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FEUP FACULDADE DE ENGENHARIA
UNIVERSIDADE DO PORTO

SunLite

Overflowing energy

Human-Computer Interaction 2024-2025

Phase III - Hi-fi prototype and user evaluation

3LEIC T12 G05

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Part I - User and Task Analysis

Idea Description

SunLite is a mobile app whose main goal is to automate users' homes, with a special focus on electrical management and its impact on household appliances. With the capability of tracking the electricity consumption and production, SunLite provides a detailed overview of a house's renewable energy production – based mostly on solar panels – ensuring that this crucial process becomes less tedious and simpler.

With its intuitive design, the app helps users navigate through numerous graphs and menus, even if they have less experience in monitoring apps. Along the same line of reasoning, the app will include suggestions to harness the produced power and warn about suspected problems.

The fact that it is available on a mobile platform offers better accessibility for users and higher practicality than other platforms. In a situation where managing house appliances and solar panels often requires direct contact and proximity, with the prevalence of mobile devices nowadays, their configuration and control can be easily achieved through the phone. Additionally, by the nature of this app's features, being on a small and portable device facilitates analysis, management, and configuring from outside the home.

Ultimately, the app will supply a succinct but thorough analysis of data, based on the energy produced by the user's solar panels, and will provide a straightforward method for users to program their house and their appliances according to their wishes.

Related Apps

To assess the viability of our app's concept within the market and to identify the importance of specific features and potential enhancements in response to any absent features, we chose to analyze 4 apps: EDP Solar, Iberdrola Clientes Portugal, Energy Brain, and Wiser Home. The following sections will detail the characteristics, unique selling points, and limitations of each application:

EDP Solar

As an app for the *Energia Solar EDP* service, which installs solar panels for individual consumers, it provides real-time data on both energy consumption and solar production, helping the tracking of savings and managing energy usage effectively. The app also allows monitoring of battery storage data and sends alerts for irregular consumption or system failures, ensuring efficient energy management and continuous power supply.

On the other hand, the app restricts its client base to subscribers to that service and lacks integration with Smart-Home devices.

Iberdrola Clientes Portugal

It allows users to manage their energy accounts, view and pay bills, monitor energy consumption, submit meter readings, and access customer support. It offers a user-friendly interface for tracking energy usage and managing contracts, providing real-time insights and notifications.

The user restriction to Iberdrola's clients and the inconsistency of the user interface (UI) and updates are some of the downsides of this app.

Energy Brain

This software, made by the Portuguese company InfoControl and available exclusively on PCs, is a platform designed for monitoring and managing energy consumption across multiple sources, such as electricity, gas, water, and steam. It allows users to gather real-time data and analyze it through extremely detailed and customizable graphical reports.

Requiring high technical knowledge and having counter-intuitive usability, coupled with a weak and outdated UI, makes this software not appealing for most users.

Wiser Home

Created by Schneider Electric, it offers full control of the smart home, integrating heating, lighting, air conditioning, and a lot more into one platform. It is available for mobile devices and integrates voice assistants (Google Assistant and Alexa). It allows monitoring of energy usage, automation of devices at once, and management of energy efficiency.

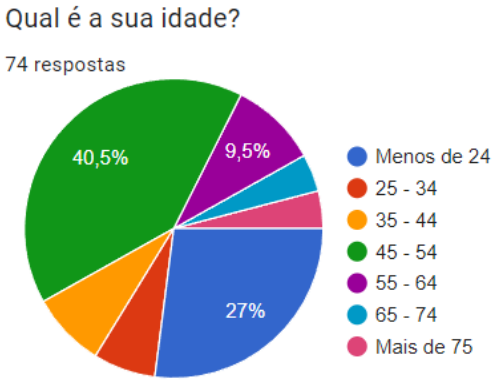
Its extreme dependence on products from the Wiser brand makes the app unusable otherwise. By focusing on Smart-Home features, it requires coverage of a wide range of devices, at the expense of the interface's quality and inconsistent connection establishment to each device.

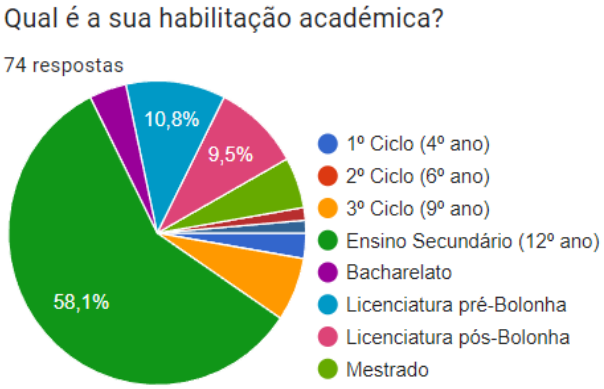
Questionnaire Highlights

To better understand the population this app is targeting, a questionnaire was shared through social media to a carefully selected sample. It includes students from several universities, namely from Faculdade de Engenharia da Universidade do Porto (FEUP), Faculdade de Economia da Universidade do Porto (FEP), Escola de Ciências da Universidade do Minho (ECUM) and Escola Superior de Enfermagem de Lisboa (ESEL), who make up most of the young population. It was also sent to the group members' families, and local communities from Porto, Vila Nova de Gaia, and Lousada, which provided information on the older age groups' views about related apps and the context surrounding them.

Participants' Characteristics

The age of the participants encompasses various age groups, with 40.5% falling within the 45-54 age range and 27% being under 24 years of age. The educational qualifications of the majority of the participants correspond to the completion of the 12th grade (58.1%). This significant diversity in responses is crucial for the reliability of the results. Furthermore, it is possible to draw a comparison between the responses of younger individuals (under 35 years old) and older individuals (35 years old and above), whose responses vary significantly in several aspects that will be explored below.





Participants' position on the electricity market

Only 24.7% of the participants currently engage in electricity production; however, 38.4% express a desire to do so, while 26% indicate that they lack the necessary conditions for electricity generation. This suggests a notable interest among the population in producing energy within their homes.

In response to the question, "If you produce energy at home, what are your reasons?", older participants (aged 35 and above) primarily cite the desire to save money (72,7% vs. 22.7% who prioritized environmental concerns), whereas younger respondents (under 35) place greater significance on environmental concerns (37,5% vs. 43,8% who prioritized saving money). The difference in motivation behind electricity production in residential settings – whether due to generational differences, evolving values and priorities with age, or other social factors – highlights two critical aspects that SunLite can enhance.

When asked, "If you do not produce energy, what are the reasons for that?", younger respondents (<35% of the participants) predominantly mention a lack of home ownership (40.9%) and insufficient financial resources (36.4%). In contrast, older participants (35 years old and above) provide a broader range of reasons, including financial constraints (28.9%) and a lack of time and effort to dedicate to energy production (21.1%).

Feature Analysis

In general, both audiences show the same interest in the functionalities. The proposed features that garnered the most interest are *monitoring electricity consumption and production*, *app notifications*, and *scheduling of house appliances' activity*. Additionally, *integration with the contracted operator*, and *categorization of consumption*, received significant approval from the public. Conversely, the features deemed less relevant are *exporting data to Excel/CSV files* and *the ability to create/customize one's statistics*.

PACT Analysis

This analysis is a framework to inform the designers about the characteristics of the *people* who will use the application, how they perform their *activities*, the *contexts* that they are inserted in, and the *technologies* that they use to perform said activities.

People

Educational Qualifications of the Population

The general population predominantly holds a completed secondary education (12th grade), indicating a relatively high level of academic qualifications.

Electricity Production

The majority of the population does not have electricity production systems in their homes. However, there is significant interest in adopting renewable energy.

Interest by Age Groups

The observation showed that various age groups within the population are interested in the electricity market, indicating the topic's relevance for different demographic segments.

Knowledge of the Electricity Market

While the population shows some knowledge of how monitoring applications function, a considerable portion of them lack an adequate understanding of how the electricity market operates and the available monitoring applications.

Financial Difficulties

Additionally, many individuals face financial difficulties that hinder their entry into the renewable energy market. This is due to the high initial investment required, and the time it takes to achieve a return on that investment may not be justifiable for many people.

However, as the years progress, the price of technology and its efficiency are on the rise, which may prove more advantageous in the future.

Activities

Real-Time Monitoring of Energy Production and Consumption

Goal: To monitor energy production and consumption within the household.

Task: Access a dashboard that displays comprehensive information regarding the household's energy production and expenditures.

Steps:

1. Access the application provided by the contracted operator responsible for the installation of the solar panels.
2. Navigate to the monitoring section and select the appropriate tab.

This structured approach enables users to effectively track their energy usage and production in real-time, promoting informed decision-making regarding energy consumption.

Identifying Optimal Times to Use Appliances

Goal: To maximize energy savings by ensuring that certain devices operate only during optimal times (when prices are lowest).

Task: To interpret a graph showing electricity costs over time.

Steps:

1. The user opens a web browser.
2. Accesses the REN website.
3. Navigates to the Data Hub.
4. Selects the "Electricity" tab, followed by "Market".
5. Chooses specific days and times to analyze market values.

This systematic approach enables users to determine the best times to use their appliances, thereby optimizing their energy consumption and reducing costs.

Analysis of Historical Production and Consumption

Goal: To identify trends and patterns over time to facilitate informed decision-making.

Task: To compare energy production data across different time periods.

Steps:

1. The user accesses the application connected to their energy network.
2. Navigates to the statistics section and selects the desired time period for the analysis.

This methodical process allows users to evaluate their historical energy data, enhancing their ability to make strategic decisions regarding energy management.

Scheduling Devices for Optimal Use

Goal: To allow the user to create a schedule for a household appliance to be turned on at a specific time.

Task: To configure a smart plug via a mobile app to program the device.

Steps:

1. Purchase a smart plug.
2. Install the smart plug into a standard electrical outlet and connect the device's plug to it.
3. Connect the smart plug to a mobile app.
4. Create a schedule for the device based on the user's preferences and prior research.

Context

Circumstances under which Activities Happen

In the context of work, professionals involved in the management and operation of energy systems face long and challenging shifts, often working in rotating schedules. The nature of these operations demands a high level of attention and constant monitoring, which can lead to significant stress. Moreover, the need to make real-time decisions, often under pressure, intensifies the situation. However, the use of mobile devices and computers nowadays has increased, creating a continuous flow of information and the simultaneous execution of tasks, although it can also contribute to cognitive overload for the user.

Social Environments

Social environments play a crucial role in shaping habits and promoting energy efficiency practices. Users may interact with family and friends, fostering discussions on ways to improve energy consumption and efficiency. Such conversations can generate valuable insights and encourage the adoption of more sustainable behaviors.

Physical Environments

The physical environments in which decisions are made have a direct impact on the quality of the choices being made. It is ideal for users to operate in quieter locations, where conditions are favorable for reflection and careful consideration. Complex decisions, especially those involving energy efficiency strategies, tend to be more challenging in chaotic environments, where distraction and external pressure can lead to hasty conclusions.

External Factors

Various external factors also shape the landscape in which energy management activities occur. Government policies, market trends, technological evolution, and climate change are among the aspects that must be considered. For example, the role of government policies is crucial in promoting incentives for the adoption of renewable energy sources, as evidenced by recent programs presented in the 2024 state budget. Awareness of these external factors and their influence on energy decisions is essential for developing effective and sustainable strategies. [1]

Technologies

Tools and Equipment

The effective management and operation of energy systems rely heavily on a diverse array of tools and equipment, particularly in the context of residential energy production. Many energy providers now offer services that facilitate the installation of energy generation systems in homes, such as solar panels and small wind turbines. These services typically include site assessments, customized solutions, installation, and ongoing maintenance, making it easier for consumers to adopt renewable energy technologies.

Solar panels, in particular, have become increasingly accessible and efficient, allowing households to harness solar energy directly. This technology not only contributes to reducing energy bills but also promotes sustainability by decreasing reliance on fossil fuels. In addition to solar panels, small wind turbines can be deployed in suitable locations, further diversifying energy sources at the residential level.

An important advancement in this landscape is the integration of smart meters. These intelligent meters enable real-time monitoring of energy consumption, providing consumers with detailed insights into their usage patterns. Smart meters facilitate two-way communication between the consumer and the utility provider, allowing for dynamic pricing models and enhanced grid management. They empower users to make informed decisions about their energy consumption and can alert them to peak usage times, enabling strategies to reduce costs and enhance efficiency.

IT Solutions

In addition to physical tools, robust IT solutions are vital for enhancing operational efficiency. Data management platforms are instrumental in aggregating and analyzing vast amounts of information generated by energy systems. These platforms facilitate data-driven decision-making, allowing users to identify patterns, forecast trends, and optimize resource usage. The integration of artificial intelligence (AI) into these systems further enhances capabilities, enabling the automation of processes and the optimization of energy flows. For instance, AI algorithms can analyze historical data to improve demand forecasting, ensuring that energy supply aligns more closely with consumer needs, thereby reducing waste and enhancing overall efficiency.

Future Innovations

Looking ahead, the energy sector is set for transformative changes driven by future innovations. Technologies for energy storage, such as advanced battery systems, will play a pivotal role in enhancing grid stability and enabling the efficient use of renewable energy. These storage solutions will allow for the accumulation of energy during periods of low demand or high production, which can then be released during peak demand times, ensuring a consistent energy supply. [2]

Smart grids represent another significant advancement, utilizing digital technology to monitor and manage the distribution of electricity more efficiently. These grids allow for interaction between consumers and providers, enabling real-time adjustments and enhancing the reliability of the energy supply. Additionally, solutions for the integration of renewable energy sources are becoming increasingly critical. Technologies that allow for the seamless incorporation of solar, wind, and other renewable sources into existing energy infrastructures are essential for reducing carbon footprints and promoting sustainability.

Personas

According to the Questionnaire Highlights and the PACT Analysis, we summarized the possible users of our app in 2 distinct personas: the Specialist and the Environmentalist.

Persona 1: The Specialist

Data collected from the survey to create this persona:

This persona is depicted as a middle-aged man who started to invest in the production of solar energy to save money in energy bills. He would like to analyze the power produced from his solar panels and understand how to increase efficiency in production and consumption, although he doesn't have all the necessary skills for the task ahead. Besides, he is also interested in automating his home by having a control panel to activate his devices whenever he wants.

Identification of the persona:

Quote: "Control over technology gives me stability in my life and decisions."

Name: Nuno Gomes Pereira

Age: 45
Education Level: Bachelor's Degree
Occupation: Electrotechnical Technician
Family: Married and lives with his family
Location: Maia, Porto
Technological Proficiency: High
Preferred Devices: Phone, Laptop
Archetype: The "Specialist"

Personality Traits: Meticulous, Skeptical, Studious, Stubborn, Enthusiast

Motivations:

Being at the forefront of technology and innovations from a young age, Nuno discovered the long-term economic advantages of home energy production through solar panels 10 years ago. Since then, he has been focused on monitoring the electrical production and consumption of his home. This task proved to be more difficult than expected, given the lack of information available from the provider.

Needs:

- He aims to achieve a high level of energy independence, reducing reliance on the information monopoly of the contracted provider.

