Watt Are You Doing

Final Report

Bruno Oliveira - up202208700
Filipe Correia - up202206776
Pedro Oliveira - up202206498
Rodrigo Silva - up202205188

U.PORTO

Bachelor's in Informatics and Computing Engineering
Human Computer Interaction

Professor: Thiago Sobral Silva

January 2025

Contents

1 Introduction

This report focuses on documenting the entire process of the Human Computer Interaction (HCI) project, developed throughout this semester. This document highlights the third part of the project, however, since this is the last delivery, it also contains the reports for the other two previous parts.

For this project, we have prototyped an energy audit web application called Watt Are You Doing, that allows users to monitor and control the energy consumption and production of home appliances.

The first part of the project focused on user and task analysis. For this, we started by discussing the idea for the application, doing some research on related apps, and creating a questionnaire that we distributed to the general public to get a feeling about the user's perspective on this topic. From there, we performed a PACT analysis on the data collected, developed personas and activity scenarios, and selected the requirements and most important functionalities for our application. All of this is documented in Part I - User and Task Analysis.

The next part consisted of developing the lo-fi prototype and doing heuristic evaluations on it. For this, we started by defining 3 tasks and the respective usability requirements for the final prototype of our application, based on the results from the previous phase, and then creating wireflows for each of the tasks. After that, we performed heuristic evaluations on them, with the help of other students and users, to understand what was working well and what needed to be improved for the next phase of the project. A more detailed overview of this phase can be seen in Part II - Lo-fi Prototype and Heuristic Evaluation.

Finally, the last part consisted of developing the hi-fi prototype and conducting user evaluations. As we had already received suggestions for improving the wireframes previously developed, our first step was to develop the final high-fidelity prototype and wireflows for the 3 tasks defined in the second phase. After doing that, we configured the tools needed and created the user evaluation protocol that was then distributed to different people. Finally, we analyzed the results of the user feedback to evaluate the final product of this project. The documentation for this part is in the Part III - Hi-fi Prototype and User Evaluation.

2 Part I - User and Task Analysis

2.1 Project Idea

For the project idea, the main restriction we were given was that the system must be centered around energy, such as an application for monitoring energy consumption or controlling electric devices.

Based on this information, we decided that we will be creating a **home energy audit app**. This idea arose from the fact that many people do not know about the power consumption in their homes, so our solution aims to provide more information to the user about the energy spent by each device. To help reduce the electricity bill, the platform will also be able to give tips and perform actions, like suggesting better hours to recharge devices or configuring smart appliances directly. Below, we present a description that better summarizes the idea behind our project:

"All-in-one web platform for energy profiling of all devices in a household. The solution will display graphically real-time data and records of the energy spent by each appliance. It will also be able to pinpoint the least energy-efficient devices and, if applicable, provide suggestions, to reduce their power consumption/cost. The users will also be able to monitor application energy consumption on smart devices, in order to improve battery life. Users will be able to register different devices, either smart devices with monitoring software or other electronics through the use of sensors. Users will also be able to filter/sort their devices by tag and power consumption."

2.2 Related Apps

During our research phase, we explored several platforms and apps that address parts of the functionalities we aim to provide. While these solutions demonstrate valuable features, they also present significant limitations, such as usability challenges or the inability to cover the full scope of our envisioned capabilities. Below is a detailed summary of the platforms and apps we identified:

- **EDP RE:DY** - This app, developed by the energy provider EDP, is primarily focused on empowering users to track their household energy consumption and associated expenses. It offers real-time monitoring and enables remote control of compatible devices, such as smart plugs or thermostats. However, the app's interface has been critiqued for being unintuitive, and its features are heavily tied to EDP services, limiting its appeal to a broader audience [3].

- **Brightly** - Aimed at professional and industrial environments, Brightly provides a comprehensive energy management software suite. Its key features include tracking energy waste across multiple locations and generating insights to optimize efficiency. While Brightly excels in providing advanced analytics for large-scale operations, it lacks the user-centric design and accessibility necessary for everyday household use, making it unsuitable for individual consumers seeking simple energy solutions [6].

- **Hark** - The Hark Connect software, a flagship product of the Hark platform, enables users to monitor industrial devices and assets. It focuses on tracking energy consumption in complex systems such as factories or data centers. Hark is well-regarded for its robust integration with IoT devices and its ability to process large datasets. However, its primary application lies in industrial settings, and it does not address smaller-scale use cases or individual user needs [7].

- **SMA Energy** - Designed for users with solar energy systems, the SMA Energy app allows individuals to monitor their solar panel energy production, manage storage systems, and optimize energy usage. It also supports some smart home functionalities, such as scheduling appliances to run during periods of peak solar production. While this app is highly specialized and efficient for solar energy users, its utility is limited to those with SMA hardware, excluding households without solar installations or alternative energy sources [1].

- **Freedompro** - Freedompro provides a range of products that integrate with existing smart home ecosystems, enabling users to manage and

monitor their devices' energy consumption. Its offerings include smart switches and controllers that allow for detailed usage data and remote control. Despite its versatility, Freedompro's setup can be complex for non-technical users, and its platform lacks advanced analytics for deeper energy insights [4].

- **Google Home** - As a well-known smart home platform, Google Home allows users to control and manage a variety of connected devices remotely. Its voice integration with Google Assistant makes it user-friendly and accessible, supporting features like lighting control, thermostat adjustments, and even energy monitoring through compatible devices. However, Google Home is not specifically designed for energy management, and its functionalities depend on third-party integrations, which may not provide the level of detail or customization that dedicated energy solutions offer [5].

While all these platforms showcase interesting features, they fail to address the full range of functionalities we envision.

2.2.1 Our application

Our web platform should implement the best features from these apps by allowing users to monitor their energy consumption, like with EDP RE:DY and Hark, but with a focus on a domestic environment and differentiation between devices like in Freedompro. An integration with solar panels is also logical similar to the one found in SMA Energy. The service should also be accessible from anywhere like with Google Home. Finally, a system of recommendations regarding each device's consumption should also be implemented.

2.3 The Questionnaire

We opened the form to the public on the 1st of October and closed it on the 7th of October. During these days, we had 100 answers.

The survey results provided valuable insights into the demographics, energy consumption habits, and technology use of respondents.

Regarding demographics, the majority of participants were aged between 51 and 65 (47%), followed by those aged 16 to 20 (21%). A small percentage (2%) were aged 66 or older. In terms of gender, 60% of respondents were female, and 40% were male.

When it came to device ownership, most households owned between 1 to 7 appliances (68%), while fewer owned 8 to 15 (29%) or more. For smart devices, 55% of respondents owned between 1 to 7 devices, while 39% did not own any. Solar panel ownership was less common, with 72% of households reporting no solar panels, and 23% having between 1 and 7 panels.

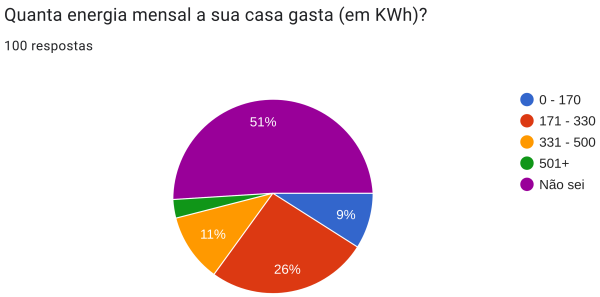


Figure 1: Responses to question 4 - ”Quanta energia mensal a sua casa gasta (em KWh)?”

In terms of energy consumption, 48% of respondents were unaware of their household’s monthly energy usage. The most common reported consumption range was 171-330 kWh (26%).

When it came to energy management systems, the majority (82%) did not use any such system. Among the 18% who did, the most popular systems were EDP Energy (11%) and SMA Energy (3%). The functionalities users liked in their systems were diverse but included features such as controlling photovoltaic energy and managing overall consumption.

In discovering energy management systems, family (12%) and friends (8%) were the most common sources of information. When asked about their interest in monitoring energy consumption, 72% expressed a desire to start, while 15% were already engaged in energy monitoring.

As for energy-saving suggestions, participants most commonly recommended identifying the best times to use appliances, pinpointing high-consumption

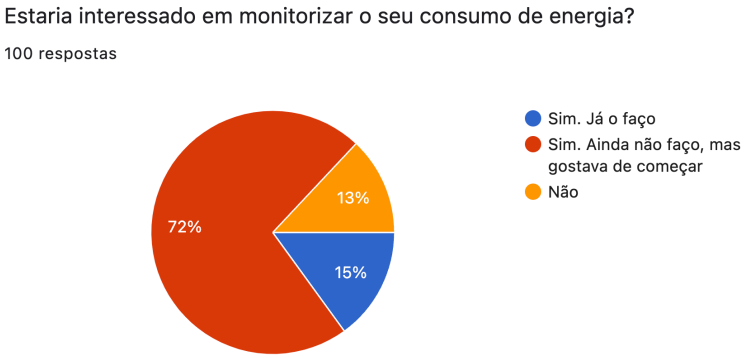


Figure 2: Responses to question 8 - ”Estaria interessado em monitorizar o seu consumo de energia?”

devices, and optimizing the use of solar energy. The preferred frequency for monitoring energy usage was weekly (44%), followed by monthly (34%) and daily (17%).

Real-time energy monitoring was considered important by 80% of respondents.

Finally, many respondents expressed interest in participating in future prototypes, providing email addresses for follow-up.

This data provides valuable insights into energy consumption behavior, device usage, and the potential for energy management systems, as well as a clear interest in improving energy efficiency and solar energy utilization.

The results of the questions can be found in the annexes [6.1.2].

2.4 PACT Analysis

Even before starting the questionnaire, we thought about some topics that we wanted to address. This way, we could create a better profile of our future users and understand what their main needs are.

For this, we divided the information we wanted to know using the PACT framework.

2.4.1 Starting to plan for PACT

Knowing that we were going to need to profile the users and understand the current solutions, the following paragraphs contain some of the topics we wanted to address.

To start, in the ”People” section, we believed the crucial information that we needed to collect was the average age, gender, and knowledge about energy. Additionally, it was also important to know their economic conditions and understand their openness to change. We were already aware that our user group would be particularly heterogeneous in certain aspects but wanted to know some characteristics they all shared.

In terms of ”Activities”, we wanted to know what apps and platforms they currently use to manage energy at their home, how frequently they use them and in which ways these systems impact their life and energy consumption. We also decided to question whether they currently use these apps alone or share access to these apps with the whole household. Understanding if they wanted to have an app running passively or if they preferred an app they could actively interact with on a day-to-day basis was also important.

In ”Context”, we needed to know how the population that used some software of energy management learned to use their current apps and in what context they used them.

Finally, during the analysis of ”Technology”, it was important for us to know where the data is stored (do people use a home server or rely on cloud servers), how the data from sensors is transmitted and whether there was the need for info in real time. Additionally, information such as in what type of devices do people use their energy management systems was also relevant.

2.4.2 Our PACT profile

Having in consideration the information that we wanted to capture in each part of the PACT framework, we include our conclusions in the remaining subsections.

2.4.2.1 People

Using the questionnaire as the basis of our information, we were able to make the following conclusions. We noticed that 31% of youngsters, from 16 to 20, use some energy management app, compared to 27% e 15% on the age gap 51-65 and 21-35, respectively.

Knowing this, we came to the conclusion that while young adults believe they need an energy management system, when they reach the age gap 21-35 there seems to be a drop in adoption, probably due to additional work responsibilities that remove time available for this. Only after reaching 50, there seems to be an increase in the use of similar apps.

Despite 72% of people showing their openness to change by stating that they would like to start monitoring their own energy consumption, about 51% of people don't have enough knowledge about their house energy consumption.

Due to the reported frequency of access to the app, we can also understand that our users will tend to be infrequent users. However, they have several devices, with 61% of people stating that they have more than one intelligent device, such as smart lights.

At the moment and respectively, 18% and 25% of males and females do use software that allows them to manage energy consumption, showing a very small difference across genders. A common motivation across all was the management of costs and understanding which appliances are spending the most energy.

We don't have any information about special needs due to blindness or color blindness.

2.4.2.2 Activities

In terms of Activities, we rapidly noticed that there was some diversity in the way activities are performed. In fact, while most people (above 80%) believe it's important that information is given in real-time, it was not reported that there was a need to check information very frequently. Most, 46% would like to check weekly summaries, and 36% monthly summaries.

Based on this, it's possible to conclude that users prefer to receive a big quantity of information presented in a compact way that can be checked back routinely. Despite being an important topic, the users show that the length of time they can spend on this task of managing their consumption is small. Through conversations with some respondents, they report feeling the need to know what is happening at the current moment to make immediate decisions, but they will only thoroughly investigate the data weekly or monthly.

The tasks users reported being more useful were understanding the best schedule to charge their devices, finding the appliances with the highest en-

ergy consumption, detecting applications running in the background, and finally optimizing energy consumption based on solar panels and configuring definitions for devices.

At the moment, we noticed that most respondents, around 11%, use a solution by EDP to manage their energy. Following comes SMA Energy and other less used software, such as Brightly, Hark, and Google Home.

2.4.2.3 Context

Getting into Context, we noticed that around 50% of the users of energy management software say they met their current platform through their family or friends. From this information, we can conclude that they had some support from these people to start using them to explain their usage and probably expect to use this kind of system cooperatively.

Additionally, taking into account the majority of the apps people report using, which are mobile-oriented, we notice they can be used in several contexts. We can expect that these apps are currently used from the comfort of the home while commuting or at work. Therefore, there will be a wide range of situations where people can manage their energy or control their appliances.

Finally, people addressed that their favorite functionalities of their software related to the control of their energy bill, while also caring for solar energy' production control and management of intelligent appliances.

2.4.2.4 Technology

Analyzing the current existing solutions, we noticed several trends. First, while some apps use cloud based systems to store information, the most used app, EDP RE:DY, takes a different approach. In fact, EDP RE:DY uses a box inside clients' homes to collect data and manage it. This box is connected to the router and is also used to send information to the App. Therefore, this app guarantees some privacy by self hosting data.

This platform also gives information about energy consumption in real time. It also includes some information about energy production on solar panels. Additionally, the app also allows control of the lights and other smart devices.

We noticed that most of the alternative platforms consist of mobile applications. However, some of them are also accessible on the web.

Most of these solutions use plug extensions appliances to manage how much energy is used and to control the devices. Data is inserted automatically using these appliances. As seen above, there was a substantial number of people that declared the need for real time information.

Google Home and other apps more focused on smart devices management share a protocol to connect with those smart devices called ”Matter”. Using this guarantees that more devices can be connected and that users can change apps whenever they want.

2.5 Personas and Activity Scenarios

This section of the report will contain the personas we created for this project. Since each of them is associated with a specific activity scenario, after describing each persona, we will also present the activity scenario associated in order to make it more engaging and easy to analyze.

Due to the results we obtained from the questionnaires, we ended up with two very distinct but complementary personas that we believe cover every main aspect of the project we want to develop and the issues we are trying to address.

2.5.1 Persona 1 - Bernardo Lima

The first persona is Bernardo Lima, a 53 year old accountant from Porto. Bernardo is married and a father of two children. He has an important position on a large firm and a very full daily schedule. Despite this, he likes to spend his free time at home relaxing with the family.

