

A Work Project, presented as part of the requirements for the Award of a Master's degree in  
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## **Derivation of a Business Plan from the Key Problems of German Rental Owners in Energetic Renovations**

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## **Abstract**

This thesis examines the challenges German homeowners face in retrofitting their homes and seeks to develop a business plan to effectively address these challenges. As the current renovation rate in Germany is insufficient to meet climate targets, understanding homeowners' barriers is crucial. The research revolves around two primary questions: first, identifying the key challenges for self-occupying and rental owners in the context of energy retrofitting, and second, exploring how a start-up can innovatively and profitably tackle these challenges. Key findings reveal significant knowledge gaps and financial concerns among homeowners. In response, "rehome" is introduced, a software startup providing digital renovation guidance and tools.

## **Keywords**

Business Plan, Key Problems, Germany, Homeowners, Energetic Renovation

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## List of Abbreviations

API	Application Programming Interface
BAFA	Bundesamt für Wirtschaft und Ausfuhrkontrolle (Federal Office of Economics and Export Control)
BMJ	Bundesministerium der Justiz (Federal Ministry of Justice)
BMWK	Bundesministerium für Wirtschaft und Klimaschutz (Federal Ministry of Economics and Climate Protection)
EaaS	Energy as a Service
EU	European Union
GEG	Gebäudeenergiegesetz (Buildings Energy Act)
GHG	Greenhouse Gas
HVAC	Heating, ventilation, and air conditioning
IEA	International Energy Agency
IÖW	Institut für Ökologische Wirtschaftsforschung (Institute for Ecological Economy Research)
IWU	Institut Wohnen und Umwelt (Institute for Housing and the Environment)
KfW	Kreditanstalt für Wiederaufbau (Credit Institute for Reconstruction)
MVP	Minimum Viable Product
PV	Photovoltaic
SaaS	Software as a Service
SAM	Serviceable Available Market
	SDGs Sustainable Development Goals
SME	Small and Medium Sized Enterprise
SOM	Serviceable Obtainable Market
TAM	Total Addressable Market

# **A Group part**

## **1 Introduction**

### **1.1 Context**

*(Group part)* The recently published report from the Intergovernmental Panel on Climate Change (IPCC) shows that we are currently heading for global warming of 3.2°C by 2100 (IPCC 2023). One of the main drivers of global warming is energy production and use, as it is responsible for more than two-thirds of global greenhouse gas (GHG) emissions (Lee and Birol 2020). In order to combat climate change, it is critical to drive fundamental changes, especially in electricity and heat production (Ritchie et al. 2020). Closer inspection reveals that buildings are one of the main emitters. In Germany, buildings, in particular residential homes, account for about 35% of the total energy consumption, with heating being the main consumer (BMWK 2023b).

In Europe, between 85% and 95% of all buildings will still exist in 2050. Therefore, energetic renovations of existing buildings are of significant importance in reducing the carbon footprint of the building sector (European Commission, 2020). To promote energy-efficient renovations and the use of renewable energy in households, the German government has launched several initiatives (BMWK 2023c). However, the current renovation rate is too low to achieve climate targets. In order to achieve climate targets, renovations must be carried out more quickly and on a larger scale (Behr et al. 2023). As homeowners are the main decision-makers in the renovation process, it is crucial to understand their motives and hesitation (Weiß et al. 2018). Therefore, this thesis aims to identify the main challenges of homeowners in energy-efficient renovations and to derive a business idea that addresses these challenges in an innovative and profitable way.

## **1.2 Research Questions**

*(Group part)* In light of Germany's low renovation rate, it is crucial to understand the challenges faced by homeowners in the renovation of residential buildings. Therefore, the first research question examined in this thesis is: What are the key challenges for homeowners in the context of the energetic retrofit of residential buildings? This question aims to explore the barriers preventing a rapid transition to energy-efficient residential buildings. However, identifying challenges is only one side of the coin.

The next step is to find an innovative and profitable solution that contributes to solving these challenges and thus accelerates the sustainable transition of residential buildings. Consequently, the thesis also aims to answer the following question: How can a start-up solve these challenges in an innovative and profitable way? This question seeks to derive a promising entrepreneurial solution that does not only address the challenges faced by homeowners but also accelerates the pace of energy-efficient renovations. By answering this question, we can potentially uncover an innovative business with the potential to catalyze the energy transition in the residential building sector.

## **1.3 Course of Action**

*(Group part)* To answer the research questions posed above, the thesis is divided into four main parts: literature review, problem analysis, solution design, and operational strategy. In the literature review, the residential building sector is defined, and its current energetic condition is examined. Moreover, the retrofitting context is outlined by describing the legal framework and stakeholders in the renovation process. The second part focuses on problem analysis. Here, a quantitative and a qualitative study with homeowners is conducted, aiming to identify the key challenges in the context of the energetic retrofit of residential buildings.

Thirdly, the challenges investigated are reviewed and utilized as a baseline for deriving a solution. Afterward, a market analysis is conducted to examine the market potential and competition. Based on this analysis, a competitive advantage can be developed. In the fourth part, an operational strategy is defined. Here, a go-to-market strategy is developed that describes the Minimum Viable Product (MVP) as well as sales and marketing activities. Second, the underlying business model as well as financial projections are outlined, including revenue and cost projections, profit and loss calculation, and liquidity planning. Furthermore, the impact of the solution will be explored with reference to the Sustainable Development Goals (SDGs). Finally, a conclusion can be drawn, including a concise summary of the results, a critical review of the thesis as well as an outlook of further steps.

## **4 Solution Design**

### **4.1 Problem-Solution-Fit**

#### **4.1.1 Problem Review**

*(Group part)* When comparing the challenges faced by self-occupying homeowners and rental owners in undertaking energetic renovations based on the two studies, several key differences and similarities emerge. First, both groups face a *significant knowledge gap*, although the nature of this gap varies. Self-occupying owners primarily struggle with a lack of information about renovation options, especially regarding the cost and financing possibilities of renovation. Besides, the uncertainty about what is feasible for their specific property indicates a need for more personalized and detailed advice. While rental owners, both private and professional, find the overall feasibility of renovation projects similarly challenging, they struggle especially with understanding the technologies involved and navigating the complex landscape of changing regulations and expert advice. This problem is even more pronounced for private owners, who often rely on ad hoc information.

*Financial concerns* are another common challenge, but they manifest differently for each group. Many self-occupying owners are deterred by the high cost of renovations, coupled with the mentioned lack of understanding about financial requirements and subsidies as well as doubts about the economic payoff. In contrast, larger rental owners in particular have considerable financial resources. Overall, however, rental owners have an even stronger economic motive. While motives such as climate protection or improved well-being also play a role for self-occupying homeowners, rental owners are more strongly focused on economic aspects. They are especially concerned about the long-term viability of investments. High initial costs and a lack of clarity about benefits and financing options contribute to these doubts. Professional rental owners face the additional challenge of balancing energy upgrades with maintaining housing affordability.

Finally, a unique challenge for professional rental owners is the *organizational hurdles* associated with managing large real estate portfolios. These challenges include managing internal processes, ensuring the quality of information, and coordinating among various stakeholders. Such complexities can delay the implementation of energy-efficient renovations and affect the overall success of renovation initiatives.

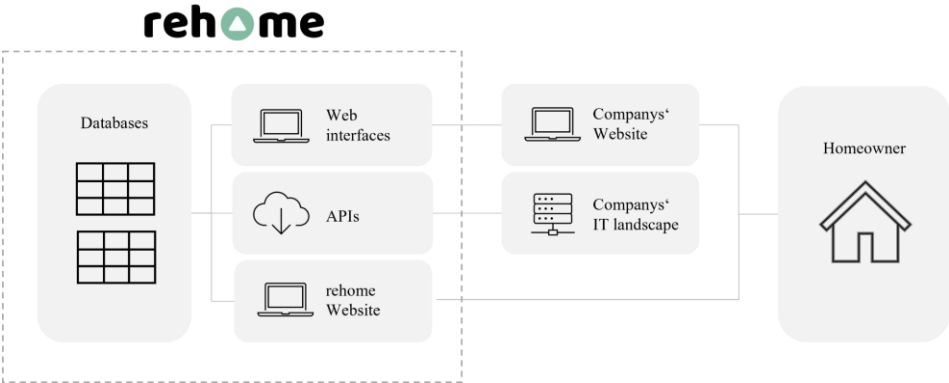
### **4.1.2 Solution Derivation**

*(Group part)* After reviewing the main challenges for self-occupying and rental homeowners, a start-up idea that contributes to innovatively solving these challenges is developed. Thereby, the second research question is addressed in the following chapters.

To solve the widespread lack of information of homeowners as well as associated financial concerns, we developed the start-up “rehome”. With rehome, we will guide self-occupying as well as rental owners through their renovation considerations and enable them to make informed decisions. As a software start-up with a focus on the information gathering and decision-making phase of renovation projects, we offer digital analyses for the energy status of

buildings, potential assessments for comprehensive renovation projects as well as individual measures and checks for specific technologies. Our software applications provide support in a variety of ways, for instance in examining the current energetic condition, identifying optimal renovation measures and available subsidies, and presenting potential savings and value increases.

Our aim is that whenever a homeowner considers an energetic renovation project, they will come across rehome’s software applications. Therefore, we see it as the most promising approach that energy and real estate companies, including professional rental owners, incorporate the applications into their existing services and infrastructure. Through simple integration via application programming interfaces (APIs) and customized adaptation of the applications, we aim to reach as many companies as possible, and thus homeowners using their services. Companies can customize our products with their own branding, modified processes within the application and even additional data. With this approach, we believe that we can reach a large number of homeowners much faster compared to developing our own platform. To test and demonstrate our solutions, self-occupying owners and private rental owners will also be able to use our solutions via our website (www.rehome.ai). The approach described is illustrated in the figure below.



**Figure 2: Graphical Representation of the rehome Solution (Own illustration)**

For the technical implementation, an iterative approach is aimed at. By constantly validating the new applications with early adopters using mock-ups and prototypes, we strive for continuous improvement in product development. The individual functionalities are developed according to the API-first approach, which should ensure vertical and horizontal integration with existing products and platforms. The technical solution comprises a web-based cloud-native application, relying primarily on a serverless tech stack. Besides, the React-based Next.js framework is used in the front end. In the medium term, it will be investigated whether individual components can be offered as plug-ins, which would ensure faster integration. Overall, emphasis is placed on the scalability of the infrastructure to ensure strong user growth.

All in all, we aim to make a significant contribution to increasing the renovation rate and promoting sustainable technologies by providing comprehensive and easily accessible guidance for the decision-making process. In the long term, we see growth opportunities by adding more services along the value chain of renovations.

## **4.2 Market Analysis**

### **4.2.1 Market Definition**

*(Group part)* Digital solutions have become increasingly important in the real estate and energy sector. New concepts such as Energy as a Service (EaaS) financing models and virtual power plant services for decentralized energy resources allow companies to build new business models and create revenue streams through digital services (IEA 2023). Even though there are no concrete figures on the use of Software as a Service (SaaS) solutions in the energy and real estate industry, the rapid transformation of these industries in combination with the current shift toward a demand-driven market is generating high innovation pressure among providers. Increasing digital innovations go hand in hand with a growing service orientation (Flach 2022).

To further define the market and determine the market size, the market for energy efficiency services is considered, using the TAM SAM SOM model (Akshat 2022). First, we address the German market for energy efficiency services, including energy consulting, energy contracting, and energy management services. With a market volume of approximately €12 billion (BfEE 2022), it represents the serviceable available market (SAM). We aim to serve at least 10% of the SAM with software solutions. The Serviceable Obtainable Market (SOM) thus has a market volume of €1.2 billion. Further growth potential is offered by the Total Addressable Market (TAM), which is the EU-wide market for energy efficiency services. The TAM has a market volume of €50 billion and is particularly important for scaling rehome (Roland Berger 2019).

#### **4.2.2 Competition**

*(Group part)* In the following, Porter's Five Forces Model is applied to determine the existing forces and competitors that are present in the energy efficiency service market (Baburaj and Narayanan 2016). The analysis focuses on energy and real estate companies that offer software solutions for obtaining information and making decisions in the context of energy-efficient renovations. A graphical representation of the analysis is provided in Appendix 8.

Regarding the first force, the threat of new entry, it can be said that it is rather inexpensive to enter the industry since a low initial investment is required. However, developing comprehensive software applications in this field requires expert knowledge, raising the barrier to enter the market. When considering the threat of substitution, it can be said that substitute products are already available. However, these products record low customer-centricity and customization features. For large companies, a relevant substitution option to be considered is to develop software on their own. When looking at the third force, the bargaining power of buyers, it must be separated between large companies and small and medium-sized

companies (SMEs). While large companies have more power due to their market coverage, they are rather price-insensitive due to their high order volumes. In contrast, SMEs have little bargaining power and are rather price-sensitive. The comparatively low competition in B2B software solutions overall reduces the power of buyers. When looking at potential suppliers, a wide range of companies that offer software-building tools can be seen. Overall, a high price sensitivity in this field results in low supplier power.

Regarding the competitive rivalry, several competitors for rehome can be identified. Below Vreed, co2online, Enter (former baupal), and Immobilienwirtschaftliche Beratung (iwb) are described in detail. Vreed is a start-up from Germany that offers software to assess the current energy status of properties and plan renovation projects. The web application can be used by homeowners as well as real estate agents, banks, craftsmen, architects and municipalities. However, there is no possibility of API integration or customization (Vreed GmbH 2023). Second, co2online is a non-profit organization offering web applications such as a modernization check or heating check to motivate private homeowners to conduct renovation measures. As the organization's main focus lies in informing homeowners, B2B applications and services are not tracked (co2online mbH 2023). Furthermore, Enter offers digital energy advice for homeowners, including quick checks and digital renovation assistance. However, the company does not focus on providing software-supported services in the B2B sector (baupal GmbH 2023). Finally, iwb offers portfolio management, consumption data analyses, neighborhood concepts, heating benchmarking and sustainability strategies for professional rental owners. They appear to be broadly positioned in the areas of portfolio analysis and sustainability consulting. While their services are accessible through web applications such as IGIS six, the integration of APIs and the customization of services are not part of their offering (iwb 2023).

All in all, the market for energy efficiency services in combination with the current technology leaps offers significant optimization opportunities that are not sufficiently exploited by existing companies.

### **4.2.3 Competitive Advantage**

*(Group part)* With rehome, we aim to exploit the unrealized potential in the energy efficiency market by creating solutions that are valuable, rare and difficult to imitate. Providing comprehensive, easy-to-access, and customer-centric software solutions, we guide private and professional homeowners through renovations and enable them to make informed decisions. While existing companies offer solutions that are only accessible through their website, we differentiate ourselves by offering solutions through third-party APIs and web interfaces, ensuring maximum flexibility and adaptability. Overall, we attach great importance to continuous optimization through customer-centric product development.

In addition, we possess energy expertise, industry insights, software skills, start-up experience, and a broad network of partners and potential customers thanks to our prior professional experience. This enables us to tailor our solutions precisely to the specific challenges and needs of the industry. Besides, we already received funding from one of the biggest energy companies in Germany giving us access to additional resources. A table comparing rehome with the discussed competitors can be seen in Appendix 9. Overall, the mentioned characteristics and resources will enable us to maintain a competitive advantage in the long term.

## **5 Operational Strategy**

### **5.1 Go-to-Market**

#### **5.1.1 Minimum Viable Product**

*(Group part)* Regarding the operational strategy of rehome, first, the go-to-market strategy is outlined. Therefore, the minimum viable product (MVP) is critical to achieving product market fit. We are currently implementing a use case that addresses at least one, but ideally, both challenges mentioned, creating real value for homeowners. Besides, we want to follow a frugal approach to product development. Frugal solutions aim to solve a specific customer problem while being simple and reliable to use rather than offering an excessive range of services right from the start (Agency for Business and Development 2020).

Since financing options are usually not known and change frequently, our MVP will be a financing and funding finder. The service consists of a front-end interface that allows homeowners to identify suitable and current financing options and subsidies for their renovation projects. In the backend, we will create a database, accessible via API, where we store all subsidies from the main government body for state subsidies, the Federal Office of Economics and Export Control (BAFA), from the states and municipalities as well as from the biggest development bank, the Kreditanstalt für Wiederaufbau (KfW). The finder consists of multiple questions and immediately shows the results in a comprehensible manner to facilitate the application process for users. By offering this solution, we aim to reduce the lack of information and the uncertainty around financing. The following figure illustrates the subsidy finder.

Setting out to make your home energy efficient can be exciting, but also daunting. With our subsidy check, we simplify your search for financing options. This service helps you find the right financing for your renovation project by searching through more than 100 Funding programs from the Federal government, local authorities and financing institutions.

Which area are you considering to renovate?



**Figure 3: Mock-Up of the Minimum Viable Product  
(Own illustration)**

Overall, the subsidy finder is intended to significantly improve accessibility to relevant information and thus promote the implementation of renovation measures. However, we do not see the MVP as our unique selling point, but rather as a frugal proof of concept that can be tested end to end, from database to API to customer interface. The product allows us to have continuous feedback loops with our early customers, providing valuable insights for product development. For us, closely aligning product development with customer feedback is critical to rehome's long-term growth. In addition, a solid marketing and sales strategy must be implemented to generate and nurture leads.

### **5.1.2 Sales and Marketing**

*(Group part)* For the go-to-market strategy, we will focus on four main areas: strategic partnerships, offline presence, online presence, and high accessibility. In early 2024, we will first leverage established relationships and try to win over some of our current contacts (manufacturers, full-service providers, and energy suppliers) as customers and pilot partners. Since our team has several years of experience in the energy industry, we consider this to be promising. We will position our software applications as the ultimate solution for energetic

renovations while offering the development of customized new use cases. By working closely with the industry, we aim to achieve product-market fit as soon as possible. This will be coupled with an offline presence based on appearances at trade fairs such as “Bau! Messe! NRW!” in Dortmund, “Green World Tour” in Stuttgart, or “re:publica” in Berlin. Trade fairs are critical in the targeted industries, serving as a vital platform for industry advancement and networking. We want to leverage these events to establish new partnerships and strengthen existing relationships.