- He has knowledge of solar panel systems. However, in his opinion, it is important to understand the best practices for using his electrical network to obtain the best cost-benefit ratio.
- He intends to maximize the efficiency of the solar panels to reduce the electricity bill at the end of the month.
- He needs tools that help him analyze production and consumption data, with this information being accurate and accessible in real-time and over time.

Frustrations:

- He does not settle for having few options in terms of functionalities and technological resources. For him, controlling a home should be done in the palm of his hand.
- He does not trust the advice of online professionals. Therefore, he intends to analyze the data himself and reach his own conclusions, which increases his frustration when he reaches a dead-end.
- His obsession with small details makes him forget the important points for his goal - saving money - leading him to constantly invest in more effective and efficient methods.
- His desire for autonomous technology conflicts with his ideal of maximizing his savings for the future.

Persona 2: The Environmentalist

Data collected from the survey to create this persona:

This persona is described as a young adult woman who wants to save the ecosystem of the world by reducing her family's environmental footprint. To achieve this mission, she will need an app she can trust to provide relevant information to produce as much renewable energy as possible. Nevertheless, she neither has knowledge of how the energy market works, nor how to use a monitoring app. Additionally, at the moment, she gives little to no importance to controlling her house appliances and other devices.

Identification of the persona:

Quote: "The world is suffering from climate change, but each of us can make a difference!"

Name: Ana Isabel Da Costa Ribeiro

Age: 24
Education Level: Graduated Highschool
Occupation: Activist
Family: Parents and brother

Location: Guimarães, Braga
Technological Proficiency: Medium
Preferred Devices: Phone, Laptop
Archetype: The "Environmentalist"

Personality Traits: Worried, Hardworking, Altruistic, Brave, Pessimist

Motivations:

Born from a wealthy family, Ana Isabel has always lived a comfortable life in the suburbs, where there are plenty of parks and gardens. Hence, growing up in this environment made her appreciation for nature flourish, and her will to stop climate change even greater. After coming of age, she decided she would take action by using her resources: the solar energy production her family already owned. However, concluding her studies early on to become an activist was detrimental to understanding how to upgrade her family's productivity and efficiency.

Needs:

- As she is unable to rebuild the planet from scratch, she limits herself to living in a house almost independent of the suburban network. To do so, she wants to invest time in upgrading the production and consumption of her solar panels, and thus reduce the extraction of natural resources needed to sustain her house.
- She looks forward to getting an app that tells her the best times to enjoy her air conditioner or charge her laptop.
- She wants a system that guarantees results succinctly and without too many complications since she is not comfortable reading technical articles.

Frustrations:

- She feels that, despite her efforts, the world is heading towards a future full of problems related to pollution and fossil fuel extraction.
- She is frustrated by the lack of support from the authorities to facilitate environmental initiatives.
- Although she knows a lot about how to reduce consumption, she still struggles to understand what actions her family should take to reduce the energy overload of her home.
- She has neither technical knowledge of how to manage an electrical network, nor of how the energy market works.
- Reticent to join new plans and apps, as many have disappointed her with their inability to detect problems.

Activity Scenarios

Persona 1: The Specialist

Nuno wants to save money by setting up a schedule for his washing machine so that it only turns on after the current electricity price is below a certain threshold, defined by him. Therefore, he opens the app and goes to the automation tab. Then he selects the outlet that is connected to his washing machine and inserts the desired electricity threshold. All that is left is choosing the day when the appliance will operate and selecting the operating mode (repetition or one time).

Persona 2: The Environmentalist

Ana Isabel does not want to rely as much on non-renewable energy, so the stability of her solar energy supply is extremely important to her. Because of this, she wishes to receive notifications about potential threats in her solar panel network. Therefore, she opens the app and goes to the settings tab. Then she turns on the notifications and selects that she wants to receive warnings about her green energy supply.

Functionalities

Monitoring panel

The monitoring panel is a feature designed to help the user with the analysis of their electricity consumption and production, electricity prices, and statistical trends over time. This tool provides users with critical insights necessary for keen decision-making in the energy sector.

Automation Center

The Automation Center is a feature that plays a pivotal role in the SunLite app. It was designed to provide users with seamless control over their appliances and other devices within their Smart Home by defining on/off schedules dependent on market fluctuations. This feature enhances efficiency, convenience, and energy management through automated processes.

Notification System

The Notification System was designed to keep users informed about optimal appliance usage through market analysis or potential issues within their electrical grid. By providing timely alerts and insights, this system enhances energy efficiency and ensures a reliable electricity supply.

Part II - Lo-fi Prototype and Heuristic Evaluation

Project abridged description

SunLite is an app whose main goal is to help its users with managing and automating their consumption and production of electricity.

Functionalities:

The functionalities that our project will accommodate to support this goal are presented in the following bullet points:

- Monitoring panel (statistical analysis of consumption and production of electricity, etc.)
- Automation center (manage the activity of devices)
- Notification system (best times of day to turn on/off devices, problems in their electrical grid, etc.)

Tasks:

These functionalities can be fulfilled by determining a set of main tasks that the user must do in the application we are currently creating. In general, the tasks that we consider worthy of exploring are:

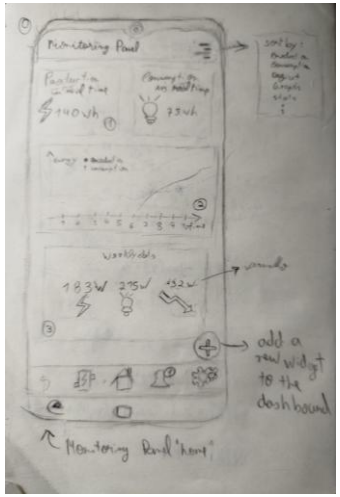
- **Check the today's production/consumption:**
  - A user must be able to check the electrical network statistics, in particular, the production levels of producing devices and consumption levels of the overall connected devices.
- **Create a new program to a specific device**
  - A user must be able to program a device to turn on whenever a condition is met. The conditions imply that the user wishes to turn on that specific device whenever their value is true. These conditions must be editable any time. Thus, requiring the user to create a new program is key.
- **See the new notification about the state of electrical market**
  - A user must be able to receive notifications not only of the status of the network but also of the prices of the electrical market.

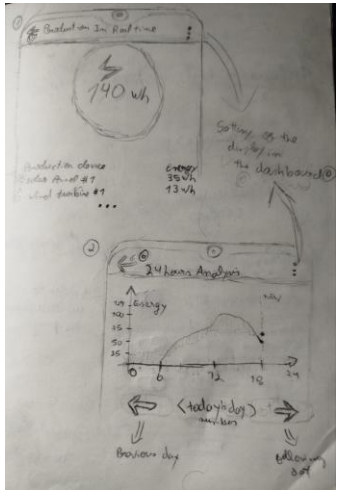
Prototype note:

The prototype for the previous tasks will be presented in a horizontal page, as to guarantee that all frames can be represented with good quality and visibility. Afterwards, the pages will be configured in the vertical view.

Prototype's Construction

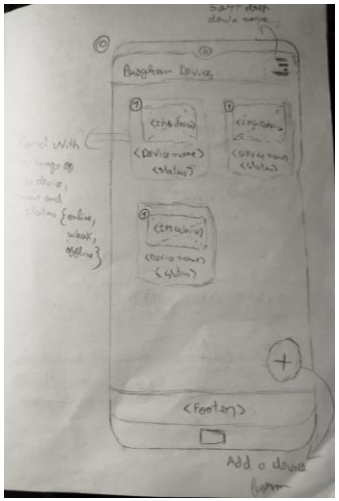
Firstly, to understand how the flow of the application would work, we started by creating a paper prototype. One of the benefits of doing a paper prototype is how easy it is to sketch and modify any frame blocks according to the received feedback. Therefore, the first prototype was represented by the following frames:

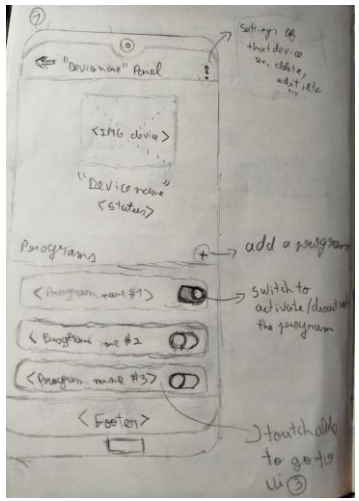


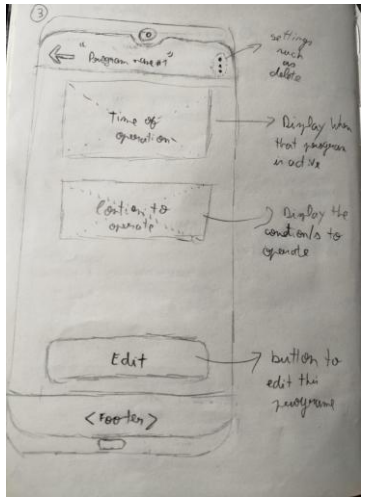


a) "Monitoring Panel", "Production in Real Time" and "24 Hour Analysis" - represent the task of monitoring the statistics of the network regarding, for example, the consumption and production of energy. Generally, the first menu is constructed in different blocks, each one representing different statistics: production and consumption in real time, daily graph of energy debit, weekly statistics for production, consumption and debit. The remaining menus will be accessible when a user clicks the first square of production or clicking the daily graph, respectively. These menus will give more detailed information regarding the topic the user clicked. In particular, "24 Hour Analysis" has the option to select viewing the statistics of the previous/ following day.

b) "Program Devices," "<Device name> Panel," and "<Program name #1>" represent tasks related to managing the programs of specific devices. For example, turning on the washing machine when a certain condition occurs. The "Program Devices" screen displays all the devices of the user, allowing the user to navigate to any device or manage them. After clicking on a device, the screen will show all programs specific to that device. Here, you can manage both active and inactive programs. By selecting a program, you can adjust its settings, including the conditions that trigger.





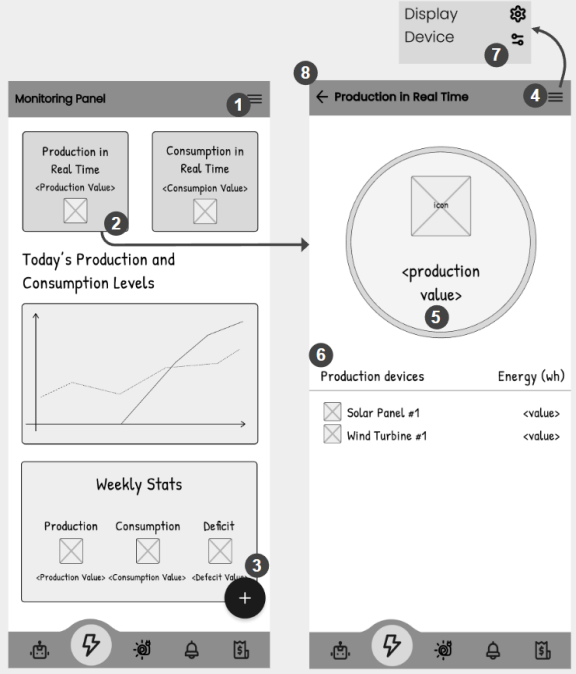


Prototype’s Wireflow

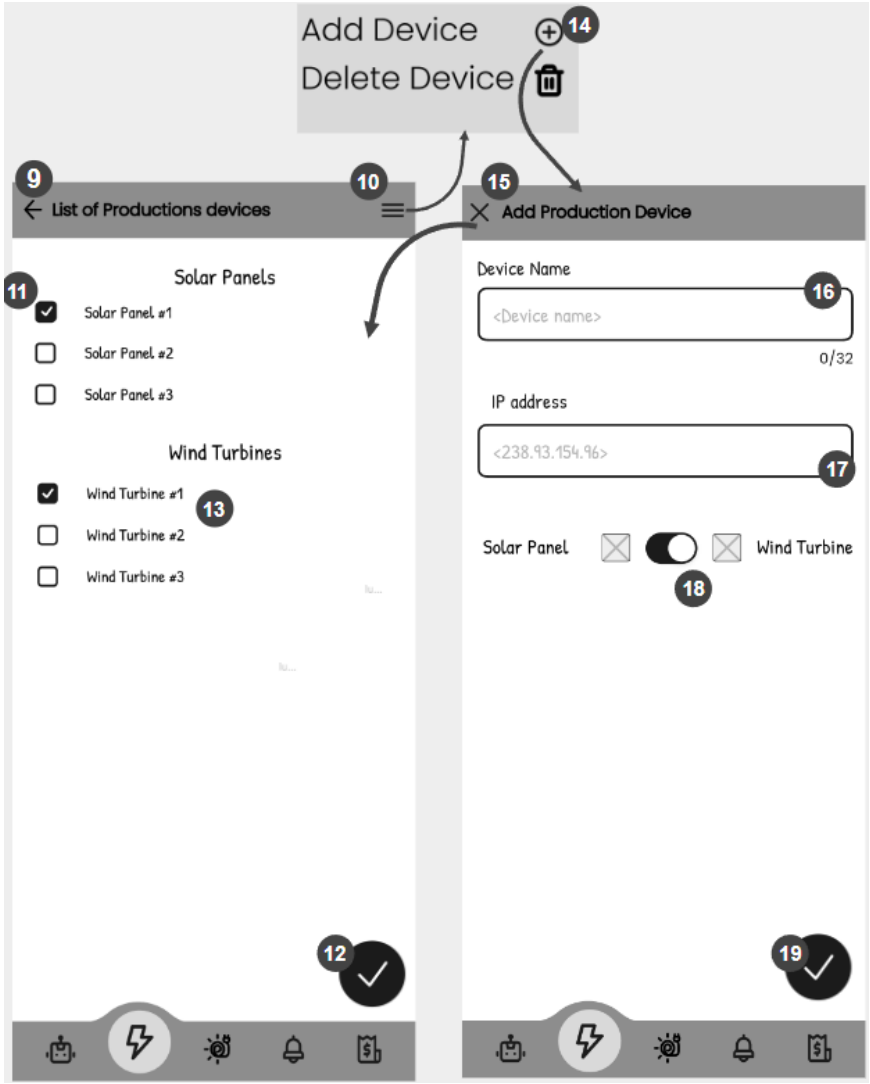
As per the guidelines, we moved to create the prototype’s wireflow using Figma. In this section, the main wireflows related to the key tasks will be presented. Not all screens and tasks are represented, only the main ones. In the event of need to confirm all the work developed in Figma, it can be accessed through the annex [5].

Check today’s production/consumption

This task aims to provide the user with valuable information regarding the energy status of their home. Specifically, it includes data on electricity production, consumption, real-time energy deficits, and historical trends, offering relevant statistics about the current state of the energy supply. The entire experience is customizable by the user, allowing them to adjust the display to enhance both its visual appeal and usefulness, ensuring it aligns with their preferences and needs.



