A Work Project, presented as part of the requirements for the Award of a Master's degree in Impact Entrepreneurship from the Nova School of Business and Economics.

Derivation of a Business Plan from the Key Problems of German Self-occupying Owners in Energetic Renovations

Henning Löbbert

Work project carried out under the supervision of:

Leid Zejnilovic

Lenia Mestrinho

10-12-2023

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

This work used infrastructure and resources funded by Fundação para a Ciência e a Tecnologia (UID/ECO/00124/2013, UID/ECO/00124/2019 and Social Sciences DataLab, Project 22209), POR Lisboa (LISBOA-01-0145-FEDER-007722 and Social Sciences DataLab, Project 22209) and POR Norte (Social Sciences DataLab, Project 22209).

Table of Contents

List of Figures

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

Group Part

1 Introduction

1.1 Context

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

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

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

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

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.

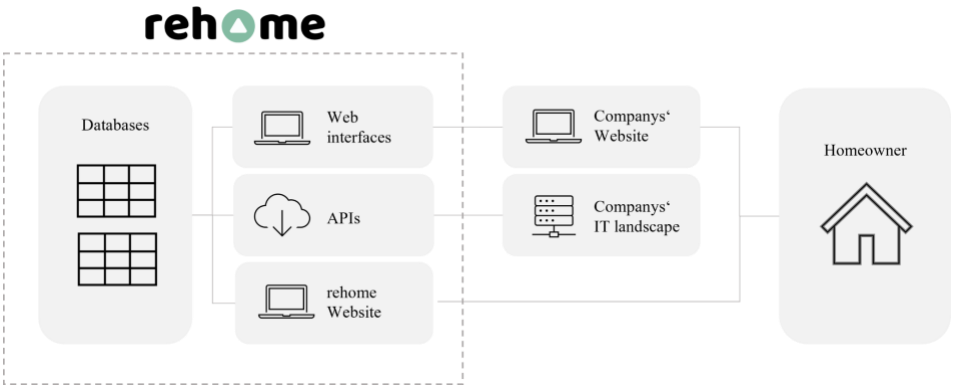


Figure 2: Graphical Representation of the rehome Solution (Own illustration)

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

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

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

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

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.

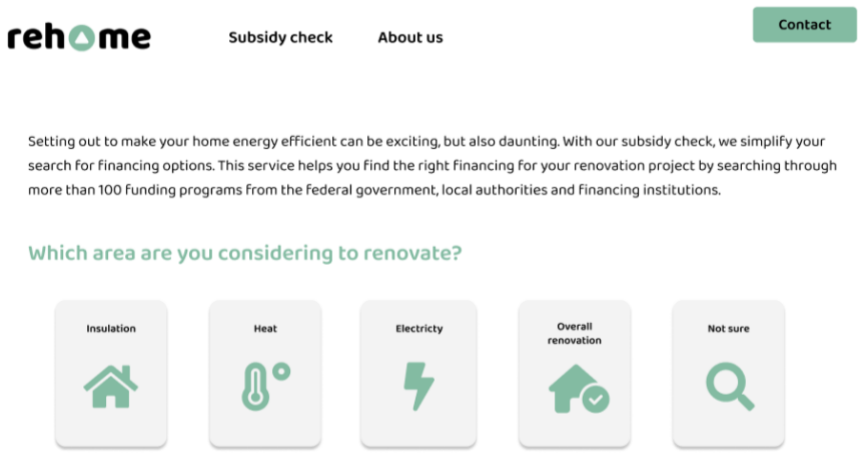


Figure 3: Mock-Up of the Minimum Viable Product
(Own illustration)

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

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

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

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

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^2 emissions. For instance, compared to fossil fuel heating systems, a heat pump saves an average of 2620 kg of CO^2 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^2 per year (Solarify 2020). Adequate thermal insulation can reduce the CO^2 emissions of an average single-family home by up to 2000 kg CO^2 per year (Qualitätsgedämmt e.V. 2023). We quantify this impact by tracking the reduction in CO^2 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

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 Germanys' 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

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

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^2 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.

Individual Part – Henning Löbbert

2 Literature Review

2.1 Residential Buildings

2.1.1 Residential Building Stock

To obtain an overview of the housing stock in Germany, the residential building sector is outlined. The German legislature distinguishes between residential and non-residential buildings. Residential buildings are defined as buildings that are primarily used for living, such as homes, elderly residences, and similar establishments (BMJ 2023a). The structure of these buildings is very heterogeneous as it consists of different building types and building ages combined with a variety of ownership forms (Walberg et al. 2022).

Concerning the building type, a distinction is made between single-family, two-family, and multi-family houses. Whereas a single-family house is a plot of land built with a single residential unit, a two-family house is defined as a plot of land built with one building and two residential units. A multi-family house is a building that has at least three residential units (Keller 2023). In 2021, approximately 19.4 million houses designated for residence were present in Germany. Single-family residences accounted for 12.9 million of these houses, two-family residences comprised 3.2 million, and multi-family residences made up 3.3 million houses. While single and two-family houses are about five times more prevalent in Germany than multi-family houses, over half of all housing units are located in multi-family houses. In 2021, there were 22.4 million housing units in multi-family houses and 19.3 million housing units in single and two-family houses (Becker et al. 2022).

With respect to the age of buildings, it can be noted that around 70% of housing units are more than 40 years old. Hereby, houses built before 1948 represent 26% of the total. The period from 1959 to 1978 was characterized by a need for rapid reconstruction, accounting for

42% of houses. From 1979 to 1990, 13% of houses were added to the housing stock. Influenced by a movement towards sustainability, 16% of houses were built between 1991 and 2010 16%, while only 3% of houses were built after 2011 (bbs 2022). Recently, Germany has experienced a noticeable downturn in its residential construction sector caused by high credit and material costs (Murray 2023).

Regarding the ownership structure, no other country in the European Union (EU) has as few people living in their own homes as Germany. The share of residential units rented out for residential purposes is around 53%. Accordingly, the share of owner-occupied housing is around 47% (Walberg et al. 2022). However, there are considerable differences in this ratio in terms of housing structures, regions, and population density. At 83.6%, more than three-quarters of single-family homes are owner-occupied, while only 21.8% of apartments in multi-family buildings are owner-occupied (LBS Research 2020). Secondly, ownership rates are traditionally higher in almost all western German states than in most of the eastern German states. Differences are also apparent from the urban-rural perspective. The ownership rate in Germany's cities was just 27% in 2018. In rural regions, on the other hand, more than one in two properties is owned by the owner himself (Krieger et al. 2021).

2.1.2 Energetic Condition of Building Stock

After creating a common understanding of the residential building stock, its energy condition can be examined to further determine the scope of retrofitting needs. Therefore, a study conducted in 2022 by the German research company F+B is used. The analysis is based on 3.92 million energy certificates from rental and sales offers for residential properties that were publicly advertised (F+B 2022).

Energy certificates contain general information about the house, the use of renewable energies, the energy demand, the building envelope, and the energy consumption. All

information is summarized in an energy efficiency class ranging from A+ (most efficient) to H (least efficient) (BMWK 2013). Each class is defined by the final energy requirement and the approximate annual energy costs per square meter. For instance, buildings in the A+ category record an energy demand of less than 30 kWh/(m²a) and have approximate annual energy costs of €3 per square meter. In contrast, energy demands of buildings in the lowest category H exceed 250 kWh/(m²a) and face annual energy costs of €50 or more per square meter. Whereas the most energy-efficient houses are so-called efficiency houses 40 and newly built houses, usually listed in class A+, A, or B, the average residential building in Germany is listed in the energy efficiency class E (Verbraucherzentrale 2023a).

