energy efficiency in existing buildings remain largely unsolved. Based on the results of this case study, recommendations for policy include a stronger orientation on the objectives with less complex funding programmes and more stringent regulation. Moreover, for future research on policy, the results underline the need to consider matching ambitions between goals and instruments, as well as the context dependency of innovation functions of instruments to achieve comprehensiveness.

Keywords: Energy efficiency, policy mix analysis, public policy, existing buildings, energy efficiency governance

Executive Summary

Research problem and objective

This research assesses the policy mix for improving the energy efficiency performance of existing buildings in Germany, using the characteristics of coherence, consistency and comprehensiveness as assessment criteria.

Using generated energy more efficiently is one way of reducing the greenhouse gas (GHG) intensity of the economy and can contribute to decoupling carbon emissions from economic growth. Energy efficiency aims at reducing the amount of energy generation needed and therefore contributes to climate change mitigation. A substantial amount of energy consumption occurs in buildings. About one third of the global energy consumption is related to buildings, which leads to buildings being responsible for about the same share of the global energy related GHG emissions.

Energy efficiency actions in Germany make an interesting case, because the country is the biggest economy in Europe as measured in GDP and has the biggest population. As the energy mix is still based heavily on fossil fuels (59% of the electricity mix, even higher shares for heat generation) but with goals to increase the share of RES, energy efficiency is becoming increasingly prominent on the agenda and can reduce GHG emissions substantially. The potential of reduction in energy consumption of the building sector in Germany is estimated to be of 40-65% according to different calculations. For all those reasons, the country has a significant potential to reduce its climate impact through energy efficiency.

However, it is highly unlikely that Germany achieves target set for energy efficiency in 2020 and even reaching mid to long-term targets is found to be uncertain, especially for buildings. The complex structures and long timeframes of the building sector require strong policy frameworks.

For this reason, and because there is still insufficient understanding of the influence of the design of the policy mix on this issue, this thesis will analyse the policy objectives and instruments currently in place to improve the understanding of the policy mix and contribute to its improvement. For this purpose, the thesis answers the research question

> RQ 1: How well designed is the German policy mix for energy efficiency in existing buildings in terms of policy mix characteristics?

The assessment of the design is guided by existing research on policy mixes, which suggest the characteristics of coherence, consistency and comprehensiveness to assess the interplay of different components of the mix. Therefore, the overall analysis is further divided into three sub research questions.

> RQ 1.1: How coherent are the policy objectives?
>
> RQ 1.2: How consistent are the instruments of the policy mix?
>
> RQ 1.3: How comprehensive is the policy mix in addressing the market failures and barriers of energy efficiency?

Research design

The analytical framework of this thesis is based on recent advances in policy mix literature. The characteristics are criteria that assess the policy mix on following design features:

- Coherence includes the alignment and mutual support of objectives of the policies that are formulated in strategy documents at high political levels. Coherent objectives do not stand in conflict and ensure long-term planning for actors. Moreover, the targets need to achievable by the instruments in place in order to be a coherent policy mix.
- Consistency describes the interplay of the instruments that are working to achieve the targets. Again, support between them represents a consistent policy mix, whereas an inconsistent mix has conflicting instruments. The predictability of the instruments is another aspect of consistency. Furthermore, the ease of access to programmes like funding support is analysed as part of consistency.
- Comprehensiveness assesses whether the market failures and barriers of energy efficiency are addressed and solved by the instruments. These economic challenges are key factors hindering the realisation of the energy efficiency potential of existing buildings. A comprehensive policy mix contains instruments with different functions to increase technology development, demand from users as well as information exchange and collaboration among the stakeholders of energy efficiency.

In order to answer the research questions and assess the three criteria, data was collected through document research and interviews with experts and stakeholders. Document research gives insights in the official government strategies and instrument description as well as evaluation reports. This data was used to delimit the policy mix to the relevant policies, identify the instrument function for the comprehensiveness assessment and triangulate statements from the interviews. The interview data is used to assess coherence, consistency and the solution of market failures and barriers based on the perception of stakeholders and experts.

Both types of data are analysed using deductive qualitative content analysis. The predefined codes originate in the operationalisation of the three characteristics, which in turn are based on the literature review of policy mix and energy efficiency governance literature.

Findings

The findings of this thesis include mapping the German policy mix for energy efficiency in existing buildings and subsequently assess its coherence, consistency and comprehensiveness.

Four strategy documents shape the policy mix four documents define the policy goals for energy efficiency. They are amended by the coalition agreement of the current government. The 2010 Energy Concept of the federal government formulates the goal of a climate-neutral building stock in 2050. This objective is reaffirmed in the Strategy for Energy Efficient Buildings of 2015, where it is clarified, and in the Climate Protection Plan of 2016. The latter also contains a list of the instruments for achieving this aim. Including the National Action Plan for Energy Efficiency, these strategies are aligned and based on the same long-term objective, the climate-neutral building stock in 2050. In contrast, political commitments to affordable housing are found to be working against the energy efficiency objectives. The goal to keep rents low creates incentive problems for refurbishment projects in a country with the highest share of households in tenancy housing in Europe.

The instruments in the policy mix for energy efficiency in existing buildings in Germany are numerous. When categorising them in types of regulatory, economic and informative instruments, a strong emphasis on economic ones is found. Multiple funding mechanisms are in place to support building owners in bearing the high initial investments. The energy tax is another economic instrument. Some informative instruments like energy efficiency labels and information campaigns are identified as central elements of the mix as well, whereas regulatory instruments do not play an important role for existing buildings.

In response to RQ 1.1, the coherence of policy objectives is found to be high when analysing the strategies and targets for energy and climate. As all objectives refer to the same target, they support each other well. However, those targets are less coherent in comparison to social objectives like affordable housing. For instance, the high costs of energy efficiency renovation projects result in increasing rents in tenancy buildings. A crucial shortcoming in the coherence of the policy mix is that the objectives for energy efficiency are more ambitious than what the instruments are able to achieve. The discrepancy between the two is a criticism expressed by almost all interviewees. It is described to cause inertia because stakeholders expect stricter regulation and higher subsidies.

Consistency – assessed under RQ 1.2 – is present at a basic level, as many funding programmes allow combination of their support. However, there are also cases explained by interviewees in which this is not the case and causes confusion. Moreover, both the predictability and the practicability of the instrument mix were found to be problematic after analysis of interview and document data. Policies have been changed repeatedly in the past and accessing funds is complex.

Answering RQ 1.3, the assessment of comprehensiveness revealed that the instruments aim at reducing most of the market failures and barriers explicitly but are not ambitious enough to overcome them. Negative externalities of traditional inefficient heating systems based on fossil fuels are not adequately addressed by the policy mix and informative instruments like labels do not reduce asymmetric information. The landlord-tenant dilemma, a manifestation of the principal-agent problem, also is found to remain unresolved. A positive finding is, that all functions of instruments are represented in the policy mix, which illustrates the existing potential of the current mix to address market failures and barriers more effectively.

Thus, the overall design of the policy mix, as investigated to answer RQ 1, is only partly coherent, not entirely consistent in its instruments and not comprehensive in solving market failures and barriers. The design is not adequate in achieving objectives and overcoming market challenges. Even though there are positive findings with respect to the aligned climate objectives and all instrument types and functions found in the mix, the negative features described in the three previous subsections dominate the assessment.

Implications

The implications of this relate to contributions to the development of policy mix theory and recommendations to improve the particular mix for energy efficiency in existing buildings in Germany.

In respect to theoretical implications, this thesis found that matching objectives and instruments are an essential design feature of a policy mix. While it was analysed under coherence here, it has been argued above that the characteristic of credibility as its own assessment criterion can help to underline the relevance of matching ambitions. Within comprehensiveness, the functions of instruments to support innovation were found to be context dependent.

Technological solutions are available for building renovation and energy efficient heating systems, meaning that technology-push is less relevant than demand-pull to make building owners install such solutions.

The recommendations for the analysed policy mix address the central design weaknesses identified in this research. They can be summarised as a call to policy makers to perceive the energy efficiency objectives and instruments as a mix and not merely a set of measures and programmes. Aligning the instruments to realistically achieve the objectives improves the credibility of the policy mix and allows stakeholders to plan with stable instruments for the future. As energy efficiency policies are interacting with other policy areas as well, a general strategic plan would reduce contradictions between goals and instruments. Finally, the process of adjusting the instruments needs to consider both stringent goal achievement and improvements in practicability for building owners, tenants and other actors.

Further research is needed to deepen the understanding of the German policy mix in respect to policies at lower governance levels as well as mapping barriers based in political processes. At the same time, energy efficiency in other national contexts can provide insights in best practices as lessons for the revision of German policies, while the findings of this thesis can inform policymakers in other countries about important the importance of coherence, consistency and comprehensiveness as design features of a policy mix.

In respect to theoretical implications, this thesis found that matching objectives and instruments are an essential design feature of a policy mix. While it was analysed under coherence in this thesis, it is argued that the characteristic of credibility as its own assessment criterion can help to underline the relevance of matching ambitions. Further research can improve the conceptualisation of credibility and test other policy mixes on this criterion.

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Abbreviations

BAFA – German Federal Office for Economic Affairs and Export

BMF – German Federal Ministry of Finance

BMU – German Federal Ministry of the Environment

BMWi – German Federal Ministry of Economic Affairs and Energy

CDU – Christian Democratic Union of Germany

CO_2 – Carbon dioxide

CSU – Christian Social Union

Dena – German Energy Agency

DP – Demand-pull

EEA – European Environmental Agency

EEG – Renewable Energies Act

EnergieStG – Energy Tax Act

EnEV – Energy Savings Ordinance

EU – European Union

EVPG - Products with Relevant Energy Consumption Act

GEA – Global Energy Assessment

GHG – Greenhouse gas

GDP – Gross Domestic Product

IEA – International Energy Agency

IPCC – Intergovernmental Panel on Climate Change

KfW – Credit Institute for Reconstruction (state-owned development bank)

MAP – Market Incentive Programme

OECD – Organisation for Economic Co-operation and Development

RES – Renewable Energy Source

R&D – Research and Development

SPD – Social Democratic Party of Germany

SY – Systemic

TP – Technology-push

UBA – German Energy Protection Agency

UK – United Kingdom

Vzbv – Federal Association of Consumer Protection Agencies

WBCSD – World Business Council for Sustainable Development

1 Introduction

Rising temperatures due to climate change are a major threat to biodiversity, food production and human health. Stronger efforts are needed in order to keep global warming below 2°C – with the aim of keeping it to 1.5°C – as stipulated in the Paris Agreement of 2015 (IPCC, 2018). Emissions of greenhouse gases (GHG) are the main cause for climate change and increasing energy consumption is a key driver for GHG emissions (IEA, 2019; IPCC, 2018). About one third of global energy use is related to buildings, making the sector crucial for reducing energy consumption. However, the complex structures and long timeframes of the building sector require strong policy frameworks. This thesis will analyse the interaction of goals and instruments for energy efficiency in existing buildings in Germany to reduce the consumption in this sector.

Using generated energy more efficiently is one way of reducing the GHG intensity of the economy and can contribute to the required decoupling of carbon emissions from economic growth (Cohen, Jalles, Loungani, & Marto, 2018). Energy efficiency aims at reducing the amount of energy generation needed and therefore contributes to climate change mitigation. It applies to all sectors into which energy consumption is broken down, from transportation to industry and agriculture, but also to the building sector which consumes substantial amounts of energy, mostly for heating and cooling. For this reason, all major institutions have energy efficiency on the agenda in their strategies to reduce GHG emissions (EU Commission, 2019b; OECD & IEA, 2018a). Security of energy supply and improved quality of life are additional reasons for public policy frameworks to address this topic.

A substantial amount of energy consumption occurs in buildings. About one third of the global energy consumption is related to buildings (Lucon et al., 2014), which leads to buildings being responsible for about the same share of the global energy related GHG emissions (Urge-Vorsatz, Petrichenko, Staniec, & Eom, 2013). In Germany, the household sector makes up 25% of the final energy consumption[1], but buildings in other sectors require energy as well (UBA, 2019b). All these areas are targeted by policy instruments. Therefore, analysing the policy mix for energy efficiency in existing buildings is crucial because of the high energy consumption of the building sector, in which a larger share of existing buildings requires renovation to be on up-to-date energy standards (Baek & Park, 2012).

Research shows that the overall energy consumption in residential buildings is increasing, while energy for heating and cooling per capita is decreasing slowly (Serrano, Ürge-Vorsatz, Barreneche, Palacios, & Cabeza, 2017). Still, the building sector has a substantial potential for energy savings. Ürge-Vorsatz's (2013) calculations indicate a potential to reduce energy use in existing buildings by more than 50%. Estimates range from 42% (Forster, Kaar, Rosenow, Leguijt, & Pato, 2016) to around 65% (BMU, 2016) of reduced energy consumption in buildings. The long lifetimes of a large stock of existing buildings make this sub-category of the building sector an important element for successful energy efficiency development (Lucon et al., 2014).

Even though European energy consumption decreases slightly (EEA, 2018), much stronger efforts are necessary to achieve the new EU targets for 2030 which are part of the broader European clean energy strategy. The targets stipulate that the EU will reduce GHG emissions and improve energy efficiency more drastically than previous ones (EU Commission, 2016,

[1] Final energy consumption refers to the energy used by end consumers (of all sectors), whereas primary energy consumption also includes the energy used to produce and distribute the energy.

2019a). This implies that member states must increase their efforts as set in multiple pieces of EU legislation[2].

Germany, as an EU member state, must oblige with the European legal requirements. On the one hand, the final energy consumption in Germany has decreased only very slightly, staying relatively stable over the last two decades (UBA, 2019b). On the other hand, Germany has been pursuing an Energy Transition ("Energiewende") since the early 2000s. While the central element of this framework is to increase the share of renewable energy sources (RES) in electricity generation, GHG reduction targets for 2020 will likely by missed (UBA, 2019d), indicating that German energy use will remain relatively carbon intensive. Energy efficiency became a focus of the Energy Transition by implementing the European strategy of "Efficiency First" into national strategies, but short term targets appear to be out of reach (Dena, 2016).

Both in Germany and on the European level, studies also found high uncertainties for achieving the longer term climate goals, particularly regarding the energy efficiency and savings targets in particular (Holm, Stolte, & Oschatz, 2018; Rosenow, Leguijt, Pato, Eyre, & Fawcet, 2016). Improved public policies are therefore key for ensuring that these targets will be met. The context of ambitious but, at least in the short run, unrealistic national targets and a European regulatory frame, dictating more stringent improvements, make Germany an interesting case to assess energy efficiency policies. Given Germany's perceived role as a leader in Energy Transition and building efficiency policy (Kerr, Gouldson, & Barrett, 2017), the insights from Germany may serve as a useful guide to policymakers in other contexts.

Due to the complexity of energy efficiency, the multiple actors and many governance levels on which it is relevant, Germany like many other countries has a number of policies in place that seek to promote energy efficiency. Even for existing buildings alone, policies are numerous (Amoruso, Donevska, & Skomedal, 2018). Reporting documents of the German federal government list more than 15 instruments for energy policy in this sector. Such a portfolio needs to be well designed for policies to support each other and not interfere in the mission to reach one or multiple objectives (Howlett & Rayner, 2013).

1.1 Problem definition

Policy mixes, like the one in Germany for energy efficiency in existing buildings, develop over time (Flanagan, Uyarra, & Laranja, 2011). Some instruments are imposed from higher levels of policymaking like the EU, while others are initiated nationally. Interest groups advocating for or against certain measures shape the policymaking process on all levels. The energy efficiency policy mix can be advantageous, if the instruments in it are well aligned with each other but, if this is not the case, instruments can also offset each other. Failing to design a policy mix that is able to improve energy efficiency in buildings will result in substantial difficulties to reach the targets and effectively tackle climate change. As Germany's energy efficiency efforts are not expected to achieve the targets, the influence of the policy mix design on this underperformance needs to be analysed using state-of-the-art concepts and methods. Assessing the public policy mix is essential to understand why energy efficiency improvements are so low.

Analysing individual policies has been part of social science research for a long time, but understanding the mixes that develop in policy areas is still a very recent and emerging academic

[2] The most notable legal acts on the European level are the Energy Efficiency Directive containing overall obligations to reduce the national energy consumption; the Energy Performance in Buildings Directive setting more specific rules for the building sector; and the Effort Sharing Regulation (which is not officially part of the Clean energy strategy) allocating shares of GHG emission reductions to member states. All those pieces of legislation have been recast in 2018 or 2019 to stipulate and support the targets for 2030.

field (Dunn, 2018; Rogge & Reichardt, 2016). Interacting instruments – may the interaction be intentional or not – require an assessment of the design of the entire mix, not only the analysis of the parts within it (Costantini, Crespi, & Palma, 2017). In the past, most attention has been given to individual instruments even though the design of the overall composition of the mix influences the outcome substantially (del Río, 2014). Policy mix research provides the framework to overcome the academic negligence of interactions of the energy efficiency instruments.

The research on policy mixes is a development at the intersection of (environmental) economics (Lehmann, 2012), political sciences (Howlett & Rayner, 2013) and technology innovation research (Cantner, Graf, Herrmann, & Kalthaus, 2016). To a lesser extent, the perspective of policy interaction has also been adopted in legal assessments (Abazaj, 2016). The variety of streams has resulted in slightly different conceptualisations with new insights to be gained from applying them to a distinct policy mix (Rosenow, Kern, & Rogge, 2017). The climate and energy realm has seen considerable analyses of mixes in recent years. Many of them focus on innovation in renewable energy generation (Cantner et al., 2016; Reichardt & Rogge, 2016).

However, energy efficiency policy mixes have been subject of analyses, too. Amongst them are, on the one hand more high level perspectives on European instruments and rough pictures from many member states (Costantini et al., 2017; Rosenow et al., 2017). On the other hand, in-depth analyses of countries have been carried out for the United Kingdom (UK) and Finland (Kern, Kivimaa, & Martiskainen, 2017; Kivimaa, Kangas, & Lazarevic, 2017). For the German context, the energy efficiency policy mix for buildings remains largely unstudied, presenting a knowledge gap of how the different objectives and instruments perform together. As policy mixes are very context dependent (Falcone, Lopolito, & Sica, 2017), more cases will enable better comparison in academia and support the evolution of conceptual and analytical models in this quickly growing area.

Germany is in the process of revising its building energy legislation and, within the government, more stringent climate action is currently being debated. Like other member states, the country also must revise its energy efficiency policies to comply with the updated EU regulation. These events present an opportunity to respond to design weaknesses of the policy mix and restructure some of the instruments to improve the overall energy efficiency performance. The important potential of buildings to reduce the use of energy and the projection of Germany missing its targets make the case for an analysis, whether the policy mix is designed appropriately. So far, even though Germany is seen as a front-runner for the Energy Transition in general and building energy efficiency more specifically (Amoruso et al., 2018), substantially higher rates of energy renovation, are necessary to tap into the high potential and achieve the national and European targets (Holm et al., 2018; Lechtenböhmer & Schüring, 2011). Detailed understanding of the existing policy mix, its design flaws and opportunities, is therefore needed in order to make the right decisions for the future.

1.2 Objective and research questions

The primary objective of this research is to contribute to the understanding of policy mixes in energy efficiency in the existing building sector. In this way, the thesis can contribute to closing the gaps in academic and practical knowledge regarding the role of policy mixes for energy efficiency as well as how to best develop them in the future. Moreover, the thesis will test an analytical framework in an additional case to broaden the basis for comparison, not only on the level of policies but also on the conceptual level.

This research will do so by performing an in-depth analysis of the German policy mix for energy efficiency in buildings using the criteria of consistency, coherence and comprehensiveness, as

suggested by Rogge and Reichardt (2016). Based on their work and other policy mix literature, a conceptual model will be defined in order to subsequently apply it to the collected data. Data will be collected in document research and interviews following the path of Kern et al. (2017) in their analysis of the policy mixes in the UK and Finland. The thesis addresses the problem defined above by identifying the relevant policies for energy efficiency improvement in existing buildings in the case of Germany, and subsequently analysing the interplay between the goals, instruments and implementation processes.

In order to reach the stated objective, the thesis will try to answer the following research questions, which in turn guide the processes of data collection and analysis.

> RQ 1: How well designed is the German policy mix for energy efficiency in existing buildings in terms of policy mix characteristics?

In line with the analytical framework that will be presented in chapter 2, RQ1 has three sub-questions.

> RQ 1.1: How coherent are the policy objectives?
>
> RQ 1.2: How consistent are the instruments of the policy mix?
>
> RQ 1.3: How comprehensive is the policy mix in addressing the market failures and barriers of energy efficiency?

1.3 Scope and limitations

Analysing energy efficiency policies can be a very broad task due to instruments targeting the large number of technical possibilities for different sectors and actors. The Odysee-Mure database contains more than 1300 policies for energy efficiency improvement across sectors and in all of Europe. Therefore, some scoping decisions had to be made.

As outlined above, this thesis will analyse the building sector. Within the sector, only existing buildings are the focus of the thesis. The high share of buildings built in Germany in the 1960s and 1970s are one reason, why the existing building stock is crucial to energy efficiency efforts (Holm et al., 2018). Additionally, the long lifetime of residences means that many of the buildings that will make up the stock in the long term future have already been built (Lucon et al., 2014). All this creates the high potential of energy consumption reduction in existing buildings. In contrast to what exists already, new construction is very well regulated. Precise standards on EU and national level are in place and can be enforced at the permission stage. As a matter of keeping the scope distinct, only the energy consumption in the use phase of buildings is considered in this study. While also highly relevant for the environmental impact, materials, construction, and demolition are not considered. Policies in those fields would target different actors and are usually not covered in the energy efficiency policies of the EU or Germany.

Energy efficiency actions in Germany were chosen for the scope of this thesis because the country is the biggest economy in Europe as measured in GDP and has the biggest population. As the energy mix is still based heavily on fossil fuels (59% of the electricity mix, even higher shares for heat generation) but with goals to increase the share of RES, energy efficiency is becoming increasingly prominent on the agenda and can reduce GHG emissions substantially (Burger, 2018; UBA, 2019b). For all those reasons, the country has a significant potential to reduce its climate impact.

Germany has a strong federal distribution of power, with *Länder* (states) having a high level of autonomy in many areas. As explicit energy efficiency policy is a federal competence, the scope of the thesis will be limited to federal policies. This also allows for a consistent assessment of all goals and instruments. It has to be noted however, that the *Länder* and even municipalities have the possibility to add their own measures and programmes within legal limits. Therefore, the exact design in the different *Länder* can vary.

Studying the case of Germany would benefit from a comparison to other cases. Multiple cases would shed light on the particularities of the Germany policy mix and offer solutions based on a broader set of experiences (Yin, 2014). However, studying more countries in sufficient depth is not possible within the frame of this thesis, which is why the scope is limited to Germany as the only case. Existing research that uses similar policy analysis frameworks to study energy efficiency and building sectors in other countries, will however provide a base for comparison across multiple cases.

The scope of the policy mix itself was limited to the instruments in place in early 2019. In order to use the most recent data available, 2018 is in general the year of reference. Some instruments have been in place for several decades with multiple updates whereas most others have only been introduced in the past ten years. Generally, only the latest version of older instruments was considered.

