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Summary of Work Project Team

From Awareness to Action: Empowering Portuguese Households in Tackling Energy Efficiency Challenges with Ecoseal

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A Work Project, presented as part of the requirements for the Master's degree in Impact Entrepreneurship and Innovation at the NOVA School of Business and Economics.

From Awareness to Action:

Empowering Portuguese Households in Tackling Energy Efficiency Challenges with EcoSeal

ECOSEAL

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Abstract

This report documents EcoSeal's entrepreneurial journey in developing a Do-It-Yourself-inspired energy assessment kit to address home energy inefficiencies, impacting approximately 80% of Portuguese homes. By leveraging the Lean Startup methodology, a solution was developed, refined, and validated to empower families to increase their home's energy efficiency through accessible tools and practical guidance. EcoSeal discovered that a Do-It-Yourself inspired approach resonates with Portugal's culture of self-reliance and has the potential to lead households from awareness to action. EcoSeal connected with organizations and affected populations to inform kit development, usability, and impact. The results are presented in this work project report.

Keywords: Energy Poverty, Energy Efficiency, Affordable Energy Solutions, Business Model Validation, Impact Entrepreneurship

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1. Introduction

1.1 Background & Context

In the historic district of Alfama, Lisbon, Rui and his family live in a chilly apartment, struggling to keep warm despite the sunny December days. Relying on a single electric heater in the living room, they bundle up in layers, avoiding extra heating costs they cannot afford. For daily comfort, they rely on wearing extra socks and simmering soup. Though Rui may not know the term "Energy Poverty," his family feels its effects firsthand, sharing the same challenges as approximately two million other households in Portugal, struggling to balance comfort and energy expenses (*Directive (EU) 2023/1791 on Energy Efficiency* 2024).

The Portuguese Long-Term Strategy for Combating Energy Poverty underscores the national severity of the issue (*Resolução Do Conselho de Ministros n.º 11/2024, de 8 de Janeiro* 2024). While the challenge is not unique to Portugal, the country faces a unique set of circumstances that position it as having one of the highest levels of energy poverty in the EU, ranking in fourth place (*Directive (EU) 2023/1791 on Energy Efficiency* 2024). Energy poverty, as defined in the EU Energy Efficiency Directive, refers to a household's lack of access to essential energy services that ensure basic levels and decent standards of living and health. These services include adequate heating, hot water, cooling, lighting, and energy to power appliances. In Portugal, it affects approximately 20-30% (1.3-3 million) of the population, with varying levels of severity (*Resolução Do Conselho de Ministros n.º 11/2024, de 8 de Janeiro* 2024).

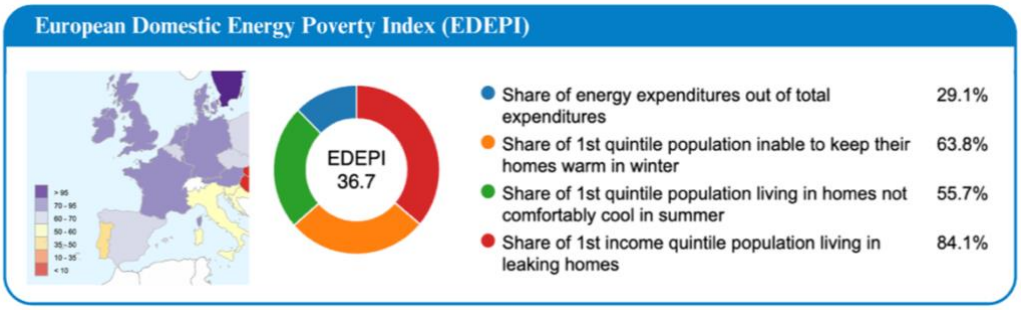

Figure 1: European Domestic Energy Poverty Index by OpenExp (2022)

Energy poverty arises from a combination of factors, including non-affordability, insufficient disposable income, high energy expenditure, and poor energy efficiency of homes (*Directive (EU) 2023/1791 on Energy Efficiency* 2024). It is further intensified by reliance on outdated energy systems, persistent cultural perceptions, and behavioral practices (Horta and Schmidt 2024). Particularly, the poor energy performance of the residential housing sector is slowing down national efforts. In fact, two out of three homes in Portugal are classified as C or lower in energy efficiency, lacking proper insulation and requiring expensive renovations that households can rarely afford (Figure 2; ADENE 2023). High energy prices strain households' budgets even more, promoting inefficient practices like reliance on portable heaters and outdated appliances. In addition to a nationwide normalization of discomfort and perception of heating as a luxury, a self-reinforcing cycle emerges. Energy-inefficient infrastructure and systems drive consumption and costs, which reduce disposable incomes needed to invest in meaningful energy-efficient upgrades (*DIRECTIVE (EU) 2018/844 on the Energy Performance of Buildings* 2018). The consequences include adverse effects on economic stability, physical and mental health, social well-being, and equality, impacting not only individuals but entire communities across the country (Feitosa and Mesquita 2023).

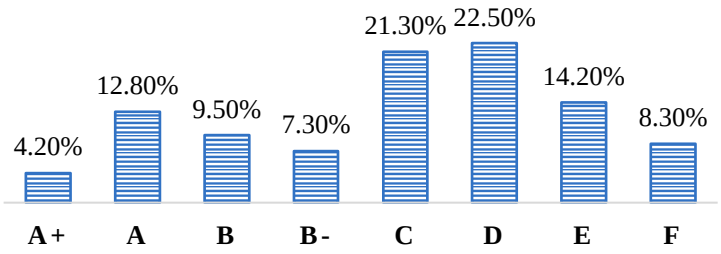

Figure 2: Energy Performance for The Residential Sector - Classes of Energy Certificates Issued up to 2022 (ADENE)

There are several opportunities for intervention: (1) *implementing consumer protection measures*, (2) *supporting household incomes*, and (3) *reducing energy needs through increased efficiency and lower consumption*. The latter focuses on structural changes and behavioral adaptations, which aligns with this project's mission.

Despite recent energy efficiency investments through public programs like More Sustainable Buildings and Energy Efficiency Voucher initiatives derived from the Recovery and Resilience Program, families like Rui's still shiver in cold apartments. Studies have shown that existing aid programs and energy service providers are particularly challenged in engaging vulnerable groups, including renters, low-income households, families, and the elderly (Gouveia et al. 2024). Even though these are groups disproportionally affected by energy-related challenges, they tend to adopt energy-efficient upgrades at significantly lower levels (Das, Richman, and Brown 2018; Klöckner and Nayum 2016).

Systemic challenges slow down the rollout of energy efficiency upgrades due to bureaucratic hurdles, lengthy processes, and the overwhelmingly large building stock requiring intervention. At the same time, these groups' specific needs and circumstances are not adequately addressed. Renters and inhabitants of historic buildings are often limited in their ability to make structural improvements in their homes, and many households generally cannot afford the high upfront costs associated with these interventions. Additionally, many households lack sufficient awareness of energy-saving practices and available solutions and face psychological barriers such as resistance to change or normalization of poor living conditions. For many of these households, the complex bureaucratic processes, financing mechanisms, and overwhelming volume of information are difficult to navigate and add a thick layer of resistance.

In summary, energy poverty disproportionately affects low-income households, renters, families, and the elderly due to a mix of low incomes, inefficient housing, high prices, and psychographic attitudes. Despite some governmental and private efforts, vulnerable groups remain hard to reach and are not adopting energy-efficient practices (Sequeira, Gouveia, and Melo 2024).

1.2 Project Overview & Goals

EcoSeal recognizes a pressing gap between existing energy efficiency initiatives and their ability to engage underserved households in a way that appeals to them, leading to low adoption rates. EcoSeal was created to bridge this gap and to encourage these groups to adopt energy-efficient practices and solutions. The primary objectives are to identify and validate a viable business model that contributes to alleviating energy poverty in Portugal and improving the energy efficiency of Portuguese homes while setting up EcoSeal for real-world success beyond this project's scope.

EcoSeal's journey began in October 2023 as part of the Impact Entrepreneurship and Innovation Master's program at Nova SBE. Initially, EcoSeal proposed the idea of **non-invasive, lower-cost** retrofits for households, targeting renters who are either unable or unwilling to make structural changes or commit to significant financial investments. With initial validations showing the potential value of non-invasive measures to improve energy efficiency, the approach was pivoted and refined during this work project, ultimately leading to the development of the DIY Energy Assessment Kit.

1.3 About this Report

This report documents EcoSeal’s journey, outlining the process from validating the problem to developing a final product and business model aimed at addressing energy efficiency challenges in Portuguese homes. The following sections outline EcoSeal’s iterative development process across three validation cycles. The methodology chapter provides an overview of the approach used. Finally, the report contains four individual contribution chapters that cover various aspects, including problem validation, customer discovery, solution design, operational strategies, financial analysis, and impact assessment. Each section presents key findings and activities that collectively shaped EcoSeal’s entrepreneurial journey.

2. Methodology

EcoSeal's approach, guided by the Lean Startup methodology, combines entrepreneurship with academic rigor to empirically validate key business model assumptions (Eisenmann, Ries, and Sarah Dillard 2011). EcoSeal focused on validating and refining the overarching concept of non-invasive energy efficiency interventions, grounding them in customer insights to develop solution approaches tailored to specific user segments. A combination of data collection methods was employed, guided by entrepreneurial frameworks to iteratively refine the solution.

2.1 Entrepreneurial Methods

EcoSeal adapted the iterative Build-Measure-Learn approach from the Lean Startup Method (Ries 2011). Each development cycle included the following stages: Plan, Build, Measure, and Learn (Figure 3). As a basis, EcoSeal used the Customer Discovery and Validation principles to develop a customer-centric solution design at each stage (Cespedes, Eisenmann, and Blank 2012). The process was documented on a validation board with Miro, where hypotheses, experiment cards and insights were organized across iterations. The team conducted design thinking workshops between cycles inspired by IDEO's human-centered design thinking approach and Alex Osterwalder's "Testing Business Ideas" to identify and reframe unmet problems and prioritize potential solutions or refinements ("Design Kit: The Human-Centered Design Toolkit," n.d.; Bland and Osterwalder 2019).

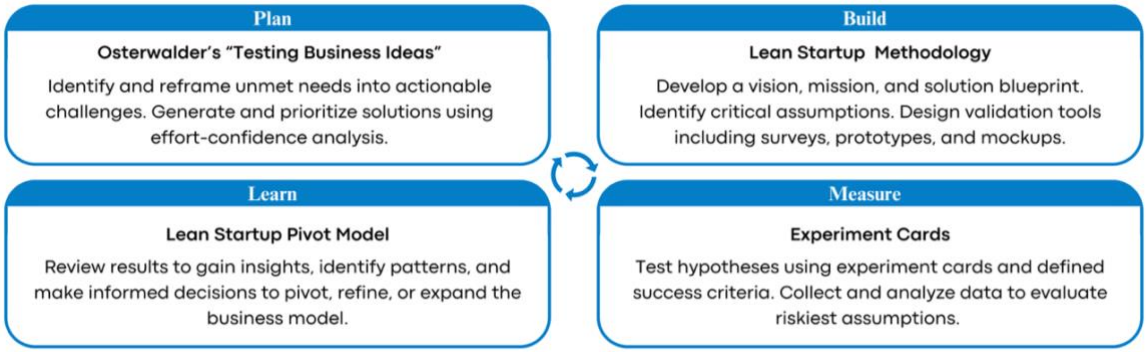

Figure 3: Plan-Build-Measure-Learn Cycle

2.2 Data Collection

EcoSeal employed various primary research methods to inform its solution development, broadly outlined in Table 1. Overall, the team engaged with various stakeholders to gather different perspectives and feedback. That included several Portuguese energy efficiency experts, with visits to Nova FCT to collaborate on the technical aspects of the solution. EcoSeal also connected with various industry players worldwide, such as the Energy Agency Codema in Dublin, which shared valuable experiences and best practices. Beyond this, the team took a hands-on approach by engaging directly with households on the street, attending workshops at the Haddad Entrepreneurship Institute, and meeting impact investors at Web Summit.

Additionally, the team held bi-weekly meetings with advisors and Galp representatives, who continuously provided insights into the proposed solutions' practical and technical aspects. Overall, the process has been marked by continuous stakeholder engagement and feedback collection. Secondary research complemented these efforts throughout the whole process. The respective research methods and collaborative inputs will be discussed in more detail in Chapter 3 and the individual sections where they were applied.

Table 1: Primary Data Collection Methods

Data Collection Method	Sample Size	Objectives
Household Surveys	2 Surveys, n = 50	Household energy challenges, preferences, and barriers to adoption
Household Interviews	n = 10	In-depth understanding of user behavior, needs, attitudes, and interest
Institutional Interviews	n = 4	Assess potential for partnerships and gauge institutional interest in supporting solutions
Expert Interviews	n = 6+	Validate solution feasibility and gain technical insights from industry professionals
Pilot Tests	1/2 carried out	Test product usability, effectiveness and gather actionable feedback
Facebook Ad Campaign	415	Evaluate market interest and engagement through digital outreach

3. EcoSeal's Entrepreneurial Journey

EcoSeal's entrepreneurial journey is characterized by three development cycles drawing closer to a solution that addresses home's low energy performance while creating alignment with household needs and preferences. This chapter will demonstrate EcoSeal's iterative development process through the three cycles. It will highlight how the team refined its approach and showcase the methodologies, insights, and learnings that guided this evolution.

Cycle 1 began with the idea of non-invasive retrofitting services, removing the need for costly, disruptive renovations. In Cycle 2, EcoSeal pivoted to a DIY Energy Saving Kit to provide households with a ready-to-assemble set of products to implement independently. Cycle 3 introduced the DIY Energy Assessment Kit to empower households to assess their energy consumption, understand savings potential, and receive actionable guidance.

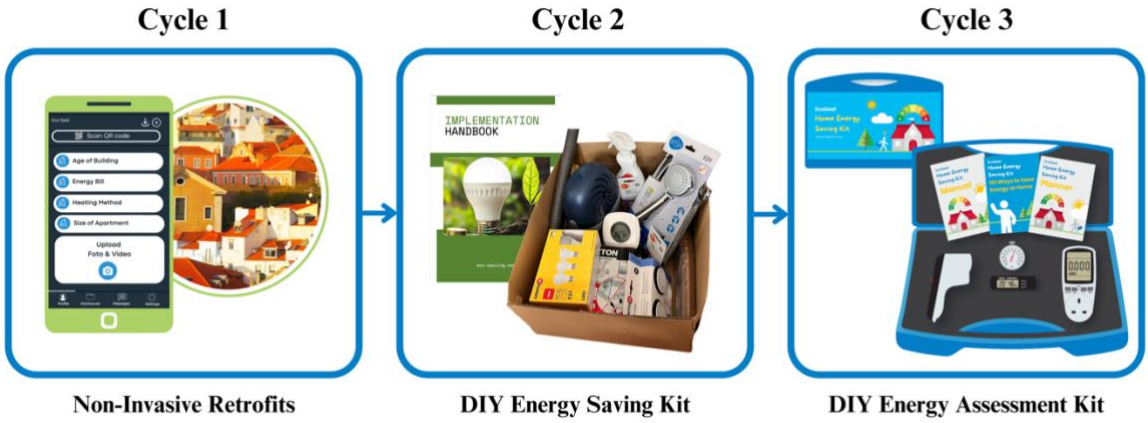

Figure 4: EcoSeal's Development Cycles

3.1 Validation Cycle 1: Non-Invasive Retrofits

3.1.1 Build

Cycle 1 began with the idea of providing non-invasive energy retrofits based on previous research on energy poverty, industry landscape, and existing energy-efficiency interventions. The solution focused on maximizing energy efficiency through non-invasive interventions, such as sealing air leaks or installing smart upgrades like thermal wallpapers and power strips. At the start of the work project, the team had already designed a preliminary solution and partnered with Galp. At the start of the work project, the team revisited critical assumptions of this model to externally validate them.

EcoSeal proposed establishing an energy service company focused on providing cost-effective, non-invasive energy-saving measures targeted for renters who cannot make structural changes to their homes and lower-income households who were assumed to prefer lower-cost options to reduce their energy use. The approach combined remote energy assessments, a customizable "intervention menu," and the provision of alternative financing options to deliver increased thermal comfort and energy savings at a lower cost and without costly, disruptive interventions. An intervention "menu" was created to provide customization at scale, tailored to urban historical apartments due to their low energy efficiency, restrictions on structural modifications, and similar energy-related problem areas.

Figure 5: Remote Energy Assessment and Non-Invasive Retrofit Packages

3.1.2 Measure

The most critical assumptions regarding this business model concerned the solution's effectiveness in lowering energy bills and increasing thermal comfort, household interest, and operational feasibility (Table 2).

Table 2: Critical Hypotheses for Cycle 1

Problem & Customer Hypotheses	
H1: At least 60% of surveyed households cite high upfront cost as the primary barrier	✓
H2: At least 50% of surveyed renters cite structural limitations as a barrier	✓
H3: At least 30% of approached households are willing to engage with the solution	x
Solution Hypotheses	
H4: At least 60% of experts agree that proposed measures will reduce energy costs	✓
H5: A pilot test reduces energy consumption by at least 10% with an investment of €1000	-
H6: Viable interventions can be offered at a price between €1000-€2000	x

EcoSeal validated that a combination of non-invasive measures has the potential to reduce energy consumption, particularly in older buildings. A panel of six energy intervention experts from Galp and Dr. João Pedro Gouveia (Work Project supervisor) confirmed the potential impact of the proposed measures, given the right conditions. The customizable intervention "menus" showed great potential with high commonalities found across similar building types in Portugal, particularly for urban historical buildings (Gouveia et al. 2021; Gregório and Seixas 2017) and multi-unit buildings.

Through a survey, EcoSeal also confirmed financial and structural constraints as relevant adoption barriers for many households, particularly renters and low-income groups (survey results discussed in Chapter 5). However, there were severe difficulties in engaging the intended audience. Despite distributing 200 flyers (Appendix H) outlining the proposed solution in low-income neighborhoods to promote the service for free to a selected pilot participant, the initiative resulted in zero sign-ups or engagement. The impact report of Ponto de Transição shared similar experiences, where vulnerable households hesitated to adopt solutions even

when offered for free (Gouveia et al. 2024), indicating other barriers at play. Later expert consultations revealed high skepticism and low prioritization as potential causes.

Lastly, a unit economic analysis investigated the potential profitability and possible pricing structure (Appendix A). The analysis revealed high startup and operational expenses attributed to the high cost of skilled labor and development or outsourcing of the remote energy assessment. While the energy interventions were found to be effective at an affordable cost, the organizational expenses would escalate without enough scale. This would limit EcoSeal's value proposition of affordable energy efficiency solutions.

3.1.3 Learn

While the potential and appeal of non-invasive interventions were confirmed, several factors challenged the feasibility of the business model. EcoSeal needed to address high transaction costs and operational expenses to reduce the price, given the highly cost-sensitive audience. Also, further psychographic barriers to adoption had to be investigated and addressed to increase engagement. EcoSeal specifically assumed high skepticism towards private service providers, hindering interest.

In an internal workshop, EcoSeal collected the main problems (e.g., high energy bills, low willingness to pay, low trust, structural limitations), reframed them into challenges, and brainstormed possible solutions. Using a matrix to rank the solution ideas, EcoSeal identified the next best solution with the highest confidence to change desired consumer behavior and the lowest effort to launch an experiment around the idea (Appendix L). The DIY Energy Saving Kit emerged, designed to offer households a user-friendly solution to improve energy efficiency through simple, self-installable measures. The kit was chosen because it focuses on simple, non-invasive measures, lowers costs by removing labor, and lets households implement changes on their own terms to increase trust.

3.2 Validation Cycle 2: DIY Energy Saving Kit

3.2.1 Build

With the decision to shift towards a DIY-inspired approach, EcoSeal built a solution to empower households to take control of their energy consumption by implementing small yet impactful changes to improve living conditions and potentially lower utility costs without professional help. Some studies emphasized that simpler energy efficiency measures are more likely to be adopted, especially when they can be implemented without professional help (Azizi, Nair, and Olofsson 2020). EcoSeal explored this approach in Cycle 2.

Figure 6: DIY Energy Saving Kit

DIY Energy Saving Kit (Prototype in Figure 6) was designed to provide households with an all-in-one solution to address common energy efficiency concerns. A second survey assessed common building challenges, which provided the foundation for the products included in the kit. The final kit included LED light bulbs, insulating window film, draft stoppers, water-saving showerhead and faucets, pipe insulation, window sealant, a moisture absorber, mechanical timers, and an anti-mold kit. Additionally, it included a Kill-A-Watt meter and tools needed for installation. Furthermore, a user-friendly instruction handbook was created to guide households in the implementation process. The development of the kit is discussed in detail in Chapter 6.

The kit was designed to deliver quick and achievable wins while motivating households to take charge of their energy consumption and home comfort. By reducing barriers such as cost, the need for extensive research, and multiple store trips, the kit is intended to make energy-saving accessible, simple, convenient, and self-driven.

3.2.2 Measure

The second validation cycle focused on understanding secondary adoption barriers, confirming resonance with self-installations, and validating the kit's effectiveness in lowering energy consumption and improving indoor comfort. The refined hypotheses focused on household resonance, kit usability, and effectiveness (Table 3).

Table 3: Critical Hypotheses for Cycle 2

Problem & Customer Hypotheses	
H1: 60% of respondents feel capable of making self-installations	✓
H2: At least 40% of respondents value self-driven improvements	✓
Solution Hypotheses	
H3: The DIY kit effectively reduces perceived energy consumption by the test user	x
H4: The DIY Kit improves perceived household comfort by the test user	✓
H4: Users can successfully install and use the kit without professional assistance.	✓
H5: At least 70% of the measures included in the kit will be implemented by the test user	x

To test these assumptions, the second survey (discussed in Chapter 5) focused on understanding user preferences and resonance with self-installations. A competitor analysis was also conducted to compare different DIY Kits to validate the solution's effectiveness (Chapter 6). After validating the kit contents, EcoSeal created a prototype and conducted its first pilot with a test user.

The DIY kit resonated strongly in both the survey and household interviews, with key drivers such as affordability, ease of use, tangible results, and suitability for renters frequently mentioned. Portuguese respondents emphasized the importance of affordability and the ability to make changes without professional assistance. These findings underscored an important insight: households are willing to make improvements independently and value self-driven solutions when given proper guidance. During the pilot participant search, interest also increased significantly. A detailed analysis of the survey insights can be found in Chapter 5.

During the pilot test, the focus was on assessing the ease of use and adaptability of the DIY energy-saving kit across different housing types. A prototype was developed and tested by a Portuguese couple of young professionals (full report in Chapter 6). After hearing about the pilot test, they expressed interest after noticing their energy bill was higher than usual. Although time constraints prevented measuring actual reductions in energy use, initial observations and perceived improvements could be documented. The test user reported a positive experience with the self-installation but highlighted a need for more customization to their specific home. Prof. João Joanaz de Melo, an environmental engineer specializing in energy efficiency (NOVA FCT), and Prof. João Pedro Gouveia, the work project supervisor and an expert on the topic of energy poverty and buildings energy efficiency, raised similar concerns. Furthermore, they raised potential issues with specific measures, such as window film and draft insulation, which could negatively affect indoor air quality.

3.2.3 Learn

The journey up to this moment has shown that EcoSeal was moving in the right direction. Initial household feedback resonated well with the DIY approach, and autonomy and self-determination emerged as significant value creators. However, respondents and interviewees continued to underline trust as a major driver in their purchase decisions. Representatives from Codema and Okotoks (Appendix E: Interview 3, 4) suggested local institutions as distribution channels in response. Furthermore, the conducted household and expert interviews (Appendix E: Interview 1, 2) uncovered another major hurdle to adoption: low problem recognition in terms of home energy challenges and savings potential of energy-efficient solutions.

Although the kit's appeal was validated, the preliminary findings suggest the need for further refinement to enhance its impact on energy bills and comfort across various housing settings and socio-economic conditions. Given that users expressed a willingness to pay for immediate

improvements in comfort or cost savings, refining the solution would be essential to uphold and strengthen its value proposition. The interview with Afonso Mendes (NOVA FCT), a student who conducted his own home energy assessment and improvement as part of Prof. Melo's class, offered valuable insights that would motivate EcoSeal's next pivot. Based on a self-performed energy audit, Afonso reduced his home energy bills by 30%, mainly by replacing old appliances and installing some similar measures as proposed by the kit.

At the end of Cycle 2, EcoSeal conducted another ideation workshop (Appendix M). EcoSeal investigated challenges related to scaling the kit across diverse housing types, intriguing households to try it, effectively communicating savings potential to raise motivation, building trust, and achieving more significant energy bill reductions. This workshop has inspired the development of the DIY Energy Assessment Kit through a lending-based system. The refined kit would help users identify inefficiencies and savings potential in their homes and guide them in making simple and immediate improvements.

This approach could address several outlined challenges: it builds trust by leveraging community institutions, lowers costs by having institutions buy and lend out kits for free, and provides meaningful, self-directed guidance on lowering energy consumption regardless of housing type.

In parallel, the Portuguese government announced the launch of the e-lar program in 2025, aligning well with EcoSeal's proposed DIY Energy Assessment Kit. The program plans to subsidize appliance upgrades to improve household energy efficiency. By combining the kit with the e-lar subsidies, households could identify and replace inefficient appliances, thereby achieving meaningful energy savings.

3.3 Validation Cycle 3: DIY Energy Assessment Kit

3.3.1 Build

EcoSeal's DIY Energy Assessment Kit provides households with a user-friendly set of tools and instructions to analyze their energy use, identify inefficiencies, discover savings potential, and take actionable steps to reduce consumption on their own terms. The development of the kit is outlined in Chapter 6.