Figure 3: Picture of Bernardo Lima

Motivators

- **Save money**: Bernardo is very concerned about his expenses and always tries to spend as little as possible. This is something he also tries to teach to his children.

- **Being Accomplished**: Bernardo always dreamed of being a successful person, which motivates him to work very hard. He is always trying to do more and climb the ranks of the company.
- **Control freak**: Bernardo feels like he is constantly responsible for his actions, so he always strives to stay on top of the problem and to solve every problem as soon as possible.

Behaviors

- **Spending time with family**: Besides the family that lives with him, his brothers are his neighbors and during the weekends they often spend time together.
- **Plays Basketball**: Despite his age, he was always a fan of basketball and plays friendly matches every Wednesday with a group of friends from work.
- **Tracking his Portfolio**: As a secondary source of income, he also invests in the stock market and likes to track his expenses and stock portfolio.
- **Watching Movies**: As a solo hobby, he likes to watch and review movies. Every month, he participates in a film club where they share their opinions on their most recent watches.

Needs

- **Work-Life Balance**: Needs to have free time where he can play basketball or spend time doing his hobbies so that he can rest from his work.
- **Reliable Supportive Network**: Trustworthy family and friends give him the energy and encouragement to follow his dreams.
- **Health and Fitness Maintenance**: Due to his very tight schedule, Bernardo spends his days dealing with huge amounts of stress. Pairing that with his age, it's evident that he needs some way of unwinding his mind and staying healthy.

Frustrations

- **Responsibility Overload**: Bernardo loves his job and taking care of his family, but he can't be everywhere all the time and sometimes he feels overwhelmed with responsibilities and tasks that he must do.

- **Road Traffic**: Every single day, he has to take a 45-minute drive to his office. This challenge is always bringing a splash of uncertainty into his life because he never knows what the traffic is like and how that single drive might affect his entire schedule.

2.5.2 Activity Scenario 1

Bernardo Lima likes to always be on top of everything. He works a strict corporate job and lives his life on a tight schedule. He lives in a big house with a lot of smart devices.

Every day, during breakfast, Bernardo wants to know the energy consumption of his daily routine, to make sure he isn't wasting any more energy than he needs to. He opens the application and takes a look at the overall spending patterns of the last 24 hours, as well as the top appliances that spend more money.

In case he notices that something is off, he searches and filters through the connected energy consumption items to find the culprit. Having these kinds of filters is very useful, as he has a lot of different connected devices and wants to quickly find what is causing the issue.

Finally, he has recently entered the market in renewable energies and solar panels by installing 5 of those in their home so he would like to see the results of this change in the app.

2.5.3 Persona 2

The second persona is Laura Araújo, a 26 year old kindergarten teacher from Lisbon. Laura is in a relationship of 5 years with her boyfriend and the couple is now making a huge transition into adulthood. She has always lived with her parents but 3 months ago, she was presented with the opportunity to start working, the only problem is that the job is far from where she lives. Despite her hesitations, her boyfriend eventually convinced her to take on the challenge and learn to be more independent.

Motivators

- **Stability**: Laura is aiming to stabilize her life after leaving home to a new city, by moving into a nice and simple apartment with her boyfriend and integrating with the local community.
- **Being Kind and Helpful**: She worries a lot about how people see her and wants to help and be liked by everyone around her. She is constantly checking up on those around her and wants to make the world a better place.

Figure 4: Picture of Laura Araújo

- **Children**: Since she was little, she developed a love for caring for younger children and decided that's what she wanted to do for the rest of her life. She recently finished her degree in education sciences and will start working full time in a kindergarten.

Behaviors

- **Socializing with her Friends**: Most of Laura's friends are from her hometown and live far away, but she still keeps in contact with them through social media, video calls, and birthday parties. She likes to remember her teenage years and the things they did together.
- **Spending time with her boyfriend**: Having moved in with her significant other, they often do simple activities together, like going to the mall, watching films/series at home, or trying new recipes.
- **Working at the Kindergarten**: She does not have the most complex schedule, but she is very passionate about the kids in her care and makes sure to keep an eye on each one at all times, which can be very stressful.
- **Books, Cartoons, and Anime**: She is fascinated with the animation styles and fantastic storylines of the modern anime and cartoons. Besides this, she also likes to read young adult novels and mysteries.

Needs

- **Support and Guidance**: This is the first time Laura is staying more than 2 weeks away from her hometown and she suddenly realizes about the many challenges and chores that must be done to take care of everything. She needs advice and help to stabilize and be able to deal with everything new in her life.
- **Making Connections**: Moving to a new city can be scary because you most likely don't know anyone there. This was the case for Laura and she wants to find a way to start meeting new friends and socializing with people from her new town.
- **Settling down**: For now, everything seems new in Laura's life, but what she really wants is a stable normal life where she can have free time to do what she wants. She is also very invested in her relationship and what to settle down soon.

Frustrations

- **Professional Career**: Although Laura was always passionate about kids, she knows that it's not the type of career to get promotions and raises in salary. She does what she loves, but sometimes, she wonders if she really made the right choice.
- **Moving Far From Home**: From her workplace to her old house, it takes 80 minutes by car. It's not that far away, but Laura is still worried she might start losing touch with her friends and family.

2.5.4 Activity Scenario 2

Laura recently got a new job in a town far from where she lives. She was a little skeptical about going but eventually found a new apartment to stay in. Luckily, her boyfriend also managed to find a job nearby so they will be living together and sharing the apartment for the first time.

As a couple entering adulthood, they want to start paying attention to their expenses and managing their finances. They are not too strict about it, but about every two weeks they would like to have a chat and track their recent expenses. During this meeting, they want to quickly see how much energy they spent and easily compare it to the weeks prior.

Since they didn't have any experience and are still getting accustomed to all of this, they like to check for suggestions and tips to save even more. Lastly, sometimes they need to work a lot from their home office, so it's useful to be able to categorize their appliances by region.

2.6 Functionalities

Based on the data retrieved from the questionnaire and the activity scenarios we described for each persona, we were able to raise the following functionalities that we think should be integrated into the final product:

Login for Personal Profile - To ensure that users keep their information safe, whether from their personal profile or their devices, the login functionality will ensure they have their information private and secure from unauthorized access. Each user will have a unique account where their data, settings, and device profiles will be safely stored. This will also allow users to access the platform on almost any device, so users can easily monitor and control their devices from any browser, whether from a desktop, laptop, smartphone, etc.

24-Hour / Weekly / Monthly Dashboard - The application will provide an intuitive overview of the user's consumption patterns through the dashboard. The dashboard will not only allow to monitor the energy usage in real-time, though the usage of charts and graphs, but also compare the consumption trends between different time periods.

Top Spending Appliances - When optimizing the power consumed, it is imperative to pinpoint the devices that consume the most energy or that are the most inefficient, so that they are prioritized. This functionality will allow the user to rank the devices based on their energy consumption, leading to easier optimization.

Device's Detailed Analysis - Through the app, the user will be able to access detailed information about each device, from its power consumption trends to efficiency ratings, power state, and anomalies that might be harming the device's efficiency.

History Comparison Features - With this functionality, users will be able to compare the power that devices consumed throughout different time periods, such as the energy spent in this week vs this month. This way, the user will get a better understanding of each device's state, whether they are facing problems that aggravate its consumption or the effect of repairing/upgrading a device.

Add and Remove Appliances Easily - In our platform, any home appliance can be effortlessly registered. To add a device, the user will need to install our specialized software, for smart devices, or add a plug sensor, for other electronic devices. From there, it's just a question of connecting the devices

to the local network and they will be ready to use. Removing a device will be even easier since the user only needs to blacklist the device from the platform. Removed devices can have their sensors reused on other devices, promoting flexibility and ecological standards.

Search, Tag, and Filter Devices - If the user ends up registering many appliances, it is imperative to have a search functionality for easier access to a certain device. In our platform, devices can be tagged for better sectioning, such as identifying ”kitchen” or ”living room” devices. The user will also have many filtering options, such as filtering by consumption level and by smart/electronic device, to further narrow down the options presented.

Information About Solar Panels - For houses that use solar panels, it is very useful to receive detailed information about them. Through our platform, users will be able to monitor the energy that each solar panel produces, compare the total energy produced with the total power consumed, and get data about the battery state and the financial savings got from the use of the solar panels, among other minor functions.

Tips and Suggestions to Improve Spending Habits - One of our main objectives is to ease the power consumption optimization of all the devices of a household, so our application would not be complete without personalized suggestions to improve power consumption habits and reduce the power bill. The platform will provide tips and suggestions, depending on each device, such as the best time to use a device (because of lower energy costs at certain times of the day).

Power Control and Automatic Adjustment of Smart Devices - Digital devices are in another class from standard electronic devices, so their optimizations should be. As its most unique functionality, our platform will be able to add personalized suggestions and control actions for smart devices, like measuring and closing the most energy-intensive applications, giving control over their power state (on, off, hibernate, etc.) and automatically adjusting their settings for increased battery life and performance per watt.

2.6.1 Most Important Functionalities

From the mentioned functionalities, we next highlight the ones that we think are the most relevant, and the reasons behind our choice. These will be chosen for the next project steps to be further developed in the prototype. Some of the functionalities below result from two or more of the previous ones, since they are closely related and can be combined as such.

- **Dashboard** - This is the main screen of our platform, and is responsible for graphically summarizing all the information of the system in different time periods, being crucial for all the users. It can also provide information regarding the top spending appliances, further focusing the user's attention.
- **Search Devices** - Through the search mechanism, users will be able to filter and organize the appliances in the platform, being essential for most users, especially those with more devices registered.
- **Device's Detailed Analysis** - It's in the detailed analysis of the device that resides most of the application's core features, such as the exhibition of the information and state of the appliance, the showcase of its consumption trends and the indication of suggestions to improve its power usage.

3 Part II - Lo-fi Prototype and Heuristic Evaluation

3.1 Project Abridged Description

Recapitulating our project theme, Watt Are You Doing is a Web application aiming to ease the trouble of checking how much energy our homes spend. For this purpose, our program will allow the user to analyze graphically the consumption/production of each home appliance throughout time, give tailored suggestions to reduce energy consumed or money spent and allow to control devices directly on the platform.

3.1.1 Most Important Functionalities

From the functionalities we have defined in the previous phase for our application, we decided that the three functionalities we're focusing in our project will be:

- **Dashboard** - Presented as our application's main screen, the dashboard provides users with a graphical summary of the consumption/production patterns, through multiple time periods, providing other filtering options, as well as statistical information regarding the overall consumption, the top spending appliances, suggestions and alerts, etc.
- **Device Search** - The search mechanism will allow users to search devices, with adequate filtering options, making devices more accessible and easing the organization of appliances in the platform.
- **Device's Detailed Analysis** - The application will provide a comprehensive view that englobes most of the application's core features, such as exhibiting the information and state of the appliance, presenting the consumption trends, and indicating suggestions to improve power usage for the device.

3.1.2 Tasks and Usability Requirements

Based on the previous functionalities, and also taking the activity scenarios we created on the previous phase as inspiration, we defined the following user tasks, which correspond to common activities a normal user will take part in when using our application. For each task, we will also mention the usability requirements we established to evaluate the quality of our prototype, concerning our project goals.

3.1.2.1 Obtain Details of a Specific Device

The objective of this task is for the user to locate a specific device quickly using the search function, and then access its detailed description and control settings with ease. It is comprised of the following steps:

1. Search for the devices with the tag ”Kitchen”.
2. Find the device named ”Refrigerator”.
3. Obtain more details about its consumption trends.

Usability Requirements:

- Efficacy:
  - 80% of users should be able to find the search page without aids.
  - 90% of users must be able to obtain detailed information about devices without aids.
- Efficiency:
  - Average time to find the search page should be less than 10 seconds, and to perform the other steps should be approximately 8 seconds for each
  - 95% of users must be able to accomplish each step with less than 8 clicks.
- Satisfaction:
  - Over 85% of users should report that the page flow is adequate.
  - Over 75% of users should report low difficulty in performing these actions on their first try

3.1.2.2 Analyze Energy Usage by Time Period and Device Tags

This task consists of the user exploring energy consumption patterns over various time periods, using the consumption trend graphs, refining the analysis by filtering devices based on specific tags, and comparing the energy consumption/production between the different options. It comprises the following steps:

1. Observe the overall home energy consumption throughout the last 7 days.

2. Obtain the energy consumption of all devices within the last 24 hours.
3. Filter the devices in the energy trend graph to the ones with the tag ”Rooms”.

Usability Requirements:

- Efficacy:
  - 90% of users should be able to find the “time period” and “filter by tag” options on their first attempt.
- Efficiency:
  - Users should be able to switch between 24-hour and weekly views within 4 seconds on average.
  - Over 80% should be able to switch options with no more than 2 clicks.
- Satisfaction:
  - 95% of users should report that the dashboard is easy to locate and understand.
  - Over 85% of users should report ease of use in the filtering options.
  - Less than 10% of users should report any dissatisfaction with the ease of comparison.

3.1.2.3 Investigate Top Energy Spending Devices

For this task, the user needs to identify the household devices consuming the most energy, receive their details, understand the factors contributing to their inefficiency, and apply the given suggestions to optimize their energy usage. It englobes the steps below:

1. Locate the device with the highest energy consumption.
2. Find details about the device.
3. Read the suggestions on how to solve its problematic energy usage.
4. Perform the first suggestion inside the application.

Usability Requirements:

- Efficacy:
  - 95% of users should find the highest energy consuming devices on the dashboard on their first try.
- Efficiency:
  - Each operation should take less than 10 seconds.
- Satisfaction
  - Over 90% of users should be satisfied with the flow of the application.
  - Over 85% of users should report low difficulty in performing these actions.

3.2 Prototype's Wireflow

For this phase of the project, we also developed the low-fidelity prototypes using Figma.

We started by following the Crazy 8 methodology and prototyped the 3 main pages: dashboard, device, and search page using pen and paper. Eventually ending up with 32 ideation designs before agreeing on the best ones and transforming them into Figma wireframes.

We decided to use Figma due to its functionalities and past experience. As suggested by the teacher, we took advantage of a plugin named "Paper Kit", which has a toolkit of pre-designed components that eased creation and guaranteed consistency across pages.

Some of the main concerns when developing our wireframes were the quantity, quality and relevance of information by page, as well as the design consistency, in order to provide an intuitive flow across the application.

3.2.1 Template Wireframes

Before focusing on the particular instances of the different pages, we made templates of each page, to better visualize the overall looks of the application and improve on this designs before moving on. Moreover, having perfected these template designs guaranteed that developing the wireflows was easier since we only had to adapt the pages to their intended functionalities.