Simultaneously, we will focus on building a strong brand and outstanding customer experience online. Our website will be enhanced with keyword-specific content to ensure SEO optimization, driving organic traffic. We will also launch a strategic content marketing campaign, publishing articles on renovation topics and sharing testimonial stories to further establish credibility in the sector. To boost visibility, we will collaborate with industry blogs and websites, securing backlinks and guest post opportunities. Targeted paid advertising on platforms frequented by our target audience will complement these organic efforts. Finally, to facilitate market entry, we will offer free versions and demos of our software applications. The accessibility of our solution will allow us to drive traffic, gain insights and enhance our product-market fit. Our goal is convincing users to upgrade to paid tariffs to benefit from advanced features, customization and additional support. With this mix of relationship-driven outreach and strong offline as well as online presence we aim to ensure a successful go-to-market.

## **5.2 Metrics**

### **5.2.1 Business Model**

*(Group part)* To describe the business model, first the customers and users of rehome are distinguished. The target customers for rehome are energy and real estate companies. More specifically, potential customers include energy service providers, manufacturers as well as

professional rental owners, and real estate companies. In contrast, the users of rehome are homeowners looking for guidance for their renovation as well as large energy and real estate companies using rehome for internal processes. Overall, we position ourselves as a Software as a Service (SaaS) provider that makes renovation expertise and use cases accessible via web interfaces and APIs.

Our business model is based on a freemium model consisting of three tariffs: Free, Premium, and Enterprise. The Free tariff comprises free access to our APIs and is aimed at small businesses or individuals looking to get started with our software. This tariff provides access to our use cases without further integration or application support. The tariff gives users an insight into the software's capabilities. However, there are limitations regarding the number of users, API requests per month, and storage space. The Premium tariff is ideal for medium-sized businesses that need advanced features and support. Here, companies receive access, flexible usage as well as integration and application support. This tariff is said to cost €129 per user per month and includes negotiable API requests and storage space. The Enterprise tariff is designed for large enterprises and organizations looking for a comprehensive solution and customized services. The price for this tariff is negotiable and depends on the specific requirements and number of users. It offers unlimited API requests, integration, and application support as well as individual customization of features. An overview of the three tariffs is provided in Appendix 10. Overall, the SaaS model with its staggered pricing structure accommodates a range of customer needs and budgets, while the API integration capability is a key feature enabling companies to simply embed the applications into their existing systems.

## **5.2.2 Financials**

### **Revenue Forecast**

*(Group part)* To enable a better assessment of the business idea, the financial projections for the next five years, and the underlying assumptions are presented below. It is important to note that at this early stage, these assumptions will need to be validated in future.

When projecting rehome's revenues, the sales are expected to be driven by the tailored market fit, resulting from the close collaboration with industry partners. In 2024, we expect a total revenue of €40,000 as we initially validate and further develop software applications with around thirty pilot customers to achieve product market fit. In 2025, we want to increase sales fivefold to €200,000. The "Premium" and "Enterprise" tariffs generate roughly the same amount of revenue at this time. We plan to have 80 to 100 users from SMEs and around ten Enterprise customers. Growth will then be intensified from 2026. Supported by a strong team, the goal is to break the €1 million revenue mark this year. Large energy and real estate companies will be specifically acquired as customers, resulting in at least 50 enterprise customers. In addition, we plan to establish a third revenue stream this year by providing qualified leads to energy companies for homeowners willing to renovate. By 2028, we expect to generate revenues of €8.2 million, mainly through software subscriptions. The expected revenues can be seen in Appendix 11.

### **Cost Forecast**

Regarding the cost, the main factor for rehome is personnel cost. At the beginning of 2024, we will expand our team with another software developer. With a permanent team of four people, two of whom have an IT background and two an entrepreneurship background, supplemented by an energy consultant in an advisory capacity, we will drive the development of rehome in 2024. In 2025, we will need additional support to manage the expected growth. To this end, we plan to hire seven additional developers as well as eight additional employees in the areas of business development, sales, design, finance, legal, and customer support, resulting in a

significant cost increase. From 2026 onwards, the focus will then be on rapid growth, for which we plan with 15 more permanent employees. By 2028, we expect the team to grow to up to 70 employees. Next to personnel cost, the second significant cost item is software development, including cloud hosting costs such as computing instances, data storage, database services, and data transfer as well as costs for business-related software-abonnements. Hosting costs are estimated to be between 10 to 12% of the overall revenues. In addition, there are costs for office rent, advertising, and legal and accounting services.

Overall, the most sensitive variable in the cost structure is the personnel costs. Given the aggressive hiring plan, any change in the expected growth, funding availability, or a shift in strategic priorities could drastically affect these costs. For example, if rehome does not grow as quickly as expected, or if additional funding is not secured, it may not be possible to hire as planned. Another sensitive variable is software costs. As the number of users and the volume of data processed by rehome increase, the costs associated with hosting, data storage, and API requests could grow significantly. The aggregated cost overview for the period 2024 to 2028, breaking down the projected costs by the various items, can be seen in Appendix 12.

### **Profit and Loss Account**

Based on the projected revenues and costs above, a profit and loss account can be made. For this purpose, a sensitivity analysis is performed, assuming a baseline scenario as well as an optimistic and a pessimistic scenario in which sales increase and decrease by 25%. In the baseline scenario, costs outweigh sales in the first four years (2024-2027). As the product matures, sales increase exponentially while costs slowly level off. Due to scaling effects, break-even will be reached by the beginning of 2028. In the optimistic scenario, break-even is already achieved in 2027, while the pessimistic scenario with higher losses in the first four years

predicts a break-even in 2028. The profit and loss account in its three different scenarios can be seen in Appendix 13.

### **Liquidity Planning**

The liquidity of rehome can be secured through two funding rounds totaling €3.85 million. The Enpulse Founder Grant will provide us with €30,000 in seed capital in 2024, which has been taken into account as “liquidity start” in 2024. Seed funding in early 2025 is expected to raise €1,250,000 and Series A funding in early 2026 is expected to raise €2,600,000. The funding rounds are included in the inflows in 2025 and 2026 and are based on the financial forecast above (baseline scenario). The full liquidity planning from 2024 to 2028 is provided in Appendix 14.

### **5.2.3 Impact**

*(Group part)* After framing the financial projections, the impact of rehome can be examined. Overall, we aim to contribute to the Sustainable Development Goals (SDGs) 7, 9, and 13 (UN 2023). By providing homeowners with free digital guidance, we enable homeowners to make informed decisions and to choose renovation measures suitable to their needs and financial means. Thereby, rehome plays a crucial role in promoting sustainable energy and enhancing its accessibility (SDG 7). The impact will be measured by tracking the number of users and collecting user feedback. Second, our solutions drive innovation in the building sector (SDG 9). We facilitate the adoption of new technologies promoting sustainable infrastructure and at the same time innovate the pre-renovation process for our customers. The impact here is measured by the rate of adoption of our solutions by industry partners, the number of sustainable renovation projects initiated, and the feedback from users and clients.

Finally, our focus on energy-efficient renovations contributes to combating climate change (SDG 13). By enabling the switch to low-carbon technologies like heat pumps and PV systems, and promoting thermal insulation, rehome helps to reduce CO<sup>2</sup> emissions. For instance, compared to fossil fuel heating systems, a heat pump saves an average of 2620 kg of CO<sup>2</sup> per year, depending on current consumption (BWP 2023). An average PV system on a single-family house with 10 kWp saves about 6250 kg CO<sup>2</sup> per year (Solarify 2020). Adequate thermal insulation can reduce the CO<sup>2</sup> emissions of an average single-family home by up to 2000 kg CO<sup>2</sup> per year (Qualitätsgedämmt e.V. 2023). We quantify this impact by tracking the reduction in CO<sup>2</sup> emissions resulting from renovations facilitated by our solutions. Overall, we are dedicated to increasing the renovation rate and promoting sustainable technologies. By providing comprehensive and accessible guidance, we aim to reduce uncertainty and hesitation among homeowners, paving the way for a more sustainable future.

## **6 Conclusion**

### **6.1 Summary**

*(Group part)* To conclude, the key findings of each chapter are presented. While chapters two and three of this thesis focus on the first research question, chapters four and five address the second question. The following section first concludes the findings on the *key challenges for homeowners in the context of the energetic retrofit of residential buildings*.

During the literature review in chapter two, the residential building stock in Germany was described. A closer look at the energetic conditions showed that large portions of the building stock record medium to low energy efficiency with a large part of self-occupied houses recording low energy efficiency. Next, the legal framework including the European Climate Law and the European Green Deal as well as Germany's Climate Protection Act and Buildings Energy Act, was outlined. Here, it became apparent that current regulations are not sufficient

to achieve climate targets. Therefore, the background paper of the Building Strategy Climate Neutrality 2045 from the BMWK as well as recommendations by the IWU were described as exemplary paradigms to gain an understanding of required measures in energetic renovations. To identify the stakeholders required for this transition, a stakeholder analysis was conducted, identifying self-occupying and rental owners as the key decision-makers in renovations and specifying their motives. In the problem analysis (chapter three), two studies were conducted to investigate the key challenges of self-occupying owners and rental owners in the context of energetic renovations. The first study, a survey with 79 self-occupying homeowners, identifies the lack of information and financial barriers as the most pressing challenges. The second study includes nine interviews with private as well as professional rental owners, largely confirming these challenges. A comparative overview of the results can be found in the problem review in Chapter 4.1.1.

The second part of the thesis answers the research question of *how a start-up can solve the identified challenges in an innovative and profitable way*. After a problem review, the start-up idea for rehome was derived. The proposed solution aims to enable homeowners to make informed renovation decisions through digital analysis tools, checks, and proposals that are provided via web interfaces and APIs. After the solution derivation, the market potential and competition of rehome was assessed, with the EU-wide market for energy efficiency services being valued at €50 billion. In addition, the market environment and competition are analyzed, identifying opportunities for growth. Subsequently, the competitive advantage of rehome could be stated, mainly based on the customizable integration of customer-centric software through APIs. In chapter five, the key metrics of the start-up are investigated. As a SaaS company targeting B2B customers rehome offers three tariffs for customers, depending on the intensity of usage and support needs. By 2028, revenues of €8.2 million are projected with costs at €5.2 million. The break-even is planned for the beginning of 2028, requiring two prior funding

rounds with a total of €3.85 million to ensure liquidity. Finally, the impact of rehome is assessed, indirectly contributing to SDGs 7, 9 and 13.

## **6.2 Limitations**

*(Group part)* When reviewing the problem analysis and its limitations, the results of the studies must be evaluated regarding their representativeness. Regarding the survey with self-occupying homeowners, the results should not claim to be representative due to several limitations. Likewise, the validity of the interviews with rental homeowners is restricted due to several limitations, such as the small sample size. Although both studies provide valuable insights into the challenges faced by homeowners, the results should be viewed with caution. A detailed analysis of the studies' limitations was conducted in the conclusion chapter of each study.

Next to the study results, the derivation of the start-up idea as well as its impact can be criticized. While we are convinced that rehome will contribute to solving the key challenges faced by homeowners in a systematic way, the possible solution space is broad and does not exclude other viable solutions. Rehome can be seen as one of several potential solutions to tackle these problems. The start-up aims to accelerate the renovation rate as this is highly relevant for climate protection. However, as a software company, rehome only has an indirect impact on renovations. While the main problem for homeowners, the lack of information can potentially be solved, an increase in the renovation rate is not guaranteed. The decision is ultimately up to the homeowner and requires additional actions. Therefore, the actual impact of rehome must be continuously measured in the future.

### **6.3 Next Steps**

*(Group part)* Finally, the next steps on the product and operational side will be outlined. On the product side, the development of the MVP is our current focus. The first version of the MVP will be published on our website by the end of this year. For the development, we receive support from the Nova SBE Prototyping Fund (Nova SBE 2023). The next steps will be the market launch and further development of our MVP based on continuous feedback loops with early adopters. Besides, developing further software products will be crucial to increase the added value of rehome. One promising product is a comprehensive renovation compass that shows homeowners the current energy status of their building, identifies appropriate renovation measures, and calculates costs and CO<sup>2</sup> emissions. Starting in January, this and other use cases will be validated in further interviews with energy and real estate experts.

At an operational level, we have been able to overcome an important hurdle in order to focus on the further development of rehome. We recently received a one-year fellowship from Enpulse Ventures, the venture builder of Germany's third-largest energy supplier EnBW (Enpulse 2023). The fellowship secures the livelihood of our founding team, consisting of Lea, Henning and Kevin, a software developer from Germany, as well as the short and medium-term software development. Moreover, we were recognized as one of the top 50 start-ups in Germany by the BMWK. As of now, we are in the final of this competition and waiting for a response regarding the award (BMWK 2023f). From January onwards, we will be working full time on rehome.

## **B. Individual part**

### **2 Literature Review**

#### **2.2 Retrofitting Context**

##### **2.2.1 Legal Framework**

*(Lea)* In alignment with the Paris Agreement objectives, the EU aims to become the world's first GHG-neutral continent by 2050. The EU's strategy for climate neutrality is described in the European Green Deal and legally enforced by the European Climate Law regulation. The law defines the goal of limiting net GHG emissions by a minimum of 55% by 2030 in comparison to 1990 figures (Council of the EU 2023). As a pivotal part of the European Green Deal, the Renovation Wave strategy emphasizes the importance of energetic renovation (European Commission 2020). This strategy seeks to double the annual renovation rate over the next decade, not only to cut emissions but also to improve living conditions and generate jobs. Focus areas of the Renovation Wave include addressing underperforming buildings and transitioning to decarbonized heating and cooling (European Commission 2023).

In Germany, the Climate Protection Act is the core of the national climate policy. The country has set legally binding climate targets that include a 65% reduction in GHG emissions by 2030 compared to 1990 as well as climate neutrality by 2045. The Climate Protection Act contains a Climate Protection Program that lists the most important measures in the areas of energy and buildings, among others. The aim of the program is to put the requirements of the Climate Protection Act into practice and thus provide for the transformation of the energy system (BReg 2023).

Specific energy requirements for buildings are established in the Buildings Energy Act (GEG). The Act is intended to contribute to the government's climate targets by increasing the share of renewable energies in final energy consumption, conserving fossil resources, reducing

the dependence on energy imports, and enabling the sustainable development of energy supply (BMJ 2023b). The GEG contains specifications for heating and air conditioning technology as well as the thermal insulation standard and heat protection of buildings (Verbraucherzentrale 2023b). For existing buildings, the Act defines replacement and retrofitting obligations that owners must fulfill by a certain date. For instance, heating systems that are more than 30 years old must be replaced and ceilings to unheated attics must meet a minimum thermal insulation standard (ibid.). In addition, there are conditional requirements that owners have to comply with if they decide to modernize. If one component is replaced, certain heat transfer coefficients (U-values) must be adhered to. In the case of comprehensive modernizations, an overall energy balance is carried out. Depending on the method, maximum values for the primary energy demand and minimum values for emissions must be met (ibid.).

### **2.2.2 Retrofitting Needs**

*(Lea)* After describing the legal framework, it must be stated that the current regulations are not sufficient to achieve Germany's climate targets (Climate Analytics 2022). However, several institutions already state more progressive strategies to meet these targets, among them the BMWK and the Institute for Housing and the Environment (IWU). In the subsequent chapter, the background paper from the BMWK and the recommendations by the IWU are reviewed to provide a comprehensive overview of the required measures in the building stock, supplementing those already codified in law.

The BMWK describes more extensive retrofitting needs and a long-term strategy in the background paper on the Building Strategy Climate Neutrality 2045 (BMWK 2022). The paper highlights that the building sector needs to adopt renewable energies and GHG-neutral energy sources. Simultaneously, there must be a decrease in consumption, achievable through enhanced thermal insulation in buildings (BMWK 2022). The IWU defines the most pressing

actions as doubling the rate of thermal insulation modernization, improving thermal insulation quality and standards as well as switching from gas or oil boilers to heat pumps, district heating, and biomass (Swiderek 2021). In the following, the three areas with the highest retrofitting needs are outlined.

Both institutions cite heating as one of the main areas. Today, more than 80% of the country's heating needs are currently met by fossil fuels (WWF 2023). According to the background paper from the BMWK, heat pumps will predominantly replace traditional fuels in single- and two-family houses (BMWK 2022). The IWU also emphasizes the crucial role of heat pumps. Besides, the IWU states that heat networks will primarily be applied in areas with high building density (Diefenbach et al. 2019).

In addition to heat generation and use, GHG-neutral electricity generation in buildings is a key measure in both strategies. Due to a shift towards electric vehicles and electric heating systems, electricity consumption is projected to rise notably in Germany. Concurrently, the goal for renewable energies is to meet 80% of the electricity demand by 2030 (BMWK 2023e). According to the IWU, wind and solar energy will be the main energy sources for residential buildings. Since the majority of heat demand in insulated buildings occurs in the winter months, wind energy is of particular importance in Germany (Diefenbach et al. 2019). For solar, the BMWK report's target scenario foresees an increase of installed photovoltaic (PV) capacity from 40 GW to about 180 GW by 2045 (BMWK 2022).

Lastly, thermal insulation is a key component to reaching a climate-neutral building stock as approximately 63% of residential buildings in Germany were constructed before the introduction of the Thermal Insulation Ordinance in 1979. These buildings use up to five times more energy than structures built post-2001 (dena 2023). The IWU states that minimizing the heat demand in current residential buildings is essential for decreasing energy use, especially in heating systems that depend on fossil fuels (Diefenbach et al. 2019). In conclusion, the IWU

as well as the BMWK offer a clear roadmap to meet climate targets in the residential building sector. To achieve this, faster and more extensive renovations particularly in the areas of heating, electricity, and insulation are required.

## **2.3 Stakeholders**

### **2.3.3 Rental Owners**

*(Lea)* Rental owners are one of the key decision-makers on the demand side. Here, a distinction can be made between private and professional rental owners (Weiß et al. 2018). With regard to private rental owners, Renz and Hacke found that renovation decisions are influenced by a mix of ecological and economic considerations, depending on their priorities (Renz and Hacke 2016). Ecological considerations stem from the owners' general environmental awareness. Ecologically motivated renovations, however, are rare among private rental owners, indicating a gap between their general environmental awareness and actual environmentally conscious actions (Weiß et al. 2018).

To understand the owners' economic considerations, their financial motives and investment behavior can be considered. Rental income is often a secondary source of income, leading private rental owners to prioritize smooth tenant relationships over maximizing profits, even if it implies accepting lower rental income. This prioritization can limit available funds for renovations (*ibid.*). Moreover, their investment behavior includes avoiding loans and relying on savings, hindering the willingness to invest in energy efficiency (Cischinsky et al. 2015). This leads to a pattern of saving for a specific project before investing, resulting in small rather than comprehensive renovations (Schätzl et al. 2007).