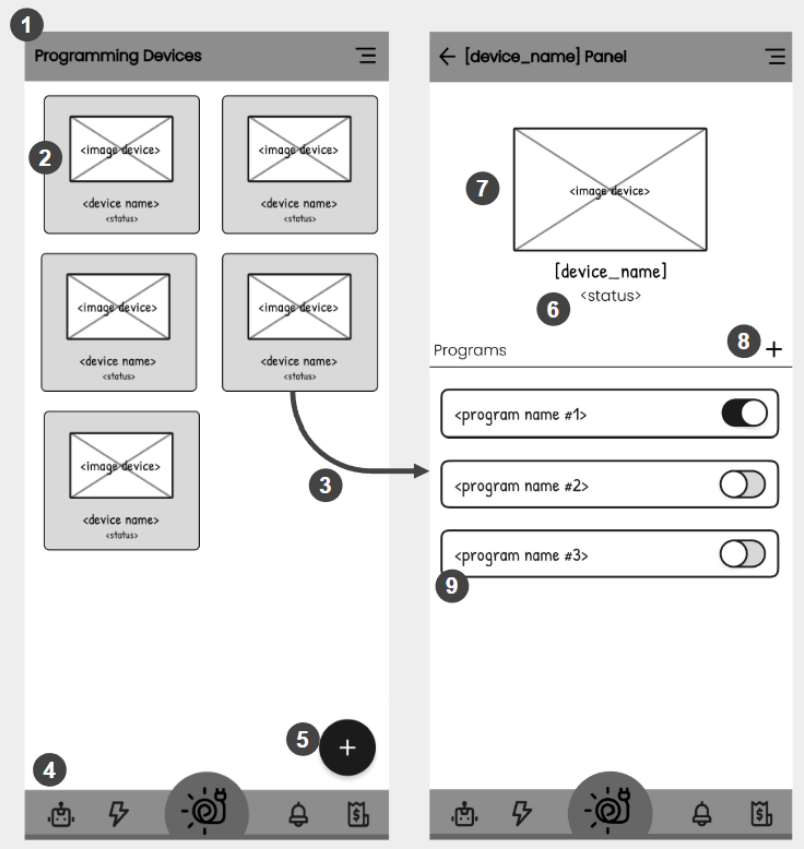
1. In this dropdown button, the user will be able to configure the display of the different widgets.
2. Widget that represents the user's real-time production. By clicking on the widget, the screen will be redirected to the "Production in Real Time" screen.
3. By clicking the button, the user will be able to add other widgets to be displayed on the "Monitoring Panel."
4. Dropdown button that displays the pop-up shown in caption #7.
5. The user's production value, summed from the selected devices, as indicated in caption #6.
6. Represents the devices selected by the user. It displays their type through an illustrative icon on the left, their name, and the amount of energy produced.
7. Result of clicking the dropdown button in caption #4. Here, it is possible to configure the widget display on the "Monitoring Panel" screen. By clicking the device button, the user can configure the selected production devices for this monitoring screen.
8. This button allows you to go back to the "Monitoring Panel" screen.



9. By clicking this button, the user can go back to the "Production in Real Time" screen. Any changes made will not take effect.
10. Dropdown button that displays the screen shown in caption #14.
11. Illustrative checkboxes for the devices to be selected for the "Production in Real Time" screen. The selection of devices will only take effect when the operation is confirmed, as shown in caption #12.
12. Confirms the operation performed by the user, redirecting to the "Production in Real Time" screen with the applied changes.
13. By clicking on the device name area, the user is redirected to a device editing screen similar to the "Add Production Device" screen, but with the fields pre-filled with the current values as placeholders.
14. Represents the result after clicking the dropdown button shown in caption #10. From here, the user can access the "Add Production Device" screen through the "Add Device" button. By clicking the "Delete Device" button, the user will be redirected to a screen to remove production devices.
15. Button to cancel the operation of adding a device and return to the "List of Production Devices" screen.
16. Mandatory field for the user to enter the name of the production device.
17. Mandatory field for the user to enter the IP address of the production device.
18. A switch to represent the type of production device.
19. A button that only appears after all mandatory fields have been filled. It completes the operation of adding a device and redirects to the "List of Production Devices" screen with the operation successfully completed.

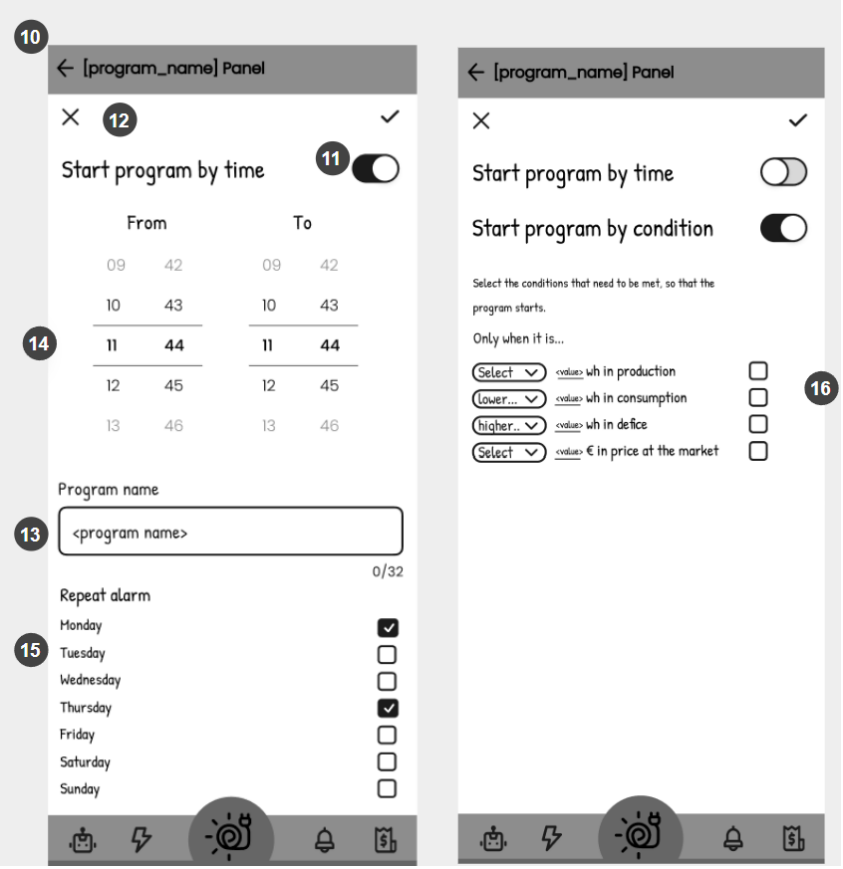
Create a new program to a specific device

“Programming Devices”, “Device Panel” and “Program Panel” - Similar to the specialist’s activity scenario, this task involves creating a new program inside a specific device, so that the device is turned on whenever the condition inside the program is true. To complete this task, the user must go first through the “Programming Devices” menu, by clicking on the ‘robot’ icon in the bottom navigation tab.



1. This menu displays all the consumption devices connected to the network.
2. Each item represents a device that was connected by the user to the application. It contains generic identification data from the device such as image, name and status.
3. Clicking any device item, invokes a child menu called “[device_name] Panel”, where it extends the information from the appliance clicked. Besides, all the programs that turn on the device are indicated below the information section.
4. The temporary bottom navigation bar (it doesn’t change with the menus the user is currently in).
5. The button to add more devices to the application.
6. Status of the appliance like “ON”, “OFF”, “NOT AVAILABLE”.
7. A default image can be replaced by a picture sent by the user.
8. The button to add more programs.
9. List of the device’s programs, with the option to set the program on/off. Clicking in any program will lead to another sub-menu with the respective program information to trigger the device to turn on/off.

*Note: Some corrections and updates have already been made ahead of the following phase. However, these images represent the final prototype before the Digested Heuristics evaluation.



10 The Program's Panel represents all the conditions a user can select to turn a device on/off. For the moment, a device can be triggered by the time or by a condition's value according to the statistical analysis visible in the monitoring panel.

11 Both the "Start program by time" and "Start program by condition" can be turned on/off, depending on the users choice to trigger the device. If both are on, it means a program will run if any of the conditions are met.

12 Options to save or cancel changes are available, although they are likely to change since the back button may raise conflicts with these options.

13 Besides the available conditions, the user can change the name of the program, helping to distinguish them.

14 Adjustable time interval that slides upwards/downwards according to the users intentions.

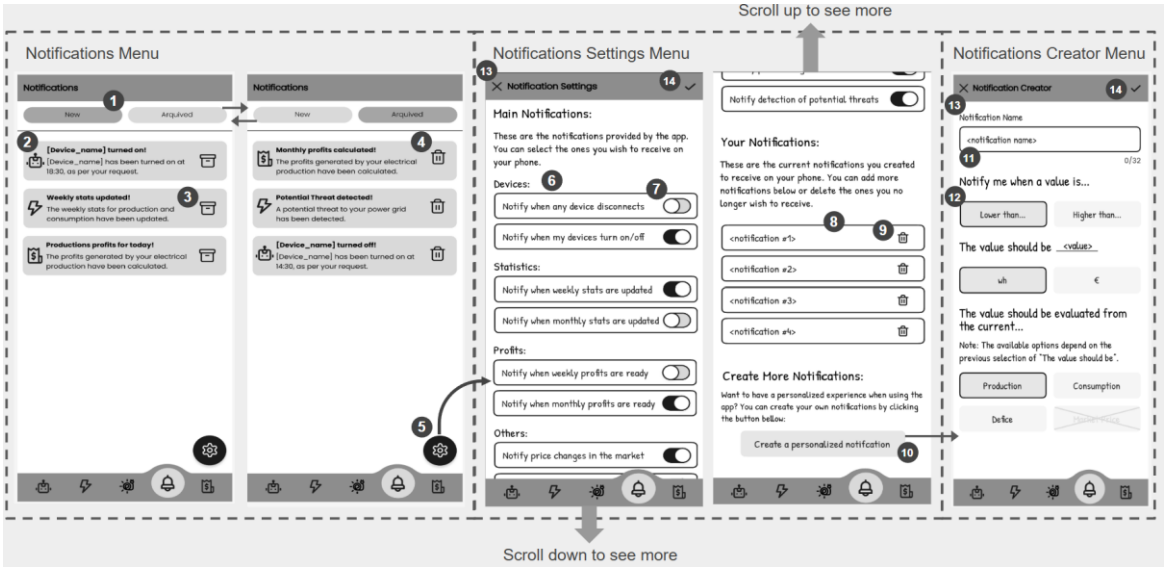
15 List of selectable weekdays that the programming will be repeated on.

16 List of general conditions that the user can customize with "lower" / "higher than" and with a value that needs to be met to run the program.

*Note: Some corrections and updates have already been made ahead of the following phase. However, these images represent the final prototype before the Digested Heuristics evaluation.

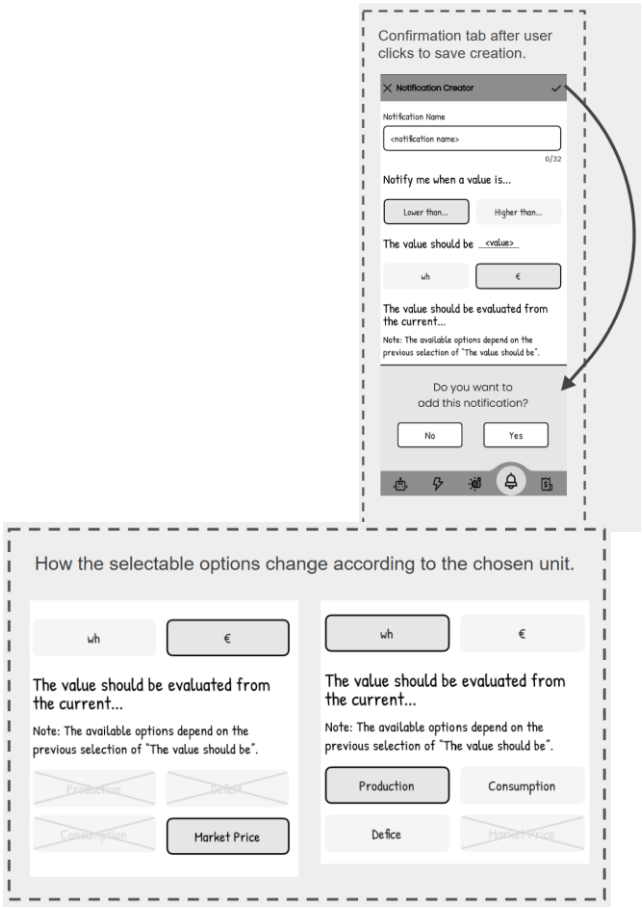
See the new notification about the state of electrical market

“Notifications” menu, “Notifications Settings” menu and “Notification Creator” menu - present the task of viewing notifications, in particular, the state of the electrical market. To complete this task, the user must go first through the “Notifications” menu, by clicking on the ‘bell’ icon in the bottom navigation tab.
If the user has already set to be notified “when price changes in the market”, then whenever there is a change in the electrical market, the user can see its notification on the “New” tab, at the “Notifications” menu. Otherwise, the user must click on the setting button (numbered as 5), which will redirect the user to the “Notifications Settings” menu. In that menu, the user must go to “Main Notifications”, scroll down to the area named “Others” and set the first notification item.
If the user wants a more customized notification from the electrical market, then the user can click the “Create a personalized notification” button in the “Notifications Settings” menu, which will redirect to the “Notification Creator” menu. Afterwards, the user must fill a form where ‘€’ and ‘Market Pricing’ must be selected for this current task. In the end, the user must click to confirm the creation of the notification when clicking number 14. The user created notifications will appear in the section “Your Notifications” in the “Notifications Settings” menu, with the only option to delete them, if the user no longer wants to view it.



1. Tab for selecting notifications, where "New" represents new notifications and "Archived" represents archived ones.
2. Represents a card with a notification. It includes an illustrative icon representing the type of notification, along with the name and a description of the notification.
3. Button that allows you to archive a notification, which will consequently be moved to the "Archived" tab.
4. Button to remove a notification from the mobile device.
5. Notification settings button. After clicking it, the screen is redirected to the "Notification Settings" screen.
6. Represents a default notification card related to a type of notification in the section it is located. It displays the name of the notification and a switch that indicates whether it is enabled/disabled.
7. Switch that allows toggling the activity status of the notification.
8. Represents a notification card created by the user, related to a type of notification. It displays the name of the notification and a switch that indicates whether it is enabled/disabled.
9. Button that allows the user to delete a notification they have created.
10. Button that allows the user to create a custom notification.
12. In this section, the user can configure their own notification. By selecting "Lesser than" or "Higher than," the user is defining the condition under which the notification will be triggered based on the chosen value. The "value" field represents a number that will activate the notification. The "wh" and "€" tabs represent the units for the value selected in the "value" field. If the user selects "wh," they can choose between the "Production," "Consumption," and "Deficit" tabs. If the "€" tab is selected, only "Market Pricing" can be chosen.