Screenshots of these wireframe templates are shown below:

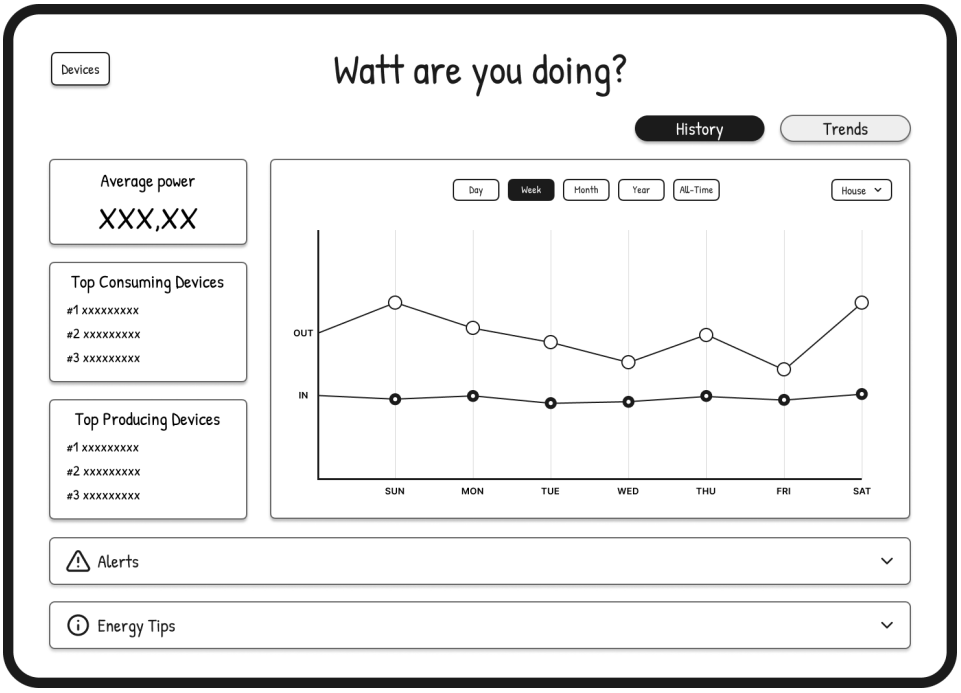


Figure 5: Dashboard template

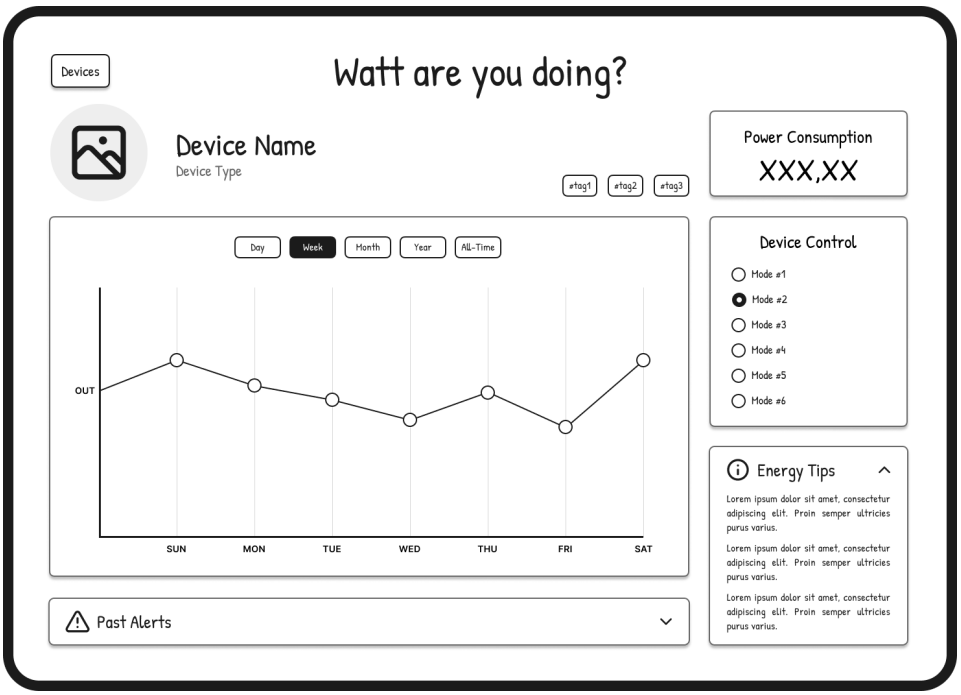


Figure 6: Device View template

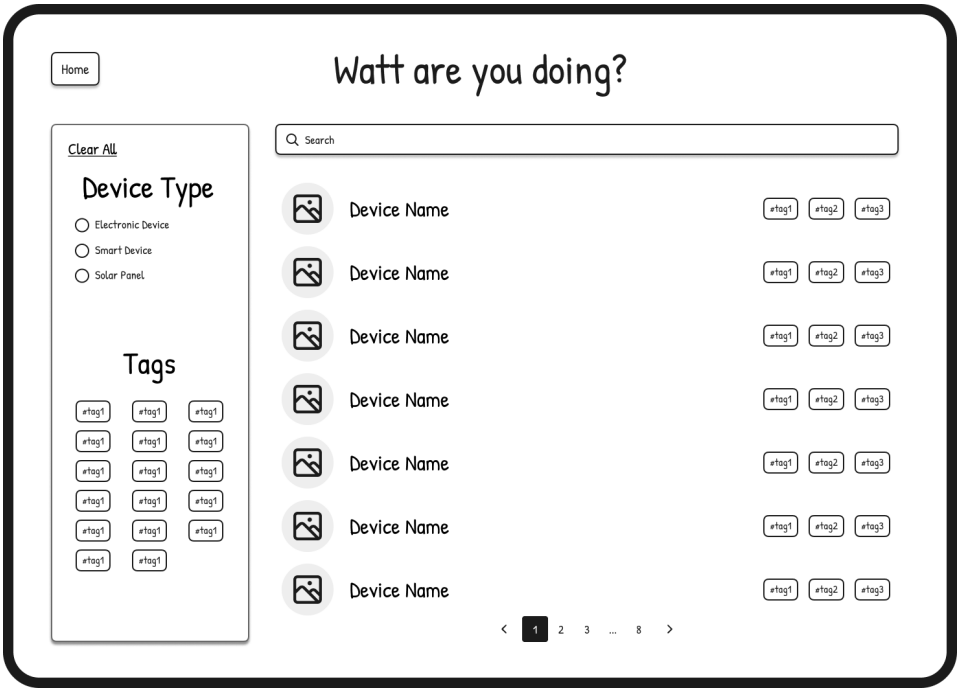


Figure 7: Search template

Having shown these templates, we will now present the wireflows for each of the specific tasks, in order. For each wireflow, we will also briefly summarize the steps needed to execute the tasks.

3.2.2 Wireflow 1: Obtain Details of a Specific Device

For the first wireflow, the goal was to visit the search page, filter devices with the ”Kitchen” tag, select the refrigerator and view details of the device in its corresponding page.

We start in the dashboard (as we will always do in these wireflows) and the first step is to click on the ”Devices” button on top to open the search page.

Figure 8: Wireflow 1: Steps 1 to 2

On the search page, we can now click on the ”Kitchen” tag on the left side of the page, which will filter the devices shown on the right to be only devices with that specific tag.

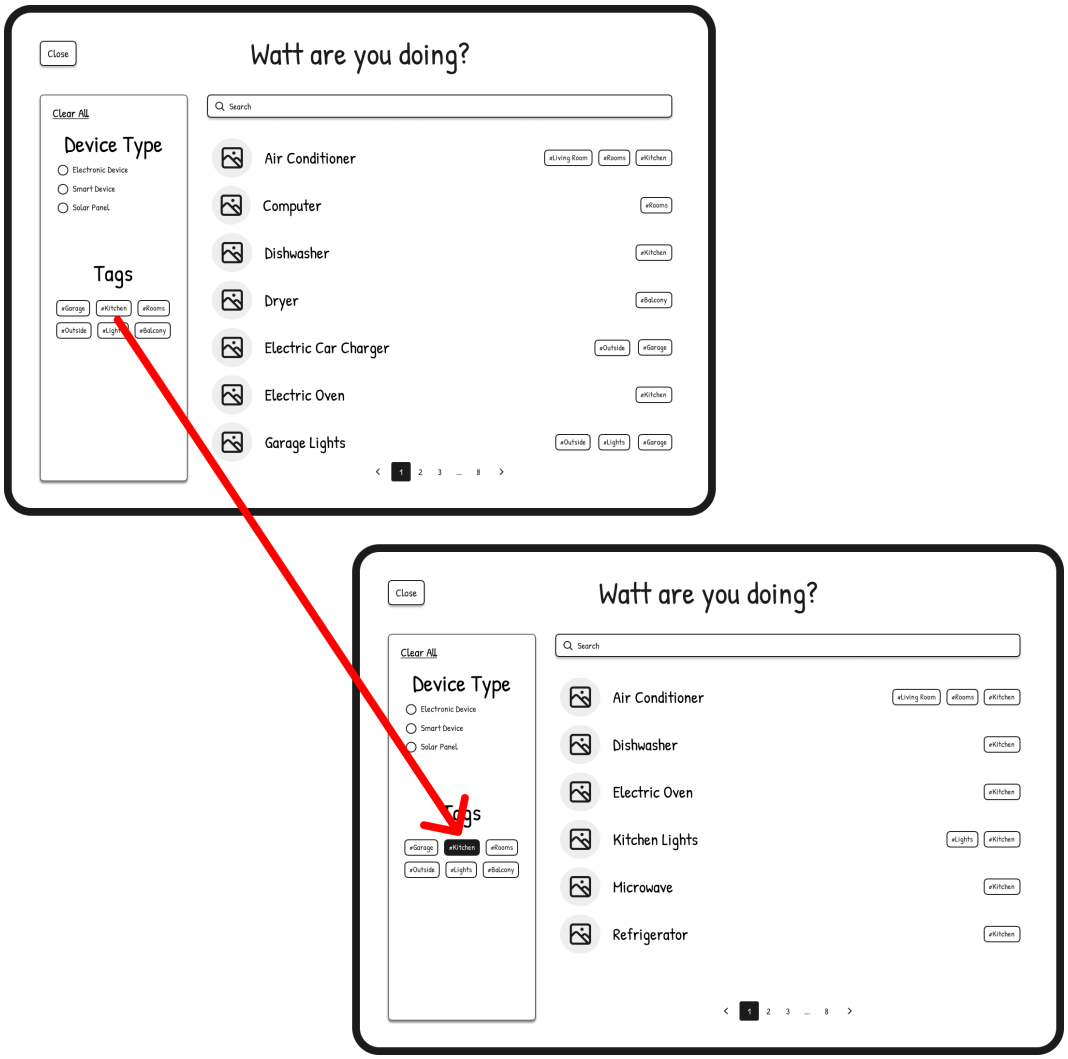


Figure 9: Wireflow 1: Steps 2 to 3

Analyzing the results, we can now click on the Refrigerator device and we will be redirected to the device page, where we can learn more about the energy spending history of this device.

Figure 10: Wireflow 1: Steps 3 to 4

3.2.3 Wireflow 2: Analyze Energy Consumption by Time and Tags

For this wireflow, the goal was analyze the consumption of the last week (7 days), change the display to show data from the last day (24 hours) and filter the graph to only show data related to specific divisions of the house, in this case, "Rooms".

Starting in the main dashboard, we can already see the information tracked from the past week, and right in the center, we have a graph showing an overview of the most important information, as well as different filters. This element is the focus of this task.

Changing the display from 7 days to 24 hours, only takes one click on the time filters located just above the graph itself, which can be done as seen below.

Figure 11: Wireflow 2: Steps 1 to 2

Finally, to retrieve the information of specific portions of the habitation, the user can take advantage of the dropdown on the right, which when expanded, reveals all the rooms that can be selected to filter the data.

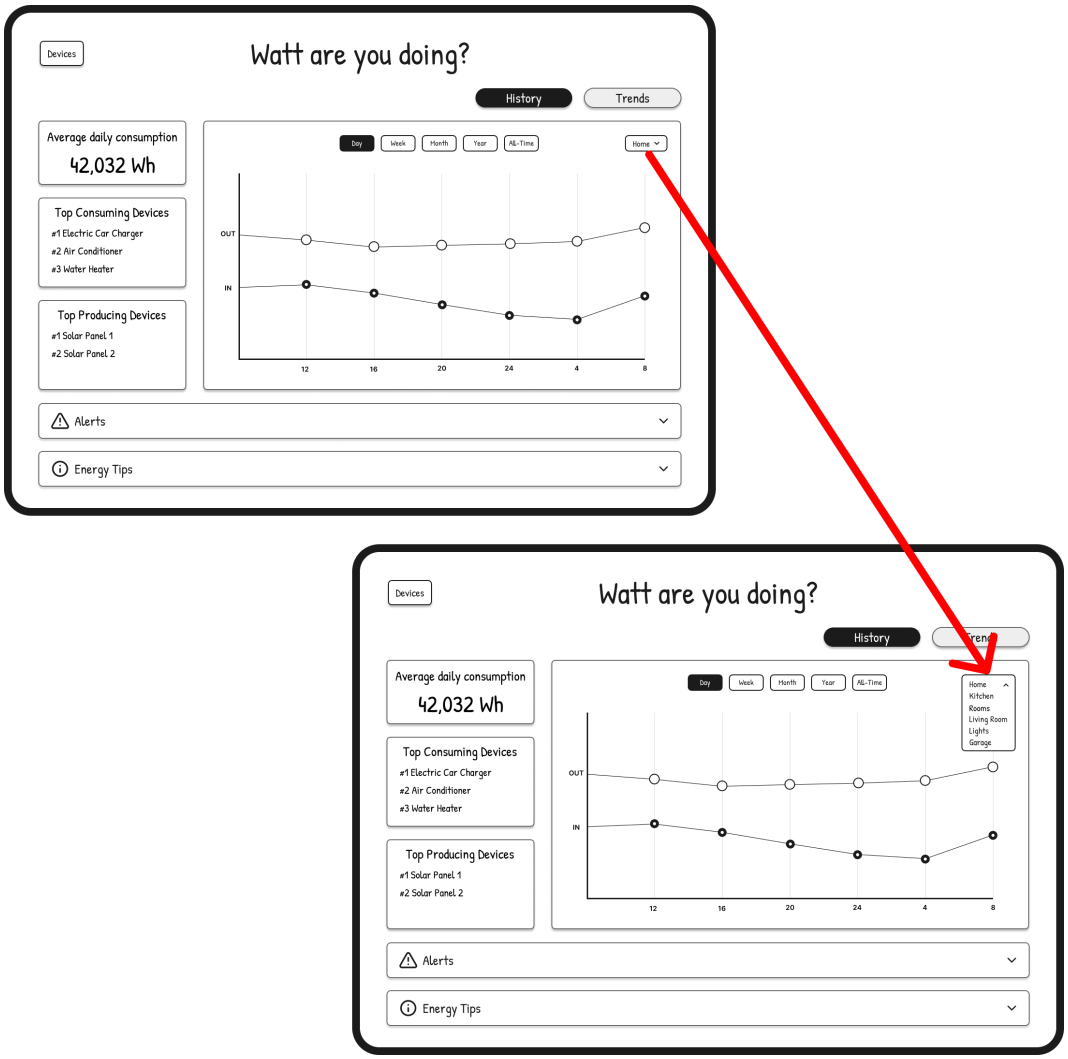


Figure 12: Wireflow 2: Steps 2 to 3

By selecting the ”Rooms” option, the graph will be updated to only show data from that specific tag.