The study from F+B breaks down the energy efficiency of three distinct types of housing: rental apartments, condominiums, and owner-occupied houses, with efficiency ratings ranging from A+ to H. The following figure gives an insight into the distribution of energy efficiency in these housing types for the year 2020 (F+B 2022).

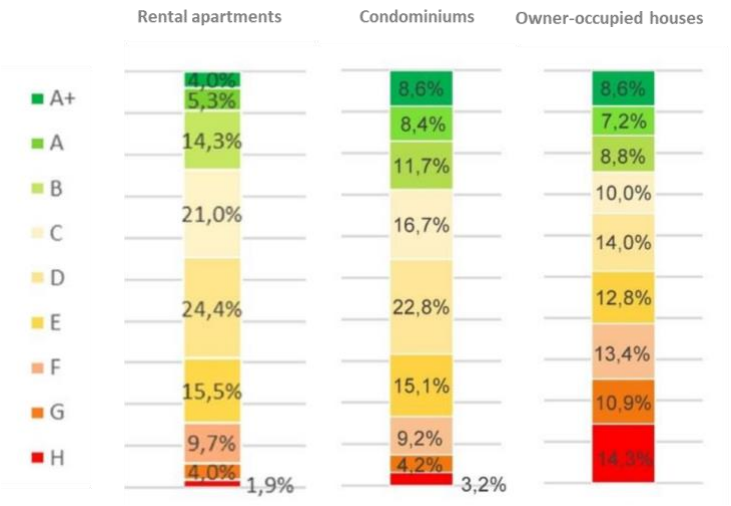


Figure 1: Distribution of Energy Efficiency Classes in Germany in 2020 (Walberg et al. 2022)

As the figure shows, rental apartments record a medium energy efficiency, with the majority rated D (24.4%), followed by C (21.0%) and E (15.5%). The least and most efficient ratings, A+ and H, are less common at 4.0% and 1.9%, respectively. Condominiums also have

a medium efficiency, with D at 22.8% and C at 16.7%. However, a higher proportion of A+ ratings at 8.6% can be seen. With the majority of houses in category E or lower (51.4%), owner-occupied houses record the highest portion of low efficiency, indicating a high need for renovation (F+B 2022).

This is supported by a study by the Working Group for Contemporary Building, based on surveys of homeowners and housing companies with a focus on modernization rates of residential buildings (Walberg et al. 2022). Overall, the data shows that large portions of the building stock are not modernized, thus recording medium to low energy efficiency. With regard to single-family and two-family houses, which are mostly owner-occupied, the study reveals that almost half of these houses are not or little modernized, while 26% are moderately or mostly, and only 10% are extensively modernized (Appendix 1). Therefore, for owner-occupied homes in particular, a significant proportion is less energy efficient (Walberg et al. 2022). Based on these findings, the next chapter examines the legal framework for an energy retrofit of the building stock.

2.3 Stakeholders

2.3.1 Stakeholder Overview

To increase the renovation rate, various stakeholders must work hand in hand. In order to gain a better understanding of their roles and interactions in the context of energetic retrofits, the stakeholders are concisely presented. Thereby, a distinction is made between decision-makers on the demand side, framework-setting actors, decision-makers on the supply side, service providers, and product manufacturers as well as other actors (Seitz et al. 2013).

The main decision-makers on the demand side are homeowners acting as the key target group when it comes to implementing energy-efficient renovations. Here, it can be differentiated between homeowners who primarily own and reside in single or two-family

homes, and those who own larger residential buildings or apartments, typically acting as private or professional rental owners (Weiß et al. 2018). The second stakeholder group is framework-setting actors, including the government, funding agencies, and information providers. The government in particular sets frameworks by passing laws and implementing environmental policy instruments (BMJ 2023a). In addition to the federal government, state and local governments play a framework-setting role, for example, in heat and infrastructure planning (BMWSB 2023a). On the other hand, the supply side is dominated by private and public energy suppliers and energy service providers. They decide which energy sources and technical solutions are available and economical and thus have a significant influence on the retrofit of residential buildings (Verbraucherzentrale NRW 2023).

In addition, service providers and product manufacturers represent a larger group of players in energetic renovations. These include banks, product manufacturers and distributors, architects, energy consultants, planners, craftsmen, construction companies, administrators, and brokers. These actors each have different perspectives and roles with regard to retrofits. Thus, they interact with the demand side at different times and for different purposes. Lastly, other actors include tenants, scientists, the press as well as the general public (Stengel 2014). Overall, a multitude of stakeholders are involved in energy-efficient renovations. Due to the focus of this thesis, the following section examines the motives and obstacles of the main players on the demand side in more detail.

2.3.2 Self-occupying Owners

As stated, the main players on the demand side are self-occupying and rental homeowners. To gain a better understanding of the challenges self-occupying owners face in energetic retrofits, their motives and barriers are concisely described, mainly based on a study by the Institute for Ecological Economy Research (IÖW). Regarding the motives of self-occupying owners,

studies show that their decision-making is influenced by a combination of economic and non-economic factors. While economic motives such as the amortization of the investment and increased property value play a role, decisions are often more influenced by non-economic factors such as the desire for comfort, reduced energy consumption, or climate protection (Weiß et al. 2018).

When deciding on a specific renovation project, barriers include the reluctance to take on loans, uncertainty about the profitability of the investment, lack of time, fear of stress during renovation work, and the belief that the house is in good condition (ibid.). Besides, since the decision for an energetic renovation requires comprehensive knowledge about renovation and financing options as well as the renovation process in general, a lack of knowledge and information poses significant obstacles (IKND 2022). Additionally, the life stage of owners and their individual economic situation influences their decision-making. Further factors such as market conditions, technical and regulatory frameworks, expert opinions, and social networks can influence the decision (Weiß et al. 2018).

3 Problem Analysis

3.1 Self-Occupying Owner Study

3.1.1 Study Design

To gain a deeper understanding of how self-occupying homeowners approach energetic renovation measures and to investigate the challenges that prevent them from conducting an energetic renovation, a survey is designed for self-occupying homeowners in Germany as a target group. This is particularly relevant as self-occupying owners record the lowest efficiency standards (see Chapter 2.1.2). I decided on this quantitative type of study since it is aimed to get a large number of answers in order to ensure a broader representation of homeowners in

Germany. The study intends to find answers to the first research question, with a focus on self-occupying homeowners: What are the key challenges of self-occupying homeowners in the context of the energetic retrofit of residential buildings?

To elaborate on the study design, the population and sample design are described, as well as the method of data collection. The population of this survey is all self-occupying homeowners in Germany. In order to achieve the target sample size of 60, the convenience sampling method is used, enabling an inexpensive, simple, and quick implementation. However, as the sample is not randomly selected using a non-probability sampling method, it cannot be considered representative of the entire population. This can lead to bias in the results, which are aimed to reduce by choosing the large sample size (Etikan et al. 2016).

Overall, the survey contains fifteen self-designed queries, segmented into three sections. First, the initial segment captures personal data and basic information about the property that can be useful for the interpretation of the results (questions 1 to 5). The second segment comprises questions regarding the perceptual barriers to energetic renovation (questions 6 to 10). Eventually, the third segment focuses on relevant decision-making factors for self-occupying homeowners (questions 11 to 15). Altogether, the survey contains three different types of questions. The most frequently used question type is multiple-choice questions, where respondents can choose from a list of possible answers. Second, five-point Likert scales are used, allowing respondents to indicate different degrees of importance from “not at all important” to “very important” for attitudes towards environmental issues (Survey Monkey 2023). Third, a dichotomous question containing two exclusive options was only used for the initial question, as it otherwise provides little added value.