Figure 7: EcoSeal's DIY Energy Assessment Kit

It includes devices like energy meters to measure appliance usage, guidance to interpret findings, and recommendations for targeted improvements based on the measurements. The kit is designed for distribution through local institutions, such as community centers or libraries, where it can be rented for free. Figure 8 depicts this journey from institutions to households.

Figure 8 DIY Energy Assessment Kit - Lifecycle Journey

3.3.2 Measure

To measure interest and engagement with the DIY Energy Assessment Kit, the team conducted validation interviews with entities offering a similar solution in other geographies[1] (Appendix E: Interviews 3, 4) and created a Facebook Ad Campaign (Appendix D). The campaign tested different messaging, click-through rates and led users to the landing page (www.eco-sealing.com), where they could sign up for a waiting list. To gauge institutional interest, several institutions were contacted and presented with the kit solution (Appendix B).

On the technical side, EcoSeal must validate whether households can easily operate the kit to identify energy inefficiencies and whether it provides actionable solutions that lower energy consumption. Part of that value proposition includes whether the kit drives meaningful behavioral changes by empowering users to act after use. The main hypotheses are in Table 4.

Table 4: Critical Hypotheses for Cycle 3

Problem & Customer Hypotheses
H1: Users feel capable of conducting an energy assessment when tools and guidance provided H2: Households are willing to learn and engage with a tool that provides insights H3: Institutions are interested to buy the kit to help their communities
Solution Hypotheses
H4: Users can easily understand and operate the kit without professional assistance H5: The kit can identify energy inefficiencies & give recommendations that result in energy savings H6: The kit is adaptable to different housing types and can deliver consistent results H7: Users will take meaningful action based on the insights provided by the kit

Initial validations have indicated interest in the kit, especially from an older demographic, who responded positively to messaging emphasizing cost savings, comfort, and availability in local community centers (complete analysis in Chapter 5). The presentations to institutions also yielded positive interest, with recommendations to improve kit branding and impact

[1] The team did not find any similar solution in Portugal. Interviews for validation and feedback with entities from Dublin, Ireland (Codema) and Okotoks, Canada (Okotoks Municipality) were conducted (Appendix E)

demonstration. EcoSeal will conduct a second pilot test to validate its real impact at a suitable partner institution and measure real-world demand, kit usability, and effectiveness.

3.3.3 Learn

The **validation process** for the DIY Energy Assessment Kit is still **ongoing**. However, some important insights that will inform further product refinements, marketing strategies, and operational processes have already been uncovered.

In the Facebook Ad campaign, older populations emerged as a likely customer segment, responding positively to the ads. The target demographic remains highly cost-sensitive, favoring affordable, self-directed, simple solutions. In future refinements, the kit design must prioritize simplicity, including an analog format with clear step-by-step instructions and visual aids. Marketing materials will emphasize the free rental model and highlight cost savings and comfort with a special focus on the wintertime when problem recognition is high. Furthermore, based on institutional feedback, the kit will be rebranded with a Portuguese name and redesigned to highlight its simplicity.

To better engage institutions, EcoSeal will conduct a pilot test to measure and quantify the kit's impact on energy savings, comfort levels, and behavioral changes. Furthermore, the operational processes for kit rental and distribution will be streamlined to minimize the effort for institutions. Once a prototype is ready, EcoSeal plans to conduct the pilot test with a local municipality to create a proof of concept and collect more feedback for further refinements.

EcoSeal plans to explore follow-up interventions to promote energy-saving measures with immediate results. This may include recommending products via affiliate links, offering booster boxes with supplementary tools, or a pick-up service at partner institutions where users can choose items like weather stripping or smart plugs based on their needs after returning the kit.

3.4 Business Model

Building on the entrepreneurial journey and development of the DIY Energy Assessment Kit, this chapter outlines EcoSeal's strategic business model under consideration. A non-exhaustive analysis of two distinct business models was developed, considering the following options: **Option A**, a one-time purchase model, and **Option B**, a subscription-based service. The decision between these models hinges on balancing customer affordability, market adoption rates, and EcoSeal's ability to sustain operational growth.

Option A presents a more simplistic solution, with a single fee and no additional costs or administrative complexities. This allows EcoSeal to generate revenue faster to cover the operational costs, making it suitable for early-stage scaling. However, it relies heavily on strong initial sales, which may be more challenging due to the higher up-front investment. It also reduces customer engagement and lacks a continuous revenue stream.

Alternatively, **Option B** introduces a subscription-based model, with a recurring monthly or yearly fee to get access to the kit and ongoing services, such as follow-up with users and informative content. This model provides continuous revenue and could be used to ensure long-term operational sustainability. It also requires lower up-front costs from the institutional partners, which could increase sales.

A social business model canvas (Appendix C) was developed, outlining the social value proposition, the key activities, resources, stakeholders, main channels, partnerships, revenue streams, and the cost structure of EcoSeal. This canvas reflects the strategic framework of EcoSeal and underlines its social purpose and vision.

A stakeholder map was created to identify the **key partners**, and an outreach strategy was conducted. Interviews with several of these provided an outline of the central partnerships for

EcoSeal. Among these are local governments, which are critical partners, ensuring the kits are distributed in the communities. The city councilman of Cascais Municipality, Dr. Nuno Lopes, was contacted, but unfortunately, the team could not get in touch with him. As another partnership to reach the end users, NGOs with the social purpose of promoting energy efficiency were also contacted. An interview with Islena Facanha from ZERO NGO was conducted (Appendix E: Interview 8). Partnerships with energy companies were also considered crucial, and EcoSeal's contact with Galp has led to close collaboration. Finally, visits to retail suppliers of the kit components and consultations with a manager at Leroy Merlin retail store were another step towards aligning all key partners for EcoSeal's business model.

The **main activities** for EcoSeal's business model are sourcing and assembling the kit components, including tools, promotional content, and a guidebook; developing and maintaining a digital platform; establishing and managing partnerships; conducting follow-up consultations with kit users; and measuring its impact. Additionally, marketing or fundraising campaigns are also relevant.

The **key resources** to conduct the previously outlined activities are an inventory of tools for the kits, a team of human resources to manage operations, storage infrastructure, and promotional and support materials, such as flyers, guidebooks, videos, and photography.

The **customer segments** being considered are institutions with community involvement, such as libraries, universities and schools, health centers, NGOs, and companies. Additionally, customers to be addressed at a later stage (see more in Chapter 8.5 "Exploring Additional Impact Avenues") are landlords, property managers, and small and medium enterprises looking to reduce their energy costs and comply with regulations. The initial approach is, however, to sell the kits to institutions with a social purpose and community proximity, which would

provide them for free to citizens and users. The kit would also be available for purchase through EcoSeal's website[2].

This is why it is considered crucial to develop strong **customer relationships** by delivering a kit that addresses a pressing issue and gives these institutions the opportunity to become leaders in social impact among their communities.

Nowadays, a digital platform is fundamental for distribution and communication **channels**, but EcoSeal's community-centered approach means that a lot of outreach has to be done through external and partnered entities that are already trusted by the target audience. Nonetheless, alternative channels have also been considered, such as ads on media outlets.

The **cost structure** of EcoSeal has been drawn out, and the main capital expenditures in startup costs are the development and optimization of the kits and the setup of a strong brand and communication strategy to attract users and customers. Once partnerships are established and the product has demonstrated positive results, the main expenses will primarily be related to human resources. These costs include managing sales and operations, conducting follow-up analysis, and exploring additional revenue streams or scaling opportunities, like consultations.

Finally, the **revenue streams** are sales of the kits to local partnered institutions and companies through their CSR initiatives and sales to a widespread audience through digital platforms. Moreover, governmental grants, subsidies, and donations, described in detail in Chapter 8, will make up the rest of the revenue for EcoSeal's initial stage.

[2] www.eco-sealing.com

3.5 The Creation of the EcoSeal Brand

EcoSeal was designed to be more than just a product. It was developed to be a reliable partner in helping households achieve energy efficiency. The brand identity emphasizes simplicity, accessibility, and empowerment, ensuring it resonates with households from all backgrounds. Every element of the EcoSeal brand was chosen to lower barriers, encourage engagement, and make energy-saving a positive experience.

EcoSeal's visual identity plays an essential role in communicating its mission. The color palette of green and blue was selected for its symbolism: **green** represents sustainability and environmental consciousness, while **blue** represents trust, reliability, and calmness. Together, these colors create a playful but professional tone that makes energy-saving approachable. Even the kit's design was inspired by a toy toolbox, emphasizing simplicity and fun and ensuring users feel encouraged rather than intimidated.

Figure 9: EcoSeal Color Palette & Logo

Messaging and communication were equally important. EcoSeal speaks with a friendly, supportive, and clear tone. The goal is to provide users with straightforward guidance that empowers them to take actionable steps without feeling overwhelmed. Every interaction — whether through the instruction handbook, website, or community partnerships — reinforces the message that energy efficiency can be simple, effective, and enjoyable. To increase engagement, EcoSeal used the concept of gamification (Xi and Hamari 2020). By making the kit and its tools feel like a challenge rather than a chore, users are more likely to engage in and

complete energy-saving activities. This approach also aligns with the brand's focus on accessibility and ensures that even less tech-savvy users feel empowered to act.

The EcoSeal brand is more than just a visual identity - it is a commitment to helping individuals and communities use energy sustainably. Through its thoughtful design, easy-to-understand messaging, and practical tools, EcoSeal aims to build trust and inspire action to make the journey to energy efficiency as simple and rewarding as possible.

3.6 Reflection & Milestones

EcoSeal's journey has been marked by important milestones and collaborations that paved its way. Partnering with Galp provided unique opportunities to engage with energy experts and receive consistent feedback. Despite an initially planned internship falling through, the EcoSeal team made valuable experiences strengthening their resilience and adaptability. Securing João Pedro Gouveia, a renowned energy efficiency expert, as our thesis supervisor was a major win for EcoSeal, providing critical insights into the Portuguese energy landscape. The timeline in Figure 10 illustrates some of EcoSeal's most notable milestones. Despite only arriving at a viable solution in late November, the team demonstrated the value of the Lean Startup Method by reducing time and resources wasted while ensuring the creation of an effective and achievable solution.

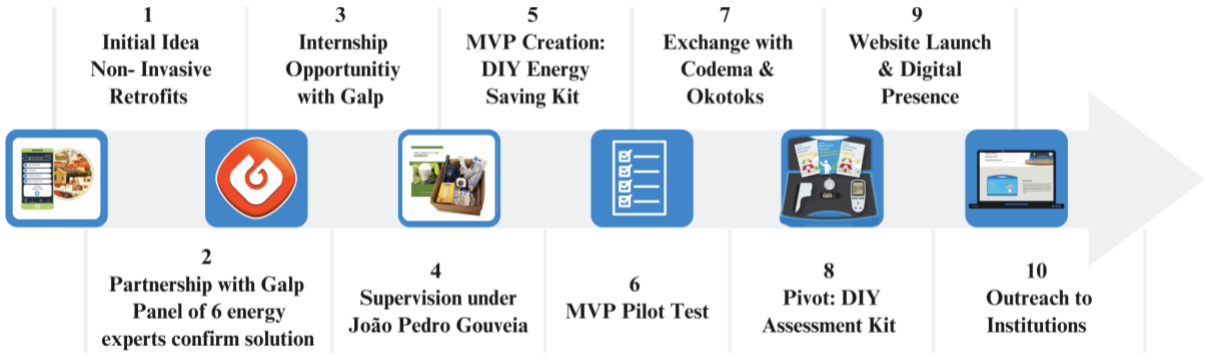

Figure 10: A chronological overview of EcoSeal's milestones

4. Individual Parts

The following chapters outline each team member's individual contribution to EcoSeal's entrepreneurial journey. The roles follow the developmental progression, naturally feeding into each other.

Problem Validation and Customer Discovery (Selina Hartmann 61965): EcoSeal's foundation began with problem validation and continuous customer discovery. Through interviews, surveys, and data analysis, the team ensured a thorough understanding of customer needs, which provided the foundation for user-centric solution development, pivots, and various aspects of business strategy.

Solution Design and Product Development (Paula Reimold 58805): Building on the previous chapter's insights, the product and solution development focused on creating technical solutions that meet the recommendations outlined in the customer discovery and offer meaningful improvements in home energy efficiency.

Operational Strategies (Maurice Moser 61263): This chapter focuses on the operational and technological foundation by validating product components, assembly, sourcing, and distribution processes. It lays the foundation for moving from concept design to the practical implementation and market entry.

Financing and Business Model Innovation (Pedro Rodrigues 57761): This chapter assesses the financial and legal requirements to start EcoSeal with a social business model tailored towards scalable impact.

Social Impact (Maurice Moser 61263): As a social impact venture at heart, EcoSeal's mission is to create measurable benefits for its community. This section develops KPIs to project, measure, and validate EcoSeal's impact.

5. Problem Validation & Customer Discovery

[Selina Hartmann, 61965]

5.1 Introduction & Relevance

This chapter documents the validation of problems associated with energy poverty, lack of thermal comfort, and low energy efficiency, uncovering the real needs of affected households. The primary objective was to gather empirical data and insights to inform the development of a more effective solution and strategy. The insights from surveys, interviews, and MVP tests were analyzed and compiled into actionable recommendations for solution development, pivots, marketing, and distribution strategies.

The *Problem Validation* served to identify and "confirm strong, unmet needs in the market" (Harvard Business School 2021). The process ensured that EcoSeal addresses an underserved pain point that truly exists and matters to enough people. The insights answered questions such as whether structural limitations to make renovations are a critical barrier for many households, to what extent Portuguese households recognize discomforts, and what specific home-energy challenges they face.

In parallel, the *Customer Discovery* deepened the understanding of the potential customer segments to build solutions that appeal to them. EcoSeal explored their unique circumstances, motivations, opinions, and attitudes influencing their home's energy efficiency. This step served to adapt solutions to user preferences, identify customer segments, and test product-market fit.

5.2 Research Design

5.2.1 Methodology

The process followed the iteration cycles outlined by the hypothesis-driven entrepreneurship methodology (Eisenmann, Ries, and Sarah Dillard 2011). For each cycle, new problems and customer assumptions were tested and refined. Table 5 provides an overview of the contribution to EcoSeal's entrepreneurial journey, elaborated in Chapter 5.5. The subsequent analysis synthesizes all learnings to inform the solution strategy of the DIY Energy Assessment Kit.

Table 5: Validation Requirements Cycle 1-3

Cycle 1: Non-Invasive Retrofits	
Objectives:	Identify core energy inefficiency pain points, validate need for non-invasive solutions for renters and low-income homeowners, gauge demand for non-invasive solutions
Activities:	Survey 1, User Interviews, Flyering, Expert Consultations
Cycle 2: DIY Energy Saving Kit	
Objectives:	Explore adoption drivers and secondary barriers, test demand for DIY kits, explore distribution channels
Activities:	Survey 2, User Interviews, Expert Consultations, Competitor Outreach
Cycle 3: DIY Energy Assessment Kit	
Objectives:	Test resonance with the DIY Energy Assessment Kit with households and institutions as distribution channels, behavioral change drivers
Activities:	Expert Consultations, Facebook Ad Campaign, "Letter of Intent" to Institutions

The activities conducted in this section are adopted from the Harvard Business School (HBS) Customer Discovery Basics, describing a structured approach to understanding potential customers and turning discovery insights into actionable recommendations (Harvard Business School 2021). The approach starts with understanding customer pain points, defining and prioritizing personas, and employing diverse discovery techniques such as interviews, ethnographic research, journey mapping, and low-fidelity testing.

5.2.2 Primary Data Collection

5.2.2.1 Household Surveys & Interviews

Two surveys were distributed to gain insights into the target audience. The first survey explored demographics, housing challenges, pain points, and barriers to adoption while also recruiting for interviews and pilot participants. The answers were collected through social media, word-of-mouth, and the distribution of 200 flyers in low-income neighborhoods (on cars, mailboxes, coffee shops, and face-to-face interactions). The second survey addressed some misalignments between initial assumptions and the proposed value proposition, focusing on adoption barriers and solution drivers on a more granular level while validating preferences for self-installation solutions. Based on participants' profiles, several interviewees were selected to conduct in-depth interviews to enrich survey findings through exploratory discussions with households. Survey 1 and 2 questions, along with the flyer, are detailed in Appendix H.

The survey data was translated, cleaned, and binarized for data analysis to calculate correlations and uncover new patterns. The data was analyzed in Python using pandas, with Spearman's rank correlation. A custom function calculated the p-values, filtering for statistically significant correlations ($p < 0.05$). The interviews were recorded, transcribed, and analyzed to complement the survey findings.

Table 6: Primary Data Collection for Households

		Survey 1 (n=20)	**Survey 2** (n=30)	**Interviews** (n=10)
Nationality	Portuguese	68%	70%	50%
	Non-Portuguese	32%	30%	50%
Housing Status	Homeowner	42%	60%	4
	Renters	58%	40%	6
Avg. Household Income		€30,000/year	€40,000/year	-

5.2.2.2 Expert Interviews

Expert interviews were conducted with representatives from corporations, competitors, energy efficiency experts, and other stakeholders (see Appendix E). They offered valuable input for various aspects of the project. Specific questions were prepared, focusing on this chapter's goals, to leverage their experience and expertise in working with vulnerable households, effective ways to engage them, and their needs.

Table 7: Expert Interviews

Participants	Area of Expertise	Associated Organizations
João Pedro Gouveia	Energy poverty and efficiency expertise	EU Energy Poverty Advisory Nova FCT; Firefly Energy Lab
João Joanaz de Melo	Home auditing, energy efficiency policy	Nova FCT
Anonymous	Innovation management, entrepreneurship	Smart Energy Lab (EDP Group)
Gobnait Ní Néill	DIY Kits, community engagement	Codema Energy Agency (DIY Kits)
Cassidy Stillie	DIY Kits, community initiatives	Clean Energy Improvement Program (DIY Kits)
João Costa Ribeiro	Open innovation, energy sector innovation	Galp Innovation Center

5.2.2.3 Institutional Interviews

With a shift towards using community institutions as distribution channels (Cycle 3), EcoSeal approached several organizations with a presentation (Appendix B) outlining the final DIY Energy Assessment Kit and its benefits to institutions and communities. The primary objective was to gauge institutional interest and gather feedback on institutional needs.

Table 8: Institutional Interviews

Participants	Function	Organization
Islene Façanha	Project and Policy Officer	**ZERO** – Portuguese environmental NGO promoting sustainability and environmental protection.
Sara Pais	Project Manager	**Calouste Gulbenkian Foundation** – Private institution advancing arts, charity, science, and education.
Nuno Francisco Piteira Lopes	Vice-President	**Câmara Municipal de Cascais** – Local governing body of Cascais, Portugal.
Margarida Queiroz	Social Impact Specialist	**Galp Foundation** – Social impact arm of Galp Group.

5.2.2.4 Facebook Ad Campaign - MVP Test

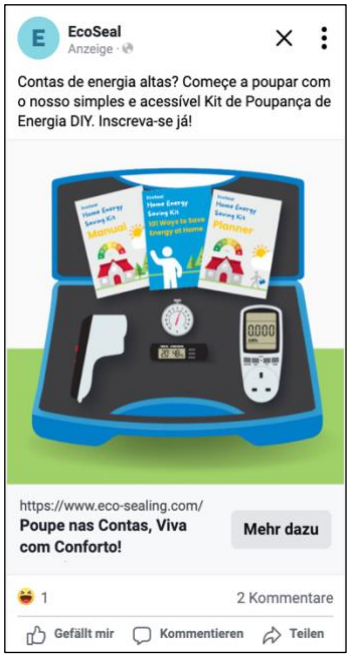

Figure 11 Facebook Ad Variation

Based on the Haddad MVP development workshop, a Facebook Ad campaign (Appendix D) was created to validate various aspects of the DIY Energy Assessment Kit. Firstly, the test validated interested consumer demographics and tested different headlines and descriptions based on various value propositions (e.g., free rental, immediate savings, DIY aspect). Lastly, users were referred to the website to join a waiting list to demonstrate user interest to institutions. The ad was targeted to the Lisbon area for 7 days with a budget of 35€, gaining 25,505 impressions. The main results can be found in Table 9.

Table 9: Facebook Ad Campaign Results

Demographics	**18-44**	**45-64**	**65+**	**Total**
Link Clicks	37	137	241	415
Click-Through Rate				0,64%
Messaging				**Total**
“Save on Bills, Live Comfortably!”				136 clicks
“Stay Warm This Winter and Save Energy! Discover Our Simple Solution Now”				130 clicks
“Save Energy Now—See Results Today!”				70 clicks
“Free Energy-Saving Kits at Your Local Community Center. Reserve Yours Now”				79 clicks

5.2.3 Secondary Data Collection

As a complementary part of the primary research, publicly available data and studies were reviewed to add depth to the research results. Several ethnographic research studies investigating how people make energy-related decisions were analyzed and discussed in conjunction with the primary research findings, adding additional insights and validations on multiple levels.

5.3 Research Results & Insights - Households

5.3.1 Problem Validation & Pain Points

The problem validation analysis demonstrated strong concerns regarding thermal discomfort and excessive energy bills. In the first survey, **79% of respondents reported energy bills that are perceived as too high** relative to their income. In terms of discomfort, Survey 1 revealed that 26% of respondents were uncomfortable year-round, with an additional 53% uncomfortable in winter. In Survey 2, **70% of respondents experienced thermal discomfort**, with similar seasonal patterns.

Several factors influenced the perceived severity of these pains. High energy bills were particularly relevant to Portuguese respondents ($r = 0.595$; $p = 0.015$) and households with moderate-low incomes of €20,000-€40,000 per year ($r = 0.630$; $p = 0.0089$), who were also less likely to have made any energy efficiency upgrades in the past ($r = -0.482$; $p = 0.007$). Discomfort was mainly linked to old home age, with older properties being more uncomfortable ($r = 0.408$; $p = 0.0251$). Renters and owners both experienced high perceived energy bills, with renters being more likely to perceive their energy bills as significantly too high. This may be explained by long-term renters being more likely to live in older homes ($r = 0.544$; $p = 0.0019$) and less likely to have made energy efficiency improvements in their homes ($r = -0.516$; $p = 0.041$), citing limitations in making structural improvements in rented homes as a main adoption barrier ($r = -0.505$; $p = 0.0044$).

The problem validation confirmed thermal discomfort and high energy bills as significant challenges for Portuguese households, with renters and low-income groups being particularly affected. Lower disposable incomes, structural barriers, and old building age amplify the cycle of inaction and high energy consumption.

5.3.2 Adoption Barriers

Only a small portion (23.3%) of respondents have made any energy-efficiency improvements in the past (Survey 2) despite reporting high levels of discomfort and energy bills. The key barriers preventing action were financial constraints, structural limitations, difficulty in accessing financial aid programs, low solution awareness, perceived complexity and skepticism, low problem recognition, and lack of knowledge and agency.

Financial constraints remain the core adoption barrier. Approximately 56% of respondents in Survey 1 and 43.3% of respondents in Survey 2 cited high expenses and upfront costs as the main adoption barriers. Adoption was also strongly linked to income, with higher-income households (>€60,000/year) being the most likely group to have made improvements ($r = 0.737$, $p < 0.00001$) and lower-income households (<€20,000/year) being the least likely group ($r = -0.737$, $p < 0.00001$).

The second most dominant adoption barrier was confirmed to be **limitations in making structural changes**, cited by 40% of respondents in Survey 2. This is reflected in the correlations showing that renters and low-income households are the least likely groups to have made past improvements and is backed by existing research (Hesselink and Chappin 2019).

Furthermore, an interesting pattern of correlated barriers emerged involving the engagement with existing solutions. Respondents frequently cited **difficulty accessing existing programs** (30%, Survey 2), **lack of awareness about solutions** (23.3%, Survey 2), and **distrust in contractors** (23.3%, Survey 2). Respondents who had difficulty accessing existing aid programs were also deterred by **skepticism regarding solution effectiveness** ($r = 0.488$, $p = 0.0062$), distrust in providers ($r = 0.499$, $p = 0.0050$), and **long waiting times** ($r = 0.385$, $p = 0.0356$). Additionally, these respondents also perceived the **processes as complex and confusing** (correlating with skepticism about solution effectiveness; $r = 0.447$, $p = 0.0132$).

These pain points were found to be particularly relevant for cost-sensitive, low-income households ($r = 0.389$, $p = 0.0337$) living in properties with low perceived thermal conditions ($r = 0.553$, $p = 0.0015$).

Given the limitations of engaging with existing solutions, there are also several factors that limit independent action by households. While some interview respondents reported having taken things into their own hands, many households reported that they **do not know what to do** (56.25%, Survey 1) or what steps to take. Expert interviews backed this, revealing that many households are **unaware of simple behavioral changes and low-cost options** to reduce their energy consumption (Appendix E: Interview 2). Despite the volume of available information online (e.g., Menu Rernovação Verde), some studies suggest that households are deterred by its complexity and lack of practical, user-friendly information (Cattaneo 2019). Interview respondents agreed that common information channels like online searches and home improvement retailers provided little practical guidance.

Lastly, expert interviews with Portuguese energy efficiency experts revealed an important cultural barrier. Many households do not recognize energy inefficiency as a problem. Cultural attitudes and adaptive coping mechanisms, such as wearing extra clothing indoors, **normalize discomfort** (Horta et al. 2019; Abrardi 2019) and reduce perceived urgency (Rotzek, Scope, and Günther 2018). Interview respondents frequently cited such coping mechanisms, including increased reliance on inefficient heating, warm clothing, or even less time spent at home. This represents a strong status quo mentality yet to be addressed.

5.3.3 Adoption Drivers

The research results on drivers and motivators revealed cost as a remaining primary concern, followed by tangible benefits, ease of use, and autonomy.