Deciding on the boundaries of the policy mix was essential. Authors have pointed to the potential of subsidies for other industries that can hinder the field under analysis (Rogge & Reichardt, 2016). In order to keep the scope manageable, the thesis focuses on direct energy efficiency policies, with only energy prices and tenancy law as exemptions, as these came up in almost every interview. The implications of this limitation will be discussed later in Chapter 6.

1.4 Ethical considerations

Collecting data from people requires a particular care for the situation and manner of interaction. Using interviews as a central method for data collection, interview partners have to be aware of the purpose of the conversation and the use of the personal data as well as their statements. Literature on ethics in qualitative research speaks of informed consent from the interviewees (Flick, 2006). The interviews for this thesis were organised via email and phone contact stating from the first moment the research context of the interview and that participation was voluntary. All interviewed participants agreed to the use of their statements for this thesis and to the recording and or transcribing of the conversation. Due to the political nature of the issue, interviewees were offered confidentiality to be able to speak freely and express personal opinions (Kvale & Brinkmann, 2009). In order to ensure the same level of confidentiality across the interviewees, no content or statement is attributed to a specific person.

A second important consideration is to ensure neutrality towards the interviewees in order to collect impartial data. Policy analysis can appear to some as a means to promote one's own values and push policymaking into a personally desired direction (Wildavsky, 1979). The open and pragmatic approach (see methodology in Chapter 3) can be misused. With respect to this point, a balanced list of interviews has been created, giving room for opinions from owners, occupants, government, environmental advocacy groups and research institutions. The interviews were all guided by the same questionnaire, with only minimal adjustments to focus on their respective expertise. This way, a comprehensive picture of stakeholders and experts was created. The same coding structure was subsequently applied to all interviews and other material.

1.5 Audience

By analysing the German policies for energy efficiency in existing buildings, this thesis seeks to contribute to the understanding of policy mixes both in this particular case and in general. Therefore, the audience is twofold. First, the general advances of policy mix in terms of theory and research methods are directed towards scholars of the field of policy analysis and especially the field of policy mix research and national energy efficiency governance. Second, the thesis hopes to inform stakeholders and policymakers in Germany with the specific findings on the design of the current policy mix. The interests of stakeholders and the decision of policymakers will shape the future of the mix. Legislative proposals on the federal level and revision processes required by the European Union are occasions to re-work and improve the policy mix. Moreover, policymaker in other countries, notably within the EU, can learn from the German case to design improved policies.

1.6 Disposition

With the aim of answering the research question set out in Section 1.2, the thesis is structured as follows: chapter 2 will lay the academic foundation of energy efficiency governance and policy mix research in order to conceptualise the object of research in the policy mix as well as the characteristics used for the analysis: coherence, consistency and comprehensiveness. Building on the existing literature, the conceptual framework is presented and operationalised. The methodology and methods for data collection and analysis to study the framework are explained in Chapter 3. Chapter 4 gives an overview of the relevant components of the policy mix for energy efficiency in existing buildings in Germany as a description of the strategies and policies considered in this thesis. The results from data analysis in respect to the three characteristics used are presented in Chapter 5 and subsequently discussed in Chapter 6 in light of policy mix literature and energy efficiency governance in order to answer the research questions. Moreover, wider reflections and recommendations are presented before the final conclusions in Chapter 7.

2 Literature review and analytical framework

An analysis of the policy mix for energy efficiency policies in existing buildings needs to be based on two main pillars: policy mix theory and ways to increase energy efficiency with the use of policies. This chapter will present the theoretical foundation for energy efficiency governance, in particular in buildings, to identify challenges and potential policy solutions. Subsequently, the analytical framework for the German case will be based more precisely on the recent advances in policy mix research.

2.1 Energy efficiency governance in buildings

Energy efficiency has multiple benefits but the primary framing for energy efficiency is generally related to climate protection and lowering carbon emissions (c.f. Lechtenböhmer & Schüring, 2011). Reducing the amount of energy used saves GHG emissions, which is why energy efficiency goals on the EU and German level are always closely linked to the obligation of the Paris Agreement (BMWi, 2018b; EU Commission, 2014). Over a third of CO_2 savings necessary to reach global climate targets can be achieved through energy efficiency (OECD & IEA, 2018b).

However, the benefits go far beyond the environmental sector, though, and are mentioned partly in the policy documents. OECD and IEA (2014) present the broad array of advantages resulting from energy efficiency which also relate to buildings. The benefits include private ones like reduced life-cycle costs due to energy cost savings and improved indoor air quality, but also public ones such as higher energy security and public health benefits (OECD & IEA, 2014).

Energy efficiency governance is the establishment of targets, rules and support set by the government for the entire economy, in an institutional set-up and in wide-range collaboration, with the objective to increase energy efficiency (OECD & IEA, 2010). The OECD and IEA report presents three components of this concept. First, enabling frameworks are the regulation and funding instruments to create incentives. Second, coordination mechanisms include targets and evaluation for within the government as well as for other stakeholders and wider outcomes. Third, institutional arrangements take into consideration all the actors and stakeholders in the creation of energy efficiency gains (OECD & IEA, 2010). Figure 2-1 illustrates the components of energy efficiency governance according to that report.

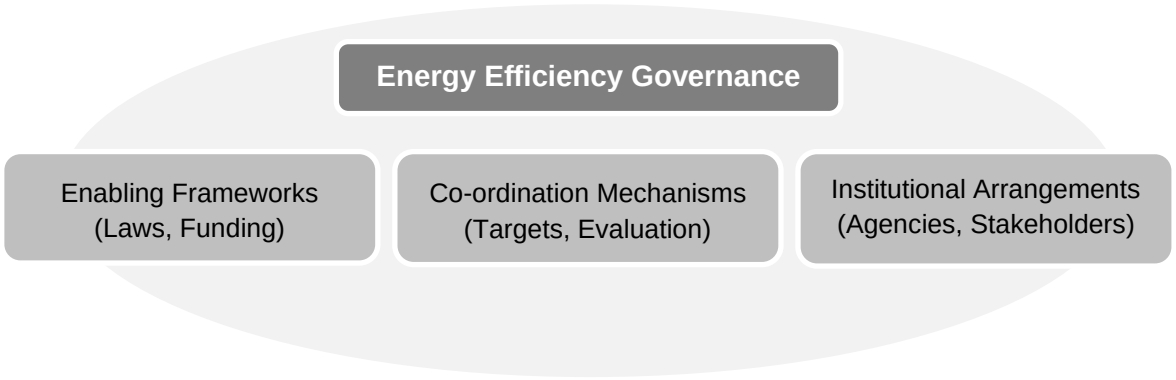

Figure 2-1: Energy efficiency governance framework.

Source: OECD & IEA, 2010, p. 15.

Governance, essentially driven by intervention of the state in the form of laws and financial mechanisms, is necessary because markets do not support energy efficiency developments in a way that exploits the potential of energy savings (Gupta & Ivanova, 2009). The framework

presented in Figure 2-1 aims at supporting a system of improved policy intervention for energy efficiency in order to overcome challenges like market failures and barrier, which will be defined below (see Section 2.2).

A mismatch between the cost-effective potential for energy efficient technology and actual progress on energy saving in practice is called the energy efficiency gap (Hirst & Brown, 1990). The gap is caused by several market failures and barriers that have been explored in literature to understand the divergence. Market failures are based on neoclassical economics and describe situations where actual mechanisms diverge from the theory of perfect market conditions (Brown, 2001). Seminal articles identify lacking publicly available information, misplaced information, positive externalities from higher adoption rates, and distorted fuel prices leading to negative externalities as the key market failures for energy efficiency (Hirst & Brown, 1990; Jaffe & Stavins, 1994b).

The list of market failures is supplemented by a number of market barriers that apply to energy efficiency. Barriers relate to behaviour that follows economic rules but is caused by current structures of society and not failed market mechanisms (Jaffe & Stavins, 1994b). Too little investment due to uncertainty of prices and regulations as well as high discount rates of decision makers are portrayed as a major barrier for energy efficiency measures, which would be cost-effective in the long run due to the savings it generates (Hirst & Brown, 1990). Moreover, the heterogeneity of users poses the risk that some will benefit, whereas others might not, which also reduces the willingness to invest in new technology (Allcott & Greenstone, 2012; Jaffe & Stavins, 1994b). Given that the concept of the gap has been under investigation since the early 1990s, policies have had the time to develop to correct the failures and lower the barriers. However, more recent articles still find proof of the energy efficiency gap and show that complex challenges like poor policy design for energy management and weak framing of effective narratives remain (Allcott & Greenstone, 2012; Backlund, Thollander, Palm, & Ottosson, 2012; Kerr et al., 2017).

2.2 Challenges for energy efficiency in existing buildings

In the building context, increasing energy efficiency is understood as improving the energetic performance by upgrading "the building envelope – windows, doors, cavity or loft insulation – or the heating and hot water systems" (Wilson, Crane, & Chryssochoidis, 2015, p. 13). This obviously aims at buildings in colder climates, as hot regions have substantial parts of buildings' energy use relate to cooling (Lechtenböhmer & Schüring, 2011). A different definition therefore not only includes cooling alongside heating, but also lighting and other appliances found in buildings under the umbrella term of equipment improvement (WBCSD, 2007).

The market failures and barriers for energy efficiency in general, as outlined just above, exist in the existing building sector as well, but some are less, others are more relevant in this particular case. Therefore, the more narrow challenges for energy efficiency in existing buildings need to be understood to analyse policy measures working towards their correction (Ryghaug & Sørensen, 2009). Table 2-1 summarises the specific market failures and barriers that apply to this case.

The central failures for the sector of existing building are similar to the general ones that explain the energy efficiency gap. For instance, social and environmental costs from GHG emissions are not priced, which leads to competitive advantages of less energy efficient technology (Ürge-Vorsatz et al., 2012). Also asymmetrical information dominates the available knowledge between buyers and sellers and between adopters of technology and the ultimate user who may benefit from it (Amoruso et al., 2018; Jaffe & Stavins, 1994b). While the former need to make decisions and invest, the latter uses and benefits from the decision, as it is the case in rental housing. The

so called landlord-tenant dilemma is therefore another market failure, referred to as principal-agent relationship (Ástmarsson, Jensen, & Maslesa, 2013). The separation of responsibility and benefit places high demands on policies to create incentives for landlords (Jaffe & Stavins, 1994a). Ástmarsson et al. (2013) found that a combination of national policies is necessary to overcome the challenging situation. Finally, there are spill-overs in knowledge and ease of large-scale deployment related to experiences that early adopters create but are not compensated for (Brown, 2001; Jaffe & Stavins, 1994b). Such positive externalities concern the combined use of the many parts that create energy efficient systems in buildings that retain owners to make use of them. In contrast to the other market failures, the contribution of positive externalities is not confirmed throughout the literature (c.f. Gillingham & Palmer, 2014).

Table 2-1: Market challenges (failures and barriers) for energy efficiency in existing buildings.

Market failures	Market barriers
Negative external effects like contribution to climate change are not reflected in market prices for energy sources	High initial investment costs that, combined with transaction costs, lead to long amortisation periods
Asymmetric information about energy performance of a building/apartment	Uncertainty of price development of energy and technologies
Principal agent dilemma between owners and tenants	Lock-in effects due to the long lifetime of buildings
Positive external effects from knowledge that innovators or adopters are not compensated for	Little interest in energy efficiency as a topic

Source: own compilation.

In addition to failures, market barriers are other challenges that prevent users from opting for energy efficiency renovations or technology but are not contradictions of the economic assumptions about markets. The barriers include financial, behavioural or policy aspects (Baek & Park, 2012; Weiss, Dunkelberg, & Vogelpohl, 2012). The most common barrier found for energy efficiency is the high initial investment necessary for renovation projects that only over many years will pay back in lower energy bills (Ürge-Vorsatz et al., 2012). The initial investment also often includes transaction costs for changing to new heating systems. Expenses linked to the information about new technology or making necessary changes to the indoor space to accommodate a new system fall into this category of investments that are indirectly related but inevitable along the way.

The high upfront costs are a financial barrier at the moment of making the decision for a refurbishment project and are opposed only by delayed gains from the savings (Wilson et al., 2015). In combination, the result is a long amortisation period that makes investments unattractive, even if they are cost-effective over their lifetime (Dodoo, Gustavsson, & Tettey, 2017).

The challenge is reinforced by risk and uncertainty about the development of prices for energy and technology (Ürge-Vorsatz et al., 2012). Making cost saving appear uncertain, investment becomes a risk that real estate owners are often not taking in the presence of familiar and easier heating systems (Wilson et al., 2015). Moreover, the long life time of buildings creates lock-in effects for any choice of insulation and building design (Lucon et al., 2014). To a lesser degree, the same applies to heating systems and other technologies related to energy efficiency in buildings. Once locked in, a renovation decision can only be reversed at high costs in case it is not an optimal choice, incompatible with new technology or does not comply with new regulation (Lucon et al., 2014).

Stability and predictability of polcies are therefore one essential aspect to enable long-term security for investment planning (WBCSD, 2016). Finally, energy efficiency does not generate a high interest in the broad public but rather lacks awareness and is easily ignored (Ürge-Vorsatz et al., 2012). Whereas asymmetric information as a market failure is relevant in cases of real estate purchases and tenancy, lacking interest and ignorance is a challenge for energy efficiency in buildings with stable ownership situation. Without awareness, owners do not think of the possibility to make renovations with the aim of increasing the energy efficiency (Ürge-Vorsatz et al., 2012).

The market barriers overall represent important challenges to energy efficiency improvements in existing buildings. Together with the market failures they are listed in Table 2-1 and shape the environment of policies targeting the increase in energy efficiency. The next sections lay out the theoretical foundation of analysing policies to build the conceptual framework for this thesis.

2.3 Policy Analysis

Public policy analysis is a well-established discipline in the social sciences. It arose as an overlap of economic theory and political sciences and essentially aims at providing political solutions to policy problems in practice (Dunn, 2018). The general approach is to compare goals and policy alternatives – either existing or potential – to inform policymakers and stakeholders with strong interest about the advantages and disadvantages of the options (Vining & Weimer, 2015). Dunn (2018, p. 3) defines policy analysis as "a process of multidisciplinary inquiry aiming at the creation, critical assessment, and communication of policy-relevant knowledge", which has descriptive and prescriptive elements. Descriptive about the status quo as well as problems arising from it and prescriptive in advocating solutions backed by empirical findings (Dunn, 2018). As it is a combination of disciplines, the emphasis on certain aspects differs. On the one hand, Wildavsky (1979) argues in a political science perspective with a focus on actors and political structures like federalism. On the other hand, Weimer and Vining (2017) make primarily use of microeconomic theory in their argumentation. The interplay of both disciplines is however always emphasised. Power structures and equity on the one hand and economic dimensions like efficiency and welfare are standard parts of classical policy analysis (Weimer & Vining, 2017).

Key rationale for the need of public policies in general are market failures. In almost all areas, the failures of public goods, externalities and information asymmetries occur, natural monopolies being a fourth common one (Vining & Weimer, 2015). Inefficiencies can also occur due to limitations that are not classified as market failures but are still based on economic theory. These are called market barriers. Preferences that defy rationality and individual behaviour when facing long-term uncertainty fall into this category (Weimer & Vining, 2017). The importance of market failures for energy efficiency, in particular in existing buildings has been introduced above (see Sections 2.1 and 2.2), underlining the necessity for policy intervention in this area.

Policy analysis becomes necessary because similarly to markets, also governance failures exist. Prioritising groups of the society that are necessary for re-election or misinterpretation of causalities can make policies no better than the market failures they try to solve (Weimer & Vining, 2017). At this intersection, policy analysis has its place to assess the market and the policies to identify problems that new, changed or less policies can solve (Dunn, 2018). Suggesting solutions is a central part of practical, client-oriented policy analysis in the way Weimer and Vining (2017) describe the core purpose of the discipline. Academic policy analysis, as in this thesis, has the descriptive and critical reflection on policies and political agendas at its centre, while still being driven by existing real world policy problems (Dunn, 2018).

Policy analysis is generally guided by a worldview that differs from other academic research. The striving for practical solutions results in a pragmatic rationale with an open choice of methods (Dunn, 2018; Wildavsky, 1979). Even though the academic ideal is to find an objective and rational solution, in reality facts and values are seen as inseparable (Wildavsky, 1979) and even in research "policy analysis is [above all] about improvement, about improving citizen preferences for the policies they - the people - ought to prefer" (Wildavsky, 1979, p. 19).

The importance of principles materialises in the prioritisation of criteria for the analysis, what Weimer and Vining (2017) explicitly call "values" in their work. Efficiency for example expressed as cost-effectiveness, equity or feasibility can be criteria for policy analysis (Weimer & Vining, 2017). For environmental policies, Mickwitz (2003) defines flexibility of the policies and persistence of the effects as further criteria. Trade-offs between different criteria are inevitable and thus require a certain prioritisation by the researcher (Weimer & Vining, 2017; Wildavsky, 1979).

2.4 Rationales for policy mix analysis

Policy mix analysis adapts the general approach of policy analysis for a more realistic scenario: the presence of many policies in a field result in overlaps between them (Flanagan et al., 2011). Multiple political influences and a combination of market failures lead to a range of policies with potential conflicts or synergies that are the object of study in policy mix research (Howlett & Rayner, 2013; Lehmann, 2012). Putting the interplay at the centre of analysis and assessing the design and performance of the entire mix, distinguishes the policy mix literature from classical policy analysis, even though many core features are shared by both approaches.

Flanagan et al. (2011) summarise the history of policy mix analysis as originally rooted in economics until it was discovered by other social sciences in the 1990s to explore public policy more broadly. The concept has seen its most notable uptake in research on environmental policy and regulation since around 2000. The focus often lies on assessing conditions for innovation to support new technological solutions through instruments of public policy (c.f. Cantner et al., 2016; Reichardt & Rogge, 2016). A normative understanding even sees "creative destruction" of existing technology and business models as the objective of policy mixes in the sustainability transition (Kivimaa et al., 2017).

2.4.1 Rationale of political sciences

The rationale in political sciences for policy mix analysis is that policymaking has become increasingly interconnected between different levels of governance (Howlett & Rayner, 2007). Existing and institutionalised policies are amended by obligations from international arenas (Howlett & Rayner, 2007, 2013). The concept of multi-level governance has evolved to describe and explain the complex systems that determine the policies on all levels (Jänicke, 2017). It can be observed in climate and environmental issues, where local, regional, national and international approaches intersect (Jänicke, 2017). Scharpf (1997) already pointed to the varying effectiveness of the results from multi-level governance in different policy areas of the EU. Thus, the result from such interplay can easily be a mix of policies seeking to achieve various targets that needs to be understood.

Some authors call policy mixes the "messy and complex, multi-level, multi-actor reality" (Flanagan et al., 2011, p. 711) that are brought to the centre of attention. While many policy mixes are not planned intentionally but imposed by the circumstances, there is still a need to analyse the effects of a policy mix to be able to assess if a single instrument could perform equally well or to understand if the mix of policies can be improved (Gunningham & Sinclair,

1999). This idea has contributed to spreading the concept of policy mix analysis among researchers of various disciplines and make them worth studying (Costantini et al., 2017).

2.4.2 Rationale of economics

The economic rationale of analysing policy mixes is that sectors with multiple market failures require multiple instruments to correct them (Lehmann, 2012), as one instrument cannot correct more than one market failure (del Río, 2014). Section 2.2 presented the multiple market failures of energy efficiency markets in existing buildings and summarised in Table 2-1. The negative and positive externalities, information asymmetries and principal-agent relationship are reasons for policy intervention along the lines of economic theory (del Río, 2014; Lehmann, 2012). The multiple market failures justify and explain the existence of policy mixes in the realm of energy efficiency in buildings. Correcting negative and positive externalities, and systemic problems like insufficient information, requires a well-designed mix of instruments (Braathen, 2007; Rogge, Kern, & Howlett, 2017). Policy mix analysis offers the framework to determine the most important characteristics of the instruments in place for improving energy efficiency in the building sector.

Policy mixes can also address deeper challenges that arise from combinations of market failures that reinforce each other (Lehmann, 2012). Understanding and optimising individual instruments would not be able to solve general and systemic problems created by the failures. For example, asymmetric information is closely linked to the principal-agent relationship between landlords and tenants and requires the strategic use of multiple policies for an effective solution (Lehmann, 2012). The research on policy mix theory and practice is then necessary to analyse and improve the way the combination of market failures are addressed by multiple instruments simultaneously (Lehmann, 2012).

For classical economists market barriers generally do not justify policy intervention (Allcott & Greenstone, 2012). The fact that costs are too high and therefore unattractive is a confirmation of economic theory and not a reason for politics to regulate or intervene in market mechanisms. However, critics of this philosophy argue for the consideration of market barriers in the design of policy instruments as well, because the effect for the energy efficiency gap is so substantial (del Río, 2014). This latter perspective is supported by other social sciences and in particular by the rationale of innovation studies.

2.4.3 Rationale of innovation and transition studies

Particularly in the field of sustainability and environmental protection, one function of policy is to foster the transition to new, clean technology (Edmondson, Kern, & Rogge, 2018). A well-designed approach to steer innovation processes is necessary in order to be successful and effective in the use of regulation and public money. As innovation processes are complex and involve a range of actors from the first basic research to demonstration and market diffusion, multiple instruments are necessary to support the entire chain (Grubb, McDowall, & Drummond, 2017). Moreover, the transformation of sociotechnical systems - systems performing essential contributions to the functioning of societies like food or mobility, but also energy and housing – requires policies to support more sustainability in central aspects of economy and society (Edmondson et al., 2018). Thus, a policy mix is necessary for the governance of innovation processes, one that is strategically planned for the objective it wants to achieve in a context of multiple trade-offs between goals, instruments and actor interests (Grubb et al., 2017; Quitzow, 2015).

A central claim of transition scholars is that policy mixes for innovation need to consist in a balanced selection of instrument functions in order to reduce the different market failures

challenging innovation processes (see Section 2.2 for the energy efficiency challenges in existing buildings). The positive effect of having a variety of functions in the instrument mix has for instance been found in development of energy efficiency technology (Costantini et al., 2017). Cantner et al. (2016) describe a mix of instruments with demand-pull, technology-push and systemic function as essential for innovation. According to their research, technology-push describes incentivising inventions, for example through funding of research or other support of certain technology. Demand-pull instruments, then, are targeting the comparative advantages of old technology in the eyes of buyers (Cantner et al., 2016). Systemic instruments, lastly, aim at improving the cooperation between actors and spread knowledge and information (Cantner et al., 2016). This use of terms for the instrument functions in also found in other research on policy mix instruments (c.f. Costantini et al., 2017; Rogge & Johnstone, 2017).

As in the perspective of political sciences and economics, the research on and understanding of the interplay between policies is only in its early developments. In order to assess and exploit the potential to boost innovation processes and create effects beyond only few inventors, a better understanding of the design and effects of policy mixes in contrast to individual policies is necessary (Cantner et al., 2016; Magro & Wilson, 2013). The task is different for every context, as stage of innovation, characteristics of the sector and existing policies all influence the conditions in which the policy mix operates (Edmondson et al., 2018). It has been found that a general optimal composition of a mix does not exist but an analysis of the policies for every transition and innovation in every political context is necessary to ensure that the objectives are strategically achieved (Quitzow, 2015). Still, research on policy mixes in a particular context help advance the entire field and contribute to informing both theory and praxis on ways to govern complex innovation processes (Magro & Wilson, 2013).