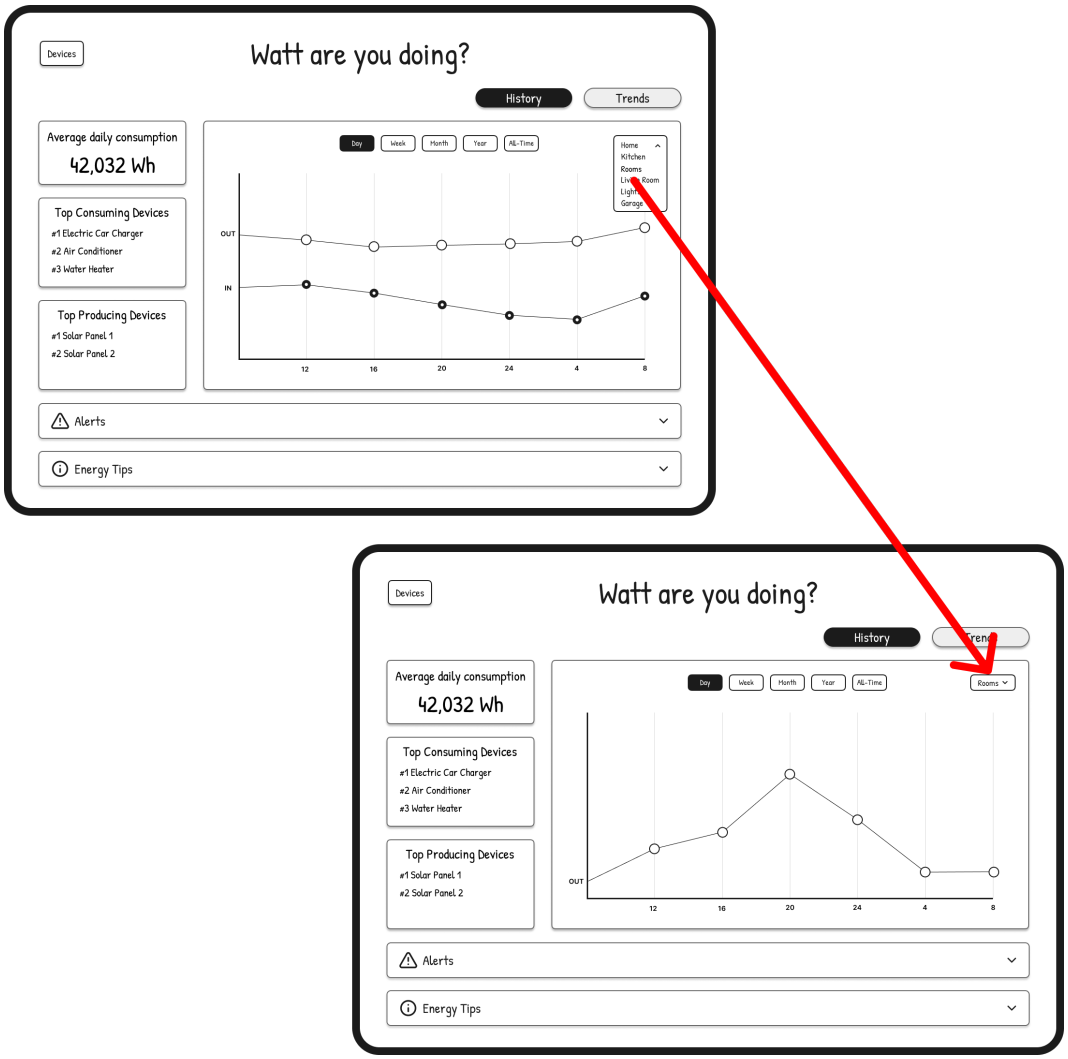


Figure 13: Wireflow 2: Steps 3 to 4

3.2.4 Wireflow 3: Investigate Top Energy Spending Devices

This final wireflow is the one that we consider more complex, hence highlighting it in the class presentation. The flow consists on locating the device with the highest energy consumption, obtaining more details about it, reading tips and suggestions on how to improve its energy consumption and finally execute the suggestion presented.

Once again, starting from the main dashboard, we can see that the left side has some relevant informative sections on the top spending and producing devices. By clicking on the first device in the "Top Consuming Devices" section, we are taken to that device's page.

Figure 14: Wireflow 3: Steps 1 to 2

Here, we can already see some details about its history, current consumption, and possibly even alerts, but the information we need is located on the bottom right side in the ”Energy Tips” section. This section would ideally start as open and take the rest of the sidebar, but for better testing, we decided to start with it closed and have a dropdown indicator that the user had to open in order to check the tips.

Figure 15: Wireflow 3: Steps 2 to 3

Reading the suggestion, we can conclude that it is recommended to power off the device for now, and turn it back on later. The final step is to do just that, by pressing the ”Power” toggle button on the ”Device Control” section.

Figure 16: Wireflow 3: Steps 3 to 4

3.3 Digested Heuristic Evaluation Results

In order to evaluate the effectiveness of our design, we performed an in class heuristic evaluation with our colleagues, asking them to perform our tasks and get a sense of the use of our wireframes. We measured the amount of time and number of clicks each person took to accomplish the tasks and then asked them what their opinion was concerning the use and flow of our website. With the goal of acquiring the maximum feedback possible, we also performed an identical heuristic evaluation outside of class.

During each evaluation, we tried to be the most honest possible and not give any suggestions that could interfere with the quality of the data, therefore, questions about how to do a certain step were never answered but were registered as a sign of initial hesitation toward the flow and design of our application.

Having said this, the majority of the feedback we received was related to the graph representation, the lack of focus on important information, some complicated flows, a lack of user freedom, and some minor inconsistencies. In this section we develop the details of these complaints, explain their importance and evaluate their severity.

3.3.1 Graph Representation

Our graph is one of the main elements in our dashboard and across all pages that have information about energy consumption. We consider it to be one of the most important points of transmission of information to the users. Therefore, we took careful notice of all the problems, hesitancy, and confusion that the individuals presented when interacting with the graph.

The first issue presented was the lack of vertical scale. This made it difficult to understand how the values compared with each other.

Additionally, it was reported that there was an abundance of information in the graph. The critics were mainly due to the existence of two lines that confused users on what kind of data they were looking at.

This complaint was mainly related to the Consistency and Standards heuristic and was given a very low severity of 1.

3.3.2 Important Information Presentation

Having in consideration that our main objective is to help our users achieve a more sustainable and efficient consumption of energy, it is of the highest importance to inform a user of detected problems as soon and as clearly as possible.

Despite this, it was very easy for a user to unintentionally ignore a device alert of unusual consumption.

This complaint was mainly related to the Consistency and Standards heuristic and was given very low severity of 1.

3.3.3 Complicated Flow to Add and Remove Devices

This complaint is mainly associated with the Efficiency of Use heuristic. We noticed from the received reports that the flow to add and remove devices was unnecessarily complicated. In fact, while it was an important feature, we didn't have good support for this functionality.

This problem was given a severity of 3.

3.3.4 Lack of Confirmation for Destructive Actions

Our project is based on the possibility of performing certain actions to the imported devices, such as turning them off or changing their settings. So, it's crucial that users are given the possibility of returning to a previous state and are asked to confirm their actions before performing them.

In the initial wireflows, we didn't include this, creating a severe problem related to the heuristic "User Control and Freedom". Even though our reviewing peers gave this severity a level of 1, as this issue facilitated destructive actions, we believe it must be considered to have a severity of 3.

3.3.5 Exporting Data to Other Formats

Since we want to appeal to as much of the public as possible, it is important that a user may be able to access its data in whichever form it prefers. Despite this, our prototype only allowed users to view their data on a single in-app format, which was pointed out by some more experienced users as a possible future inconvenience.

The went against the heuristic "Flexibility and Efficiency of Use" and was considered a problem with low severity of 1.

3.3.6 Minor Inconsistencies

Throughout the reviewing session, our peers indicated some minor inconsistencies that, while not violating a heuristic per se, made their use of the app less pleasant. These criticisms were mainly related to font size, icon use, and the display of data in different units. We also were criticized for the relative lack of documentation that violated the heuristic "Help and Documentation". As this version still consisted of wireframes, it is to be expected that the design choices pointed out would not be as user-friendly as is intended for an official release. However, it was a good reminder to pay closer attention to

these issues on the next prototype. Because of this, the pointed-out problems were considered as having a low severity of 1.

3.4 Corrections to Perform in the Next Phase

In this section, we will describe how we decided to incorporate the received feedback into our next prototype.

3.4.1 Clearer Graph

Based on the feedback received, we decided to completely redesign the graph. Removing information overload and giving more control to the user was our main focus. Therefore, we plan to add a clearer vertical scale, the possibility to choose what is presented (choosing to either see consumption or production lines or both), and, finally, allow easier access to more specific information when hovering on a point of the graph.

To showcase our plan, we include here a high-level design of the changes:

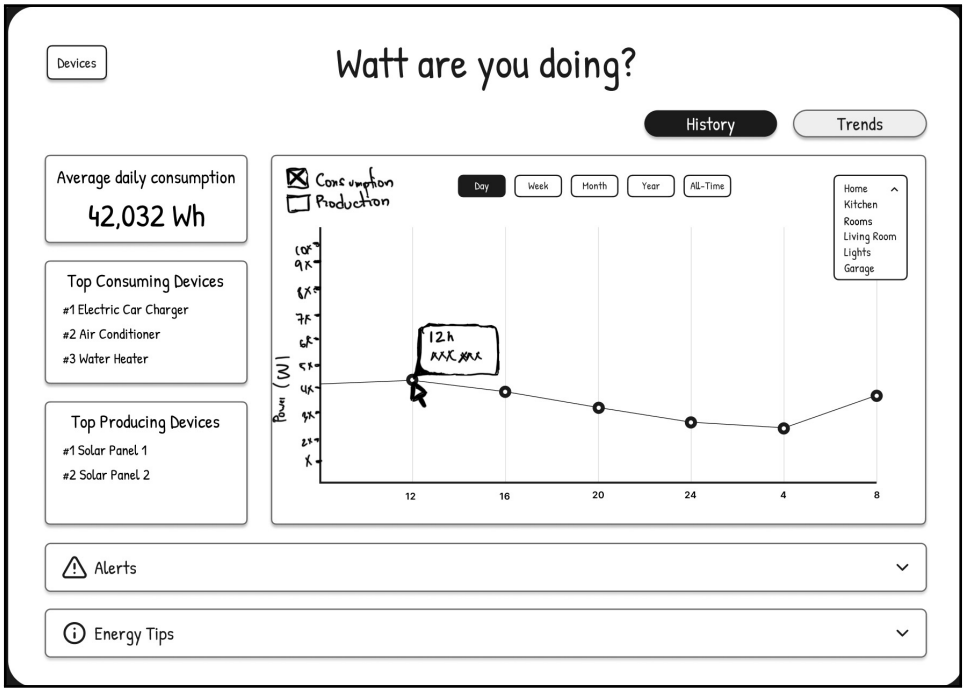


Figure 17: Graph Redesign

3.4.2 Pop-up System

In order to better communicate unusual device behavior, we added a pop-up system in which, when an unusual consumption is first detected, a pop-up notification will appear on the main screen, informing the user about the problem and, when clicked, redirecting them to the device page where they can better understand the problem and check for improvement suggestions.

We present here a high-level design of our idea:

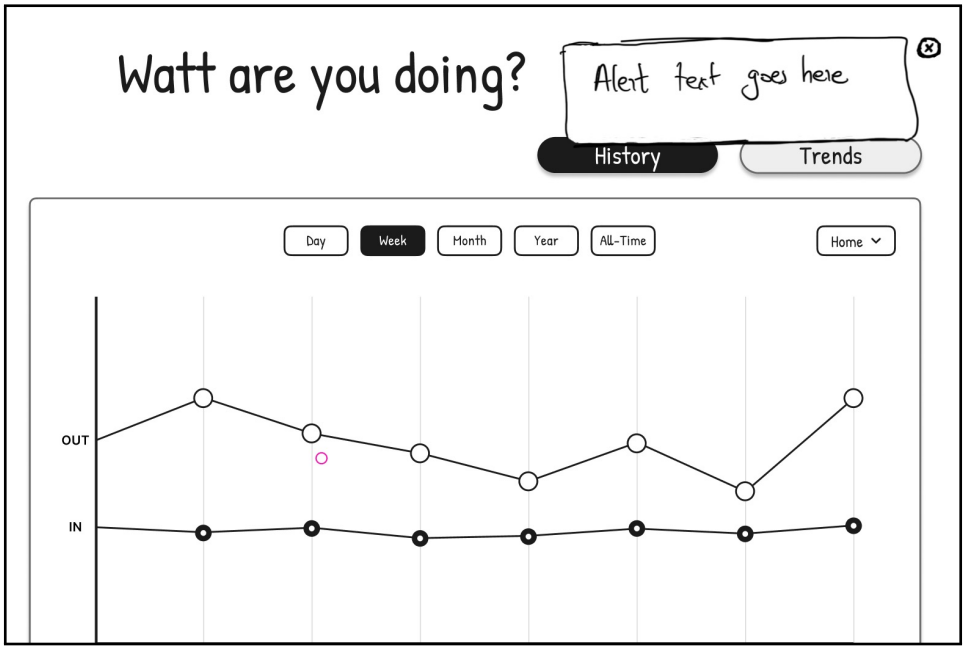


Figure 18: Alert Pop-up

3.4.3 Improve Addition and Removal of Devices

To facilitate the process of adding and removing a device, we are planning to include a button in the listing page of devices, to allow the addition of devices, and include an option to remove the device in the settings and options of that device.

We include a high-level design of this proposal below.

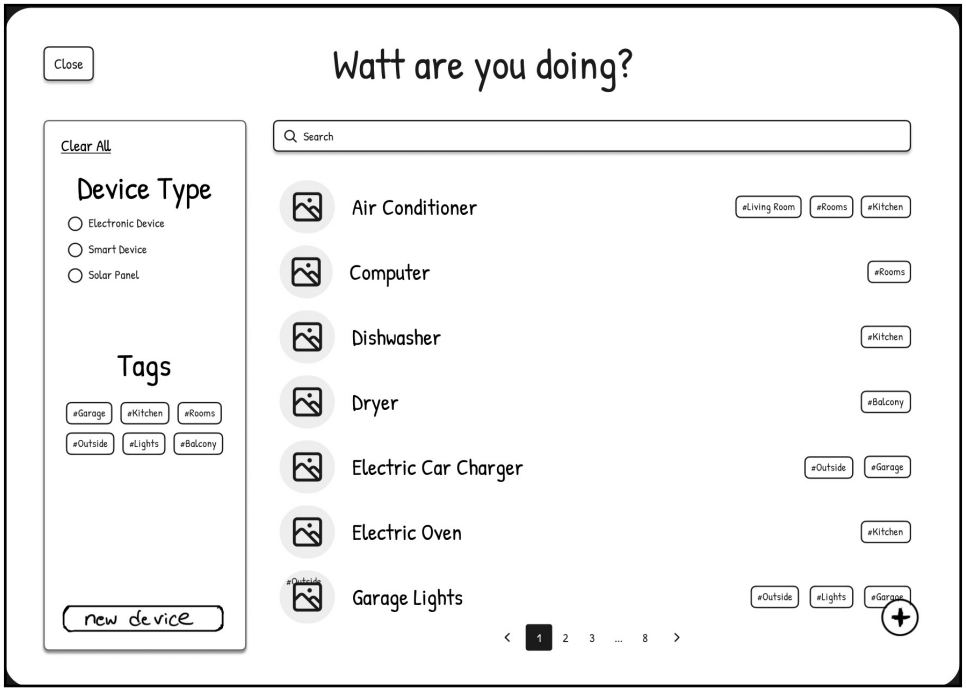


Figure 19: Add Device

3.4.4 Command Confirmation

In order to prevent users from removing a device, or changing its settings accidentally, we will add a system in which any of these alterations require confirmation from the user as presented on the following figure.