Affordability and low upfront cost for solutions remain the primary concern for most respondents (63.3%, Survey 2). Immediate savings were a strong incentive for most households (50%, Survey 2). However, 40% of respondents (Survey 2) also valued energy savings over time, especially those who desired flexibility in making gradual improvements.

Furthermore, the research highlighted a strong desire for **tangible and quick results** on energy bills or comfort (50%, Survey 2). Interviewees who have made past improvements expressed motivation from small wins and tangible benefits, as simple as defrosting their freezer. Researchers back this notion, supporting that visible benefits increase value perception, sense of accomplishment, and motivation (Schwartz and Krarti 2022; Cagno, Moschetta, and Trianni 2019).

Trust is also a critical factor in adopting energy-efficient solutions and has been repeatedly cited by interviewees, experts, competitors, and existing research. Competitors like Codema highlight the importance of using trusted intermediaries in the distribution, which is also a primary finding of several researchers who underline the role of local organizations as intermediary connectors, especially when high levels of skepticism are present (Bird and Barnes 2014; Horta et al. 2019; Sequeira, Gouveia, and Melo 2024). In the Facebook Ad campaign, the headline citing local institutions as intermediaries performed second best of ten other headlines. However, as described by Sequeira et al. (2024), scarce research has engaged with these organizations to assess if they are willing and capable of contributing, if they can reach households, and if they have unmet needs.

Simplicity and ease of use are other critical factors for success. Feedback from experts and respondents highlighted low energy literacy and perceptions of complex and confusing processes to improve energy efficiency. Clear instructions, simple tools, and user-friendly guidance are essential to ensure accessibility to all households, as was highlighted by 40% of survey respondents in Survey 2. These findings align with the National Energy Poverty Strategy, which shows an energy literacy index of 42.8 out of 100 among Portuguese consumers, with particularly low energy literacy for vulnerable groups who are more at risk for exclusion (*Resolução Do Conselho de Ministros n.º 11/2024, de 8 de Janeiro* 2024).

Autonomy and control over the process emerged as potentially powerful drivers to increase motivation and engagement with energy efficiency solutions. 60% of respondents felt comfortable installing energy-efficient measures independently, with an additional 30% considering it with clear instructions and guidance (Survey 2). The respondents strongly resonated with the idea of making energy improvements independently. 43.3% valued the flexibility of making changes on their own schedule and the option to implement small, gradual changes, and another 20% preferred to do so without professional help.

Interviews with sampled households also revealed a positive sentiment towards self-driven solutions, though this may not apply to all Portuguese homes. Portuguese households were shown to frequently perform their own repairs, however, often resulting in the extended use of outdated appliances and subpar outcomes (Sabino 2015; Østergaard, Soares, and Ferreira 2014). EcoSeal sees potential in leveraging this resourcefulness by giving them the right tools and knowledge to manage their own energy consumption and potentially the adoption of energy-efficient solutions (Iskin and Daim 2012; Shaukat et al. 2018). External research supports this notion, underlining autonomous motivation, clear goals, self-directed actions, and visible results in reinforcing motivation, satisfaction, and adoption (Webb et al. 2013; Legault and Inzlicht 2013; Juntunen and Martiskainen 2021; Shaukat et al. 2018; Deci and Ryan 1987).

In conclusion, the research results highlight several key adoption drivers and motivators that EcoSeal aims to target. Addressing financial barriers with affordable solutions is essential, highlighting cost savings as a key benefit. Empowering solutions with tangible benefits showed great potential in enhancing user motivation and satisfaction. Moreover, the findings highlight a strong willingness of individuals to take action themselves, particularly when provided with clear instructions, simple tools, and actionable guidance. Additionally, trusted intermediaries as distribution channels are critical to overcome skepticism and build credibility.

5.3.4 Consumer Segmentation

For the consumer segmentation, the following variables were chosen and investigated: location, age, income level, housing age, occupancy type, and pain points related to home energy efficiency.

Initially, EcoSeal considered renters and energy-poor households as primary customer segments. EcoSeal deprioritized extremely low-income households throughout the journey due to their severe financial constraints and competing priorities. Furthermore, renters have been demoted from the primary customer segment as they showed less willingness to invest in non-owned homes and only made up about 22% of Portuguese households in 2022 ("Portugal: Share of Homeowners 2008-2022" 2024).

Elderly homeowners emerged as a likely customer segment for the DIY Energy Assessment Kit. This was indicated by the Facebook Ad campaign results (Figure 12). Similar trends were observed by the DIY Audit initiative in Okotoks, with primary interest from seniors. Insights from Prof. Melo indicated a growing number of elderly individuals in Portugal burdened by high energy costs. Notably, over 23% of Portugal's population is aged 65 years or older, one of the highest shares in Europe ("Índice de envelhecimento e outros indicadores de envelhecimento" 2023). This presents significant potential for targeting these groups. The

elderly are also highly reachable through community centers and were shown to prefer simpler, less intrusive upgrades over comprehensive structural changes in their homes (Das, Richman, and Brown 2018; Klöckner and Nayum 2016). While designing the kit for the elderly requires user-friendliness and simplicity, it could ultimately benefit all users across varying literacy levels.

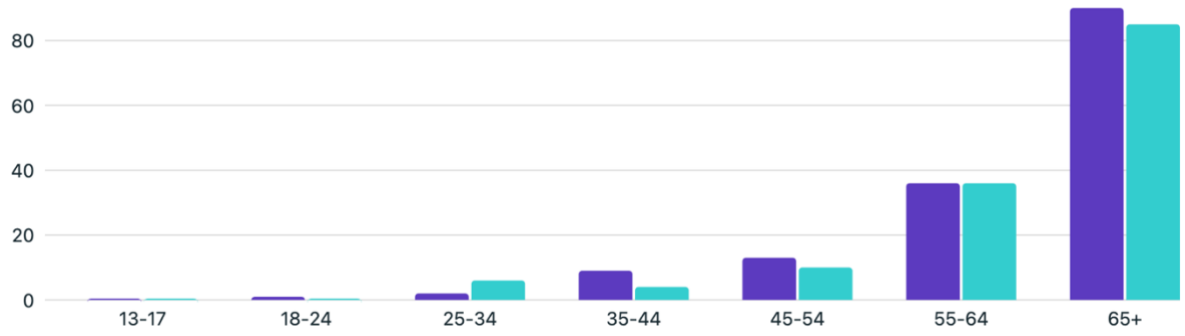

Figure 12: Link Clicks by Age and Gender: Facebook Ads Performance Breakdown

Some industry experts (Appendix E: Interview 1, 3) have suggested that the DIY Energy Assessment Kit requires a less narrow customer segmentation. While the kit remains applicable across different households, segmentation is still relevant. The overarching focus will be on lower-income households in the Lisbon area, primarily residing in older homes with high thermal discomfort and energy bills, especially in winter. The following three customer segments (Table 10) were developed in conclusion to the research.

Table 10: User Segments

Segment	Pain Points	Drivers & Motivators
Elderly Homeowners	high energy costs; cost sensitive; hesitant about large renovations; limited awareness on available solutions; overwhelmed by complexity	simple affordable and non-intrusive solutions; maintain independence; improve comfort without major disruptions; trust through community interaction and familiar places
Low/Mid Income Families	struggle with high upfront costs for improvements; uncertain how to address inefficiencies; skepticism, and low trust in existing programs	affordable kits providing immediate savings, improve living conditions and reduce financial strain, step-by-step guidance
Long-Term Renters	structural limitations; high energy bills; lack of landlord investment; little willingness to invest	affordable DIY solutions that do not require landlord approval, reduce energy costs independently, renter-friendly solutions

Figure 13: User Persona 1

As guided by the user persona António in Figure 13 (full persona in Appendix G), EcoSeal focuses on the needs of the least adaptable users to ensure an appealing approach for and beyond this group. Like António, EcoSeal's target audience is often overwhelmed by complex processes and information. Many rely on limited incomes, making them very budget-conscious. They tend to rely on traditional practices and display skepticism toward unfamiliar products but trust recommendations from trusted institutions and neighbors. This audience values independence and resourcefulness and takes pride in handling problems on their own, but they require intuitive tools and guidance to point them in the right direction. Their behavior is motivated by comfort and practicality, prioritizing solutions that are simple, effective, and proven.

5.4 Research Results & Insights - Institutions

Starting in Cycle 3, EcoSeal adopted a dual audience model, addressing households as end-users and local institutions as intermediary distributors and customers. While households benefit from reducing energy costs, institutions may benefit from alignment with their institutional goals and additional support to their beneficiaries. This approach necessitates an analysis and adaptation to both groups.

5.4.1 Customer Segmentation

To identify suitable partner institutions, EcoSeal chose organizations based on their social impact orientation, with close and trusted relationships to local communities. To gain feedback on resonance and needs, EcoSeal contacted five different organizational types and conducted three DIY Energy Assessment Kit presentations so far (Appendix E: Interviews 6, 7, 8). Furthermore, a study mapping 198 local organizations around Setubal conducted 34 interviews

that examined institutional barriers and drivers to promoting energy efficiency initiatives in their communities (Sequeira, Gouveia, and Melo 2024). Consolidating the insights, four organizational types and respective considerations were identified (Table 11). Both researchers and institutions indicated a positive inclination to collaborate and connect citizens in promoting energy-efficient initiatives.

Table 11: Institutional Mapping

Organization	Motivators	EcoSeal's Benefit	Barriers
Government Institutions	Quantifiable impact; community-wellbeing; policy alignment; cost-effectiveness	Credibility; scalability & broad population reach; infrastructure; funding opportunities; endorsement	Limited human resources; budget constraints; bureaucracy; skepticism; impact uncertainty
Universities	Sustainable & social leadership demonstration; student engagement; community reputation; research	Networks for distribution; students & staff as early advocates; thought leadership	Competing priorities; budget constraints; operational complexity
Energy Providers	CSR, community commitment (Galp foundation), upselling (EDP), measurable outcomes	Additional revenue streams; technology adoption; joint value creation; market penetration	Cost concerns; brand perception; impact skepticism
NGOs	Community empowerment, measurable outcomes	Community reach; donor networks; endorsement	Resource constraints; competing priorities; impact measurement

5.4.2 Market Size

To estimate EcoSeal's market size, the total number of potential institutional partners was assessed. For a conservative estimation, EcoSeal initially only considered municipalities and universities. Portugal has 308 municipalities and approximately 95 universities, rounding up to 400 potential partner institutions in the country (**total addressable market**). Initially, EcoSeal will focus on the Lisbon metropolitan area, where it could partner with 10-15 government entities and five universities as initial partners, leading to a **serviceable addressable market** of around 20 institutions. In the first year, EcoSeal may secure 2-5 partnerships with organizations willing to pilot the kit (**serviceable obtainable market**). That year could serve to collect feedback and endorsement and build a proof-of-concept.

EcoSeal sees positive scaling potential in these partnerships. A single Portuguese municipality could deploy dozens of kits for their communities. Using Codema as a benchmark, they distributed about 200 kits without any active promotion. Adjusting for population, EcoSeal could potentially distribute at least 400 kits organically. Given the higher prevalence of energy inefficiencies, this number could reasonably grow to 800 kits even without promotion. With universities, NGOs, energy providers, and other entities, EcoSeal could easily achieve sales of over 800 kits. This growth could just mark the beginning of EcoSeal's impact.

5.5 Consumer-Focused Design through the Cycles

In **Cycle 1**, the problem validation and customer discovery confirmed the problem of thermal discomfort and high energy bills, particularly for renters and low-income households. Renters faced barriers due to limitations in making structural improvements but showed less incentive to invest in non-owned homes. Homeowners comprise a larger target group for EcoSeal (76% of Portuguese households) and showed slightly less price sensitivity. Furthermore, discomfort was identified as a key driver to engagement, strongly tied to older buildings. EcoSeal should leverage the issue of discomfort, especially in winter, and focus its activities before and during the colder months when willingness to act is exceptionally high. Despite recognized pain points, respondents had little knowledge of what steps to take, often resorting to inefficient practices. Even though non-invasive energy-saving measures showed some potential, the solution was rejected due to low trust and perceived complexity. As a result, EcoSeal retained its focus on non-invasive measures, exploring ways to reduce cost, increase trust, and provide guidance on how to get started. The DIY Energy Saving Kit was developed, aimed to lower costs by eliminating human labor, increase trust by giving households more control, and reduce complexity through a ready-to-assemble set of tools.

In **Cycle 2**, validation activities confirmed a high resonance with self-installations among respondents and interviewees. A flexible, gradual, and low-fidelity approach, motivated by quick wins, was well perceived by respondents. However, trust and low problem recognition remained critical barriers. EcoSeal shifted to the DIY Energy Assessment Kit via a rental model, motivated by institutional needs for low operational complexity and cost-effectiveness. Providing the kit for free at local institutions would also increase trust and allow households to discover problem areas and savings potential on their own, leading them from awareness to problem recognition to willingness to adopt energy-efficient solutions and pracices.

Cycle 3 aimed to validate the concept on a household and institutional level. The Facebook Ad campaign showed interest from the older population, revealing a new relevant customer segment. To combat problem recognition, EcoSeal must retain a simple analog approach while still highlighting potential savings and benefits to motivate users. Emphasizing simplicity, control, and gradual improvements is recommended, alongside quick-to-implement recommendations. For institutions, EcoSeal needs to provide a quantitative impact assessment to demonstrate value and reduce the operational complexity of the kit rental.

5.6 Limitations & Future Directions

While the research offers valuable insights, several limitations need to be addressed. First, the small sample sizes limit the generalization of findings. Additionally, the surveys did not collect data on age, as the significance of this demographic factor was not initially apparent. Although efforts were made to cross-check insights with existing research and expert opinions, the correlations and resulting conclusions may not apply uniformly across all households. In the future, EcoSeal needs to conduct pilot tests with institutions directly to collect feedback from real users. Furthermore, additional insights into behavioral intervention and nudging strategies are worth looking into to enhance the kit’s actionability and drive behavioral transformation.

6. Solution Design & Product Development

[Paula Reimold, 58805]

6.1. Introduction & Relevance

Building on the insights from the Problem Validation and Customer Discovery activities, this chapter outlines the development and refinement of EcoSeal's solution and final product. Two main objectives and priorities marked this process. Initially, it aimed to address the validated customer pain points, preferences, and adoption barriers to create a user-centric solution. Secondly, the process ensured the solution’s technical effectiveness in improving energy efficiency and indoor thermal comfort. Furthermore, Eco Seal aimed to increase scalability by improving effectiveness across different user contexts and needs.

Following the iterative approach laid out by the Lean Startup Method, the solution evolved through multiple stages of prototyping and testing. This ensured a continuous improvement in problem-solution fit and solution efficiency. Through iterative refinements, a product was developed that balances simplicity and functionality.

6.2 Methodology

The methodology behind the kit developments combined primary and secondary research methods. The solution design started with Design Thinking ideation workshops, outlining an initial solution proposition. Given the technical nature of energy efficiency interventions, the planning process required developing a more detailed solution from a technical perspective, which was heavily informed by existing research and expert consultations. In the second step, the solution concepts were validated to ensure their effectiveness in reducing energy bills and alignment with the outlined customer needs. Secondary research included a review of existing literature, case studies, and best practices in energy efficiency solutions on the market.

6.3 Market Analysis

Following the pivot in Cycle 2, EcoSeal shifted towards a DIY Kit approach. Various organizations that are already distributing DIY kits were reviewed and analyzed to assess their merit and inform the development of EcoSeal's kit.

Existing DIY kits were found in several shapes and forms, both from public and private providers. This idea has gained some traction, especially in the United States and Canada. Several kits and models were compared, considering their strengths and weaknesses (see Appendix F). Some notable initiatives were the Tri-County Regional Energy Network, California in the United States, the Codema Home Energy Audit Kit in Ireland, the Okotoks DIY Energy Kit Program in Canada, and HomeBoost in the United Kingdom.

The kit from the Tri-County Energy Network is being distributed through libraries and includes tools like light bulbs and weatherstripping. While the kit was highly accessible to vulnerable groups, problems with replenishments and refilling were highlighted (3C-REN, n.d.). Codema's kit, on the other hand, did not include quick fixes but included tools for conducting energy assessments with supporting training videos and workbooks (Codema, n.d.). Therefore, the kit is operationally less complex and is being distributed through a lending system in public libraries all over Ireland. With a price point of €570, the kit is sold as a one-time purchase to institutions but requires additional steps from households to reduce their energy savings. The Okotoks DIY Energy Kit Program in Canada takes a hybrid approach combining measurement tools with post-assessment quick fixes, available for pickup at local institutions. It includes an energy meter, an infrared camera, and further measurement tools. The kit and products are provided for free, but only for residents of Okotoks ("Do-It-Yourself Home Energy Audit Kit Program | The Town of Okotoks," n.d.). Lastly, HomeBoost provides a home improvement kit for £99 (€119), including advanced tools and app-guided assessments. Users receive a detailed report with tailored recommendations after the assessment ("HomeBoost | DIY Home Energy

Assessment," n.d.-b). Despite the innovative digital guidance and comprehensive reports, it has a relatively high cost compared to community-based programs, making the offering less accessible.

Overall, there are several unique approaches to DIY energy kits. Some kits emphasize initial assessments to educate users, while others provide immediate relief. Furthermore, the pricing varies among the different kits depending on quality, desired impact, and operational model. Especially many community-based models were discovered, where intermediary institutions or governments address households directly. In many cases, institutions such as libraries, are the customers who buy the kit, acting in the community's interest. These community-based lending models not only increase accessibility but also promote a sense of shared responsibility.

Based on the market analysis, there are several opportunities for differentiation, leveraging the strengths of different initiatives. While many existing DIY kits focus on either assessments or quick fixes, a lack of user support during implementation can lead to frustration and incomplete adoption of energy-saving measures. By integrating a digital feedback system, EcoSeal can provide tailored guidance, ensuring users successfully implement improvements and achieve measurable results. The team saw an opportunity for a DIY kit that is specifically tailored to Portuguese homes, which often face similar challenges in poor insulation, humidity, drafts, and use of inefficient appliances. Many existing DIY kits only contain a small number of products that are unlikely to make a significant impact. This could call for a more practical, targeted, and comprehensive kit. On the other hand, the assessment-focused kits have other benefits, like lower logistical complexities and higher accessibility, but require stronger follow-ups to track and prompt the adoption of energy-efficient improvements. Additionally, customization has shown that customized kits have a higher potential for an immediate impact on energy consumption and user comfort, as well as increased logistical efforts and the cost of the kit. Kits

like HomeBoost show that considering specific information like budget or residential characteristics could pave the way for self-driven customizable guidance.

6.4 Solution Design - Cycle 2

6.4.1 Building the DIY Energy Saving Kit

Following the pivot in Cycle 2, EcoSeal's new concept outlined a DIY Energy Saving Kit, including non-invasive measures for immediate and independent relief. The planning process for the Cycle 2 kit required an independent installation by the user and provided immediate relief. The kit required a detailed handbook explaining each measure's implementation steps and potential impact for easy installation. Based on secondary research, expert consultations, and prototype development, a kit was built to address household needs for simple, low-cost, and non-invasive interventions while impacting energy savings and indoor comfort.

Following the Lean Startup principle, the first Minimum Viable Product was built, including the minimum set of features to quickly validate its merit, gather user feedback, and further optimize the product. For the initial MVP testing round, the Piecemeal MVP approach was chosen. This approach follows the combination of existing tools to create a product without designing or manufacturing anything yet (Göcke and Weninger 2021). Therefore, the strategy was to minimize sourcing efforts and costs and conduct a pilot project in a Portuguese home. Testing the kit in a real-life scenario had the objective of assessing usability, time requirements, and impact on energy bills and indoor comfort.

The technical product specifications were driven by secondary research on residential energy challenges conducted in the previous cycle, new insights collected by Survey 2, and consultations with experts. The inclusion of a mold kit, for instance, was motivated by the overwhelming reports on humidity issues reported by the survey respondents. Ultimately, a set

of measures was chosen to provide immediate relief for commonly cited residential issues, which were categorized into the following categories: humidity and temperature, electricity use, and water consumption (Table 12). Based on preliminary insights from household interviews and both surveys, the design focused on simplicity, ease of use, and clear instructions. A printed instruction handbook (Figure 14) was created to guide each step, explain the contents of the kit, and highlight the benefits of each implementation. The kit was specifically designed to reduce complexity and information overload by simplifying the implementation process and reducing the time invested.

Table 12: Energy Efficiency Kit Contents

Category	Feature
Water Consumption	low-flow water faucets; efficient showerhead
Electricity Consumption	LED light bulbs; energy meter; mechanical timer; pipe insulation
Humidity and Temperature	Moisture absorbers or dehumidifiers; window insulation film; silicone sealant; weather stripping; anti-mold kit

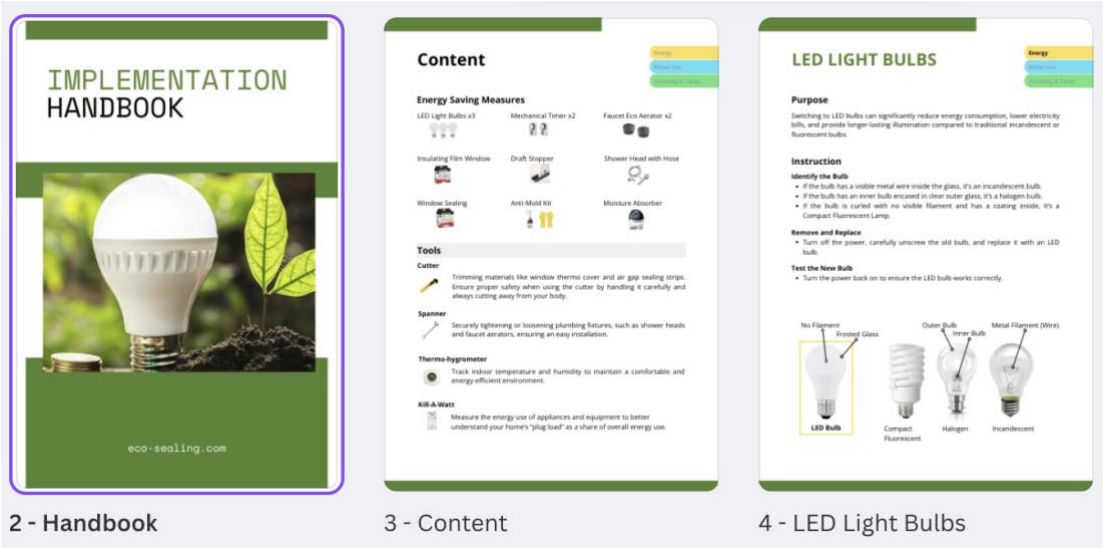

Figure 14: Implementation Handbook for DIY Energy Saving Kit

6.4.2 Testing the DIY Energy Saving Kit

The MVP Pilot test was a key step to validate usability and technical assumptions of the DIY Energy Saving kit. Through the conducted household interviews, a voluntary participant for the pilot test was selected. This step was crucial to understand user satisfaction, usability, and impact of the kit. A set of hypotheses was developed and tested during the pilot test (Table 13).

Table 13: Hypotheses Cycle 2

Hypothesis	Validation Status
H1: The implemented DIY Kit results in measurable energy savings of at least 10%	-
H2: The implemented DIY Kit results in perceived improvements in energy consumption & comfort	✓
H3: The user was able to independently implement the Kit contents only using the handbook	✓
H4: The user implemented over 70% of the Kit's products	✓

The usability testing approach proposed by Joseph F. Dumas was employed to conduct a representative pilot test (Dumas and Redish 1993). Usability testing is a method used to evaluate a product by observing how real users interact with it under realistic conditions. It aims to identify areas where users encounter difficulties and assess how effectively the product meets their needs (Dumas and Redish 1993). In line with this approach, the user was provided with the necessary materials: the product and the implementation handbook. Furthermore, the participant received the pilot test instructions (Appendix N), entailing the users' tasks and a survey to track progress. No additional explanation regarding the objectives or measurements was given. By limiting external information, the test encouraged genuine feedback on the clarity and sufficiency of the handbook and the overall user experience, aligning with Dumas' principle of observing users in naturalistic settings to uncover usability issues. After the pilot test was complete, a short interview was conducted with the participant to receive feedback (Appendix E: Interview 9).

6.4.3 Pilot Test Results

The feedback from the pilot participant provided valuable insights into the practicality of various measures included in the kit, as seen in Figure 15.

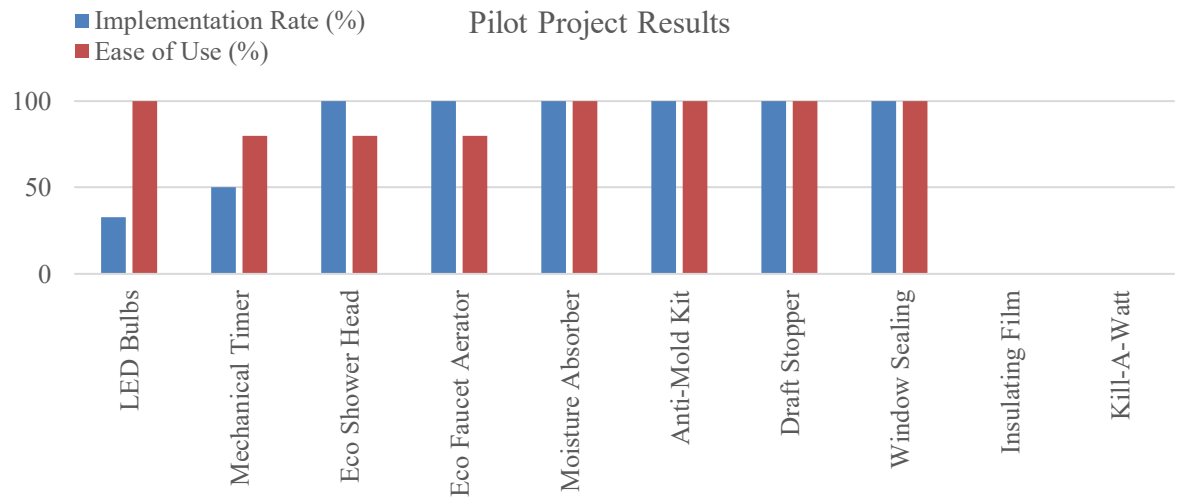

Figure 15: Implementation rates and ease-of-use perceptions for DIY Energy Kit from the pilot project

The pilot project also provided critical insights into the adoption and practicality of various measures included in the kit. For instance, products such as the moisture absorber, the anti-mold kit, and the draft stopper were successfully implemented, requiring less than five minutes each for installation. Ultimately, the previously outlined hypotheses were revisited.