2.5 Elements of the policy mix

Following the above rationales, the analysis of the policy mix is built on two central pillars. First, this section presents the elements of the mix that form the object of analysis. Second, Section 2.6 will outline the characteristics that serve as criteria for the analysis and will be applied to the elements. Their connection forms the analytical framework.

2.5.1 Defining and delimiting policy mixes

In light of the different research streams in which policy mix analysis is applied, definitions of what is a policy mix as well as units of analysis differ from study to study. At a general and rather descriptive level, Kern and Howlett (2009, p. 395) describe "policy mixes [as] complex arrangements of multiple goals and means which, in many cases, have developed incrementally over many years." Thus, the core features are a multitude of instruments for different goals and the fact that these were not created all together. This definition acknowledges the gradual emergence of the instruments but essentially takes the present mix at one moment to analyse its characteristics. Other papers refer to this part of policy mix analysis as the instrument mix, the interaction of the measures adopted (Rogge & Reichardt, 2016).

More comprehensive definitions therefore go beyond the instruments and phrase a policy mix as "a concept that at its basics considers the combination of policies into a composite set, but that also includes the processes through which different instruments emerge and interact" (Costantini et al., 2017, p. 800). This is along the lines of Rogge and Reichardt (2016), for whom the analysis of a policy mix includes three building blocks, elements, policy processes and characteristics which will be defined in more detail in Sections 2.5.2 and 2.6 below.

This research follows a narrower definition along the lines of Kern and Howlett (2009) cited above and Gunningham et al. (1998) saying that the complex interactions between goals and

instruments in one policy area create a system that together can achieve synergies or result in conflicts. The resulting focus is therefore on the interplay between the policy objectives as well as between the instruments in place for achieving the objectives. However, the more recent and broader definitions presented highlight the need to consider the practical implementation and institutional arrangements of the policies as an important design feature affecting the effectiveness of the overall mix. The elements, the objectives and instruments, include implementation design that is referred to as policy processes in other studies.

For an analysis of the policy mix, the limits to the composition of the mix in question needs to be clear, as it is the object of research. There is only little guidance on how to delimit the policy mix in an analysis. Rogge and Reichardt (2016) point to the strong dependency on the research aim and the policies that are studied. Their findings on the relevance of boundary setting show that a larger scope of the policy mix leads to an overall decrease in consistency and coherence in the analysis (Rogge & Reichardt, 2016). While policies for a narrow aspect like energy efficient heating systems in existing buildings can easily be well aligned, larger topics such as refurbishment of buildings or even the energy system in total need to incorporate multiple different goals and interest, resulting in generally less alignment. However, the more holistic the analysis is, the more realistic the setting and the results will be, a central claim of policy mix analysis (Rogge & Reichardt, 2016).

In the trade-off between those two considerations, the policy mix in this research focuses mainly on the specific policies for energy efficiency in existing buildings. The various market challenges in this sector alone have been outlined above (see Section 2.2) and require well-designed policy instruments for intervention within the relatively narrow field. Still, the influence of more general energy policies and implications for social equity are part of the analysis as well in order to understand and assess the reality of energy efficiency policies more widely.

2.5.2 Understanding the components of policy mixes

Elements are the main components of the mix and comprise the objectives as well as the instrument mix in place for accomplishing the strategy (Rogge & Reichardt, 2016). First, policy objectives contain the targets for a certain policy area and are often formulated in strategy documents or other not legally binding political statements. Targets from different documents and from different area can overlap in the policy mix (Kivimaa et al., 2017).

Instruments as the second component of the elements can be classified according to their use of the state's power, the instrument type. Rogge and Reichardt (2016) order possible instruments in the types of regulation, economic instruments and information to facilitate the structuring of existing instruments and potential lacks thereof even though overlaps between them cannot be avoided in reality. Regulatory instruments are also referred to as command and control instruments and are based on the power to set norms and bans by the government (Popp, Newell, & Jaffe, 2010). Economic instruments, or market-based instruments, use market mechanisms to make certain behaviour more or less expensive through taxes or financial support from the government (Popp et al., 2010). Informative instruments as the last group are such that make use of public means for awareness campaigns, education, or labelling programmes (Rogge & Reichardt, 2016).

Many strategy plans for policy areas like energy efficiency contain a description of the current and planned instruments. Still, more general instruments, or ones from other policy areas can affect the functioning of the specific measures and programmes for, in this case, energy efficiency in existing buildings.

When juxtaposing the types of instruments with the functions that were described in the innovation rationale above (see Section 2.4.3), the combinations address different market failures and barriers present in the realm of energy efficiency in existing buildings. Table 2-2 shows challenges addressed by each combination.

Table 2-2: Market challenges addressed by instrument types and functions.

		Instrument function		
		Technology-push	**Demand-pull**	**Systemic**
Instrument types	**Regulatory**	Negative external effects	Negative external effects Uncertainty of future prices	Principal-agent dilemma
	Economic	Positive external effects Negative external effects	Negative external effects High initial costs	Positive external effects
	Informative	Positive external effects Information asymmetries	Information asymmetries Lacking interest	Information asymmetries Lacking interest

Source: own compilation.

In relation to the concepts of energy efficiency governance presented in Section 2.1 and Figure 2-1 the policy objectives describe the necessary coordination mechanisms, whereas the mix of instruments relate to the enabling frameworks for the improvement of energy efficiency under government interventions (OECD & IEA, 2010). Table 2-3 presents examples of policies for each combination of instrument types and instrument function similarly to Table 2-2 in relation to energy efficiency.

Policy processes are the other block of the elements and sometimes seen as separated from the instruments (Rogge & Reichardt, 2016). The processes refer in this thesis to the practical implementation of the instruments regarding accessibility and distribution of authority among administrative agencies. Such a close link to the design of the instrument mix in general makes a stronger distinction unnecessary. The policy processes reflect the institutional arrangements of the energy efficiency governance framework in Figure 2-1 (OECD & IEA, 2010).

Table 2-3: Examples of policy options for the combinations between instrument types and functions.

		Instrument function		
		Technology-push	**Demand-pull**	**Systemic**
Instrument types	**Regulatory**	Minimum requirements for efficient product design	Ban of old heating systems	Mandatory consultations
	Economic	Funding support for R&D	Funding support for renovation project costs	Subsidising research collaboration
	Informative	Energy efficiency label	Energy efficiency label	Energy efficiency label

Source: own compilation

For the policy mix analysis, the interaction between the policy objectives and the instruments, both within themselves and with effect for the other, are the central research interest. When analysing the German mix for energy efficiency in existing buildings, the alignment of the objectives and of the instruments, the effective implementation and the solution of all market failures and barriers are the core factors for determining if the overall mix is well designed.

The research interest in policy mix analysis indicates that every policy mix has to be analysed specifically to assess its design on those criteria (Magro & Wilson, 2013). Recent studies find that the characteristics of coherence, consistence and comprehensiveness are well suited to analyse the policy mix for design strengths and weaknesses (Costantini et al., 2017; Reichardt & Rogge, 2016).

2.6 Characteristics as assessment criteria for policy mix analysis

Characteristics are the concepts used to analyse the policy mix in its interaction and indicate the appropriateness of the design (Rogge & Reichardt, 2016). They are used as assessment criteria for the German policy mix for energy efficiency in existing buildings in this thesis. The common characteristics are consistency and coherence but in addition to those two, credibility, comprehensiveness and the use of long-term targets appear in the literature (Cantner et al., 2016; Reichardt & Rogge, 2016; Rogge & Reichardt, 2016). This research uses the common characteristics of coherence of policy objectives, consistency of instruments and their practicability, as well as comprehensiveness of addressing the relevant market challenges by the various instruments of the mix. The following sections will elaborate on these characteristics in detail and provide definitions and indicators for each of them.

Credibility and the use of long-term targets are not used as distinct characteristics in this thesis. Credibility as the level of political commitment is seen as having a very vague meaning (Rogge & Reichardt, 2016). It is also only used in this one study and therefore not applied as a characteristic in this thesis. For that reason, aspects of credibility are included in the operationalisation of coherence. The feature of long-term targets is used to give an indication on the stability of a policy mix in order to analyse if long-term planning will be supported under the goals of a mix (Reichardt & Rogge, 2016). Indicators of long-term stability are included in the characteristics of coherence and consistency and will therefore not be use as a separate criterion.

2.6.1 Coherence

Coherence is used to describe the relationship of different goals of policies in the policy mix (Howlett & Rayner, 2013). Many authors have adopted the notion of Howlett and Rayner (2013, p. 174) that coherence is "the ability of multiple policy goals to co-exist with each other and with instrument norms in a logical fashion". Some authors use coherence and consistency as synonyms, as Rogge and Reichardt (2016) point out. The general understanding is, however, that a difference exists between them (c.f. Howlett & Rayner, 2013; Mickwitz & Partnership for European Environmental Research, 2009). Coherence usually refers to the higher levels of policy strategies, whereas consistency addresses the interaction of smaller details of the mix. Still, not all authors share the same definition. Whereas Howlett and Rayner (2013) apply coherence at the goals only, Rogge and Reichardt (2016) use it to characterise policy processes. A different conceptualisation sees coherence as "an attribute of policy that systematically reduces conflicts and promotes synergies between and within different policy areas to achieve the outcomes associated with jointly agreed policy objectives" (Nilsson et al., 2012, p. 396).

In this thesis, coherence is defined to characterise the objectives of the policy mix overall and the alignment (conflict or support) of the goals with each other, following Nilsson et al. (2012)

and Howlett and Rayner (2013). To what extent the policy mix is coherent depends on the level of support or contradiction between the objectives, the possibility for long-term planning, and whether the instruments match the targets set in the objectives. Table 2-5 below gives an overview of the indicators for operationalising the coherence of the German policy mix for energy efficiency in existing buildings.

2.6.2 Consistency

For Rogge and Reichardt (2016, p. 1626) "consistency captures how well the elements of the policy mix are aligned with each [other]". Here, elements cover the more detailed instruments, rather than overarching goals. According to Howlett and Rayner (2013, p. 174), it refers to the "ability of multiple policy tools to reinforce rather than undermine each other in the pursuit of policy goals". It is thus related to the instruments that seek to achieve the targets of the policy mix (Kern et al., 2017). Just like coherence for the objectives, consistency assesses the interaction of the instruments to identify contradictions or synergies between them. The characteristic also indicates the stability of programmes and measures or the ability to predict the development of instruments to include the long-term characteristic described above.

Consistency also includes practical implementation of the instruments as part of the policy processes. "The arrangements by authorities and other actors for putting policy instruments into action" (Nilsson et al., 2012, p. 397) influence the actual outcome substantially. This aspect of consistency captures potential difficulties of understanding regulation and structures, or of accessing information and funding. Such a design flaw can have a negative impact on the policy mix in general (Rogge & Reichardt, 2016). Indicators for the implementation consistency (see Table 2-5) aim at the distribution between implementing agencies and the ease of access for addressees of the policy mix, capturing two big levers of policy processes for a well-designed mix (Rogge & Reichardt, 2016).

2.6.3 Comprehensiveness

The final characteristic is comprehensiveness, which – unlike coherence and consistency – is not applied throughout the literature. It has however been conceptualised repeatedly and in different contexts. Comprehensiveness at its core refers to addressing all the market failures and barriers that are found in a technology innovation context (Rosenow et al., 2017). As outlined in the rationale of innovation and transition studies above, Cantner et al. (2016) argue that a comprehensive policy mix should include instruments of technology push, demand pull and systemic improvement (see Section 2.4.3). The combination of these instrument functions follows the innovation rationale. The multiple market failures and barriers on the one hand, and the complexity of socio-technical transformation require diverse types of instruments for a strategic and effective solution (see Section 2.4). Cantner et al.'s (2016) study finds technology push instruments like subsidies for research and development (R&D) to correct failure from positive externalities, whereas demand pull instruments like taxes and obligations to account for negative externalities (Cantner et al., 2016). Systemic instruments aim at fostering collaboration and the exchange of information to correct positive externalities and information shortages together (Cantner et al., 2016).

Thus, in light of the multiple market failures and barriers that have been found to result in the energy efficiency gap, for this thesis all of those instrument functions should be present in the mix for it to be comprehensive (del Río, 2014). As mentioned above, the correction of market barriers is controversial for economists. Political scientists as well as technology and innovation scholars, however, argue for a broader need for policy intervention, also requiring for solutions for barriers in the instrument mix (del Río, 2014). Comprehensiveness has also been linked to potential problems in recent research. Attempting to address every barrier possible and with

specific measures for different actors can lead to too many instruments in a mix and a reduced overall effectiveness (Costantini et al., 2017).

2.7 Analytical Framework

Table 2-4 summarises the analytical framework of this thesis based on the policy mix theory presented before. The elements of policy objectives, instruments, and policy implementation form the pieces which together create the policy mix. They are shown in the left part of Table 2-4 and form the object of study to which the analysis of the characteristics is applied. Coherence, consistency and comprehensiveness analyse different parts of the mix, as the right column illustrates. Combined, they give an overall assessment of the design.

Table 2-4: Analytical framework for this thesis.

Policy Mix		
Components		**Characteristics**
Elements	Policy objectives and strategies	Coherence
	Instruments	Consistency Comprehensiveness
Policy processes	Policy implementation	Consistency
Object of study		**Assessment criteria**

Source: own compilation.

In order to be able to research the characteristics and assess the policy mix, Table 2-5 shows their operationalisation for the analysis in this thesis. It is a checklist of indicators that increase in strength from top to bottom if multiple indicators are part of a single code. The first point under each group is only a minimum to indicate very weak coherence/consistency/etc. Fulfilling the latter ones indicates strong coherence, etc. The choice of indicators is determined by the characteristics definitions in the previous sections and inspired by operationalisations of other authors such as Kern et al. (2017), Rogge and Reichardt (2013) and Kivimaa et al. (2017). As described earlier, alternative characteristics used in the policy mix literature like long-term targets have been incorporated in the indicators for coherence and consistency.

Table 2-5: Operationalisation of coherence, consistency and comprehensiveness.

Characteristic	Indicators	Assigned code
Coherence	Objectives are not conflicting	Complementarity of objectives
	Objectives are neutral to one another	
	Objectives are complementary to one another	
	Objectives are predictable over long time horizons	Degree to which objectives are predictable
	Objectives are achievable through the instruments	Degree of matching ambition between objectives and instruments

Consistency	*For instruments of the policy mix:* There is no contradiction with other instruments There is support (unilateral or mutual) for/from other instruments	Coexistence with other instruments
	The instruments are predictable over time	Degree to which the instrument is predicable
	For policy implementation: Instruments are implemented in close collaboration Instruments are implemented under the same agency (e.g. Federal Office for Economic Affairs and Export)	Implementing authority
	Instruments are implemented understandably and accessibly	Degree to which instrument is useful in practice
Comprehensiveness	Instruments target a distinct market failure or market barrier	Clearness of market failure or barrier
	The policy mix includes - Technology push, - Demand pull, and - Systemic instruments	Instrument function of the measure
	All relevant actors for energy efficiency in buildings are addressed (enabled or encouraged)	Actor inclusiveness
	The policy mix reduces the market failures and barriers	Adequacy for the market failure or barrier

Source: own compilation, following Kern et al. (2017), Rogge & Reichardt (2013) and Kivimaa et al. (2017).

3 Methodology

Policy analysis as a broad field of social sciences follows a pragmatic rationale (Dunn, 2018). As Dunn (2018) puts it, its main purpose is to create knowledge that solves a policy problem. To varying extents, it is a descriptive and normative discipline at the same time. Consequently, the choice of method has few restriction but should be based on the best way to generate such knowledge (Wildavsky, 1979). The goal of research in a pragmatic way is to find out what works at a certain moment in time, for which there might be different understandings between different researchers (Creswell, 2014). Whereas this worldview offers high potential to contribute to the solution of real-world policy problems and reaching the audience of practitioners, it also comes at a great responsibility for clear and justified choice of methods to ensure academic value. This chapter will describe the methods used in this thesis and present the rationales for them.

3.1 Case study design

The research follows a qualitative approach with a case study design as Creswell's (2014) overview describes it. In policy analysis, qualitative methods are recognised to play a useful role for getting in-depth insights in a policy field that requires analysis (Ritchie & Spencer, 2002). Recent studies use qualitative methods for example to investigate beliefs and conceptions of actors that shape the policy process (Thow et al., 2018). As deep understanding of the energy efficiency policy mix and its stakeholders is essential for the assessment of the characteristics, a qualitative approach offers the tools for a well-founded analysis. A common method in qualitative research is a case study. Case studies are seen as a useful way for in-depth analysis and assessment of a very distinct situation (Creswell, 2014). A case study design relates to both the object of study and the method of data collection and analysis (Yin, 2014). The object is studied in the real-world context, in line with the pragmatic paradigm of policy analysis. Regarding the object of a case study, Yin (2014, p. 16) defines that

> *"A case study is an empirical inquiry that*
>
> - *investigates a contemporary phenomenon (the "case") in depth and within its real-world context, especially when*
> - *the boundaries between phenomenon and context may not be clearly evident*"

Both elements of the definition are applicable in the analysis of the policy mix of energy efficiency in existing buildings and core features of the policy mix analysis framework as the literature review has pointed out.

The frame of a case study as a method is also consistent with the conceptions of this research as a contribution to policy mix literature and explicitly includes a deductive proceeding like the one described below.

> *"A case study inquiry*
>
> - *Copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result*
> - *Relies on multiple sources of evidence, with data needing to converge in triangulating fashion, and as another result*
> - *Benefits from the prior development of theoretical propositions to guide data collection and analysis"* (Yin, 2014, p. 17).

Unsurprisingly, case study designs have been used in the field of policy mix research by a number of authors (Kern et al., 2017; Kivimaa et al., 2017; Reichardt & Rogge, 2016). Most notably, the study of Kern et al (2017) can give guidance to the data collection and analysis for this research. A scoping interview with one of the co-authors of that article validated the design and was able to support the development with some advice.

The case study tries to understand the particular reality as thoroughly as possible but does not create results beyond lessons from the current situation (Kvale & Brinkmann, 2009; Yin, 2014). Inferences about other policy mixes are not backed by this method. A core purpose is the testing and development of the theory. Adding more and more cases to the collection of knowledge strengthens the theory or reveals weaknesses that can be uncovered and addressed (Yin, 2014).

This research seeks to expand the foundation of policy mix analysis by adding a new case and improve the theoretical framework. For that purpose, the case was selected as a critical one to the theory (Yin, 2014). As described in the introduction, Germany is a key part of European energy efficiency ambitions and has been setting the scene for the Energy Transition for about two decades. This environment for energy policy is unique in its combination of energy efficiency with renewable energy support. The complex policy situation creates challenges for traditional policy analysis approaches. Policy mix research in the area can reveal strengths and weaknesses of the theory, while simultaneously improving the understanding of German energy efficiency efforts with the insights from the emerging theoretical perspective.

3.2 Data collection

The theoretical background and major scoping decisions are based on a review of academic literature through searches on ScienceDirect, Google Scholar and in the Lund University library catalogue, as well as a scoping interview with a prominent researcher in the area. Starting with (combinations of) the search terms policy mix, energy efficiency, building, Germany as well as policies and measures, other articles have been identified. Snowball techniques of suggested articles and keywords from the articles further expanded the literature selection. Priority was given to peer reviewed papers, but a few sources from books and grey literature have been included, too. The data collection process was based on two pillars. First, documents were reviewed to inform the delimitation of the policy mix. Objectives and instruments with a direct effect on energy efficiency in existing buildings were considered, while additional instruments were identified that needed further clarification on the relevance for the mix. In the second step, interviews with experts and stakeholders of the policy mix were conducted with the goal of validating the chosen instruments, creating a comprehensive picture and triangulate the findings.

3.2.1 Document review

Documents are a valuable source as they are publicly available, convey the official language and, in the case of high level policy documents, often have to comply with legal mandates on transparency (Creswell, 2014). Therefore, the data provides information with high methodological reliability and also a shared baseline for all stakeholders and experts.

In desktop research, a review of the policy mix elements like objectives, strategies and instruments was carried out. The focus of this part of the research was to gain a better understanding of the individual elements currently in place. A starting point for the identification of important instruments is the German national energy efficiency action plan (BMWi, 2017a). On this basis and in combination with other strategic documents for building energy efficiency, the core measures and support programmes could be identified. For those objectives and instruments, the documents for the review were taken from official German

ministry websites and databases. The Odysee-Mure database[3] offers an overview on energy efficiency policies with short descriptions and evaluations.

Essential source for the identification of the instruments are the strategy documents that are found on the websites of the BMWi and BMU. The Energy Concept of the federal government (BMWi & BMU, 2010), the Strategy for Energy Efficient Buildings (BMWi, 2015) and the National Action Plan for Energy Efficiency (BMWi, 2017a) are all publicly available on ministries websites and contain information on the goals of policies and the important instruments to achieve these goals. In addition, Germany like all other EU member states has to inform the European Commission about actions taken to reduce GHG emissions and on other climate change related issues to comply with Regulation (EU) 525/2013. The most recent report from early 2019 contains up-to-date information on the actions for increasing energy efficiency in buildings (Federal Government of Germany, 2019a).

A visual overview of the strategies as well as instruments in place is presented in Figure 4-2. A German version of this illustration was sent to the interviewees in preparation of the interviews. A detailed list of the instruments that were identified as fundamental parts of the policy mix can be found in Appendix A.

The instruments and goals that were identified in this process were mapped to explore their temporal overlap and the evolution of the policy mix in broad terms, as well as to compare the goals they seek to achieve. For this purpose, an Excel spreadsheet helped to create visual support that was also used during the interviews.

More detailed information on measures and programmes was collected in different ways according to the type of instrument. For regulatory instruments, the text of the legal provision together with the official justification were used. Extensive information on financial support programmes was retrieved from an official German database that contains all subsidy programmes[4]. For each programme, information on who, why and how can benefit is made public on the website. The detailed information was useful for the classification into demand pull, technology push and systemic instruments.

A similar approach of document study in preparation and complementation of interviews was carried out by Kern et al (2017) in their study for the UK and Finland.

3.2.2 Semi-structured interviews with experts and stakeholders

The document review was complemented by semi-structured interviews with policymakers and stakeholder of the energy efficiency policy mix in existing buildings. Interviews are a useful source of context dependent data (Creswell, 2014). With the more open setting, they also allow for the collection of valuable opinions from experts and stakeholders that differ from official language (Flick, 2006). The informants were selected because their experiences relate to the close practical contact with the policies in the case of stakeholders, and they can provide more objective assessments from expert researchers. Thus, the data collected in the interviews is diverse in angles but highly relevant to the functioning of the policy mix.