    For example, if a user selects "Lesser than," "wh," and "Production," it means they are creating a notification that will be triggered when the electricity production reaches a value lower than X (where X is the value selected in the "value" field).
13. Button to cancel the operation of adding a custom notification and return to the "Notifications Settings Menu" page.
14. Button to finalize the creation of a custom notification. After this, the user is redirected to the "Notifications Settings Menu" screen with the custom notification they created already added.



Digested Heuristic Evaluation Results

To get some feedback on the usability of the project, we got help from groups 2 and 6 from class 12 to carry out a heuristic evaluation of the project. The results were as follows:

Problem number	Context	Made	Severity	Made by	Importance given by our group (1-5)
1	“There exists few information about the confirmation of the alarm setup”	1 (Visibility of the System Status)	1	Group 2	5
2	“There is no explanation of what the [device’s] programs do or how to use them”	10 (Help and Documentation)	2	Group 2	4
3	“Doesn’t allow to add more [production] devices, even though we could have more”	2 (Match between the System and the Real World)	1	Group 2	3
4	“The nav bar doesn’t tell us which page we are currently on, meaning we have to remember where we are in the app.”	6 (Recognition rather than Recall)	2	Group 2 and 6	4
5	“It would be more efficient if we could set alarms for more than one panel at the	7 (Flexibility and Efficiency of Use)	1	Group 2	1

	same time if we wanted”				
6	“There’s a thin line between the top bar and the phone, which is not very aesthetically pleasing”	8 (Aesthetic and Minimalist Design)	1	Group 6	1
7	“Spelling mistake: ‘Defecit’ instead of ‘Deficit’, violating the heuristic.”	4 (Consistency and Standards)	1	Group 6	1
8	“The spacing between the devices [in the programming device list] is irregular, which is not very aesthetically pleasing.”	8 (Aesthetic and Minimalist Design)	1	Group 6	1
9	“Some fonts are too small.”	8 (Aesthetic and Minimalist Design)	2	Group 6	4

Corrections to perform in Phase 3

Based on the report, we have identified several key corrections that need to be made to our prototype in the next phase.

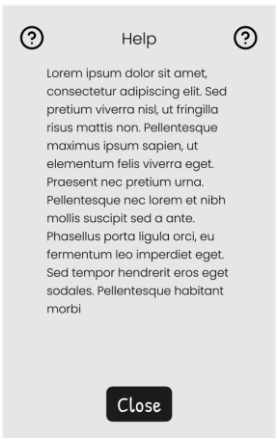
Correction no 1:

When performing tasks that may be difficult to reverse, there was no feedback asking for confirmation. Although we don't agree that the specific functionality - creating an alarm - referred to by the heuristic needs this warning, other screens need this confirmation, so that visibility of the system’s status is maintained.

We need to create a pop-up menu that asks the user to confirm if changes made to important forms and tabs in the application are meant to be saved. At the same time, we can aso add a pop-up menu when the user clicks on the “X” icon, to verify if the changes

are to be discarded. In the same line of reasoning, if no changes were made by the user, these pop-up menus aren't displayed.
An example of its implementation would be:

Correction no. 2:
Throughout the screens with more complex functionalities, there was no meaningful indication of how they work. Even though in a Lo-Fi prototype, this type of functionality wasn't expected, we recognize its importance and have drafted a solution.
Therefore, a new section will be added to the more complex screens, which, when clicked, will show a pop-up with relevant information, guiding the user through small tutorials and the necessary steps to interact with the respective tab.
An example of how this would be implemented is as follows:



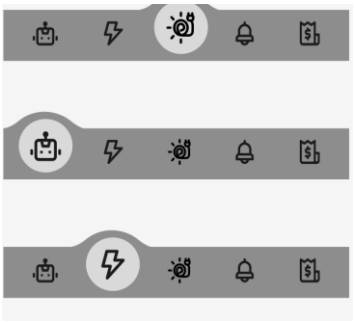
Correction no. 3:
On the "Production in Real-Time" tab, there was no way to add/edit/remove an electrical production device from being tracked.
With this in mind, a whole set of screens has been developed to manage them. These include form menus to fill in the information required to connect to a new device, options to edit the forms of each device, to disable a device from being tracked without removing the created configuration and an option to remove a device configuration from the app.

This implementation can be seen in the Prototype's Wireflow "Check today's production/consumption" .

Correction no. 4:

When navigating through the application, no feedback was sent to the user regarding their location in the application. This was mainly due to the application's footer not changing visually on different screens.

With this in mind, we developed the following prototype to correct this navigation problem:



Correction no. 5:

Problem number 5, due to its vague description and unclear terminology, we interpreted it in two ways. Either of them goes against the concept envisioned for the program-management functionality. It can be interpreted as having two program creation tabs side-by-side, which isn't plausible due to size constraints from it being a phone application, and the fact that it's confusing to create/edit two different programs at the same time, when they are intrinsically independent and separate tasks, even though they are related to the same device. The other interpretation is to allow the creation of a program that can be applied to two different devices, which goes against the established logic of the settings programs for devices: devices have programs, programs don't have devices.

Corrections nos. 6, 7, 8 and 9:

In some parts of the interface there were problems with their structure, for example where there is too much space available between objects in the UI, and text inconsistencies. In the next iteration we will take into account a better distribution of the available space, the formatting of the pages so that the Aesthetic and Minimalist Design, as well as Consistency and Standards are not violated.

These heuristic evaluations, the subsequent analysis and the solution development based on it, were invaluable in helping us focus on the more meaningful aspects of SunLite's prototype for the last stretch of Phase 2, and, more importantly, the overall direction for

the work in Phase 3. They have, therefore, raised awareness on other valued aspects of the application's interface, which we will take into account, in addition to the details already present and highlighted in the current Phase, ensuring further refinement of the application and the user experience.

Part III - Hi-fi prototype and user evaluation

Introduction

In the last phase of our project, we will summarize the work done in the previous parts and explain the testing done on the latest version of the SunLite application. In particular, we will recapitulate important steps such as the “User and Task Analysis” and “Lo-fi prototype and heuristic evaluation” from Phase I and II. In addition, we will delve into the wireflows designed for all tasks according to the past heuristic evaluation. Consequently, we will also describe the “User evaluation protocol” and analyze the results obtained during the testing using the Maze platform.

SunLite is an app whose main goal is to help its users manage and automate their consumption and production of electricity. As such, we will scrutinize based on the app's goals and functionalities.

Changes to Parts I and II

Leading up to this last Phase, we used the feedback from the heuristic evaluation to make the necessary changes and elevate the final prototype to the best state, improving its visual appeal and usability through the use of colors. To better reflect these modifications, a small change, was made to the tasks to be tested by the end users, which led to a significant improvement to the usability testing carried out in this Phase.

The task “Check today’s production/consumption” was expanded and subdivided into three tasks, “Add a new production device to the monitoring panel”, “Create a new production device” and “Remove a production device”, that, according to the description of the major task in Phase II, more accurately represent the different features referred. As the actions available to the consumption devices would be the same as the production ones, that aspect was simplified. Therefore, the title of this main task, now a group of tasks, changed to “Check and manage the production”

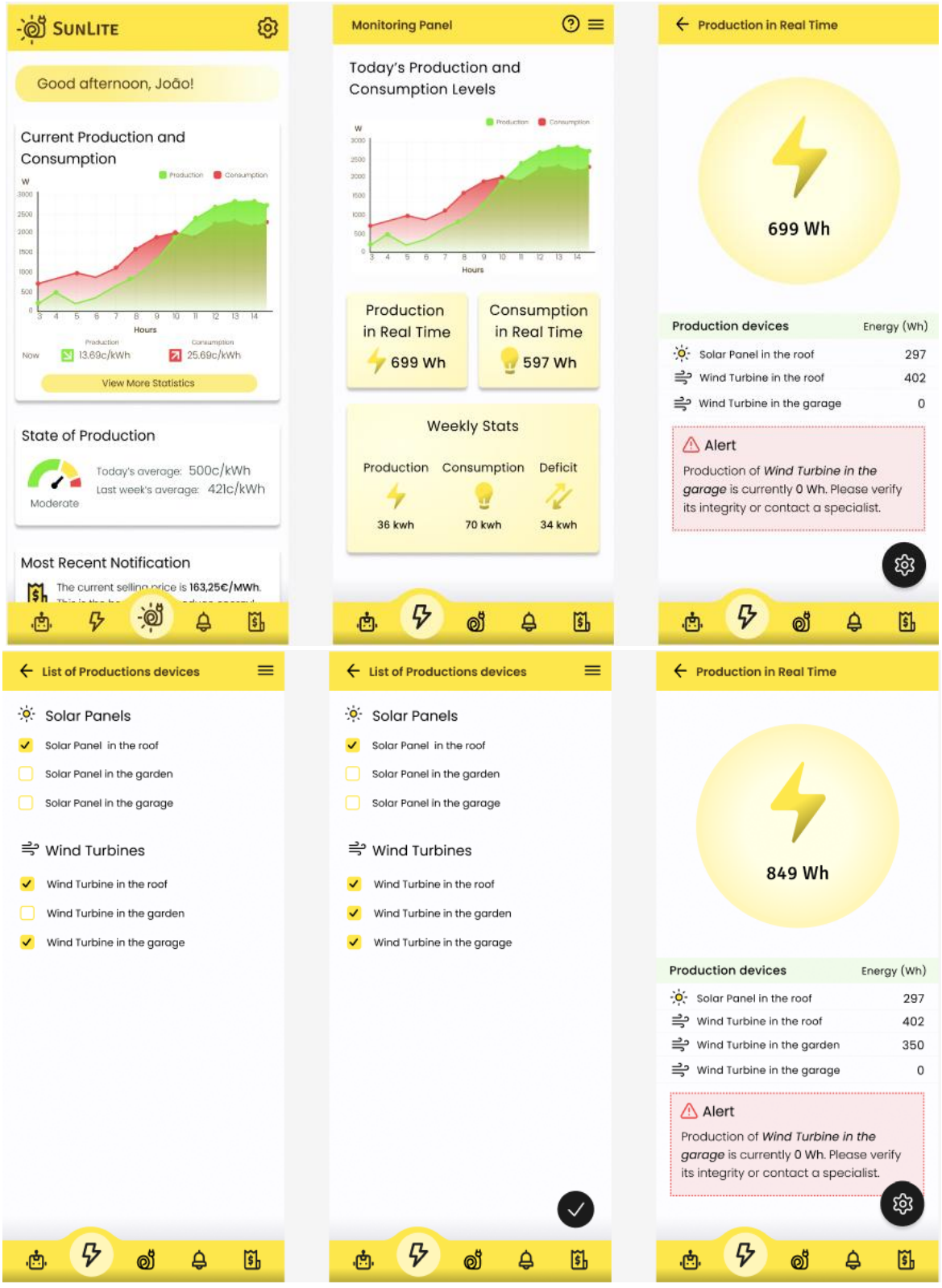
In the same way, the “Create a new program to a specific device” task, was subdivided into three tasks, “Edit the dryer's *Low Market Prices* program”, “Delete the *Winter Cycle* program from the dryer” and “Create the *Monday Program* for the dryer”, to better separate the features related to programs and illustrate how to properly manage a device. The task for the creation of a program was not possible to be tested, as explained in the sections below, due to limitations with the testing tool, but the wireflow for it is detailed in its section.

The last change expanded the “See the new notification about the state of electrical market” task, into the following three tasks: “View the notifications tab and archive the first notification”, “Create a new custom notification”, “Analyze a potential problem in wind energy production”. Identically to the previous ones, the title of the task didn’t accurately reflect the in-depth exploration of the features that accompanied it in the respective description, so we divided the functionalities talked about in that section into those tasks, to allow for better testing of each specific wireflow.

Prototype's Wireflow

Task 1: Check and manage the production

Task 1.1: Add a new production device to the monitoring panel



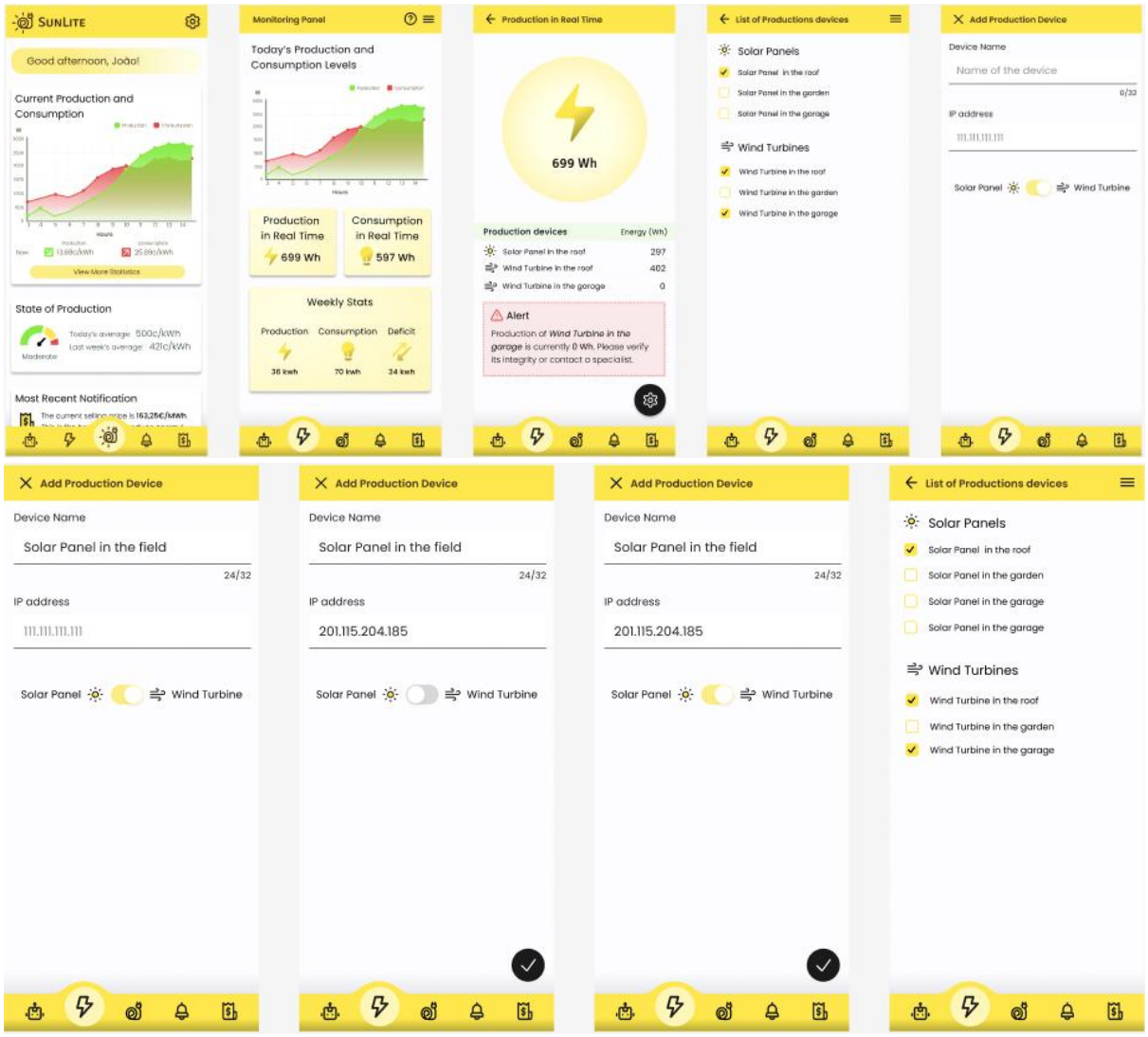
1- From the home page, locate and click the second icon to navigate to the Monitoring Panel section