(H1 Validation Pending) The hypothesis that the DIY Energy Saving kit would deliver measurable reductions in energy consumption could not yet be validated due to time constraints. The team suspects a moderate reduction in energy use, with room for improvement.

(H2 Validated) The hypothesis that DIY kit would deliver noticeable benefits was validated through user feedback. The pilot project participant reported noticeable improvements, particularly in comfort, after implementing quick fixes such as the draft stopper and the window sealing.

(H3 Validated) The hypothesis that the user will be able to independently implement the provided products was validated. The pilot test user could implement 70% of the provided measures without external assistance. Quick fixes like draft stoppers and moisture absorbers were implemented successfully due to their simplicity and minimal learning curve. However, tools like the Energy Meter and Insulating Films were not implemented due to challenges such as unsuitable home conditions or lack of instructions in the user handbook. More complex tools, like the Energy Meter, require improved instructions to provide additional clarity.

(H4 Partially Validated) The tools were successfully implemented in over 80% of cases, demonstrating their practicality and impact. However, later concerns about some measures were raised by the consulted experts, calling for further revision.

Overall, the results confirmed that DIY solutions have merit. The test user reported high satisfaction with the product and documented initial improvements in home comfort. He also mentioned ideas for improvement, such as more visual instructions or demonstration videos for better guidance. Additionally, the test user also mentioned the issue of standardization. While some measures could not be implemented and remained unused, other materials were not sufficient to cover all problem areas (Appendix E: Interview 9).

6.4.4 External Feedback Collection

Expert interviews further confirmed the assumption that behavioral changes play a critical role in achieving energy savings. Prof. Joanaz de Melo emphasized the importance of problem recognition and thorough energy assessments in encouraging user engagement (Appendix E: Interview 2). This insight reinforced the need for comprehensive educational materials alongside quick fixes and the opportunity to build connections with existing energy efficiency platforms like the European Energy Efficiency Platform “E3P.” Additionally, the logistics of managing and distributing the kits could bring operational challenges, especially when

considering how to scale the solution. Implementing all measures could be very time-consuming, which could discourage engagement.

Customer discovery highlighted the demand for immediate relief measures, validating their inclusion in the kit. However, it also revealed gaps in user awareness regarding the impact of outdated appliances and inefficient heating systems. These findings informed the decision to enhance the educational aspects of the kit and to focus on actionable insights for long-term energy efficiency.

6.4.5 Final Considerations

Overall, the DIY Energy Saving Kit received positive feedback from the test user and interview respondents. Households generally felt capable of implementing tools and found value in the approach. However, some additional considerations need to be addressed. One key observation was the dilution between creating comfort and cost savings. While comfort drives urgency, most survey participants prioritized lowering costs, highlighting the need to address cost-saving measures more. The kit's exact impact on cost savings is yet to be assessed, but preliminary results highlight improvement potential in this area. Furthermore, experts raised concerns about the applicability of certain measures, highlighting the need for a more individual assessment before providing appropriate tools. A key challenge remains to balance customization and scalability. Another consideration is the institutional fit. EcoSeal initially considered partnering with institutions to distribute the kit. However, the relatively high cost per kit raised questions about whether institutions would be willing to invest, given the limited customization and impact on energy efficiency. Going forward, EcoSeal could aim to close this gap by starting with a returnable energy measurement kit and providing tools and products based on individual needs.

6.5 Refined Solution Design - Cycle 3

The refined solution design in Cycle 3 builds on the insights from earlier iterations, shifting from immediate energy-saving measures to an advanced energy assessment approach. This cycle introduces a DIY Energy Assessment Kit, offering households valuable insights into their energy consumption and customized recommendations to improve efficiency. The design focuses on precision, usability, and sustainability to ensure long-term impact and ease of adoption. The solution included additional measurement tools to better understand the households' current state of energy consumption. The implementation manual, provided in physical and digital form, focuses on guiding users step-by-step through a detailed energy assessment process and collecting consumption data for further analysis.

Initially, the workspace was developed as a digital platform to simplify data entry and provide users with automatic recommendations. Hosted as a separate page on the EcoSeal website using Squarespace as the content management system, the workspace allowed users to enter their measured data and compare it to reliable energy benchmarks. These benchmarks, researched via sources such as the IEA ("Appliances & Equipment," n.d.), guaranteed accurate and actionable results and are further analyzed in Chapter 7. The platform is equipped with a user-friendly interface, simplifying understanding of energy consumption, and creating customized recommendations. The workspace also includes an overview of quick fixes and partner links so users can take immediate action based on their assessment. However, as the project evolved and further insights into the target audience were gathered, the older population was identified as an important customer segment. This led to the need for an analog alternative to the digital workspace. While the digital workspace remains a valuable option for tech-savvy users, an analog workbook was introduced as a simplified solution for older users or those without reliable access to digital tools. This workbook provides a physical, step-by-step guide that mirrors the functionality of the digital platform. Users can record measured values and manually

compare them to printed benchmark values, allowing them to identify areas for improvement without relying on online tools.

The inclusion of both options - digital workspace and analog workbook - ensures accessibility and usability for a wider audience while maintaining the main goal of empowering users to improve their energy efficiency.

6.5.1. Strategy and Design Approach

The main objective of Cycle 3 was to create a solution that supports a comprehensive energy assessment while maintaining simplicity and affordability for users.

While moving beyond the quick fixes, the refined kit prioritizes accurate energy measurements and actionable insights. The inclusion of reusable tools ensures sustainability and cost-effectiveness. Guided by user-centered design principles (D. A. Norman 2002), the focus was on simplicity, clarity, and accessibility. This resulted in a printed manual and a digital workspace that provides users with step-by-step guidance. The digital workspace, integrated into the EcoSeal website, allows users to enter measurement data, create automatic calculations, and receive customized recommendations. To ensure accuracy, reliable energy consumption benchmarks have been included (“Appliances & Equipment,” n.d.).

6.5.2 Design Specifics & Features

The DIY Energy Assessment Kit includes tools for measuring energy and water consumption, detecting air leaks, and monitoring room temperature and humidity. Each function has been carefully selected based on secondary research, expert consultation, and practical usability.

Table 14: Overview of the DIY Energy Assessment Kit

Feature	Purpose
Infrared digital thermometer	Identify air leaks and measure temperature
Kill-A-Watt	Measure energy consumption of different household appliances
Flow and temperature measuring connector	Assess water consumption in the shower
Thermometer & Hygrometer	Check humidity, temperature and CO_2 levels

The **printed handbook** simplifies the user experience with a clear, step-by-step guide to the assessment process. It explains each tool's function, provides implementation steps, and highlights the benefits of energy-saving actions.

The **digital workspace**, integrated into EcoSeal's website, complements the physical kit by allowing users to input their measured data, receive automated insights, and access tailored recommendations. It also provides quick fixes and affiliate links for users seeking further actions. Having reliable energy consumption benchmarks enabled EcoSeal to create a system with automated calculations to ensure accurate comparisons of user data with standard metrics. The team prioritized a user-friendly and visually clear interface in the design process, which helps users input data and understand results easily. The third part of the workspace provides an overview of quick fixes and affiliate links, enabling the user to take immediate action.

After recognizing the needs of an older target group, the **analog workbook** was developed as an alternative. This physical guide enables users to manually record their measured values and

compare them to printed benchmark values, allowing them to identify areas for improvement without requiring digital access.

6.5.3 Rental Process

The rental process for the kit has been designed to streamline operations and accommodate both digital and analog users. Users can sign up via a Google Form, where they need to provide their contact information and NIF- Número de Identificação Fiscal and agree to terms and conditions. This form can be embedded on partner websites or displayed as a QR code in community centers. Once registered, users select a pickup time based on availability, and the facility prepares the kit for collection. Users can also book a kit directly at the partner institution. Each kit includes all necessary tools, a printed handbook, and an optional analog workbook for manual data recording.

During the two-week rental period, users can either input measured data into the EcoSeal online workspace or record their findings in the workbook to compare values with printed benchmarks. EcoSeal offers user support via the platform throughout this period to ensure a smooth assessment process. After use, the kit is returned to the institution, where staff inspect the contents, address missing items, and prepare it for the next rental. User feedback is collected through the EcoSeal platform or, for analog users, via a short-written form included in the workbook. Partner institutions receive onboarding support and a manual to ensure the process runs efficiently. This approach ensures accessibility, supports scalability, and reduces friction for both partners and end users.

6.5.4 Testing & Final Validation

The refined solution design was validated through a structured, evidence-based approach based on principles from entrepreneurial literature, such as the lean startup method (Ries 2011) and

user-centered design principles (S. Norman 1986). These frameworks emphasize iterative feedback loops and user involvement as critical product development and validation components. Due to time constraints, a second pilot project was not conducted. Instead, EcoSeal validated its new approach across multiple channels. Feedback from pilot users from Cycle 2 highlighted the need for actionable, customized recommendations and tools to identify inefficiencies. Users emphasized the need for additional measurement tools to guide the following steps to improve energy efficiency (Appendix E: Interview 9). Institutional feedback from potential partners, such as community centers and libraries, showed strong alignment with their goals of promoting community well-being and reducing energy poverty. In addition, benchmarking with similar initiatives, such as Codema and Okotoks, confirmed the feasibility of DIY energy kits in comparable settings, further validating EcoSeal's design for the Portuguese market. While these results indicate great potential for the refined solution, further validation through a larger scale pilot is required to accurately assess the ease of use and long-term impact of the assessment kit.

6.6 Discussion & Next Steps

By bringing together insights from institutional partners, pilot projects, and validated external sources, EcoSeal presents its final solution as a robust, evidence-based design ready for real-world application. The alignment of user feedback, institutional interest, and best practices from similar initiatives ensures practicality, scalability, and the potential for significant impact in addressing the issue of Energy Inefficiency in Portugal. While the development and refinement of the DIY Energy Assessment Kit has created a solid foundation, further validation of the solution is required. EcoSeal's next steps include conducting a larger pilot project to rigorously test the usability and solution hypotheses listed in Table 15. This extended testing will provide valuable insights into how users interact with the kit, how accurate the recommendations are, and their impact on user understanding and energy-saving behavior. By exploring these

hypotheses, EcoSeal can further refine the kit and ensure that it effectively meets users' needs and can be scaled to reach a wider audience.

Table 15: Hypotheses to Be Tested

Usability Hypotheses	
H1: Users can independently assess their energy needs by conducting an energy assessment with the tools provided in the DIY Kit. **H2**: The recommendations and actionable insights provided by the DIY Kit accurately reflect users' energy consumption patterns and needs. **H3**: The DIY Kit enhances users' understanding of their energy consumption patterns.	- - -
Solution Hypotheses	
H4: The kit provides real-time or periodic insights into energy usage patterns, allowing users to pinpoint inefficient appliances or practices **H5**: The kit provides clear and actionable feedback that helps users identify and implement energy-saving measure	- -

7. Technology & Operations Management

[Maurice Moser, 61263]

7.1 Introduction & Relevance

This chapter focuses on the operational and technological aspects of the EcoSeal Cycle 2 and Cycle 3 products: the DIY Energy Saving Kit and the DIY Energy Assessment Kit. It aims to review the functionality of the selected components and explain the reasons for their inclusion in the kits. The discussion assesses how these choices contribute to energy efficiency and support project’s overall objectives. The chapter also looks at key processes such as sourcing materials, assembling the kits, and distributing them efficiently, focusing on ensuring affordability and accessibility.

In addition to evaluating the individual components, this chapter also describes critical processes such as material procurement, kit assembly, and efficient distribution strategies. These operational elements are examined with a focus on scalability and simplicity to ensure

that the kits can be adopted by institutions and end users alike. It concludes by presenting the hypotheses underlying the operational and technological decisions and the rationale behind EcoSeal's iterative approach to delivering practical and impactful energy solutions.

7.2 Methodology & Validation

The methodology for this chapter is designed to validate the components and operational processes of EcoSeal's DIY Energy Saving Kit and Assessment Kit. To analyze the components, product reviews from platforms like Amazon and manufacturer websites were assessed based on criteria such as durability, ease of use, and overall user satisfaction. These sources were selected because they provide real-life feedback from a wide range of users, highlighting performance, usability, and potential issues. Additional validation came from testing the kits in a pilot project, where users applied them in their own homes. This helped EcoSeal gather practical insights about how the kits perform in everyday conditions. At the same time, internal testing was conducted to simulate real-world usage and identify any areas for improvement. Operational processes were reviewed by sourcing materials from local suppliers to reduce costs and carbon emissions. To validate this approach, EcoSeal compared costs with international alternatives and ensured supplier reliability. This approach validated EcoSeal's commitment to balancing operational efficiency with environmental responsibility

7.3 Product Optimization

EcoSeal produces kits that are both practical and easy to use. The process involves two main phases: Cycle 2 for the DIY energy saving kit and Cycle 3 for the energy assessment kit. In each phase, the team looks closely at the product details, tests the kits in real-life conditions, and selects the components that work best. The optimization process builds on the findings from Chapter 6, Solution Design and Product Development, which identified actions to address energy efficiency challenges. The Technology and Operations chapter refines these findings by

selecting models, evaluating the inclusion or exclusion of components, and ensuring alignment with operational goals. Through testing, research, and user feedback, EcoSeal ensures that the kits are reliable, user-friendly, and deliver tangible energy savings.

7.3.1 Cycle 2 DIY Energy Saving Kit

Cycle 2 DIY Energy Saving Kit focuses on practical solutions for reducing energy consumption and improving comfort:

LED Lightbulbs were chosen for their high efficiency, using only 6 watts to produce 806 lumens. They save over 90% in energy compared to incandescent bulbs, costing just €1.92 annually per bulb when used for 4 hours daily (Banse 2024). Their long lifespan reduces the need for frequent replacements. **Window Thermo Cover** creates an insulating air cushion that reduces heat loss and prevents condensation, mimicking the effect of double glazing. It's a cost-effective solution for older homes where window replacement is too expensive. However, precise application is essential to achieve the desired results, as the installation requires careful alignment to ensure airtight sealing. Misalignment or an improper airtight seal can significantly reduce its effectiveness. **Air Leak Sealing Tape** was selected for its versatility and easy installation. It effectively seals gaps around windows and doors, cutting drafts and improving indoor comfort. This can save up to 40% on heating costs by reducing the load on heating systems. **Mechanical Timer** helps prevent energy waste, automating off-times for devices. This simple, mechanical solution was chosen to reduce phantom loads and is cost-effective and easy to use. **Master Power Strip** was included for its ability to minimize standby power usage, automatically shutting off connected devices when the main device is turned off. This feature helps lower energy bills and improves home safety. **Kill-A-Watt** meter is included to measure and monitor energy consumption, helping identify opportunities for further efficiency improvements. **Eco Faucet Aerator Saver** reduces water flow by up to 50% while maintaining

pressure. It was chosen because it helps conserve water and lowers energy costs for heating water, making everyday tasks more efficient. **Showerhead Edy** cuts water use by 40% without compromising shower quality. This results in substantial water savings, up to 192 liters per day for a family of four, and reduces the energy needed to heat water. **Moisture Absorber** is a non-electric device that controls humidity, preventing mold and mildew while improving air quality. It's effective for small spaces like closets and bathrooms and requires no power. The need for regular replacement of the absorbent tabs is a drawback, adding to ongoing maintenance costs. **Entrance Door Seal** ensures a tight seal around doors to prevent drafts, aiding in temperature control and energy efficiency. Easy installation and long-lasting durability make it a practical addition. **Door Sealing** was chosen to block drafts at door bottoms, enhancing room insulation and reducing energy use for heating or cooling. **Mold kit** is included for health and safety. It helps tackle mold issues effectively, improving air quality and reducing potential damage to home materials ("Leroy Merlin" 2024).

7.4.1.1 Optimization Efforts

Optimizing the DIY kit came with challenges, especially due to the limited time for long-term durability testing. To fill these gaps, a large focus was placed on Amazon reviews, as the platform hosts a large community that provides detailed feedback, often with pictures. Additional input was gathered from various online reviews and user feedback. This information revealed that the products were often appreciated for their ease of installation and immediate effectiveness. However, concerns were also raised about longevity and maintenance requirements. These considerations were key to selecting products that not only work well from the outset but are also designed for long-term reliability.

7.3.2 Cycle 3: DIY Energy Assessment Kit

The DIY Energy Assessment Kit is designed to accurately measure energy and water consumption and help households identify where savings can be made. Due to budget constraints, it was not possible to purchase the equipment for extensive testing. Instead, interviews with other energy efficiency kit providers and detailed research on platforms such as Amazon and manufacturer websites were used to understand the key features and potential issues of these products. The focus was on finding devices that combine durability, reliability, and ease of regular use. Below are key considerations for each device.

The **Digital Thermometer/Hygrometer**[3] must be durable enough to handle regular movement without damage. Buttons should remain responsive even after frequent use. Accuracy is key, so the internal sensor must maintain consistent readings regardless of storage or usage conditions. The battery should last at least one year without needing replacement, ensuring convenience and reliability. A sturdy design could also help protect the device from accidental drops.

The **Kill-A-Watt**[4] must include a well-designed and easily accessible reset button, avoiding small, recessed designs that require a pin or tool for operation. Durable pins are essential to prevent loosening over time, a common issue with similar devices. The device should also be fall-resistant, ensuring reliability even after accidental drops. Surge protection is equally critical to guard against power spikes, especially in older electrical systems, protecting the internal electronics from damage.

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3 https://www.leroymerlin.pt/produtos/jardim/estufas-e-protecao-de-culturas/protecao-de-culturas/termometro-higrometro-equation-preto-82718936.html

4 https://www.leroymerlin.pt/produtos/eletricidade-e-smart-home/fichas-e-adaptadores/programadores/medidor-de-consumo-digital-branco-lexman-84586358.html

The **Flow Connector**[5] must address potential issues related to water quality, particularly in areas with hard water, where mineral buildup could clog sensors or valves, reducing accuracy over time. Seals and gaskets need to be made from high-quality, water-resistant materials to prevent degradation, as weakened seals could lead to leaks. The connector should also be designed to resist pressure fluctuations in plumbing systems, which could strain the internal components and cause wear. Maintenance accessibility is important to ensure users can clean or replace parts when necessary.

The **Infrared Thermometer**[6] must be durable, with a sturdy casing to protect internal components from damage caused by drops or bumps. Ideally, it should be equipped with rechargeable batteries to enhance convenience and reduce the need for frequent replacements. The battery compartment should be stable and robust, designed to avoid fragile hinges or closures that can easily break if not handled carefully. Buttons need to remain responsive with frequent operation, and the display screen and lens should resist scratches to maintain clarity. Calibration mechanisms must ensure consistent accuracy, even after extended storage or exposure to varying conditions.

7.3.3 Optimization Efforts

Optimizing the DIY Energy Assessment Kit is an ongoing process. As more users use the kits, patterns will emerge, revealing devices that need improvement. Devices may show specific vulnerabilities under frequent handling or varied household conditions, making it essential to monitor performance closely. For instance, components like seals or connectors might degrade faster than anticipated. The more kits are in active use, the easier it becomes to evaluate what

5 https://www.leroymerlin.pt/produtos/conector-medidor-de-caudal-e-temperatura-cromado-ekogest-91039393.html?utm_source=google&utm_medium=cpc&utm_campaign=pmax-shopping-ao_canalizacao_ao_google&utm_content=1p&utm_term=&placement=&gad_source=1

6 https://www.leroymerlin.pt/produtos/ferramentas/ferramentas-de-mao/medicao-e-nivelacao/medicao/termometro-digital-infravermelho-17277575.html

is essential for long-term reliability. Feedback from users will be critical to understanding what works and where upgrades are needed. User feedback will be collected through follow-up surveys and performance monitoring to identify underperforming devices. When issues are identified, immediate action must be taken to replace underperforming devices with better-quality alternatives. Building experience through repeated use will also refine the criteria for selecting devices. The goal is to create a kit that not only meets current demands but can also adapt to future needs, ensuring long-term value for households.

7.3.4 Sourcing & Supplier

For the DIY Energy Assessment Kit, sourcing locally in Portugal remains a key priority. Leroy Merlin, identified as the primary supplier, provides dependable products that align with sustainability goals by reducing the carbon footprint associated with long-distance shipping. Local sourcing ensures quicker responses to issues, such as malfunctions, with the possibility of swift replacements or repairs. Current negotiations with Leroy Merlin aim to secure bulk discounts for orders of 10 units or more, which would help control costs as scaling continues. This approach supports not only cost efficiency but also operational flexibility.

EcoSeal is starting with hand-assembling the DIY Energy Assessment Kits to maintain close quality control and adjust the process as needed. Each tool will be carefully placed in foam inserts within the case to keep everything protected and organized.

7.3.5 Order Process, Fulfillment & Delivery Methods

Currently, orders are fulfilled by sourcing products directly from Leroy Merlin, as there is no storage space to maintain a large stock of kits. Two kits are kept on hand for immediate dispatch to handle small orders, ensuring quick fulfillment while maintaining cost efficiency. Larger orders require a direct purchase from Leroy Merlin, which typically takes about two days for

delivery. Once the products arrive, assembly is completed within a day, allowing the kits to be shipped or delivered the following day. For shipping, CTT (Correios de Portugal) is used to handle up to five kits in a 15kg box, providing reliable delivery within three days. This approach keeps logistics simple and affordable during the early stages of operation. For local customers, kits are delivered personally, offering a more personal experience that helps build trust and strengthen client relationships. As operations scale, partnerships with logistics companies are being explored to manage higher order volumes. While this could lead to higher costs, it would streamline the delivery process and increase efficiency. Ensuring that the kits are securely transported and arrive in perfect condition remains a top priority to meet client expectations and maintain quality standards.

7.3.6 Risk Assessment & Mitigation

The DIY Energy Assessment Kit may face wear and damage from frequent handling. Durable components are selected, and maintenance instructions are included to mitigate this risk. Budget constraints limit testing, but feedback from energy kit suppliers and reviews help to select reliable equipment. Procurement delays are minimized by local suppliers such as Leroy Merlin in Portugal, allowing for quick replacement in the event of component failure. Clear instructions for use and regular inspections after use further reduce misuse or damage. These measures ensure that the kit remains functional and reliable for its intended use.

7.4 Discussion of Operational Findings & Outlook

The operational findings highlight significant progress in developing the DIY Energy Assessment Kit, although certain limitations remain. Of the hypotheses, **H2**, **H3**, and **H4** were successfully validated. **H2**, concerning local sourcing, was confirmed through Leroy Merlin, ensuring reliable and cost-effective access to components while reducing the carbon footprint. **H3**, focusing on ease of maintenance, was supported by the selection of devices that are simple

to clean and maintain, meeting user needs without requiring specialized tools. **H4**, which emphasizes usability, was validated through research and feedback.

Table 16 Hypotheses for DIY Energy Assessment Kit Development and Validation

Hypotheses	
H1: Components remain functional and accurate after three months of frequent use.	-
H2: Kit can be locally sourced at competitive prices without compromising quality or sustainability.	✓
H3: Devices are designed for ease of cleaning and maintenance without requiring special tools.	✓
H4: Assessment Kit is easy to use and meets the needs users based on research.	✓

However, **H1**, addressing long-term durability, could not be validated due to the absence of a pilot program for the DIY Energy Assessment Kit. While durability remains a key objective, future testing under real-world conditions is required to assess how well the components withstand frequent use over extended periods. This gap underscores the importance of conducting field trials as the project evolves.

In the future, the focus will be on the continuous improvement of the kits. The expansion of pilot testing will allow for a more thorough evaluation of durability and user experience. Partnerships with local suppliers will continue to be important to ensure cost efficiency and fast response times. Feedback from early users will form the basis for further improvements to ensure that the kits remain reliable, and energy deficiencies are effectively addressed. By addressing these areas, EcoSeal can improve both the functionality and scalability of the DIY Energy Assessment Kit in future iterations.

8. Financing and Business Model Innovation

[Pedro Rodrigues, 57761]

8.1 Introduction

A fundamental part of the validation conducted in this Work Project, which resulted in the development of the EcoSeal DIY Energy Assessment Kit, was understanding the financial viability of the project. By adopting a lean and flexible approach, the team has decided that, in its early stage, EcoSeal will be approached as part-time or side-project, as a pragmatic assessment of the need to achieve minimal capital expenditure dedicated to human resources. The estimated timeline to achieve a fully operational project is four to seven months, and it was with these assumptions that the financial viability of the project was assessed.

This chapter explains the analysis of the necessary financial and legal requirements to kickstart EcoSeal for the business model described earlier in this report. Additionally, an assessment of how to achieve long-term sustainability, scale, and impact of the project is also referenced. For this validation, the following topics were analyzed: firstly, a cost-benefit analysis and unit economics study were conducted to assess the direct and indirect costs, as well as the tangible and intangible benefits of the development of the kit solution. Secondly, a cost structure outlining the capital and operational expenditures to define the necessary funding to launch the project and sustain it. Additionally, a pricing and break-even analysis is needed to identify at what point and if the project can cover its costs or if additional funding will be necessary. A risk-sensitivity analysis outlined Ecoseal's exposure to demand and funding uncertainty. Based on this assessment, the decision on the legal structure to launch the project is explained, and according to this strategic approach, a tailored funding strategy was developed to determine what sources of capital could be captured to bring the project to life. Finally, a look at the long-term strategy for EcoSeal, with additional impact streams and a future outlook for the project, is also detailed.