In particular, the semi-structured interview method offers insights into implicit as well as explicit knowledge and ideas that are of practical relevance (Kvale & Brinkmann, 2009). In this interview form the researcher asks open questions that are driven by theory and the particular conceptual

[3] http://www.measures-odyssee-mure.eu/topics-energy-efficiency-policy.asp

[4] http://www.foerderdatenbank.de/

model to guide the conversation but give freedom to the interviewee to prioritise and expand on specific areas more than on others (Flick, 2006).

Table 3-1: List of interviews with stakeholders and experts.

	Organisation		Type
1	BMU	Federal Ministry for the Environment	Government
2	BMWi	Federal Ministry for Economic Affairs and Energy	Government
3	BBR	Federal Office for Buildings and Regional Planning	Government
4	AGFW	Energy Efficiency Association for Heating, Cooling and CHP	Industry/Owners
5	DENEFF	German Initiative for Energy Efficiency	Industry/Owners
6	GdW	Federal Association of Housing Companies	Industry/Owners
7	Verband Wohneigentum	Association of Property Owners	Industry/Owners
8	DGNB	German Sustainable Building Council	Occupants/Environment
9	vzbv	Federal Association of Consumer Protection Organisations	Occupants/Environment
10	DUH	German Environmental Support	Occupants/Environment
11	BPIE	Buildings Performance Institute Europe	Occupants/Environment
12	Dena	German Energy Agency	Research/Think tank
13	IFEU Heidelberg	Institute for Energy and Environmental Research	Research/Think tank
14	RWI Essen	RWI – Leibniz Institute for Economic Research	Research/Think tank
15	Agora Energiewende	Agora Energy Transition	Research/Think tank

Source: own compilation.

For the research of this thesis, interview partners were identified starting from the organisations directly involved in the policies, to the ones advocating for various interests and organisations that analyse the mix from different academic perspectives. During the first interviews, interviewees were asked to recommend further organisations. This led to a total amount of 15 interviews including ministries, government agencies, industry associations, third sector organisations and research institutes. The list of interviews conducted is presented in Table 3-1. All interviews had to be carried out remotely via internet and phone calls in the period between end of June and end of July 2019. Two interviews were made in written form. Full information on the interviews can be found in Appendix B.

The three governmental actors that were interviewed represent the ministries working on energy efficiency in buildings and together propose and adopt measures. Energy issues and the oversight of the central subsidy programmes are located at the Ministry for Economic Affairs and Energy. The Federal Office for Building and Regional Planning is subordinate to the Ministry of the Interior, Building and Community which has the general building policy competence and administers a research support programme. The competence for building policy used to be located at the Ministry for the Environment which also is responsible for the progress on overall climate targets. From an industry perspective, the association for district heating technology was interviewed as an actor interested in further deployment of new energy technology. Moreover, two central association of building owners, real estate companies and private owners were interviewed for perspectives of actors in charge of buildings. Interviews with associations gave insight from tenant, environmental and building design perspectives, whereas research institutes were asked for their assessment from economic and environmental viewpoints. In this thesis, the groups of government, industry, owners, tenants, building and

environmental perspectives are referred to as stakeholders, while research institutions and think tanks are experts for the issue of energy efficiency in existing buildings.

The questions for the semi-structured interviews were based on the research questions and operationalisation of the characteristics presented in the previous chapter. In that way, the literature on policy mix theory has shaped the data collection process. All interviews were conducted in German, as all interviewees and the interviewer are German native speakers. The interview questionnaire used can be found in an English and German version in Appendix C. In majority, interviews were recorded with permission of the interviewee. Technical problems caused difficulties in four interviews during which notes had to be taken by hand and digitalised afterwards.

3.3 Data analysis

Both document and interview data require tools for text analysis in order to create comparable results. Qualitative content analysis is a common tool for this purpose that systematically categorises the text into useful sections (Flick, 2006). The foundation of qualitative content analysis were laid by Mayring (1991). The analysis method exists in different forms covering different research designs and aims.

Hsieh and Shannon (2005) define three types of qualitative content analysis. Conventional and summative analysis have a focus on explorative research and frequency respectively. In contrast, directed content analysis aims at testing and extending a concept like the policy mix theory in this thesis (Hsieh & Shannon, 2005). Mayring refers to this approach as approach deductive category assignment (Mayring, 2014). As the name suggests, this type uses predefined categories from the theoretical framework and based on the research problem to extract a structure from the data (Mayring, 2014). The method is therefore suited for the research in this thesis in its deductive approach on applying and testing the policy mix concept in the German mix for energy efficiency in existing buildings.

The analysis process starts with the categories already in place, which are further defined in examples that are found in a first screening of the material (Hsieh & Shannon, 2005). The first trial run thus creates rules for coding to apply the categories systematically and consistently in the main step of coding the entire data (Mayring, 2014). Coding is the assignment of a category and possibly a value to sections of the text. During the coding process, changes in the coding structure that contains all the categories and codes can be made to ensure capturing all relevant details (Mayring, 2014). Figure 3-1 illustrates the process of qualitative content analysis in the deductive form. The clearly defined rules and codes ensure reliability of the data analysis.

For the aim of this thesis – applying the policy mix framework to the case of energy efficiency policies in the sector of existing buildings in Germany – the deductive content analysis offers the right tools to analyse both document and interview data. This research tries to validate and extend the policy mix theory with the German case. Starting with the literature review presented in the previous chapter, categories to structure the content were formulated.

After starting to go through the collected data, a few categories have been added. Appendix D contains the final coding structure. The operationalisation in Table 2-5 above formed the basis of the coding structure. The indicators identified based on the literature review were transformed into categories to be searched for in the data. Whereas the indicators for coherence and consistency are mainly applied to the interviews, the different instrument functions under comprehensiveness are tested in the documents for the various measures.

Most codes of the structure are ordinal codes that rank the manifestation of the content in respect to the category (Mayring, 2014). This way, the responses from interviews and documents could be grouped into positive, neutral and negative statements when analysing the indicators. The categories reflect the operationalisation of the characteristics presented in Chapter 2 and are therefore used to structure the analysis in Chapter 5.

For the coding process itself, the software NVivo was used. It is a commonly used software for qualitative data analysis which facilitates the coding process. It allows coding and structuring of audio files as well as text in a systematic way. All data sources were imported to NVivo and the coding structure (see table in Appendix D) was replicated in the software. NVivo supports the data analysis process and offers summaries of codes and word frequency. The audio recordings of the interviews were coded without transcription, the notes taken during interviews and the official documents for the instruments were coded in the text documents. After revision of the coding structure, the files were re-listened and re-read for the final coding run.

Together, the multiple sources of data allow for triangulation, which increases the validity of the results (Creswell, 2014). Material collected from the various interviews and such from document study can be contrasted to test the respective claims and understand the situation in-depth.

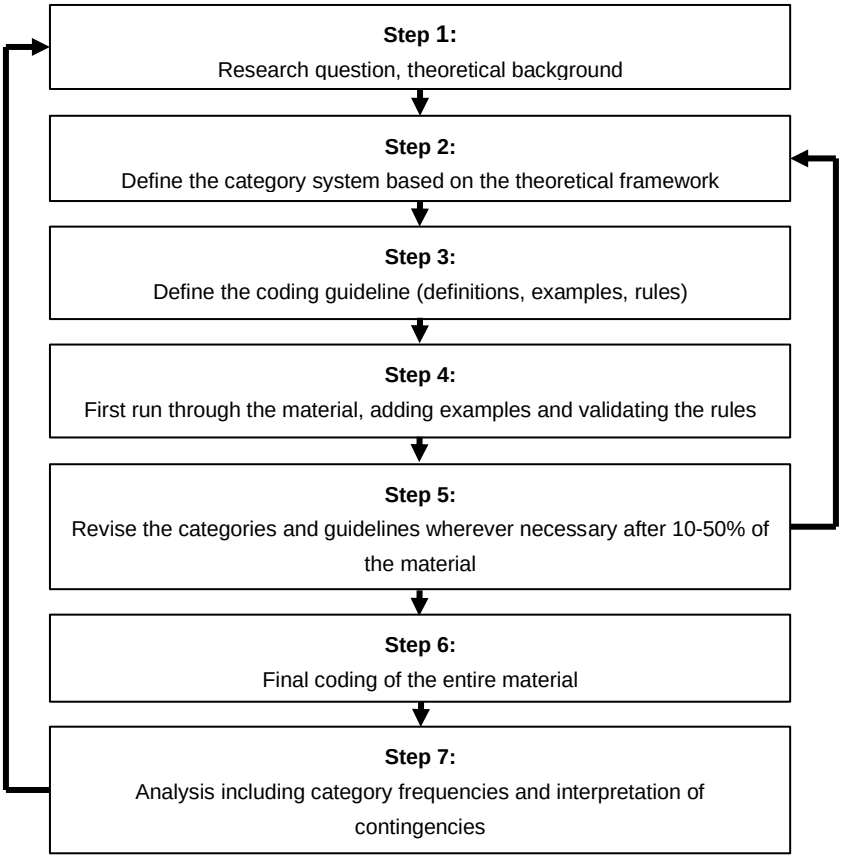

Figure 3-1: Steps of the research process for deductive qualitative content analysis.

Source: own illustration based on Mayring, 2014, p. 96.

4 Elements of the policy mix for energy efficiency in existing buildings in Germany

The following chapter presents the elements of the German policy mix. The relevant context for the analysis of energy efficiency policies is presented in the following section before turning to the policy objectives and strategies as well as the instruments in turn. Figure 4-2 visualises the elements of the policy mix that are presented in Sections 4.2 and 4.3. The present chapter describes the current setting and lays the ground for the analysis of the characteristics that will follow in Chapter 5.

4.1 Context of the energy efficiency policy mix in Germany

To start with, the context of the policy mix needs to be understood in order to illustrate the political, economic and regulatory environment of energy efficiency governance. As mentioned in Chapter 1, Germany's energy efficiency efforts are part of the wider energy transformation. Many contextual factors therefore concern other aspects of the transition like overarching goals and instruments to increase the share of RES.

As described above, the German policy mix is integrated in a system of multi-level policymaking. Goals at the international levels indicate the direction of energy policy and climate change mitigation and express commitment beyond national objectives. Germany is party to the Paris Agreement and therefore bound by the treaty to limit global warming to less than 2°C (United Nations, 2015). In further detail, the EU has set differentiated targets for each member states. The Effort-Sharing Regulation (EU 2018/842) from 2018 requires Germany to reduce its GHG emission by 38% in 2030 compared to 2005.

Whereas breaching most other goals on a national and international level does not entail direct consequences, the EU is able to impose fines on member states in case of violation of its regulations. The international commitments increase the pressure on energy efficiency improvements in buildings to enable the increased deployment of RES (Rosenow et al., 2017).

The main pieces of European legislation are the Energy Efficiency Directive and the Energy Performance of Buildings Directive. The former directive sets general targets for energy savings across member state's economies for which two pathways are possible. Germany chose the option of multiple instruments instead of a single obligation for energy providers (Rosenow et al., 2016). The latter requires the member states to implement measures such as energy labels for buildings and apartments to improve the energy performance of existing and new buildings.

On a national level, the German context for energy efficiency in buildings is shaped by the Energy Transition. The central instrument of this strategy is the Renewable Energy Act, which aims at increasing the share of RES in electricity generation using feed-in-tariffs for notably wind, solar and biomass generation (*EEG*, 2014). As a result, the share of RES in electricity generation has risen to 37.5% in 2018 (UBA, 2019c). The higher tariffs are financed by charges on electricity consumption that have made Germany's electricity prices the second highest in Europe (Eurostat, 2019a). Market prices of fossil fuels for heating are much lower, making the use of electric heating technology like heat exchangers unprofitable. The share of RES in heating is only at 13.9% (UBA, 2019c). The price advantage of fossil fuels under the current regulatory conditions increase the need for incentives in order to make new, more efficient technologies competitive compared to keeping old heating systems.

A further relevant contextual factor for energy efficiency in buildings is the overall economic situation and fiscal policy of Germany and the EU. The German GDP has been growing faster than most industrialised countries until recently but the interest rate for savings and bonds is

continuously low (World Bank, n.d.). Together with trends of urbanisation, this development has made real estate attractive for investment and increased the demand for residential buildings, especially in urban centres (Statista, 2019). Criteria that are seen as non-essential, like energy efficiency performance, get less attention from buyers in their purchase decisions (Amecke, 2012). At the same time, skilled workers are scarce in the construction industry, also making refurbishment projects more expensive and harder to plan (Müller, 2018). This reduces the willingness of all types of property owners to make changes to the building envelop or the heating equipment. The economic context is thus not very favourable to energy efficiency improvements.

Finally, an important factor impacting the energy efficiency policy mix is the high share of tenants as tenure status. The percentage of German households in tenancy is at 57% according to 2018 data (Destatis, n.d.), making it the EU country with the highest share of renters (Eurostat, 2019b). As described earlier, tenancy is a particular challenge to energy efficiency because landlords will have to make investments in insulation or new heating systems but tenants would be the ones profiting from it (Ástmarsson et al., 2013). However, the tenant often has to finance the investment with a higher rent in the long term which creates pressure on low-income households. A core challenge for energy efficiency governance, especially for Germany, is therefore the balance between incentives for landlords and socially equitable rent development (Ástmarsson et al., 2013). German laws limit the amount landlords can raise rents after renovation projects. Since recently, rents have been frozen locally by regulation to stop the loss of affordable housing, for instance in Berlin. It is still too early to assess the success and the effect of these rent control policies on energy efficiency renovation, though.

4.2 Policy objectives and strategies

Four strategy documents shape the German policy mix for energy efficiency in existing buildings. Those four documents define most of the policy goals but are amended by some goals originating from other sources like the coalition agreement of the current government.

The first of the strategies to come into place was the Energy Concept of the federal government in 2010, which formulates a general plan for the development of energy consumption in Germany (BMWi & BMU, 2010). It includes all sectors of the economy and various aspects of energy policy. It is highly relevant for this thesis because, on the one hand, it positions energy efficiency as a centrepiece of the energy policy. On the other hand, it sets clear targets for the building sector leading to a nearly climate-neutral building stock by 2050 (BMWi & BMU, 2010).

Such a long-term target in a short document dealing with energy issues from nuclear power, grid stability and transport consequently made a more detailed strategy for the building sector necessary. For this purpose, the federal government issued the Strategy for Energy Efficient Buildings in 2015, the second of the strategy documents. It confirms the target of the climate-neutral building stock while containing concrete numbers for the goal, a stocktake of measures in place and a pathway to achieve the target. The climate-neutral building stock is now defined as reducing the primary energy consumption by 80% compared to 2008 by means of energy efficiency and deployment of energy from RES (BMWi, 2015). As the essential step to achieving the target, the annual rate of refurbishment of buildings needs to increase from about 1% to 2% (BMWi & BMU, 2010). Those numbers are used in the earlier Energy Concept too, but in a less precise and normative way. Ultimately however, the two documents set the same targets – the Strategy for Energy Efficiency further develops the building part of the Energy concept.

Targets for the building sector are part of the overall climate goals, which are measured in a reduction of GHG emission. The goal is an 80% overall reduction by 2050 in comparison to

1990 with stepwise milestones along the way (BMWi, 2015; BMWi & BMU, 2010). The high level GHG reduction target is thus setting the frame for the ambitions in the building sector.

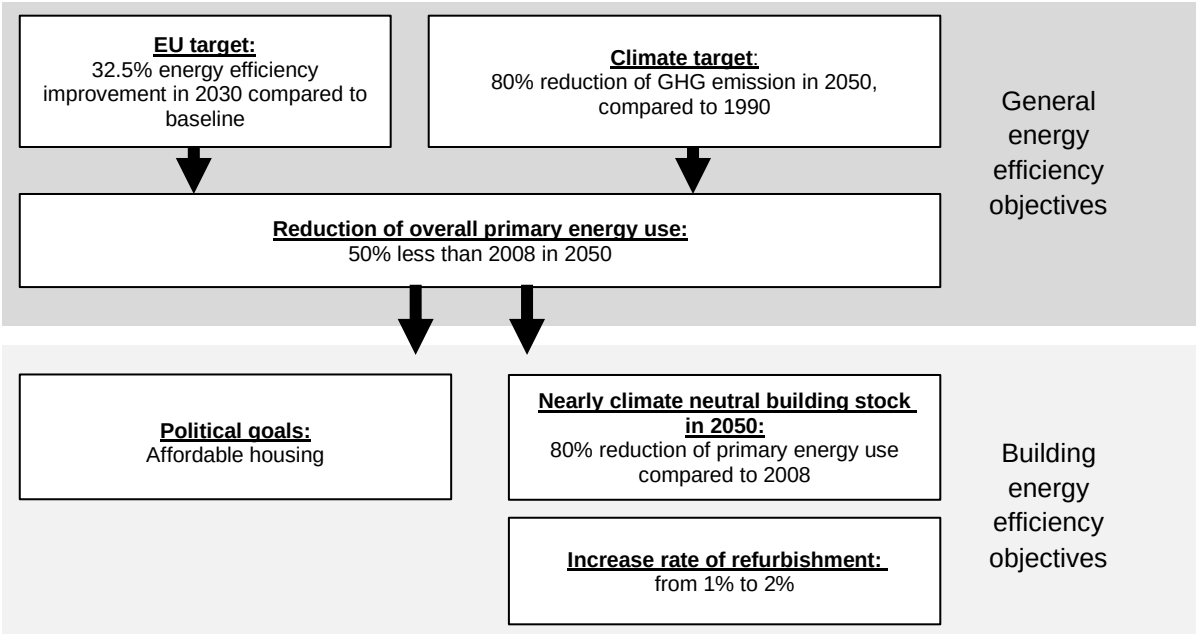

Figure 4-1: Overview of the policy objectives

Source: Objectives founds in BMWi & BMU (2010), BMWi (2015), BMU (2016) and CDU et al. (2018).

Within the sector, the strategic objectives are broken down. This is where the increase in the rate of refurbishment is located. Figure 4-1 illustrates the targets on the various levels.

A third important strategy document, the Climate Protection Plan from 2016, reaffirms the objectives set in the two previous documents (BMU, 2016). With the aim to present the total of Germany's climate protection efforts and pathways for all sectors, the plan calls for the same savings in primary energy consumption in the building sector (BMU, 2016). As it was the case from the Energy Concept to the Strategy for Energy Efficient Buildings, the Climate Action Plan also increases the level of detail of what is supposed to happen for a climate-neutral building sector. However, the scope is broader and includes a wider array of potential technological solutions (BMU, 2016). Moreover, the objective of keeping the transition to more climate friendly buildings – which includes energy efficiency measures, and the deployment of RES technology for electricity and heating – affordable for all parts of society is added to the objectives of the policy mix (BMU, 2016). The concept of economic feasibility had been part of energy efficiency policy from the beginning, meaning that renovations and refurbishments have to recoup the investment during the lifetime (BMWi & BMU, 2010). But explicitly adding the goal of affordability, creates an objective that is not automatically in line with the targets for climate-neutrality.

While the aforementioned strategy documents were created under previous governments, the coalition that formed in early 2018 committed itself to the targets of the Climate Protection Plan and sectoral strategies with the clear aim of achieving the targets from 2030 onwards (CDU, CSU, & SPD, 2018). The coalition agreement also contains more targets on social effects of the building and housing sector. On the one hand, a plan to build 1.5 million new homes will affect the energy consumption of the sector but is more of a concern in the field of new construction. The agreement to keep rents affordable and limit the increase in rent that is possible, on the other hand affects renovation of existing buildings that are rented out (CDU et al., 2018).

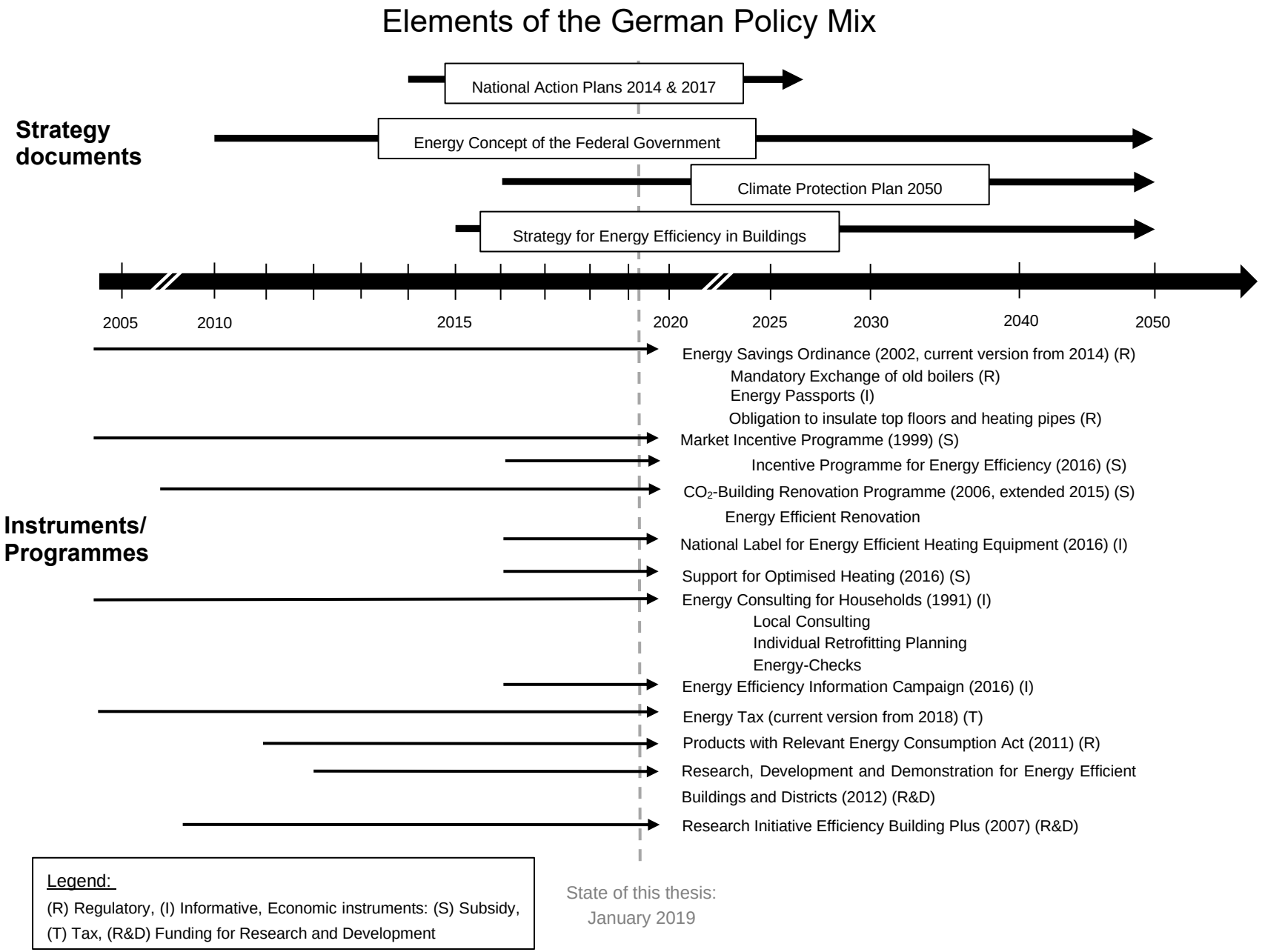

Figure 4-2: Elements of the policy mix for energy efficiency in existing buildings in Germany.