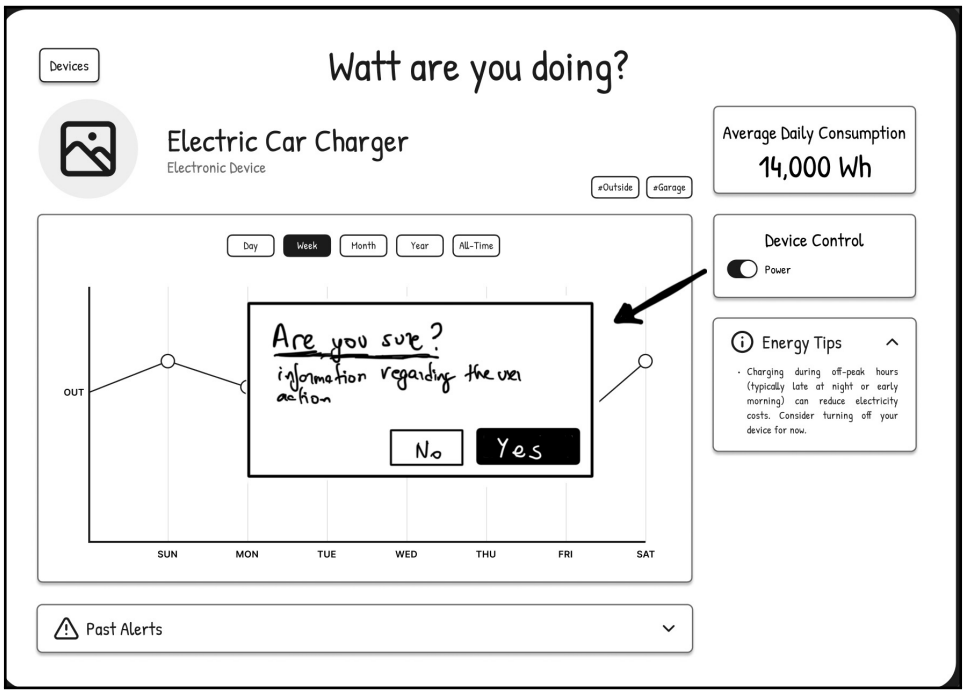


Figure 20: Confirmation Pop-Up

3.4.5 Allowing the exportation of data to other formats

To facilitate the flow for expert users, we plan on adding functionality to export data to other formats, such as CSV and PDF.

4 Part III - Hi-fi Prototype and User Evaluation

4.1 Changes to Parts I and II

- We included more details about the related apps and services to create a better context of the research we made about it
- We included a brief highlight of the results of the questionnaire in its section

4.2 Prototype's Wireflow

As asked for the third part of this project, we developed the **high fidelity prototype** for our platform.

The prototype was developed in Figma (just like the wireframes). It focused on the support of the tasks defined in phase II, not excluding many elements that, although unrelated to the tasks themselves, should be included to enhance the user experience further. We also based our prototype on the wireframes we defined in phase II, applying the corrections we ended up with, with the heuristic evaluation, and performing many improvements to increase fidelity, such as adding a proper color scheme, defining more and better interactions, and "sharpening" the style to make it look more like a real application.

Similarly to the low-fidelity wireframes, instead of directly creating multiple pages for each specific device, search page or home page state, we initially developed template pages for each of them. This allowed us to improve the design and make it cohesive before adapting it to our needs. Moreover, we also created most of the components of the page separately, allowing them to be easily reused throughout the different screens. Examples of these templates are shown in figure 21 below.

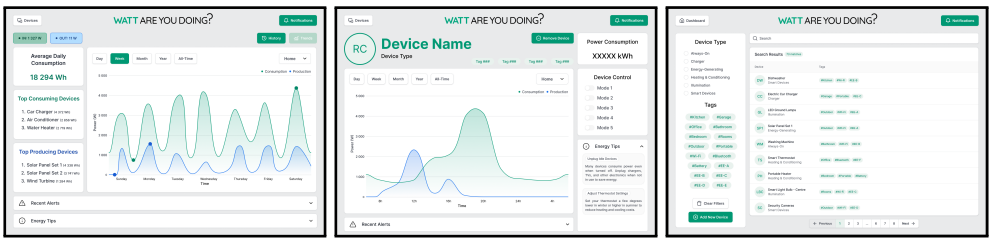


Figure 21: Home page, Device page and Search page templates

When developing the prototypes, we also took special care about the platform's usability. Some tasks (the most notable case being task 1) had a base flow that could be troublesome for some users, e.g. due to the number of options presented, so we added alternative flows for the task completion, that do not deviate much from the original flow. Other improvements we're also made, such as the confirmation modals mentioned in the corrections to the wireflows. Also, after the pilot tests (better described in the User Evaluation Protocol section), we took the chance to further revise some of our prototype's components.

In addition, since the prototype was oriented to the tasks, we added two special pages to the prototype, the "Under Construction" page, and the "Wrong Way" page, to better inform the user that it is going outside of the intended task flow. Under similar principles, we also added task completion pages,

presented when the user successfully finishes a specific task.

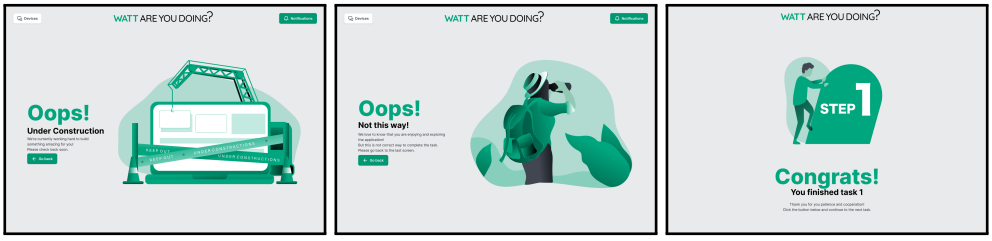


Figure 22: "Under Construction" page, "Wrong Way" page and Task 1 Completion Page

About the prototype development, we should mention that we used some external plugins and libraries. Most components used are based on Untitled UI components[9], which we've included in our product after many modifications to better adapt to our wanted look and feel. Other libraries used were Loading Spinner & Bars[2] for our loading animations, the Tailwind Color Palettes plugin[10] for the color scheme, and the Stark plugin[8] for accessibility analysis on the prototype.

Here we present the **link** for accessing the live prototype directly from Figma.

4.2.1 Task 1: Obtain Details of a Specific Device

To recapitulate, this task consisted of the user visiting the device's page from the dashboard, searching for the devices with the "Kitchen" tag, and accessing the refrigerator details on the respective page.

The flow on the final prototype is identical to the flow on the wireframes: from the platform's dashboard, the user must click on the "Devices" button on the top left corner to access the device search functionality, as shown in Figure 23.

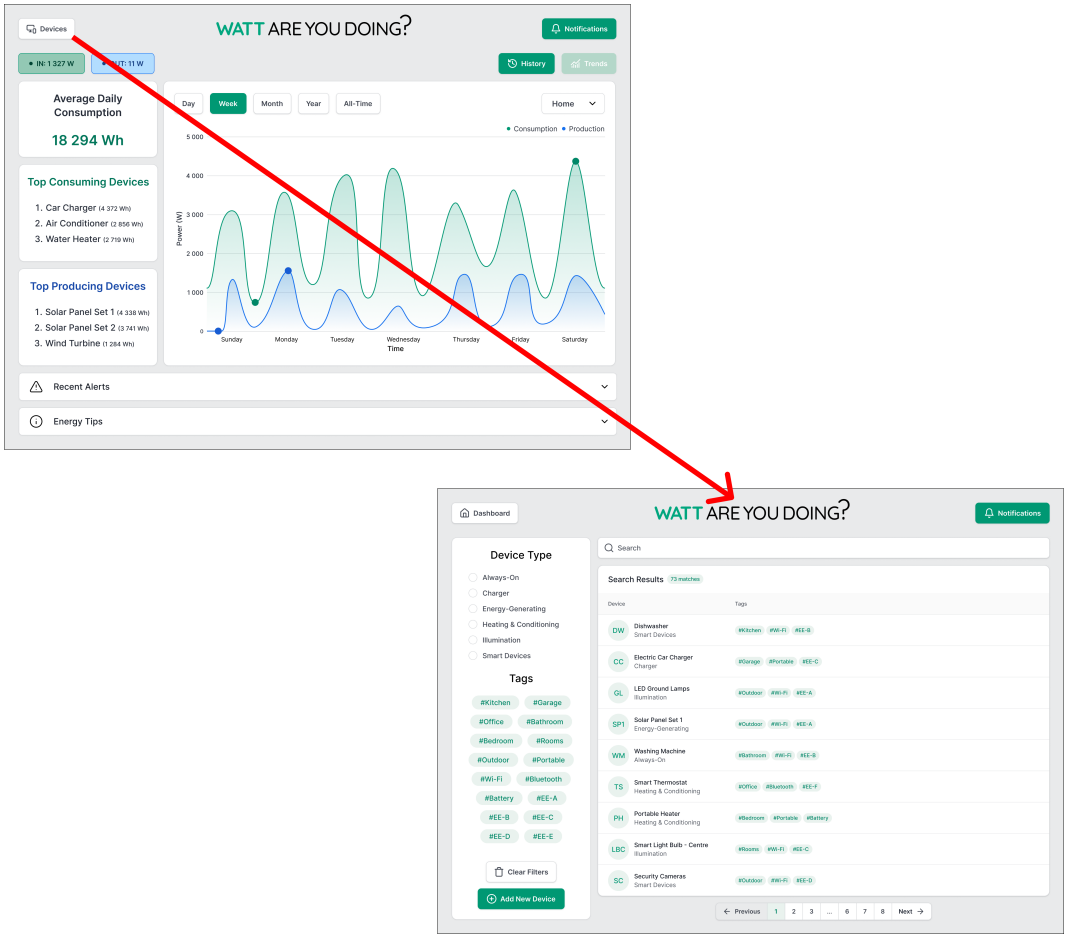


Figure 23: Prototype Task 1: Step 1 to 2

From there, the user must apply filters to reduce the search, until the refrigerator appears. This is where the final prototype starts to deviate from the flow defined for the tasks and wireframes. Originally, the user should click on the ”Kitchen” tag, to appear the kitchen devices, making the refrigerator appear. However, as we saw from the pilot tests, many users we’re trying to also use the ”Device Type” filters and the search field, since the thought solution may not be as expressive. For this reason, we also allowed the filtering of devices down to the refrigerator by clicking on the ”Always On” filter, or clicking on the search bar (which will fill the search field automatically and perform the search). In any case, the user should identify the refrigerator entry on the search results and click on it to access the refrigerator page and complete the task.

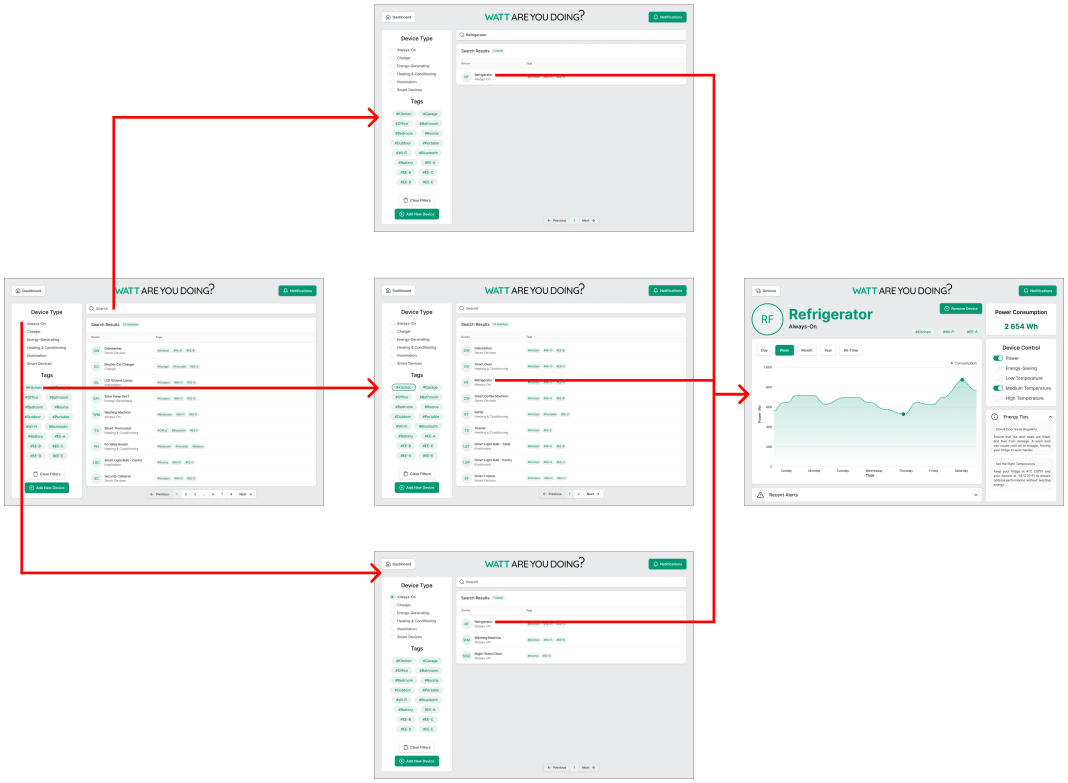


Figure 24: Prototype Task 1: Step 2 to 4

4.2.2 Task 2: Analyze Energy Usage by Time Period and Device Tags

This second task focused on having the user interact with one of the main elements of our product, the graph. The graph is the main element of the dashboard page and allows the user to quickly filter data according to time periods, energy consumption/production, and house locations.

The overall steps for this task are to analyze the initial information of the graph, general data for the last 24 hours (day), and finally data for the last 24 hours in the “Rooms” division.

The flow is very similar to the one in the wireframes where the user starts on the dashboard and then clicks on the “Daily” button on the top part of the graph section. After that, the user just needs to click on the dropdown on the upper right side of the graph section which will expand to reveal the possible locations for the house. By clicking on the “Rooms” tag, the graph will display the data for the “Rooms” section in the last 24 hours, completing the task.