8.2 Cost-Benefit Analysis & Unit Economics

The financial analysis for EcoSeal started by assessing the unit economics (see Appendix I) for the toolkit developed in Cycle 3 (see Chapter 3.3 for more detail). For this analysis, all direct and indirect costs were considered, such as the components of the kits, promotional materials, transportation, and assembly costs. A 15% buffer was included, and potential malfunctions and other miscellaneous costs were also taken into account.

Table 17: Unit Economics - DIY Energy Assessment Kit

Items	Unit Cost (incl. VAT)	Supplier
Thermometer	€13.99	Leroy Merlin
Hygrometer	€6.59	Leroy Merlin
Energy Meter (x2)	€27.98	Bricomarché
Flow Gauge	€15.99	Leroy Merlin
Infrared Thermometer	€41.99	Cindar
Transport Case	€25.00	Leroy Merlin
Handbook and Guide[7]	€9.58	In-House
Promotional Materials[8]	€57.00	Copimat
Buffer (15%)	€29.72	-

Assuring the affordability of the kit, while sourcing good quality components, (see chapter 7) was pivotal to guarantee enough willingness to pay for this solution. The interviews with contact points from entities who have also developed a similar product (see Appendix F), served as validation of the utility of each of the measurement tools included in the kit and provided insights for the pricing strategy.

The interview with Cassidy Stillie (Appendix E: Interview 4), coordinator for the DIY Home Energy Audit Kit Program, provided insights on what the expected price of a similar kit would be. The Okotoks kit is produced for €1.300, with the most expensive item being the thermal

[7] Includes 17 pages printed and colored on coated paper

[8] Includes leaflets, flyers and a MUPI

camera, priced at €930. The EcoSeal team had a discussion about the price point to sell the EcoSeal Kit and concluded that the cost at which Okotoks is producing their kit is prohibitive for EcoSeal's target audience. This conclusion was the driver of the decision to reassess the approach of the kit, moving from Cycle 2 to Cycle 3 (see Chapter 3), from a kit aimed at providing quick fixes, to one that focused solely on measuring tools for energy auditing. This allowed a significant reduction in production costs, as the team tried to find ways of dropping the costs of production. Ultimately, the decision to develop a solution that does not require re-stocking in each use was based on the assessment of the unit economics of the kit and the aim of increasing its circularity and reducing operation costs, too. Additionally, by reflecting on the context of Portuguese households and from feedback from the interview with Cassidy (Okotoks), it was concluded that some of the tools included in the Okotoks kit didn't fit the cost-benefit standards. Ultimately, the team was able to achieve a DIY Energy Assessment Kit for the cost of €227,84.8.2.1 Cost Structure

Breaking down the cost structure (see Appendix J) of EcoSeal into upfront Capital Expenditures (CAPEX) and Operational Expenditures (OPEX), based on the considerations mentioned above, an estimation of around €17.500 in start-up costs and €4.200 in operational costs, assuming an initial approach with an inventory of 15 kits at a cost of approximately €230, it was possible to understand the initial capital requirements to kickstart EcoSeal.

This cost breakdown included an estimation of legal and administrative fees, such as legal registration, trademarks, legal consultations, and accounting and financial services, reaching €2.650 in expenses. Additionally, marketing, branding, and partnership-building expenses, such as advertising and promotional campaigns, cost around €2110. The cost of infrastructure and technology includes the development of a digital platform, management software subscriptions, and other related costs, at an estimation of €4650. The initial inventory of 15 kits will cost a

total of €2451. Finally, a contingency buffer of 15% and €2.000 in other miscellaneous costs was also included.8.2.2 Pricing & Breakeven Analysis

A pricing analysis for EcoSeal's energy efficiency kit explored both business models referenced in Chapter 3.4.

For **Option A,** three scenarios based on different profit margins per kit were considered. A 20% margin set the price per kit at €275, a 40% margin increased it to €320, and a high-margin scenario of 60% set the price at €365. To assess financial viability, a breakeven analysis (detailed in Appendix K) was conducted under the assumption of selling 15 kits per month.

Table 18: Pricing Scenarios

	Scenario 1 (20%)	**Scenario 2 (40%)**	**Scenario 3 (60%)**
Final Price[9]	€275	€320	€365
Total Margin[10]	€45,57	€91,14	€136,70
Breakeven (months)	4,2	3,6	3,1

For the breakeven analysis (see Appendix K for more details), an estimation of an average of 15 kits sold per month is considered, assuming that the team is focused initially on outreach to institutions in and around Lisbon. In Scenario 3, each kit is sold for €365, with the breakeven point being reached after only 3 months.

Alternatively, for **Option B,** a subscription model has been considered (see Chapter 3.5), with a monthly fee per kit. In this option, the number of kits sold increases to 30 per month, based on an assumption of higher sales rates due to a reduced barrier of entry with lower up-front

[9] Total Cost + Contribution Margin

[10] Cost + Margin

investment. The average monthly revenue in a year would be €6825, with approximately €2560 in monthly profit, which results in a breakeven in around seven months.

8.3 Risk-Sensitivity Analysis

Another analysis conducted to assess the sustainability of the project was its risk sensitivity by identifying the key risk factors that may influence the outcomes of the solution. These risks were divided into demand risks, cost fluctuations, funding shortfalls, and user adoption.

Table 19: Risk Sensitivity Analysis

Demand Risks	**Risk Level**
Hypothesis: Institutional demand and willingness to pay is lower than expected. *Sensitivity:* A significant reduction in kit sales could delay breakeven and limit ability to cover operational costs.	High
Cost Fluctuations	**Risk Level**
Hypothesis: Increase in the cost of components or distribution. *Sensitivity:* An increase in components costs of over 10% could raise price per kit and reduce willingness to pay or result in lower margins.	Low
Funding Shortfalls	**Risk Level**
Hypothesis: Risk of not securing sufficient external funding during the early-stage *Sensitivity*: The financial analysis conducted has showed that EcoSeal will be dependent on funding to kickstart and support its operations as a NGO.	Medium
User Adoption	**Risk Level**
Hypothesis: Low engagement from citizens and the lack of a follow-up consultation. *Sensitivity:* EcoSeal solution is mainly focused on the assumption that citizens can benefit from using the kit and will engage in a follow-up. Limited engagement from users may put the continuation of the project or the development of the EcoSeal kit.	High

The main risk is the low engagement of both institutions and users, which stems from a lack of problem recognition and perception of energy efficiency as a low priority. Additionally, technological skepticism is mainly present among less tech-savvy and older populations.

To mitigate these risks, the main strategies being considered are partnering with trusted institutions aligned with the mission and increasing awareness through pilot programs, demonstrational workshops, and campaigns.

8.4 Legal Structure & Governance

With a mission and value proposition geared towards tackling a social problem, it was clear from the start that EcoSeal vision was one being achieved in the form of a social organization. It was, however, to be decided what the ideal legal structure should be. As the idea evolved into an awareness mechanism, the team reflected on its vision and, by taking into account the approach of the final solution, ensuring trust and transparency became a priority. Moreover, creating synergies within the ecosystem of social impact became imperative to build a strong network of institutions with proximity to the target groups of users. Finally, the financial analysis proving that the initial business model would be difficult to monetize and generate revenue in the early stage, also was a key factor for this decision.

With this in mind, and after institutional validation (Appendix E), the decision was that the best approach was to be set-up as a not-for-profit organization, based on the following reasoning: firstly, a non-profit organization signals a clear commitment to social impact over profit, which resonates more with potential partners and funders (Castagnola and Yawson 2021). Secondly, as a non-profit, a wide range of funding opportunities are available, including grants from foundations and government subsidies. Access to this early-stage funding could prove to be crucial for the development of the project. Additionally, benefits such as income tax exemption can help reduce operational costs. Because Ecoseal's initial business model is heavily dependent on collaboration with partnering institutions, the non-profit status is important to attract interest from such entities.

However, despite the non-profit governance model, one of the key learnings of the master's remains present: a non-profit organization can, in fact, operate as a social enterprise, generate revenue and be profitable. In fact, a sustainable non-profit must generate economic value and should avoid being dependent on grants and subsidies for its survival. It is only through the form of a revenue-generating business model that an organization can generate long-term sustainable impact, by generating capital that allows it to attract talented people, scale operations and innovate towards more effective solutions.

8.4.1 Taking Legal Form

In Portugal, to be set up as a not-for-profit social organization, there are usually two ways to take form: an association or a foundation. An association is formed by a group of individuals with a common pursuit without the intention of profit. On the other hand, a foundation requires an endowment of assets that must be dedicated to a specific cause and are subject to tighter restrictions and oversight. Both structures must solely focus on societal benefit and operate under principles of no profit distribution. Based on this, the approach chosen was to be set up as an Association. The first step of this procedure is to define the mission, vision, and goals, which have been highlighted earlier in the report - these provide clarity in guiding the subsequent legal and structural decisions. Secondly, the articles of association need to be drafted, which are critical for the legal recognition of the association, and include the following: organization name, its purpose, and objectives, membership rules, the governance structure, general rules for financial management and asset distribution in case of a dissolution. To officially be set up as an association, an initial endowment is required, and at least two founding members agree on the governance structure outlined in the articles of the association. In the case of EcoSeal, the founding members are the four elements of the group, which are to be part of the board of directors from the start.

The next step is to be registered through the Instituto dos Registos e Notariado (IRN), which involves submitting the articles of association, providing the founding member's identification documents, and paying the registration fee of €300. Through this process, a Certificate of Incorporation is obtained, and once registered, the organization receives a legal entity number (NIF - Número de Identificação Fiscal).

8.5 Funding Strategy & Opportunities

As shown in the previous topic, EcoSeal requires around €40.000 to be kickstarted, and to do so, a funding strategy is imperative. A pool of funding opportunities was assessed, including government grants, acceleration programs, prizes and competitions, impact investment funds and philanthropic donations.

As has been highlighted before, the topic of energy efficiency stands as a cornerstone of European Union strategy for sustainable development, with the Energy Efficiency Directive (EU/2023/1791) guiding energy policy and investment decisions. As more than just an environmental imperative, energy efficiency is seen as a driver for social and economic wellbeing (Chen et al. 2024). In Portugal, the government has announced the approval of its National Long-term Strategy for Combating Energy Poverty 2024-2050 (*Resolução Do Conselho de Ministros n.º 11/2024, de 8 de Janeiro* 2024) and the Long-Term Strategy on Buildings Renovation (*Resolução do Conselho de Ministros n.º 8-A/2021*), which signal a strong commitment to finance a transition towards a more energy efficient society, and EcoSeal aims to take on an active role in this movement.

At an early stage, the immediate focus is on connecting with relevant stakeholders within the social impact ecosystem and energy efficiency and energy poverty space and developing partnerships with institutions that can provide guidance and expertise. Next up is finding the right funding mechanisms or programs to accelerate the project.

The most immediate opportunity being considered is Colmeia[11], an open innovation program by Galp Foundation, in partnership with the Municipality of Matosinhos, that is looking to support social entrepreneurship ideas to drive the energy transition. In this program, the selected project will be implemented on a pilot project in Matosinhos. An interview with Margarida Queiroz, Social Impact Manager at Galp Foundation (Appendix E: Interview 7) has provided the necessary validation on the alignment of the program and EcoSeal's vision. The next edition is expected to start in January 2025, and it is seen as the ideal opportunity to roll out EcoSeal on an "Open Innovation Test Bed". This initiative provides the ideal platform and institutional support to test out the kit in a community, and taking part in this acceleration program also includes the chance of winning up to €50.000.

After concluding all pilot tests and taking, potentially, taking part in the Colmeia Program, a crowdfunding campaign through Kickstarter will be launched, with the goal of reaching €1.800 - the necessary funds for an initial inventory of the kits. With this inventory, the first partnerships will be developed, and the kits will be distributed across different communities.

Philanthropic funds from institutions aligned with EcoSeal's mission are also one of the key sources of early-stage funding considered. The following foundations have been identified for their fit and type of funding opportunities provided:

- **Calouste Gulbenkian Foundation**: funds projects in social development and sustainability. The foundation developed the Transition Point[12] initiative, a 'one-stop shop' solution to support communities in alleviating energy poverty. An interview with

[11] https://www.energiser.pt/en/commitment/2023-07-04-Colmeia-in-search-of-new-talent-f03aa0d2

[12] https://gulbenkian.pt/en/climate-and-ocean/transition-point/

Sara Pais (Appendix E: Interview 6) showed the alignment of the foundations mission and EcoSeal's solution.

- **La Caixa Foundation:** has financed multiple projects related to energy poverty, including the study "Energy Poverty in Portugal: A Municipal Analysis".
- **EDP Foundation:** the philanthropic arm of the EDP Group, has developed and funded numerous initiatives on the topic of energy efficiency, including Energético Social[13], a digital platform to promote knowledge about energy consumption.

At a later stage, with a solid proof-of-concept and the ability to generate revenue and create significant impact, a crowdlending campaign will be launched through GoParity. The impact investments platform requires proof of revenue generation and a financial track record of at least two years to launch a campaign, so it is only considered as an option at a more established stage.

As the project matures, gains traction and proves to be able to deliver impact at a large-scale, other impact investment mechanisms may be considered. One promising avenue for EcoSeal is the issuance of a Social Impact Bond (SIB)[14]. Once EcoSeal delivers a solution which yields signficant cost savings, and is able to present measurable KPI's, through a robust mechanism for impact evaluation (Chapter 9), the design of a SIB would be possible. To do so, a pool of private investors is needed, who will cover upfront costs. Once the intervention is carried out and expected outcomes of social impact are achieved, a payer - typically a government body - reimburses the investors. A social impact bond could scale EcoSeal's reach, allowing it to address broader systemic challenges while delivering both social and financial returns. In

[13] https://www.energetico-social.pt/

[14] Social Impact Bonds are innovative financing tools where private investors fund social initiatives upfront, and repayment is contingent upon achieving predefined social outcomes, which are validated independently.

Portugal, the entities involved in the development of SIBs are Portugal Inovação Social[15] and MAZE Impact[16].

8.6 Exploring Additional 'Impact' Streams

This chapter explores innovative ways on how EcoSeal could achieve impact beyond its core offering by aligning with the broader goal of promoting energy efficiency in Portugal and leveraging its position and network of partners.

8.6.1 Specialized Consultancy Services

A specialized consultancy service aligns closely with EcoSeal's mission of addressing energy efficiency, and by selling the kits to an extended target audience, such as property managers and landlords, who could benefit by optimizing energy usage across multiple units, reducing costs and meeting regulatory requirements. Additionally, small and medium enterprises (SME's), particularly those with office spaces looking to reduce their utility bills, would gain from paid energy efficiency audit and consultancy services. A percentage of the revenue from this business model would be used to subsidize free, on-site consultations for vulnerable populations, such as elderly or incapacitated citizens, who are not able to independently use the DIY Energy Assessment Kit.

[15] Public initiative launched to promote social innovation and entrepreneurship (https://inovacaosocial.portugal2020.pt/)

[16] Impact investment firm that supports impact-driven entities through advisory services and accelerator programs (https://maze-impact.com/)

8.6.2 Data Insights

By adhering to European frameworks, including the Open Data Directive and the General Data Protection Regulation (GDPR), EcoSeal can responsibly contribute to the collective mission of improving energy efficiency while ensuring the privacy of the households it serves.

The ability to collect data through the promotion of energy efficiency assessments offers unique opportunities to gather information on household energy usage, building characteristics, and the effectiveness of specific energy-saving solutions. EcoSeal can collect anonymized data on insulation quality, appliance efficiency, and energy consumption trends, which may serve to support informed decisions for public policy.

Under the European Open Data Directive (Directive (EU) 2019/1024, 2019), data can be openly shared with researchers, policymakers, and other social enterprises. Furthermore, EcoSeal can publish periodic reports and visualizations that showcase the impact of its initiatives, to amplify its credibility as a key stakeholder in the energy transition discourse. To comply with GDPR, securing explicit consent during data collection is mandatory and shall be included in the data gathering tools used by EcoSeal.

8.6.3 Referral Programs

By partnering with energy service companies, or equipment and appliances providers, EcoSeal can act as a trusted intermediary, and achieve significant savings for citizens, by connecting users of EcoSeal's kit to the best value for investment solutions, through a referral program. For instance, a user who decides to upgrade an appliance will be referred to the best solution on the market, based on their budget and cost-benefit. As another example, EcoSeal users could get access to exclusive discounts for services from companies that do home renovations, install solar photovoltaic panels or heat pumps. In these agreements, a specific referral fee structure

would be defined, which could range from a flat fee per successful referral or a percentage of sales coming from EcoSeal. This fee model should reflect the effort required to match users with suitable providers, ensuring fair compensation while guaranteeing good quality services and competitive pricing for users. As the number of users grows, so will the potential pool of referrals, providing a scalable revenue model, with a minimal increase in operational capacity and capital investment.

8.7 Learnings & Key Insights

Choosing the proper legal structure for EcoSeal was a defining step in our journey. While EcoSeal began as a social enterprise, the need to build trust and engage with communities pushed the team to evolve into a non-profit organization. This shift was not just about legal formalities – it reflected the commitment to prioritizing impact over profit, especially in the early stages when monetization seemed premature, and trust was crucial. That said, this transition came with valuable lessons. Being a non-profit does not mean ignoring financial sustainability. On the contrary, the team learned that staying independent of grants and donations requires a thoughtful balance. By creating revenue-generating opportunities, EcoSeal can ensure it remains resilient and impactful in the long term.

This chapter has been about finding the balance between purpose and practicality. In moving forward, the team will continue building a model that not only makes energy efficiency simple and accessible but also keeps us grounded in the mission to empower households, create lasting change, and prove that doing good can be sustainable too.

9. Impact Assessment & Validation

[Maurice Moser, 61263]

9.1 Introduction & Relevance

Demonstrating impact is a critical component of validating social impact ventures. EcoSeal's DIY Energy Assessment Kit empowers households to independently identify and address energy inefficiencies, fostering greater energy literacy and self-reliance. To ensure its effectiveness, the kit's ability to drive behavioral change and reduce energy bills through actionable guidance must be evaluated. This chapter examines its impact across key metrics, validating the kit's effectiveness and highlighting EcoSeal's contribution to households and communities in promoting sustainable practices.

9.2 Objectives

This chapter establishes the metrics and KPIs required to evaluate the DIY Energy Assessment Kit's potential to enhance energy efficiency and encourage sustainable behavioral changes. Using findings from relevant case studies, it examines key outcomes such as energy savings, financial relief, and carbon dioxide (CO_2) reductions. These evaluations aim to project both immediate and long-term impacts on households and broader communities. The chapter also outlines a strategy for measuring these impacts, ensuring alignment with the Sustainable Development Goals (SDGs) and Portugal's national energy efficiency targets ("Statistics Portugal," n.d.).

9.3 Developing Impact Metrics & KPIs

9.3.1 Methodology

The development of KPIs for the DIY Energy Assessment Kit was informed by PwC's *Guide to Key Performance Indicators* and additional principles for KPI development. These frameworks provided guidelines for creating meaningful and actionable metrics. PwC's recommendations emphasize aligning KPIs with strategic goals, defining their purpose and calculation method, and using benchmarks to provide context (PricewaterhouseCoopers 2007). The KPI development principles, as outlined in Table 20, serve as a structured guideline to ensure clarity and focus.

Table 20: KPI Development Principles Based on PwC Guidelines

1. Aligning KPIs with strategic objectives to directly measure progress.
2. Clearly defining each KPI, including its purpose, calculation method, and its link to project goals.
3. Limiting the number of KPIs to a maximum of 10 to maintain clarity and focus.
4. Using historical trends and benchmarks to provide a contextual foundation for the metrics.
5. Disclosing assumptions and limitations to ensure transparency.
6. Setting measurable targets with actionable plans to track progress over time.
7. Regularly reviewing KPIs to ensure they adapt to evolving project conditions and strategies.

The *Home Energy Plan* case study by João Afonso Mendes (see Appendix P), conducted under the supervision of Prof. Joanaz de Melo, provided real-world data comparable to the type of measurements the DIY Energy Assessment Kit is designed to collect and analyze. This study served as a benchmark for metrics such as energy savings, CO_2 reductions, and energy bill reduction. Its findings offered valuable insights into estimating household appliance consumption and calculating the impact of interventions, helping to refine the KPI framework. Additionally, Prof. Joanaz de Melo was interviewed as an expert, contributing valuable insights to the project. The interview details are available in Appendix E, Interview 2.

9.3.2 Impact Metrics & KPIs

Developing these metrics focused on three core areas: user benefits, environmental contributions, and societal value. User benefits included behavioral changes, energy savings, and financial relief, while environmental contributions measured CO_2 reductions and resource conservation. Societal value emphasizes promoting collective energy literacy and sustainable practices. Due to time and financial constraints, no official DIY Energy Assessment Kit prototype was tested. Instead, impact projections relied on the *Home Energy Plan* case study (see Appendix P) and research, focusing on identifying common inefficiencies like energy-draining appliances or heat loss and assessing the effectiveness of proposed solutions, such as shorter showers or upgrading to energy-efficient appliances. Table 21 outlines the finalized KPIs and their corresponding measurement methods.

Table 21: KPIs and Measurement Methods for EcoSeal

Financial Relief (SDG 1: No Poverty)
KPI: Average monthly and yearly cost savings per household (€). **Measurement:** Compare pre- and post-intervention utility bills (electricity and water) to validate cost reductions. Use regional pricing for electricity (€/kWh) and water (€/liter) to estimate monthly and yearly savings based on measured reductions.
Energy Savings (SDG 7: Clean Energy)
KPI: Percentage reduction in household energy consumption (kWh) per month and year. **Measurement:** Compare pre- and post-intervention electricity bills to calculate the change in energy consumption. Use the appliance data recorded by users during the DIY Energy Assessment Kit's measurement period to estimate both monthly and yearly savings.
Quality of Life (SDG 11: Sustainable Cities)
KPI: Percentage of users reporting improved household comfort and satisfaction. **Measurement:** Collect qualitative feedback through post-implementation surveys to gauge perceived improvements in comfort and satisfaction. Supplement with open-ended questions to identify specific areas of impact.
Behavioral Changes (SDG 12: Responsible Consumption)
KPI: Percentage of users adopting new energy-saving habits (e.g., shorter showers, targeted ventilation). **Measurement:** Conduct surveys and follow-up interviews to collect self-reported data on behavioral changes before and after the kit's usage. Validate the reported changes with cross-referenced data, such as reduced energy or water consumption.
CO_2 Reduction (SDG 13: Climate Action)
KPI: Amount of CO_2 emissions avoided (kg) per month and year. **Measurement:** Apply standardized emission factors to the recorded energy savings to estimate monthly and yearly reductions in CO_2 emissions. For example, using the European grid factor 0.233 kg CO_2 per kWh (European Environment Agency 2024) multiply the calculated energy savings in kWh by this factor to determine emissions saved on a monthly and yearly basis.

9.4 Projected Impact & KPI Targets

This section outlines the projected impact of the DIY Energy Assessment Kit and the key performance indicators (KPIs) used to evaluate its effectiveness. Table 22 illustrates an apartment where multiple high-impact interventions have been implemented, such as replacing outdated appliances, installing efficient water fixtures, and addressing energy inefficiencies.

The values for older appliance consumption were derived from the *Home Energy Plan* case study, while benchmarks for modern energy-efficient alternatives were sourced from Leroy Merlin. These data points provide the basis for estimating energy savings, energy bill reductions, and CO_2 reductions.

Table 22: Possible Efficiency Gains from Appliance and Home Upgrades

Appliance/ Feature	**Current Consumption**	**Upgraded Consumption**	**Savings in kWh and €**	**CO_2 Reduction**	**Intervention**
Refrigerator (20 years old)	771 kWh/year	150 kWh/year	621 kWh/year (~€124/year)	~144 kg CO_2/year	Replaced with an efficient model
Washing Machine (20 years old)	625 kWh/year	143 kWh/year	482 kWh/year (~€96/year)	~112 kg CO_2/year	Replaced with an efficient model
Dishwasher (20 years old)	425 kWh/year	140 kWh/year	285 kWh/year (~€57/year)	~66 kg CO_2/year	Replaced with an efficient model
Heater (10 years old)	400 kWh/year 200 hours	150 kWh/year	250 kWh/year (~€50/year)	~58 kg CO_2/year	Replaced with an efficient model
Showerhead 15 liters/min	12,000 liters/ year)	8,400 liters/ year	~€20/year	~50 kg CO_2/year	Eco showerhead 10 liter/min
Window Sealing	Significant heat loss	Reduced heat loss	5% energy savings	-	Weather stripping
Faucet Aerator	20 liters/min	9 liters/min	-	-	Eco Aerator
Standby Devices	20 kWh/year	10 kWh/year	10 kWh/year (~€2/year)	~2.5 kg CO_2/year	Master power strip

While these projections demonstrate the kit's potential for energy efficiency and cost reduction, they remain theoretical. Actual savings depend on household conditions, user behavior, and the extent to which recommended interventions are implemented. For instance, while some households may adopt all suggested measures, others may implement only partial changes.

9.5 Impact Measurement Strategy

9.5.1 Methodology

Developing an impact measurement strategy involves defining clear objectives aligned with organizational goals and stakeholder needs. Key metrics combining quantitative and qualitative data are selected to track progress. Engaging stakeholders ensures the strategy reflects diverse perspectives. Suitable tools and frameworks were chosen, and challenges like data limitations were proactively addressed. Consistent data collection and monitoring allow accurate assessment of progress. Findings are analyzed and communicated transparently, highlighting successes and areas for improvement. The strategy remains iterative, evolving based on insights to ensure ongoing relevance and effectiveness (Feor, Clarke, and Dougherty 2023).