Source: own compilation.

All strategy documents emphasise the need for a combination of energy efficiency action and higher shares of energy from RES to achieve the goal of a climate-neutral building sector. Due to the ambition to create policies that are open to all kinds of technology, a further breakdown of the contributions that the two options are supposed to make is not made (BMWi, 2015). Additionally, the National Action Plan for Energy Efficiency summarises the German objectives and instruments in place as a communication to the European Commission (BMWi, 2017a). It does not contain separate objectives but presents achievements and future plans across the economy in a systematic way. It also forecasts the amount of primary energy saved. The objectives for the policy mix are laid out by the strategic documents presented in this chapter. Many of the documents include reference to instruments already. The following section will give an overview of the instruments in the mix.

4.3 Instruments and programmes

The instruments in the policy mix for energy efficiency in existing buildings in Germany are numerous. As described in the scope of this thesis (see Section 1.3), delimiting the policy mix to the essential measures and programmes is challenging but inevitable (Rogge & Reichardt, 2016). Fossil fuel subsidies, provisions in civil law that regulate rental contracts influence the outcome of the policy mix under analysis but are here considered contextual to the policy mix. This section outlines the instruments at the core of achieving the objectives described above. The instrument mix analysed in this thesis contains measures that are mentioned in various of the strategic documents for energy efficiency in existing buildings (BMU, 2016; BMWi, 2017a) and measures that are flanking the direct measures in a broader way. Only instruments that actually regulate, inform or supply funding to projects are included in the subsequent analysis, while mere legal bases are disregarded (see Appendix A for all the instruments).

The rest of this chapter describes the instruments of the policy mix briefly following the classification of regulatory, economic or informative type.

4.3.1 Regulatory instruments

Energy efficiency in existing buildings is governed by only two regulatory instruments. One act regulating building owners contains three measure, whereas the other act targets producers of heating equipment.

- The Energy Savings Ordinance (EnEV) sets rules for the energy consumption. In general, it is the central instrument for energy efficiency in buildings. But whereas the provisions for new construction are numerous and demanding, the measures for existing buildings are more limited. The first obligation consists in an interdiction to operate boilers that are older than 30 years. Second, energy passports with the key figures on energy consumption are mandatory for sales and rentals of residential and non-residential buildings. This is an informative instrument within the list of regulatory measures. Finally, ceilings of the highest level and heating pipes have to be insulated according to parameters set by the ordinance (*EnEV*, 2014).
- The Products with Relevant Energy Consumption Act (EVPG) implements the Ecodesign Directive (2009/125/EC) of the EU into German law. The German act and an ordinance that is based on it refer to the European minimum standards for products that consume energy. In the context of energy efficiency in buildings, products like boilers and air conditioners are relevant and need to fulfil the standards to be sold on the European market (*EVPG*, 2015).

4.3.2 Economic instruments

Economic instruments are the centrepiece of the instrument mix when it comes to existing buildings. The philosophy of the German policy mix is to support measures that exceed the legally required limits set in the regulatory instruments, notably the EnEV (BMWi, 2017b). As the mandatory standards are low for existing buildings, economic instruments have to create the largest share of incentives. Four funding programmes to support refurbishment projects aim at improving the energy efficiency performance. Additionally, energy consumption in any form is subject of a tax.

- The Market Incentive Programme (German abbreviation: MAP) supports energy efficiency projects in the larger context of renewable energy utilisation for heating in buildings. Measures like solar photovoltaic, biomass, and heat pumps qualify for funding. Small projects (measured by installed capacity) are supported by grants from the Federal Office for Economic Affairs and Export (BAFA), whereas larger projects can receive low-interest loans from the state-owned development bank KfW. All types of actors can apply for the funding which amounts to 320 million Euro per year ('Maßnahmen zur Nutzung erneuerbarer Energien im Wärmemarkt (Marktanreizprogramm) [Measures for the use of renewable energy in the heating market (Market Incentive Programme]', n.d.).
- Part of the MAP is the Incentive Programme for Energy Efficiency that was introduced in 2016. The programme improves the support for measures that increase the energy efficiency of buildings with grants. It has to be combined with support from the MAP to qualify for this programme as well. The additional financial volume is of 165 million Euro per year ('Anreizprogramm Energieeffizienz (APEE) [Incentive Programme for Energy Efficiency]', n.d.).
- The CO_2 Building Programme is managed by the KfW. It has two components: energy efficient renovation and energy efficient construction. Only the former is considered in this thesis. Energy efficient renovation funding is only available for residential buildings and supports measures to improve the building envelope. It is divided into two types of funding: a low-interest loan for larger refurbishment projects and grants for smaller, individual measures. Only private real estate owners can apply for the grants of a volume of 1.36 billion Euro in total in 2018 (BMWi, 2018a; 'Energieeffizient Sanieren—Investitionszuschuss [Energy efficient renovation—Grant for investment]', n.d.; 'Energieeffizient Sanieren—Kredit [Energy efficient renovation—Loan]', n.d.).
- The Programme for Support of Optimised Heating helps all kinds of actors exchange old heating systems and optimise current ones in form of a grant from the BAFA ('Förderung der Heizungsoptimierung durch hocheffiziente Pumpen und hydraulischen Abgleich [Funds for optimisation of heating systems with efficient pumps and hydraulic control]', n.d.).
- The Energy Tax applies to all energy sources but has a high variation depending on the purpose the energy is purchased for. Fossil fuels for heating have comparatively low tax rates. Therefore, the tax is not primarily a tool to increase energy efficiency in building heating but has an important influence on energy consumption behaviour overall (*EnergieStG*, 2019).

4.3.3 Informative instruments

Finally, three informative instruments that address different aspects of decision making in relation to refurbishment projects are part of instrument mix as well. Moreover, two programmes that provide funding for research and development are considered as informative instruments because they aim to generate knowledge about energy efficiency measures buildings, and both involve displaying model buildings to the public.

- The Label for Energy Efficient Heating Equipment is designed to inform consumers of the energy efficiency status of their heating equipment. District chimney sweepers place the label on boilers older than 15 years. The label is only fully in place since 2017 and seeks to reduce the number of old equipment before they have to be exchange under EnEV provisions (BAFA & UBA, 2016).
- Energy Consulting is subsidised by the state to create pathways to high energy efficiency standards targeted at a specific building. Different actors offer consulting, including consumer organisations like the Federal Association of Consumer Protection Agencies (vzbv) and publicly owned local utility companies. Energy consulting combines the technical potential of measures in the building and opportunities for funding support from the programmes above ('Energieberatung für Wohngebäude [Energy Consulting for Residential Buildings]', n.d.).
- The informative instruments are completed by the energy efficiency information campaign, which consists in a public advertisement campaign to promote energy efficiency in buildings and a website to give an overview of possibilities of support and advantages of improving the energy performance of homes ('Deutschland macht's effizient [Energy efficiency information campaing]', 2019).
- As the first of the research funding instruments, the EnEff.2050 programme aims at showcasing the possibility to achieve a climate-neutral building stock in 2050 by creating examples of how buildings can achieve climate-neutrality. It is part of the programme for Research, Development and Demonstration for Energy Efficient Buildings and Districts. The programme currently does not accept new project applications because the funds are exhausted (BMWi, 2017c).
- Finally, the Research Initiative Efficiency Building Plus tests technological options for buildings in combination with each other and under real-life conditions (BMI, 2018).

In summary, the description of policy objectives in the strategy documents and the instruments shows that the goals of the policy mix focus on energy savings as a means for climate change mitigation. However, keeping housing affordable is an important driver of the buildings policies as well. The instruments to improve the energy efficiency in existing buildings are dominated by economic ones that provide financial support to renovation projects and the exchange of heating systems. Informative instruments also play a substantial role, whereas the legal obligations for existing buildings are only minimal.

5 Characteristics of the German policy mix

The previous chapter laid out the context of the German policies for building energy efficiency and the elements in terms of objectives and instruments. This chapter will assess the policy mix that is the result of all the elements using the characteristics coherence, consistency and comprehensiveness.

5.1 Coherence

As presented in Section 2.6.1, the characteristic of coherence assesses to what extent policy objectives are aligned in a way that they support each other, or if there is contradiction between them. Additionally, coherence is used to analyse the congruence between the ambition of goals and the actual impact created by the instrument mix. Following the coding structure, the first aspect to be analysed is the alignment and interplay of policy goals. Second, the long-term stability is investigated, before, third, the level of ambition in the objectives is compared to the ambition of the instruments.

5.1.1 Alignment of policy objectives

In the interviews, the alignment of the goals was assessed differently depending on the scope they were considering. Whereas objectives related to climate targets are perceived as very coherent, the interplay with social policy objectives is a concern for most interviewees. The description of the goals in Section 4.2 showed already that the targets related to energy savings and climate neutrality of buildings are all based on the same origin, the Energy Concept of 2010. The actual number of policy objectives is therefore low. The stakeholders perceive the alignment of the goals in a similar way, pointing to the "good fit of the big strategies" (Interview Government) and high consistency, because they are all based on the Energy Concept and EU law (Interview Research/Think tank). The only criticism raised by two interviewees on the energy savings targets is the reduction in energy consumption as the basis for calculation. According to those stakeholders, a direct use of GHG emission reduction as the target would be more adequate for climate change mitigation and at the same time offer higher flexibility for users to choose between RES in the building or lower the consumption through higher efficiency (2 Interviews: Industry; Research/Think tank).

Flexibility can be a relevant aspect because of the social repercussions of costly energy efficiency measures. When assessing the interplay of energy efficiency and social objectives, the opinions on coherence were more diverse and less favourable. Some interviewees see a fundamental conflict between energy efficiency and affordable housing (5 Interviews: Government; Industry/Owners; Occupants/Environment), whereas others say that the trade-off is only used as an excuse for inaction by owners (2 Interviews: Occupants/Environment). The former side argues that renovation of all buildings is financially not feasible for owners or for tenants (Interview Industry/Owners). The latter side points to the fact that energy costs for tenants would decrease, thus the conflict does not exist. Only landlords would have to be much stronger supported when investing in efficiency (Interview Government). Despite such disagreement on details, almost all interviewed stakeholders perceive the current situation as a conflict that hinders energy efficiency improvements and effective climate change mitigation. In triangulation, the Climate Action Plan 2018 confirms the problematic trade-off as a challenge for climate action in buildings (Federal Government of Germany, 2019b).

The findings on the interplay of objectives are illustrated in Figure 5-1. The mixed distribution of manifestations of the code represents the difference between the positive assessments of the climate targets alone and the negative interaction with affordable housing objectives. One interviewee describes the situation as being "caught between the energy targets and social housing promises made in the coalition agreement" (Interview Government). Neutral

manifestations are related to perception as a staged conflict – as "played off against each other by the housing companies" (Interview Occupants/Environment). The distribution indicates that there is need for improvement but also potential. Many interviews contain not only one manifestation of this code which proves the complex situation at the overlap between climate and social objectives in building policy.

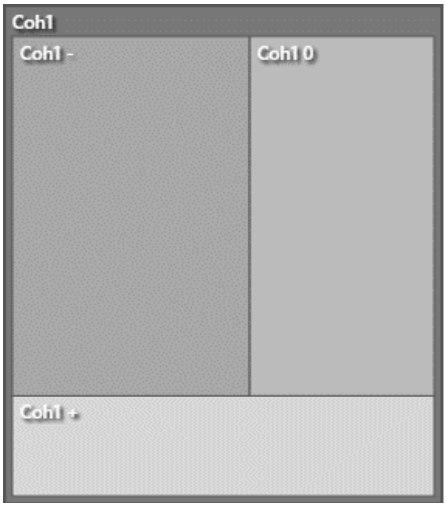

Figure 5-1: Coding results for the complementarity of the objectives (code: Coh1); (-) indicates negative statements, (+) positive statements, and (0) ambiguous statements. 41 references (interviews and documents).

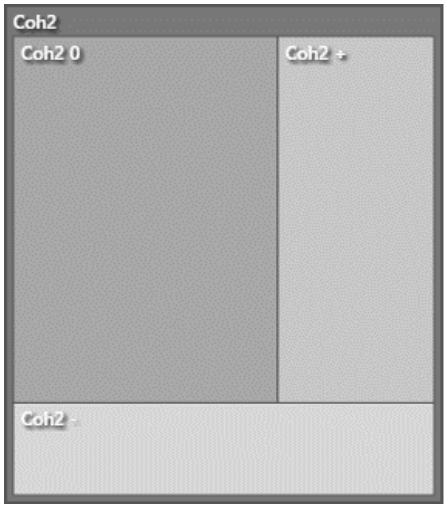

Figure 5-2: Coding results for the predictability and stability of the objectives (Coh2); (-) not allowing for planning, (0) enabling partial predictions and (+) giving good predictability. 15 references (interviews).

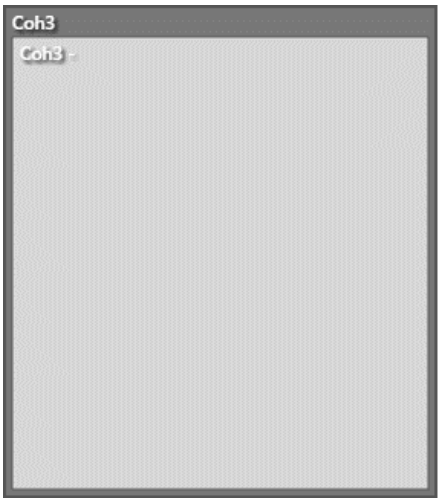

Figure 5-3: Coding results for the shared level of ambition between objectives and instruments (Coh3); (-) referring to a mismatch between the two. No expressions of (0) or (+) was found. 33 references (interviews).

5.1.2 Long term predictability of the objectives

The opinions on long term predictability were in general much more positive, although often put into context with mixed results. The objective of climate neutrality is formulated for the year 2050 which allows for forecasting and adjustment by stakeholders according to an interviewee (Interview Research/Think tank). The good predictability until 2050 and with intermediate targets in 2030 is perceived as a positive feature of the policy mix. At the same time, entirely satisfied responses are rare, as Figure 5-2 shows. The goals are seen as too far away in the future to slow down climate change (Interview Occupants/Environment) and only formulated as "political plans that are neither necessarily achievable nor binding for anybody" (Interview Industry/Owners). For some stakeholders those negative features dominate the assessment, but the overall opinion on the long-term stability is slightly favourable, as expressed by one interviewee: "the problem is for sure not with the objectives" (Interview Occupants/Environment).

5.1.3 Matching ambitions between objectives and instruments

The objectives themselves are not the problem, but their reflection in the instruments is perceived to be a major problem by all stakeholders. As presented, there is some conflict between climate and social objectives while long term planning is assessed as partly beneficial. But while the goals for energy savings are described as "remarkably ambitious" (Interview Occupants/Environment), all interview partners point out that the existing instrument mix does not share this level of ambition with respect to climate change mitigation. The opinions of stakeholders are expressed in ways like "big gap to the targets" (Research/Think tank), "not on track for the targets" (Government) or having "very strong doubts that targets in 2030 and 2050 will be achievable in the current situation" (Industry/Owners). As Figure 5-3 illustrates, all manifestations of this code were negative, sometimes in a desperate way, saying "the goals are simply nowhere close to reality" (Interview Research/Think tank).

The extent of the gap between original expectations of strategy documents and recently updated estimations of GHG savings is confirmed in official reports of the government as well. For most instruments aiming at energy efficiency improvements in buildings, the updated estimations in 2018 are substantially lower than the previously predicted ones (Federal Government of Germany, 2019b). For instance, the Incentive Programme for Energy Efficiency was expected to reduce GHG emissions by 2.1 million tons CO_{2eq} in 2020. The 2018 update estimates the effect at only roughly one third of this number. This indicates that their level of ambition falls short of the expected contribution of the time the policy objectives were adopted.

According to the experts and stakeholders the discrepancy is problematic for two main reasons. First, missing the targets required by EU legislation will result in fines for the German government. So, Germany will have to pay money that could have been invested in energy efficiency programmes (Interview Research/Think tank).

Second, all stakeholders – including the government – expect that more ambitious instruments will be implemented in the future. For building owners, the result is described as inertia in order to make sure renovation projects comply with future regulation and building standards (Interview Industry/Owners). Private owners delay action even more as they have reason to expect tax cuts or higher subsidies for their projects in the future (Interview Research/Think tank). The unanimity of statements in this regard as shown in Figure 5-3, indicates that the problem is large in the current situation. The shared opinion gives hope for a possible solution supported by all sides. However, the opinions on the necessary means to resolve the discrepancy

are very different in the mix of stakeholders. Section 5.3 will go in more detail on this matter in the analysis of the comprehensiveness.

In summary, the policy objectives are perceived to be in line and predictable when it comes to the targets focusing on energy efficiency in connection to climate change but conflict with goals for affordable housing. Fundamentally, however, the level of ambition in the goals is not reflected in what the instruments achieve. The next section will now analyse the instruments for the characteristic of consistency.

5.2 Consistency

The characteristic of consistency in this thesis refers to the interplay between the policy measures and programmes in the instrument mix, as presented in the definition (see Section 2.6.2). A central aspect of is to analyse to what extent instruments support or counteract each other. Again, the predictability is a criterion for this characteristic. Besides the provisions of the instruments, also the overall practicability of the instrument mix that is resulting from the instruments themselves and the setup of competences for administering them is assessed based on interview findings and document study under consistency.

5.2.1 Consistency of instrument mix

In the analysis of the consistency of the instrument mix, the nature of coexistence of the various instruments is studied. The findings show that some combinations are beneficial, whereas others have contradicting effects. Figure 5-4 illustrates that although the "contradiction" manifestation is slightly dominating, the finding for this code is very balanced.

The positive assessment results from possible combinations between various funding support programmes that have been found in triangulation from documents and interviews. Applications for the Market Incentive Programme can be combined with the Incentive Programme for Energy Efficiency and the KfW loans for energy efficient renovation ('Maßnahmen zur Nutzung erneuerbarer Energien im Wärmemarkt (Marktanreizprogramm) [Measures for the use of renewable energy in the heating market (Market Incentive Programme]', n.d.). Also, the programme for energy consulting is designed to not only inform about possible measures to implement in buildings, but also on the funding sources available ('Energieberatung für Wohngebäude [Energy Consulting for Residential Buildings]', n.d.). Thus, renovation projects that are designed according to energy consulting plans and fulfil the funding criteria can benefit from support from multiple programmes. These instances are emphasised by stakeholders in interviews as well (Interview Occupants/Environment). Furthermore, standards set in the Ecodesign Directive and the German implementation facilitate the regulation and support of heating systems in the EnEV and KfW Programmes (Interview Government).

However, there are cases in which programmes are not additional, or where they contradict each other according to interview statements. On the one hand, funding programmes like the KfW grant for renovation programmes cannot be combined with the Market Incentive Programme, which creates confusion even among stakeholders ('Energieeffizient Sanieren—Investitionszuschuss [Energy efficient renovation—Grant for investment]', n.d.; Interview Occupants/Environment). On the other hand, is the idea of the Market Incentive Programme to increase the efficient consumption of renewable energy while the KfW programmes also support the installation of new boiler systems running on fossil fuels (c.f. 'Energieeffizient Sanieren—Investitionszuschuss [Energy efficient renovation—Grant for investment]', n.d.). Several interviewees criticise the continuous funding for fossil fuels for heating, reasoning that such heating systems will need to be replaced again soon, in order to achieve climate neutrality

targets (4 Interviews: Occupants/Environment; Research/Think tank). The result will either be missing the objective or creating higher costs for the state and the owner.

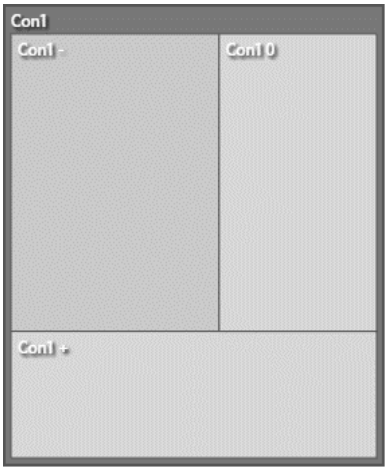

Figure 5-4: Coding results for the coexistence of instruments (Con1); (-) indicating contradiction, (+) indicating support and (0) referring to mixed coexistence. 50 references (interviews and documents).

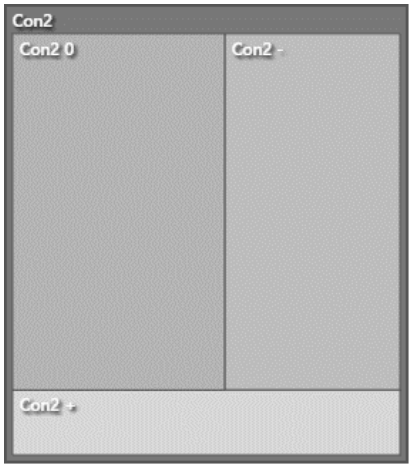

Figure 5-5: Coding results for the opinions on the implementing authority (Con2); (-) represents missing cooperation, (0) some and (+) good cooperation between authorities or implementation by the same one. 17 references (interviews).

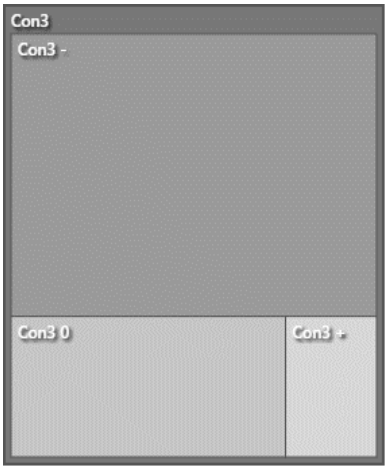

Figure 5-6: Coding results for the predictability and stability of instruments (Con3); (-) being unpredictable, (0) partly and (+) well predictable and enabling planning. 14 references (interviews).

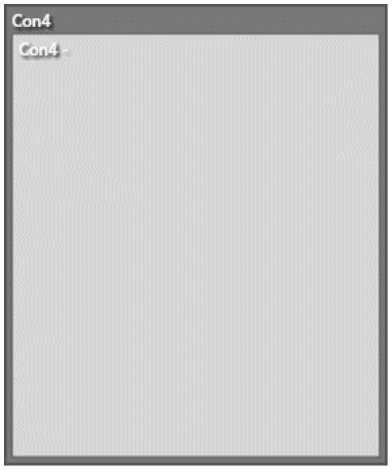

Figure 5-7: Coding results for the practicability of the instruments in interviews and documents (Con4); (-) indicating unpractical design of the instruments. No expressions of (+) was found. 22 references (interviews).

An additional contradiction is found in respect to the prices of energy. Fossil fuel sources for heating benefit from a very low energy tax making them financially attractive in the short term (*EnergieStG*, 2019). In combination with the high electricity prices, this approach contradicts incentives for energy efficient heating systems or for ones based on RES (Interview Research/Think tank).

Thus, the assessment of the interplay within the instrument mix is mixed but tending to a slightly negative conclusion, meaning that mutual support is not provided. This is also influenced by the fact that some actors like real estate and housing companies do not benefit from combinations of the support funds as support for companies is capped under EU state aid regulation.