Overall, it was tried to avoid double-barreled and leading questions in order to prevent any ambiguity and one-sided influence on the participants and to obtain as consistent and

unbiased results as possible (Lietz 2010). The full survey including the response options and the results can be seen in Appendix 2.

3.1.2 Implementation

Regarding the implementation of the study, the survey was carried out entirely online using SurveyMonkey in order to ensure free, fast, and convenient processing. The implementation period lasted from 24.08.2023 to 15.09.2023. During this period, one of the primary challenges was recruiting enough participants. Therefore, the recruiting procedure is briefly explained. Adopting the convenience sampling approach, I started by contacting as many people as possible in my personal network. Whenever feasible, I reached out to potential participants on an individual basis, believing that this personalized approach mitigates the likelihood of refusal. To increase participation, I emphasized that the survey takes only five to seven minutes to complete. In addition, I asked close friends and family to forward the survey to as many self-occupying homeowners as possible. Overall, this approach proved to be promising. In the end, 79 self-occupying homeowners participated in the survey. After the implementation of the survey, it was translated into English for processing the results.

3.1.3 Analysis

Descriptive Analysis

To present the results of the survey, the results will first be analyzed descriptively. In a descriptive analysis, the selection of appropriate measures is crucial to ensure both the clarity and validity of the findings. For this dataset, the primary analytical tools are frequency distributions with the measures of frequency and proportion as well as central tendencies with the measure of mode (Oh and Pyrczak 2023). Frequency provides a straightforward count of occurrences for each category, offering an overview of the response distribution. The proportion

further contextualizes this by presenting the relative prevalence of each category to the whole, making it easier to compare different categories. The mode, being the most frequently occurring value, offers insights into the dominant or most typical response within the dataset (ibid.).

The main reason for the utilization of these analytical tools is that the dataset is predominantly categorical, meaning that it contains information aggregated into groups rather than numerical values (Kotu and Deshpande 2019). As the survey aims to capture the main challenges and decision-making factors of self-occupying homeowners, nominal data arise from the individual assessment of certain renovation processes. In addition, ordinal data are generated from Likert-scale questions, among others. Further measures such as mean or standard deviation are not used as they are more suitable for numerical data.

Section 1: Personal data and basic information about the property

The survey starts by confirming property ownership (Question 1), where 87% of respondents state they own their property, while 13% do not. For the 13%, the survey ends here, the 79 remaining respondents can simply continue the survey. Secondly, the age distribution (Question 2) shows a mode in the 25-40 years category, comprising 38% of the sample, while those under 25 are the least represented at 18%. Regarding the type of property owned (Question 3), with 76% as the mode, the majority of participants own a single-family house, followed by 15% with an apartment and 9% with a multi-family house. The energetic condition of the properties (Question 4) is also assessed, with 39% evaluating the energetic condition of their homes as average. With a frequency of 29, 37% of homeowners considered the energetic condition as good or very good, while 19 people (24%) chose poor or very poor. Regarding the heating situation (Question 5), the mode is gas heating with 58% of responses. Oil, on the other hand, is the energy source for about 14%, while heat pumps are utilized by around 10%.

Section 2: Perceptual barriers to energetic renovation

In addressing the challenges homeowners face when considering energetic renovations, the survey results provide salient insights. First, the homeowners' level of information regarding existing options for energetic renovations is investigated (Question 6). The data shows that 56% of respondents feel they are barely or not at all informed about the various options available. In contrast, 29% say they feel somewhat informed and a comparatively low proportion of 15% say they feel fairly or very well informed. Moreover, the inquiry into homeowners' awareness of renovation costs (Question 7) shows that the majority feels barely (mode) or not at all informed, with 53% indicating they do not feel adequately knowledgeable about the costs involved in energetic renovations. Similarly to question 6, only 13% feel fairly or very well informed in this context.

Regarding the knowledge about available funding options (Question 8), it can be seen that a large proportion of respondents, 57%, do not feel well-informed (barely or not at all). With only 5% who consider themselves to be fairly or very well informed, the lack of knowledge, here in relation to funding, is consolidated. When it comes to reservations about conducting energetic renovations (Question 9), homeowners express diverse concerns. With a frequency of 40 people, a majority of 53% state the concern to not know what is feasible in their homes. The second and third most frequently mentioned reservations are that the investment does not pay off (43%) and long waiting times (42%).

The extent to which these reservations impact the decision to proceed with renovations (Question 10) varies among homeowners. With a mode of 34% of participants, such doubts significantly complicate the decision, while 29% state that these reservations entirely prevent them from taking action. Overall, 19 respondents (24%) say they are barely or not at all affected by those reservations.

Section 3: Relevant decision-making factors

Regarding the decision-making factors for self-occupying homeowners, first, the consideration of specific energetic renovation measures can be analyzed (Question 11). Hereby, solar panels emerge as the mode, considered by 46% of homeowners within the last two years. This is followed by heat pumps as well as insulation with a proportion of 28% each. However, carbon-intensive technologies are still considered, as the responses (13%) for gas heaters show. When asked how homeowners evaluate available renovation options (Question 12), it can be seen that personal recommendations and consultations with local installation companies are the most common modes of evaluation, each used by 66% of the respondents. In contrast, online comparison options are utilized by 32% (via comparison platforms) respectively 30% (via Google). With regard to relevant factors when deciding to invest in an energetic renovation (Question 13), the most important factor is the price with a proportion of 85%. Recommendations from others (65%), the availability of the installation company (54%), and reliable customer service (53%) follow with a majority of responses. Besides, the significance of environmental impact in renovation decisions (Question 14) was investigated and affirmed by a high proportion of homeowners. With a frequency of 46, 58% rate environmental impact as important or very important. This emphasizes the relevance of non-economic factors for self-occupying owners as mentioned in Chapter 2.3.2. Finally, when asked about the kind of support that would most assist in making decisions about energetic renovation (Question 15), clear overviews of different offers are favored by 66% of participants, while comprehensive information about technologies and price indications follow with 56% respectively 53%.

Cross Tabulation Analysis

To further analyze the survey data, a cross tabulation analysis (also known as contingency table analysis) is conducted. This method serves to identify clear relationships between two variables, enabling direct comparisons to be made between these variables (White 2004). To avoid over-

complexity and given the existence of primarily categorical data, further analysis methods such as regression or cluster analysis are not considered. In order to enable performing the cross tabulation analysis, the data of the multiple choice questions 5, 9, and 11 are normalized to the sample size of 79. Hence, the responses were first analyzed individually in the dataset and then scaled to the sample size using the exact percentage. The relations examined are those I consider most relevant with regard to the first research question. Resulting findings can be used to interpret the results and may help to identify a suitable business idea. The data of the cross tabulation analysis are provided in Appendix 3.

First, the relationship between the age of the participants (question 2) and the level of information about renovation options (question 6) is examined. It can be seen that participants over 55 tend to be less informed, with only 10% answering to be “Informed” or “Very informed”. Respondents between the age 41 and 55 and young adults under 25 are on a similar level with 13% respectively 14%. Overall, the 25-40 age group displays the highest level of information, with 20% answering to be “Informed” or “Very informed” and an additional 33% being “Moderately informed”.