9.5.2 Goals

The impact measurement strategy for the DIY Energy Assessment Kit aims to achieve three primary objectives. First, it seeks to evaluate the immediate effects of the kit on household energy consumption, water usage, and cost savings. This includes quantifying measurable outcomes such as kWh reductions, CO_2 savings, and energy bill reduction. Second, the strategy focuses on understanding behavioral changes among users, such as adopting energy-saving practices and improving energy literacy. Third, it ensures the scalability and adaptability of the kit by assessing its alignment with broader sustainability goals, including SDG 1 (No Poverty)**,** SDG 7 (Affordable and Clean Energy)**,** SDG 11 (Sustainable Cities and Communities)**,** SDG 12 (Responsible Consumption)**,** and SDG 13 (Climate Action) (“THE 17 GOALS | Sustainable Development,” n.d.).

9.5.3 Proposed Metrics & KPIs for Real Impact Validation

Building on the metrics developed in *Part 9.3.2 Impact Metrics & KPIs*, this section outlines how these indicators will validate the kit's impact. These KPIs ensure that the validation process remains aligned with the project's objectives and broader sustainability goals. Challenges such as variability in user engagement or data collection will be addressed through iterative adjustments, ensuring the robustness and credibility of the validation framework.

9.5.4 Impact Measurement Framework & Reporting

The Impact Measurement Framework for the DIY Energy Assessment Kit ensures that the metrics and KPIs developed in Section 9.3 and outlined in Table 20 are systematically tracked and analyzed. This framework organizes the data collection process, validation methodologies, and reporting mechanisms to measure real-world impact effectively.

9.5.4.1 Data Collection

The data collection process for the DIY Energy Assessment Kit involves a structured approach to gather both quantitative and qualitative data from users. Each user begins by filling out a before-use form hosted on EcoSeal's website to record baseline data, such as energy consumption, water usage, and current habits. The data entered is saved by Squarespace[17], which ensures that the input is standardized and does not require manual reworking, streamlining the process for efficient analysis.

[17] *Squarespace* is a website-building platform that allows businesses and individuals to create and host customizable websites with integrated tools for data collection, such as forms. (squarespace.com)

The data collected through Squarespace is automatically transferred to Airtable[18] using Zapier[19] as an integration tool. Airtable serves as a centralized database to store and organize all user and client data, offering advanced tools for tracking, filtering, and reporting, which are not available in Squarespace.

9.5.4.2 Validation Methods

Ensuring the accuracy and reliability of the data collected with the DIY Energy Assessment Kit is essential to gain actionable insights. This is achieved through a combination of methods to cross-check and validate the data. Primary data sources include user-measured appliance energy consumption, water consumption, and temperature readings, which are collected using instruments included in the kit such as energy meters, shower flow meters and thermometers. These measurements are compared to standard benchmarks, such as household appliance manufacturer specifications provided by Leroy Merlin. The collected data is transferred to Airtable, where automated checks highlight anomalies, such as unusually high or low levels of energy or water consumption compared to expected ranges for similar homes and appliances. To increase accuracy, the devices included in the kit, such as energy and flow meters, are regularly calibrated to ensure they are working properly. If errors are detected, the devices are immediately replaced with functional units to maintain data quality and reliability.

[18] *Airtable* is a cloud-based platform that combines database functionality with spreadsheet simplicity. It allows users to store, organize, and manage data collaboratively while offering advanced tools for filtering, tracking, and reporting. (airtable.com)

[19] *Zapier* is an automation tool that connects applications and automates workflows by transferring data between platforms. For example, it links Squarespace and Airtable to ensure seamless data transfer. (zapier.com)

9.5.4.3 Analysis

The analysis step processes data collected through the DIY Energy Assessment Kit into practical recommendations for users, guided by the KPIs outlined in the Impact Metrics section. Quantitative data, including energy and water usage, is measured using tools like energy meters, flow gauges, and thermometers. Users input appliance energy consumption for one hour and provide daily usage via a form on EcoSeal's website. Combining measured values with user-reported habits ensures accurate annual consumption estimates. Collected data is compared against benchmarks for modern, energy-efficient appliances, sourced from manufacturer specifications of household appliances provided by Leroy Merlin. These benchmarks reflect updated efficiency standards across appliance categories. Metrics such as annual energy savings, cost reductions, and CO_2 emission reductions are calculated based on the KPIs, ensuring consistency with the project's objectives. The final analysis delivers insights into recommendations for each household.

9.5.4.4 Reporting

Reporting is a key component of EcoSeal's DIY Energy Assessment Kit, transforming data into clear, actionable recommendations for households. Each report offers specific suggestions, such as upgrading appliances or adopting energy-saving habits, based on the household's measured data and user input. This includes detailed cost-benefit analyses that show energy savings and estimated payback periods for proposed measures. To improve understanding, the reports are presented in an accessible format with intuitive graphs, charts, and concise explanations so that the information is easy to interpret. A sample report format illustrating these features is provided in Appendix O.

The reports are manually reviewed during the initial phases to ensure accuracy and relevance. As the project grows, the reporting process will integrate automated tools to efficiently organize and analyze data while maintaining consistency. This automation will focus on streamlining repetitive tasks, such as calculations and formatting, while tailored recommendations remain dedicated to each household's unique profile.

9.6 Future Directions

The impact assessment and validation chapter highlights the real potential of the DIY Energy Assessment Kit. While the current approach provides a good starting point, there is still room to improve accuracy and validate long-term results. By thinking creatively and building on what EcoSeal has already achieved, we can take this impact to the next level. One way is to refine the analysis and presentation of data. For example, tools that predict energy savings or provide clearer cost estimates could make recommendations even more practical. Interactive reports or dashboards could provide users with an easy way to see their progress, compare their results, and understand where improvements can be made.

Sustainable results depend on users maintaining energy-saving habits beyond the initial assessment, such as reducing energy and water consumption or upgrading appliances. A longer test period of 6-12 months would help to observe sustained improvements and illustrate the long-term benefits of the kit. By tracking these trends over time, the kit could demonstrate its true value, build greater trust and encourage continued commitment to energy-saving measures.

10. Conclusion

10.1 Limitations

EcoSeal achieved significant milestones during the development process but encountered several limitations that must be addressed in future iterations.

The pilot test was limited to one participant, which restricted the ability to validate applicability across different household types. Due to the short duration of the project, it was not possible to validate the long-term impact. Future pilot tests on a larger scale would provide more insights into product performance over time. User feedback also revealed that some households lack awareness or motivation to implement energy-saving measures, which is an issue that EcoSeal must further address and requires more extensive engagement strategies. EcoSeal is currently sourcing the kit components from one single supplier, which creates the risk of sourcing delays and scalability. Therefore, the team needs to consider diversifying suppliers to improve resilience. Additionally, the manual assembly process of kits relies on manual labor, which is feasible for the initial phase. If demand increases suddenly, EcoSeal could face a bottleneck, so outsourcing options should be considered.

10.2 Reflection on the Entrepreneurial Journey

EcoSeal's journey was characterized by an iterative and adaptive process that was heavily influenced by methods such as Lean Startup and Design Thinking.

Throughout the development process, EcoSeal continued to evolve. The team moved from an initial idea of apartment retrofits in Cycle 1 to the DIY energy saving kit of Cycle 2 and finally to the DIY assessment kit of Cycle 3. Each iteration brought improvements based on user and expert feedback, which enabled EcoSeal to refine the value proposition. Stakeholder involvement also played an important role during EcoSeal's journey so far – the feedback provided by all entities, experts and users was fundamental in the decisions taken throughout this Work Project.

Several challenges were also part of the process – from opportunities of collaboration that did not develop further, outreach to several additional stakeholders that did not get a reply, and the challenge of pivoting to a different approach and solution along the development of this journey. All these setbacks became valuable lessons in resilience and flexibility. Despite limitations, significant progress was made. Not all hypotheses could be fully validated, but the project provided key insights into user needs and operational feasibility.

10.3 Conclusion & Future Outlook

After completing the validations, EcoSeal will proceed with establishing its legal entity as a formally recognized NGO, through the steps described above (Chapter 8.3). Once a legal entity is formed, raising funds to build the first kits will be the main priority. With the legal entity in place, an inventory of kits and capital to cover the initial costs, EcoSeal will commence its operations by launching the first batch of DIY Energy Assessment Kits to institutional partners. Success at this stage will be measured by the number of kits distributed, and the number of users who follow-up after using the kit and book a consultation with the EcoSeal Team.

In the long-term, scaling the operations and expanding geographically to underserved regions within Portugal will be a priority. This expansion will be complemented by delivering training programs to prepare local consultants, towards educating households on energy efficiency across Portugal, and developing partnerships with municipalities to integrate the kits into broader energy programs. Regular publication of impact reports will ensure transparency and accountability, while bolstering the reputation among stakeholders.

While EcoSeal may not be the next million-dollar unicorn, it is a practical and impactful project with real potential. With interest from partners already in place and the ability to launch immediately, EcoSeal is ready to make its mark.

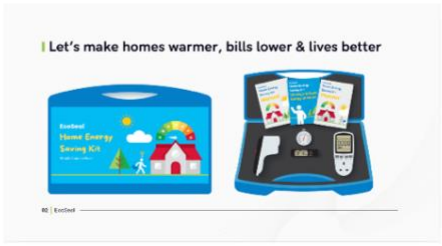
Looking ahead, EcoSeal aspires to establish itself as mission driven organization, that serves the purpose of improving the levels of energy efficiency in Portugal, by collaborating with a network of partnered entities to increase problem recognition and empower Portuguese citizens to make changes towards a more sustainable and fair energy transition.

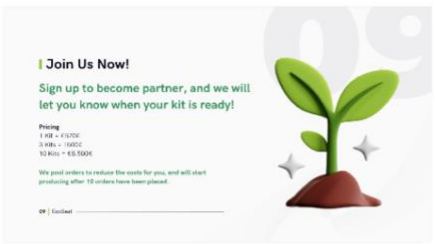
11. Appendix

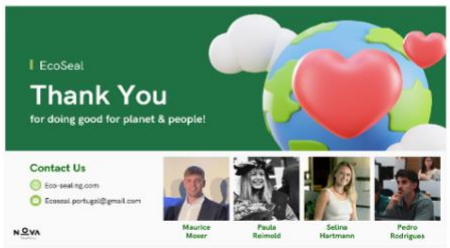
Appendix A: Excerpt Unit Economics Analysis for Cycle 1

EXPENSES	PACKAGE 1	PACKAGE 2	PACKAGE 3
DIRECT EXPENSES	View in "Service Packages"		
TOTAL DIRECT EXPENSES	$ 1.000,00	$ 2.000,00	$ 3.000,00
INDIRECT EXPENSES			
Processing & Administrative Expenses	$ 50,00	$ 50,00	$ 50,00
Customer Acquisition Cost	$ 50,00	$ 50,00	$ 50,00
Insurance	$ 10,00	$ 10,00	$ 10,00
Technician Salary	$ 300,00	$ 300,00	$ 300,00
TOTAL INDIRECT EXPENSES	$ 410,00	$ 410,00	$ 410,00
MONTHLY OVERHEAD TOTAL	$ 14.725,90	$ 14.725,90	$ 14.725,90
OVERHEAD PER UNIT	$ 736,30	$ 736,30	$ 736,30
CONTIGENCY BUFFER (10%)	$ 214,63	$ 314,63	$ 414,63
TOTAL EXPENSE PER UNIT	$ 2.360,92	$ 3.460,92	$ 4.560,92
TOTAL PRICE PER UNIT	$ 2.715,06	$ 3.980,06	$ 5.245,06
CONTRIBUTION MARGIN (in %)	15%	15%	15%
CONTRIBUTION MARGIN (in €)	354,14 €	519,14 €	684,14 €

Appendix B: Presentation for Institutions







Appendix C: Social Business Model Canvas

Appendix D: Facebook Ad Campaign

Campaign Overview

- **Name**: EcoSeal Smoke Test
- **Objective**: Drive traffic to the website to gauge interest in the DIY Energy Saving Kit.
- **Total Budget**: €35.00
- **Duration**: December 4, 2024, 00:13 CET – December 10, 2024, 17:18 CET.

Target Audience

- **Location**: Lisbon, Portugal (+40 km radius).
- **Age Range**: 18+
- **Interests**: Home renovation, household appliances, and DIY projects.

Report Dez.-1-2024 until Dez.-14-2024 Report Period: Dec 1, 2024 - Dec 14, 2024

Name	Age	Headline	Reach	Clicks (all)	CTR (all)	Budget Spent	Timstamp
EcoSeal Ad Test	All	All	25565	420,00	0,65	30,47	2024-12-01
	65+	All	12870	243,00	0,74	18,84	2024-12-01
		Poupe nas Contas, Viva com Conforto!	4579	105,00	1,54	7,28	2024-12-01
		Poupe Energia Agora—Veja os Resultados Hoje!	2787	45,00	1,33	3,43	2024-12-01
		Kits de Poupança de Energia Gratuitos Perto de Si!	674	7,00	0,88	0,78	2024-12-01
		Kit de Poupança de Energia DIY: Economize de forma fácil!	417	3,00	0,69	0,51	2024-12-01
		Assuma o Controle dos Seus Custos de Energia!	293	2,00	0,64	0,33	2024-12-01
	55-64	All	6207	103,00	0,61	6,46	2024-12-01
		Poupe nas Contas, Viva com Conforto!	1600	41,00	1,90	2,21	2024-12-01
		Poupe Energia Agora—Veja os Resultados Hoje!	936	15,00	1,37	0,91	2024-12-01
		Kits de Poupança de Energia Gratuitos Perto de Si!	267	3,00	0,99	0,30	2024-12-01
		Kit de Poupança de Energia DIY: Economize de forma fácil!	130	3,00	2,16	0,17	2024-12-01
		Assuma o Controle dos Seus Custos de Energia!	100	0,00	0,00	0,02	2024-12-01
	45-54	All	2944	36,00	0,45	2,58	2024-12-01
		Poupe nas Contas, Viva com Conforto!	522	13,00	1,91	0,72	2024-12-01
		Poupe Energia Agora—Veja os Resultados Hoje!	302	5,00	1,50	0,22	2024-12-01
		Kit de Poupança de Energia DIY: Economize de forma fácil!	41	1,00	2,22	0,02	2024-12-01
		Kits de Poupança de Energia Gratuitos Perto de Si!	75	1,00	1,32	0,09	2024-12-01
		Assuma o Controle dos Seus Custos de Energia!	25	0,00	0,00	0,01	2024-12-01
	35-44	All	1760	23,00	0,65	1,28	2024-12-01
		Poupe nas Contas, Viva com Conforto!	324	6,00	1,54	0,44	2024-12-01
		Poupe Energia Agora—Veja os Resultados Hoje!	143	2,00	1,26	0,11	2024-12-01
		Kits de Poupança de Energia Gratuitos Perto de Si!	38	1,00	2,33	0,07	2024-12-01
		Kit de Poupança de Energia DIY: Economize de forma fácil!	32	1,00	2,94	0,06	2024-12-01
		Assuma o Controle dos Seus Custos de Energia!	14	0,00	0,00	0,01	2024-12-01
	25-34	All	1328	11,00	0,42	0,90	2024-12-01
		Poupe Energia Agora—Veja os Resultados Hoje!	66	2,00	2,78	0,08	2024-12-01
		Assuma o Controle dos Seus Custos de Energia!	11	1,00	9,09	0,01	2024-12-01
		Kits de Poupança de Energia Gratuitos Perto de Si!	15	0,00	0,00	0,03	2024-12-01
		Kit de Poupança de Energia DIY: Economize de forma fácil!	13	0,00	0,00	0,01	2024-12-01
		Poupe nas Contas, Viva com Conforto!	140	0,00	0,00	0,23	2024-12-01
	18-24	All	456	4,00	0,34	0,41	2024-12-01
		Poupe Energia Agora—Veja os Resultados Hoje!	36	1,00	2,56	0,07	2024-12-01
		Kit de Poupança de Energia DIY: Economize de forma fácil!	8	1,00	12,50	0,03	2024-12-01
		Kits de Poupança de Energia Gratuitos Perto de Si!	8	0,00	0,00	0,01	2024-12-01
		Poupe nas Contas, Viva com Conforto!	46	0,00	0,00	0,03	2024-12-01
		Assuma o Controle dos Seus Custos de Energia!	5	0,00	0,00	0,00	2024-12-01

Appendix E: Interviews

Interview 1: João Pedro Gouveia

Interview Details	
Interviewee: João Pedro Gouveia	
Position: Principal Researcher for Environmental and Sustainability Research at Nova FCT; Leader of Firefly Energy Lab; Coordination Team member of the EU energy Poverty Advisory Hub	**Organization:** Nova FCT
Date of Interview: 25.10.2024	**Mode of Interview:** Zoom
Key Discussion Points: Cultural and behavioral barriers, outreach strategies; strategies for stakeholder engagement; key recommendations; product design; funding and partnerships	

Insights Created	
Cultural & Behavioral Barriers	● Lack of recognition of energy poverty as a problem, influenced by cultural adaptation to discomfort in homes. ● Low energy literacy: People struggle to understand technical and financial impacts of energy efficiency decisions (e.g., energy classes, savings potential). ● Stigma associated with energy poverty prevents people from seeking help or participating in initiatives.
Outreach Strategies	● Importance of proactive, trust-building approaches through partnerships with local organizations and municipalities. ● Multi-channel awareness efforts (leaflets, community workshops, events) to reach diverse demographics. ● Bottom-up approaches, engaging people through entities they already trust (e.g., NGOs, social support schemes).
Recommendations for Engagement	● Simplify messaging to avoid the perception of a sales pitch; emphasize help and trustworthiness. ● Offer tangible incentives (e.g., LED bulbs, smart plugs) to attract participants to initiatives. ● Conduct groundwork with municipalities and social entities to pre-engage communities before project rollouts.
Product Design	● Address basic needs with low-cost, impactful tools, focusing on common problems (e.g., drafty windows, poor insulation). ● Distinguish between comfort-focused and cost-saving solutions, adapting kits to both. ● Develop measurement tools as part of the kit to empower users to recognize and address energy inefficiencies independently.
Partnerships and Funding	● Collaborate with local governments and foundations for sustainable funding and broader reach. ● Avoid partnerships with corporations that might erode public trust in the initiative. ● Explore multi-layered support mechanisms, including European funding for long-term stability.

Interview 2: João Joanaz de Melo

Interview Details	
Interviewee: João Joanaz de Melo	
Position: Associate Professor at the Department* of Environmental Sciences and Engineering at Nova FCT; Lecturer in Home Energy Auditing	**Organization:** Nova FCT
Date of Interview: 30.10.2024	**Mode of Interview:** In-Person
Key Discussion Points: Cultural and behavioral barriers, energy literacy, engagement strategies, energy auditing methods and tools	
Insights Created	
Behavior & Awareness:	● Most people do not read handbooks; visual aids, videos, and hands-on guidance are far more effective. ● Very low energy literacy among many households; even basic energy-saving actions are not understood or implemented. ● A significant cultural focus on comfort over structural solutions (e.g., using blankets instead of fixing inefficiencies). ● Accurate measurement is crucial; poorly conducted audits can lead to incorrect recommendations ("garbage in, garbage out").
Target Groups and Engagement	● Clear entry strategy is needed to define the target audience: ○ Renters with limited ability to make structural changes. ○ Elderly individuals who often live alone and need volunteer assistance. ○ Families in extreme poverty who can only be reached through existing social support schemes. ○ Homeowners who have more flexibility to make changes. ● Outreach through community hubs like libraries and community centers is a promising approach.
Energy-Saving Actions	● Small behavioral changes can yield up to 50% savings in energy usage, such as: ○ Using washing machines at the lowest possible temperature. ○ Installing shower timers to reduce water usage. ○ Managing sunlight exposure in apartments effectively.
Energy Auditing	● Suggested tools for audits include: ○ Infrared thermometer. ○ Energy meter. ○ Temperature and humidity monitoring devices (house meteorological set). ○ Thermal imaging camera (optional). ○ Measuring tape for wall thickness. ● Energy audits should focus on teaching users what and how to measure effectively.
Volunteer and Community Support	● Volunteer networks are essential for assisting vulnerable groups, especially the elderly and energy-poor households. ● Public-private partnerships and decentralized, independent organizations are needed for scalability and sustainability.

Interview 3: Gobnait Ní Néill (Codema)

Interview Details	
Interviewee: Gobnait Ní Néill	
Position: Energy Planner at Codema, Dublin' Energy Agency; Project Manager for the Energy Saving Kit initiative	**Organization:** Codema Dublin Energy Agency
Date of Interview: 22.10.2024	**Mode of Interview:** Zoom
Key Discussion Points: Challenges & best practices for Assessment kit distribution, user insights, impact measurement, operational considerations	
Insights Created	
Market Insights and Target Audience	● Main motivators for interventions: cost, health, comfort (climate is secondary). ● Owners or long-term renters are more likely to invest in energy efficiency than short-term renters ● People often lack awareness or knowledge about simple interventions that can improve energy efficiency and comfort ● Basic home energy-saving behaviors (e.g., sealing leaks, managing indoor moisture) are not widely practiced ● Digital integration (e.g., smartphone apps) could appeal to some users but not all, as not everyone is comfortable with advanced technology ● Lack of trust in information sources or institutions, especially among vulnerable groups ● Difficulty in sharing personal data (e.g., utility costs, home conditions) due to privacy concerns and discomfort discussing such matters ● People often default to behaviors they are comfortable with (e.g., layering clothes instead of addressing insulation or heat loss)
Engagement and Outreach Strategies	● Work with trusted middle actors already engaged with target audiences ● Partner with trusted middle actors ● Trust is key, particularly for vulnerable groups who may distrust municipalities or institutions
Solution Design	● Users value tools that are easy to understand and use ● Essential tools: Thermal leak detector, electricity monitor, radiator key, fridge freezer thermometer, temperature, and humidity meter ● Hard copy resources (e.g., printed guides) remain essential for some audiences ● Tools with small displays or poor usability (e.g., non-backlit displays) are problematic, particularly for older users or those with vision issues ● Incremental improvements, such as backlit displays and larger numbers, improve user satisfaction
Challenges	● Lack of technical skills among users to implement changes ● Tool durability and consistent quality control issues ● Surveys are the main channel, but collecting long-term impact data is difficult due to privacy and self-reporting biases ● Libraries serve as intermediaries for kit distribution but face challenges replenishing consumables
Strategic Advise	● Start small with clear focus areas ● Test interventions in manageable environments before scaling ● Target students or university communities as a starting audience for feedback and piloting

Interview 4: Cassidy Stillie (Okotoks)

Interview Details	
Interviewee: Cassidy Stillie	
Position: Project Specialist for the Clean Energy Improvement Program in Okotoks, Canada; Coordinator for the DIY Home Energy Audit Kit Program	**Organization:** Town of Okotoks
Date of Interview: 08.11.2024	**Mode of Interview:** Zoom
Key Discussion Points: DIY Kit program design, user engagement, challenges, best practices, impact measurement	
Insights Created	
Program Design	● Kit customization is important; users can select only what they need, avoiding unnecessary items. ● User-friendly designs and walkthroughs (booklets, websites) reduce confusion but don't fully prevent it. ● Including tools like thermal imaging cameras, energy meters, and radon monitors is impactful but requires guidance for proper use ● Seasonal factors influence the effectiveness of certain tools (e.g., thermal imaging cameras are less effective in warmer months). ● Clear and simple instructions are critical to ensuring the kits are effectively utilized by diverse users ● Users often require support to fully utilize more technical tools, such as thermal cameras, pointing to the need for accessible resources like video tutorials.
User Engagement	● The primary motivators for users to engage with the kit include cost savings, curiosity, and environmental consciousness ● Seniors are the largest demographic engaging with the kit. ● Word of mouth and community-focused advertising (e.g., local newspapers, social media) are highly effective. ● Building a strong community network ensures higher participation and trust in the program
Challenges	● Ensuring usability of advanced tools like thermal cameras and radon monitors. ● Seasonal limitations: Thermal imaging is less effective in warmer months. ● Reliance on grants makes long-term financial sustainability challenging
Scalability	● DIY kits offer a simplified, hands-off model with high potential for scaling. ● In-person audits are resource-intensive and less scalable compared to DIY approaches.
Partnerships	● Partnerships with local sponsors (e.g., radon monitor suppliers) can offset program costs. ● Municipal support ensures operational sustainability.
Program Impact and Metrics	● Measuring the impact of the program through energy savings and behavioral changes is critical for refining its design. ● Feedback loops from users can help improve the kit's usability and ensure it addresses the most common challenges. ● Success metrics include cost savings, increased energy literacy, and expanded adoption of energy-saving practices.