When analysing the long-term predictability of the instrument mix, the stakeholder assessment is more negative than for the policy objectives that were presented in Section 5.1.2. As Figure 5-6 shows, the majority of stakeholders describes planning problem under the current measures and programmes. One main source of insecurity was described above under the level of ambition of the instruments (see Section 5.1.3). The high discrepancy between objectives and the reality of instruments will make changes in the instruments necessary which will need to achieve the targets for 2030. A second reason for lacking predictability is the fact that many of the funding programmes need to be renewed frequently and their means depend on the federal budget or the revenue from emission trading (Interview Industry/Owners; BMF, 2019). However, other interview partners see the yearly renewal as normal and do not perceive a threat to continuity because "instruments like the Market Incentive Programme exist for such a long time" (Interview Research/Think tank) and are "simply indispensable if the goals are supposed to be reached" (Interview Industry/Owners).

5.2.2 Practicability of implementation

The other aspect of consistency is the ability to use the instruments in practice. The distribution of competences and responsibilities as well as ease of applications for funding is assessed in this section. Figure 5-5 and Figure 5-7 illustrate the negative opinions interviewees have on this aspect of the policy mix, which is also reflected in the document analysis. Complicated application processes are the main reason, caused by the different agencies and the ways and requirements for receiving funding.

Administrative responsibilities are spread over different agencies in a way that makes applying to funds and using them tedious in the eyes of many interviewees. Figure 5-5 shows the mostly unfavourable opinion of the arrangement of implementing agencies that experts and stakeholders have. BAFA and KfW both administer some parts of the support programmes. At the moment, the strategic competence is located at the Ministry for Economic Affairs and Energy (BMWi) which also oversees the BAFA. However, interviewees have pointed to the scattered programme landscape that is the result from dispersed competences in the past, when the responsibility for some building programmes was located at the Ministry for the Environment. The current situation is seen as an opportunity to simplify the mix of funding programmes, but no results can be seen yet (Interview Research/Think tank).

The perception of the general practicability is even lower. Only negative statements were given by the experts and stakeholders, as Figure 5-7 shows. To illustrate the situation, interviewees speak of "a jungle of programmes" (Interview Occupants/Environment) created by "uncontrolled development" (Interview Research/Think tank). The main reason for complaints from across all types of interview partners is that the application process varies significantly between the programmes. On the one hand, loans from the KfW, for example, can only be received via a private bank. On the other hand, grants from the KfW will be paid directly but require a different application process through a different portal than grants from the BAFA (Interview Occupants/Environment). For this reason, owners who would like to get funding, often do not understand the requirements according to an interviewee (Industry/Owners). A result linked to this is that funding budgets do not get exhausted and the number of supported projects decreases according to interviews and documents (Interview Government; Stuible et al., 2018).

Another reason is the mandatory use of energy experts to receive funding from most programmes, for instance for the Market Incentive Programme ('Maßnahmen zur Nutzung erneuerbarer Energien im Wärmemarkt (Marktanreizprogramm) [Measures for the use of renewable energy in the heating market (Market Incentive Programme]', n.d.). Interviewees point to the additional time and documentation requirements when involving an official expert (2 Interviews: Occupants/Environment, Government). Moreover, making the involvement of experts mandatory, raises transaction costs in a way that small subsidies are not worth the effort anymore and that creates an additional bottleneck for applicants (Interview Industry/Owners).

In Section 5.2.1 above, the ability to combine several of the funding programmes was perceived as beneficial for the support of energy efficiency renovation projects. In the context of complex application processes, however, the feature is less convincing. The call for an easier access to funds is voiced explicitly in order to make exhaustive use of the available funds for effective climate action (Interview Research/Think tank). For all those reasons, the strongly negative picture on practicability is a weakness of the policy mix. Only two stakeholders expressed understanding of the situation, that dispersed responsibilities are necessary, and that the overall situation is manageable (2 Interviews: Government, Occupants/Environment).

5.3 Comprehensiveness

The final characteristic for analysing the policy mix is comprehensiveness which assesses the composition of the policy mix. As the introduction to this characteristic laid out, different functions of instruments in the form of demand pull, technology push and systemic instruments make a policy mix more effective in addressing market failures and barriers and supporting innovation processes (see Section 2.6.3).

Of the instruments in the mix for energy efficiency in existing buildings, most instruments target a specific market barrier or market failure. Barriers are addressed by the funding support programmes, whereas informative instruments and the energy tax address market failures. As Figure 5-8 illustrates, the majority of instruments target a clearly defined problem in one form of the instrument functions. The findings for each function are presented later in this chapter. The following subsection assesses whether the instruments are successful in overcoming market failures and barriers.

5.3.1 Reducing market failures and barriers

As presented earlier, one of the main rationales for policy mix analysis is the ability to correct multiple market failures with different instruments in combination. The previous chapters and sections have presented the objectives and instruments of the German policy mix for energy efficiency improvements in existing buildings. After assessments of coherence and consistency, the criterion of comprehensiveness analyses the instrument mix on their functions. A central aspect of the characteristic is to what extent barriers are reduced in the pursuit of the policy objectives.

The interviews validate all the market failures and barriers identified in the literature (see Table 2-1), except for the positive externalities. Interviewees were asked about the most important challenges they see, and the overall responses are in line with the theoretical market failures and barriers outlined in Section 2.2. However, the response to whether market failures and barriers were sufficiently addressed, was assessed in majority negatively by the interviewees, because not all relevant actors are addressed, and individual instruments are not adequately designed for their purpose, as the remainder of this section will find.

The opinion of interviewees on the inclusiveness of actors is very negative with only a few neutral statements as Figure 5-10 shows. The first point of criticism that is raised by the experts and stakeholders is the imbalance of financial support for private owners and commercial ones (3 Interviews: Research/Think tank; Industry/Owners). It is portrayed as crucial to "make subsidies more accessible for commercial owners" (Interview Research/Think tank). The requirements and expectations are the same for all actors but funding for businesses is limited, partly due to EU regulation (EU de minimis regulation). Even though there is disagreement on this view (Interview Occupants/Environment), several stakeholders point to the need of stronger incentives for commercial housing companies.

This position relates to a second criticism of a barrier that remains high under the current instruments. Whereas private owners often – though far from exclusively – occupy the property themselves, commercially owned buildings have a high share of renting occupants. The resulting landlord-tenant dilemma was mentioned in many of the interviews as a significant challenge that is not adequately addressed or even solved by existing policies (5 Interviews: Industry/Owners, Research/Think tank, Occupants/Environment).

Criticism, even from within the government, sees "fragmented pieces of policymaking that try to improve the imperfect reality with small adjustments here and there but lose the strategy and big picture of the actors out of sight" (Interview Government). According to most of the interviews, a stronger immediate financial advantage is necessary to incentivise all types of owners in a similar way, rather than pieces of regulation and funding that target small groups in different ways. For example, previous provisions on the distribution of energy efficiency investments on tenants were changed to reduce the rise of rents in urban centres to reflect concerns of a housing crisis for low-income households (BMWi, 2019). For some stakeholders, this makes energy efficiency investment in rental buildings impossible (3 Interviews: Industry/Owners; Research/Think tank), whereas for others the costs should not be imposed on tenants at all, but landlords need to be supported more strongly in their investment costs (3 Interviews: Research/Think tank; Industry/Owners).

Interviewees from all categories also point to the lack of attention the construction and craftsmen sector is receiving. Architects often do not think of energy efficiency as a priority and do not receive any incentives to do so when planning renovation projects (2 Interviews: Occupants/Environment; Research/Think tank). Moreover, craftsmen who need to perform the work, do not have the capacities to keep up with demand in general and therefore also represent a bottleneck in the value chain (3 Interviews: Research/Think tank; Government). In this context, difficult long-term predictability of policies was given as an explanation for hesitant construction businesses from hiring apprentices to reduce the aforementioned lack of skilled workers (Interview Research/Think tank). Many of the funding support instruments require specialist craftsmen to do the renovation projects, even increasing the shortage (e.g. 'Energieeffizient Sanieren—Investitionszuschuss [Energy efficient renovation—Grant for investment]', n.d.; 'Energieeffizient Sanieren—Kredit [Energy efficient renovation—Loan]', n.d.).

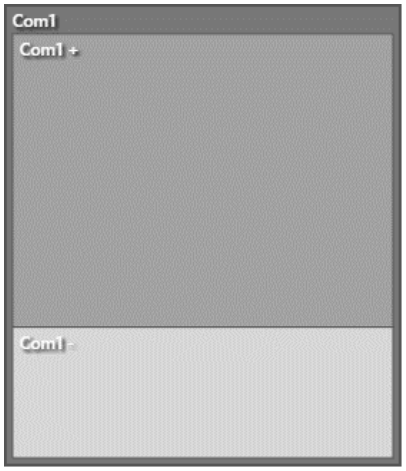

Figure 5-8: Instruments found to address a specific market failure/barrier (+) or not (-) (code: Com1). Total number of references: 12 (documents).

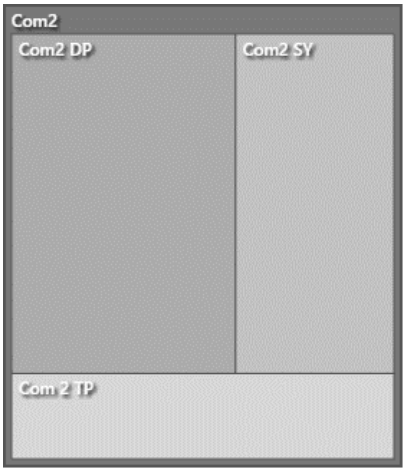

Figure 5-9: Distribution of instruments between demand-pull (DP), systemic (SY) and technology-push (TP) (code: Com2). Total number of references: 15 (documents, multiple measures under the Energy Saving Ordinance are separated).

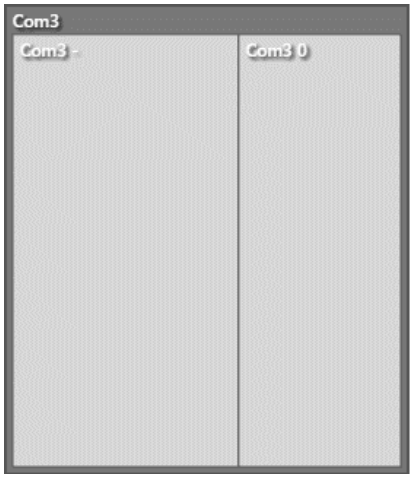

Figure 5-10: Coding results for actor inclusiveness (Com3); (-) indicating missing relevant actors, (0) that most actors are addressed but not entirely. No expression of (+) was found. 18 References (interviews and documents).

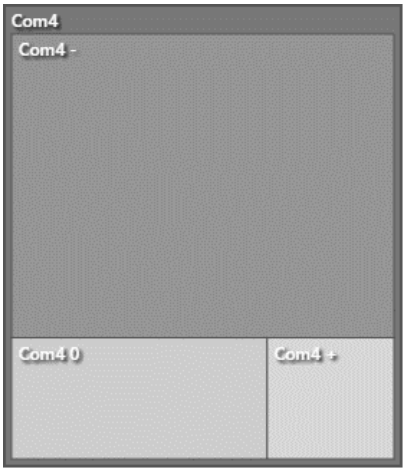

Figure 5-11: Coding results for adequateness of solving the market challenges (Com4); (-) being attributed if instruments are not adequate to overcome market challenge, (0) if they are partly and (+) if they are fully adequate to solve the market challenge. 21 References (interviews).

Thus, by not addressing all relevant actors, as the negative opinions illustrated in Figure 5-10 show, market barriers such as a strong dilemma between landlords and tenants, or bottlenecks in the implementation of renovation projects remain.

Furthermore, instruments to reduce other market failures are inadequate, too. Interviewees have strongly negative opinions on the design and performance of individual instruments, as Figure 5-11 shows. The most prominent example mentioned by multiple stakeholders are the energy

passports mandated by the EnEV (2014). The ordinance allows sellers and landlords to choose between two options when offering real estate or searching for new tenants. One that indicates the actual consumption of the previous occupant, or another one indicating the calculated energy need (*EnEV*, 2014).

Interviewees criticise the lack of transparency that results from this due to a number of reasons. First, the two versions do look very much alike and therefore can easily cause confusion (Interview Occupants/Environment), and second neither of the passport versions indicates the costs that result from the given energy consumption, when in reality the costs are the main factor for effectiveness of a label like the energy passport according to an interviewee (Interview Research/Think tank). As they energy passports are created to reduce information asymmetries by increasing transparency, the instrument does not achieve its aim in the eyes of most stakeholders. Other informative instruments also have flaws like limited outreach and do not translate into higher demand for public funds and thus also reduce the market failure only marginally (Interview Occupants/Environment; c.f. Stuible et al., 2018).

Moreover, as mentioned under consistency above (Section 5.2.1), the Energy Tax for fossil fuels for heating is very low in comparison to electricity prices. The tax rates for heating oil and natural gas are well below the social costs estimated for CO_2 emissions by the German Environment Agency (UBA, 2019a) (*EnergieStG*, 2019). Thus, the tax is not able to internalise the externalities caused by the use of fossil fuels for heating, a point also raised by several experts and stakeholders (4 Interviews: Research/Think agency, Occupants/Environment).

The market barrier of high initial investment costs is at the focus of most of the financial support instruments. Even though the adequacy is sometimes assessed positively by the interviewees, as Figure 5-11 shows, the negative opinions prevail by large. An example of failing instrument design in response to market barriers according to the interviewees is the difference in access to funding support between complete refurbishment projects and single measure projects. KfW programmes – both loans and grants – fund only smaller percentages of the project costs for single measures than for overall renovation projects where higher percentages are covered ('Energieeffizient Sanieren—Investitionszuschuss [Energy efficient renovation—Grant for investment]', n.d.; 'Energieeffizient Sanieren—Kredit [Energy efficient renovation—Loan]', n.d.). In case of the loan, the difference can be of up to 20 percentage points of the spending. Single measures like installing some new windows have much lower barriers, because the initial costs are lower. Their effect on energy consumption can however be substantial (Interview Industry/Owners). As certified energy efficiency experts need to approve and document the project, interviewees point out that for such single measures, the financial benefit from KfW programmes is often marginal (2 Interviews: Occupants/Environment; Industry/Owners). Easy progress on energy efficiency would be possible if single measures received similar support to large-scale refurbishment projects (Interview Occupants/Environment).

Table 5-1 summarises the results on the solution of market failures and barriers. The overview draws on findings of the previous sections on coherence and consistency as well. The market challenges that were presented in Table 2-1 are now contrasted with the response of the German policy mix and a general assessment of the interviewees.

Table 5-1: Overview of responses of the policy mix to market failures and barriers.

Challenges	Situation under the German policy mix
Market failures	
Negative external effects like contribution to climate change are not reflected in market prices for energy sources	Not sufficiently addressed, energy tax levels favour fossil fuels for heating over electricity
Asymmetric information about energy performance of a building/apartment	Multiple labels but Energy Passports do not improve transparency
Principal agent dilemma between owners and tenants	Distribution of renovation costs possible but all stakeholders are unsatisfied with current solutions
Positive external effects from knowledge that innovators and adopters are not compensated for	Support of research and showcasing; not identified as a major challenge by the interviewees
Market barriers	
High initial investment costs that, combined with transaction costs, lead to long amortisation periods	Important challenge mentioned by most stakeholders and experts; addressed by multiple funding programmes
Uncertainty of price development of energy and technologies	Instruments only partially predictable, core challenge not addressed
Lock-in effects due to the long lifetime of buildings	Inadequately addressed, fossil fuel heating still qualifies for public funding
Little interest in energy efficiency as a topic	Use of information campaigns; not possible to draw conclusion

Source: Own compilation based on results from interview and document analysis.

All in all, the assessment of the policy mix in its ability to address market barriers and failures is negative. On the one hand, relevant actors do not receive incentives according to the interviewees. The landlord-tenant dilemma is not resolved by the current instruments and bottlenecks in the construction industry are a problem in the eyes of many stakeholders. On the other hand, interviewees point out that information asymmetries are not effectively reduced by transparency instruments and externalities are not reflected in the instruments either. While the market barrier of high initial costs of energy efficiency measures is of central attention, interviewees criticise the difference between large-scale renovation projects and single measures.

5.3.2 Instrument functions

The different instrument functions that comprehensiveness calls for are mainly based in the innovation rationale of policy mix literature. Innovation in the sense aims at technology development and the multiple stages of that process, that require policy support for socio-technical transformation like in energy efficiency (Costantini et al., 2017; Grubb et al., 2017). The complexity of socio-technical systems and innovation processes also reflects in the building sector. However, the vast majority of interviewees perceive the need for technical innovation as minor. Challenges are seen in markets, behaviour and policy but not in the availability of technical solutions (6 Interviews: Research/Think tank; Occupants/Environment; Government). As one stakeholder puts it explicitly, "from a technical point of view, we are ready. We have all we need for a climate neutral building stock, but the demand side does not care about it" (Interview Occupants/Environment).

The functions for innovation support address different market barriers or failures. A clear case are the systemic (SY) instruments that aim at creating connections between the actors, foster collaboration and the exchange of information. Instruments like energy consulting or energy passports for buildings that seek to reduce the asymmetric access to information fall into this

category. This type of instruments is less common than demand-pull but still has a central role when looking at the numerical distribution visualised in Figure 5-9. Informative instruments are the main components of the systemic instruments, as they target the intersection of investors, landlords, and buyers/renters and reduce information asymmetries. More transparency and knowledge among buyers and tenants is supposed to increase the importance of energy efficiency for all actors ('Energieberatung für Wohngebäude [Energy Consulting for Residential Buildings]', n.d.).

Demand-pull (DP) instruments are the most numerous kinds of instrument function in the mix, as shown in Figure 5-9. This category aims at increasing the interest in buyers to grow the market for the new, desired products. In the context of this thesis, DP instruments address the demand side to change to more energy efficient technology. The DP instruments consist in the regulation of building minimum standards in the EnEV, the multiple funding programmes and the energy tax. Of those, only the energy tax targets a clear market failure, the externalities from using energy from any source (*EnergieStG*, 2019). In contrast, the funding programmes aim to reduce the market barrier of high initial investment cost and only indirectly shorten the period of amortisation caused by the market failure of not internalised externalities (e.g. 'Energieeffizient Sanieren—Investitionszuschuss [Energy efficient renovation—Grant for investment]', n.d.). The primary aim, however, is to make investments in energy efficiency measures more attractive by reducing the immediate costs. The official documents that justify and explain the DP instruments are found to be mostly clear in addressing this particular barrier. Only the Incentive Programme for Energy Efficiency aims at increasing technology innovation from suppliers and investments in energy efficiency from buyers simultaneously ('Anreizprogramm Energieeffizienz (APEE) [Incentive Programme for Energy Efficiency]', n.d.).

The smallest share when classified by function are technology-push (TP) instruments (see Figure 5-9), which set incentives for innovation and market diffusion of new technology. In the current mix, this type is the least clear about the market failure or barrier it addresses. As described right above, the Incentive Programme for Energy Efficiency states the objective to increase innovation in energy efficiency technology but does so by providing funding for new heating systems in homes – a demand side lever. The two research funding programmes are TP instruments as they support technology development and deployment in buildings and districts (BMI, 2018; BMWi, 2017c). Both programmes emphasise the importance of showcasing opportunities to the broad public, which brings them close to a systemic instrument as well. As their main focus is to create new insights and knowledge in the use of energy efficient buildings, they are overall found to play a TP role in the instrument mix.

In summary, the instruments are mostly clear and unambiguous in the market failures or barriers they address, as shown in Figure 5-8. DP, TP and SY instruments are all represented in the instrument mix, but DP and to a lesser extent SY instruments dominate the TP ones numerically. However, also in terms of financial means, demand pull is much better equipped than technology push (see detailed overview in Appendix A). Moreover, both research funding programmes stopped accepting new projects in the end of 2018, which illustrates the priority of DP and SY instruments in the mix. The next section will analyse whether the existing measures and programmes are able to address the market failures and barriers that exist in the energy efficiency market adequately.

6 Discussion

The research carried out in this thesis shows that the policy mix for energy efficiency in existing buildings in Germany has some well-designed aspects but at the same time, lacks essential features of coherence, consistency and comprehensiveness that prevent the mix from working effectively. The following chapter will discuss the findings in the light of the policy mix literature and answer the research question set out in the beginning. The chapter will also discuss opportunities for development of both, policy mix theory the German policy mix, and link back to research on energy efficiency governance.

6.1 Reflections on key findings

The three sub research questions on the coherence of policy objectives (RQ 1.1), the consistency of policy instruments (RQ 1.2), and on the comprehensiveness of addressing market challenges (RQ 1.3) aimed at analysing the policy mix from the angle of the three characteristics used as criteria in this thesis in order to assess the design of the overall mix as an answer to RQ 1. The results of this research and to the research questions paint a dominantly negative image of the German policy mix for energy efficiency in existing buildings. While the opinions of stakeholders and experts is in many cases agree and are confirmed in documents, the results are sensitive to assumptions and choices made that will be presented in the following sections.

A central assumption underlying this thesis is that effective policies are an essential prerequisite to govern energy efficiency in a way that advances climate change mitigation effectively. A different view on the role of policy would come to different conclusions.

The research on energy efficiency governance as well as the different rationales for policy mix analysis give support for the central contribution of policy frameworks consisting in the objectives, instruments and institutions (OECD & IEA, 2010). The multiple market failures and barriers require policies according to the economic rationale (see Section 2.4.2), in line with the rationale of complex innovation processes for socio-technical transition (see Section 2.4.3). Those challenges have been assumed as the core problem for energy efficiency as they form the basis of the argumentation for the energy efficiency gap (see Section 2.2). Political challenges, however, also do affect the design of the policy mix as will be discussed in Section 6.1.2 below.

6.1.1 Assessment of coherence

Answering RQ 1.1, the policy objectives are coherent within the energy and climate area but collide with targets for social and affordable housing. The different strategy documents have been found to contain similar goals for energy efficiency improvement. Even though the documents are head-authored by different ministries and cover a timespan of six years, the targets remain stable and coherent among them (c.f. BMU, 2016; BMWi, 2015; BMWi & BMU, 2010). The context of the documents differs, covering the entire energy sector, buildings or climate action, but the targets do not change. With their target year of 2050, they also provide long-term guidance for all actors from policymaking to industry and private owners.

However, the conflict with social policy targets has been raise by many interviewees and is obvious in the coalition agreement of the current government (CDU et al., 2018). While energy and climate goals are brought in line, doing the same with enough and affordable housing is more difficult. This reduces the assessment of coherence as found in this thesis.

The coordinating role that the framework of energy efficiency governance ascribes to targets is therefore only partially found in the analysis of this thesis (c.f. OECD & IEA, 2010). Even though the specific targets for energy efficiency improvements are set for long-term development, the trade-offs between climate and social politics hinder effective coordination.

Moreover, the current instrument mix is unable to achieve the objectives (c.f. Federal Government of Germany, 2019b), making stakeholders question the sincerity of the targets. This discrepancy between the ambition of the two components of the policy mix is raised by the vast majority of stakeholders as a central shortcoming (13 Interviews: all categories). The outcome is inaction from all actors and the fact that short-term climate targets will very certainly be missed (see findings for coherence in Section 5.1.3).