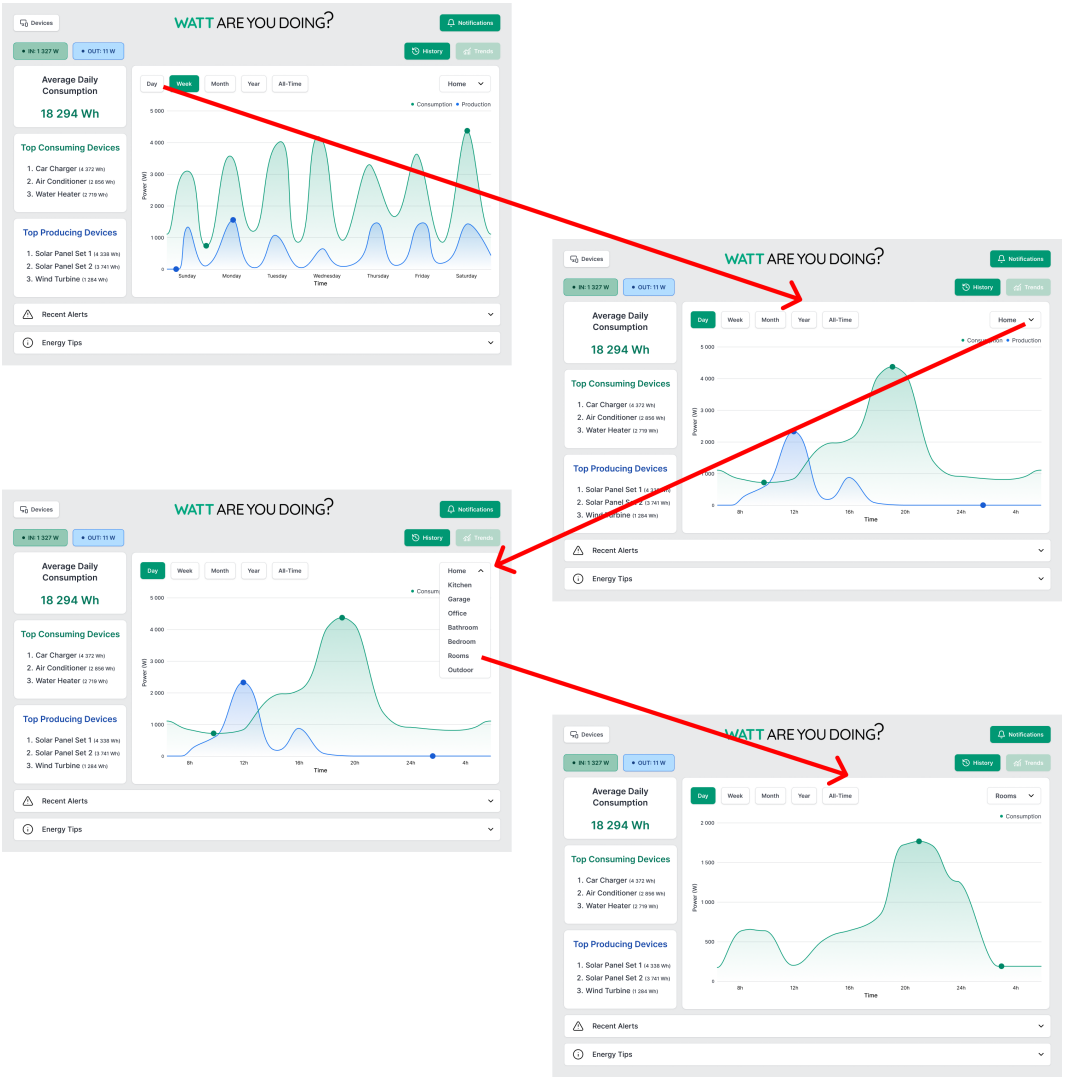


Figure 25: Prototype Task 2

Although not mentioned explicitly in this task, the graph also allows users to filter the data according to energy production/consumption by clicking on the corresponding text on the upper right of the graph. Additionally, the graph also has small dots throughout the lines themselves which serve as indicators of highs and lows on the graph. When the user hovers over one of these points, and indicator is shown giving more information about that event.

4.2.3 Task 3: Investigate Top Energy Spending Devices

Last but not least, the third and most complex task consists of having the user locate the highest consuming device at the moment and performing the

first suggestion to reduce energy consumption.

Similarly to the first task, this task has users going through different screens of the application, so we added different possible flows that could reach the result expected.

To start off, the users has to visit the device page of the highest consuming device. This can be done in two distinct but closely related ways. Starting from the dashboard, we can see on the left a section containing a ranking of the top consuming and producing devices and, in first place, we see the “Car Charger”. To reach the page of the car charger, the user can either directly click on the first place text or go to the “Devices” page by clicking on the button on the top left corner and from there select the “Car Charger” device.

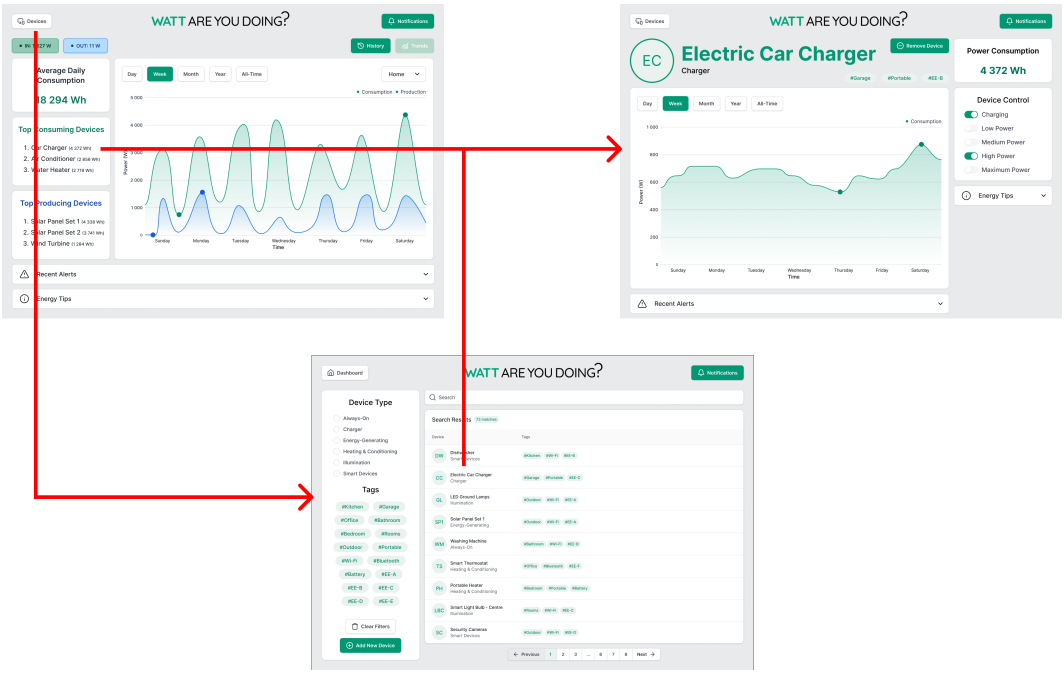


Figure 26: Prototype Task 3: Step 1 to 2

After reaching the page of the top spending device, the user should try to find what suggestions the application has for this device. This can be done by expanding the “Energy Tips” dropdown, which reveals two different tips. The goal of this task is to execute the first suggestion which is to turn off the device for now. At this stage, the user can also complete this action in one of two ways either by clicking on the “Turn Off” switch in the “Device Control” section or by clicking on the energy tip itself. Both of these interactions will create a prompt modal asking the user to confirm the action that is about to be performed. By clicking “Yes”, the user completes the final task.

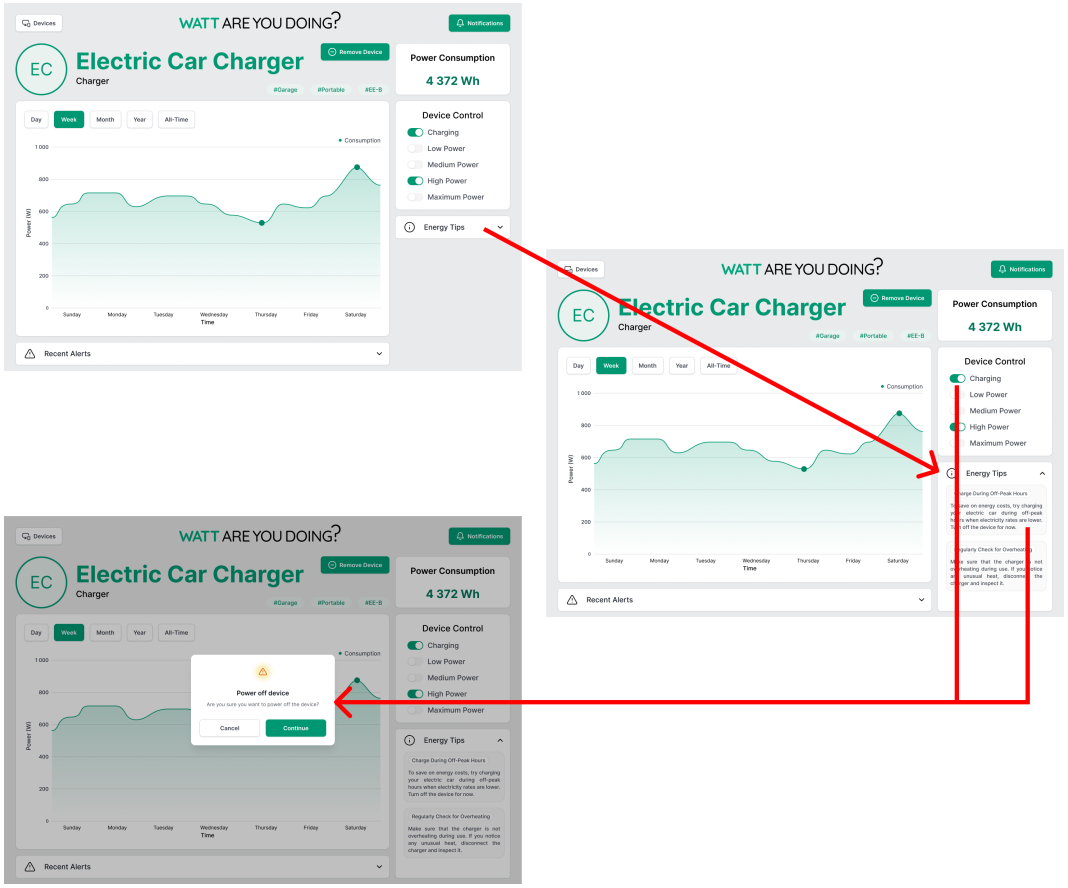


Figure 27: Prototype Task 3: Step 2 to 4

4.3 User Evaluation Protocol

4.3.1 Goal

In this stage of the development of our application, we were aiming to gather summative user feedback on the current version of our prototype. In detail, we want to obtain data about the efficiency and usability of our website interface.

For this, we designed a usability test with an estimated duration inferior to 9 minutes and that would be based on the execution of the three user tasks that we presented earlier. These tasks are related to the most important functionalities of our website, guaranteeing that our most valuable functionalities are implemented in a satisfying and usable way for our users.

4.3.2 Respondents

As presented earlier, our website is mainly targeted at users who would like to control more profoundly and efficiently their energy usage at home.

With this in mind, our target audience for testing is users who are owners or have some responsibility for managing a house. For this, we expect them to be over 18 and under 60 years old, we assume there to be no relevant gender or occupation disparity, however, in order to confirm these assumptions, we asked our respondents to disclose their age, gender, and occupation.

We also planned to ask the respondents of the first questionnaire who showed openness to help in future stages of our development in the questionnaire to execute this test.

To: participants@wattareyoudoing.com
From: survey@wattareyoudoing.com
Subject: Avaliação do protótipo | Equipa Watt Are You Doing?

Olá,

Estamos a entrar em contacto contigo depois de teres preenchido o nosso formulário sobre a plataforma "Watt Are You Doing?" em finais de outubro.

Nós somos a equipa por trás do desenvolvimento deste projeto. Relembrando-te, nós desenvolvemos uma plataforma que permite gerir a energia que consomes em casa de forma fácil e gerir os teus dispositivos.

Desde outubro, temos trabalhado em criar um produto baseado nas opiniões que deste e temos um protótipo que gostávamos que avaliasses.

Desta forma, sem mais demoras, pedíamos-te que preenchesses o seguinte teste de usabilidade, para compreendermos como é que podemos melhorar o nosso website.
Teste de Usabilidade - Watt Are You Doing (no maze)

Acreditamos que demorarás menos de 10min. Caso tenhas problemas a aceder, entra em contacto!

Obrigado pela tua ajuda!
Filipe
em nome da equipa WattAreYouDoing

Figure 28: Email sent to respondents of the first questionnaire

4.3.3 Method

In order to better collect user usage data, we decided to use the Maze platform that through its integration with the Figma platform allows us to test our user experience by defining goals our respondents need to achieve, while letting them test our prototype and recording relevant user data such as time taken for each objective, number of clicks and success percentage.

It's extremely valuable to us to guarantee the quality of the test executed. For this reason, we started by creating the first version of the test that we decided to execute for a small number of people, to understand the problems that the test and the prototype had. We explain the logic for this test below. After this, we executed the complete usability test which we used to draw conclusions.

4.3.4 Pilot test

In order to ensure that our form is clear and our respondents understand the process at hand, we planned to conduct a pilot test with a small group of users. This allowed us to identify any potential ambiguities in the instructions, refine the prototype based on their feedback, and ensure that the goals and tasks set for respondents were achievable and aligned with our research objectives. Feedback from the pilot test will be used to make necessary adjustments before rolling out the full testing phase.

4.3.5 Tasks

While testing our prototype, the respondents were requested to perform the following 3 tasks, which match the tasks defined in phase II.

1. Find details of Refrigerator Device
2. Analyze and Filter Overall Energy Usage
3. Investigate Top Energy Spending Device

4.3.6 Ethics

We believe our test doesn't create any form of stress larger than normal day to day life.

All data provided is anonymized and protected. All GDPR rights apply to all participants.

4.3.7 Metrics

To evaluate the efficiency of our design, we recorded key metrics for each task, including success rate, drop-off rate, misclick rate, and time to completion.

By synthesizing these insights, we aim to understand how our UI aligns with our website's mission from the perspective of our users.

4.3.8 Timeline

In terms of the timeline, by December 7th, we completed the development of our first wireflow. From December 8th to 10th, we conducted a pilot test. Over the following two days, we worked on improvements to the test and the wireflow, and on December 12th, we launched our final usability test. Responses to our form were collected until December 18th.

4.4 Feedback of Pilot Test

As outlined in the evaluation protocol, we conducted a pilot test with 12 users to gather feedback. To maximize the richness of insights, the sessions were conducted in-person, often in the respondents' homes. This approach allowed us to observe users interacting with the form and the prototype in a natural environment, fostering honest responses and minimizing distractions.

During these sessions, participants were guided through the testing process, with the facilitator clarifying what the goal of the test was, taking notes, and occasionally inquiring for clarification on specific behaviors or comments. By engaging directly with the respondents, we were able to capture valuable feedback, identify potential usability issues, and better understand the context of their interactions.

With this first pilot test, apart from minor inconsistencies that we found in the usability test, namely tasks not very clearly explained and incorrect settings at the maze platform, we gathered data that was extremely valuable in refining our prototype.

In fact, we noticed most users neglected the "Devices" button at the top of the page. Due to this, we developed an over-the-interface help that was presented on the first interaction with the prototype.