Other influencing factors in the context of renovations are knowledge, social networks, and market conditions. Familiarity with technology options and successful examples from social networks can reduce barriers, increasing the likelihood of undertaking renovation

projects. Market conditions also play a significant role for private rental owners as they consider whether investment costs can be regained through rent. Low rent levels or high vacancy rates negatively impact energy-efficient renovation activities. Legal regulations and financial incentives do not significantly motivate private rental owners to undertake renovations (März 2017).

Professional rental owners include housing cooperatives, municipal housing companies, and private-sector housing companies (BMWSB 2023b). Most professional rental owners pursue long-term management strategies for their portfolios, in which the long-term preservation of the value or substance of the building is the main motivation for carrying out modernization measures (Weiß et al. 2018). For professional landlords, economic considerations and obstacles are of great importance. Their modernization behavior is strongly affected by their corporate form and ownership structure. Besides, legal regulations such as technical specifications of the GEG, rental law provisions for rent increases post-modernization, and financial incentives play a crucial role in shaping their renovation decisions. In general, it can be assumed that incentives for energy retrofits are lower in tight rental markets as rental owners are more likely to find tenants regardless of the energy standard (Adan and Fuerst 2015).

### **3 Problem Analysis**

#### **3.2 Rental Owner Study**

##### **3.2.1 Study Design**

*(Lea)* Alongside self-occupying owners, rental owners are the key decision-makers on the demand side when carrying out energetic renovations. Understanding the decision-making process and identifying the challenges rental owners face in renovation projects is therefore also crucial to address the retrofitting needs in the residential building sector. In the following

chapters, a study is conducted to answer the first research question of the thesis, with a focus on rental owners: What are the key challenges of rental owners in the context of the energetic retrofit of residential buildings? Thereby, the study examines the approaches and challenges of both private as well as professional rental owners.

As this study is intended to provide in-depth insights into real problems, perspectives, and motivations of a specific stakeholder group, a qualitative study is being conducted. Unlike quantitative research, qualitative research involves gathering information about participants' experiences, perspectives, and behaviors, aiming to address questions related to "how" and "why" rather than "how many" or "how much" (Tenny et al. 2022). For the purpose of this study, semi-structured interviews are conducted. While following a predefined set of questions, the interviewer is allowed to adapt the questions to the course of the interview to explore topics in greater depth. Conducted one-on-one, these interviews are particularly suitable for discussing sensitive subjects and exploring topics in detail (ibid.).

Qualitative data can be evaluated based on its credibility, transferability, dependability, and confirmability. By ensuring that these concepts are adequately addressed and carefully considered, potential issues can be reduced or prevented from occurring (Korstjens et al. 2018). In this study, credibility is addressed through a cross-section of the target demographic and a comparison with other study results. Transferability is addressed by using rich descriptions and providing details and quotes from participants. Lastly, dependability and confirmability are addressed by providing documentation of how participants are selected, and the data is collected (ibid.).

The population for this study is all rental owners in Germany. This population is divided into the subgroups of private rental owners, private-sector housing companies, municipal housing companies, and housing cooperatives (see Chapter 2.3.3). To select the sample, a mix of purposive sampling and convenience sampling is used (Tenny et al. 2022). First, research is

conducted to identify potential participants who can provide meaningful information. Then, the participants are contacted and selected based on their availability. In addition, convenience sampling is used by reaching out to private and professional rental owners in my network. The aim of the study is to conduct 15 interviews. However, data saturation and practical limitations must be considered (Mwita 2022).

To answer the research questions, the interview is divided into six parts. First, key facts about the participant and their residential units are collected to understand the initial situation and to be able to draw conclusions as to whether other initial situations lead to different motives, actions, and challenges. Parts two to five delve deeper into the renovation process. Here, questions cover the energy state of the property (part two), the identification of renovation measures (part three), the decision-making process (part four), and the implementation of renovation measures (part five). These parts focus on identifying the participants' current approach and whether they face any challenges. In the final part, future renovations and support requirements are addressed. Moreover, participants can ask questions and give feedback. The interview guideline can be found in Appendix 4.

### **3.2.2 Implementation**

*(Lea)* With regard to the implementation of the study, I will shortly describe the recruiting procedure and my behavior during the interviews. For purposive sampling, I assumed a response rate of 10%, so I contacted about 100 companies or people via email and LinkedIn. For convenience sampling, I assumed a response rate of 60%, so I contacted about ten people in my network. Finally, I interviewed nine rental owners of which four are private rental owners, three are employees of private-sector housing companies, one is an employee of a municipal housing company, and one is a member of a housing cooperative. Due to time constraints, the recruitment of additional participants was not feasible.

Before the interview, the participants were guaranteed confidentiality and informed that participation is voluntary and that they can withdraw from the study at any time. Each interview lasted 30 to 45 minutes. At the beginning, I briefly introduced myself and explained the purpose of the interview as well as the duration and the documentation method. Subsequently, I conducted the interview based on the interview guideline while adapting to the course of the conversation. To conclude, I thanked them for their participation and finished the documentation. Afterward, the interviews were transcribed into written form and translated into English to conduct the analysis. The interview transcripts can be found in Appendix 5.

### **3.2.3 Analysis**

#### **Method**

*(Lea)* In the context of qualitative research, various analysis approaches can be employed. For all methods, the analysis process serves to reduce the collected text, categorize, and group elements, and ultimately gain a deeper understanding of the data (Bengtsson 2016). For the purpose of this study, a manifest analysis, a form of qualitative content analysis, is conducted. This method expresses data in terms of words and themes, enabling the interpretation of the findings. The researcher delineates what the participants say, sticking closely to the text and describing the apparent elements within the text (*ibid.*).

The manifest analysis consists of four distinct stages. The first stage, decontextualization, involves the researcher familiarizing themselves with the data and gaining an overall understanding of its content before breaking it down into smaller meaning units. These meaning units are the smallest components that contain relevant insights related to the study's objectives. The second stage, recontextualization, requires the researcher to revisit the original text. The text is again carefully evaluated to determine if any content other than the

meaning units contributes to answering the research questions. If certain content is relevant, it is included in the analysis, otherwise, it is excluded (ibid.)

In the third stage, the units of meaning are condensed, and codes are generated without losing the essence of the units. Afterward, categories are identified within these codes. The final stage, compilation, involves writing up the analysis results. Overall, the participants' words are used, and the original text is closely retained. The focus of the analysis is primarily on the categories that help answer the research questions (ibid.). An exemplary analysis of an interview can be found in Appendix 6.

## **Results**

As described before, the interviews are divided into six parts: key facts, the energy state of the property, identification of measures, decision-making process, implementation of measures, and future renovations. In the following, the results for each part of the interview are summarized based on the categories identified during the third stage of the analysis process.

The first part of the interviews (key facts) reveals differences between rental owners in terms of portfolio size and renting purposes. Private rental owners own two apartments on average, of which 75% are apartments and 25% are houses. The primary type of renting is private renting. The main reasons for becoming a rental owner are investments for the future, additional income, and inheritance supporting the findings of previous research (see Chapter 2.3.3). Professional owners manage a larger number of units, ranging from 1,800 in a municipal housing company to 450,000 in one of the private housing companies. Here, the majority of the housing units are also apartments (84%), with the remainder being houses (16%). In addition to private renting, commercial renting, social renting, and collective renting are offered.

The second part of the interviews (energy state of the property) highlights a clear need for energy renovation measures across the board. The energy states of the properties suggest a

generally dated housing stock, with most buildings being over 20 years old. It becomes apparent that the majority of these properties fall within the C to F energy efficiency rating range. Private owners' portfolios average a D rating in energy efficiency, matching the findings in Chapter 2.1.2 and indicating room for improvement. Professional rental owners have a broader range of energy efficiency, with an estimated 20% to 30% of units at the lower end of the scale, rated G or H.

The energy-related responsibilities among the interviewees typically include maintenance, repairs, and replacements. Private rental owners generally handle these tasks personally, while professional rental owners tend to delegate them to either external property management firms or dedicated in-house teams. Whereas private rental owners have either not undertaken any renovations in the past five years or have only sporadically implemented upgrades, professional rental owners demonstrate a systematic approach, having developed a long-term strategy, and conducted pilot projects. One professional rental owner explains “we've started to conduct pilot projects to test our strategic assumptions and to learn from experience with new technologies such as heat pumps or PV panels about two years ago” (Appendix 5, Interview 6). Especially the renewal of heating systems and the improvement of insulation appear necessary according to the statements of the interviewees. Overall, the energy state of the properties and the extent of previous renovations underline the retrofitting needs presented in Chapter 2.2.2.

Regarding the third part (identification of renovation measures), the findings highlight the contrast in how private and professional rental owners identify appropriate measures. Two out of four private owners rely on long-term planning, internet research, and professional assessments. They seem to adopt both proactive and reactive approaches, leaning on personal networks and online information. Professional owners, in contrast, follow a long-term approach. Four out of five professional owners identify measures based on data analysis and

long-term planning, informed by professional assessments and regulations. They also consider specific technical aspects such as low-temperature readiness, indicating a more advanced and structured approach.

When identifying renovation measures, six out of nine rental owners define lack of knowledge as a key challenge. In addition, both, private as well as professional rental owners, mention uncertainty about the profitability of renovation measures as a key challenge. One private rental owner says “it can be difficult to know what to do. Oftentimes, it gets very technical, complex and costly” (Appendix 5, Interview 4). For professional rental owners, internal processes and the complexity of projects are further challenges. One employee explains “Sometimes, theory and data do not align with what is possible in reality which can lead to miscalculations” (Appendix 5, Interview 5).

Regarding future renovations, both private and professional rental owners are primarily focusing on heating systems and insulation. As proposed in the background paper from the BMWK (see Chapter 2.2.2), both heating networks and heat pumps are equally considered as future solutions for multi-family houses. Insulation is another key area, often in conjunction with heating improvements. One private rental owner mentions “I would start with the heating appliance [...]. In this process, I think I will also have to look at the general insulation and its quality” (Appendix 5, Interview 4). Overall, the focus areas reflect a push towards energy efficiency.

The findings in the fourth part (decision-making process) emphasize different motives and decision factors among the participants. Four of four private rental owners seek out a return on investment when carrying out renovations. Besides, two each are motivated by creating comfort for their tenants, contributing to climate protection, or achieving long-term savings. One private rental owner explains “for me it is about increasing the value of the apartments while doing something that is good for the future economically speaking and environmentally

speaking. [...] I rather take some more time and money now than having to renovate again and again” (Appendix 5, Interview 2). This statement contradicts research findings indicating that small private landlords tend to carry out renovations more often but on a smaller scale (see Chapter 2.3.3). The main reasons preventing private rental owners from undertaking renovations include a lack of knowledge, a lack of financial resources, and the unavailability of experts. For professional rental owners, the main motive for undertaking renovations is compliance with laws. Other motives include the return on investment, the creation of comfort, and the contribution to climate protection. The main reason holding them back from renovations is internal processes, followed by coordination and a lack of financial resources.

For all private rental owners, the decision of whether to renovate is mainly influenced by the availability of financial resources. Two out of four also mention the expected return on investment or the availability of experts as key decision factors. The relationship with the tenants, however, seems to play a subordinate role in the decision-making process contradicting the findings in Chapter 2.3.3. For professional landlords, the most important decision factor is the return on investment, followed by regulations and the availability of financial resources. One professional rental owner summarizes “there has to be a profitable business case, and then it’s the contribution to climate protection based on the regulatory requirements that counts” (Appendix 5, Interview 7).

For the implementation of renovation measures (fifth part), all private rental owners primarily consult and work with known contractors. Three out of four use the internet as a source of information. One owner explains “I also like to do my own research to know what I want and to be able to evaluate the offers I get from contractors” (Appendix 5, Interview 1). The majority of professional rental owners, on the other hand, have in-house experts at their disposal, complemented by external contractors for specific tasks. This distinction showcases the broader resource base available to professional rental owners compared to private owners

who navigate between established relationships and the open market. To finance their renovation projects, both groups utilize savings, loans, and subsidies. Contrary to the research findings (see Chapter 2.3.3), the use of financial incentives to offset renovation costs appears to play a significant role for both groups. One private rental owner states “For the replacement of my heating appliance, I might also look for subsidies and see if they’re available” (Interview 1). Challenges in the implementation phase include the unavailability of experts and the unreliability of workers. A professional rental owner emphasizes “We have to find new ways and solutions to renovate buildings more efficiently” (Appendix 5, Interview 7). Whereas private rental owners also cite financing as a key challenge, professional rental owners again refer to the complexity of projects and internal processes as obstacles to the realization of projects.

With regard to future renovations (sixth part), private rental owners anticipate focusing more on sustainability, influenced by regulations and the availability of subsidies and experts. Professional rental owners state that their renovation approach will mainly be influenced by regulations. Besides, both groups foresee an emphasis on sustainable heating technologies. One employee of a private housing company states “We will have to get a better understanding of these technologies and their implications so that we can plan renovation strategies and projects for longer periods” (Appendix 5, Interview 5). Both private and professional rental owners express a need for guidance, the availability of funding, and the availability of experts as crucial support for their renovation efforts. Professional owners specifically emphasize the role of stringent regulations and partnerships, highlighting the need for collaborative efforts to facilitate their renovation strategies. One professional rental owner says “good partnerships to learn and develop the skills and capacities we need for this transition” would be helpful. A summary of these results can be found in Appendix 7.

### 3.2.4 Conclusion

#### Summary

(Lea) The study provides insights into the energetic condition of buildings as well as the approaches and challenges faced by private and professional rental owners regarding energy renovations. The study reveals that most buildings are over 20 years old and fall within the C to F energy efficiency rating range. The findings underscore the need for comprehensive energy renovation measures. However, rental owners face various challenges when considering or conducting renovation measures.

One key challenge that arises along the renovation process is the *lack of knowledge*. This lack of knowledge mostly concerns technologies and the feasibility of projects and is reinforced by the overall complexity of projects and the lack of experts. Private owners often rely on online information and personal networks which do not provide the needed guidance. Professional rental owners, despite having more resources, also struggle with assessing the feasibility of projects and the implications of sustainable technologies. This lack of knowledge leads to uncertainty and hesitation.

Another main factor holding rental owners back from undertaking renovations is financial concerns. Here the key challenges include *raising the financial resources* and *assessing the return on investment*. Private rental owners are primarily concerned with generating a steady source of income. High initial costs associated with renovation measures and a lack of knowledge lead to uncertainty surrounding the long-term profitability of renovations. Professional rental owners, managing larger portfolios, confront this uncertainty on a broader scale. They must balance the need for energy efficiency upgrades and the financial viability of such projects. In general, they see a major challenge in achieving climate targets while maintaining housing affordability.

Finally, professional rental owners, unlike private owners, face additional challenges due to their *organizational structures*. These challenges arise from the complexity of managing a large number of properties and the scale of renovation projects. Professional rental owners cite internal processes, the quality of information, and the coordination among stakeholders as obstacles in renovation projects. All in all, the challenges mentioned by private and professional rental owners can slow down the implementation of energy-efficient renovations in the building sector.

### **Limitations**

All in all, the study demonstrates a comprehensive approach to qualitative research in understanding the renovation behaviors of rental owners in Germany. However, several limitations can be identified. First, the study employs a mix of purposive and convenience sampling, which could introduce bias. While purposive sampling aims at selecting participants relevant to the research questions, convenience sampling, particularly from the researcher's network, may not provide a fully representative sample of the target demographic. This approach limits the generalizability of the findings. Moreover, the aim was to conduct 15 interviews but eventually, the study included nine participants. This means that certain perspectives or experiences relevant to the research questions may be missing, potentially affecting the depth and breadth of the findings.

Furthermore, the observer-expectancy effect remains a concern in qualitative research. The researcher's presence and interaction during interviews can inadvertently influence participant responses. Although I did not intend to express any personal views, subtle reactions during the interviews can still impact the data collected. Lastly, the interviews were transcribed and translated into English for analysis. This process can introduce errors or nuances in translation, potentially affecting the accuracy and integrity of the data being analyzed. All in

all, the results should only be interpreted with these restrictions in mind and additional studies with a larger sample size are recommended to validate the findings.

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## Appendix

### Appendix 4: Interview Guideline

Topic	No.	Question
<b>1 Key facts</b>	1.1	Are you a private or a professional rental owner?
	1.2	If professional: Can you classify the organization you work for? (Private-rental owner, Private-sector housing company, Municipal housing company, Housing cooperative)
	1.3	What type of property do you rent out? (Apartment/s or house/s)
	1.4	For what purpose do you rent out your property? (Private renting, commercial rental, social housing, tourist rental, other purpose)
	1.5	How many residential units do you rent out?
	1.6	If private: Why and when did you become a rental owner?
	1.7	If private: What is your professional background? If professional: What is your job within the organization you work for?
<b>2 Energy state of property</b>	2.1	If private: In which energy state would you say your property is? If professional: How do you classify your portfolio with regard to the energy state and what is the distribution?
	2.2	What are your main tasks with regard to energy in your property?
	2.3	If privat: Did you carry out any renovation measures in the last 5 years? If so, what measures? If professional: Did you start any renovation initiatives for your properties in the last 5 years? If so, what kind of initiatives?
<b>3 Identification of renovation measures</b>	3.1	How do you identify appropriate renovation measures?
	3.2	Do you face any challenges when identifying appropriate renovation measures? If so, what are they?
	3.3	What areas will you most likely renovate in the future and why?
<b>4 Decision-making process</b>	4.1	What are your main motives when carrying out renovation measures?
	4.2	What are the main reasons that hold you back from carrying out renovation measures?

	4.3	Can you describe the factors that influence your decision to renovate or not to renovate?
	4.4	How do you prioritize these factors?
<b>5 Implementati on of measures</b>	5.1	Who do you consult for renovation measures?
	5.2	Who conducts renovation measures at your property?
	5.3	How do you finance your renovation projects?
	5.4	Do you face any challenges when implementing renovation measures? If so, what are they?
<b>6 Future renovations &amp; Conclusion</b>	6.1	Looking ahead, how do you see your approach to renovations evolving, and what trends or changes in the market might influence this?
	6.2	What kind of support would help you most in this context?
	6.3	Do you have any additional feedback or questions as part of this interview?

## **Appendix 5: Transcripts of Interviews with Rental Homeowners**

### **Interview 1**

Interviewer (I): Good morning and thank you very much for taking the time today. First, I would like to ask you some general questions to get to know you a bit better. As a start, could you tell me if you are a private or a professional rental owner and what type of property you rent out?

Rental Owner (RO): Sure, no problem. I am a private landlord and take care of all matters concerning the apartment myself. I rent out a three-room apartment in a building from the 1970s in Berlin Lichtenberg.