Another insightful relation is the one between the age of respondents (question 2) and doubts regarding an energetic renovation (question 9). Here it can be seen that the lack of knowledge about feasibility at home is the biggest concern in all age groups. However, the two older age groups tend to express worries about customer service (20%), while this is much less relevant for younger people (0% for <25 and 3% for 25-40). Younger people especially have concerns regarding the investment not paying off, with 29% of respondents younger than 25 and 23% of the 25-40 age group stating this concern. This underlines the finding from Chapter 2.3.2 that self-occupying owners are often uncertain about their investment’s profitability.

Third, the same relations can be investigated for the type of property the respondent owns (question 3). For the relationship between the type of property and the level of information

(question 6), the data suggest that single-family homeowners are better informed about the energetic condition of their house, with 48% being moderately informed or better. Apartment and multi-family homeowners are less informed, with 29% of multi-family owners and 25% of apartment owners being moderately informed or better. In contrast, no significant difference can be recognized in the reservations of participants owning different property types (question 9). Among single-family homeowners, there is a slight tendency towards a lower knowledge deficit about feasibility at home, with only 22% stating this compared to 29% of multi-family homeowners and 33% of apartment owners.

Moreover, the relation between the heating system at home (question 5) and the consideration of energetic renovation systems (question 11) can be examined. The data suggest that those with gas heaters consider particularly solar panels (38%) and heat pumps (25%). Users of oil heaters lean towards insulation improvements (40%) and solar panels (30%), similar to owners of fireplaces (36% for insulation and 45% for solar). Another recognizable relationship is the one between the level of information (question 6) and existing doubts about an energetic renovation (question 9). Overall, the less informed individuals feel about energetic renovation options, the more they tend to not know what is feasible in their home, with 63% of participants not knowing what is feasible being not or just slightly informed. Finally, to evaluate the severity of the doubts, the relation between questions 9 and 10 is insightful. Hereby, the lack of knowledge about feasibility emerges as the strongest factor, with 79% of respondents stating that this significantly or entirely influences their renovation decision. This is followed by investment concerns and doubts about outdated technology with 67% each.

3.1.4 Conclusion

Summary

The statistical analysis provides a detailed investigation of the challenges faced in undertaking energetic renovations. The findings articulate several concerns that stand as obstacles to implementing renovation measures, whereby two can be predominantly highlighted.

The first and foremost challenge is the widespread *lack of information*, leading to doubts regarding the feasibility and value of energetic renovations. The survey indicates that a majority of homeowners (56%) do not feel well-informed about the renovation options available to them. More than half of the survey participants (53%) are uncertain about what is feasible for their specific properties, indicating a need for customized, property-specific advice. This knowledge gap is a significant barrier, as it can lead to indecision and inaction regarding energetic renovations. As outlined in the cross tabulation analysis, a large majority of respondents (79%) state that their renovation decision is significantly or entirely influenced by their reservations about not knowing what is feasible in their home. Furthermore, the analysis reveals that this lack of knowledge is consistently the most prominent concern across all age groups. Therefore, based on the survey results it can be assumed that this challenge slows down energetic renovations. Overall, the lack of information emphasizes the need for innovative solutions to provide accessible and comprehensive information about energy-efficient renovation.

The second major obstacle is *financial barriers* for self-occupying homeowners, with the elevated cost of renovation measures deterring many. This leads to the continued installation of outdated technologies, such as gas heating systems, which lack future-proofing and sustainable credentials. The mentioned information deficit extends to the costs involved, with 53% of participants indicating a lack of understanding of the financial requirements and 57% not being aware of the subsidies available to them. Additionally, a substantial proportion of homeowners (43%) question the economic payoff of such investments, reflecting concerns about the long-term benefits versus the immediate costs. Overall, the survey highlights a need for greater financial guidance and straightforward processes. Thus, an innovative solution for

these challenges should not only provide targeted, accessible, and comprehensive information about renovation options but also about correlating costs and funding support.

In addition to these two key challenges, insights regarding the decision-making process of homeowners could be gained. In this context, the reliance on trusted sources such as local installation companies and recommendations from friends and family became apparent. Solar systems emerge as the current prevalent choice of renovation measures, with the price being the dominant decision factor for the majority of homeowners. While non-economic factors, as shown in Chapter 2.3.2, are more important motives for the decision to renovate, the decision for a particular offer is mainly based on the price. Besides, homeowners express a significant need for clearer overviews of available offers and more in-depth information on various technologies when being asked about the type of support favored.

Limitations

When interpreting the data, it must be kept in mind that the survey refers exclusively to self-occupying homeowners and not to all households in Germany. Moreover, the convenience sampling method does not ensure representative coverage of the overall population. Due to my origin in western Germany, a higher number of participants from this region can be assumed. In addition, while the participants have a diverse age structure, this is also not representative of the entire population. Further factors such as household income were not included to reduce complexity, potentially further limiting the representativeness. Therefore, the representativeness of the results for the population as a whole must be questioned. Nevertheless, the findings of the survey suggest a need for a multifaceted approach that addresses the key challenges for self-occupying homeowners in energetic renovations.

Another limitation of this study is the predominant existence of categorical data as it restricts the types of statistical methods to be used for the analysis. Moreover, categorical

responses may lack precision and detail compared to numerical data, potentially oversimplifying responses and hiding nuanced insights that could be gained from more detailed numerical scales. Finally, the translation into English can be another limitation. It may be that the translated words are perceived slightly differently than in German. However, attention has been paid to ensuring that the translation is as accurate as possible.

References

Adan, Hassan, and Franz Fuerst. 2015. *Modelling energy retrofit investments in the UK housing market: A microeconomic approach.* Smart and Sustainable Built Environment 4(3)251–267. https://doi.org/10.1108/SASBE-03-2013-0016.

Agency for Economy and Development. 2020. *Was sind eigentlich frugale Innovationen?* https://wirtschaft-entwicklung.de/blog/was-sind-eigentlich-frugale-innovationen/

Agarwal, Akshat. 2022. "TAM, SAM & SOM: How To Calculate The Size Of Your Market." https://www.antler.co/academy/tam-sam-som

Baburaj, Yamuna and Vadake Narayanan. 2016. *Five Forces Framework*. Augier, M., Teece, D. (eds) The Palgrave Encyclopedia of Strategic Management. Palgrave Macmillan, London. https://doi.org/10.1057/978-1-349-94848-2_632-1

baupal GmbH. 2023. https://www.enter.de/

Becker, Simon, Jonas Hagen, Rico Krüger and Alexander Exner. 2022. *DENA-GEBÄUDEREPORT 2023 – Zahlen, Daten, Fakten zum Klimaschutz im Gebäudebestand*. German Energy Agency (dena). https://www.gebaeudeforum.de/wissen/zahlen-daten/gebaeudereport-2023/

Behr, Sophie M., Merve Küçük and Karsten Neuhoff. 2023. *Energetische Sanierung von Gebäuden kann durch Mindeststandards und verbindliche Sanierungsziele beschleunigt werden.* German Institute for Economic Research e.V. (DIW Berlin). March 13, 2023. https://www.diw.de/documents/publikationen/73/diw_01.c.868217.de/diw_aktuell_87.pdf

Bundesverband Wärmepumpe (BWP) e.V. 2023. *Wärmepumpen tragen zum Klimaschutz bei.* https://www.waermepumpe.de/waermepumpe/klimaschutz/