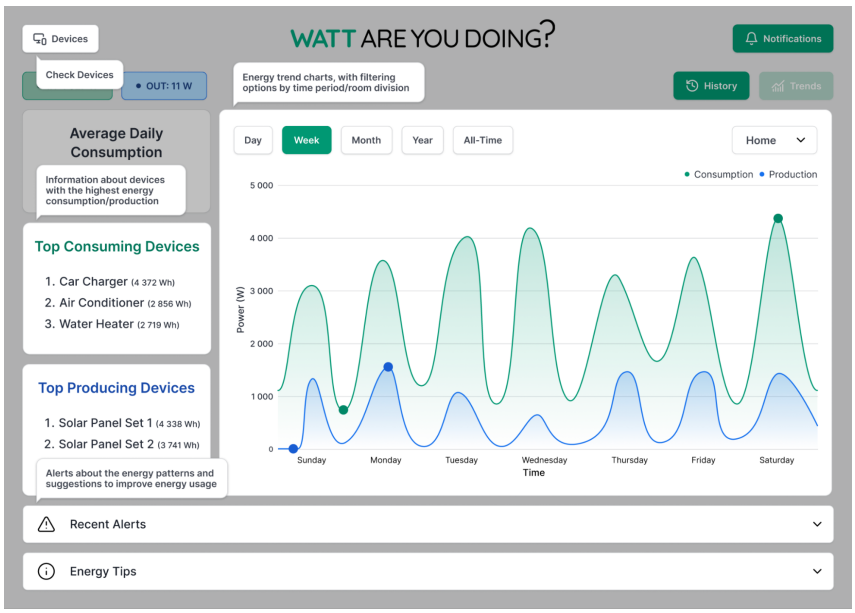


Figure 29: Over-the-Interface help developed after gathering user feedback on pilot test

Additionally, we observed that the layout of the “Devices” page was frequently misunderstood. A significant number of users instinctively looked for a search functionality at the top of the page, which was not implemented in the current design. This highlighted a gap between user expectations and the available features. We then implemented the search functionality.

To address this, we redesigned the interface to improve clarity and usability. The updated layout includes a prominently placed search bar, aligning with user expectations and streamlining the navigation process. We also enhanced the visual hierarchy to guide users more intuitively toward key functionalities.

Moreover, we added more alternative navigation routes within the Figma prototype. These routes ensure users have multiple pathways to complete their tasks, reducing the likelihood of confusion and frustration. By providing more flexibility in navigation, we aimed to accommodate different user behaviors and preferences.

Finally, we updated the text of the test that caused misunderstandings.

These improvements were incorporated into the next iteration of the prototype, ready for subsequent testing phases to validate their effectiveness and ensure they met user needs effectively.

4.5 Results

4.5.1 Sample Characterization

We had 34 respondents who answered all the questions of our test. As the variety of the respondents is sufficiently large and it's greater than 30, we assume a normal population in all the following sections.

4.5.1.1 Age

Most users were in the 18-30 age range with a considerable presence of the 51-65 age range as well, this time we didn't obtain responses from people over the age of 66.

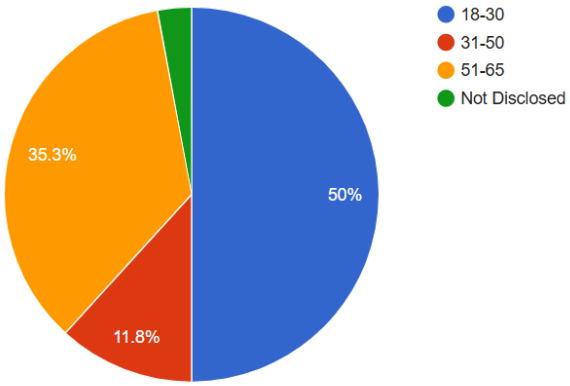


Figure 30: Age of respondents

4.5.1.2 Gender

This time there was little prevalence of the male gender, however, due to its small proportion, no gender preference was considered.

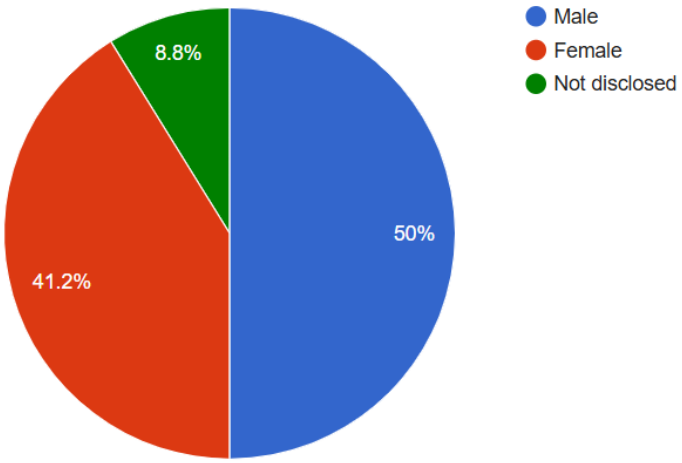


Figure 31: Gender of respondents

4.5.1.3 Occupation

As expected most respondents were either workers or students, with nearly an even split between the two.

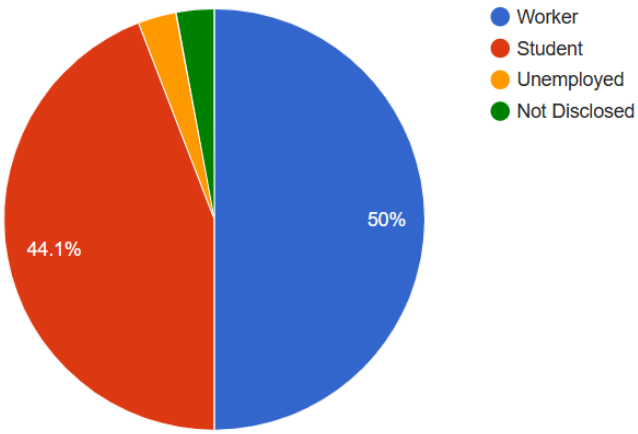


Figure 32: Occupation of respondents

4.5.2 Statistical Analysis

In the following section, we present the results of our statistical analysis for each of the usability test tasks.

4.5.2.1 Task 1

On task 1, we had a 97.1% success rate, having only one individual who was not able to complete the task.

In terms of completion time for the task, these were the statistics we collected:

	Mean	Median	Std. Dev.	CI (85%)	Exp. Value	Q1	Q3	IQR
Time(s)	52.37	38.3	40.59	[42.20-62.54]	40	19.57	68.11	48.54

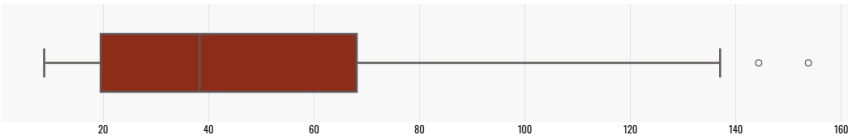


Figure 33: Box-plot of time taken on task 1

As the expected value is below the confidence interval we can determine with 85% confidence level that the duration for task 1 will be 40 seconds or lower.

In terms of clicks, we noticed 11.9% of misclicks, which were clicks on areas not intended to be performed to complete the task.

4.5.2.2 Task 2

In this task we had a 100% success rate and collected the following statistics for completion time:

	Mean	Median	Std. Dev.	CI (85%)	Exp. Value	Q1	Q3	IQR
Time(s)	36.03	19.35	41.53	[25.78-46.28]	35	11.43	46.64	35.21

Figure 34: Box-plot of time taken on task 2

As the expected value falls within the confidence interval, we can't deduce the duration for the completion of task 2.

For this task, maze reported 26.8% of misclicks.

4.5.2.3 Task 3

In Task 3 we also obtained a 100% success rate and collected the following data regarding the completion time:

	Mean	Median	Std. Dev.	CI (85%)	Exp. Value	Q1	Q3	IQR
Time(s)	35.22	21.08	29.81	[27.86-42.57]	30	9.52	61.77	52.25

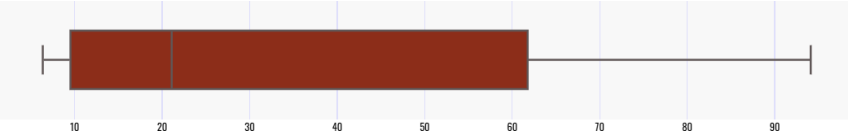


Figure 35: Box-plot of time taken on task 3

Similarly, as the expected value falls within the confidence interval it is not possible to determine with an 85% confidence level the time completion of task 3.

For this task, the misclick rate was 4.8%.

4.5.2.4 Conclusions from the statistical analysis

With only one exception, all users were able to complete the tasks, which indicates a base level of intuitiveness of our design, and, while most tasks had an average completion time bigger than expected, not only can that phenomenon be attributed to the desire of some users to explore the application before trying to complete the task but said time disparity never took big proportions, a similar explanation applies to the misclick rate, which was kept low but its initial higher values can be explained as users trying to understand every functionality of our prototype.

4.5.3 Qualitative Analysis

4.5.3.1 Rating

When asked about their satisfaction level we obtained the following data.

Rating:	1	2	3	4	5	6
Number of occurrences:	1	0	1	3	5	24

Giving an average of 5.4.

4.5.3.2 Feedback

In the beginning, to analyze the qualitative feedback given by the respondents, we built the following word map:

Figure 36: Word map of the qualitative feedback given

And, while analyzing our feedback in a more detailed way, we reached the following conclusions.

Overall, the app has received positive feedback for its intuitive design and clean interface. Users found it easy to navigate and appreciated the layout, which made key information stand out without feeling cluttered. Many highlighted features, like tracking consumption by device and receiving tips, added to the app's overall value. The quality of the widgets and buttons also impressed users, who described the app as user-friendly and well-constructed. This way, the simplicity of the app made it easy to use, and many felt it was effective for its purpose.

However, there were a few areas where users felt the app could be improved. Some found the navigation confusing, with menus that were sometimes overwhelming due to too much information. The first task was particularly mentioned as being hard to figure out, though it got better as they progressed. There were also issues with the app layout, with one person noting that it was too large for their screen, while others wondered how well it would work on mobile devices. Suggestions included adding a tutorial for first-time users, especially for older users, and rethinking the confirmation modal when disabling charging, as it felt unnecessary and frustrating for some.

5 Conclusion

Throughout this project in Human Computer Interaction, we were able not only to develop a high fidelity prototype for a web application we designed, but more importantly we experienced the methodologies used to develop this product deepening our understanding about Human Centered Design.

The goal of this project is to iteratively develop a user interface with the user's needs and perspectives as the central point, and, in order to achieve that, we used several different techniques discussed in class, such as technology and user research, questionnaires, PACT analysis, personas and activity scenarios, heuristic evaluations and user evaluations (in our case, including pilot testing). We believe that learning and especially applying these methods greatly contributed to the success of the final product and also renewed our approach to developing software and applications.

Besides this, we were also encouraged to work with commonly used tools (such as Figma and Maze) in order to develop and test the low and high fidelity prototypes. This allowed us not only to learn more about how and when to use them but also strengthened our capabilities in adapting to different tools.

In conclusion, we can say that we are very proud of the final product and the entire process associated with this project. We believe that we learned a lot by doing this practical assignment and hope to be able to use the skills grasped in future challenges.

6 Appendix

6.1 Part I Annexes

6.1.1 Questionnaire

6.1.1.1 Description

Title: Opinião sobre Plataforma de Gestão Energética @Home

No âmbito da cadeira de Interação Pessoa-Computador, a equipa L0402 pretende desenvolver uma aplicação web que permita o controlo do consumo energético e gestão de dispositivos, quer estes sejam eletrodomésticos clássicos ou dispositivos inteligentes.
Este sistema tem como objetivo final ajudar os seus utilizadores a poupar energia com sugestões personalizadas ao seu perfil de consumo e tipo de dispositivo.
Este inquérito pretende compreender qual o perfil dos nossos utilizadores e compreender em que funcionalidades nos devemos focar para que o nosso produto se adapte à sua vida.
As respostas adquiridas neste inquérito serão tratadas de acordo com o RGPD. Não são associadas quaisquer informações pessoalmente identificáveis às suas respostas.

6.1.1.2 Questions

1. Idade
    - 16-20
    - 21-35
    - 36-50
    - 51-65
    - 66+
2. Género
    - Masculino
    - Feminino
    - [Open-ended response] Outra opção...

3. Quantos destes dispositivos tem em casa?

    - Eletrodomésticos (ex. Frigorífico, Máquina de lavar,..)
    - Dispositivos inteligentes (inc. luzes inteligentes,..)
    - Paineis Solares

    Columns: 0, 1-7, 8-15, 16+

4. Quanta energia mensal a sua casa gasta (em KWh)?

    - 0-170
    - 171-330
    - 331-500
    - 501+
    - Não sei

5. Utiliza algum sistema de gestão de energia e dispositivos em sua casa?

    - Não utilizo nenhum sistema
    - App EDP Energy
    - Brightly
    - Hark
    - SMA Energy
    - [Open-ended response] Outra opção...

6. [Open-ended response] Que funcionalidades usa/gosta mais no seu atual sistema de gestão de energia

7. Como descobriu o seu atual sistema de gestão de energia?

    - Amigos
    - Família
    - Website/Blog
    - Revista/Jornal
    - Cartazes
    - Redes Sociais

8. Estaria interessado em monitorizar o seu consumo de energia?
    - Sim. Já o faço
    - Sim. Ainda não faço, mas gostava de começar
    - Não
9. [Max. 3 choices] Que tipo de sugestões de poupança e gestão de energia gostaria de receber?
    - Melhor horário para carregar ou usar dispositivos
    - Dispositivos com maior consumo (ou pior eficiência)
    - Detetar aplicações de dispositivos inteligentes a correr em segundo plano
    - Configurar definições dos dispositivos
    - Otimização consumo da energia elétrica produzida por painéis solares
    - [Open-ended response] Outra opção...
10. Com que frequência gostaria de monitorizar o seu consumo energético?
    - Diariamente
    - Semanalmente
    - Mensalmente
    - Anualmente
11. Considera importante monitorizar o consumo energético em tempo real?
    - Sim
    - Não
12. [Open-ended response] Tem alguma sugestão que gostaria de dar?
13. [Open-ended response] Caso queira participar em futuros protótipos e testes da aplicação por favor deixe aqui o seu e-mail:

6.1.2 Questionnaire Results

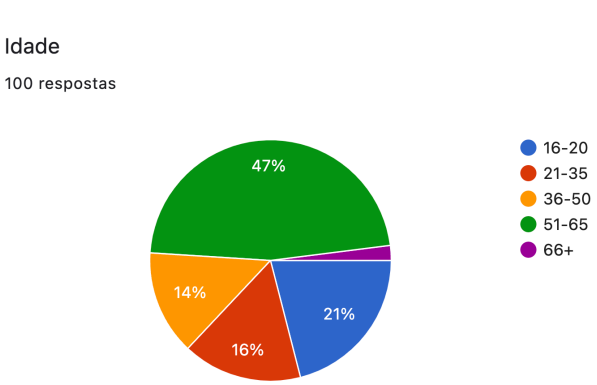


Figure 37: Responses to question 1 - ”Idade”

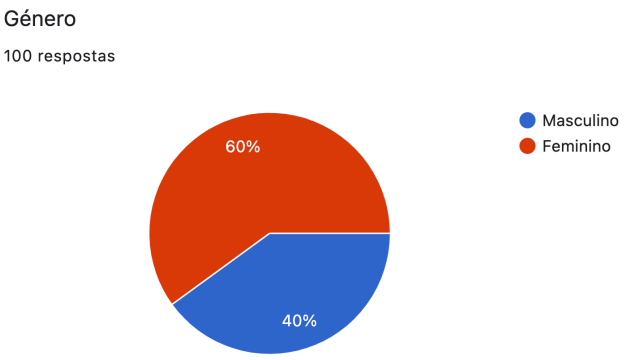


Figure 38: Responses to question 2 - ”Género”

Figure 39: Responses to question 3 - ”Quantos destes dispositivos tem em casa?”