The difference between targets and recently estimated effect of the instruments as well as the agreement between stakeholders and experts indicate the importance of matching ambitions as a feature of a well-designed policy mix. While the discrepancy was assessed as part of coherence in this thesis, the relevance for the effectiveness makes the case for a separated characteristic to analyse it in more detail. Some authors have argued for the use of credibility as assessment criteria defining the term as "reliability and believability of the policy mix" (Rogge & Johnstone, 2017, p. 131; see also: Rogge & Reichardt, 2016).

The exact conceptualisation of credibility as a characteristic is vague and hardly elaborated on in literature. Therefore, aspects like temporal stability, which is also attributed to credibility, has here been studied within coherence (for objectives) and consistency (for instruments). However, the effect of the discrepancy clearly is a substantial shortcoming of the design of the German policy mix, lowering the assessment of coherence. The potential of credibility as an additional characteristic will be further discussed below (see Section 6.2.1).

6.1.2 Assessment of consistency

The instrument mix contains a diverse set of measures and programmes of regulatory, economic and informative type. The compilation of instruments in Section 4.3 and Figure 4-2 shows that the policy mix is built on many economic instruments of which funding programmes are the major group, some informative instruments and few regulatory instruments.

The consistency of the instrument mix in response to RQ 1.2 is low as a result of a design that stakeholder and experts perceive as complex and with important limits of the practicability. Positively, the high share of funding programmes offer support to building owners in a way that allows combinations and synergies between several programmes. However, accessing the funding is described as complicated and available funds remain unused, as interviewees as official documents point out (c.f. Stuible et al., 2018). Additionally, the long-term predictability and stability receives negative assessment from interviewees. As only few experts and stakeholders raise this point explicitly, it can be seen as minor in comparison to the impracticability and the discrepancy discussed before.

The focus of the analysis of consistency was placed on the interplay between programmes and measures, as this is the key determinant of the effectiveness of the policy mix currently in place. However, the implications of politics the processes of designing the instruments can be a factor in determining the design as well.

Policy mix research claims to analyse policy performance in a real-world setting and consider the many complexities of policymaking in multilevel settings. Analysing the broad mix of objectives, instruments and their interaction improves the ability to identify design flaws that analyses of individual policies would not have been able to capture. For instance, an assessment whether the market failures and barriers that prevent energy efficiency in buildings from improving are addressed, is only possible when looking at the entire policy mix.

The definition of policy processes suggested by Rogge and Reichardt (2016) also includes earlier and later stages of related processes like policy making and enforcement. While the scope of

this thesis did not allow a thorough analysis of those features, interview responses still point to their importance. Policy processes are the less obvious of the policy mix components but are an important factor in the claim to analyse the real-life situation (Rogge & Reichardt, 2016). The indicators and coding categories on the distribution of agencies and practicability for users revealed important weaknesses of an instrument mix that otherwise creates benefits by allowing the combination of funding programmes to large extents.

Considering policy processes can reveal further insights in the reality of a policy for two reasons. On the one hand, the influence of stakeholder groups and public debate on political decisions about instruments was a concern for multiple interviewees from occupants and environmental organisations. On the other, enforcement of any mandatory standards is particularly difficult in existing buildings as there is no record and possibility for indoor checks (2 Interviews: Government; Research/Think tank).

An in-depth analysis of those features would likely be able to explain the chosen paths and allow an assessment of the policy mix through its process of creation. Such an approach has been used on policy mixes in the UK and Finland before (Kern et al., 2017; see also Howlett & Rayner, 2013). That study finds a more coherent and consistent policy development in Finland than in the UK and use the common existence of coalition governments as an explanation. The analysis of Germany, where coalition governments are also the norm, could test this further.

6.1.3 Assessment of comprehensiveness

RQ 1.3 aimed at the comprehensiveness of the policy mix in addressing market failures and barriers present in energy efficiency markets in existing buildings. The instruments mix contains all functions of instruments: demand pull, technology push and systemic ones. Most instruments also address a clearly identified market failure or barrier in their underlying documents. While this is supposed to be beneficial to the overall effectiveness of the policy mix, there are two points to consider.

First, in line with Costantini et al. (2017), the mere number of measures of each function does not by itself advances the innovation and transition process. Thus, the multitude of instruments to address all challenges for all actors comprehensively does not by itself lead to higher effectiveness. The number of instruments needs to be justified by the challenges and limited at as few as possible. The many similar but different programmes in the area of energy efficiency for existing buildings in Germany result in a high complexity without consideration of the design of the entire policy mix.

Other research has found a similar reliance on subsidies and voluntary instruments as the central measures of policy mixes (Kivimaa et al., 2017). Just like for Germany, this kind of instrument was perceived as problematic by Finnish stakeholders because addressed niches of energy efficiency were not connected (Kivimaa et al., 2017).

Second, the findings of this thesis have also shown that the market failures and barriers are not solved, because the measures are not fully adequate as in the case of negative externalities and asymmetric information. The instruments reduce the market failures partially but do not overcome them. The market barrier of high initial costs is addressed with multiple funding programmes, but other ones remain as indicated by the analysis of interview and document data. The implications for comprehensiveness will be discussed further in Section 6.3.2

6.1.4 Assessment of the overall policy mix

Thus, the overall design of the policy mix, as investigated to answer RQ 1, is only partly coherent, not entirely consistent in its instruments and not comprehensive in solving market

failures and barriers. The design is not adequate in achieving objectives and overcoming market challenges. Even though there are positive findings with respect to the aligned climate objectives and all instrument types and functions found in the mix, the negative features described in the three previous subsections dominate the assessment. Based on the findings, Section 6.3 below will discuss policy recommendations for the German energy efficiency mix.

When interpreting the results of the analysis, the data collected obviously has a substantial influence. The method of data collection impacts the analysis and therefore on the assessment of the policy mix. On the one hand, the aim to analyse policies as close to reality as possible leads researchers to take the perspective of actors working with the policies in their daily life (c.f. Kivimaa et al., 2017). The stakeholders of a policy mix are the ones affected, they need to implement regulation, communicate information and make use of funding. Their perspective on the mix therefore reveals how the design reaches those which it addresses.

On the other hand, the stakeholders have interests in a particular outcome and seek to change the mix in their favour. For that reason, a general satisfaction with the situation cannot be expected. Results like the negative view on actor inclusiveness in Figure 5-10 indicate, can be explained by the perceived imbalance of responsibilities and support between the stakeholders. Environment and Occupant associations see too little responsibility for commercial owners, whereas industry and owner groups criticise that most support is aimed at private owners for whom application processes are too complicated. Many of the stakeholders expressed that their position should receive more attention (4 Interviews: Occupants/Environment; Industry/Owners).

The level of frustration with certain aspects of the policy mix expressed in almost all interviews can also be responsible for the negative overall assessment. The discrepancy between objectives and ambition of the instruments or their low practicability can potentially affect the opinion on other aspects of the characteristics, too.

However, many opinions were stated in different interviews and from actors of various stakeholder groups as well as experts. The fact that experts, who do not have a particular interest in the policy mix like the stakeholders do, also confirm the assessments and their foundation can be found in documents gives strong reason to follow the results received from the interviews in general.

6.2 Theoretical and methodological implication for policy mix research

One of the aims of this thesis was to contribute to the development of policy mix literature and enrich the research in this field with a new case. The analysis of the German mix for energy efficiency was selected to test and improve the understanding of policy mixes in general. The following sections discuss the implications for the choice of characteristics and method for future analyses.

6.2.1 Choice of the characteristics as assessment criteria

The characteristics that are chosen for the policy mix analysis determine the assessment fundamentally because they channel the perspective on the design in a certain way. Policy mix analysis differs from traditional policy analysis approaches in its focus on the interactions between instruments rather than single measures. With this change of angle, the criteria change as well. The characteristics used in this thesis are very recent in their current definitions, as is the field overall (Rogge & Reichardt, 2016). As described in the presentation of characteristics in Section 2.6, there is no agreement of which to use, even though coherence and consistency

are found in most of the studies. Comprehensiveness has received increasing attention as well, particularly in relation to socio-technical innovation.

The characteristic of coherence included the assessment of matching ambitions between objectives and instruments. As discussed in the assessment of coherence above, a few other scholars have argued to use credibility as a specific characteristic for this purpose (Kivimaa et al., 2017; Rogge & Reichardt, 2016). However, the conceptualisation remains vague, which is why matching ambitions are seen as a subset of coherence in this thesis.

Given the strong discrepancy between policy objectives and what the instruments are able to achieve, it would be beneficial to the overall assessment of other policy mixes to analyse whether or not such divergence exists and what its implications are in a specific characteristic of credibility. Many stakeholders and experts question the ability to achieve the mid-term targets of 2030 because of the lacking alignment (8 Interviews: Industry/Owners; Occupants/Environment; Research/Think tank). As mentioned, this results in an expectation of stricter rules and higher financial support creates a deadlock in building owners' energy efficiency renovation actions (see Section 5.1.3).

One component of credibility identified by Rogge and Reichardt (2016) is a committed political leadership. This aspect comes close to the problem of discrepancy found in this study. Strategy documents with ambitious targets will receive some coverage in media but do not create any legal obligations for the government or citizens. Although repeated restating of the value of such objectives is seen as a form of commitment (Interview Research/Think tank), consequences are missing.

The only exception are targets set by EU regulations. Based on them, Germany will face penalties for missing energy efficiency and climate targets in 2020 (EU Commission, 2019c). While experts and stakeholders are aware of this, the topic is hardly discussed in the media and therefore do not cause dissatisfaction among constituents. More ambitious instruments like stricter regulation could potentially receive much higher attention and scare off voters. Thus, the mismatch between the levels of ambition clearly is an expression of lacking commitment by the governing parties. The characteristic of credibility in this sense is highly relevant to a policy mix overall if objectives are to be achieved and trust in the governance design to be built (OECD & IEA, 2010).

The results of this research show, that the analysis of the alignment of objectives and instruments is possible when using other characteristics. However, the importance of it in the context of the present case justifies a specific characteristic of credibility.

A central indicator for both coherence and consistency used in this thesis is the predictability and long-term stability of policy objectives and instruments. Some other studies use the characteristic as a distinct criterion for analysis and make the point that innovation requires stability of regulations (Reichardt & Rogge, 2016). The results of the previous chapter show that while long-term stability is present in the objectives and perceived as mostly beneficial, the instruments have a substantial lack of predictability. Interviewees have pointed to the various changes of direction the instrument mix has taken because of general elections (Interview Industry/Owners). Government representatives counter that idea with the mechanisms of democracy (2 Interviews: Government). In no policy area, full predictability is possible. However, past developments are an indicator for stakeholders of how likely future revisions of instruments are (2 Interviews: Industry/Owners; Research/Think tank). In this respect, the German policy mix needs to improve, but future long-term stability cannot be required.

Especially when looking at the characteristic of comprehensiveness, the criteria chosen for the analysis was strongly based on the rationales of economics and innovation support. Market failures and barriers for energy efficiency in buildings were the main focus of the analysis. Starting from the energy efficiency gap, those challenges are found to be responsible for the untapped potential of energy efficiency – in general and in buildings too. The strong economic rationale entails a perspective on the policy mix design that revolves around the assumptions of markets as mechanisms for rational choices. The failures and – debatably – the barriers justify policies for their correction (c.f. Lehmann, 2012).

The perspective of the theory on innovation and transition, stipulates the ideal of a variety of instrument functions that formed the basis for comprehensiveness. In contrast to economists, the idea of transition of socio-technical systems sees the need for targeted support of innovative technologies and – as discussed above – disruptive measures for old technology (Costantini et al., 2017). In combination, this choice has an influence on the focus of the analysis.

A stronger emphasis of political structures would have shifted the focus and possibly the results as well. The importance of policy processes discussed above adds political barriers to the challenges energy efficiency is facing. Those are not captured by the economic and only party by the innovation perspective. Several stakeholders and experts mentioned lacking communication platforms between policymakers and stakeholders as a key barrier to increased efforts (3 Interviews: Research/Think tank; Industry/Owners). Such challenges on the way to finding solutions for market failures are not reflected upon in-depth and support the addition of research in policy processes stated above. However, the market failures and barriers are the ones that need to be overcome ultimately so that building retrofitting increases. In that respect, analysing a policy mix in place on the solutions it brings to the market challenges is directly linked to the design.

6.2.2 Lessons for delimiting the policy mix

A central challenge of policy mix research is delimiting the mix in order to, on the one hand, reflect reality as thoroughly as possible, while on the other hand, ensuring manageable and meaningful results (Rogge & Reichardt, 2016). For traditional policy analysis, this is less problematic, because all other instruments than the analysed one are contextual. In policy mix research, the decision on the scope becomes much more critical.

This research followed an approach of identifying the relevant policies from official strategic documents. Therefore, the scope was limited on the essential policies for achieving the targets for energy efficiency in buildings. A comparable approach has been chosen by Kern et al. (2017) in their assessment of British and Finnish policy mixes. As in their study, this thesis subsequently confirmed the list of objectives and instruments with stakeholders and experts.

However, it can prove valuable to involve expert opinions earlier in the research process. The effectiveness of a policy mix in a specific area is only partly determined by the mix itself, but also by the policies and political interests working against it. Identifying these instruments is much harder without strong background knowledge of the area under analysis. For the purpose of choosing the relevant policies within the given policy area and simultaneously including the most important instruments supporting or counteracting the specific mix, a few early interviews with stakeholders or experts is highly advantageous.

Still, the approach of this thesis led to relevant findings. It finds that even within the policy mix for energy efficiency in existing buildings in Germany, the shortcomings are numerous and the need for revision is high. This indicates that design weaknesses of the specific policies need attention while also aligning contextual policies that were beyond the scope of this thesis.

6.2.3 Reflections on the methods of policy mix research

The objective of policy mix research to account for the complex, often chaotic reality of policies when analysing the design and performance has advantages and disadvantages. In comparison to traditional policy analysis research, the explicit and central consideration of the interactions between instruments and institutions represents a more realistic setting. Through the policy mix analysis, this thesis was able to understand and reveal the design flaws of energy efficiency governance for existing buildings from a perspective of stakeholders and experts who work with the policy mix in practice.

As explained above (see Section 6.1.2), the policy processes are one aspect of reality that needs to be accounted in the understanding of the design (c.f. Kern et al., 2017). The same applies to the levels of national policies, which in Germany often see substantial competencies at the regional Länder level. Considering overlaps between federal instruments, European influences and local or regional policies would bring the analysis even closer to reality (c.f. Ringel, 2017). Future research designs should explore these aspects to complement the picture of this thesis.

Furthermore, the number of stakeholder perspectives was relatively low, given the broad array of actors in the area of energy efficiency in buildings. The results could therefore be validated through other methods and more perspectives. The implications for research design would be a larger and even more diverse group of stakeholders to be considered in the analysis. The policy mix design has potential to be assessed through surveys with an ability to include higher numbers of opinions than qualitative studies have been able to (c.f. Kern et al., 2017; Kivimaa et al., 2017). The contribution this thesis has made to the literature on the selection of characteristics and their operationalisation can be used in quantitative data collection and analysis research. Comprehensiveness for innovation processes has been studied through quantitative, econometric research before (Cantner et al., 2016; Costantini et al., 2017). The analysis of a policy mix for all the important characteristics could reveal even further aspects of successful policy mix design. Such research could also strengthen the comparative study reducing the challenge of generalising very context dependent insights (Magro & Wilson, 2013). Economic modelling can help in determining the contribution of instruments to solving the market failures and barriers as well as the inefficiencies resulting from contradiction between objectives or instruments.

6.3 Policy implications for energy efficiency in Germany and beyond

Besides the advances for policy mix research as a discipline, the results also contribute to the understanding of the German policy mix in particular. The results give insights on why the performance of the energy efficiency policies is ineffective. Effects of the general design are discussed in this section, complemented by considerations on the comprehensiveness and energy efficiency governance structure more specifically.

The results of this research do not only generate implications and recommendations for energy efficiency in Germany, but also for policy mixes in other areas and other country contexts. The recommendations presented in the previous subsections should be considered as lessons to avoid. The potential existence of a discrepancy between objectives and instruments, the low practicability or the insufficient responses to the market challenges of a particular policy field, need to be determined from case to case. But the findings show that it is worth preventing such situations to ensure the effectiveness of a policy mix.

6.3.1 Adapt instruments to match the objectives

Short-term energy efficiency targets will not be achieved in Germany as has been mentioned multiple times above. The analysis of the policy mix that this thesis has performed indicates the main policy design features that hinder a better performance.

Most importantly, the discrepancy between objectives and the level of ambition of the instruments creates a major barrier to all stakeholders. This thesis has outlined the challenges of lacking security and credibility various times (see Section 6.2.1 above). Making the policy framework more reliable for actors to plan and carry out refurbishment projects, can have a substantial impact for improving energy efficiency in existing buildings.

Credibility has been found to be a key determinant of innovation, for example in RES in Germany in the context of the Energy Transition (Rogge & Johnstone, 2017). In the case of renewable energy support, credibility of policy mixes have been found both as present, as in the case of Germany in the early 2010s, and as lacking, for instance the recent time of the Energy Transition in Germany or solar power in India (Quitzow, 2015; Rogge & Johnstone, 2017). These findings made in other contexts indicate the difficulty of creating credible policy mixes, and that the degree of the characteristic is dependent on more general developments, as well. Nevertheless, the results of this thesis, in combination with previous research, highlight the need for more attention for a matching level of objectives and instruments in the policy mix for energy efficiency.

6.3.2 Align other policy areas with energy efficiency instruments

The policy mix under analysis in this thesis has been found to contain notably more demand-pull instruments than technology-push ones. The state of the technical availability helps to explain this imbalance. Compared to research on innovation for renewable energy and broader energy efficient products (c.f. Cantner et al., 2016; Reichardt & Rogge, 2016), the barriers in the existing building stock are financial and regulatory (Weiss et al., 2012). Some interviewees see the need for innovation on an entrepreneurial level to create new business models for energy efficiency (2 Interviews: Industry/Owners; Occupants/Environment), but the lacking push for technology innovation is hardly criticised by stakeholders and experts. Thus, comprehensiveness of a policy mix does not necessarily need to have an even distribution between the instruments functions, as long as the instruments provide solutions to the market failures and barriers of the sector in question.

The analysed policy mix contains multiple funding programmes that aim at reducing high initial investment costs and make energy efficiency measures more attractive to owners. The central focus on the demand-pull mechanism is in line with the strong predominance of financial barriers. However, as the results from interviews and documents indicate, the high number of funding support programmes causes negative opinions on the practicability of the overall mix. Reducing the number of similar instruments to make them clearer and more understandable can improve the effectiveness without compromising the comprehensiveness.

Furthermore, policy mix research argues that reducing the barriers that prevent potential users from adopting new technology is not enough, but destructive policies need to be adopted for the traditional systems (c.f. Rogge & Johnstone, 2017). In the above mentioned case of renewable energy support in Germany, the phase-out of nuclear power was perceived as such destruction of incumbent technology by the stakeholders (Rogge & Johnstone, 2017).

For energy efficiency, such measures are not found in other policy studies. Kivimaa et al. (2017) find a lack of instruments for destabilising traditional energy consumption in buildings in the Finnish policy mix which otherwise is found to be very consistent. Similarly, this thesis also did

not find any of such measures in the German mix. A better understanding of destructive policies would require a broader assessment than possible in the relatively narrow scope of this thesis. Still, in particular the tax rates of the energy tax indicate a continuous support of traditional energy consumption and no willingness to actively overcome old systems.

6.3.3 Strengthen the energy efficiency governance components

When linking the results of the research to the concept of energy efficiency governance presented earlier (see Section 2.1), it appears that all three components – co-ordinating mechanisms, enabling frameworks and institutional arrangements – are present in the German policy mix.

First, the objectives generally serve as the co-ordinating mechanisms of the mix with the targets they set (c.f. OECD & IEA, 2010). However, the co-ordination output is limited in practice, as the conflict between targets shows. Both within the government institutions and for the stakeholders of the policies, the objectives do not co-ordinate efforts in a way that interviewees perceive the targets as achievable.

Enabling frameworks, the second component, are formed by the multiple funding support mechanisms and the less numerous and stringent regulation for existing buildings. It has been shown and discussed that the instruments are lacking ambition and power to improve the energy efficiency performance substantially. Thus, the incentives from the instrument mix need to be adapted in order to effectively enable actors.

Opinions of interviewees differ about the best option for a redesigned instrument mix, and so does research on the topic. Several experts and stakeholders see the need for a shift towards even more economic instruments instead of regulation (6 Interviews: Research/Think tank; Industry/Owners; Occupants Environment). The argument is that for instance taxes can provide substantial improvements by targeting easy but impactful "low-hanging fruits" first and at low cost (Interview Research/Think tank). A German study on a regional regulation to increase RES in heating supports the prioritisation of economic over regulatory instruments as the mandatory standard is found to have no effect (Achtnicht, Germeshausen, & von Graevenitz, 2017). The authors expect the same to be true for energy efficiency regulation and the difficulty of enforcing standards is pointed out by government policymakers themselves (Interview Government). Broad consensus on an economic instrument exists about the introduction of a price for carbon that applies for building energy use. Except for one stakeholder from industry and owner associations, all interviewees see the need and benefits of such a measure. However, the exact setup of such pricing is contended both in the public debate and in the suggestion of the interviewees. Trading of certificates for emissions from buildings (Interview Research/Think tank) or a tax on CO_2 emissions (Interview Occupants/Environment) are the two possible options. Concerns about a further divergence from social equity objectives (Interview Industry/Owners) of the policy mix are countered by a recent study finding that an equitable tax design is possible for building heating in Germany (Bach et al., 2019).

Almost all experts and stakeholders express support for tax rebates as an economic instrument to create financial incentives for building owners (11 interviews, all categories). Such rebates are described as "beneficial for tenants because they replace increasing rents" (Interview Occupants/Environment) as the main form of amortisation for landlords. On the other hand, owners who do not need subsidies to be able to afford the initial investments have a direct benefit from their investment even if prices for fossil fuels remain lower than renewable energy (Interview Industry/Owners). All stakeholders are thus expecting lower costs. The burden would be shifted to the governmental budget which would lose tax revenue. Some of the

governmental representatives interviewed, however, also suggest tax rebates as a way to increase the refurbishment rate. An explanation for this is, that the ministries interviewed are not responsible for budget planning but have an interest in achieving energy efficiency and GHG reduction targets.

Opposingly, the opinion that more regulation is necessary is very pronounced among the interviewees too. The same number of interviewees ask for more and stricter regulation as those who would like to see more economic instruments (6 Interviews: Research/Think tank, Occupants/Environment). The rationale in this case is that it is impossible to capture the multiple co-benefits of energy efficiency retrofitting with economic instruments (Interview Occupants/Environment) and that it is the appropriate approach for the urgency of the situation in the building sector (Interview Research/Think tank).