Cischinsky, Holger, Joachim Kirchner, Martin Vaché, Markus Rodenfels and Galina Nuss. 2015. *Privateigentümer von Mietwohnungen in Mehrfamilienhäusern.* No. 02/2015. BBST-Online-Publikation. Bonn: Institut Wohnen und Umwelt (IWU). http://www.bbsr.bund.de/BBSR/DE/Veroeffentlichungen/BBSROnline/2015/DL_ON022015.pdf?__blob=publicationFile&v=4

co2online gemeinnützige Beratungsgesellschaft mbH (co2online mbH). 2023. https://www.co2online.de/

Council of the EU and the European Council. 2023. *European Green Deal.* https://www.consilium.europa.eu/en/policies/green-deal/

Qualitätsgedämmt e.V.. 2023. *Klimaschutz und Umweltschutz*. https://daemmen-lohnt-sich.de/fassadendaemmung/vorteile-von-waermedaemmung/klima-und-umweltschutz

Enpulse Ventures GmbH. 2023. https://enpulse.io/

Etikan, Ilker, Sulaiman Abubakar Musa and Rukayya Sunusi Alkassim. 2016. *Comparison of convenience sampling and purposive sampling*. American journal of theoretical and applied statistics, 5(1), 1-4. https://doi.org/10.11648/j.ajtas.20160501.11

European Commission. 2020. *Mitteilung der Kommission an das Europäische Parlament, den Rat, den Europäischen Wirtschafts- und Sozialausschuss und den Ausschuss der Regionen - Eine Renovierungswelle für Europa – umweltfreundlichere Gebäude, mehr Arbeitsplätze und bessere Lebensbedingungen.* October 14, 2020. https://eur-lex.europa.eu/legal-content/DE/TXT/HTML/?uri=CELEX:52020DC0662

F+B Forschung und Beratung für Wohnen, Immobilien und Umwelt GmbH. 2022. *Energiekennwerte Analyse von Eigentums-, Mietwohnungen und Eigenheimen – in Schleswig-Holstein (+ Deutschland).*

Federal Ministry for Economic Affairs and Climate Protection (BMWK). 2023a. *Deutsche Klimaschutzpolitik.* https://www.bmwk.de/Redaktion/DE/Artikel/Industrie/klimaschutz-deutsche-klimaschutzpolitik

Federal Ministry for Economic Affairs and Climate Protection (BMWK). 2023b. *Unsere Energiewende: sicher, sauber, bezahlbar.* https://www.bmwk.de/Redaktion/DE/Dossier/energiewende.html

Federal Ministry for Economic Affairs and Climate Protection (BMWK). 2023c. *Das passende Förderprogramm für Hauseigentümerinnen und Hauseigentümer finden.* https://www.energiewechsel.de/KAENEF/Navigation/DE/Foerderprogramme/Hauseigentuemer/hauseigentuemer.html

Federal Ministry for Economic Affairs and Climate Protection (BMWK). 2023d. *Sicher in die Zukunft mit Erneuerbaren!* https://www.energiewechsel.de/KAENEF/Navigation/DE/Energiewechsel/Erneuerbare-Energien/erneuerbare-energien.html

Federal Ministry for Economic Affairs and Climate Protection (BMWK). 2023e. *Der Weg in unsere Energiezukunft.* https://info.bmwk.de/weg-zur-klimaneutralitaet

Federal Ministry for Economic Affairs and Climate Protection (BMWK). 2023f. *TOP 50 in*

der Winterrunde 2024 ausgewählt. https://www.de.digital/DIGITAL/Redaktion/DE/Gruenderwettbewerb/Artikel/GW-Startseite/Preistraeger-Nominierung.html

Federal Ministry for Economic Affairs and Climate Protection (BMWK). 2013. *Anlage 6 (zu § 16) - Muster Energieausweis Wohngebäude.* https://www.bmwk.de/Redaktion/DE/Downloads/E/energieausweis.pdf?__blob=publicationFile&v=1

Federal Ministry of Housing, Urban Development and Building (BMWSB). 2023a. *Kommunale Wärmeplanung*. https://www.bmwsb.bund.de/Webs/BMWSB/DE/themen/stadt-wohnen/WPG/WPG-node.html

Federal Ministry of Justice (BMJ). 2023a. *Gesetz zur Einsparung von Energie und zur Nutzung erneuerbarer Energien zur Wärme- und Kälteerzeugung in Gebäuden* (Gebäudeenergiegesetz - GEG) § 3 Begriffsbestimmungen.* https://www.gesetze-im-internet.de/geg/__3.html

Federal Office for Energy Efficiency (BfEE). 2022. *Empirische Untersuchung des Marktes für Energiedienstleistungen, Energieaudits und andere Energieeffizienzmaßnahmen im Jahr 2021*. https://www.bfee-online.de/SharedDocs/Downloads/BfEE/DE/Energiedienstleistungen/edl23_kurzfassung.pdf?__blob=publicationFile&v=6

Flach, Dominik. 2022. *Digitale Potenziale in der Energiewirtschaft.* Hy. https://hy.co/2022/10/26/digitale-potenziale-in-der-energiewirtschaft/

Gebäudeforum klimaneutral. 2021. *Berechnungsgrundsätze.* https://www.gebaeudeforum.de/ordnungsrecht/energieausweis/berechnungsgrundsaetze/

German Building Materials Association (bbs). 2022. *bbs-Zahlenspiegel 2022 - Daten und Fakten zur Baustoff-Steine-Erden-Industrie.* June 20, 2022. https://www.baustoffindustrie.de/fileadmin/user_upload/bbs/Dateien/Downloadarchiv/Konjunktur/2022-06-20_BBS_Zahlenspiegel_klein_final.pdf

Initiative Klimaneutrales Deutschland (IKND). 2022. *Energetische Sanierung: Ein unsichtbarer Schatz.* https://initiative-klimaneutral.de/fileadmin/iknd_content/Publikationen/2207_IKND_Factsheet_Umfrage_EZFH_korrigierte_BU.pdf

Intergovernmental Panel on Climate Change (IPCC). 2023. *Summary for Policymakers.*

Climate Change 2023: Synthesis Report. IPCC, Geneva, Switzerland. 1-34. https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_SPM.pdf

International Energy Agengy (IEA). 2023. *Digitalisation.* https://www.iea.org/energy-system/decarbonisation-enablers/digitalisation

iwb Immobilienwirtschaftliche Beratung GmbH (iwB). 2023. https://iwb-e.de/

Keller, Helmut. 2023. *Objektart.* Gabler Wirtschaftslexikon. https://wirtschaftslexikon.gabler.de/definition/objektart-53141

Korstjens, Irene and Albine Moser. 2018. *Series: Practical guidance to qualitative research. Part 4: Trustworthiness and publishing.* European Journal of General Practice. 120-124. https://doi.org/10.1080/13814788.2017.1375092

Kotu, Vijay and Bala Deshpande. 2019. *Data Science - Concepts and Practice.* Morgan Kaufmann. https://www.sciencedirect.com/science/article/pii/B9780128147610000010

Krieger, Sascha, Kerstin Kortmann, Kristina Kott and Cordula Schöneich. 2021. *7 Wohnen - Auszug aus dem Datenreport 2021*. Destatis. https://www.destatis.de/DE/Service/Statistik-Campus/Datenreport/Downloads/datenreport-2021-kap-7.pdf?__blob=publicationFile

LBS Research. 2020. *Mehr selbst nutzende Eigentümer in neuen Mehrfamilienhäusern.* Statistisches Bundesamt (Mikrozensus) / LBS Research. March 2, 2020.