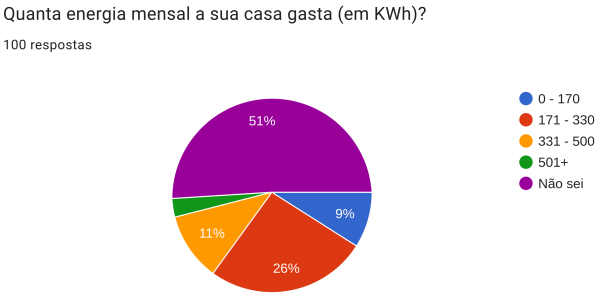


Figure 40: Responses to question 4 - ”Quanta energia mensal a sua casa gasta (em KWh)?”

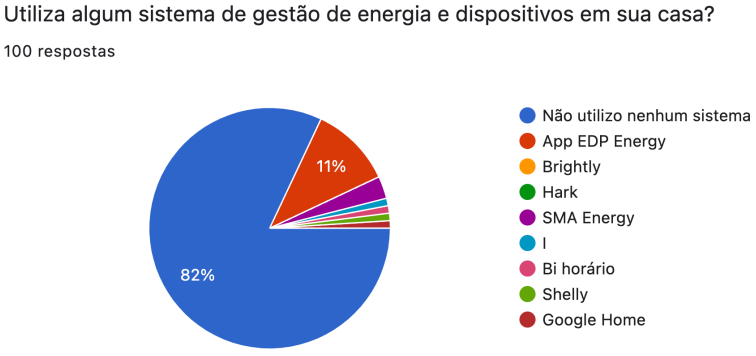


Figure 41: Responses to question 5 - ”Utiliza algum sistema de gestão de energia e dispositivos em sua casa?”

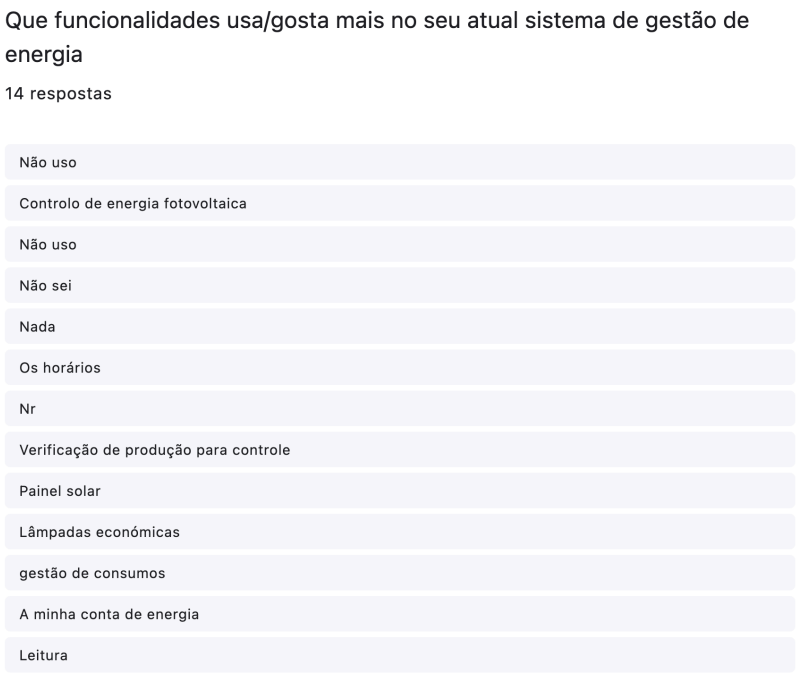


Figure 42: Responses to question 6 - ”Que funcionalidades usa/gosta mais no seu atual sistema de gestão de energia”

Figure 43: Responses to question 7 - ”Como descobriu o seu atual sistema de gestão de energia?”

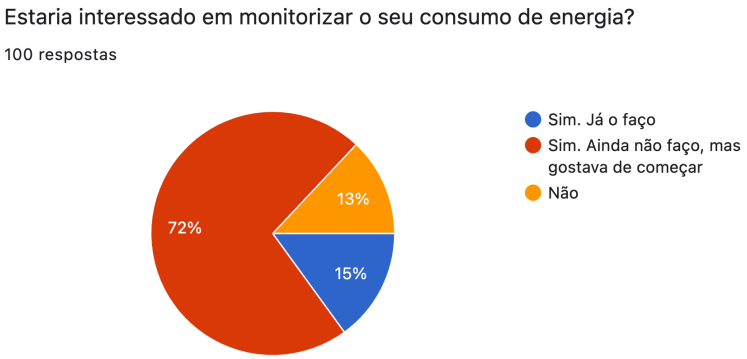


Figure 44: Responses to question 8 - "Estaria interessado em monitorizar o seu consumo de energia?"

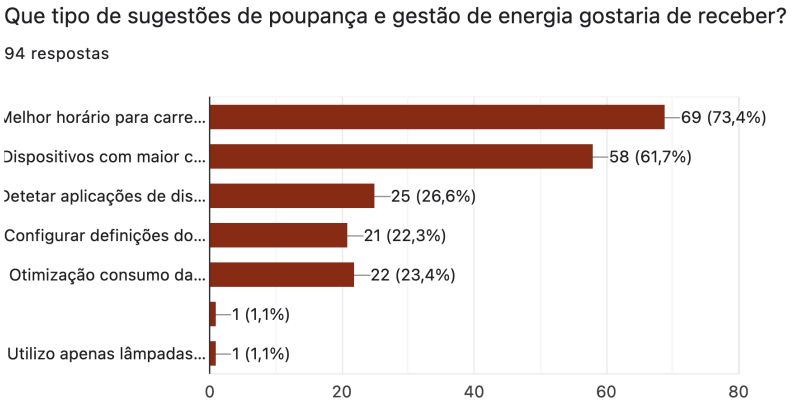


Figure 45: Responses to question 9 - "Que tipo de sugestões de poupança e gestão de energia gostaria de receber?"

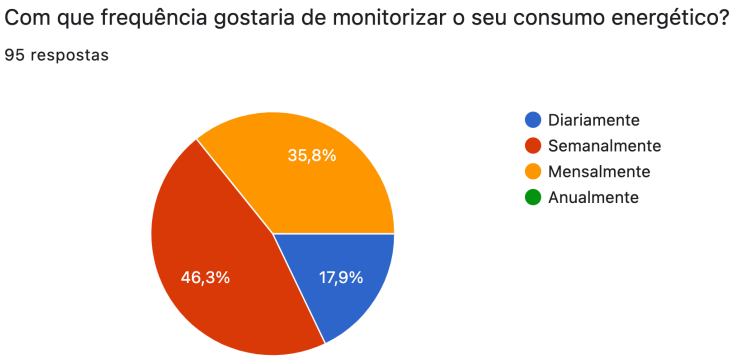


Figure 46: Responses to question 10 - "Com que frequência gostaria de monitorizar o seu consumo energético?"

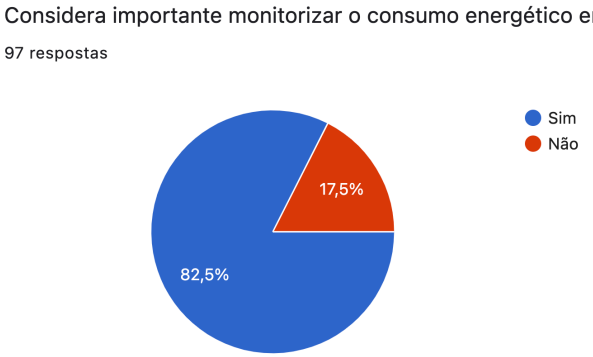


Figure 47: Responses to question 11 - "Considera importante monitorizar o consumo energético em tempo real?"

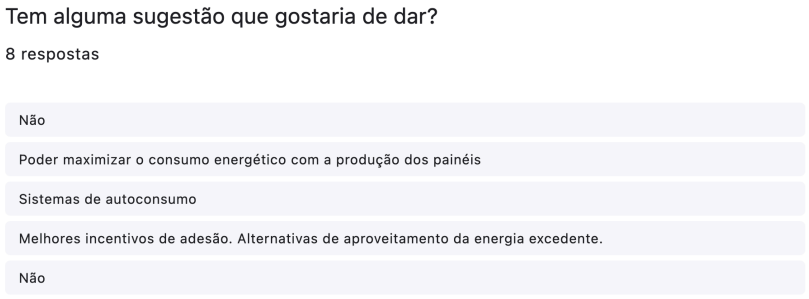


Figure 48: Responses to question 12 - "Tem alguma sugestão que gostaria de dar?"

6.2 Part II Annexes

6.2.1 Sent Heuristic Evaluation Reports

HCI Winter Semester 2024 - 2025

Heuristic Evaluation Report

Class Nr.: LEIC04 - 12/11/2024 - Thiago Sobral Silva
Group evaluated: 04 - EnergySync
By group: 02

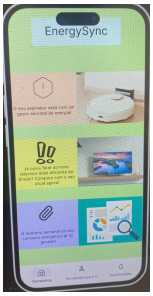
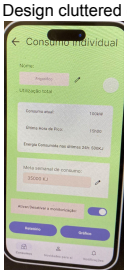
Problem #	Issue (include screenshot)	Heuristic(s)	Severity (1-4)
1	Texto demasiado pequeno (baixa acessibilidade). 	4. Consistency and Standards	2
2	Design cluttered (e pouco minimalista). 	8. Aesthetic and Minimalist Design	3

Figure 49: Sent Heuristic Evaluation Report - Page 1

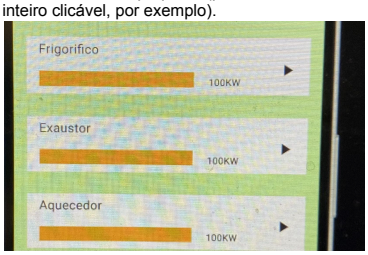
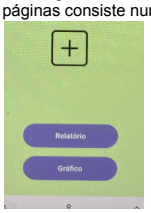
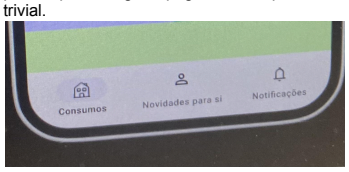
3	O botão que redireciona para a página do consumo dos dispositivos, no card da página de consumo, é muito pequeno (podia ser o card inteiro clicável, por exemplo). 	7. Flexibility and efficiency of use	2
4	O flow é pouco eficiente (é necessário fazer demasiados cliques para chegar à página de gráficos).	7. Flexibility and Efficiency of Use	2
5	Existe alguma inconsistência incomodativa entre os designs de botões e elementos textuais (certas páginas consiste num símbolo, noutras texto). 	4. Consistency and Standards	1
6	Não há link para página inicial home (embora se possa voltar para trás, não é o mais intuitivo e podia ser acrescentado um botão na navbar). Desta forma, implica que seja memorizado um padrão para chegar à página inicial que não é trivial. 	5. Recognition rather than Recall	1

Figure 50: Sent Heuristic Evaluation Report - Page 2

7	Apesar de a plataforma não ser muito complexa, não há qualquer ajuda ou documentação e podiam haver mais indicações visuais.	10. Help and Documentation	1

NOTA: Além disso, consideramos que a linguagem era muito clara e natural pelo que seguia a heurística “Match Between the System and the Real World”.

Figure 51: Sent Heuristic Evaluation Report - Page 3

6.2.2 Received Heuristic Evaluation Reports

HCI Winter Semester 2024 - 2025

Heuristic Evaluation Report

Class Nr.: LEIC04 - 12/11/24 - Thiago Sobral
Group evaluated: 02 - Watt are you doing?
By group: 04

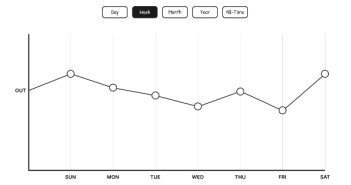
Problem #	Issue (include screenshot)	Heuristic(s)	Severity (1-4)
1	As opções de filtragem, como filtrar os gráficos de consumo (por dia, mês, etc), ver elementos consumidores por tag, são demasiado pequenas, o suficiente para tornar a leitura difícil. 	7	1
2	É demorado o processo de encontrar a opção de adicionar um dispositivo consumidor, ou mesmo a de removê-lo, e sendo estas duas funcionalidades importantes, poderia ser mais rápido encontrá-las.	3,7	3
3	O gráfico de consumo principal não tem escala para os valores de consumo. 	2	1
4	O consumo geral do domicílio é expresso em Wh o que pode não dar termo de comparação ao utilizador.	2	1

Figure 52: Received Heuristic Evaluation Report - Page 1

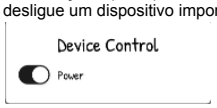
			
5	O botão de desligar um dispositivo não requer confirmação e pode permitir que um utilizador desligue um dispositivo importante por engano. 	5	2

Figure 53: Received Heuristic Evaluation Report - Page 2

References

[1] SMA Solar Technology AG. SMA Energy App | SMA Solar. https://www.sma.de/en/products/apps-software/sma-energy-app, [Online; accessed 14 October 2024].

[2] Frederic Christian. Loading Spinner & Bars | Animated | Figma. https://www.figma.com/community/file/1183111865001388870, [Online; accessed 30 December 2024].

[3] EDP. Re:dy. https://www.edp.com/pt-pt/inovacao/redy, [Online; accessed 14 October 2024].

[4] Freedompro. Freedompro | Build your smart home, module by module. https://freedompro.eu/, [Online; accessed 14 October 2024].

[5] Google. Manage Your Smart Home With Google Home | Google Home. https://home.google.com/welcome/, [Online; accessed 14 October 2024].

[6] Brightly Inc. CMMS & Enterprise Asset Management Solutions | Brightly. https://www.brightlysoftware.com/, [Online; accessed 14 October 2024].

[7] Hark Systems Ltd. Hark: Energy Management Software for Commercial & Industrial Buildings & Assets. https://harksys.com/, [Online; accessed 14 October 2024].

[8] Stark. Stark - Contrast & Accessibility Checker | Figma. https://www.figma.com/community/plugin/732603254453395948/stark-contrast-accessibility-checker, [Online; accessed 30 December 2024].

[9] Untitled UI. Untitled UI — Figma UI Kit and Design System. https://www.untitledui.com/, [Online; accessed 30 December 2024].

[10] Varun. Tailwind Color Palettes | Figma. https://www.figma.com/community/plugin/853905984020840743/tailwind-color-palettes, [Online; accessed 30 December 2024].