Interview 5: João Costa Ribeiro

Interview Details	
Interviewee: João Costa Ribeiro	
Position: Lead Open Innovation Manager at Galp; Professor in innovation and technology at the University of Bergen and Porto Business School	**Organization:** Galp
Date of Interview: 30.09.2024	**Mode of Interview:** Zoom
Key Discussion Points:	

Insights Created	
Project Development and Strategy	● Exploring DIY energy-saving kits to empower individuals to implement energy-saving measures themselves ● Discussion of Galps role in EcoSeal ● Collaborative models with companies like Galp can diversify distribution channels and funding
Market Research and Feasibility	● Visits to local stores (e.g., Leroy Merlin) are planned to gather information on existing DIY energy-saving kits and assess market offerings ● The goal is to benchmark existing solutions to improve the DIY kit design
Insights on Energy Poverty and Audience	● Low to mid-income households often lack the financial resources or knowledge to invest in energy-saving measures ● Empowering users with simple, low-cost solutions, like DIY kits, can overcome accessibility challenges ● Households may struggle with recognizing the importance of energy efficiency or lack confidence in implementing solutions themselves ● There's a significant knowledge gap about low-cost, impactful energy-saving measures
Pilot Testing Advice	● Digital testing (e.g., mockups, quick interviews) can help assess initial desirability before investing in physical prototypes ● Real-world physical testing highlights practical feasibility issues (e.g., tool usability, accessibility) ● Testing should focus on practical interventions with measurable outcomes
Product & Solution Discussion	● DIY energy-saving kits on the market may lack customization for specific household needs ● In-person store visits and competitor analysis are critical for identifying gaps in existing products ● The scalability of DIY solutions depends on ease of distribution, cost-efficiency, and user education ● The process must balance affordability with impact to ensure adoption
Collaboration and Partnerships	● Collaboration with external partners, including Galp and the Galp Foundation, is critical ● Potential roles for the foundation include: supporting pilot project, act as customer channel for distribution ● Next steps include rekindling the conversation with Galp Foundation and exploring potential collaboration models ● Working with organizations already active in the energy poverty space accelerates validation and access to data ● Co-development opportunities (e.g., involving libraries or municipalities in kit design) can enhance the relevance of the solution

Interview 6: Sara Pais

Interview Details	
Interviewee: Sara Pais	
Position: Sustainability Project Manager	**Organization:** Calouste Gulbenkian Foundation
Date of Interview: 04.12.2024	**Mode of Interview:** Teams
Key Discussion Points:	
Insights Created	
Alignment with the Institutions Mission	● Gulbenkian has developed a variety of projects focusing on the topic of energy efficiency, as sustainability and a fair energy transition is a top priority of the foundation. ● One of the latest projects has been "Transition Point", a one-stop-shop that aims to promote energy efficiency in a community-centered approach, through a re-used container working as a information center that goes around neighbourhoods in Portugal.
Communication Strategy	● Sara highlighted the importance of adjusting the way the product is communicated to the target audience, referring to the importance of having it in portuguese, and the branding be reflective of the solution being presented. ● Sara felt that "EcoSeal" didn't provide an immediate signal of the solution offered.
Insights on Energy Poverty and Audience	● Sara was very familiar with the data used to highlight the problem, and gave some insights on other sources that could be considered. ● From the experience of Transition Point, engaging with the target audience is the most difficult challenge. ● The solution of the kit could have the potential of eliminating various in reaching this audience, by eliminating the need to get into peoples homes, which may be a barrier for many.
Product & Solution Discussion	● Sara understood the utility of the kit and it's design, highlighting the importance of the guide. ● She shared concerns on if the target audience would have the time and mindspace to engage in using the kit and reporting back their findings.
Collaboration and Partnerships	● For potential collaboration, Sara highlighted the potential to work with ADENE, who already delivers various training programs and workshops on the topic. ● Although Gulbenkian is no longer directly involved in the Transition Point project, she refered to the potential of the kit being used by the Transitiom Agents, those working at the one-stop-shop and providing guidance to the citizens that visited.

Interview 7: Margarida Queiroz

Interview Details	
Interviewee: Margarida Queiroz	
Position: Social Impact Manager	**Organization:** Galp Foundation
Date of Interview: 05.12.2024	**Mode of Interview:** Microsoft Teams

Insights Created	
Alignment with the Institutions Mission	● The concept of the kit was given positive feedback by Margarida, although she highlighted that the main value is in the follow-up, through providing actionable measures to the users. ● The initial goal of this interview, which was to test if the kit would be interesting for Galp to have it available for their employees wasn't validated, because Margarida refereed that the Foundation works independently from the company, and that should be validated with someone from the People & Spaces Department.
Avenues to Develop the Solution	● Galp Foundationn is lauching a new edition of Colmeia, a open innovation program, that supports projects/startups/ideas to promote a fair energy transition in the municipality of Matosinhos. Margarida said that there was a great alignment between Ecoseal and what they are looking for with this program, and that she is expecting an application to be part of it when it opens (January 2025)
Collaboration and Partnerships	● Galp Foundation has collaborated with many institutions on the topic of energy poverty and efficiency, delivering workshops in schools and community centers. Margarida referred to ADENE as a potential key partner, and showcased the work that has been done in collaborateion with the agency. ● Margarida explains the way Galp Foundation always works in partnerships with organizations closer to the target audience they are trying to reach, by supporting them in delivering real impact - she insisted that the only way to tackle a social problem is to build trust with the communities and there is no better way than through organizations that have already developed that type of trust in their day-to-day work.

Interview 8: Islene Facanha

Interview Details	
Interviewee: Islene Facanha	
Position: Project & Policy Officer	**Organization:** Zero NGO
Date of Interview: 04.12.2024	**Mode of Interview:** Google Meet

Insights Created	
Alignment with the Institutions Mission	● ZERO NGO is a non-profit organization addressing the problem of energy efficiency and poverty. Islene highlighted the great fit of EcoSeal with the organizations mission and goals. ● Some alignment with the Project Live Effect, by the Social Climate Fund, which aims to help people in the most vulnerable status of energy poverty.
Communication Strategy	● Islene provided important feedback on how to communicate the problem of energy poverty in an inclusive manner, refering to the importance of not using the term "poverty" when communicating to the people living in that condition. As an alternative, she mentioned how it's being widely referred to as "energy dignity".
Insights on Energy Poverty and Audience	● With extensive experience in engaging with the target audiences of those more enthusiast about energy efficiency (through their associates), Islene referred that those would be a great audience to test out the kit with, and the ones more likely to use it properly.
Collaboration and Partnerships	● The main insight from the interview with Islene regarding potential partnerships, was to consider also Health Centers as institutions where the kit could be interesting to have available, due to their close contact with the local communities.

Interview 9: Pilot Test User

Interview Details	
Interviewee: Pilot Test User **Position**: Young Professional **Date of Interview:** 05.12.2024 **Mode of Interview:** In-Person **Key Discussion Points:** DIY Energy Saving Kit Feedback	
Insights Created	
Usability and Simplicity	● **Ease of Use**: - Easiest: LED lights, moisture absorber, humidity thermometer - Moderate: Timer (used on TV and computer), window sealing (applied on two windows), draft stopper (very nice) - Most Difficult: Eco aerator ● **Instructions**: Clear and straightforward. No confusing or overly complicated parts. ● **Setup Process**: Met and surpassed expectations in terms of simplicity and clarity. ● **Improvements**: Suggestions for tips on behavioral changes (e.g., solutions for flushing water effectively).
Perceived Improvements	● **Understanding**: Improved understanding of home energy consumption. ● **Energy-Saving Opportunities**: Identified inefficiencies. ● **Immediate Benefits**: - Draft stopper and dehumidifier improved comfort. - Mold kit is effective. - Sealing improved sound insulation, reduced drafts, though no significant temperature change noted.
Value and Willingness to Pay	● **Price Willingness**: €80-€150, depending on the customization. ● **Value Improvement**: - Customization based on specific needs (e.g., separate humidity or electricity kits). ● **Overall Value**: Kit perceived as offering good value for its purpose.
Net Promoter Score	● **Score**: 8/10 ● **Motivation**: Motivated to make further improvements
Feedback and Suggestions	● **Liked Most**: - Draft stopper, window sealing, and humidity kit were most impactful. - All-in-one design appreciated. ● **Challenges**: Difficulty with the Eco Faucet Aerator. ● **Suggestions**: Include more visuals and a QR code for video instructions.

Appendix F: DIY Kit Comparison

Competitor	Business Model	Product/ Service	Strengths	Weaknesses	Price Range
Tri-County Regional Energy Network (California)	Government-funded, free kits through libraries	DIY Kit: Includes LED bulbs, weather-stripping, aerators, and measuring tools	Accessible; Includes quick fixes and behavior advice	High logistical effort; Limited to local residents	Free
Codema (Ireland)	Non-profit, institution-driven lending model	Measurement-focused kit: Professional tools, training guides, and user workbook	Professional tools; Reusable; Strong digital support	High cost for institutions; No immediate user relief	€570 (for institutions, free for users)
Okotoks (Canada)	Community-based lending program	DIY Kit: Measurement tools + quick fixes; free materials post-assessment	Includes free tools post-assessment; Extended user support	Limited to residents; High demand limits access	Free for local residents
HomeBoost (UK)	For-profit, direct-to-consumer	Digital-first kit with app integration for detailed assessment	Comprehensive reports; App-based guidance	Expensive; No quick fixes included	£99

Appendix G: User Persona 1

USER PERSONA 1

NAME	Joao Costa
LOCATION	Lisbon
AGE	69 years
JOB	Retired

About: António Costa is a 69-year-old retired teacher living in a small apartment on the outskirts of Lisbon. He has lived there for 35 years and takes pride in his home, though it's starting to feel less comfortable due to its age. He manages on a modest pension, carefully budgeting each month to make ends meet.

Frustrations: António feels frustrated by the rising energy costs that take a large chunk of his pension. During winters, his apartment is cold and damp, but he can't afford expensive renovations. He finds technical solutions confusing and is reluctant to try unfamiliar products.

Motivation: António wants to reduce his energy bills to ease his financial strain and make his home more comfortable, especially in the colder months. He values solutions that are straightforward, low-cost, and allow him to remain self-sufficient.

Behaviors & Attitudes: António is practical and down-to-earth, preferring tried-and-true solutions. While he's skeptical of new products, he trusts recommendations from local community centers or neighbors. Living on a fixed pension, he is highly frugal, prioritizing cost-effective solutions with clear long-term savings. While he tries to adapt to digital tools, such as using his smartphone for basic tasks, he prefers simple, practical solutions with clear, visual instructions. He values his independence, appreciates tools that empower him to make improvements on his own.

Appendix H: Household Surveys

Survey 1 - published 21. September 2024

Questions	Answer Options
Which nationality best describes you?	Portuguese / EU National / Non-EU National
Are you a homeowner or long-term renter in the Greater Lisbon area?	Homeowner / Long-term renter / Neither
What type of home do you live in?	House / Apartment
How old is your home?	< 10 years / 10-30 years / > 30 years / Not sure
How comfortable is your home's temperature year-round?	Comfortable year-round / Uncomfortable in summer or winter / Uncomfortable year-round
Do you consider your energy bills too high for your income?	Yes, definitely / Yes, somewhat / No / Unsure
What is your income range?	< €20,000 / €20,000-€40,000 / €40,000-€60,000 / > €60,000
Have you made any energy efficiency improvements?	Yes / No, but planning / No, not interested
What has prevented you from making energy efficiency improvements?	Too expensive / Don't know what to do / Lack of time / Other
Additional comments (optional).	Free text
Contact information for follow-up interviews?	Name, Email, Phone

Flyer for Survey 1

Survey 2 - published on October 5. 2024

Questions	**Answer Options**
Which nationality best describes you?	Portuguese / EU National / Non-EU National
Where do you live?	Lisbon Area / Other Region in Portugal / Outside of Portugal
What is your income range?	Not sure / Under €20,000/year / €20,000-€40,000/year / €40,000-€60,000/year / More than €60,000/year
What type of home do you live in?	House / Apartment / Other
How old is your home?	Less than 10 years / 10-30 years / More than 30 years / Not sure
How comfortable is your home's temperature during the year?	Comfortable year-round / Comfortable in summer, uncomfortable in winter / Comfortable in winter, uncomfortable in summer / Uncomfortable year-round
How would you describe the thermal condition of your house?	Scale: Very Poor (1) to Very Good (8)
What are the biggest energy efficiency issues in your home?	I don't know what the main issues are in my home/ Air drafts through windows or doors/ Windows that don't retain heat or cold/ Poor insulation in walls or ceilings/ High humidity, mold or dampness/ Inefficient lighting/ Outdated or inefficient heating systems/ Heat loss from radiators or heaters/ Gaps around pipes or vents/ Old or inefficient appliances/ Water waste/ Poor ventilation in some areas/ My home does not need improvements/ Other (specify)
Have you made any energy efficiency improvements in your home?	Yes, I've made some improvements / No, but I'm interested or planning to make improvements / No, and I'm not interested
What has prevented you from making energy efficiency improvements so far?	Lack of awareness about available programs or solutions / Solutions are too expensive or have high upfront costs / Difficulty accessing existing programs (e.g., eligibility requirements, paperwork) / Long waiting times or delays in getting improvements done / Concerns about the effectiveness of available solutions / Lack of trust in contractors, government programs, or energy companies / I rent my home and cannot make structural changes / The process seems too complex or confusing / I don't want to make large financial commitments / I am unsure of how to make energy-efficient changes myself (lack of technical knowledge) / Energy efficiency is not a high priority for me right now / I'm used to the problem and cope differently (e.g., wearing warm clothing inside) / Fear that making changes will disrupt my daily life / Lack of time / I don't think energy efficiency improvements are necessary in my home / I don't know where to start or who to ask for help / Other (specify)
If given clear, step-by-step instructions, would you feel comfortable installing DIY improvements?	Yes, I would be comfortable / Maybe, I would try if the instructions were very clear / No, I would need professional help
What would motivate you to use a DIY energy efficiency kit?	It's affordable and requires a low upfront cost / It's easy to install and use without professional help / I can see immediate results in energy savings or comfort / It allows me to make improvements on my own schedule / It's flexible and I can start small with gradual improvements / I get a personalized kit based on my apartment's needs / It's suitable for renters and doesn't require structural changes / It's simple / I can save money on my energy bills over time / It comes with clear instructions and guidance, even for those without technical knowledge / I can purchase it online / I can rent it out in local institutions / I feel empowered to make changes without needing external help / It's a fast and convenient solution for improving home comfort / There is an option to have someone install the kit for me (e.g., by a volunteer or paid additional service) / I would not be interested / Other (specify)
Additional comments (optional).	Free text
Contact information for follow-up interviews.	Name, Email, Phone

Appendix I: Unit Economics DIY Energy Assessment Kit

Expense Category	Item	Unit Cost (€)	Units Per Kit (#)	Total Cost (€)	Sourcing
Kit Equipment					
	Thermometer	13,99	1	13,99	Equation
	Hygrometer	6,59	1	6,59	Equation
	Energy Meter	13,99	2	27,98	Lexman
	Flow Gauge	15,99	1	15,99	Ekogest
	Infrared Thermometer	41,99	1	41,99	Cindar
	Transport Case	25,00	1	25,00	Leroy Merlin
Handbook & Promotional Materials					
	Printing Pages	0,50	17	8,50	In-House
	Promotional Material	18,30	1	18,30	Copimat
Additional Costs					
	Transportation and Distribution	18,99	1	18,99	CTT
	Kit Assembly	20,45	1	23,75	Klog
	Buffer (15%)	23,30	1	26,60	
TOTAL COST PER UNIT				**227,68**	

Appendix J: Cost Structure

BUSINESS EXPENSE	START-UP COST	MONTHLY COST
LEGAL & ADMIN		
Business Registration	500,00 €	0,00 €
Trade Name Registration	150,00 €	0,00 €
Legal Consultations	1.000,00 €	50,00 €
Accounting & Financial Services	1.000,00 €	80,00 €
TOTAL LEGAL & ADMIN	2.650,00 €	130,00 €
MARKETING/BRANDING		
Brand & Logo	10,00 €	80,00 €
Partnerships Development	300,00 €	4,00 €
Marketing Materials	1.000,00 €	80,00 €
Social Media Campaigns	800,00 €	50,00 €
TOTAL MARKETING/PROMO	2.110,00 €	214,00 €
TECH & INFRASTRUCTURE		
Digital Plaform Development	4.250,00 €	
Software Subscriptions	400,00 €	
Platform Maintenance		300,00 €
TOTAL TECH & INFRASTRUCTURE	4.650,00 €	300,00 €
PRODUCT		
Initial Inventory (15 Kits)	3.417,57€	
New Kits per Month (15 kits p/ month)		3.417,57€
TOTAL INVENTORY	3.417,57€	3.417,57€
OTHER		
Contigency Buffer (15%)	1.760,84 €	401,60 €
Misc.	2.000,00 €	
TOTAL EXPENSES – OPERATIONAL	**37.156,29 €**	**8.433,60 €**

Appendix K: Breakeven Analysis

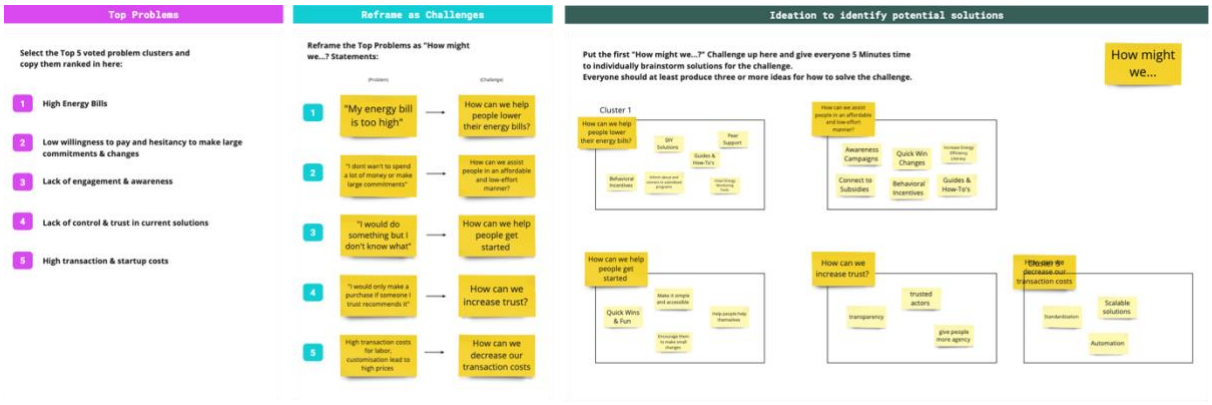
(Option A)

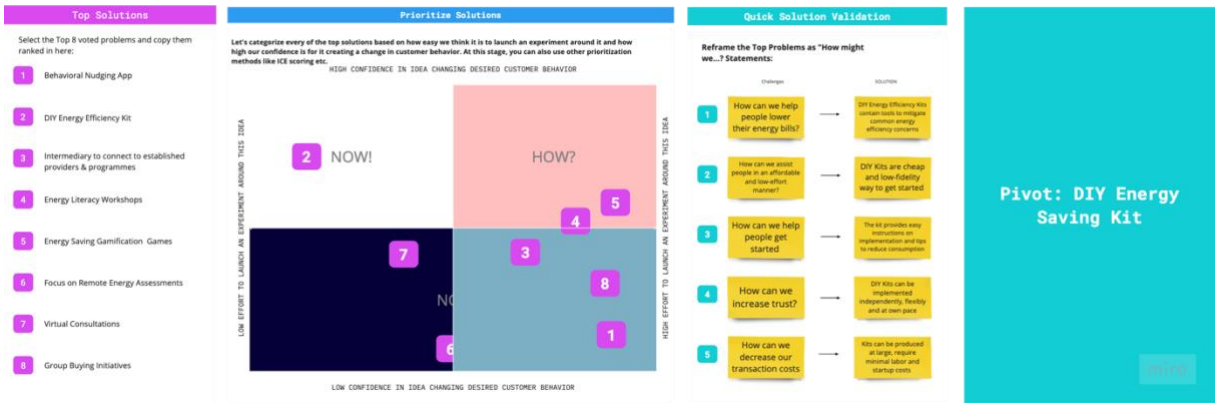
Breakeven Analysis	Scenario 1	Scenario 2	Scenario 3
CONTRIBUTION MARGIN (in %)	20%	40%	60%
CONTRIBUTION MARGIN (in €)	45,54	91,07	136,61
Final Price (in €	275,00	320,00	365,00
Total Margin (in €)	47,32	92,32	137,32
Average Montlhy Revenue	4125,00	4800,00	5475,12
Breakeven (in months)	**4,19**	**3,60**	**3,15**

(Option B)

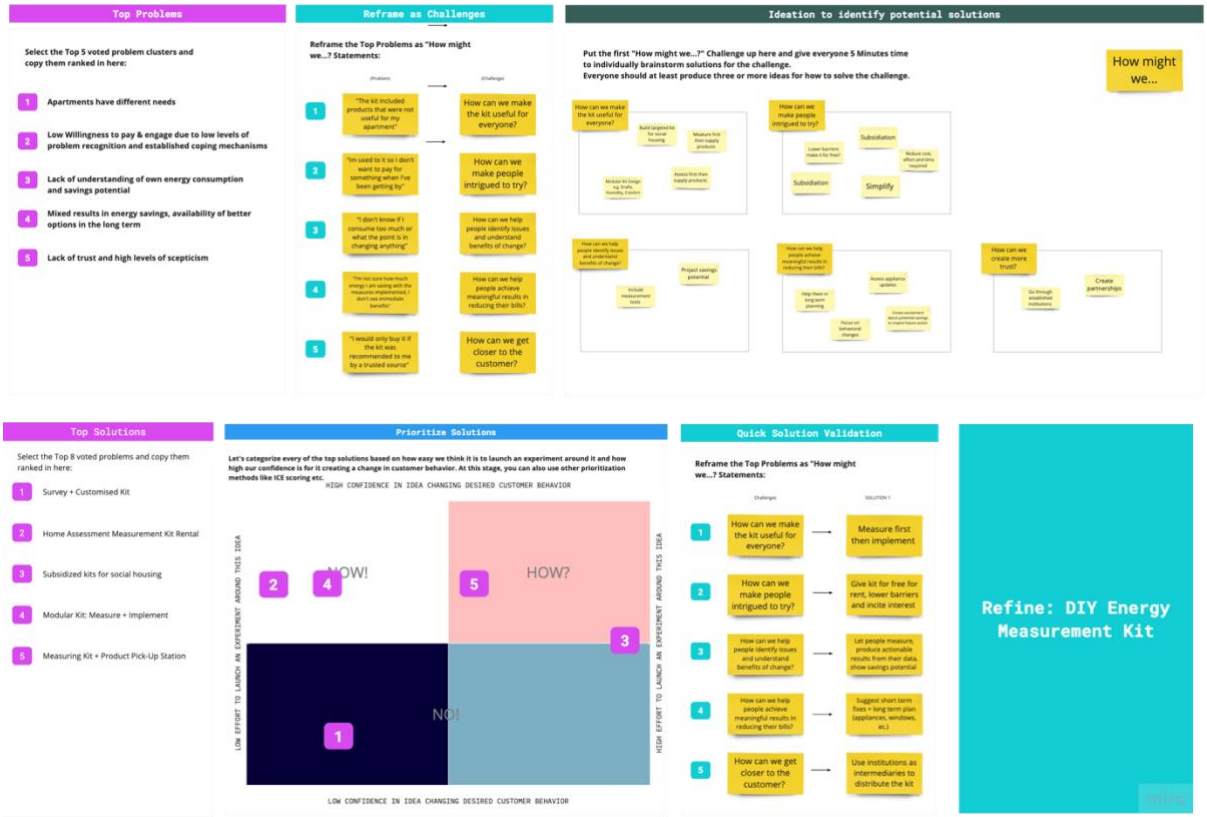
Breakeven Analysis	
Subscription Fee	35€
Kits Sold	30
Average Monthly Revenue (1 year)	6825€
Annual Revenue	81.900€
Breakeven (in months)	**6,74**

Appendix L: Solution Ideation Workshop After Cycle 1





Appendix M: Solution Ideation Workshop After Cycle 2



Appendix N: **Pilot Test Instructions**

Pilot Test Instructions (Read First)

Hello! Thank you for agreeing to test our prototype energy efficiency kit! Your feedback is incredibly valuable to us, and we're excited to hear your thoughts. The goal of this test is to evaluate how well the kit works in your apartment and to gather feedback on its usability and effectiveness. Below you can find the instructions. Please go through the tasks and let us know if you encounter any issues. Feel free to share your thoughts throughout the process, and remember, there's no right or wrong way to use the product – we want your honest experience!

Once you're done, please get in touch with us for a brief follow-up about your experience. We appreciate your time and input!

Instructions:

In the kit you will find various tools and materials that will allow you to implement energy-saving measures in your home. Your task involves installing these measures, following the provided handbook.

Your Tasks:

- Unpack the kit and review its contents
- Install each item using the handbook, following the step-by-step instructions to ensure proper setup of each component.
- Attempt to complete the installation independently, without external assistance, to help us assess the clarity and usability of the handbook.
- Note any challenges and thoughts during installation, documenting any unclear steps or difficult-to-execute instructions to help improve the user experience.
- You can use the checklist below to document your experience

To monitor the usability we kindly ask you to implement the measures following the steps in the following check-list. The process covers three main areas:

1. Energy Consumption
2. Water Use
3. Humidity & Temperature

After completing each category we ask you to document your work & give honest feedback regarding time consumption & complexity of the implementation process.

1

1. Energy Consumption

In this section you will implement the following measures:

1. LED Light Bulbs
2. Energy Meter
3. Mechanical Timer
4. Pipe Insulation

1.1 LED Light Bulbs

How many LED Light Bulbs did you implement?

☐ 3 ☐ 2 ☐ 1 ☐ None

How easy was the implementation?

☐ Very Easy ☐ Easy ☐ Complex ☐ Very Complex

Time required: _____

Is there anything you would like to share about the process?

1.2. Energy Meter

Did you use the Energy Meter?

☐ Yes ☐ No

How easy was the application?

☐ Very Easy ☐ Easy ☐ Complex ☐ Very Complex

Is there anything you would like to share about the process?

1.3 Mechanical Timer

Did you implement both mechanical timers?

☐ Yes ☐ Only One ☐ None

How easy was the implementation?

☐ Very Easy ☐ Easy ☐ Complex ☐ Very Complex

Time required: _____

Is there anything you would like to share about the process?

2

1.4 Pipe Insulation

Did you implement the Pipe Insulation?

☐ Yes ☐ No

How easy was the installation?