Lee, Hoesung, and Fatih Birol. 2020. *Energy is at the heart of the solution to the climate challenge*. IPCC, July 31, 2020. https://www.ipcc.ch/2020/07/31/energy-climatechallenge/

Lietz, Petra. 2010. *Research into Questionnaire Design: A Summary of the Literature.* International Journal of Market Research, 52(2), 249-272. https://doi.org/10.2501/S147078530920120X

Murray, Miranda. 2023. *German housing construction sector cancellations hit new high, survey shows*. Reuters. September 12, 2023. https://www.reuters.com/markets/europe/german-housing-construction-sector-cancellations-hit-new-high-ifo-2023-09-12/

Nova School of Business and Economics (Nova SBE). 2023. *Prototyping Fund Fall '23: Meet the winning projects.* https://www.novasbe.unl.pt/en/whats-happening/news/news-detail/id/1059/prototyping-fund-fall-23-meet-the-winning-projects

Oh, Deborah and Fred Pyrczak. 2023. *Making sense of statistics: A conceptual overview.* 8th

Edition. https://doi.org/10.4324/9781003299356

Renz, Ina, and Ulrike Hacke. 2016. *Einflussfaktoren auf die Sanierung im deutschen Wohngebäudebestand. Ergebnisse einer qualitativen Studie zu Sanierungsanreizen und -hemmnissen privater und institutioneller Eigentümer.* Institute Housing and Environment (IWU).

Ritchie, Hannah, Pablo Rosado and Max Roser. 2020. *Emissions by sector: where do greenhouse gases come from?* OurWorldInData.org, June 10, 2020. https://ourworldindata.org/emissions-by-sector

Roland Berger. 2019. *Energieeffizienz: Markt für Dienstleistungen in Europa wächst bis 2025 auf ca. 50 Milliarden Euro.* https://www.rolandberger.com/de/Media/Energieeffizienz-Markt-f%C3%BCr-Dienstleistungen-in-Europa-w%C3%A4chst-bis-2025-auf-ca-2.html

Seitz, Kilian, Karoline Fath, Russell McKenna and Julian Stengel. 2013. *Information needs for community-level energy investments: some insights from a CONCERTO questionnaire.* eceee Summer Study proceedings, Belambra les Criques, S. 845-854.

Solarify. 2020. *Ein kW PV-Strom vermeidet 627 g CO2.* https://www.solarify.eu/2020/02/20/957-ein-kw-pv-strom-vermeidet-627-g-co2/

Stengel, Julian. 2014. *Akteursbasierte Simulation der energetischen Modernisierung des Wohngebaeudebestands in Deutschland.* KIT Scientific Publishing.

Survey Monkey. 2023. *What is a Likert scale?* https://www.surveymonkey.com/mp/likert-scale/

United Nations (UN). 2023. *The 17 Goals.* https://sdgs.un.org/goals

Verbraucherzentrale. 2023a. *Energieausweis: Was sagt dieser Steckbrief für Wohngebäude aus?* https://www.verbraucherzentrale.de/wissen/energie/energetische-sanierung/energieausweis-was-sagt-dieser-steckbrief-fuer-wohngebaeude-aus-24074

Verbraucherzentrale. 2023b. GEG: *Was ändert sich mit dem Gebäude-Energie-Gesetz?*

https://www.verbraucherzentrale.de/wissen/energie/energetische-sanierung/geg-was-aendert-sich-mit-dem-gebaeudeenergiegesetz-13886

Verbraucherzentrale NRW. 2023. *Strom und Gas: Preiserhöhungen trotz Garantie und plötzliche Kündigungen.*

https://www.verbraucherzentrale.nrw/wissen/energie/preise-tarife-anbieterwechsel/strom-und-gas-preiserhoehungen-trotz-garantie-und-ploetzliche-kuendigungen-69345

Vreed GmbH. 2023. https://vreed.de/

Walberg, Dietmar, Timo Gniechwitz, Klaus Paare and Thorsten Schulze. 2022. *Wohnungsbau: Die Zukunft des Bestandes - Studie zur aktuellen Bewertung des Wohngebäudebestands in Deutschland und seiner Potenziale, Modernisierungs- und Anpassungsfähigkeit.* Arbeitsgemeinschaft für zeitgemäßes Bauen e.V. February 17, 2022. https://www.gdw.de/media/2022/02/studie-wohnungsbau-tag-2022-zukunft-des-bestandes.pdf

Weiß, Julika, Anja Bierwirth, Jan Knoefel, Steven März, Jan Kaselofsky and Jonas Friege. 2018. *Entscheidungskontexte bei der energetischen Sanierung.* Institute for Ecological Economy Research (IÖW). https://www.ioew.de/fileadmin/user_upload/BILDER_und_Downloaddateien/Publikationen/2018/Wei%C3%9F_et_al_2018_Entscheidungskontexte_bei_der_energetischen_Sanierung.pdf

White, Douglas R.. 2004. *A Student's Guide to Statistics for Analysis of Cross tabulations.* World Cultures, 14(2).

WWF. 2023. *Ohne Wärmewende keine Energiewende.* https://www.wwf.de/themen-projekte/klimaschutz/klimaschutz-deutschland/ohne-waermewende-keine-energiewende

Appendix

Appendix 1: Overview of the Energy Modernization Status of Single-Family and Two-Family Houses in Germany in 2020, Walberg et al. 2022

Ein-/Zweifamilienhäuser		vor 1919	1919-1948	1949-1978	1979-1986	1987-1990	1991-1995	1996-2000	2001-2004	2005-2008	2009 und später
nicht/gering modernisiert bzw. Errichtungszustand	**Anteil Gebäude**	**3,4 %**	**3,0 %**	**10,2 %**	5,2 %	2,6 %	4,1 %	6,1 %	3,8 %	2,8 %	5,7 %
	Anteil Nutzfläche	2,6 %	2,1 %	6,7 %	3,8 %	1,7 %	3,0 %	4,5 %	2,8 %	2,1 %	4,6 %
	Anteil Endenergieverbrauch	3,5 %	2,7 %	8,6 %	4,1 %	1,5 %	2,7 %	4,0 %	2,1 %	1,2 %	1,7 %
	Anteil CO_2e-Emissionen	3,3 %	2,5 %	8,6 %	3,8 %	1,4 %	2,5 %	3,6 %	2,2 %	1,2 %	1,8 %
	Endenergieverbrauch [TWh]	22,30	17,38	54,19	26,07	9,90	17,42	25,07	13,45	7,84	10,48
	CO_2e-Emissionen [Mio. t]	4,40	3,32	11,32	5,05	1,85	3,28	4,71	2,95	1,64	2,36
mittel/größtenteils modernisiert	Anteil Gebäude	4,5 %	4,6 %	13,2 %	2,3 %	0,6 %	0,6 %	0,3 %	0,0 %	0,0 %	
	Anteil Nutzfläche	4,1 %	3,0 %	9,2 %	1,7 %	0,4 %	0,3 %	0,4 %	0,0 %	0,0 %	
	Anteil Endenergieverbrauch	5,2 %	3,8 %	11,4 %	1,7 %	0,4 %	0,3 %	0,3 %	0,0 %	0,0 %	
	Anteil CO_2e-Emissionen	4,8 %	3,5 %	11,1 %	1,7 %	0,3 %	0,3 %	0,2 %	0,0 %	0,0 %	
	Endenergieverbrauch [TWh]	33,02	23,84	71,96	11,09	2,26	1,85	1,98	0,11	0,12	
	CO_2e-Emissionen [Mio. t]	6,37	4,58	14,61	2,20	0,42	0,35	0,30	0,02	0,02	
umfassend modernisiert	Anteil Gebäude	1,8 %	1,9 %	5,7 %	0,5 %	0,0 %	0,1 %	0,0 %			
	Anteil Nutzfläche	1,8 %	1,4 %	3,8 %	0,4 %	0,0 %	0,0 %	0,0 %			
	Anteil Endenergieverbrauch	1,8 %	1,4 %	3,7 %	0,3 %	0,0 %	0,0 %	0,0 %			
	Anteil CO_2e-Emissionen	1,7 %	1,3 %	3,5 %	0,3 %	0,0 %	0,0 %	0,0 %			
	Endenergieverbrauch [TWh]	11,32	9,17	23,68	2,13	0,08	0,19	0,02			
	CO_2e-Emissionen [Mio. t]	2,21	1,73	4,65	0,42	0,01	0,03	0,00			