2- Within the Monitoring Panel dashboard, locate and select the 'Production in Real Time' widget positioned in the center to access the production tracker

3- Navigate to the production device management menu by clicking the settings icon found in the production tracker interface

4- To add a new device, select the desired device by clicking its corresponding checkbox, then confirm your selection by pressing the checkmark button

Task 1.2: Create a new production device



1- From the home page, locate and click the second icon to navigate to the Monitoring Panel section

2- Within the Monitoring Panel dashboard, locate and select the 'Production in Real Time' widget positioned in the center to access the production tracker

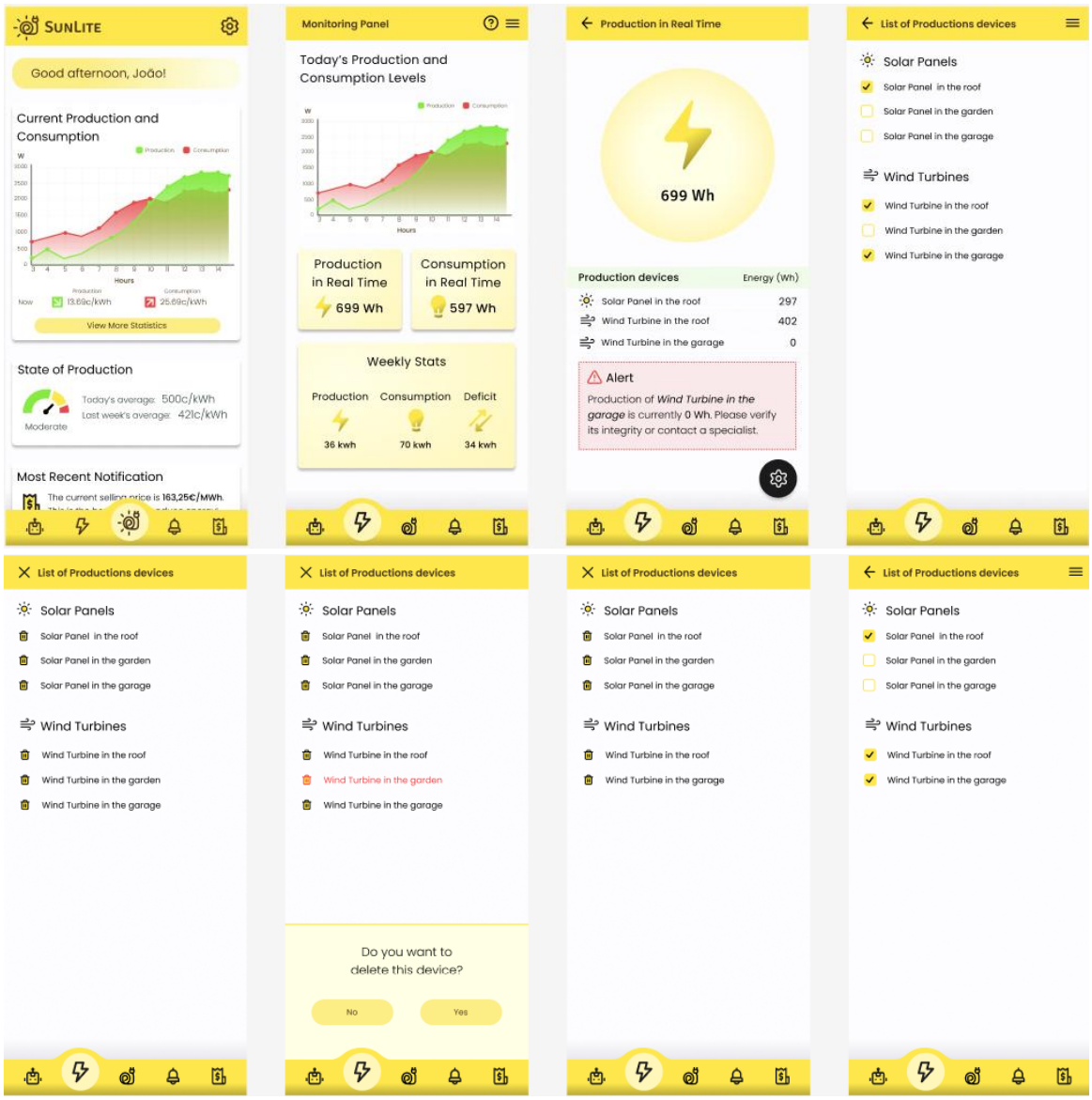
3- Navigate to the production device management menu by clicking the settings icon found in the production tracker interface

4- To create a new production device, click the drop down button in the top right corner and select 'Add Production Device' to access the creation menu

5- Fill in the required device information in this menu, including the device name, IP address, and specify the device type (solar panel or wind turbine)

6- Complete the device creation by clicking the check mark, which will redirect you to the production device management menu where your newly created device will be displayed

Task 1.3: Remove a production device



1- From the home page, locate and click the second icon to navigate to the Monitoring Panel section

2- Within the Monitoring Panel dashboard, locate and select the 'Production in Real Time' widget positioned in the center to access the production tracker

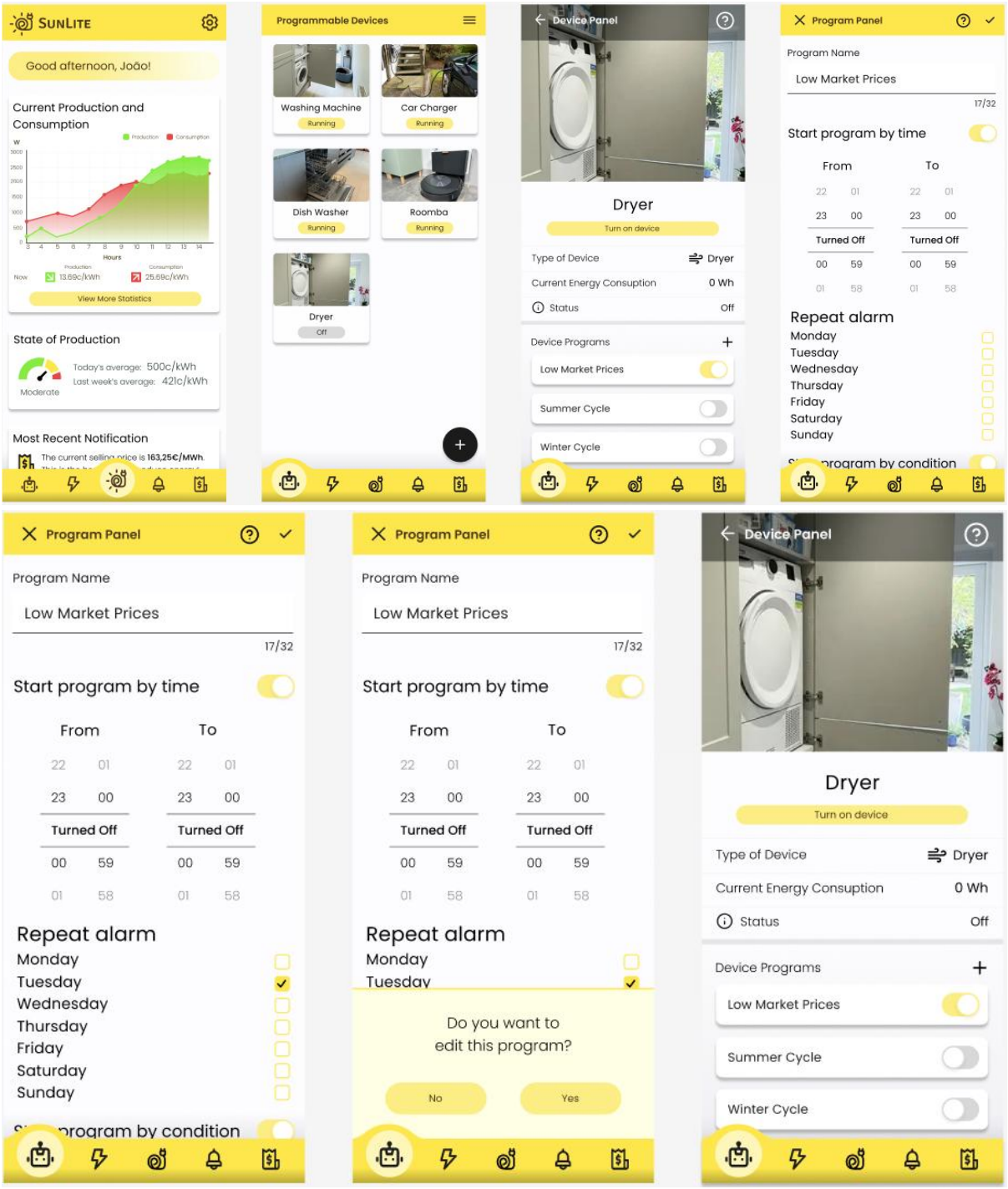
3- Navigate to the production device management menu by clicking the settings icon found in the production tracker interface

4- To delete a device, tap the drop down button in the top right corner and select 'Remove Production Device' to access the deletion menu

5- Select the device you wish to remove from the list, then confirm the deletion and exit the menu by tapping the X button. The device will now be removed from your list

Task 2: Manage device programs

Task 2.1: Edit the dryer's “Low Market Prices” program



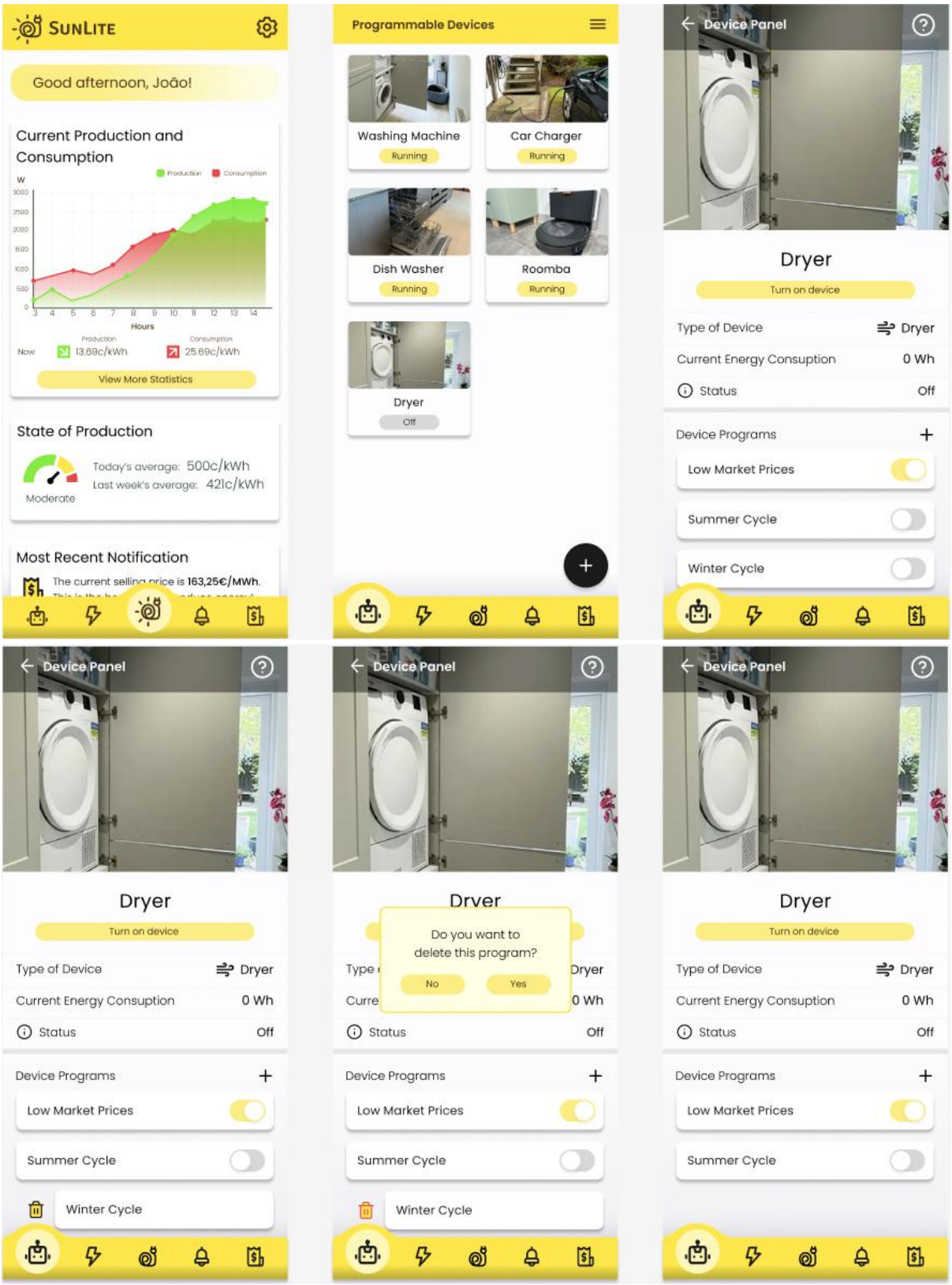
1- Navigate to the Programmable Devices tab by selecting the first icon from the home page

2- Select the device you wish to program to access its Device Panel

3- Open the program panel by clicking an existing program, where you can modify its start conditions, timing, and scheduled days

4- Save your changes by clicking the check mark in the top right corner and confirm. You will then return to the Device Panel