The global energy assessment reflects this position and lays out that economic instruments will likely not be able to close the energy efficiency gap, but effective command-and-control measures need to set regulatory incentives, too (GEA, 2012). One challenge where regulatory instruments can be a stronger solution than economic ones is the principal-agent-problem. In the relationship between landlords and tenants, economic instruments may have an effect, but tenants are still relying and dependent on the willingness of the owners. Strict and enforceable rules, however, would decrease this dependency.

Ultimately, it will be a mix of different measures, as this thesis has argued and shown, because the multiple market failures and barriers as well as the various political influences are shaping the policy landscape. This is also the conclusion of the GEA report for energy use in buildings (GEA, 2012).

Institutional arrangements as the third of the energy efficiency governance components are not performing in favour of an effective governance system. The collaboration between ministries is perceived as poor by experts (Interview Research/Think tank) and the arrangements for applying for funding are too complex to be practicable. Stakeholders are confident about positive change towards better communication among the government and interest groups but also about an improvement of the information programmes and application processes (3 Interviews: Research/Think tank, Occupants/Environment).

In summary, all three components of the energy efficiency governance structure reveal substantial weaknesses and confirm the low performance for the characteristics analysed above. Targets without a link to the rest of the policy mix do not serve as effective co-ordination mechanisms, the enabling framework needs reinforcement to work towards the targets and the institutional arrangements cause complexity. It becomes even more evident that the design of the policy mix needs revision and improvement.

7 Conclusion

This thesis aimed at understanding and assessing the objectives and instruments of the German policy mix for energy efficiency in existing buildings. In order to contribute to achieving the aim and contributing to a solution of the underlying problem of untapped energy efficiency potential and lack of knowledge about how well the design of the German policy mix increases the energy efficiency performance of existing buildings, this thesis set out the research question:

> RQ 1: How well designed is the German policy mix for energy efficiency in existing buildings in terms of policy mix characteristics?

RQ1 was further divided into the sub-research questions

> RQ 1.1: How coherent are the policy objectives?
>
> RQ 1.2: How consistent are the instruments of the policy mix?
>
> RQ 1.3: How comprehensive is the policy mix in addressing the market failures and barriers of energy efficiency?

According to the literature of policy mix analysis, the three characteristics used in the three sub-research questions allow an assessment of the design of a policy mix from a practical perspective. Therefore, data was collected from stakeholders and experts that work with the policies on a day to day basis. The interview data was amended by analysis of documents on the various instruments of the policy mix.

This thesis has shown that the German policies for energy efficiency improvements in existing buildings are numerous and cover a wide set of instrument types as well as instrument functions. The mix relies on economic instruments – notably funding support programmes – as central type of instruments. They aim at reducing the barrier of high initial investment that is described as a central challenge by the literature on building energy efficiency and the interview partners of this research. Several informative instruments are found as well, addressing information asymmetries and awareness deficits. Only little use is made of regulatory instruments to oblige building owners to carry out refurbishment projects.

In response to RQ 1.1, the coherence of policy objectives is high when analysing the strategies and targets for energy and climate. As they are all referring to the same original set of objectives, they support each other well. However, those targets are less coherent in comparison to social objectives like affordable housing. For instance, the high costs of energy efficiency renovation projects result in increasing rents in tenancy buildings. A crucial shortcoming of the policy mix that was analysed in this thesis is that the objectives for energy efficiency are more ambitious than what the instruments are able to achieve.

Consistency – assessed under RQ 1.2 – is present at a basic level, as many funding programmes allow combination of their support. However, both the predictability and the practicability of the instrument mix were found to be problematic after analysis of interview and document data.

Answering RQ 1.3, the assessment of comprehensiveness revealed that the instruments aim at reducing most of the market failures and barriers explicitly but are not ambitious enough to overcome them. Especially negative externalities of traditional inefficient heating systems based on fossil fuels are not adequately addressed by the policy mix.

As a sum of those findings, the overall design of the policy mix requires revision and change to a stronger approach as a policy mix than a set of objectives and instruments to solve the shortcomings identified in this thesis. To inform the path of re-designing the policy mix, further research is needed on the interplay with lower layers of German policies and politics, to increase the in-depth knowledge of the contradictions and synergies between instruments and strategies. Moreover, the relevance of policy processes requires further investigation to assess their influence on the development of instruments.

In respect to theoretical implications, this thesis found that matching objectives and instruments are an essential design feature of a policy mix. While it was analysed under coherence here, it has been argued above that the characteristic of credibility as its own assessment criterion can help to underline the relevance of matching ambitions. Further research can improve the conceptualisation of credibility and test other policy mixes on this criterion.

Within comprehensiveness, the functions of instruments to support innovation were found to be context dependent. Technological solutions are available for building renovation and energy efficient heating systems, meaning that technology-push is less relevant than demand-pull to make building owners install such solutions.

Finally, energy efficiency policy mixes need to be researched in other countries to contribute to the results of this thesis. Being highly context specific, this research presented findings about Germany that can be of relevance for other national policy mixes but do not allow direct inferences. For instance, the influence of an EU membership of the country under analysis requires research in the future, as much of the German legislation is prescribed by EU directives and regulations. Comparing EU countries to non-EU ones can highlight strengths and weaknesses of national policy mixes shaped by the European legislation.

In general, this research has shown that policies need to be assessed as part of a mix to understand the supporting and contradicting effects. This is true for energy efficiency policies in Germany but also for most other policy areas as well as other countries.

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Appendices

Appendix A: Detailed list of instruments

	Title (German)	Title (English)	Type	Agency	Funding in 2018 (in million €)	Starting Year
1	Energieeinsparverordnung (EnEV), Stand 2014	Energy Savings Ordinance, 2014 version	Regulatory	Federal Government	N/A	2002
2	CO_2-Gebäudesanierungs-programm	CO_2 Building Renovation Programme	Economic (Subsidy)	KfW	1,360 (a)	2006/ 2015
3	Marktanreizprogramm	Market Incentive Programme for Renewable Energy in Heating	Economic (Subsidy)	BAFA + KfW	320	1999
4	Anreizprogramm Energieeffizienz	Incentive Programme for Energy Efficiency	Economic (Subsidy)	BAFA + KfW	165	2016
5	Nationales Effizienzlabel für Heizungsaltanlagen	National Efficiency Label for Old Heating Equipment	Information	District chimney sweepers	N/A	2016
6	Förderprogramm Heizungsoptimierung	Support Programme for the Optimisation of Heating Equipment	Economic (Subsidy)	BAFA	50	2016
7	Energieberatung	Energy Consulting	Information	BAFA, vzbv	N/A	1991
8	Deutschland macht's effizient	Energy Efficiency Information Campaign	Information	BMWi	N/A	2016
9	Energiesteuer	Energy tax	Economic (Tax)	Federal Ministry of Finance	N/A	1939 (b)
10	Energieverbrauchsrelevante-Produkte-Gesetz (Ökodesign Richtlinie)	Law on Products with Relevant Energy Consumption	Regulatory	N/A	N/A	2011
11	Forschung, Entwicklung und Demonstration für energieeffiziente Gebäude und Quartiere	Research, Development and Demonstration for Energy Efficient Buildings and Districts	Research (Financing)	Federal Ministry of Economic Affairs and Energy, Federal Ministry of	180	2012

				Education and Research		
12	Bauforschungsinitiative Effizienzhaus Plus	Research Initiative Efficiency Building Plus	Research (Financing)	Federal Ministry of the Interior, Building and Community, Others	10	2007
Additional Instruments (c)						
13	Energieeinspargesetz (EnEG)	Energy Savings Act	Regulatory	N/A	N/A	1976
14	Energie- und Klimafonds	Energy and Climate Fund	Economic (Subsidy)	Federal Ministry of Finance	2,500	2010
15	Erneuerbare-Energien-Wärmegesetz (EEWärmeG)	Renewable Energy for Heating Act	Regulatory	N/A	N/A	2009

(a) Total of both the "energy efficient renovations" programme and the "energy efficient construction" part.
(b) Multiple amendments over the years, e.g. "ecological tax reform" in 2002; latest version from 2018
(c) The additional instruments are not active components of the policy mix for energy efficiency in existing buildings. They form legal basis (Energy Savings Act), are the umbrella for funding of programmes (Energy and Climate Fund) and target RES for heating in buildings with energy efficiency improvements as a possible substitute (Renewable Energy for Heating Act).

Appendix B: Detailed list of interviews

	Organisation		Type	Date	Time	Method
1	BMU	Federal Ministry for the Environment	Government	27.06.2019	35 minutes	Phone/Skype
2	BMWi	Federal Ministry for Economic Affairs and Energy	Government	10.07.2019	54 minutes	Phone/Skype
3	BBR	Federal Office for Buildings and Regional Planning	Government agency	05.07.2019	36 minutes	Phone/Skype
4	AGFW	Energy Efficiency Association for Heating, Cooling and CHP	Industry association	19.07.2019	N/A	Written
5	DENEFF	German Initiative for Energy Efficiency	Industry association	05.08.2019	N/A	Written
6	GdW	Federal Association of Housing Companies	Commercial owner association	16.07.2019	41 minutes	Phone/Skype
7	Verband Wohn-eigentum	Association of Property Owners	Private owner association	06.08.2019	40 minutes	Phone/Skype
8	DGNB	German Sustainable Building Council	Non-profit association	04.07.2019	47 minutes	Phone/Skype
9	vzbv	Federal Association of Consumer Protection Organisations	Non-profit association	27.06.2019	39 minutes	Phone/Skype
10	DUH	Environmental Action Germany	Non-profit association	23.07.2019	49 minutes	Phone/Skype
11	BPIE	Buildings Performance Institute Europe	Non-profit association	19.07.2019	42 minutes	Phone/Skype
12	Dena	German Energy Agency	Public think tank	03.07.2019	51 minutes	Phone/Skype
13	IFEU Heidelberg	Institute for Energy and Environmental Research	Research institute	18.07.2019	46 minutes	Phone/Skype
14	RWI Essen	RWI – Leibniz Institute for Economic Research	Research institute	01.07.2019	41 minutes	Phone/Skype
15	Agora Energie-wende	Agora Energy Transition	Think tank	02.07.2019	55 minutes	Phone/Skype

Appendix C: Interview questionnaire

As all interviews were conducted in German, both the English and the German version of the questionnaire are presented here.

English:

Introduction:

Thank you for your participation in this interview. The Interview is conducted for my master thesis at Lund University in Sweden. The thesis performs a policy mix analysis of the currently existing strategies, targets and instruments for energy efficiency in existing buildings on the federal level in Germany.

Is it okay for you if I record and transcribe the interview? It will be treated confidentially and only be used for the purpose of this thesis. Your organisation will only appear in the list of interviews (more than 10) and not related to content.

Do you have any questions before we start?

Questions: (*Possible probes in italics*)

Q1: What does energy efficiency in the context of existing buildings mean to you?

Q1.1: What is your professional relationship to energy efficiency?

Q1.2: What are the biggest challenges for energy efficiency in existing buildings? Please think in terms of economic, political or technical challenges, if applicable.

- *Examples: Awareness among consumers, lacking price incentives, missing standards*
- *Can you explain this in more detail? Incentives for whom?*

Q2: What is your general evaluation of the German (federal) policy mix for energy efficiency in existing buildings?

- *Why positive? Why negative? Are there negative/positive aspects as well?*

Q2.1: What elements are most important in your opinion (the opinion of the organisation)?

Q3: Let's focus on the goals/objectives first. What is your assessment on the alignment of the goals in the policy mix?

- *Examples of goals: climate neutral building stock, more and affordable housing/rents, renewable energy goals*

Q3.1: Do particular goals stand out?

- *For which reasons?*

Q3.2: Do goals enable long term action?

- *How do they do that? Why not?*

Q4: Let's move to the instruments/measures/programmes of the policy mix. How well are the measures aligned to one another?

Q4.1: Are there examples of good support or strong contradiction?

- *How does the support/contradiction work?*
- *How did this come about?*

Q4.2: What are your thoughts on the distribution of administrative responsibility?

- *BMWi, BAFA, KfW*
- *Why is this advantageous/problematic?*
- *How did this happen?*

Q4.3: Do the instruments enable long term action?

- *How? How and why not?*

Q5: In your opinion, are all relevant issues for an improvement of energy efficiency in existing buildings addressed?

- *Examples: Awareness among consumers, lacking price incentives, missing standards*
- *What exactly is missing?*

Q5.1: What about actors, are all actors accounted for in the present mix?

- *Examples: landlords, tenants, owners, investors, research and development*

Q6: Do you have ideas for the future of energy efficiency policy in Germany?

End:

That were all the questions I had. Thank you very much for taken the time to talk to me. Do you have any further questions or comments?

If anything else comes up, please feel free to contact me.

German

Intro

Vielen Dank für Ihre Einwilligung zu diesem Gespräch. Ich führe es für meine Masterarbeit, die ich an der Universität Lund in Schweden schreibe. Das Thema der Arbeit ist eine Analyse des aktuell bestehenden Politikmixes – also des Zusammenspiels von Strategien, Zielen und Maßnahmen – für Energieeffizienz im Gebäudebestand in Deutschland auf Bundesebene.

Ist es okay, dass ich das Gespräch aufnehme, um es später zu transkribieren? Die Daten werden nicht weiterverbreitet und nur für den Zweck dieser Masterarbeit verwendet. Der Name Ihrer Organisation wird nur in der Liste der Interviews (mehr als 10) zu finden sein, nicht in Verbindung mit Inhalt.

Haben Sie noch weitere Fragen bevor wir anfangen?

Fragen:

Q1: Was bedeutet Energieeffizienz im Gebäudesektor für Sie?

Q1.1: Was ist Ihre berufliche Beziehung zu Energieeffizienz?

Q1.2: Was sind die wichtigsten politischen und Markt- Herausforderungen für Energieeffizienz in Gebäuden

- *Beispiele: Bewusstsein bei Verbrauchern oder Industrie, fehlende Preisanreize, fehlende Standards?*
- *Können Sie das noch etwas genauer erklären? Anreize für wen?*

Q2: Wie schätzen Sie ganz generell die deutsche Ziele- und Maßnahmenlandschaft auf Bundesebene in Deutschland ein?

- *Warum positiv oder negativ? Gibt es auch negative/positive Aspekte?*

Q2.1: Welche Elemente der Politiklandschaft sehen Sie (Ihre Organisation) als die wichtigsten für die Steigerung der Energieeffizienz im Gebäudebestand an?

Q3: Zunächst zu den Zielen der Politik und des Instrumentenpakets: Wie ist Ihre Einschätzung des Zusammenspiels der Ziele?

- *Beispiel für Ziele: Klimaneutraler Gebäudebestand in 2050, mehr Wohnraum, langfristige Kostenersparnis, bezahlbare Mieten, Wettbewerbsfähigkeit, Erneuerbare Energien,*

Q3.1: Gibt es bestimmte Ziele, die herausstechen, weil sie schlecht mit anderen vereinbar sind?

- *Aus welchen Gründen?*

Q3.2: Ermöglichen Ihnen die Ziele langfristiges Planen und Vorgehen?

- *Warum und wie? Oder warum nicht?*

Q4: Konkreter zu Instrumenten/Maßnahmen und Programmen: Wie gut funktionieren die Maßnahmen zusammen?

Q4.1: Gibt es Beispiele für sehr gute gegenseitige Unterstützung oder aber Widersprüche?

- *Wie funktioniert die Unterstützung/der Widerspruch in diesem Fall?*
- *Wie ist es dazu gekommen?*

Q4.2: Sind Sie mit der Zuständigkeitsverteilung von Behörden zufrieden?

- *BMWi, BAFA, KfW*
- *Vorteilhaft oder problematisch? Warum?*
- *Wie ist es dazu gekommen?*

Q4.3: Ermöglichen die Instrumente in ihrer Gesamtheit langfristige Planung?

- *Warum und wie, oder warum nicht?*

Q5: Werden Ihrer Ansicht nach alle wichtigen (Markt-) Herausforderungen für verstärkte Energieeffizienz im Gebäudebestand adressiert?

- *Beispiele: Verhalten und Bewusstsein von verschiedenen Gruppen, Abhängigkeiten und Aufteilung zwischen Eigentümer und Mieter, Preisvergleich zu traditionellem Vorgehen, Investitionssicherheit*
- *Welches verstärkte Handeln wäre notwendig?*

Q5.1: Und Akteure, werden alle wichtigen Akteure adressiert?

- *Vermieter, Mieter, Eigentümer, Industrie, Investoren, Forschung und Entwicklung*

Q6: Haben Sie Ideen für die zukünftige Gestaltung der Ziele und Maßnahmen?

Abschluss:

Das waren alle Fragen von meiner Seite. Vielen Dank, dass Sie sich die Zeit genommen haben. Haben Sie noch Fragen an mich?

Sollten Sie noch Anliegen haben oder Ihnen etwas einfallen, kontaktieren Sie mich gerne.

Appendix D: Coding structure

Characteristic	Category	Code	Manifes-tation	Definition	Example
Coherence	Complementarity of objectives	Coh1	-	Goals are in conflict, cannot be achieved simultaneously	"Obviously, there is a conflict between the climate action policies and social equity." (Interview Research/Think tank)
			0	Goals are neutral, no support and no interference	"Climate and social goals are not automatically in conflict. That applies to the building sector, too. But affordable housing is often leveraged as a pretext by investors to not prioritise energy efficiency and convince politics of that as well." (Interview Occupants/Environment)
			+	Goals are complementary, work for a common target	"The big strategic documents fit very well together because they are following the same targets." (Interview Government)
	Degree to which objectives are predictable	Coh2	-	Goals are not predictable, do not enable long term planning	"An honest and fundamental commitment to a heating transition from policymakers is lacking." (Interview Occupants/Environment)
			0	There is some predictability but not for all	"The targets for 2050 are clear and well-formulated but we need stronger milestones on the way, even to 2030". (Interview Government)
			+	Development of goals is predictable, enables planning	"Many of the goals exist in the same wording since 2010 and are restated again and again. That is a long period." (Interview Research/Think tank)

	Degree of matching ambition between objectives and instruments	Coh3	-	Instruments do not match the goals in ambition, achievement of goals is unlikely	"The objectives are all good and fine but there is a clear lack of measures to achieve any of them." (Interview Occupants/Environment)
			0	Differentiated matching, overall achievement is not probable	N/A
			+	Instruments and goals match, achievement of goals is likely	N/A
Consistency	Coexistence with other instruments	Con1	-	Contradiction between instruments	"There are still subsidies for the use of fossil energy in buildings like the grant for investments in oil fuelled heat systems in the support programme "Energy efficient renovation" by the KfW." (Interview Occupants/Environment)
			0	Acknowledgement of other instruments, neither contradiction nor support	"The measures which are supported through the program are those which well-exceed the legal requirements of the Energy savings ordinance" (MURE-Database, 2015)
			+	Support between instruments	"There are positive examples like KfW subsidies that can be combined in a way that makes sense and helps the applicant." (Interview Occupants/Environment)
	Implementing authority	Con2	-	Instruments are implemented by different authorities without collaboration	"One of the ideas comes from the Ministry for the Environment and the other from the Ministry of Economic Affairs. They have different perspectives on the issue." (Interview Research/Think tank)
			0	Instruments are implemented with some degree of collaboration	"The different ministries have created support programmes that they seem fit. There is only little exchange between them, so we have a jungle as a result." (Interview Research/Think tank)

			+	Instruments are implemented by the same authority or in close collaboration	"The competence is currently merged at the BMWi, which can be a big opportunity." (Interview Industry/Owners)
	Degree to which instruments are predictable	Con3	-	Instruments are not predictable, do not enable long term planning	"Predictable support is needed to show that the government follows through with the targets and that investment and training will be valuable in the medium and long term." (Interview Government)
			0	There is some predictability but not for all	"The measures simply need to remain in place and need to be expanded, otherwise we will never achieve the targets." (Interview Industry/Owners)
			+	Development of instruments is predictable, enables planning	"Even though EnEV has been recast several times due to European specifications, the stipulations for existing buildings have remained stable." (Interview Government)
	Degree to which instrument is useful in practice	Con4	-	Instruments are not appropriate in the practical circumstances	"The measures are very fragmented and dispersed, in particular the financial support programmes." (Interview Research/Think tank)
			+	Instruments work smoothly in practical circumstances	N/A
Comprehen-siveness	Clearness of market failure or barrier	Com1	-	Instrument is unclear about which market failure it targets	"Mobilise the opportunities available for energy savings to economically viable conditions in the existing building stock." (Federal Government of Germany, 2008)
			+	Instrument addresses specific market failure	"This way, consumers are informed about the efficiency status of their heating system and about energy consultations and funding support available. The label is supposed to increase the exchange rate of old heating equipment and incentivise energy savings." (BAFA & UBA, 2016)

Instrument function	Com2	TP	Instrument functions as technology push	The goal is to set new incentives for innovation and investment for the heating transformation in boiler rooms." ('Anreizprogramm Energieeffizienz (APEE) [Incentive Programme for Energy Efficiency]', n.d.)
		DP	Instrument functions as demand pull	"The programme serves the low-interest long-term financing on loans of measures to save energy and reduce carbon emissions from existing residential buildings." (('Energieeffizient Sanieren—Kredit [Energy efficient renovation—Loan]', n.d.))
		SY	Instrument is a systemic instrument	"The federal Ministry for Economic Affairs and Energy supports energy consultations that inform about the possibilities of refurbishment for residential buildings." (('Energieberatung für Wohngebäude [Energy Consulting for Residential Buildings]', n.d.))
Actor inclusiveness	Com3	-	The policy mix is unbalanced on relevant actors	"Craftsmen are important people for the first contact. They give advice and hints, but they also need to have an incentive to do so. So, they need to be better integrated in the instruments" (Interview Research/Think tank)
		0	Many actors are addressed but not entirely comprehensive	"More focus on private owners and small-scale landlords could make a difference. They provide most homes in Germany and have a big effect." (Interview Occupants/Environment)
		+	The policy mix addresses all important actors	N/A
Adequacy for the market failure or barrier	Com4	-	Instrument (mix) not adequate to overcome targeted market failure/barrier	"Two different energy passes are a big problem and certainly do not create more transparency about energy consumption and costs." (Interview Research/Think tank)

			0	Instrument (mix) reduces the targeted market failure/barrier only partly	"The support by the KfW was innovative at the time and has a very good reputation in other countries but it is totally unclear how many extra refurbishments it has led." (Interview Occupants/Environment)
			+	Instrument (mix) is adequate for the targeted market failure/barrier or reduces is greatly	"The suggested merger between EnEV, the Energy Savings Act and the Renewable Energy for Heating Act to form the Buildings Energy Act is much better able to set a clear regulatory frame." (Interview Government)
Other	Market properties	Mar	MF	Important market failure	"The demand doesn't exist because fossil fuels are so cheap, and we don't include externalities in the costs." (Interview Research/Think tank)
			MB	Important market barrier	"The high initial costs of most measures are a substantial barrier to many owners." (Interview Industry/Owners)
	Political barrier	Pol	/	Barrier to energy efficiency improvements arising from the political situation and the actors	"Communication between interest groups is very poor and broader collaboration does not happen, which would be essential for success of new instruments." (Interview Research/Think tank)
	Outlook	Out	/	Opinions on the future development of the policy mix	"Tax cuts for the investment would appeal to so many types of actors and resolve pushing investments into the future." (Interview Government)