Appendix 2: Overview of Survey Results with Self-Occupying Homeowners

1: Is the property you currently live in owned by you?

Response Options	Responses in Percentage	Responses in Number
Yes	86.81%	79
No	13.19%	12

2: What is your age group?

Response Options	Responses in Percentage	Responses in Number
<25 years	17.72%	14
25-40 years	37.97%	30
41-55 years	18.99%	15
>55 years	25.32%	20

3: What best describes the type of property you own?

Response Options	Responses in Percentage	Responses in Number
Single-family house	75.95%	60
Multi-family house	8.86%	7
Apartment	15.19%	12
Other (please specify)	0.00%	0

4: How would you estimate the energetic condition of your property?

Response Options	Responses in Percentage	Responses in Number
Very poor	3.80%	3
Poor	20.25%	16
Average	39.24%	31
Good	26.58%	21
Very good	10.13%	8

5: How do you heat at home?

Response Options	Responses in Percentage	Responses in Number
Gas heater	58.23%	46
Oil heater	13.92%	11
Heat pump	10.13%	8
Pellet heater	2.53%	2
Fireplace	16.46%	13
Other (please specify)	13.92%	11

6: How do you feel informed about existing energetic renovation options?

Response Options	Responses in Percentage	Responses in Number
Not at all informed	10.13%	8
Barely informed	45.57%	36
Somewhat informed	29.11%	23
Fairly informed	11.39%	9
Very well informed	3.80%	3

7: How do you feel informed about the cost of energetic renovation measures?		
Response Options	Responses in Percentage	Responses in Number
Not at all informed	13.92%	11
Barely informed	39.24%	31
Somewhat informed	34.18%	27
Fairly informed	10.13%	8
Very well informed	2.53%	2

8: How do you feel informed about available funding options for energetic renovation measures?		
Response Options	Responses in Percentage	Responses in Number
Not at all informed	22.78%	18
Barely informed	34.18%	27
Somewhat informed	27.85%	22
Fairly informed	12.66%	10
Very well informed	2.53%	2

9: If you have any reservations about conducting an energetic renovation, what are they?		
Response Options	Responses in Percentage	Responses in Number
Not knowing what is feasible in my home	52.63%	40
Decision-making takes a lot of time	17.11%	13
Technology will soon be outdated	32.89%	25
Investment does not pay off	43.42%	33
Bad customer service of companies	23.68%	18
Long waiting time	42.11%	32
No reservations	10.53%	8

10: To what extent do these reservations affect your decision to proceed with an energetic renovation measure?		
Response Options	Responses in Percentage	Responses in Number
Not at all	15.19%	12
Barely	8.86%	7
Somewhat	12.66%	10
Significantly	34.18%	27
Entirely	29.11%	23

11: Have you considered installing any of the following systems for energetic renovation in the last two years?		
Response Options	Responses in Percentage	Responses in Number
Gas heater	12.82%	10
Solar panels	46.15%	36
Heat pump	28.21%	22
Insulation	28.21%	22
Other (please specify)	7.69%	6
I have not considered any	10.26%	8

12: When deciding on an energetic renovation measure, how do you evaluate your options?		
Response Options	Responses in Percentage	Responses in Number
Via Google	30.38%	24
Via comparison platforms	31.65%	25
Via installation company websites	24.05%	19
Via installation companies nearby	65.82%	52
Via friends and family	65.82%	52
Other (please specify)	3.80%	3
I do not evaluate more than one option	3.80%	3

13: What factors are most important to you when deciding to invest in an energetic renovation?		
Response Options	Responses in Percentage	Responses in Number
Reputation of installation company	46.84%	37
Availability of installation company	54.43%	43
Price	84.81%	67
Financing possibilities	21.52%	17
Recommendations from others	64.56%	51
Reliable customer service	53.16%	42
Other	3.80%	3

14: Can you rate the importance of environmental impact in your decision to undertake energetic renovations?		
Response Options	Responses in Percentage	Responses in Number
Not at all important	2.53%	2
Barely important	10.13%	8
Somewhat important	29.11%	23
Important	46.84%	37
Very important	11.39%	9

15: What kind of support would most assist you in making a decision about energetic renovation?		
Response Options	Responses in Percentage	Responses in Number
Overview of different offers	65.82%	52
Price indication	53.16%	42
Installation company by my side	31.65%	25
Comprehensive information about technologies	55.70%	44
Other	5.06%	4

Appendix 3: Results of the Cross Tabulation Analysis for the Survey with Self-Occupying Homeowners

Question 2 - Question 6								
Age Group	Not at all informed	Slightly informed	Moderately informed	Informed	Very informed	TOTAL		
<25 years	2	6	4	1	1	14		
25-40 years	3	11	10	5	1	30		
41-55 years	1	7	5	2	0	15		
>55 years	2	12	4	1	1	20		
TOTAL	8	36	23	9	3			

Question 2 - Question 9								
Age Group	Not knowing what is feasible	Decision-making time	Outdated technology	Investment concerns	Bad customer service	Waiting time	No reservations	TOTAL
<25 years	3	1	2	4	0	3	1	14
25-40 years	7	2	5	7	1	6	2	30
41-55 years	4	1	2	2	3	3	0	15
>55 years	5	2	3	2	4	3	1	20
TOTAL	19	6	12	15	8	15	4	

Question 3 - Question 6								
Property Type	Not at all informed	Slightly informed	Moderately informed	Informed	Very informed	TOTAL		
Single-family house	6	25	18	8	3	60		
Multi-family house	1	4	2	0	0	7		
Apartment	1	7	3	1	0	12		
Other	0	0	0	0	0	0		
TOTAL	8	36	23	9	3			