I: Okay great. And for what purpose do you rent out your property? Is it for private rental, for commercial or for tourist purposes?

RO: It's for private renting. I prefer long-term tenants. At the moment, there is a couple living in the apartment.

I: I see, how many residential units do you rent out? Is it only this one?

RO: Yes, just the one apartment. I bought the property as an investment and to provide something of a nest egg for the future. I bought it about ten years ago.

I: Interesting! So your main intention was to have a second source of income?

RO: Yes, that's right, the offer had come up through acquaintances and I had been thinking about investing my savings for some time at that point.

I: Sounds exciting. And what is your professional background? Do you have anything to do with real estate?

RO: No, not at all. I'm an engineer by trade, specializing in mechanical systems. But owning an apartment for 10 years has taught me quite a lot.

I: I can imagine. Now that I know about the basic facts, I would like to discuss the topics of energy and renovation with you in more detail. To start, perhaps you can tell me in which energetic condition your property currently is?

RO: As already mentioned, the building was built in the 70s. I don't really know what has been done during the time between the construction and me purchasing the apartment. I took over the gas heating appliance back then. I think it was installed in the early 2000s. With regard to the quality of the construction material and the energy efficiency of the house, I would assume some improvements were done.

I: I see, do you know the energy efficiency class of your apartment?

RO: Yes, it's D.

I: Interesting. And what are your main tasks with regard to energy in your property?

RO: Overall, of course, I try to create a comfortable living environment for my tenants. This includes good furnishings, a functioning heating system and good insulation so that there are no draughts and tenants don't complain about high energy costs.

I: I see, and have you carried out any renovation measures in the last five years?

RO: When I bought the apartment, I repainted, renewed the floor and renovated the kitchen. About I think three years ago, I replaced the windows. So with regard to energy, it's probably just the windows that improved the overall energy efficiency.

I: Okay, and could you tell me how you identify appropriate renovation measures like the window replacement?

RO: Well, in this case, I had been planning to replace the windows for some time. I knew they were quite old and there was a slight draught. Another reason for a renovation could be that there is a fault or a problem, or new laws are passed that force me to change something. Although this rarely happens, it is no longer so unlikely with the discussion about heating.

I: I see. And do you face any challenges when identifying appropriate renovation measures? For example, do you find it difficult to assess whether something should be repaired or replaced?

RO: Hm, yes, actually sometimes it is quite difficult to assess whether it makes sense to repair something or to replace it. In general, it is sometimes hard to tell which measures make sense and pay off economically.

I: I understand, and could you say which areas you will most likely renovate in the future and why?

RO: I've been afraid for a long time that the heating will have to be replaced soon. And at the same time, I think that all the discussions about the heating law and the recent high heating costs show that it would make sense to change something here.

I: I understand. You've mentioned regulations and costs here. Can you tell me a bit about your main motives when carrying out renovation measures?

RO: Yes, of course. I would say that first and foremost I try to make good investment decisions for the future. Of course, I also want to offer my tenants a pleasant living environment. And finally, as you said, I naturally also look at the legal requirements.

I: Interesting, and how do you define whether something is a good investment decision or not?

RO: Well, I would say that I aim to reduce my operating costs, so costs for maintenance and repairs as well as energy costs for my tenants. Also I think of what tenants look for and whether I can increase rent by implementing certain measures. So basically, whether the renovation adds value to the overall apartment or not.

I: Interesting. Could you tell me a bit more about what holds you back from carrying out renovation measures?

RO: The initial investment is always quite high, which is a deterrent at first. And not knowing whether it will be worth it in the long term. I have to rely on my research or advice from friends and craftsmen. Overall, it can be quite difficult to find reliable experts.

I: Can you describe the factors that influence your decision to renovate or not?

RO: I would say that it is most important that the investment pays off in the long run. And of course, whether I have the money, whether I have time and also whether I am able to find a contractor and arrange meetings with the contractor and my tenants.

I: I understand, and how do you prioritize these factors? For example what matters most to you?

RO: I would say that knowing it is a good investment matters most. Then, its having time and the financial resources to actually do it.

I: I see. So once you've decided to invest some money, who do you consult for renovation measures?

RO: I know a few local craftsmen that I've worked with before. But I also like to do my own research to know what I want and to be able to evaluate the offers I get from contractors. It also helps because most of the craftsmen you call, won't consult. They don't have time or just have a limited product range, so they only offer certain things. For example, I find it quite hard to find an expert that can advice me on heating. And in the internet you also find all kind of information and recommendations, but how can I be sure that it is solid.

I: I can imagine, and who conducts the renovation measures at your property? Is it a local contractor that you know then?

RO: Yes, I know a guy or two who are specialized in gas heating but I am not sure if they can consult me on electrical heating or solar thermal energy for example. They've come to the

apartment a few times to do some repairs. Sometimes, I also look for new experts, contractors and sources to compare offers and to ensure that I make the right decision.

I: And if I may ask, how do you finance your renovation projects?

RO: Well, for the window replacement, I used a combination of savings and a loan. For the replacement of my heating appliance, I might also look for subsidies and see if they're available.

I: And also here, do you face any challenges when implementing renovation measures?

RO: Yes, financing the renovation can be challenging and ensuring that the work is done to a high standard and within a reasonable time is always something to keep an eye on.

I: I imagine, thank you for answering all these questions in such detail. To end the interview, I have two more general questions to ask. So first, looking ahead, how do you see your approach to renovations evolving, and what trends or changes in the market might influence this?

RO: In the future, I might place greater emphasis on sustainability and energy efficiency. Market trends are increasingly favoring eco-friendly and energy-efficient properties, and I think this will influence my renovation decisions.

I: And since we talked a lot about challenges, what kind of support would help you most doing renovation projects in the future?

RO: Clearer guidance would be a great help and better access to funding, for example grants. Also having expert opinions to rely on and to help me identify reasonable measures.

I: Great, thanks a lot! Now, that we have come to the end of this interview. Do you have any additional feedback or questions?

RO: No further questions, but I am curious to see what you will find out and I wish you good luck with your thesis!

I: Thank you, and thank you for your time and insights.

## **Interview 2**

Interviewer (I): Good afternoon and thank you for taking the time for this conversation. To begin, could you tell me if you are a private or a professional rental owner and what type of property you rent out?

Rental Owner (RO): Good afternoon, sure. I'm a private rental owner and I own two residential apartments situated in a suburban area of Cologne. The apartments are about 50qm and 70qm.

I: Great, and for what purpose do you rent out your property? Is it private renting, social housing, for tourists, free of charge or another purpose?

RO: I rent out the apartment as normal to private individuals and try to find tenants who want to live there for longer. Overall, I see the apartments as another source of income alongside my job.

I: Sounds good. Could you share why and when you've become a rental owner?

RO: I considered buying property as an investment many years ago. In 2009, the first opportunity arose and I bought one of the apartments. In 2011, I bought the second, the bigger apartment. Both to secure additional income for the future.

I: I see, and what is your professional background?

RO: I work as a project manager in the IT sector.

I: Interesting! Now that we have covered the main facts, I would like to move on to the topics of energy and renovation. First of all, it would be great if you could share in which energy state your property is.

RO: I would describe the energy state of the apartments as typical for their age and design. The building with the smaller apartment is from the late 90s. The energy rating of the apartment is D. The other building was constructed in the 80s, here the energy rating of the apartment is E.

I: What type of heating do you use?

RO: Both apartments have a gas appliance from 2008 I think.

I: Thank you for the explanation. Could you share what your main tasks are with regard to energy in the apartments?

RO: Well, everything that has to do with energy and energy costs, for example heating and warm water. I make sure that everything works well and that my tenants' energy needs can be met.

I: I see, and have you implemented any renovation work in the last five years with a focus on energy?

RO: When I bought the apartments, I wanted to rent them out first to quickly pay off my loan. Over the years, I have done some smaller upgrades on thermostats and I also had some repairs on the heating system, but I haven't changed much.

I: Thank you for the insights. And are there any areas where you will likely renovate in the future?

RO: Definitely, now that I had the apartments and paid off my credit for a while, I want to invest again and make them ready for the future. So much has happened in the last years, regulations have changed, energy costs have risen and I think it just makes sense to upgrade a few things to increase the energy efficiency. It also becomes more and more important for tenants and gives the opportunity to increase the overall value of the apartments.

I: And how do you identify suitable renovation measures for your properties?

RO: I like to research online first to get an overview of technologies, possibilities, maybe subsidies or offers. I think my goal would be to improve the energy rating, since this is an official assessment and also a sign for tenants and other investors. Since the energy rating in the 70qm apartment is quite low, I might start with this apartment or maybe I would try to get an assessment for both apartments and then see what makes sense.

I: I understand, do you have any measures in mind or would you wait and see what the assessment tells you?

RO: I think heating is definitely a lever for improving the energy balance. Otherwise, I could imagine renewing the windows. But I'm not sure to what extent I can decide that on my own and whether it's worth it.

I: I see, would you say that this is a challenge? Or do you face any challenges in general when identifying appropriate measures?

RO: Yes, definitely, I might need to check regulations or talk to other owners of apartments to find out what I can do on my own. In general, I believe in the long-term benefits of energy-efficient renovations, but I want to be sure I invest my money wisely, especially with two apartments. Here I would definitely need some expert opinion.

I: I understand, could you tell me a bit more about your motives when carrying out renovation measures? Is it improving the energy rating as you said before or are you pursuing other goals as well?

RO: Yes, its about improving the energy rating. But for me there is more to it than an energy rating result. I think for me it is about increasing the value of the apartments while doing something that is good for the future economically speaking and environmentally speaking. If I invest money now, I want to invest it wisely and look at different factors like initial costs, operating costs, contribution to climate protection. I rather take some more time and money now than having to renovate again and again.

I: Very interesting and understandable. Thank you for the detailed answer. In contrast to your motives, are there any reasons that hold you back from carrying out renovation measures? Is there something that held you back in the past?

RO: First, I didn't renovate because I didn't have the financial resources to do so. Then, I think time just passed and to some extent, I also didn't know where to start. And in the last couple of years, there was just so much going on and so much insecurity with Covid, the Ampel coalition coming to power and announcing new laws and subsidies, the war in Ukraine breaking out, so I wanted to wait and see how things develop I think.

I: I understand. Can you describe or summarize the factors that influence your decision to renovate or not to renovate?

RO: For me its always a mix of factors, including initial costs, expected return on investment, potential energy savings in the long run, market developments, regulations, feedback from tenants, ... Many factors I think.

I: And how do you prioritize these factors when making a decision?

RO: That's a difficult one. Probably return on investment summarizes it quite well and is the most important factor. Then of course, this return can be economically but environmental, a good energy rating and carbon footprint can help attract tenants and justify a rent increase.

I: I see, interesting. Maybe moving away from the decision process to actually conducting renovation projects in reality. Who do you consult or who would you consult for renovation measures?

RO: Usually, I consult craftsmen, but I also would like to read up and educate myself by doing some research and maybe talking to energy consultants in the future, so that I know what I am talking about and where I invest my money.

I: Makes sense, and who conducts renovation measures at your properties or who would you hire?

RO: I would only hire licensed and experienced craftsmen to carry out the renovation work. I would only want to collaborate with professionals to ensure the quality and safety of renovations.

I: I understand. Would you tell me more about how you financed your renovation projects in the past or how you plan to finance them in the future?

RO: Since I am planning on investing in energy efficient and sustainable solutions, I would try to receive some government funding. Besides that, I would try to finance the measures with my savings.

I: And are there challenges you face or anticipate when implementing renovation measures?

RO: Challenges related to the implementation? Hm I would say finding qualified and reliable craftsmen and not having any unforeseen costs or delays. And of course, coordinating the renovation work with tenants can be challenging.

I: I see. To finish the interview, I would be interested in knowing how you envision your approach to renovations to evolve, and what market trends or changes might impact your decisions in the future?

RO: I want to explore more sustainable options and see what expert opinions are out there and how this translates into subsidies. By doing so, I want to reduce my investment costs, ensure that it is a good decision in the long term and that it is sustainably reasonable.

I: And what kind of support would be most beneficial to you in this context?

RO: I think good and reliable information sources would help, and subsidies would be helpful as well.

I: Lastly, do you have any additional feedback or questions as part of this interview?

RO: No, I believe we've covered quite a lot.

I: Yes, I agree. Thank you for sharing your detailed insights. Your perspective and experiences are highly valuable. Thank you!

### **Interview 3**

Interviewer (I): Hello, and thank you for taking the time for this conversation. As a start, I would like to know some general facts about you and the property that you own if that is okay. So the first question is if you are a private or a professional rental owner and what type of property you rent out?

Rental Owner (RO): Hello, and of course. I'm a private landlord. I own four apartments in and around Münster.

I: Great thank yo. Could you tell me for what purpose you rent out the apartments? Is it private renting, social housing, for tourists, free of charge or another purpose?

RO: Three of the apartments are rented out normally and advertised on public platforms and one is rented out to tourists.

I: Interesting, could you share why and when you've become a rental owner?

RO: The construction of the apartment building was put out to tender in 2005 and I had been looking for investment opportunities for some time beforehand. After some consideration and negotiations with the bank, I got involved in the project. I have been interested in the real estate market for a long time and always saw this as an opportunity to invest and generate passive income.

I: I understand, and what is your professional background?

RO: I am a self-employed financial advisor.

I: Okay, I see, so you have some expertise in investment decisions. Now, I would like to dive deeper into the topics of energy and renovation. First of all, it would be great if you could tell me in which energy state your property is.

RO: Since all the apartments are in one house and the house was newly built in 2005, I would say that the apartments have more or less similar facilities.

I: Could you explain a bit more? Could you for example share which energy efficiency class the apartments have?

RO: Of course, the apartments are well insulated and have double-glazed windows. The radiators date back to the year of construction and the heating systems were replaced in 2016. All apartments either have the energy classes B or C.

I: Thank you for sharing these details. And what are the main tasks with regard to energy in the apartments today?

RO: Today, there is a property management company that takes care of the operational management. That includes tenants search or organizing maintenance and repair visits. I take care of future investment decisions and long term planning.

I: I see, and have you conducted any renovation measures in the last five years?

RO: No, I haven't. The last change was the replacement of heating appliances in 2016 and the renovation of the one apartment that was transformed into a vacation apartment in 2014.

I: I see, what type of heating is installed in the apartments if I may ask?

RO: In all apartments, we installed electric instantaneous water heaters.

I: Interesting. And are there any areas where you will likely renovate in the future?

RO: I am considering the installation of solar panels on the roof and smart home devices. Since the water heaters use electricity, electricity costs can be quite high. With solar panels, part of the energy could be covered by the panels. Overall, I would like to get a better understanding of energy costs and savings which is why smart home devices could make sense.

I: And how did you identify these renovation measures or how do you identify them in general?

RO: I see the apartments as an investment. That's why I also think very strategically about refurbishment and consider which investments make sense and increase the value of the properties. Since the heating is relatively new, I am thinking about other suitable measures at the moment. Since the market favors solar panels right now, this could be a good investment.

I: I see. And in general, when these considerations and decisions have to be made, do challenges arise?

RO: Well, the government hasn't made it easy for rental owners in recent months. There has been a lot of uncertainty surrounding certain draft laws. That definitely makes considerations and decisions more difficult.

I: Can you explain this a bit?

RO: Well, for a long time, it was not clear how exactly the heating plan for apartment buildings would look like, then there was a lot of uncertainty about generating tenant electricity and, overall, it was kept open as to how much of the costs could be added to the monthly rent. But well, now the relevant laws have been passed and there is clarity for the time being.

I: I understand. You said you try to make good investment decisions, can you elaborate a bit more about your motives when carrying out renovation measures?

RO: Sure, I consider market trends and try to anticipate how the market will emerge in the next few years. In general, I aim to increase the value of my property with well-thought-out investment decisions that bring higher rents or lower operating costs in the long term.

I: And could you name any reasons that hold you back from carrying out renovation measures?

RO: Of course, as I said uncertainty about regulatory changes make me postpone certain projects sometimes. Besides, I look for good contractors that have a specialized expertise in the areas where I want to invest. Here, it can be difficult to find the right experts. And lastly, I sometimes just don't have time to plan and conduct new projects, so it also depends on my workload.

I: That makes sense. Could you describe or summarize the factors that influence your decision to renovate or not to renovate once again and how you prioritize these factors?

RO: So, first I consider my overall investment plan for the apartments and my long term strategy. Then, if there is something I would like to look into, I wait until I have the time to consult with experts. And lastly, I check whether I can gather the financial resources and I hire the expert.

I: Who do you consult or who would you consult for renovation measures?

RO: A friend of mine is an architect and energy consultant, I often talk to him about certain ideas first and then see what the market has to offer.

I: Interesting. And who do you hire to conduct renovation measures at your properties?

RO: I hire experts. Either experts and craftsmen I know from experience or new experts if I feel like I don't know the right person or I want to compare offers. For the installation of solar panels, I know a few companies in the area that install them. However, they probably cannot help with the regulatory issues of generating tenant electricity, so I might look for other more innovative and advanced market players or service providers.

I: I understand, generating tenant electricity really is a new field. With regard to the implementation of measures, I would be interested in knowing how you finance your renovation projects. Could you share something about this?

RO: I either use my own savings or do a mix between savings and a loan. For the solar panels I will probably just finance the installation myself.

I: And overall, are there challenges you face when implementing renovation measures?

RO: As I said, finding the right experts and craftsmen can be challenging by that I mean someone who is well experienced yet innovative, someone who delivers high quality and reliable work.

I: I see. To conclude, I would be interest in knowing how you envision your approach to renovations to evolve, and what market trends or changes might impact your decisions in the future?

RO: Further regulations might have an effect on my future decisions. Moreover, I will have to see whether it is feasible and economically viable to install solar panels or smart home devices. Since this is a new field, I will rely more on contractors and market players than with other decisions.

I: Is there any kind of support that would be beneficial to you in this context?

RO: Well, finding a good contractor who has experience with the topic of tenant electricity would be great. Other than that, I think not.

I: Okay and lastly, do you have any additional feedback or questions as part of this interview?

RO: No, I don't.

I: Okay, then thank you very much for taking the time and for sharing your insights with me today!

RO: Your welcome.

#### **Interview 4**

Interviewer (I): Good morning again and thank you for taking the time for this interview. I would like to start with some general questions if that is okay. So first, could you tell me if you are a private or a professional rental owner and what type of property you rent out?

Rental Owner (RO): Of course. I rent out a house that I inherited from my parents four years ago.

I: Thank you. And for what purpose do you rent out your property? Is it for private rental, for commercial, for tourist purposes or another special purpose?