☐ Very Easy ☐ Easy ☐ Complex ☐ Very Complex

Time required: _____

Is there anything you would like to share about the process?

2. Water Use

In this section you will implement the following measures:

1. Low-Flow Shower Head
2. Faucet Eco Aerator

2.1 Low-Flow Shower Head

Did you implement the Low-Flow Shower Head?

☐ Yes ☐ No

How easy was the implementation?

☐ Very Easy ☐ Easy ☐ Complex ☐ Very Complex

Time required: _____

Is there anything you would like to share about the process?

2.2 Faucet Eco Aerator

Did you implement the Faucet Eco Aerator?

☐ Yes ☐ No

How easy was the installation?

☐ Very Easy ☐ Easy ☐ Complex ☐ Very Complex

Time required: _____

Is there anything you would like to share about the process?

3

3. Humidity & Temperature

Almost done! In this section you will implement the following measures:

1. Moisture Absorber
2. Anti-mold kit
3. Draft stopper for doors
4. Window Sealing
5. Insulating film for windows

3.1 Moisture Absorber

Did you implement the Moisture Absorber?

☐ Yes ☐ No

How easy was the implementation?

☐ Very Easy ☐ Easy ☐ Complex ☐ Very Complex

Time required: _____

Is there anything you would like to share about the process?

3.2 Anti-mold kit

Did you use the anti-mold kit?

☐ Yes ☐ No

How easy was the application?

☐ Very Easy ☐ Easy ☐ Complex ☐ Very Complex

Time required: _____

Is there anything you would like to share about the process?

4

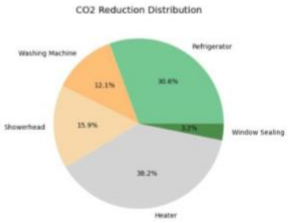
Appendix O: **EcoSeal Energy Efficiency Report**

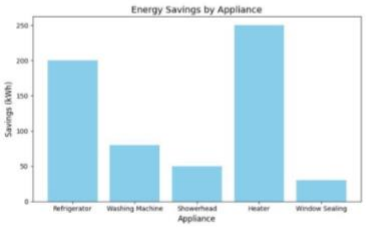
EcoSeal Energy Efficiency Report

Actionable Insights for Sustainable Living

ECOSEAL

The EcoSeal Energy Efficiency Report provides a comprehensive analysis of your household's energy consumption patterns and offers tailored recommendations to reduce energy use, save costs, and minimize environmental impact. By utilizing the data collected through the EcoSeal Measurement Kit, this report highlights potential areas for improvement and suggests actionable steps to achieve greater sustainability.



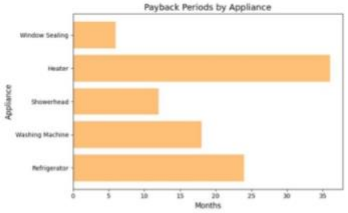


Recommendations

Based on the data collected, we recommend the following measures:

- Appliance Upgrades: Replace older appliances, such as your refrigerator or washing machine, with energy-efficient models. This can save up to €56 annually and has an average payback period of 18-24 months.
- Water Efficiency: Install a water-saving showerhead to reduce water consumption by up to 30%, saving approximately €20 annually while conserving resources.
- Behavioral Changes: Adopt simple practices like targeted ventilation and reducing standby energy use by unplugging devices when not in use.

Appliance	Savings (kWh)	CO2 Reduction (kg)	Cost Savings (€)	Payback Period (Months)
Refrigerator	200	96	40	24
Washing Machine	80	38	16	18
Showerhead	50	50	20	12
Heater	250	120	50	36
Window Sealing	30	10	15	6



Water Usage Savings Analysis

The water usage savings chart highlights the reductions achieved by upgrading appliances such as showerheads, dishwashers, and washing machines. By replacing inefficient appliances, you can save up to 30% of your annual water consumption. For instance, switching to a water-saving showerhead can reduce usage from 12,000 liters/year to 8,400 liters/year, conserving resources and lowering costs.

Payback Period Overview

The chart on Page 3 outlines the payback periods for recommended upgrades, helping you prioritize changes based on affordability and impact. For instance, sealing windows can pay for itself within 6 months, while replacing an old heater offers substantial savings over time despite a longer payback period.

Next Steps

Implementing these recommendations will not only reduce your energy costs but also contribute to a more sustainable lifestyle. We encourage you to explore additional energy-saving products through EcoSeal's website for further guidance and support. A sample action plan with product suggestions and savings estimates is included in the Appendix for reference.

Appendix P: Case Study Home Energy Plan

NOVA SCHOOL OF SCIENCE & TECHNOLOGY

Energy and Climate Change

Professor Júlia Seixas
Professor Joanaz de Melo

Effort: 60 hours

Home Energy Plan

by João Afonso Mendes, Integrated Master in Micro and Nanotechnology Engineering
(student ID: 50770)

UNIVERSIDADE NOVA DE LISBOA

2021

Energy By Use

Category	Equipment	Source	Cons. (kWh/year)	Cons. (GJ/year)	Cons. (%)	Method for Computation
Lighting	Lamps	Electricity	417,16	1,502	7,50	Assumption
Cooking	Oven	Electricity	322,70	1,162	5,80	Energy Monitor
	Stove	Electricity	438,40	1,578	7,88	Tech. Note
	Microwave	Electricity	10,95	0,039	0,20	Tech. Note
	Coffee Machine	Electricity	10,40	0,037	0,19	Energy Monitor
	Toaster	Electricity	1,56	0,006	0,03	Tech. Note
	Sandwich Maker	Electricity	4,90	0,018	0,09	Tech. Note
	Blender	Electricity	7,80	0,028	0,03	Tech. Note
Cold Storage	Refrigerator #1	Electricity	321,60	1,158	5,78	Energy Monitor
	Refrigerator #2	Electricity	771,20	2,776	13,86	Energy Monitor
Hot Water	Water Boiler	Natural Gas	4018,33	14,466	100,00	Gas Invoice

2021

Category	Equipment	Source	Cons. (kWh/year)	Cons. (GJ/year)	Cons. (%)	Method for Computation
Climatization	Fireplace	Firewood	123,00	0,443	100,00	Assumption
	Oil Heater #1 (x2)	Electricity	486,00	1,750	8,74	Tech. Note
	Oil Heater #2	Electricity	243,00	0,875	4,39	Tech. Note
House Keeping	Washing Machine	Electricity	625,90	2,253	11,25	Energy Monitor
	Dishwasher	Electricity	425,10	1,530	7,64	Energy Monitor
	Vacuum Cleaner	Electricity	23,40	0,084	0,42	Tech. Note
	Iron	Electricity	200,85	0,723	3,61	Tech. Note
	Hair Drier	Electricity	17,52	0,063	0,31	Energy Monitor
Audiovisual	Main TV + Extras	Electricity	418,50	1,507	7,52	Energy Monitor
	PC #1	Electricity	161,10	0,580	2,90	Energy Monitor
	PC #2	Electricity	621,23	2,24	11,17	Energy Monitor
Total		**Electricity**	**5562,47**	**20,025**	**100**	
		Natural Gas	**4018,33**	**14,466**	**100**	
		Firewood	**123,00**	**0,443**	**100**	

Energy Balance and Indicators

Source	Acquisition					Identified Uses	Unidentified Uses	
	Quantity (orig. units)	Quantity (GJ/year)	Cost (€/year)	Per Capita (GJ/year/person)	Per Useful Area (MJ/year/m²)	Quantity (GJ/year)	Quantity (GJ/year)	%
Electricity	6231 kWh/yr	22,43	1107,77	4,49	208,26	20,03	2,4	10,70
Natural Gas	353 m³/yr	14,47	254,62	2,89	134,35	14,47	0	0
Firewood	30 kg/yr	0,44	15	0,09	4,09	0,44	0	0
Total	**-**	**37,34**	**1377,39**	**7,47**	**346,7**	**34,94**	**2,4**	**6,43**

House Classification (REH)

Indicators expressed as (fossil) primary energy				Total
kWh PE/m²/year	Winter Warming	Summer Cooling	Hot Water	
My Home	Nic	Nvc	Nac	**Ntc**
	25,93	5,88	26,28	**104,33**
Reference	Ni	Nv	Na	**Nt**
	33,74	11,89	26,28	**131,63**

Certificação Energética e Ar Interior EDIFÍCIOS

$$R_{NT} = \frac{Ntc}{Nt} = \frac{104,33}{131,64} \cong 0,79$$

Energy Class "B –"

Corresponds to the energy classification of new buildings that fulfill the **minimum energy regulation requirements**.

The house is well oriented and has good window-wall ratio, except for the Eastern facade wall. It is relatively well insolated for summer cooling and less so for winter warming.

2021

Savings Potential

As seen on "Energy By Use"

Equipment	Source	Cons. (kWh/year)	Cons. (GJ/year)	Cons. (%)
Refrigerator #2	Electricity	771,20	2,776	13,86
Washing Machine	Electricity	625,90	2,253	11,25
PC #2	Electricity	621,23	2,240	11,17
Dishwasher	Electricity	425,10	1,530	7,64
Total	**Electricity**	**2443,33**	**8,799**	**43,92**

More Efficient Equipments:

Kitchen Renovations (expected to happen in 1 to 2 years):

- **Refrigerator #2** (underground storage room) has double the consumption of the fridge in the kitchen → *BECKEN BDD5394 WH 246L (222 kWh/year, A++ energy efficiency)*
- **Washing Machine** is over 20 years old → *CANDY CSS 1610TWMCE/1-S (143 kWh/year, A+++ energy efficiency)*
- **Dishwasher** is also over 20 years old → *CDPN 4D620PW/E (140 kWh/year, C energy efficiency)*

PC #2 is a custom built "tower" which has not been upgraded in 10 years → *can become more efficient (consumption of 350 kWh/year or less) or be substituted.*

2021

Savings Potential Table

Type of Measure	Measure	Savings Potential			Investment (€)	Payback Time (years)	Comfort Change	Practical Difficulty
		Energy (GJ/year)	GHG ($kgCO_2eq$/year)	Cost (€/year)				
More Efficient Equipments	Replacing Fridge #2	1,98	107,64	97,76	350	3 years, 7 months		
	Replacing Washing Machine	1,74	94,65	85,97	450	5 years, 3 months		
	Overhauling PC #2	0,98	53,16	48,28	1200	25 years		
	Replacing Dishwasher	1,03	55,88	50,75	400	8 years		
Subtotal	-	**5,73**	**311,33**	**282,76**	**2400**	**8 years, 6 months**	-	-

Savings Potential Table

Type of Measure	Measure	Savings Potential			Investment (€)	Payback Time (years)	Comfort Change	Practical Difficulty
		Energy (GJ/year)	GHG ($kgCO_2eq$/year)	Cost (€/year)				
Alternative Sources	Installation of Solar Panels	22,43	1223,43	200	2400	12 years		
Better Practices	Implementing Current-cutters	0,44	21,87	54,67	20	5 months		
	Defrosting refrigerator #2	0,28	15,11	13,73	0	0		
	Sealing Air Leaks	0,13	7,14	6,49	5	10 months		
	Taking Cooler Showers	0,72	25,92	12,73	0	0		
Total	-	**29,73**	**1604,80**	**570,38**	**4825**	**8 years, 6 months**	-	-

Measures for Implementation

Type of Measure	Measure	Savings Potential			Investment (€)	Payback Time (years)	Comfort Change	Practical Difficulty
		Energy (GJ/year)	GHG ($kgCO_2eq$/year)	Cost (€/year)				
Alternative Sources	Installation of Solar Panels	22,43	1223,43	200	2400	12 years		
Better Practices	Implementing Current-cutters	0,44	21,87	54,67	20	5 months		
	Defrosting refrigerator #2	0,28	15,11	13,73	0	0		
	Sealing Air Leaks	0,13	7,14	6,49	5	10 months		
	Taking Cooler Showers	0,72	25,92	12,73	0	0		
Total	-	**24,00**	**1293,47**	**287,62**	**2425**	**8 years, 5 months**	-	-

Savings Potential - Synthesis

	Savings Potential						Investment	Payback Time
	Energy		GHG		Cost			
	GJ/year	% BL	$kgCO_2eq$/year	% BL	€/year	% BL	€	years
Total Identified Potential	29,73	79,62	1604,80	88,28	570,38	43,10	4850	8 years, 6 months
Selected Measures	**24,00**	**64,27**	**1293,47**	**71,15**	**287,62**	**21,73**	**2425**	**8 years 5 months**

References

3C-REN. n.d. “Do-It-Yourself (DIY) Home Energy Savings.” *3C-REN* (blog). Accessed December 17, 2024. https://www.3c-ren.org/diy-savings/.

Abrardi, Laura. 2019. “Behavioral Barriers and the Energy Efficiency Gap: A Survey of the Literature.” *Journal of Industrial and Business Economics* 46 (1): 25–43. https://doi.org/10.1007/s40812-018-0107-z.

ADENE. 2023. “Certificação Energética dos Edifícios.” Sistema de Certificação Energética dos Edifícios. 2023. https://www.sce.pt/.

“Appliances & Equipment.” n.d. IEA. Accessed December 17, 2024. https://www.iea.org/energy-system/buildings/appliances-and-equipment.

Azizi, Shoaib, Gireesh Nair, and Thomas Olofsson. 2020. “Adoption of Energy Efficiency Measures in Renovation of Single-Family Houses: A Comparative Approach.” *Energies* 13 (22): 6042. https://doi.org/10.3390/en13226042.

Banse, Stefan. 2024. “Smart-Rechner.” smart-rechner.de. November 29, 2024. https://www.smart-rechner.de/lumen_watt_umr/infothek/gluehbirne_led.php.

Bird, C., and J. Barnes. 2014. “Scaling up Community Activism: The Role of Intermediaries in Collective Approaches to Community Energy.” *People, Place and Policy Online* 8 (3). https://ora.ox.ac.uk/objects/uuid:446957f8-b0b8-4525-84d4-0e83094d5029.

Bland, David J., and Alexander Osterwalder. 2019. *Testing Business Ideas: A Field Guide for Rapid Experimentation*. 1st edition. Wiley.

Cagno, Enrico, Davide Moschetta, and Andrea Trianni. 2019. “Only Non-Energy Benefits from the Adoption of Energy Efficiency Measures? A Novel Framework.” *Journal of Cleaner Production* 212 (March):1319–33. https://doi.org/10.1016/j.jclepro.2018.12.049.

Castagnola, Lauren, and Robert Yawson. 2021. “Corporate – Nonprofits Partnerships to Improve Social Innovation and Corporate Social Responsibility.” https://doi.org/10.31124/advance.14680938.

Cattaneo, Cristina. 2019. “Internal and External Barriers to Energy Efficiency: Which Role for Policy Interventions?” *Energy Efficiency* 12 (5): 1293–1311. https://doi.org/10.1007/s12053-019-09775-1.

Cespedes, Frank, Thomas R. Eisenmann, and Steven Blank. 2012. “Customer Discovery and Validation for Entrepreneurs.” SSRN Scholarly Paper. Rochester, NY: Social Science Research Network. https://papers.ssrn.com/abstract=2053355.

Chen, Wei, Majed Alharthi, Jinjun Zhang, and Irfan Khan. 2024. “The Need for Energy Efficiency and Economic Prosperity in a Sustainable Environment.” *Gondwana Research* 127 (March):22–35. https://doi.org/10.1016/j.gr.2023.03.025.

Codema. n.d. “Home Energy Saving Kit.” *Codema* (blog). Accessed December 17, 2024. https://www.codema.ie/our-work/home-energy-saving-kit/.

Das, Runa, Russell Richman, and Craig Brown. 2018. “Demographic Determinants of Canada’s Households’ Adoption of Energy Efficiency Measures: Observations from the Households and Environment Survey, 2013.” *Energy Efficiency* 11 (2): 465–82. https://doi.org/10.1007/s12053-017-9578-4.

Deci, Edward L., and Richard M. Ryan. 1987. “The Support of Autonomy and the Control of Behavior.” *Journal of Personality and Social Psychology* 53 (6): 1024–37. https://doi.org/10.1037/0022-3514.53.6.1024.

“Design Kit: The Human-Centered Design Toolkit.” n.d. Accessed December 17, 2024. https://www.ideo.com/journal/design-kit-the-human-centered-design-toolkit.

DIRECTIVE (EU) 2018/844 on the Energy Performance of Buildings. 2018. *OJ L*. Vol. 156. http://data.europa.eu/eli/dir/2018/844/oj/eng.

Directive (EU) 2023/1791 on Energy Efficiency. 2024. https://eur-lex.europa.eu/EN/legal-content/summary/energy-efficiency-from-2025.html.

“Do-It-Yourself Home Energy Audit Kit Program | The Town of Okotoks.” n.d. Accessed December 17, 2024. https://www.okotoks.ca/your-community/green-living/green-living-programs-tools/do-it-yourself-home-energy-audit-kit.

Dumas, Joseph F., and Janice C. Redish. 1993. *A Practical Guide to Usability Testing*. USA: Greenwood Publishing Group Inc.

Eisenmann, Thomas, Eric Ries, and Sarah Dillard. 2011. “Hypothesis-Driven Entrepreneurship: The Lean Startup.” 812–095. Harvard Business School. https://www.hbs.edu/faculty/Pages/item.aspx?num=41302.

European Environment Agency. 2024. “Greenhouse Gas Emission Intensity of Electricity Generation in Europe.” October 31, 2024. https://www.eea.europa.eu/en/analysis/indicators/greenhouse-gas-emission-intensity-of-1.

Feitosa, Lucas, and Rafael Mesquita. 2023. “Access, Technology, and Transition: Mapping the Themes of the Debate on Energy at the United Nations General Assembly (2000-2020).” *Brazilian Political Science Review* 17 (October):e0002. https://doi.org/10.1590/1981-3821202300030002.

Feor, Leah, Amelia Clarke, and Ilona Dougherty. 2023. “Social Impact Measurement: A Systematic Literature Review and Future Research Directions.” *World* 4 (4): 816–37. https://doi.org/10.3390/world4040051.

Göcke, Lutz, and Robin Weninger. 2021. “Business Model Development and Validation in Digital Entrepreneurship.” In *Digital Entrepreneurship*, edited by Mariusz Soltanifar, Mathew Hughes, and Lutz Göcke, 71–85. Future of Business and Finance. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-53914-6_4.

Gouveia, João Pedro, Miguel Mendes, Miguel Macias Sequeira, and Pedro Palma. 2024. "A New Way to Mitigate Energy Poverty: Lessons from the Transition Point 'One-Stop Shop' Pilot." Fundação Calouste Gulbenkian. https://gulbenkian.pt/wp-content/uploads/2024/06/FCG-Ponto-de-Transicao-%E2%80%94-Relatorio-de-Impacto-EN-Digital.pdf.

Gouveia, João Pedro, Júlia Seixas, Pedro Palma, Henrique Duarte, Henrique Luz, and Giovan Battista Cavadini. 2021. "Positive Energy District: A Model for Historic Districts to Address Energy Poverty." *Frontiers in Sustainable Cities* 3 (April). https://doi.org/10.3389/frsc.2021.648473.

Gregório, Vera, and Júlia Seixas. 2017. "Energy Savings Potential in Urban Rehabilitation: A Spatial-Based Methodology Applied to Historic Centres." *Energy and Buildings* 152 (October):11–23. https://doi.org/10.1016/j.enbuild.2017.06.024.

Harvard Business School. 2021. "Customer Discovery Basics." Harvard Business School and BullsEye Resources. https://entrepreneurship.hbs.edu/Documents/Session%20Summary/HBSRock-Customer-Discovery-Final.pdf#:~:text=Customer%20discovery%20involves%20defining%20and%20prioritizing%20personas%20and,markets.%20Discovery%20should%20encompass%20the%20entire%20customer%20journey.

Hesselink, Laurens X.W., and Emile J.L. Chappin. 2019. "Adoption of Energy Efficient Technologies by Households – Barriers, Policies and Agent-Based Modelling Studies." *Renewable and Sustainable Energy Reviews* 99 (January):29–41. https://doi.org/10.1016/j.rser.2018.09.031.

"HomeBoost | DIY Home Energy Assessment." n.d.-a. HomeBoost. Accessed December 17, 2024. https://www.homeboost.com/.

"———." n.d.-b. HomeBoost. Accessed December 17, 2024. https://www.homeboost.com/.

Horta, Ana, João Pedro Gouveia, Luísa Schmidt, João Carlos Sousa, Pedro Palma, and Sofia Simões. 2019. "Energy Poverty in Portugal: Combining Vulnerability Mapping with Household Interviews." *Energy and Buildings* 203 (November):109423. https://doi.org/10.1016/j.enbuild.2019.109423.

Horta, Ana, and Luísa Schmidt. 2024. "Chapter 18 - Energy Poverty: Overview and Illustrative Case." In *Environmental Health Behavior*, edited by Osvaldo Santos, Ricardo R. Santos, and Ana Virgolino, 247–57. Academic Press. https://doi.org/10.1016/B978-0-12-824000-7.00002-7.

"Índice de envelhecimento e outros indicadores de envelhecimento." 2023. PORDATA. 2023. https://www.pordata.pt/pt/estatisticas/populacao/populacao-residente/indice-de-envelhecimento-e-outros-indicadores-de.

Iskin, Ibrahim, and Tugrul Daim. 2012. "Review of Energy Efficiency Adoption Literature from a Demand Side Management Perspective: Taxonomy of Research Approaches." In *Global Sustainable Development and Renewable Energy Systems*, 54–78. IGI Global Scientific Publishing. https://doi.org/10.4018/978-1-4666-1625-7.ch004.

Juntunen, Jouni K., and Mari Martiskainen. 2021. “Improving Understanding of Energy Autonomy: A Systematic Review.” *Renewable and Sustainable Energy Reviews* 141 (May):110797. https://doi.org/10.1016/j.rser.2021.110797.

Klöckner, Christian A., and Alim Nayum. 2016. “Specific Barriers and Drivers in Different Stages of Decision-Making about Energy Efficiency Upgrades in Private Homes.” *Frontiers in Psychology* 7 (September). https://doi.org/10.3389/fpsyg.2016.01362.

Legault, Lisa, and Michael Inzlicht. 2013. “Self-Determination, Self-Regulation, and the Brain: Autonomy Improves Performance by Enhancing Neuroaffective Responsiveness to Self-Regulation Failure.” *Journal of Personality and Social Psychology* 105 (1): 123–38. https://doi.org/10.1037/a0030426.

“Leroy Merlin.” 2024. December 17, 2024. https://www.leroymerlin.pt/.

Norman, Donald A. 2002. *The Design of Everyday Things*. Reprint edition. New York: Basic Books.

Norman, Stephen. 1986. *User Centered System Design*. CRC Press.

Østergaard, Poul Alberg, Isabel Soares, and Paula Ferreira. 2014. “Energy Efficiency and Renewable Energy Systems in Portugal and Brazil.” *International Journal of Sustainable Energy Planning and Management*, June, 1-6 Pages. https://doi.org/10.5278/IJSEPM.2014.2.1.

“Portugal: Share of Homeowners 2008-2022.” 2024. Statista. 2024. https://www.statista.com/statistics/543428/house-owners-among-population-portugal/.

PricewaterhouseCoopers. 2007. “Guide to Key Performance Indicators: Communicating the Measures That Matter.” https://www.pwc.com/gx/en/audit-services/corporate-reporting/assets/pdfs/uk_kpi_guide.pdf.

Resolução Do Conselho de Ministros n.º 11/2024, de 8 de Janeiro. 2024. https://diariodarepublica.pt/dr/detalhe/resolucao-conselho-ministros/11-2024-836222486.

Ries, Eric. 2011. *The Lean Startup*. Crown Business.

Rotzek, Jan Niklas, Christoph Scope, and Edeltraud Günther. 2018. “What Energy Management Practice Can Learn from Research on Energy Culture?” *Sustainability Accounting, Management and Policy Journal* 9 (4): 515–51. https://doi.org/10.1108/SAMPJ-07-2017-0067.

Sabino, C. 2015. “Decreasing the Residential Energy Consumption in the Portuguese Residential Sector: Potential of Energy Saving Behaviours.” In , edited by A. G. Martins, 785–96. Istanbul, Turkey. https://doi.org/10.2495/SDP150661.

Schwartz, Emily K., and Moncef Krarti. 2022. “Review of Adoption Status of Sustainable Energy Technologies in the US Residential Building Sector.” *Energies* 15 (6): 2027. https://doi.org/10.3390/en15062027.

Sequeira, Miguel Macias, João Pedro Gouveia, and João Joanaz de Melo. 2024. "(Dis)Comfortably Numb in Energy Transitions: Gauging Residential Hard-to-Reach Energy Users in the European Union." *Energy Research & Social Science* 115 (September):103612. https://doi.org/10.1016/j.erss.2024.103612.

Shaukat, N., S.M. Ali, C.A. Mehmood, B. Khan, M. Jawad, U. Farid, Z. Ullah, S.M. Anwar, and M. Majid. 2018. "A Survey on Consumers Empowerment, Communication Technologies, and Renewable Generation Penetration within Smart Grid." *Renewable and Sustainable Energy Reviews* 81 (January):1453–75. https://doi.org/10.1016/j.rser.2017.05.208.

Webb, Dave, Geoffrey N. Soutar, Tim Mazzarol, and Patricia Saldaris. 2013. "Self-Determination Theory and Consumer Behavioural Change: Evidence from a Household Energy-Saving Behaviour Study." *Journal of Environmental Psychology* 35 (September):59–66. https://doi.org/10.1016/j.jenvp.2013.04.003.

Xi, Nannan, and Juho Hamari. 2020. "Does Gamification Affect Brand Engagement and Equity? A Study in Online Brand Communities." *Journal of Business Research* 109 (March):449–60. https://doi.org/10.1016/j.jbusres.2019.11.058.