Task 2.2: Delete the “Winter Cycle” program from the dryer

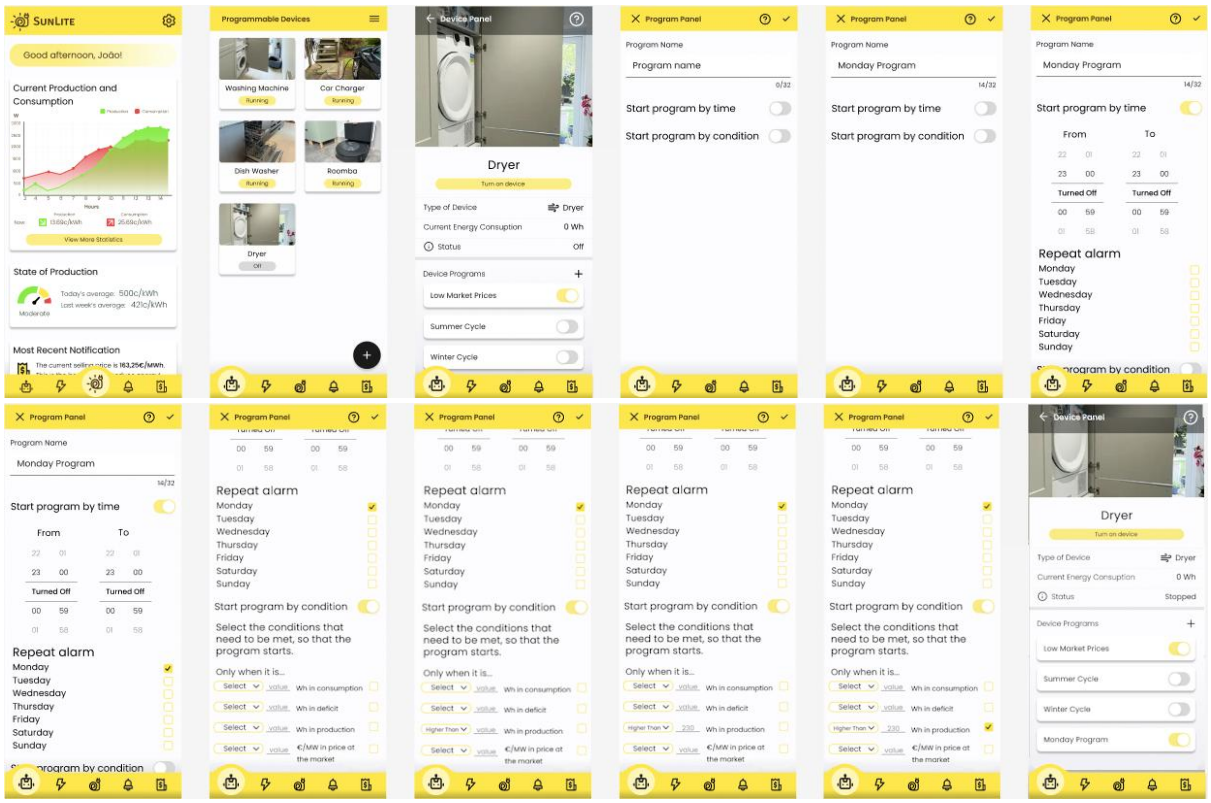


1- Navigate to the Programmable Devices tab by selecting the first icon from the home page

2- Select the device you wish to program to access its Device Panel

3- Delete a program by dragging it to the right until a trash can icon appears. Then click the icon and confirm your deletion

Extra Task: Create the “Monday Program” for the dryer



1- Navigate to the Programmable Devices tab by selecting the first icon from the home page

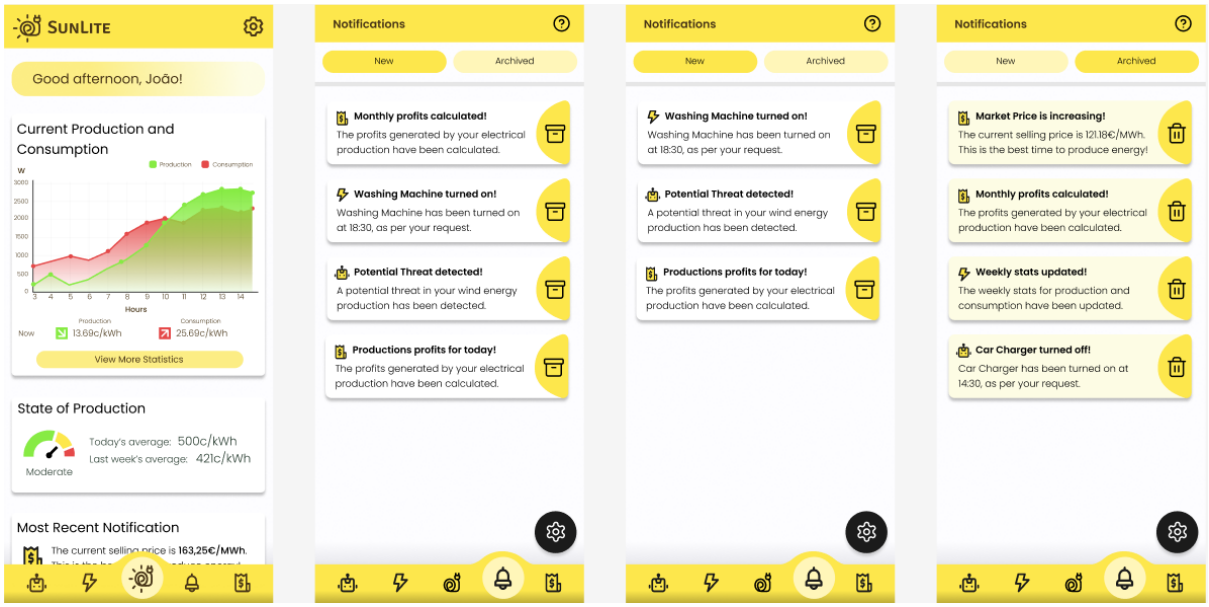
2- Select the device you wish to program to access its Device Panel

3- Create a new program by tapping the plus button, which opens the program panel where you can set start conditions, timing, and scheduled days

4- Save your new program by clicking the check mark in the top right corner. You will then return to the Device Panel where your new program will be displayed

Task 3 - View and Archive Notifications

Task 3.1: View the notifications tab and archive the first notification

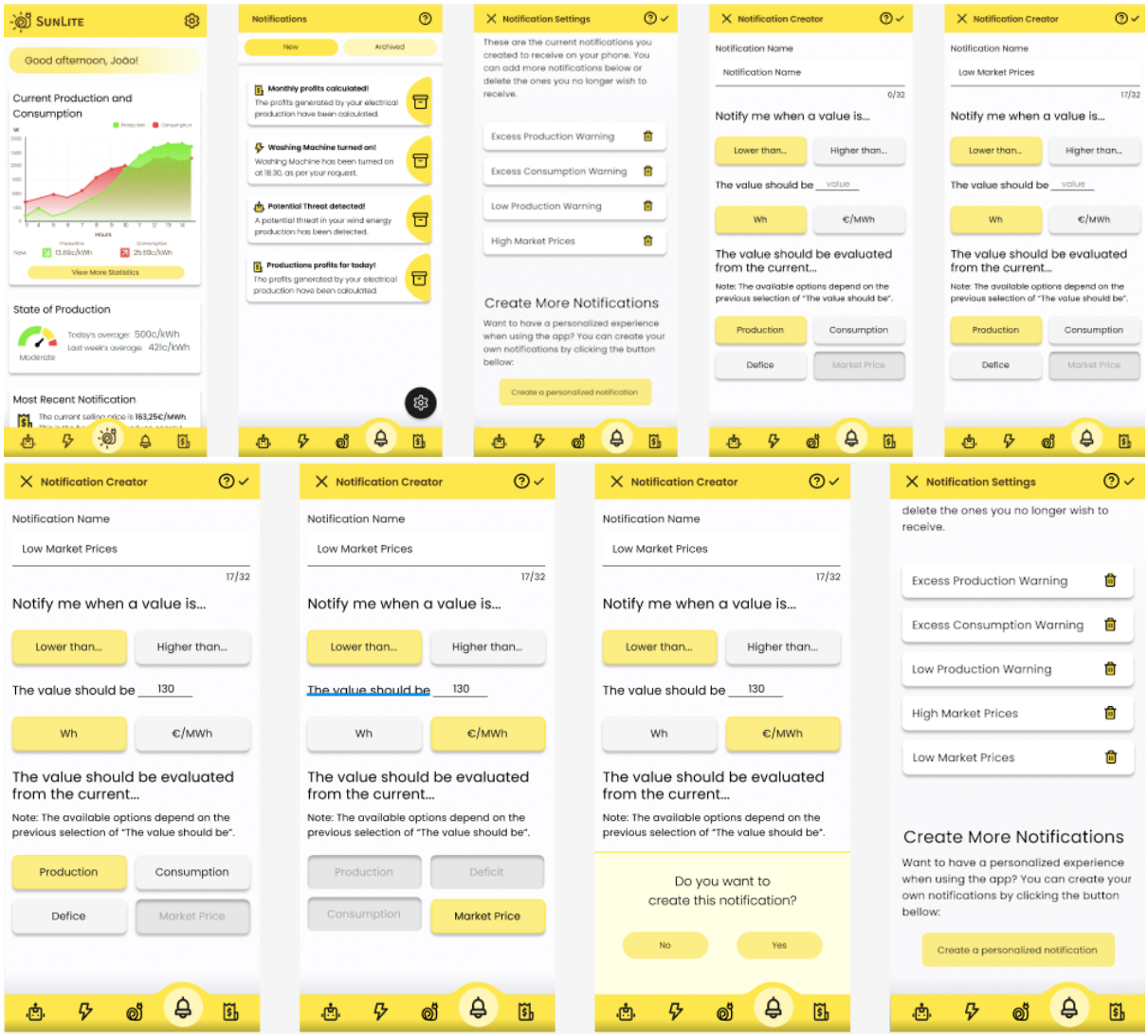


1- Navigate to the notification tab by selecting the fourth icon from the home page

2- Here, you are able to view your notifications and archive one by clicking the cardboard box icon on the first notification

3- Access your archived notifications, including the recently archived one, by selecting the archived button

Task 3.2 - Create a new custom notification



1- Navigate to the notification tab by selecting the fourth icon from the home page

2- Access notification settings by clicking the settings icon

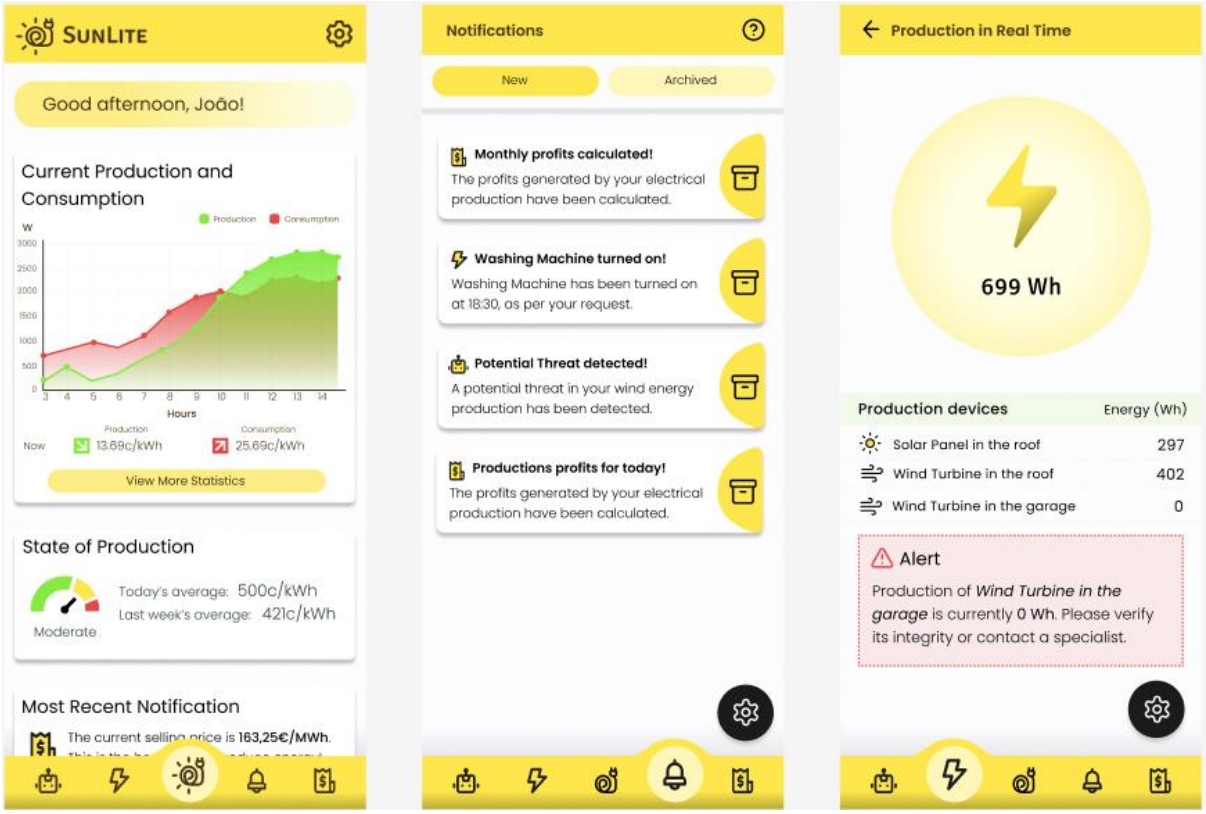
3- Scroll to the bottom of the page and click 'Create a personalized notification' to enter the notification creator menu

4- Enter the notification details in this menu, including its name and the value that will trigger the notification

5- Save your notification by clicking the check mark in the top right corner

6- Confirm your choices in the pop-up menu to return to notification settings, where your new custom notification will appear

Exploration Task: Analyze a potential problem in wind energy production



1- Navigate to the notification tab by selecting the fourth icon from the home page

2- Click on the wind production threat notification to be redirected to the production tracker, where you can view details about the potentially faulty device

User Evaluation Protocol

The user evaluation was done with the help of an online usability testing tool called Maze, which allows for the creation of projects. Each of these projects contains tasks and other activities to evaluate the user experience with an interface. We chose this tool due to its seamless and direct integration with Figma, where we developed SunLite's interface.

It is important to note that the number of tasks provided to users was limited due to the Maze's restrictions for the Free plan (7 tasks per link). As an increasing amount of links would increase the amount of time necessary for testing, resulting in a lower user adherence to the sessions, we omitted the evaluation of the "Creation of a device's program" task but decided to still provide its wireflow, in the section above, for context. In the same line of thinking, the second Maze link was created expecting a lower adherence rate, consisting of "free-roam" tasks that allowed the user to explore

Objective

Although not specifically written on the Maze page, each participant received a brief description of the solution to be evaluated, the evaluation session, and the purpose of the evaluation. These summaries were given face-to-face by the team members, who helped the participants not only in clearing any doubts before starting the evaluation session but also in translating terms in the application (if the participant was a non-English speaker - more on that in the following sections). The descriptions given were similar to:

"*SunLite is an app that manages the consumption of electricity at your home and the production of electricity by the solar panels or wind turbines that you own. Not only does it show helpful statistics, but it can also automate the control of your devices. In addition, you can see the market price of the electricity for selling your produced energy. A complex app like the one we present to you requires lots of testing to make sure we are providing the best experience while using the product. Thus, we would love to gauge your interest for a few minutes to evaluate and classify our product.*

The evaluation session you are about to embark on consists of multiple small steps that will guide you to complete your objectives. You will have a prompt explaining the goal of the current task, which might include you moving through the app by clicking buttons and filling out forms. Beware that not every page will lead to your goal, so you can go back on the top-left arrow in the header, or use the navigation bar at the bottom to navigate to the different menus. Moreover, the evaluation session might ask you to remember certain values provided during the task to complete it, so you must be attentive and use your intuition to complete the task.