RO: It's for private renting. Right after I decided to rent out the house, I found a young family who has been living there ever since.

I: How nice. So this house is the only property you rent out and it is one housing unit, you didn't install multiple apartments, did I understand correctly?

RO: Yes, that's right, just the one house with one unit for a family.

I: Great. And if I may, when exactly did you start renting out the house and why? Why not sell it for example?

RO: Yes, of course you can. I grew up in this house and I collected many memories in it. It was clear to me that I wanted to keep it for the time being. Maybe one day I'll move in myself or my children will, or maybe I'll sell it after all. But in the medium term, renting is the best solution for me.

I: I understand. And one last question before diving deeper into energy topics. What is your professional background?

RO: I am an assistant tax consultant.

I: Great, no that we've talked about some general facts, I would suggest we dive deeper in energy topics. To start, can you tell me in which energetic condition your house currently is?

RO: It was built in 1989, so it's about 30 years old. The insulation could probably need some improvements.

I: Can you tell me what type of heating is used and what energy efficiency class the house is allocated to?

RO: Yes, there is an oil heating system installed. I think it lasts back to the late 90s and the energy class is E, probably also from large parts because of the oil heating.

I: Okay, thank you. Now, could you tell me what your main tasks with regard to energy in your property are?

RO: Of course, just related to energy?

I: Yes exactly.

RO: I take care of the oil supply once in a while and we have some maintenance visits or repairs that I arrange. For electricity, the tenants are free to choose their own electricity provider.

I: I see, and have you carried out any renovation measures in the last five years?

RO: We renewed the floor, repainted the walls, and installed new bathrooms and a kitchen before renting out.

I: Ah okay, and did you change something on the building envelope, for example insulation or windows?

RO: No this is all in the original state.

I: I see, and how do you identify appropriate renovation measures or how would you approach renovation measures in the future?

RO: I think I would start to look online for some helpful information and I would ask friends who have already conducted renovation projects. Besides that, I would look at which experts exist in the area. For heating for example, I could ask the craftsman that renewed the bathrooms. He has a plumbing and heating business.

I: Great, do you anticipate any challenges in this process or have you started looking for appropriate measures already and experienced certain challenges?

RO: I had already informed myself four years ago when I inherited the house. Some of the information I got online or from craftsmen was unsettling or contradictory. Since there was so much to take care of and to do in the house, I stopped looking at some point. But I know from experience that it can be difficult to know what to do. Oftentimes, it gets very technical, complex and costly.

I: And are there any areas you will likely renovate in the future? And if so, why these areas?

RO: Yes, I think at some point I will have to and it also makes sense. I think I would start with the heating appliance and see whether I can upgrade to a gas or electrical heating. In this process, I think I will also have to look at the general insulation and its quality.

I: And what would be or are your main motives when carrying out renovation measures?

RO: I would try to make the place more pleasant with measures that make sense money-wise and environment-wise.

I: Interesting. You already mentioned the contradictory information that you sometimes find when looking into renovation topics. Is there anything else that holds you back from carrying out renovation measures?

RO: Yes, I mean I don't have a lot of knowledge about these topics. So I would need to find some reliable sources and experts, but it can be hard to find someone who is available and willing to look at your house these days. In addition, most of these improvements are quite costly which is also something to consider.

I: I understand, and could you describe the factors that influence your decision to renovate or not?

RO: I would say it's mostly about having a good understanding of the matters and the opportunities and about having the financial resources to invest some money.

I: I see, and how do you prioritize these factors?

RO: I would say, being informed comes first. And if I am informed and know what is actually possible and what makes sense, I can look at the costs and see what is feasible from a financial point of view.

I: That makes sense. And who would you consult for renovation measures?

RO: I would consult google first haha. And then I would contact some local businesses nearby and see if they could come and take a look.

I: And would these local businesses also be the ones you hire to conduct the renovation measures at your property?

RO: Yes, once they visited the house and made an offer, I would decide which one to hire.

I: And, if I might ask, how would you finance your renovation measures or how are you planning to finance them in the future?

RO: I would also look online to see whether there are some programs or subsidies available. And then, I would probably also take on a loan depending on the costs of the project.

I: And last question regarding the implementation, did you face or do you anticipate any challenges when implementing renovation measures?

RO: Well, yes. As I said, not a lot of local businesses are willing to offer free consultations without knowing they get the job. So finding out what should and could be done will be tricky. Moreover, I would need some external money, securing the money would also take some time and can be quite difficult.

I: What do you mean by securing money can be difficult?

RO: For loans, I would have to negotiate with my bank which could take some time and for subsidies, well I don't really know, I assume there are some bureaucratic hurdles to overcome.

I: I understand. To conclude, looking ahead, how do you see your approach to renovations evolving, and what trends or changes in the market might influence this?

RO: I think, going forward, I just want to keep the place nice and maybe update a few things to make it more sustainable. If there's a new trend or something comes up, I'll think about adding it. But overall, I just want to make sure the house is a good place to live in and that it makes sense money-wise.

I: And to finish, what kind of support would help you most doing renovation projects in the future?

RO: Oh ehm, I would need to see what is out there. Maybe some help with comparing technologies or measures or finding my way through financing would be helpful.

I: Interesting, I'll note that. Thank you. Since the interview has come to an end, do you have any additional feedback or questions for me?

RO: No I am just curious to know what your thesis will be about and I hope it goes well for you.

I: Thank you so much, that is really nice! And thank you for taking the time for this interview. It was really helpful!

## **Interview 5**

Interviewer (I): Thank you for joining me today. First, I would like to cover some general questions. So, for the record, could you tell me if you are a private or a professional rental owner?

Employee (E): I work for a professional rental company.

I: Could you describe and classify the organization you work for?

E: We're a private housing company, located in Düsseldorf and we are focused on managing and renting out multi-family residential units.

I: What type of property do you rent out? Is it mainly apartments or houses?

E: We mostly rent out apartments. We also have a small number of single- and two-family houses in our portfolio, but I would say that 90% of our units are apartments.

I: Interesting. And for what purpose do you rent out your property? Is it renting for private individuals, or is it social housing or let's say renting out to tourists or businesses?

E: They are rented out primarily for private residential use.

I: Great, and how many residential units do you rent out?

E: The company owns and rents out approximately 4,300 apartments in about 680 buildings around the Rhine region.

I: I see, and what is your job within the organization?

E: I am a Portfolio Manager within the organization.

I: Interesting, could you tell me how you classify your portfolio in general, but also with regard to its energy state?

E: Our portfolio is very diverse. In general, we classify buildings based on their type, size, number of apartments and construction year. With regard to energy, we use energy efficiency classes for the buildings and in our portfolio, we have buildings ranging from A to H energy ratings. For every building we have all the information stated in the energy efficiency rating, heating structure, heat losses, insulation quality and so on.

I: I understand, so you have a large database then. And can you tell me something about the distribution, how many buildings are classified as H, how many as G and so on?

E: I'm not allowed to tell exactly, but I can say that in about 70% of the buildings, we will conduct renovation measures over the next 20 years to achieve a climate neutral building stock. The reasons behind the renovation measures differ, sometimes it is because of the energy rating, sometimes it is because we expect a regulatory change or new requirements from the municipal heat planning.

I: That sounds really interesting, we will come back to the reasons for renovations later. For now, maybe you can tell me what the company's main tasks are with regard to energy in the buildings and apartments?

E: Of course. We are a full service provider for our tenants. We coordinate the installation and repair of appliances and any other renovation measures. Also we monitor the current state and develop renovation strategies for the future.

I: Interesting, and did you start any renovation initiatives for your properties in the last 5 years?

E: First of all, we have a renovation strategy in place to comply with the climate protection goals. In this strategy, we consider regulatory requirements and the classification of buildings. We also define measures for the next 2-3 years. Based on this strategy, we've initiated several projects, focusing on insulation, heating systems, and window replacements to enhance energy efficiency. We first look at buildings with the energy rating H. We have in-house energy experts who analyze these building classes, assess how the energy rating can be improved most efficiently and define measures.

I: I see, so these energy experts identify appropriate renovation measures based on the status quo? And what are the key parameters here?

E: We use data to prioritize measures that provide the best efficiency gains. We compare the status quo, propose measures and show the costs and expected results. Then this proposal is proposed to the management board.

I: Interesting, and do you face any challenges when identifying appropriate renovation measures? Do you know of any challenges the energy experts face?

E: One challenge is having the right data in the right quality. Sometimes, theory and data do not align with what is possible in reality which can lead to miscalculations. Besides, aligning renovation projects with budget constraints is a challenge.

I: I can imagine. And are there any areas in particular that you will most likely renovate in the future?

E: We'll focus on thermal insulation and HVAC systems because these have a significant impact on energy consumption.

I: I see, and what are the main motives when carrying out renovation measures? Is it achieving a certain energy rating or are there other motives?

E: First and foremost, we have to meet regulatory requirements and do our part in achieving a climate neutral building stock. In this process, we want to improve all energy ratings that need to be improved, starting with the worst performing buildings.

I: And what are the main reasons that hold you back from carrying out renovation measures or initiatives?

E: Financial limitations I would say matter most. Renovation projects require a lot of capital and we have internal budget policies and business goals to comply with.

I: Thank you for this insight. So, capital required is probably the most important factor to consider, right? Are there any other factors that influence your decision to renovate or not to renovate?

E: Yes, as I said, we first look at regulatory requirements. If we think a renovation is needed, we do a cost-benefit analysis. The costs include all costs of realization and the benefits include KPIs with regard to the expected energy rating, property value, rent potential and the contribution to climate protection.

I: And is there some prioritization of these factors?

E: Well, financial feasibility comes first, followed by expected energy rating I think. The others are about equally important.

I: I see, and who would you consult for renovation measures? You talked about in-house energy experts, do you consult only them?

E: Yes, mostly them. Sometimes, we also consult with external planning offices, experts and contractors.

I: In more complex cases?

E: Yes, exactly, or if we are not sure about the energetic conditions. Then, we sometimes send someone to evaluate the property in person.

I: Interesting, and who conducts renovation measures for you - Do you have certain craftsmen in-house or do you hire external craftsmen?

E: We have in-house craftsmen for standardized repairs or replacements. For bigger projects, we hire general contractors or specialized companies for different tasks.

I: I see, and how do you finance your renovation projects? Do you also use subsidies for example?

E: Yes, we finance them, through internal investment budgets, loans, and sometimes government grants.

I: Okay. And again here, do you face any challenges when implementing renovation measures?

E: Yes... hm how can I put this? I said before, our data and theoretical approach can sometimes differ from what is possible on site. Before a project starts, we normally do some inspections with our contractors and see whether the plan is feasible. However, there can always be bad surprises or delays. We always try to build long-term partnerships with companies to ensure reliability, quality and trust. Besides that, we have some bureaucratic processes and budget policies that can complicate the implementation of some projects.

I: I understand. To conclude the interview, I would like to take a look at future projects. How do you see your approach to renovations evolving, and what trends or changes in the market might influence this?

E: We will need to gain more experience in renovation projects and implementing certain technologies. So far, heat pumps or district heating have only been discussed on paper but never integrated in one of our projects. We will have to get a better understanding of these technologies and their implications, so that we can plan renovation strategies and projects for longer periods. Besides that, we will need to evaluate different financing options in order to carry out renovation projects on the scale we envisage.

I: I see, and what kind of support would help you most in this context?

E: Hm I would say expertise in the areas I just mentioned and financial incentives would be most beneficial.

I: Okay, thank you very much! We have come to an end with the interview. Do you have any additional feedback or questions as part of this interview?

E: No additional questions, if you have any more questions feel free to contact me.

I: Thank you, that is very kind.

E: No problem and have a good day!

## **Interview 6**

Interviewer (I): Good day and thank you again for taking the time today. To start, could you briefly clarify whether you are a private or professional rental owner?

Employee (E): I represent a private housing company that owns and manages multiple residential properties.

I: I see, and what type of property is in your portfolio? Is it apartments or do you also rent out houses?

E: We mainly rent out apartments, for 95% of our portfolio. We have about 175000 apartments which are spread over 30000 buildings that we own.

I: For what purpose are these properties rented? For residential use, or commercial use as well or any other use?

E: Mainly for private residential use, but also for commercial use.

I: I see, and what is your role within the company?

E: I am a Business Development Manager. I manage strategic projects focusing on growth and sustainability. This means I am responsible for identifying and implementing energy efficiency projects and for exploring renewable energy opportunities.

I: Interesting. I am eager to learn more about the projects you conduct. But first, let's talk about the current status of your portfolio. How do you differentiate your portfolio with regard to its energy state?

E: We have different classification steps. First, we differentiate between neighborhood or scattered stock. Thereby, you can already make assumptions for energy measures for example in neighborhoods the connection to local heating networks could be feasible. Second, we differentiate between terraced houses and detached houses, number of residential units, building age, roof shapes and much more.

I: And how do you define or track whether they are less efficient energy optimized?

E: We have a register where we store data about all our buildings. This includes the data I just mentioned as well as the energy efficiency class, energy consumption, historic data on what has happened with the building, repairs, renovation measures and so on.

I: I understand, and in which state are most of your buildings? Can you say how the buildings are distributed across the energy efficiency classes?

E: With our portfolio, I think we almost cover the whole range from A to H. We don't have many buildings in the outer classes. Most buildings, I would say 60% lie somewhere between C and F, then maybe 20% in the worst performing and 20% in the best performing classes.

I: I see, and just to get the whole picture, could you describe your energy-related responsibilities for the properties?

E: Mine or the company's in general?

I: Sorry, ehm both would be interesting to know actually.

E: The company in general has different divisions. One division takes care of the operational property management that include all kinds of services, among other things the coordination of maintenance, repair or replacements of appliances such as the heating system, the radiators, water pipes or electrics.

I: I see, so you are well positioned here. And what are your takes in particular?

E: Well, in the team that I work in, we are responsible for the strategic property management one could say. We focus on growth in terms of increasing our portfolio in numbers as well as in value. And since the climate protection targets were adopted, we have also focused particularly on renovating our portfolio, following our sustainability strategy.

I: That sounds really interesting. And have you initiated any renovation projects recently?

E: In the past years, we have primarily worked on collecting data, establishing clusters and developing a strategy per cluster based on the implications of climate regulations and expert opinions. I mean we've never stopped our operational maintenance and repairs, but for more strategic renovation projects, we've started to conduct pilot projects to test our strategic assumptions and to learn from experience with new technologies such as heat pumps or photovoltaic panels about two years ago.

I: I see, and how do you determine which renovations are possible or necessary?

E: The buildings with the worst energy efficiency classes are tackled first. These have the highest energy consumption. The buildings are particularly inefficient due to poor or no insulation, poorly insulated windows or old heating systems. Here, holistic measures must be carried out on the insulation and system technology. For other efficiency classes such as C, we look at which individual measures have the greatest effect, for example a heat pump or solar thermal energy.

I: I see, and do you encounter any challenges in this process?

E: There are lot of challenges that lie in the detail. A lot of measures and their feasibility depend on the current system. If for example, a centralized oil heating is installed, we may look at centralized heat pumps. But if heating systems are installed on each floor, implementing a centralized solution can be difficult. In Germany I think, there are about 4 million gas heating systems installed on an apartment-level. How do you turn these into climate neutral solutions? You could switch to a gas supplier that uses 65% biomethane. This would fulfill the legal requirements. But you first have to find a supplier that offers this. Besides, this depends on the municipal utilities and the question arises whether there even is enough biomethane on the market. The situation is similar for district heating. Switching to district heating is easy for homeowners to implement. All we have to do is switch from decentralized to centralized and connect our pipes to the central network. But district heating

suppliers first have to expand the network and then provide climate-neutral heat. There are still many question marks and construction sites here.

I: Super interesting, the complexity and feasibility is nothing to be underestimated within this context. I mean you still have to find your way around these challenges and you mentioned that you have a strategy for each building cluster. What is the strategy about then? What areas will you most likely renovate in the future and why?

E: As our apartments are mainly located in urban areas, we are looking into the possibility of district heating first and foremost. From 01.01.2024, it must always be checked first whether there is a municipal heating plan. In Baden-Württemberg, heat planning is already in place, in Berlin/Brandenburg we can assume that it will certainly take another 3 years. In any case, we expect to supply 55% of our buildings with district heating by 2045. Our second priority is heat pumps, if they make sense. We assume that this will be the case for a third of our buildings by 2045. And for the rest, it will come down to a gas, hybrid or biomass solution. Of course, we also always look at additional measures such as windows, basement ceilings, insulation and, in the worst-case scenario, the facade.

I: Interesting, thank you for the detailed insights. Could you tell me a bit more about your motives as a company? What are your main goals behind all this?

E: First of all, of course, we have to act economically and comply with legal requirements. We understand the responsibility that the building sector bears in the area of climate and naturally want to make our contribution here.

I: I understand. You already mentioned certain challenges that can occur. Could you maybe tell a bit more about the main reasons that hold you back from carrying out certain renovation measures?

E: As a private company, financial constraints are the biggest obstacle, followed by a lot of planning and bureaucratic efforts. There are many ways to move forward, measures to implement and trades to coordinate. So identifying the right measures, raising the financial means and managing the whole implementation can be difficult and in certain cases, it holds us back from conducting certain projects.

I: I totally understand, and how do you decide whether to renovate or not? What are the decisive factors and how do you prioritize them?

E: It's a combination of regulatory framework conditions, keyword municipal heat planning, financial viability, and contribution to climate protection I would say. At the moment, we look for projects with a high contribution to climate protection at low costs. But, in the end, the most important factor for us as a company is, of course, that it is financially viable.

I: And who advises you on these projects?

E: We have a division internally, that consists of energy specialists, architects, and engineers and that plans these projects in detail.

I: I see, and does your company also carry out these renovations?

E: We have a team of craftsmen internally, yes. But we also use contractors who specialize in energy-efficient construction on a bigger scale.

I: Makes sense, and how are these projects funded?

E: They are primarily financed through a combination of our capital reserves, bank loans, and when available, government subsidies.

I: I see, and here again the question, do you face any challenges when implementing renovation measures?

E: As I said at the beginning, the devil is in the detail and this often applies to the implementation of projects. First of all, it takes several months of planning and coordination before a project can be implemented. And as already mentioned, we are only just starting with the first pilot projects. But of course, when it comes to implementation, everything has to come together, good planning, all trades, coordination with tenants, ...

I: I can imagine. To finish this interview, I would like to know how you see your approach to renovations evolving, and what trends or changes in the market might influence this?