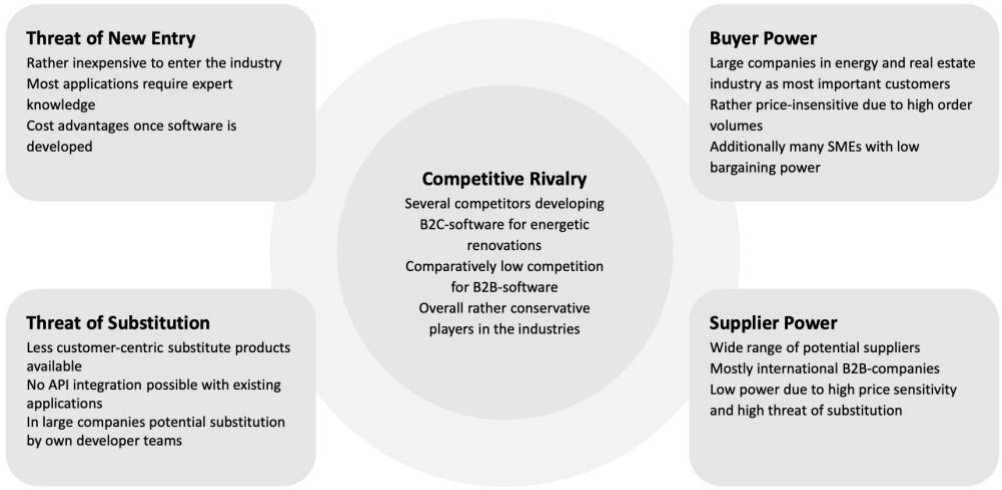
Question 3 - Question 9								
Property Type	Not knowing what is feasible	Decision-making time	Outdated technology	Investment concerns	Bad customer service	Waiting time	No reservations	TOTAL
Single-family house	13	4	10	12	6	12	3	60
Multi-family house	2	1	1	1	1	1	0	7
Apartment	4	1	1	2	1	2	1	12
Other	0	0	0	0	0	0	0	0
TOTAL	19	6	12	15	8	15	4	

Question 5 - Question 11							
Heating System	Gas heater	Solar panels	Heat pump	Insulation	Other	I have not considered any	TOTAL
Gas heater	3	15	10	6	2	4	40
Oil heater	1	3	1	4	0	1	10
Heat pump	2	2	0	1	1	1	7
Pellet heater	1	0	1	0	0	0	2
Fireplace	0	5	1	4	1	0	11
Other	1	2	4	2	0	0	9
TOTAL	8	27	17	17	4	6	

Question 6 - Question 9								
Level of information	Not knowing what is feasible	Decision-making time	Outdated technology	Investment concerns	Bad customer service	Waiting time	No reservations	TOTAL
Not at all informed	4	0	2	1	0	0	1	8
Slightly informed	8	3	6	8	4	7	0	36
Moderately informed	6	1	2	5	1	6	2	23
Informed	1	1	1	1	2	2	1	9
Very informed	0	1	1	0	1	0	0	3
TOTAL	19	6	12	15	8	15	4	

Question 9 - Question 10						
Reservations	Not at all	Barely	Somewhat	Significantly	Entirely	TOTAL
Not knowing what is feasible	2	0	2	7	8	19
Decision-making time	1	1	1	2	1	6
Outdated technology	1	1	2	6	2	12
Investment concerns	3	0	2	3	7	15
Bad customer service	0	1	2	4	1	8
Waiting time	2	3	1	5	4	15
No reservations	3	1	0	0	0	4
TOTAL	12	7	10	27	23	

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



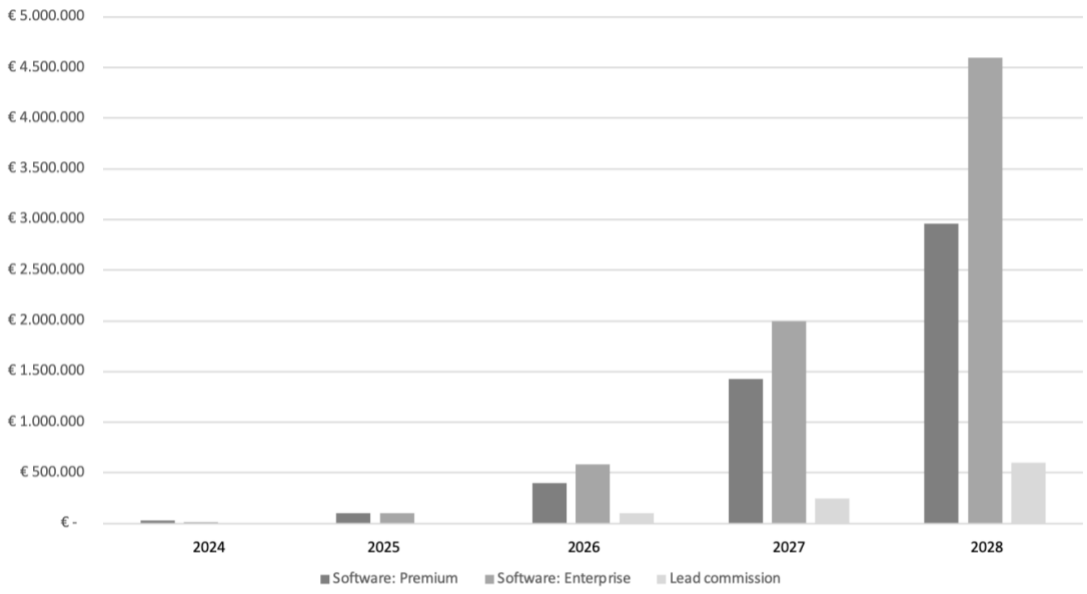
Appendix 9: Tabular Overview of Competitor Analysis

	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	✗	✗	✓

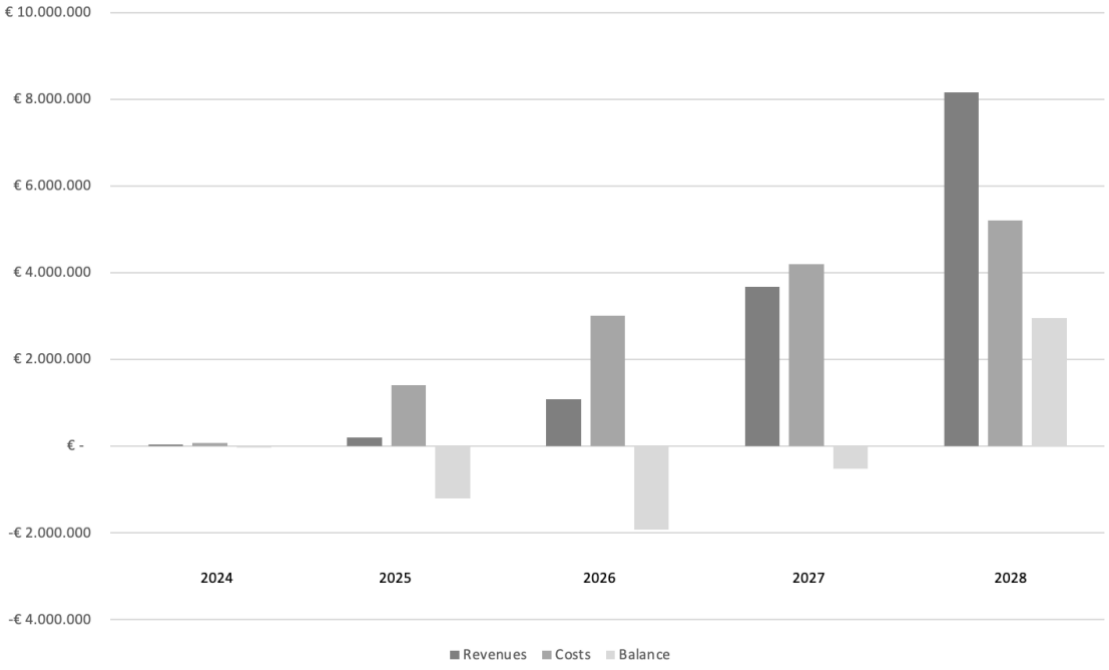
Appendix 11: Revenue Forecast for the Period from 2024 to 2028



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
Total costs	€ 13.870.000

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