If you have any questions during the test, you can ask us and we will be sure to provide more info. However, this evaluation session requires little intervention from outsiders, hence you should limit the questions to the most necessary ones such as not understanding the vocabulary used.

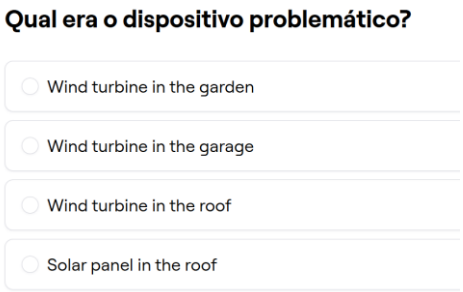
With this in mind, we wish you good luck! You may start the session."

Users

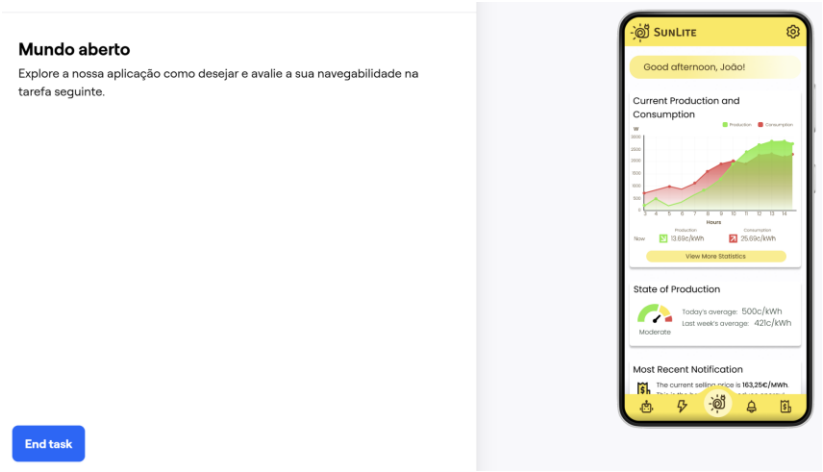
To follow through the user evaluation protocol, we have to recruit participants to experiment with the product. The participants must belong to the general group described in the first phase: hold a completed secondary education (12th grade), have an interest in adopting renewable energy and electricity market, with either partial or no understanding of how monitoring applications work. The participants will be recruited from direct contact with them via word of mouth or phone. We will also include members of family and college students who have filled out Phase 1's questionnaire.

Method

To properly set the foundation of the evaluation sessions, we will navigate the participants through a set of tasks they must complete to finalize the session. First, the participant must read the prompt that will entail the objective of the task, the restrictions of movement that will be applied to the task, and some additional information. The participant will have an opportunity to look at the app during the reading of the prompt, before the task's timer is activated. For example, the participant may be asked to search for a specific piece of information and use their intuition to make the final selection.



Once the participant starts the task, they must navigate through the app until they are confident to move to the next task by pressing "End task". The prompt will be always available in the meantime. The session also includes a confirmation menu that will appear if the participant chooses to end the task.



In addition, the participant will be also asked to classify the app based on specific traits like accessibility, design, and usability. They must rate it based on their opinion. A final commentary about the app will be used as input to obtain further feedback from the participant.

Tasks

During the evaluation session, the participants will come across 3 general tasks that were defined in Phase II. These tasks will be divided into sub-tasks that the participants must go through in sequence in order to end the session.

Task 1: Check and manage the production

In the first task, the respondent is required to manage the electricity production devices. This includes adding a production device to the "Monitoring Panel - Production in Real Time," as well as removing and creating a new production device in the production device list. The list of production devices can be accessed after navigating to the "Production in Real Time" page, which is located under the "Monitoring Panel" section.

Task 2: Manage device programs

In the second task, a user must be able to manage their household devices and their programs to turn on whenever a condition is met. The conditions imply that the user wishes to turn on that specific device whenever they are met. These conditions must be editable at any time.

Edite o programa "Low Market Prices" da maquina de secar

Tente editar o programa "Low Market Prices" do dispositivo "Dryer", de modo a que este apenas se realize às terças-feiras.

Apague o programa "Winter Cycle" da maquina de secar

Tente apagar o programa "Winter Cycle" do dispositivo "Dryer".

Dica: No caso de dificuldades na realização da tarefa, considere utilizar o botão help para informações extra.

Task 3: Handle and Interpret Notifications

In the third task, the participant must be able to use the notification interface:

Visualize a aba de notificações e arquive a primeira notificação

Tente aceder à aba de notificações, arquivar a notificação mais recente e visualizá-la na secção de notificações arquivadas.

Crie uma nova notificação personalizada

Tente criar uma nova notificação chamada "Low Market Price", que seja acionada quando o valor da eletricidade no mercado estiver abaixo de 130 €/MWh.

Nota: Para facilitar a interação do utilizador, só é necessário clicar nas caixas de texto, em vez de inserir o valor à mão.

They will need to click on the notifications menu button, to open the notifications menu. Afterwards, they will have to choose the correct sequence of clicks to complete the task. In particular, in the second sub-task, they have to fill out a form. However, to help with the user input, the participants only need to click on the text input to fill it with the correct text.

Exploration Task: Analyze a potential problem in wind energy production

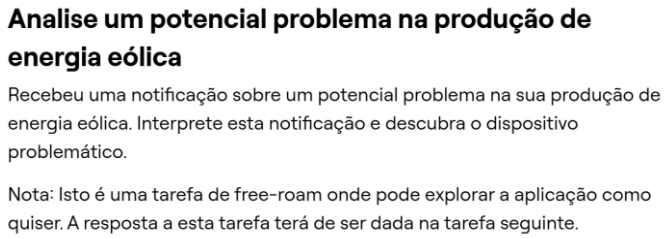
In addition to the conventional tasks, an evaluation task was also developed to assess the integrity between the application's features, where a context is provided:

"Recebeu uma notificação sobre um potencial problema na sua produção de energia eólica. Interprete esta notificação e descubra o dispositivo problemático.

Nota: Isto é uma tarefa de free-roam onde pode explorar a aplicação como quiser. A resposta a esta tarefa terá de ser dada na tarefa seguinte.”

This task expects that, based on previously acquired knowledge about the different functionalities, the respondent must identify which production device is experiencing a malfunction. In this task, the respondent can navigate freely within the application, and when they believe they have found the problematic device, they end the free-roam task and select the device they identified as having an issue from a multiple-choice option.

The purpose of this task is not only to assess how the user utilizes the different functionalities to identify the problematic device but also to evaluate the integrity between the different features (in this case, the notifications and the monitoring panel). In this way, it is possible to evaluate how the application would perform in a situation closer to real-world conditions.



Measures

During the evaluation session, we will capture, through Maze, the duration, the number of clicks, and misclicks (clicks that don’t interact with any part of the interface) each participant makes. At the same time, Maze also generates heatmaps, based on the clicks and misclicks detected, so that we can understand which elements of the interface people perceive as the tools that progress the task. Furthermore, the success rates are measured as direct or indirect. It is direct if the user follows exactly the path through the interfaces as outlined by us, and indirect if the user visits different menus and interfaces but ends up reaching the last interface successfully. The success criteria for the tasks in the first Maze project is to reach the Figma frame defined as the last one (successful completion and end of the task). If the user does not reach this part of the interface, it is classified as a drop-off.

To complete the sample characterization, we provided questions, both for user profiling and satisfaction. The satisfaction questions relied on how navigable the product was based on traits like accessibility, design, and usability. The participants have to rate the product when they complete all the tasks, using symbolic rankings: the satisfaction icon and the number of stars the product deserves.

Finally, we will use a text input at the end of the session to interpret the classification and the data provided. The participant must fill the input text with their opinions or comments regarding the application.

Due to Maze being a specialized usability testing platform, the measurements align with the usability requirements studied in theoretical classes and elaborated for each task.

It is meaningful to note that the number of clicks expected is higher than the amount required to complete the task because we foresee that, due to the usability testing being an interaction with the interface at first glance, the navigation will require trial and error and backtracking to complete the task. Furthermore, given the existence of “Help” menus (aids) in the SunLite interface, the number of clicks includes two values, where the second one takes into account the number of necessary clicks to interact with those menus and complete the task: one to open the menu, and another to close it. In the same way, the expected time taken to complete the task includes a second value, accounting for the time taken to read these menus.
Nevertheless, the number of clicks required is an important factor to keep in mind, due to it being the ultimate goal of efficiency when interacting with the app.

Differently from how we obtained the results for the questionnaire in Phase 1, we expected to run the usability testing with a carefully selected sample of testing users and expected to be mostly present during the testing process, to ensure that users fully completed the tasks, persevered through the difficulties and gave feedback about them. This led us to expect a perfect success rate (100%) in all the tasks, which was verified to be true in the Maze report (except for the first test done for the 3.1 task, which had an interface bug). This rate would undoubtedly be lower if the testing was not monitored and the users started giving up on facing difficulties during the interaction. Still, in the usability requirements, the success rate estimation

Therefore, the usability requirements are as follows:

Task 1.1: Add a new production device to the monitoring panel

Description: Add “Wind Turbine in the garden” to the list of production devices in the real-time production monitoring panel.

Efficacy

- Success rate of 80%
- No aids used
- No more than 5 misclicks

Efficiency

- Expected time taken - 45 seconds
- Number of clicks required to complete the task - 5
- Number of clicks expected - 10

Satisfaction: 5 out of 5

Task 1.2: Create a new production device

Description: Create a new production device called “Solar Panel in the field”, with IP address “201.115.204.185”.

Efficacy

- Success rate of 70%
- No aids used
- No more than 8 misclicks

Efficiency

- Expected time taken - 60 seconds
- Number of clicks required to complete the task - 8
- Number of clicks expected - 16

Satisfaction: 4 out of 5

Task 1.3: Remove a production device

Description: Remove the “Wind Turbine in the garden” device from the list of production devices.

Efficacy

- Success rate of 85%
- No aids used
- No more than 3 misclicks

Efficiency

- Expected time taken 35 seconds
- Number of clicks required to complete the task - 8
- Number of clicks expected - 11

Satisfaction: 4 out of 5

Task 2.1: Edit the dryer's “Low Market Prices” program

Description: Try editing the “Low Market Prices” program on the “Dryer” device so that it only runs on Tuesdays.

Efficacy

- Success rate of 80%
- 2 aids used (question mark icons on the Programmable Devices and Program Panel menus)
- No more than 5 misclicks

Efficiency

- Expected time taken - 45 seconds
- Number of clicks needed - 6
- Number of clicks expected - 11

Satisfaction: 4 out of 5

Task 2.2: Delete the “Winter Cycle” program from the dryer

Description: Try deleting the “Winter Cycle” program from the “Dryer” device.

Efficacy

- Success rate of 80%
- 1 aid to be used (question mark icon on the Device Panel menu)
- No more than 2 misclicks

Efficiency

- Expected time taken - 25 seconds (35 with the use of aids)
- Number of clicks needed 5 (7 with the use of aids)
- Number of clicks expected 8 (10 with the use of aids)

Satisfaction: 5 out of 5

Task 3.1: View the notifications tab and archive the first notification

Description: Try going to the notifications tab, archiving the most recent notification and viewing it in the archived notifications section.

Efficacy

- Success rate of 95%
- 1 aid to be used (question mark icon on the Notifications menu)
- No more than 2 misclicks

Efficiency

- Expected time taken - 25 seconds (45 seconds with the use of aids)
- Number of clicks needed - 3 (5 clicks with the use of aids)
- Number of clicks expected - 7 (9 clicks with the use of aids)

Satisfaction: 5 out of 5

Task 3.2: Create a new custom notification

Description: Try creating a new notification called “Low Market Price”, which is triggered when the value of electricity on the market is below 130 €/MWh.

Efficacy

- Success rate of 80%
- 3 aids to be used (question mark icons on the Notifications, Notification Settings and on Notification Creator menus)
- No more than 10 misclicks

Efficiency

- Expected time taken - 60 seconds (100 seconds with the use of aids)
- Number of clicks needed - 8 (14 clicks with the use of aids)
- Number of clicks expected - 20 (26 clicks with the use of aids)

Satisfaction: 4 out of 5

Exploration Task: Analyze a potential problem in wind energy production

Description: You have received a notification about a potential problem with your wind energy production. Interpret this notification and find the problematic device.

Efficacy

- Success rate of 95%
- 1 aid to be used
- No more than 1 misclicks

Efficiency

- Expected time taken - 25 seconds (45 seconds with the use of aids)
- Number of clicks needed - 2 (4 clicks with the use of aids)
- Number of clicks expected - 5 (7 clicks with the use of aids)

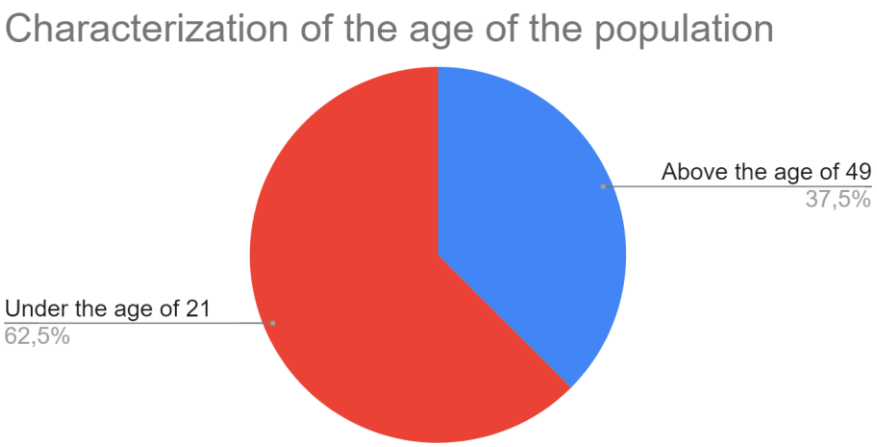
Satisfaction: 5 out of 5

Results

Sample characterization

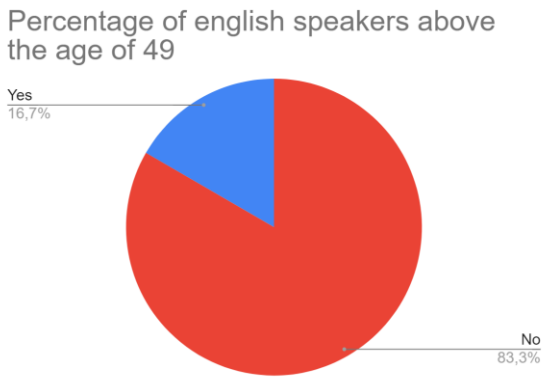
After concluding the Wireflow testing with the help of the Maze, a user research tool, with Figma integration, we can declare that the total number of participants was 20. Although it represents a small sample, we believe that it was sufficient to obtain the following results.
The studied population can be characterized based on two parameters: first, the age of the respondents, and second, their fluency in the English language.