E: We're moving towards more sustainable practices, aiming for energy neutrality. Market trends, technological advances, regulatory changes and best practices will guide us most I think. Since we are just starting this transformation, everyone in the industry seems to be quite open and willing to learn. We will try to form good partnerships and learn as well with our projects to find our own best practices in the upcoming years.

I: Thank you for this classification, really exciting. Is there any kind of support that would help you along the way?

E: I would say, financial incentives for sustainability initiatives and a clear guidance through regulations would be a great help. Besides that, good partnerships to learn and develop the skills and capacities we need for this transition.

I: Thank you so much for answering all my questions in such detail. We have come to an end now. Do you have any additional feedback or questions as part of this interview?

E: No further questions, no thank you.

## **Interview 7**

Interviewer (I): Hello again, and thank you for taking the time today for this interview. For the record, could you clarify whether you are a private or professional rental owner?

Employee (E): I work for a housing company, so we are professional rental owners if you like.

I: Great, and what type of property do you rent out, is it apartments, houses or mix for example?

E: We rent out apartments, terraced and detached houses.

I: Could you tell me how many residential units you own?

E: Sure, we have about 450.000 units in our portfolio, they are spread over about 55.000 buildings. The largest part, let's say 80%, of these buildings are multi-family houses with 4 to 8 units. The other 20% are terraced or detached houses.

I: I see, and do you only rent out for private residential use or also for social or commercial or other purposes?

E: We rent out for private residential use and for commercial use.

I: Noted, now could you tell me a bit more about your role within the company?

E: Sure, I am a strategy manager. In my team, we focus on long-term investments, sustainability and the strategic development of our property portfolio. So, you could say that we are managing and reporting all projects that correlate to achieving a climate neutral portfolio by 2045.

I: That sounds super interesting. Before we dive deeper into these topics, I have a few questions regarding the current status of your portfolio. First of all, how do you differentiate your portfolio in general and with regard to energy? Or in other words, how do you track the progress towards climate neutrality?

E: We use the building typology of the Institute for Housing and the Environment and distinguish between detached houses, terraced houses and apartment buildings. We also differentiate according to the number of residential units, the age of the building, as this can result in special features in the material properties of the houses, according to energy certificates and many other static data. For our team and work in particular, we have developed a tool that is linked to all relevant internal databases, feeds in all the building data and forms groups based on logics or key figures that we define. In this tool, we manage and report our renovation initiatives as we see where we are on the path to climate neutrality, which measures are proposed for which building and what the impact of these measures would be.

I: How exciting. And can you share how far you are on the path to climate neutrality, I mean in which energetic state your portfolio is right now?

E: I am not allowed to share the exact numbers, no. But the energy classes from our buildings range from A to H. Since most of our buildings date back to the 70s or 80s, we still have some way to go like most companies in the industry. However, we are serious and are defining our measures in such a way that we can achieve a climate-neutral building stock by 2045.

I: I see, before we jump into specific measures, could you briefly describe your energy-related responsibilities for the properties?

E: Of course. We have internal teams to cover all operational services and tasks. We have a team that manages vacancies and tenant changes, one that manages services assignments for heating systems, electrics, the building and its windows, roofs, basements, and so on. We work very specialized and cover all topics either internally or through external contractors.

I: That sounds quite extensive, but reasonable for the size of your company. And for the last five years, which areas have you been renovating or focusing renovation projects on? Can you give me a brief overview?

E: Puh, let me think about that. I mean, of course, we have done some renovations. In high numbers, we mainly focused on the exchanges of windows and heating systems I would say. On a more strategic level, we have piloted serial renovation, district heating and heat pumps.

I: Very interesting. Could you explain the concept of serial renovation a bit more?

E: Of course, in the process of serial renovation, the building is captured to the millimeter in 3D. A timber constructor then models the facades and produces facades with window and door cut-outs that fit precisely. The facades already contain the insulation and the window frames contain a controlled ventilation system. All components are made to fit precisely and assembled on site. This means that renovation work can be reduced from several weeks to a few days, so it is a really interesting case for us to test.

I: That sounds too good to be true. What are the downsides?

E: Right? But you are right, serial renovation is still in its infancy. There are only a few providers who can produce such precise 3D models, only a few providers who can turn these models into reality and manufacture complete systems. And short-term adaptation on the construction site is very difficult once the complete system has been manufactured so there is a high risk involved.

I: I see, and in general, how do you decide which measure makes sense for which building? How do you identify renovation measures?

E: As already mentioned, we use our internal tool. All building data is stored here and buildings are clustered. Our aim is to achieve low-temperature readiness for all buildings. Therefore, we...

I: Sorry, to interrupt, but could you explain what you mean by low-temperature readiness?

E: Oh sorry, sure. Low-temperature-capable or low-temperature-ready refers to the new thermal insulation standard from which the use of renewable heat is economically viable. The worse a building is insulated, the more difficult and uneconomical it is to install a heat pump. So, we either look at buildings that are low-temperature-capable already, and we install a heat pump to gain even more efficiency and improve on the energy class rating. Or we look at the buildings in which low-temperature readiness can be achieved at an acceptable cost. Here, we improve the insulation first and look at the heating system afterwards.

I: I see, very interesting. Do you encounter any challenges in this process?

E: Hm for some buildings it can be very difficult or costly to achieve this low-temperature readiness. Right now, we are identifying measures that make sense from an economical and environmental point of view. But at some point, we will have to decide how we proceed with the more difficult or complex cases and who pays for these renovations. Ensuring economic, environmental and social success might not work at some point, so we will have to see who bears the cost or what to neglect at some point.

I: I understand. So you said, you are focusing on less complex cases at the moment. What areas or building types are these? So, what are you most likely to renovate in the future and why?

E: The cases and projects we choose in the future can differ. Sometimes, the insulation and overall structure of a building is good, and we will invest in the heating system because it is financially viable and by this measure, we improve the energy rating from D to B. But we will also look at other cases, where we have to exchange windows, improve insulation, install centralized heating systems such as heat pumps in combination with a gas appliance or instantaneous water heaters. To learn and to start improving on the worst performing buildings.

I: I see, could you tell me a bit more about your company's motives and main goals behind the renovation initiatives?

E: We want to continue to offer affordable and comfortable living space. At the same time, as one of the largest real estate companies, we also want to make our contribution to the climate targets and be a role model for future housing.

I: Great, now could you maybe tell a bit more about the main reasons that hold you back from carrying out certain renovation measures?

E: Well, we have some internal approval and decision-making processes that take some time. Also only those projects that are financially viable make it through. So identifying the right measures and establishing a good business case that works in the end is probably the biggest challenge.

I: I see, and how do you decide whether to renovate or not? What are the decisive factors and how do you prioritize them? From your answers so far, I assume that affordability is the most important factor.

E: Yes, definitely, there has to be a profitable business case, and then it's the contribution to climate protection based on the regulatory requirements that counts.

I: And who do you consult for these renovation measures or decisions?

E: We have internal and external planning offices and energy consultants with which we work.

I: I see, and does your company also carry out these renovations?

E: We have teams of fitters for the implementation, in total we have over 1000 fitters, drywallers, heating installers and so on. But we also work with external partners for certain tasks. We always outsource structural engineering, for example, and currently also TGA planning for the design of the heat pump.

I: Okay, good to know. And could you tell me a bit more about how you finance renovation projects?

E: We have internal budgets for these projects and we have a team that looks for available subsidies that we can use.

I: I see, and also here in this phase, do you face any challenges when implementing renovation measures?

E: Well, the refurbishment rate in Germany as a whole is less than 1 percent and it should actually be 3 percent. Overall, we have to find new ways and solutions to renovate buildings more efficiently. The whole industry is affected by the lack of skilled workers and we need those skilled workers to achieve climate neutrality. So overall, there are many challenges in this phase.

I: And is there a challenge for you in particular?

E: For us, there is also the variety of stakeholders and the complexity and size of projects can be challenging.

I: I see, and to conclude the interview, I would be interested in knowing how you see your approach to renovations evolving, and what trends or changes in the market might influence this?

E: There are a lot of market developments and regulations now and will be in the future to guide us. The topic of sector coupling will for example be exciting, so how energy generation and power supply can be implemented in existing buildings, keyword solar package II, storage, e-mobility, tenant electricity and so on. However, there have been so many changes on the capital market in recent months that have startled many people, many are now more cautious about investing. Besides, the regulator leaves a lot open and is guided by the interests of a few. Why is the government continuing to focus on hydrogen or pellet heating? Certain companies are being given a lot of leeway here and a real energy transition is being delayed. Then, there will always be a conflict between the need for refurbishment and its costs. What costs must the government bear, what must we bear, what will be passed on to tenants? Tenants are often protected, rents should not rise, but somehow these projects have to be financed.

I: Really interesting points that you mention here, I will definitely look into these effects and trends. To finish the interview, is there any kind of support that would help you with your future renovation initiatives?

E: Hm, funding programs and low-interest loans should come and be stable over several years for planning security. In addition, skilled workers need to follow so that we can really achieve the energy transition.

I: Thank you very much, the interview was really helpful for me and shed light on some interesting and important topics. Do you have any additional feedback or questions as part of this interview?

E: You're welcome, no questions from my side. Feel free to reach out again in case of questions.

## **Interview 8**

Interviewer (I): Hello again, and thank you for participating in this interview today. To start, I have some general questions. First of all, could you tell me for the record, whether you are a private or a professional rental owner?

Employee (E): Hello again and no problem. I work for a municipal housing company in Baden-Württemberg, we rent out houses and apartments professionally.

I: I see, and what is the size of your portfolio? How many apartments or houses do you rent out?

E: We rent out about 1.800 apartments and houses. We have around 340 buildings in our portfolio, about 60 of them are single family houses or two family houses, the others are multifamily houses.

I: And for what purpose do you rent out these buildings?

E: We rent out to private people, with part of our portfolio consisting of social housing.

I: I see, how many units are for social housing?

E: About 40% are for social housing.

I: And what is your job within the company?

E: I am a Portfolio Manager, we oversee strategic investments, do reportings and market research.

I: Interesting, do these investments include investments for renovation?

E: Yes, not maintenance or repairs, that is managed by another team, but replacements and bigger renovation projects.

I: I see, and how do you classify your portfolio in general and with regard to its energy state?

E: We differentiate between the housing type, so multi-family housing or single-family housing and market-oriented housing versus social housing. With regard to energy, we differentiate between new-builds and existing buildings. For all buildings, we track the age, energy class, heating system and renovation history.

I: Really interesting. Could you tell me a bit about the distribution? So, how many of your buildings are new-builds or existing buildings, how many of your buildings have a very good or good energy rating or a medium to low energy rating?

E: Hm about 90% of our buildings are existing buildings, so they are older than 20 years. And they have energy classes that range from C to H I would say. And the new-builds, they have energy ratings of A, B or C I would say.

I: Why do some of them have a C rating if I may ask?

E: Well, they are all well insulated, but most of them have a gas heating installed. So with that, you cannot really reach an A+ or A rating.

I: I understand. Now could you tell me a bit more about the tasks you have with regard to energy in your property?

E: Well, as I said before, we have a team that takes care of operational maintenance work and repairs. And we have our team that proposes investment decisions based on our reportings

I: I see, and did you start any renovation initiatives for your properties in the last 5 years? If so, what kind of initiatives?

E: I wouldn't say initiatives, but we did some renovation projects, yes. In most cases, there either was a heating system failure or a problem with the windows, so that cold air or moisture entered the apartment. In these cases, we did not only conduct a small repair but a bigger measure that had an impact on the energy efficiency lets say.

I: Okay, but those measures mostly focussed on heating and window replacement?

E: Yes, I would say so. I mean, we also did some bathroom and kitchen renovations, but I would assume these are not really interesting for your research right?

I: Right, okay thanks. Could you maybe take me through the process a bit of how you identify appropriate renovation measures? Is a failure or breakdown always the initiating factor or are there others as well?

E: A failure or breakdown can be the trigger. Other triggers can be new subsidies from the EU or the federal government. But yes, since we are a rather small housing company and we partly offer social housing, we do not have a lot of strategic investments based on capital reserves I would say. If we have new funding, we sometimes initiate strategic renovation projects that we identify based on our portfolio reports.

I: I fully understand. Maybe one step back again, do you face any challenges when identifying appropriate renovation measures? I mean for example whether something is worth repairing or worth replacing or what measures to conduct?

E: Definitely, we always have to communicate closely with our operations team to learn about the failure and its extent. And if we know, we need to gather information fast and prepare the investment decision fast because as you can imagine, it is not nice living without a functioning heating system. So, there is a time pressure that can differ from case to case. And then, as I said, we have to gather all the data and prepare the decision-making, so we do a cost-benefit analysis. But sometimes, we need to talk to external experts first to see what is feasible and how much something would cost.

I: I see, that does sound quite challenging. And looking ahead, do you have certain measures or areas or housing types that you are more likely to address or renovate than others?

E: We mainly conduct renovation measures for the houses and apartments that we rent out market-based rents instead of socially acceptable rents.

I: Could you explain why?

E: Well, as I said, for the investment decision, we prepare a cost benefit analysis, and in this analysis, we define how long it will take to cover the costs with future rental income. And since rents are higher in our market-based rents, we can cover the costs faster here, so the business case is better overall.

I: I see. Sorry, I didn't not want to interrupt. Before that, you were talking about the housing types and the areas that you will most likely renovate in the future.

E: Yes, exactly. So we mostly renovate buildings where we have a short period of cost recovery. This is also why we do not invest in a lot of buildings where the overall energy efficiency is really low and where you have to invest in insulation, windows and heating at the same time. We try to invest our financial resources in buildings where we can have the highest impact with lowest costs. That is mostly replacing old heating systems or improving the insulation at low costs.

I: Okay, makes sense. Could you tell me then, in a nutshell, what your main motives are for renovation measures?

E: Hm, first and foremost our goal is to offer affordable and pleasant housing. And if that is interrupted, we try to find a cost-efficient solution. In the long run, regulations could cause us to invest on a bigger scale, but for now, we manage our portfolio based on these principles.

I: I see. Even if this has already been said, could you also name the main reasons that hold you back from carrying out renovation measures?

E: Of course, primarily it's not being able to pay for certain measures in advance because we do not have the capital reserves. And sometimes, it is also because we would have to increase rents to cover the costs, and we cannot do that with some apartments. Besides, there are lots of reasons, administrative and coordination efforts, lack of craftsmen, and so on.

I: I understand. And what are influencing factors in your decision-making to renovate or not to renovate? Starting with the most important one to the least important one maybe.

E: Hm, in a nutshell, I would say its looking at regulatory requirements and the cost-benefit analysis results, and if we have the capital reserves at that moment. And as I said, the analysis requires the availability of information and expert knowledge.

I: Okay, thank you. Let's move on to the realization of projects. Who do you consult for renovation measures?

E: We consult external planning offices and energy consultants. Most of them, we have known for quite some time.

I: I see, and who conducts renovation measures at your property?

E: That too is done by external contractors. Depending on the measure, we have some craftsmen in our network or we look for specialists.

I: Okay, and how do you finance your renovation projects?

E: We use our own capital reserves as well as loans or subsidies from the government or the EU.

I: And do you face or have you faced any challenges during the implementation before?

E: I mean this is the construction industry, so you can imagine that there are some challenges to expect.

I: What kind of challenges would that be in your case?

E: Well, first of all finding available craftsmen, then coordinating the measures with tenants and all the trades involved, then there are sometimes nasty surprises that mean more money has to be spent or the project is delayed - so especially challenges like that.

I: I see, that really are challenges you hear about quite often. Okay, to finish the interview, I would be interested in knowing how you see your approach to renovations evolving, and what trends or changes in the market might influence this?

E: Hm...well as I said, at some point we will have to deal with the complex and costly renovation cases in our portfolio and the question arises, how these renovations should happen in a socially acceptable way. If we bear the costs for those projects, we will have to add the costs to the rents. Here, we need clear regulations, subsidies and a societal plan for how the energy transition can be implemented in its entirety.

I: I understand, it's really interesting to hear your perspective. To end the interview, what kind of support would help you most in the context of renovations in your company?

E: As I said, clear regulatory guidance. more financing options and subsidies and also maybe expertise on which measures to conduct and the costs and benefits to expect.

I: I see, before we finish, do you have any questions or additional feedback in this context?

E: No, I don't think so, thank you.

I: If questions still arise afterwards, you can always email me. Then, there is nothing else for me to say than thank you very much for your time and your detailed insights! It was really interesting and helpful.

E: No problem and good luck for your project!

I: Thank you!

## **Interview 9**

Interviewer (I): Good afternoon and thank you for taking the time. I would like to start with some more general questions and then later I would like to dive deeper into the topic of renovation.

Member (M): Sounds good.

I: Great, so first, could you tell me whether you are a private or a professional rental owner?

M: I am a delegated representative of a housing cooperative.

I: I am really happy about the opportunity to talk to you today. Could you maybe explain briefly what a housing cooperative is and does?

M: Of course. A housing cooperative is a specific type of housing company, I would say. The members of a cooperative jointly own the company and its housing stock and the purpose of the cooperative is to serve its members' needs. Overall, it is more about ensuring a reliable, pleasant and affordable home rather than financial gains.

I: Thank you very much. Could you tell me how many members your cooperative has and how many housing units the cooperative owns?

M: We are 590 members and we collectively own 120 buildings of which 40 are single family houses and 80 are multi-family houses. I would say in terms of housing units, we have 40 houses plus about 480 apartments, so 520 units.

I: Okay, so you have more members than housing units...

M: This is just because if a married couple lives together, for instance, both can be part of the cooperative.

I: I see, and do members own the apartments and houses or do they rent them? How would you define the ownership structures?

M: Becoming a member of the cooperative means acquiring shares of the company. With these shares, members have a right to housing. While they don't take ownership of the apartment itself, they are granted a perpetual right to use it. So it is similar to a rental agreement. This perpetual right remains secure as long as the member adheres to the contractual terms, and the cooperative has no authority to end this arrangement under those conditions. Our members also pay a monthly fee, it is called permanent usage fees.

I: Interesting. And is it private rent based on market prices? Or do you also have commercial rents or social rents for example?

M: We only rent out to private people and the rent is, I would say somewhere between market prices and social housing prices. On the one hand, one of our main goals is to ensure affordable housing, on the other hand, we need to make profits to be able to invest in new buildings and in keeping existing buildings pleasant.

I: I see, this is really interesting. Could you tell me a bit about the organizational structure and your role within the cooperative?

M: Yes of course, the primary governing body is the assembly. In the case of larger cooperatives, like ours, this assembly consists of delegated representatives. I am such a representative. Our assembly is responsible for making key decisions and electing the Supervisory Board. The Supervisory Board then selects the Management Board, entrusting it with the cooperative's operational management. The board is allowed to act autonomously, but as the Supervisory Board, it is always accountable to our members.

I: Thank you so much. In view of the time available, we should now turn to the questions surrounding the topic of renovations. My first question here is, how do you classify your portfolio with regard to its energy state and what is the energy state like?

M: We only differentiate our housing units between apartments and houses if necessary. For energy discussions, we refer to the age of the house, the age of the windows and doors, the building material and insulation quality, the heating system and the energy efficiency rating.

I: And what is the distribution for example among energy efficiency classes?

M: Hm I would have to check for the exact numbers, but I would say, that of our 120 buildings, none, I think have a rating of A, maybe 10 have a rating of B, 40 to 50 have a rating of C or D, 30 have a rating of E or F and then 30 to 40 have a rating of G or H. I am pretty sure, we cover the whole range except for A.

I: I see, and what are your main tasks with regard to energy in your property? Do you work with a property management company?

M: Yes, we work with a property management company that takes care of cleaning shared spaces, arranging maintenance visits or so. They mainly take on operational tasks that we have defined in a framework agreement.

I: And for renovation projects, who initiates and decides when it is time for a renovation?

M: Our members can submit an application for more complex or extraordinary renovation measures. These requests are then discussed in our Management Board on a quarterly basis. We have a specific budget for renovation work and can decide based on urgency, costs, available budget and so on. If a certain measure exceeds a specific amount, member votes are held on a yearly basis.

I: Interesting. And did you or any of your members carry out any renovation measures in the last 5 years? And if so, what measures?

M: Yes, actually, we are renovating one of our multi-family houses right now. The renovation includes new facade paint, new windows, doors, floors, bathrooms and kitchens, a complete renovation, so to speak.

I: Interesting. And are there any other renovation measures that you have conducted over the last years?

M: Besides this bigger project, no nothing other than maintenance and repairs.

I: And how do you identify appropriate renovation measures? Or did you identify the need for the renovation of the multi-family house?

M: Our housing cooperative was founded with the goal of creating affordable and intergenerational living space. In recent years, however, we have noticed that fewer and fewer young families are interested in our apartments. The layout of the apartment building is very suitable for young families, but the condition was not appealing. We realized that minor investments and maintenance work, which had been carried out repeatedly over the years, would no longer be sufficient. We therefore jointly decided that the building should be modernized.

I: Interesting, so it was a long term investment decision. But you also mentioned that your members can propose certain measures, right?

M: Yes, of course. So there either is the idea of investing strategically in our cooperative portfolio or there is a member or a group of members who come together and identify measures they want to conduct. They often do some research, talk to friends or local businesses and come up with a proposal.

I: I see. And with these two approaches, let's say collective and individual approach, do you face any challenges when identifying appropriate renovation measures?

M: Hm identifying the right measures in general can be challenging. No matter which approach, it is often difficult to say what is feasible and what makes sense economically or strategically. We usually consult architects or energy consultants for that. Besides that, the overall decision-making process can be challenging since we have a lot of members and interests.

I: I can imagine. And are there any areas that you will likely renovate in the future? For example, other multi-family houses that are suitable for families or do you have certain measures in mind that you think will make sense in the near future?

M: Also here, I would say, it depends on what members consider important. In the last few months, there have been a lot of discussions about heating in our assembly and our future approach to heating. Next year, we might create a kind of committee that works with energy experts to find a long term approach for our buildings, where to start and what to do first.

I: Okay, interesting. You said it before, but could you summarize your main motives when carrying out renovation measures?

M: Yes, of course. Our main motive is to always offer reliable and pleasant homes for our members. When considering renovation measures, we look at the urgency, benefits and costs, I would say. Only if urgency is given or benefits and costs align, we conduct measures.

I: I see, and what are the main reasons that hold you back from carrying out renovation measures?

M: Hm we often do not have the expertise needed. Besides, I would say we do not renovate if costs outweigh the benefits, if we have budget restraints or members vote against it.

I: Okay, makes sense. Could you describe the factors that influence your decision or your members decision to renovate or not to renovate?

M: Again first we have to see whether we have the financial resources and then I would say its costs against benefits, for the residents but also for the cooperative as a whole. Besides, sometimes we just have other priorities at that time, for example, the handling of a house fire or the filling up of a cellar.

I: I see. And you said you always consult with architects and energy experts, is that right? Anyone else who you consult for renovation measures?

M: Yes, that's right, some of our members are architects, craftsmen or so. So we can consult with them internally. But most of the time, we hire external experts to help with a project.

I: Okay, and who carries out the renovation work?

M: This is always done by local businesses, so externally.

I: Alright. and how do you finance your renovation projects?

M: It can be a mix between cooperative budgets or loans.

I: Do you make use of subsidies as well?

M: Oh yes, we have used them before.

I: Okay, noted. When carrying out renovation measures, do you face any particular challenges there?

M: Oh yes, when I think about the renovation of our multi-family house right now, there have been quite some challenges throughout the whole process. From finding a contractor, to defining the scope, figuring out a financing plan, and actually starting the work, there have been many hurdles to overcome.

I: I can imagine. Looking at the time available, I have to move to the remaining questions. First, looking ahead, how do you see your approach to renovations evolving, and what trends or changes in the market might influence this?

M: Hm... As I said, we have the idea of creating a committee for the purpose of energy efficiency measures and renovations. The topic becomes more and more relevant for us because of rising costs, new regulations, et cetera. So, we will definitely change our approach there and try to build up more knowledge and experience. Puh market trends... I would say that future heating will be quite a big topic for us and how to realize sustainable heating. We often have discussions about heat pumps, district heating, gas heating and so on. That's all I can think of for now.

I: I see. Thank you very much. And lastly, I would like to know whether there is any kind of support that would help you most in the context of renovations?

M: I think guidance and expertise on feasibility, technologies, and all those matters would be the most helpful.

I: Okay, great. Thank you so much for this interview. Do you have any additional feedback or questions before we finish the interview?

M: I would be interested in your findings, maybe you can send a report someday so that we can learn from other examples and your ideas.

I: Oh thank you very much. Of course, I can do that.

M: Great, thanks.

I: Thank you and have a nice day!

## Appendix 6: Exemplary Analysis for Interview 4

Content	Transcript	1 Decontextualization	2 Recontextualization	3.1 Categorization	3.2 Categorization
Description	Transferring interview into written transcript	Familiarizing with data, creating meaning units -> smallest components that contain relevant insights	Revisiting the original text and evaluating remaining text; deciding to exclude or include additional content	Coding of the meaning units by reducing their word count without losing their essence	Creating internally homogeneous and externally heterogeneous categories
Output	Written transcript	Meaning units	Additions to meaning units	Codes	Categories
	Interviewer (I): Good morning again and thank you for taking the time for this interview. I would like to start with some general questions if that is okay. So first, could you tell me if you are a private or a professional rental owner and what type of property you rent out?				
	Rental Owner (RO): Of course. I rent out a house that I inherited from my parents four years ago.	house inherited from parents four years ago		house inherited from parents four years ago	private rental owner house inherited
	I: Thank you. And for what purpose do you rent out your property? Is it for private rental, for commercial, for tourist purposes or another special purpose?				
	RO: It's for private renting. Right after I decided to rent out the house, I found a young family who has been living there ever since.	private renting family who has been living there		private renting family who has been living there	private renting
	I: How nice. So this house is the only property you rent out and it is one housing unit, you didn't install multiple apartments, did I understand correctly?				
	RO: Yes, that's right, just the one house with one unit for a family.	one house with one unit		one house with one unit	one unit
	I: Great. And if I may, when exactly did you start renting out the house and why? Why not sell it for example?				
	RO: Yes, of course you can. I grew up in this house and I collected many memories in it. It was clear to me that I wanted to keep it for the time being. Maybe one day I'll move in myself or my children will, or maybe I'll sell it after all. But in the medium term, renting is the best solution for me.	I grew up in this house, collected many memories keep it Maybe one day I'll move in myself or my children will or maybe I'll sell it after all medium term, renting is the best solution		grew up in house keep it one day move in or my children or I'll sell it medium term, renting is the best solution	emotional value
	I: I understand. And one last question before diving deeper into energy topics. What is your professional background?				
	RO: I am an assistant tax consultant.	assistant tax consultant		assistant tax consultant	assistant tax consultant
	I: Great, so that we've talked about some general facts, I would suggest we dive deeper in energy topics. To start, can you tell me in which energetic condition your house currently is?				
	RO: It was built in 1989, so it's about 30 years old. The insulation could probably need some improvements.	built in 1989 insulation probably need some improvements	about 30 years old	built in 1989 insulation probably need some improvements	apartment more than 30 years old original insulation
	I: Can you tell me what type of heating is used and what energy efficiency class the house is allocated to?				
	RO: Yes, there is an oil heating system installed. I think it lasts back to the late 90s and the energy class is E, probably also from large parts because of the oil heating.	oil heating system lasts back to the late 90s energy class is E	large parts because of oil	oil heating system lasts back to the late 90s energy class is E	oil heating from the late 90s energy efficiency class E
	I: Okay, thank you. Now, could you tell me what your main tasks with regard to energy in your property are?				
	RO: Of course, just related to energy?				
	I: Yes exactly.				
	RO: I take care of the oil supply once in a while and we have some maintenance visits or repairs that I arrange. For electricity, the tenants are free to choose their own electricity provider.	oil supply once in a while maintenance or repair visits the tenants free to choose their own electricity provider		oil supply maintenance or repairs choose their own electricity provider	oil supply maintenance repairs
	I: I see, and have you carried out any renovation measures in the last five years?				
	RO: We renewed the floor, repainted the walls, and installed new bathrooms and a kitchen before renting out.	renewed the floor, repainted the walls, and installed new bathrooms and a kitchen before renting out		nothing related to energy	no
	I: Ah okay, and did you change something on the building envelope, for example insulation or windows?				
	RO: No this is all in the original state.	[building envelope] is all in the original state		[building envelope] is all in the original state	
	I: I see, and how do you identify appropriate renovation measures or how would you approach renovation measures in the future?				

I. Great, do you anticipate any challenges in this process or have you started looking for appropriate measures already and experienced certain challenges?	RO I think I would start to look online for some helpful information and I would ask friends who have already conducted renovation projects. Besides that, I would look which experts exist in the area. For heating for example, I could ask the craftsman that renewed the bathrooms. He has a plumbing and heating business.	look online for information ask friends experts in the area For heating, I could ask the craftsman that renewed the bathrooms	look online for information ask friends experts in the area ask the craftsman that renewed the bathrooms	Internet friends professional assessments
I. And are there any areas you will likely renovate in the future? And if so, why these areas?	RO I had already informed myself four years ago when I inherited the house. Some of the information I got online or from craftsmen was unsettling or contradictory. Since there was so much to take care of and to do in the house, I stopped looking at some point. But I know from experience, that it can be difficult to know what to do. Oftentimes, it gets very technical, complex and costly.	informed myself when I inherited the house information online or from craftsmen was unsettling or contradictory Since there was so much to take care of, I stopped looking. difficult to know what to do technical, complex and costly	informed myself when I inherited the house information online or from craftsmen was contradictory I stopped looking, difficult to know what to do technical, complex and costly	unreliable information lack of knowledge complexity
I. And what would be or are your main motives when carrying out renovation measures?	RO Yes, I think at some point I will have to and it also makes sense. I think I would start with the heating appliance and see whether I can upgrade to a gas or electrical heating. In this process, I think I will also have to look at the general insulation and its quality.	I will have to and it also makes sense start with the heating appliance see whether I can upgrade to a gas or electrical heating will also have to look at the general insulation and its quality	have to and it makes sense start with the heating appliance see whether I can upgrade to a gas or electrical heating look at the general insulation and its quality	heating insulation
I. Interesting. You already mentioned the contradictory information that you sometimes find when looking into renovation topics. Is there anything else that holds you back from carrying out renovation measures?	RO Yes, I mean I don't have a lot of knowledge about these topics. So I would need to find some reliable sources and experts, but it can be hard to find someone who is available and willing to look at your house these days. In addition, most of these improvements are quite costly which is also something to consider.	don't have a lot of knowledge need to find reliable sources and experts hard to find someone who is available and willing to look at your house quite costly	don't have a lot of knowledge need to find reliable sources and experts hard to find someone who is available and willing to look at your house quite costly	lack of knowledge unavailability of experts lack of financial resources
I. I understand, and could you describe the factors that influence your decision to renovate or not?	RO I would say it's mostly about having a good understanding of the matters and the opportunities and about having the financial resources to invest some money.	having a good understanding of the matters and the opportunities having the financial resources to invest	having a good understanding having the financial resources	knowledge availability of financial resources
I. I see, and how do you prioritize these factors?	RO I would say, being informed comes first. And if I'm informed and know what is actually possible and what makes sense, I can look at the costs and see what is feasible from a financial point of view.	being informed comes first, if I know what is actually possible and what makes sense, look at the costs and see what is feasible from a financial point of view	being informed if I know what is possible and makes sense see what is feasible from a financial point of view	1. knowledge 2. availability of financial resources
I. That makes sense. And who would you consult for renovation measures?	RO I would consult google first haha. And then I would contact some local businesses nearby and see if they could come and take a look.	google local businesses	google local businesses	internet known contractors
I. And would these local business also be the ones you hire to conduct the renovation measures at your property?	RO Yes, once they visited the house and made an offer, I would decide which one to hire.	once [local businesses] visited the house and made an offer, I would decide which one to hire	once [local businesses] visited the house and made an offer, I would decide which one to hire	known craftsmen
I. And, if I might ask, how would you finance your renovation measures or how are you planning to finance them in the future?	RO I would also look online to see whether there are some programs or subsidies available. And then, I would probably also take on a loan depending on the costs of the project.	look online to see whether there are programs or subsidies take on a loan	loan depending on the costs of the project look online for programs or subsidies take on a loan if needed	subsidies loan
I. And last question regarding the implementation, did you face or do you anticipate any challenges when implementing renovation measures?	RO Well, yes. As I said, not a lot of local business are willing to offer free consultations without knowing they get the job. So finding out what should and could be done will be tricky. Moreover, I would need some external money, securing the money would also take some time and can be quite difficult.	not a lot of local business are willing to offer free consultations without knowing they get the job So finding out what should and could be done will be tricky need some external money, securing can be quite difficult	not a lot of local business are willing to offer free consultations tricky finding out what should and could be done need some external money, securing can be quite difficult	unavailability of experts financing
I. What do you mean by securing money can be difficult?	RO For loans, I would have to negotiate with my bank which could take some time and for subsidies, well I don't really know, I assume there are some bureaucratic hurdles to overcome.	for loans, negotiate with my bank which could take some time for subsidies, some bureaucratic hurdles to overcome	negotiate with bank, takes time for subsidies, bureaucratic hurdles to overcome	negotiations bureaucracy
I. I understand. To conclude, looking ahead, how do you see your approach to renovations evolving, and what trends or changes in the market might influence this?	RO I think, going forward, I'm just want to keep the place nice and maybe update a few things to make it more sustainable. If there's a new trend or something comes up, I'll think about adding it. But overall, I just want to make sure the house is a good place to live in and that it makes sense money-wise.	keep the place nice maybe update a few things to make it more sustainable make sure the house is a good place to live in and that it makes sense money-wise	keep the place nice maybe update to make it more sustainable make sure the house is a good place to live in makes sense money-wise	sustainability
I. And to finish, what kind of support would help you most doing renovation projects in the future?	I. And to finish, what kind of support would help you most doing renovation projects in the future?			
I. And to finish, what kind of support would help you most doing renovation projects in the future?	RO Oh, um, I would need to see what is out there. Maybe some help with comparing technologies or measures or finding my way through financing would be helpful.	need to see what is out there help with comparing technologies or measures finding my way through financing would be helpful	need to see what is out there help with comparing technologies or measures finding my way through financing	guidance availability of funding
I. Interesting, I'll note that. Thank you. Since the interview has come to an end, do you have any additional feedback or questions for me?	RO No I am just curious to know what your thesis will be about and I hope it goes well for you.	curious about findings	curious about findings	interest in findings
I. Thank you so much, that is really nice! And thank you for taking the time for this interview. It was really helpful!				