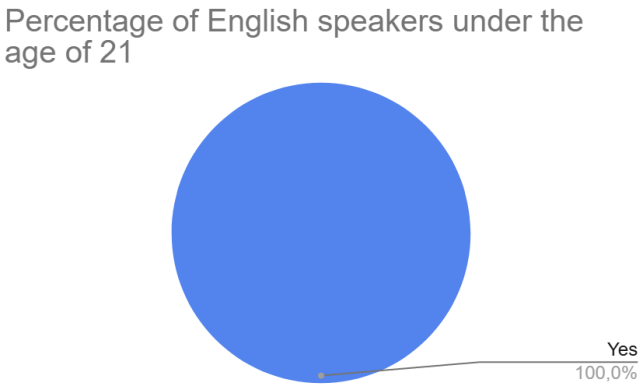
Firstly, the respondents can be categorized into two main groups: those under the age of 21 and those over the age of 49. This classification not only facilitates a better understanding of the second parameter analyzed, but also provides a clearer



interpretation of the values obtained in relation to different age groups.

Secondly, it is important to explain that the results might have been influenced by the language skills of the participants. In brief, the Wireflow is written in English, although the documentation and guidance for each step were done in Portuguese. Thus, further personal help translating the application was required for non-English speakers, consuming more time to complete the tasks and hence possibly influencing the results.
Statistical analysis was conducted to determine the percentage of influence the language





barrier affected the results.

Whilst the English language was dominated by the participants under the age of 21, most of the individuals above the age of 49 didn't have any fluency in the language. Thus, it was a substantial number of people whose results might have been affected by the language barrier. However, knowing we had an almost equal number of participants from both groups (37,5% of the total sample were above the age of 49), we can conclude that the results might be under control, with a small influence of the no ability to speak English.

For better accuracy of the results, it would not only have been important to obtain a larger number of responses but also to ensure a greater diversity of age groups in the testing process. This approach would enhance the reliability of the results and allow for the identification of additional issues that other age groups could more easily pinpoint regarding the application's usability.

Statistical analysis (Quantitative Analysis)

Where applicable, the values that include the interaction with "Help" menus will be shown in the respective table cells, in between a pair of parenthesis.

Task 1.1: Add a new production device to the monitoring panel

	Average	Median	Standard Deviation	CI (95%)	Expected Value
Time spent (s)	84,559	74,51	53,869	[60,95 ; 108,168]	45
Number of clicks	31,15	17,5	30,747	[17,675 ; 44,625]	10
Number of misclicks	18,1	6,5	23,429	[7,832 ; 28,368]	5

The results exceeded the expectations by a meaningful margin. By inspecting the respective heatmaps, we concluded that, for some users, the "Production in Real Time" widget in the "Monitoring Panel" was not indicative that it would take them to a different menu containing the list of production devices, visiting other pages first (as indicated by the number of clicks and time spent), before returning to explore the widget further.. Upon reaching the list, the users quickly and with few misclicks managed to add a new production device.

Task 1.2: Create a new production device

	Average	Median	Standard Deviation	CI (95%)	Expected Value
Time spent (s)	88,022	74,755	67,537	[58,423 ; 117,621]	60
Number of clicks	30,65	16	31,456	[16,864 ; 44,436]	16
Number of misclicks	15,25	5,5	21,716	[5,733 ; 24,767]	8

As this task was preceded by another that interacted with the production monitoring panel, the time spent was overall lower and according to our expectations. The higher-than-expected clicks and misclicks, however, indicate, through the heapmaps, that the interface does not show a clear distinction between adding the (already created) device

to the monitoring panel (using the checkbox) and the button to create a new device (initially hidden in a dropdown menu, which contributed to the confusion), leading to mistakenly click the checkboxes of the already created devices, before exploring the dropdown option.

Task 1.3: Remove a production device

	Average	Median	Standard Deviation	CI (95%)	Expected Value
Time spent (s)	43,997	31,15	43,488	[24,938 ; 63,056]	35
Number of clicks	16,3	11	11,365	[11,319 ; 21,281]	11
Number of misclicks	5,65	2	7,727	[2,263 ; 9,037]	3

For the same reasons as before, this task had a shorter average time spent and a lower number of clicks due to it being in the same menus as the previous tasks, and the button to remove being in the dropdown menu that was opened in Task 1.2, for people that remembered both options when creating a new device. This resulted in our expectations being met.

Task 2.1: Edit the dryer's “Low Market Prices” program

	Average	Median	Standard Deviation	CI (95%)	Expected Value
Time spent (s)	128,953	85,72	126,795	[73,384 ; 184,522]	60
Number of clicks	35,1	19	63,61	[7,222 ; 62,978]	11
Number of misclicks	18,15	5	46,66	[0 ; 38,6]	5

In this task, one of the user evaluations registered outlier values for each of the measurements, due to their exploration of the entire app before actually starting the task

as evidenced by the respective standard deviations, and consequently, the confidence intervals (another meaningful example of this is the extreme lower end of misclicks' confidence interval, which is amortized to 0 from -2,3, due to the impossibility of the there being a negative amount of clicks). In this case, the median value of these measurements is a more accurate representation of the sample.
Even with that evaluation skewing the results, the other users' heatmaps showed a significant amount of the task's time and clicks exploring all the different combinations and options in the Program Panel before following the correct steps to complete the task.

Task 2.2: Delete the "Winter Cycle" program from the dryer

	Average	**Median**	**Standard Deviation**	**CI (95%)**	**Expected Value**
Time spent (s)	49,386	43,635	26,848	[37,62 ; 61,152]	25 (35)
Number of clicks	15,75	14,5	7,691	[12,38 ; 19,12]	8 (10)
Number of misclicks	5,85	4	5,412	[3,478 ; 8,222]	2

In this task, the results obtained were generally worse than expected. The reason for this can be attributed to the fact that the "Delete" button for a program was placed in a way that was not intuitive. This issue was also highlighted by several respondents later in the section where they could express their opinions about the application and mention the problems they considered relevant. Based on the results obtained and the users' feedback, we can conclude that this functionality needs to be revisited in order to change the way this button is accessed.

Task 3.1: View the notifications tab and archive the first notification

	Average	Median	Standard Deviation	CI (95%)	Expected Value
Time spent (s)	41,415	37,53	28,878	[29,064 ; 53,766]	25 (45)
Number of clicks	8,667	5	7,512	[5,454 ; 11,88]	7 (9)
Number of misclicks	5,158	2	19,389	[2,281 ; 8,035]	2

In this task, the results obtained can be considered as within expectations, as the expected values fall within the confidence interval. Therefore, we can conclude that this task was successfully implemented.

Task 3.2: Create a new custom notification

In this statistical analysis, we will exclude the 879,25s bugged try since it clearly doesn't represent the overall user experience in this task would mislead the results

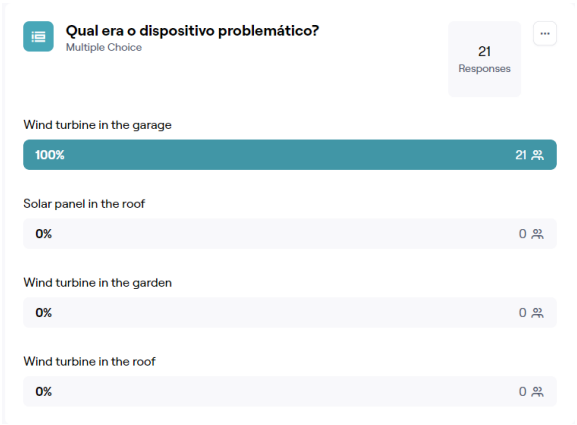
	Average	Median	Standard Deviation	CI (95%)	Expected Value
Time spent (s)	126,510	96,99	107,826	[79,393 ; 173,627]	60 (100)
Number of clicks	28,75	20	25,277	[17,939 ; 39,561]	20 (26)
Number of misclicks	14,35	5	17,330	[6,938 ; 21,762]	10

In this task, the results obtained differed from those previously analyzed. The time taken to complete the task was above expectations; however, the number of clicks and misclicks required to complete it was within the expected range. The reason for this is

primarily due to what was reported by some respondents in the section where they could report issues with the application. The button to create a notification was located at the bottom of the page, requiring a long scroll. Although there was a "Help" section where this was mentioned, it did not prevent users from taking longer than expected to find it. Since they knew the functionality was on that page, the number of clicks was within expectations. Therefore, we can conclude that the location of the "Create Notification" button should be reviewed in a future iteration.

Exploration Task: Analyze a potential problem in wind energy production

Out of the 21 responses received, all participants successfully completed the task. This indicates that the application is intuitive enough that, upon receiving a notification about a device with a production issue, users were able to use the notifications to identify that there was indeed a problem with the production devices. This allowed the respondents to navigate to the production device list in the "Monitoring Panel" to check which device was malfunctioning.



Discussion (Qualitative Analysis)

Respondents' opinions about the application's navigability

After allowing the respondents to explore the application freely to assess its navigability, the average score given on a scale from 0 to 10 was 8. In direct conversations with the respondents, it was generally noted that the application’s navigability was quite intuitive and that the developed design facilitates easy identification of the user's location within the application.

Respondents' opinions about the application

In response to the question, "What final rating would you give to our application?" the average score was 4.2 out of 5. To gain a better understanding of the strengths and weaknesses of the project in terms of usability, we included an open-ended question at the end of the survey, allowing respondents to describe any issues that may have caused them discomfort.

In general, the application was received positively, with various aspects being highlighted. Among these, the chosen design stood out (buttons, colors, graphs, and others). The implementation of the different functionalities was also praised for its quality, as well as the seamless interaction between them. Furthermore, the approach we took to the theme and the practical benefits the features provide to the users were also mentioned as positive points.

However, some aspects of different functionalities were identified as potential areas for improvement. Below are the ones that our group deemed to have the greatest need for change:

Initially, the creation of a guided tutorial was suggested when the user first opens the application. Although it would not make much sense to have a guided tutorial at the beginning of this usability test (since its purpose is to evaluate how accessible the features are for a person with no knowledge of how the application works, and the introduction of a tutorial would directly interfere with the results for assessing the usability of the implemented product), the creation of a guided tutorial in a final product release could help build initial user familiarity with the application. This would assist the user in performing tasks more efficiently while also familiarizing them with all the functionalities the application can offer.

Another suggested improvement was the option for the application to be available in Portuguese. Although the application was designed with a global audience in mind, where English made more sense as the primary language, the target audience we are most involved with predominantly speaks Portuguese. Another important aspect to highlight is the advantage that the presence of multiple languages offers in terms of increasing accessibility for a broader audience. In the event of a future usability survey, there is an added consideration to ensure that the tested product is in the same language as the respondent, so that the results obtained are as close as possible to reality.

Finally, several design/consistency issues were referenced during the execution of the different tasks. These include:

- Design of the notification tab button;

- Changing the name from "By Condition" to "Condition by Value";
- The delete program button could have been placed in a three-dot menu;
- The "Accept" action button moves depending on the functionality;
- The design of the energy type selection button is not intuitive;
- The notifications are designed for different types of notifications.

These changes, in a future iteration, would not only ensure greater consistency across the entire application but also facilitate the user's ability to recognize and familiarize themselves with the application's features. With these adjustments, users will be able to perform their tasks more efficiently, reducing the learning curve. Furthermore, given that the functionalities implemented are inherently complex, these changes will enable users with less familiarity with electric markets to integrate more seamlessly with the application, making the developed product more accessible to all.

Conclusion

After all the work done to accomplish one solution to monitor modern individual production of energy, as well as consumption, we can conclude that the overall classification of the app 4.2 out of 5, which closely follows the initially expected usability requirements. All the steps to finish the application were made to obtain the best results, taking the user's opinion into account at every stage. Ultimately, the app remained with the same objectives, user profiling, context, and required technologies. However, tasks and functionalities were changed and expanded upon across the different phases. Nevertheless, the results of the final evaluation showed the expected results compared to our initial thinking.

This last iteration helped solidify the application in terms of design, making a future software implementation easier, both in terms of understanding how the functionalities work and in terms of its visual appearance. With the usability test conducted, it was possible to identify usability issues to be addressed in a future iteration.

In the end, the elaboration of this solution was presented with difficulties and challenges, which led us to learn how to overcome them, contributing to our understanding of the steps required in the development of a fully fledged application.

Annexes

Phase I

Questionnaire:
https://docs.google.com/forms/d/e/1FAIpQLScnMXfpJlWbUnwvdRQN9f81mIfiO3T6lIbha7mMKOdh5tOxGQ/viewform

Results' spreadsheet:
https://docs.google.com/spreadsheets/d/1UxY6yNoMy18Wv84DB0dOs4gLGKAg4I8K8NZvwhRXJps/edit?usp=sharing

REN website:
https://datahub.ren.pt/pt/eletricidade/mercado/

References

[1] - https://www.repsol.pt/particulares/assessoramento/incentivos-para-energias-renovaveis-no-orcamento-de-estado-2024/

[2] - https://www.ayvens.com/pt-pt/blog/inovacao/inovacao-e-tecnologia-o-futuro-das-baterias-para-veiculos-eletricos/

Phase II

[1] Sent Heuristic Evaluation Report 1 (to Group 2):
https://docs.google.com/document/d/19_XDREi7ziuoSkCJZqGI7ukRZF-YOPCY/edit?usp=drive_link&ouid=103879111576750040337&rtpof=true&sd=true

[2] Sent Heuristic Evaluation Report 2 (to Group 6):
https://docs.google.com/document/d/1CtWE-v4plrJB0wpeT9oegXv3ncuenFcj/edit?usp=drive_link&ouid=103879111576750040337&rtpof=true&sd=true

[3] Received Heuristic Evaluation Report 1 (from Group 2):
https://drive.google.com/file/d/17Sg7qAg3bT8--BmffzOpo8BpNAPUuhXV/view?usp=drive_link

[4] Received Heuristic Evaluation Report 2 (from Group 6):
https://drive.google.com/file/d/16xUJV5fbAgbFybVVQUL0Hbqn5tuTiMFO/view?usp=sharing

[5] Link to access the developed Figma prototype:
https://www.figma.com/design/RMeRTAkV7JVa64yCMtMrX1/Lo-fi-Prototype?node-id=42-640&t=Y3KdhU5bhkA0zlKA-1

[6] Paper Prototype PDF:
https://drive.google.com/file/d/1md88kTEY1aii369kFAp7fPr9XnngdBQC/view?usp=sharing

Phase III

Figma Project (Final Prototype):
https://www.figma.com/design/RMeRTAkV7JVa64yCMtMrX1/Lo-fi-Prototype?node-id=296-1994&t=6OeGX3NYjPPNvt0n-1

Maze Project One:

https://t.maze.co/319825286

Maze Project One Report:
https://app.maze.co/report/SunLite-Part-1/bcwby7m4dfbink/intro

Maze Project Two:

https://t.maze.co/319937400

Maze Project Two Report:
https://app.maze.co/report/SunLite-Part-2/fhxaf7m4dg1yim/intro

Extracted Statistics from Maze Reports:
https://docs.google.com/spreadsheets/d/1CyFmbHXasPJzjBa5joVyFt-S5miofGQ3ZhmoVOGsDP4/edit?usp=sharing