# Appendix 7: Summary of Interview Results with Rental Homeowners

## Key facts

Topic	Question	Answer 1_Categories	Answer 2_Categories	Answer 3_Categories	Answer 4_Categories	Answer 5_Categories	Answer 6_Categories	Answer 7_Categories	Answer 8_Categories	Answer 9_Categories	Summary_Private rental owners	Summary_Professional rental owners	
1 Key facts	1.1 Are you a private or a professional rental owner?	private rental owner	private rental owner	private rental owner	private rental owner	professional rental owner	professional rental owner	professional rental owner	professional rental owner	professional rental owner	4 private rental owners	5 professional rental owners	
	1.2 If professional: Can you classify the organization you work for? (Private-rental owner, Private-sector (Apartment) or house)	-	-	-	-	private-sector housing company	private-sector housing company	private-sector housing company	private-sector housing company	municipal housing cooperative	-	3 private housing companies 1 municipal housing company	
	1.3 What type of property do you rent out? (Apartment) or house)	apartment (100%)	apartment (100%)	apartment (100%)	house (100%)	apartment (90%) house (10%)	apartment (100%)	apartment (80%) houses (20%)	apartment (85%) houses (15%)	apartment (60%) houses (33%)	75% apartments 25% houses	84% apartments 16% houses	
	1.4 For what purpose do you rent out your property? (Private-renting, commercial rental, social housing, tourist rental, other purpose)	private renting	private renting	private renting touristic renting	private renting	private renting	private renting	private renting commercial renting	private renting commercial renting	private renting social renting	collective renting	4 private renting 1 touristic renting	4 private renting 1 commercial renting 1 social renting 1 collective renting
	1.5 How many residential units do you rent out?	1 unit	2 units	4 units	1 unit	4300 units 680 buildings	17500 units 2900 buildings	450000 units 55000 buildings	1.800 units 340 buildings	520 units	2 apartments on average	private housing companies own 4300 units, 17500 units and 450.000 units municipal housing company owns 1.800 units housing cooperative owns 520 units	
	1.6 If private: Why and when did you become a rental owner?	future investment	additional source of income	additional source of income	inherited	emotional value	-	-	-	-	future investment additional source of income inheritance	-	
	1.7 If private: What is your professional background? If professional: What is your job within the organization you work for?	Mechanical Engineer	IT Project Manager	Self-employed Financial Advisor	Assistant Tax Consultant	Portfolio Manager	Business Development Manager	Strategy Manager	Portfolio Manager	Delegated Representative	diverse backgrounds no one works in real estate	diverse job descriptions with various focus areas	

## Energy state of property

2 Energy state of property	Question	Answer 1_Categories	Answer 2_Categories	Answer 3_Categories	Answer 4_Categories	Answer 5_Categories	Answer 6_Categories	Answer 7_Categories	Answer 8_Categories	Answer 9_Categories	Summary_Private rental owners	Summary_Professional rental owners
2 Energy state of property	2.1 If private: In which energy state would you say your property is? If professional: How do you classify your portfolio with regard to the energy state and what is the distribution?	apartment more than 20y old energy efficiency class D improved insulation gas heating from early 2000s	apartment more than 20y old energy efficiency class D energy efficiency class E original insulation gas heating from 2008	apartment between 15-20y old energy efficiency class (ee class) B or class C good insulation electrical heating from 2016	apartment more than 30y old ee class E original insulation oil heating from the late 90s	ee classes range from A to H measures in 10% of buildings in the next 20 years	ee classes range from A to H 60% between C and F 20% G and H 20% A+, A, B	ee classes range from A to H buildings from 70s and 80s	ee classes range from A to H older than 20 years 10% A to C, 20% B 35% have a rating of C or D 25% have a rating of E or F 30% have a rating of G or H	ee classes range from B to H none have a rating of A 8% have a rating of C or D 25% have a rating of E or F 30% have a rating of G or H	majority of buildings is 20 years or older energy efficiency rating between B and E average energy rating is D mix of original and improved insulation majority of heating appliances are 15 years or older need for renovation measures becomes apparent	in the portfolio of professional rental owners, all energy classes are represented, it can be assumed that about 20% of the residential units have an energy rating of G or H need for renovation measures becomes apparent
	2.2 What are your main tasks with regard to energy in your property?	creation of comfort maintenance repairs future investments	maintenance repairs meet tenants needs	property management future investments	oil supply maintenance repairs	coordination of measures installations repairs monitoring future investments	internal property management maintenance repairs replacements	internal property management maintenance repairs replacements	internal property management maintenance repairs replacements	external property management company bigger renovation projects	creation of comfort & tenant needs (2) maintenance (4) repairs (4) future investments (2) energy supply (3) mold private rental owners take care of most matters themselves	coordination of measures installations repairs (4) monitoring future investments internal property management (3) maintenance (3) replacements (3) external property management company bigger renovation projects
	2.3 If private: Did you carry out any renovation measures in the last 5 years? If so, what measures? If professional: Did you start any renovation measures for your properties in the last 5 years? If so, what kind of initiatives?	renewal of windows	renewal of thermostat	no	no	insulation improvement renewal of heating energy efficiency data analysis strategy development	data analysis strategy development pilot projects heat pumps photovoltaic panels	data analysis strategy development renewal of windows renewal of heating pilot projects serial renovation district heating heat pumps	renewal of heating insulation improvement	pilot project insulation improvement	no renovation measures (2) smaller upgrades (2)	insulation improvement (3) renewal of heating (3) energy efficiency data analysis (3) strategy development (3) pilot projects (3) heat pumps (2) photovoltaic panels serial renovation district heating

## Identification of measures

3 Identification of renovation measures	Question	Answer 1_Categories	Answer 2_Categories	Answer 3_Categories	Answer 4_Categories	Answer 5_Categories	Answer 6_Categories	Answer 7_Categories	Answer 8_Categories	Answer 9_Categories	Summary_Private rental owners	Summary_Professional rental owners
3 Identification of renovation measures	3.1 How do you identify appropriate renovation measures?	long-term planning occurrence of problems compliance with laws	internet professional assessments	long-term planning market trends	internet friends professional assessments	data analysis cluster building long term planning compliance with laws professional assessments (in-house)	data analysis cluster building long term planning compliance with laws professional assessments (in-house)	data analysis cluster building long term planning professional assessments (in-house) low-temperature readiness	occurrence of problem new funding data analysis	long term planning members research local businesses	long term planning (2) occurrence of problems compliance with laws internet (2) professional assessments (2) market trends friends	data analysis (4) cluster building (3) long term planning (4) compliance with laws (2) professional assessments (in-house) (3) low-temperature readiness occurrence of problems new funding members research local businesses
	3.2 Do you face any challenges when identifying appropriate renovation measures? If so, what are they?	lack of knowledge uncertainty about return of investment	lack of knowledge uncertainty about return of investment	regulatory uncertainty	unreliable information lack of knowledge complexity	quality of information lack of knowledge internal processes	complexity uncertainty about return of investment	complexity uncertainty about return of investment contradictory goals	internal processes quality of information time pressure lack of knowledge	lack of knowledge complexity uncertainty about return of investment internal processes lack of long term approach	uncertainty about return of investment (2) lack of knowledge (3) regulatory uncertainty unreliable information complexity (2) uncertainty about return of investment (2) contradictory goals lack of long term approach	quality of information (2) lack of knowledge (3) internal processes (3) complexity (3) uncertainty about feasibility (2) uncertainty about return of investment (2) time pressure lack of long term approach
	3.3 What areas will you most likely renovate in the future and why?	heating	heating windows	installation of photovoltaic panels installation of smart home devices	heating insulation	insulation heating	heating district heating (55% of buildings) heat pumps (33%) gas, hybrid or biomass (12%) insulation	heating only insulation + heating	one measure investments heating low cost insulation	heating	heating (3) windows and insulation (2) PV (1) smart home (1)	insulation (4) heating (5)

## Decision-making process

4 Decision-making process	4.1	What are your main motives when carrying out renovation measures?	return of investment creation of comfort compliance with laws	return of investment contributes to climate protection long term cost savings	market trends return of investment long term cost savings	creation of comfort return of investment contribution to climate protection	compliance with laws	return of investment compliance with laws contribution to climate protection	return of investment contribution to climate protection	affordability of housing creation of comfort compliance with laws	attractiveness for potential members creation of comfort	return of investment (4) compliance with laws contribution to climate protection (2) long term cost savings (2) market trends	compliance with laws (3) contribution to climate protection (2) return of investment (2) affordability of housing creation of comfort (2) attractiveness for potential members
	4.2	What are the main reasons that hold you back from carrying out renovation measures?	initial investment uncertainty about the return of investment lack of knowledge reliance on others	lack of financial resources lack of knowledge uncertainty about market development	regulatory uncertainty unavailability of experts lack of time	lack of knowledge unavailability of experts lack of financial resources	lack of financial resources internal processes	lack of financial resources bureaucracy complexity coordination	internal processes complexity uncertainty about return of investment	lack of financial resources internal processes coordination unavailability of experts	lack of knowledge no return of investment internal processes	initial investment uncertainty about long term effects reliance on others lack of financial resources (2) lack of knowledge (2) uncertainty about market development regulatory uncertainty unavailability of experts (2) lack of time	lack of financial resources (3) internal processes (4) bureaucracy complexity (2) coordination (3) uncertainty about return of investment unavailability of experts lack of knowledge no return of investment
	4.3	Can you describe the factors that influence your decision to renovate or not to renovate?	return of investment availability of financial resources time availability of experts	return of investment long term cost savings regulations tenants feedback	long term planning availability of experts availability of financial resources	knowledge availability of financial resources	regulations return of investment	regulations availability of financial resources contribution to climate protection	return of investment contribution to climate protection	regulations return of investment availability of financial resources availability of information availability of experts	availability of financial resources return of investment current priorities	return of investment (2) availability of financial resources (3) time availability of experts (2) long term cost savings regulations tenants feedback long term planning knowledge	return of investment (4) availability of financial resources (3) investments (3) contribution to climate protection (2) availability of information availability of experts current priorities
	4.4	How do you prioritize these factors?	1. return of investment 2. financial resources 3. time	1. return of investment (economic impact, contribution to climate protection)	1. long term planning 2. availability of experts 3. financial resources	1. knowledge 2. financial resources	1. financial feasibility 2. return of investment	1. availability of financial resources 2. regulations and contribution to climate protection	1. return of investment 2. contribution to climate protection	1. return of investment 2. availability of financial resources	1. availability of financial resources 2. return of investment 3. current priorities	1. return of investment 2. financial resources	1. return of investment 2. return of investment

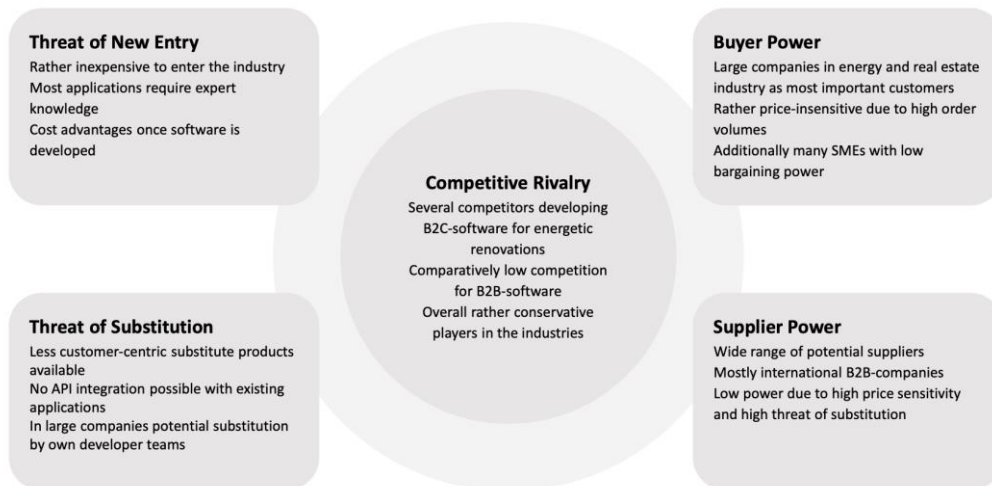
## Implementation of renovation measures

5 Implementation of renovation measures	5.1	Who do you consult for renovation measures?	known contractors new contractors internet	known contractors internet energy consultant	known contractors new contractors	internet known contractors	in-house experts external contractors	in-house experts external contractors	in-house experts external contractors	external contractors	in-house experts external contractors	known contractors (4) new contractors (2) internet (3) energy consultant (1)	in-house experts (4) external contractors (4)
	5.2	Who conducts renovation measures at your property?	known craftsmen new contractors	known craftsmen external contractors	known craftsmen new contractors innovative market players	known craftsmen	in-house craftsmen external contractors	in-house craftsmen external contractors	in-house craftsmen external contractors (specific tasks)	external contractors	external contractors	known craftsmen (4) new contractors (3) innovative market players	in-house craftsmen (3) known contractors (4)
	5.3	How do you finance your renovation projects?	savings loan subsidies	subsidies savings	savings loan	subsidies loan	internal reserves loans subsidies	internal reserves loans subsidies	internal reserves loans subsidies	internal reserves loans subsidies	internal reserves loans subsidies	savings (3) subsidies (4) loan (3)	internal reserves (5) loans (4) subsidies (5)
	5.4	Do you face any challenges when implementing renovation measures? If so, what are they?	financing quality of work unreliability of workers	unavailability of experts unreliability of workers coordination with tenants	unavailability of experts	unavailability of experts financing negotiations bureaucracy	quality of information quality of work unreliability of workers internal processes	complexity internal processes lack of knowledge coordination	unavailability of experts internal processes complexity	unavailability of experts coordination unreliability of workers	unavailability of experts complexity financing	financing (2) quality of work unreliability of workers (2) unavailability of experts (2) coordination with tenants negotiations bureaucracy	quality of information quality of work unreliability of workers (2) internal processes (3) complexity (3) lack of knowledge coordination (2) unavailability of experts (3) financing

## Future renovations & Conclusion

6 Future renovations & Conclusion	6.1	Looking ahead, how do you see your approach to renovations evolving, and what trends or changes in the market might influence this?	sustainability energy efficiency	sustainability experts subsidies	regulations tenant electricity generation	sustainability	sustainable heating technologies financing options	sustainability technological advances regulations industry best practices partnerships	sector coupling capital market fluctuations regulations	social accountability regulations financing options	costs regulations finding long term approach sustainable heating technologies	sustainability (3) energy efficiency experts subsidies regulations tenant electricity generation	sustainable heating technologies (2) financing options (2) sustainability technological advances regulations (4) industry best practices partnerships sector coupling capital market fluctuations social accountability costs finding long term approach
	6.2	What kind of support would help you most in this context?	guidance availability of funding availability of experts	guidance availability of funding	availability of experts	guidance availability of funding	guidance (heat pumps, district heating) stringent regulations availability of funding	availability of funding stringent regulations partnerships	availability of funding stringent regulations availability of experts	stringent regulations availability of funds availability of expert	guidance availability of expert	guidance (3) availability of funding (3) availability of experts (2)	guidance (2) availability of funding (4) stringent regulations (3) partnerships availability of experts (2) expertise
	6.3	Do you have any additional feedback or questions as part of this interview?	no	no	no	interest in findings	no	no	no	no	no	interest in findings	no (3) interest in findings

## Appendix 8: Graphical Representation of the Porter's Five Forces Model



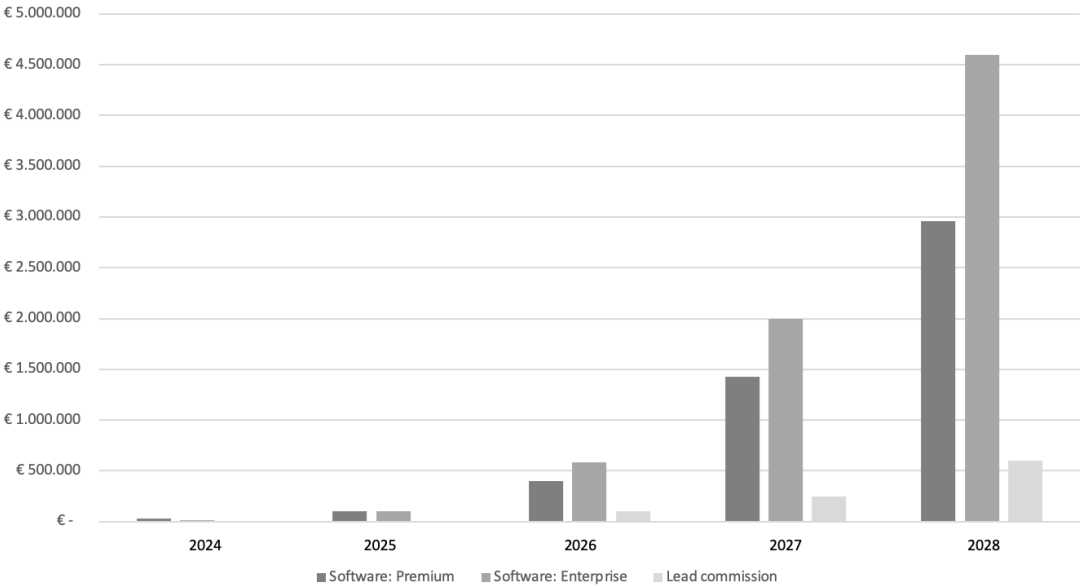
## Appendix 9: Tabular Overview of Competitor Analysis

	Vreed	co2online	enter	IWB	rehome
B2C solutions	✓	✓	✓	✗	✓
B2B solutions	✓	✗	✗	✓	✓
Web applications	✓	✓	✓	✓	✓
API integration	✗	✗	✗	✗	✓
Customization	✗	✗	✗	✗	✓

## Appendix 10: Overview of Business Model with Free, Premium and Enterprise Tariff

	Free	Premium	Enterprise
API access	Limited	Negotiable	Unlimited
Integration support	✗	✓	✓
Application support	✗	✓	✓
Customization	✗	✗	✓

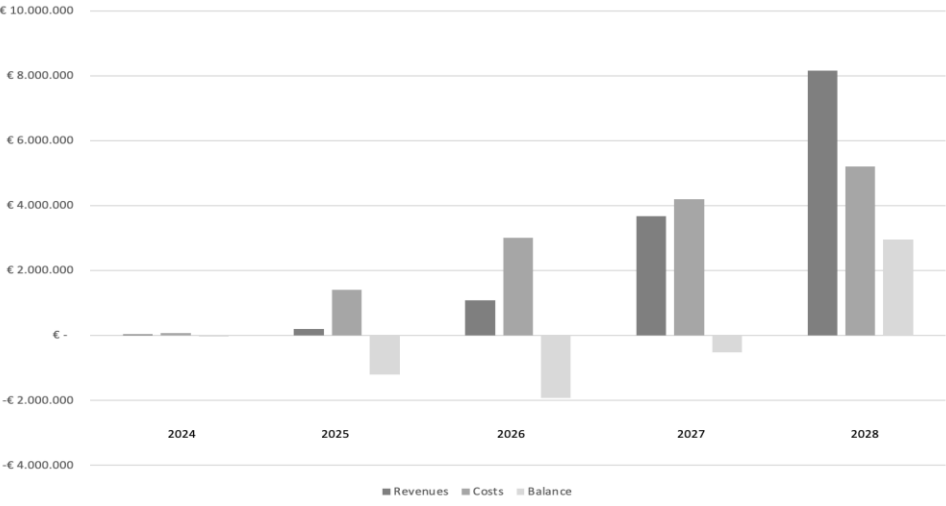
**Appendix 11: Revenue Forecast for the Period from 2024 to 2028**



**Appendix 12: Aggregated Cost Forecast for the Period from 2024 to 2028**

Cost Category	Amount
Personnel costs	€ 10.100.000
Software costs	€ 2.650.000
Office rent and incidental expenses	€ 350.000
Office supplies	€ 200.000
Marketing and advertising costs	€ 270.000
Legal and accounting services	€ 300.000
<b>Total costs</b>	<b>€ 13.870.000</b>

**Appendix 13: Profit and Loss Account for the Period from 2024 to 2028**



## Appendix 14: Liquidity Planning for the Period from 2024 to 2028

Category	2024	2025	2026	2027	2028
Liquidity start	€ 30.000	€ -	€ 50.000	€ 630.000	€ 105.000
Outflows	€ 70.000	€ 1.400.000	€ 3.000.000	€ 4.200.000	€ 5.200.000
Inflows	€ 40.000	€ 1.450.000	€ 3.580.000	€ 3.675.000	€ 8.156.250
Net cash flow	-€ 30.000	€ 50.000	€ 480.000	-€ 525.000	€ 2.956.250
Liquidity end	€ -	€ 50.000	€ 630.000	€ 105.000	€ 3.061.250