Requirements Document

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1. Introduction

1.1. Purpose

This document describes the user requirements for the Future House System as requested by “Esteem”, a client whose aim is to raise environmental awareness and incentivize positive actions for the home dwellers as well as home managers. The System is intended to be used by members of the general population who will own the ‘future-proofed, zero-carbon, solar-powered’ house that will be presented by Esteem as part of World Expo 2020 in Dubai. The system will track and record energy generation and energy consumption inside the house, provide control over Internet enabled devices and make behavioral suggestions for the home dwellers and managers. The document is created for the benefit of “Esteem”, and the developers, Group Name developers.

It is therefore intended that the readers are:

1. Esteem and their appointed representatives: for the client to gain an insight and understanding of what exactly the end product will be capable of.
2. Group Name: to act as a guide for us during the development process.

1.2. Scope

There is one software product – Future House System.

The System will consist of a native mobile application, web-based application, as well as a tablet-like screen installed inside the house, interacting with a backend server to provide the user with energy data information and control over IoT devices in the house. The backend server will be receiving the relevant information about the energy data of the house from a Central Monitoring Unit (CMU), which is pre-installed in the solar-powered house. The database will hold all the energy data, as well as the user information data.

The main functionality of the system is to record energy generation and consumption inside the smart house, and display these data in a user-friendly format through the mobile app as well as the web app. Also, the user will be able to control and manage IoT devices through the app. Furthermore, the user will be receiving daily feedback on the energy generation and consumption inside the house, and suggestions to improve the energy efficiency of the house.

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2. General Description

2.1 Product perspective

The development of this product is being sponsored by Esteem. It will provide a unique service for the owners and dwellers of Esteem's solar powered houses. It will allow the users to view the energy consumption and as well as energy generation data, and will help them interact with IoT devices, lighting and A.C. in their home.

As this product will be providing a relatively unique service from most current smart home systems it has great potential for long term development and the capability to adapt to ever changing needs of the market.

2.2 Product functions

The system has 4 main functionalities:

- Record energy generation
- Record energy consumption
- Provide feedback to the user based on the usage patterns
- Provide control over IoT devices

2.3 General constraints

The general constraints that would be encountered by the smart home system can be classified into the below categories:

- **User based constraints**: Users may find it very hard to keep pace with the smart home device configuration as they will be updated every time there is a change in preference or when new habits and routines are formed.
  Users may also be burdened with the additional expense that will incur when an IoT device has to be replaced or when the server has to be updated as the income capacity of these users may not always be predictable.

- **Technological constraints:** There is always a chance of risk of malfunctioning of the IoT devices, or sensors or the central unit in smart home systems, along with the potential damage to the power storage which would all lead to hindrance in the working of the smart home system.
  The risk of traffic overload in IoT devices in the network is also prevalent as extensive number of IoT devices are involved in the system.

- **Security based constraints:** There is a possibility of the loss of control of a thermostat or a smoke detector that will have consequences on the user safety. In case of fire, the emergency number has to be dialed which won't happen in case of a power down of the system.

- **Energy Constraints**: Majority of devices are operated with battery power and the availability of battery power is based on the frequency of the storage data and computations. Therefore, energy is limited for smart home devices. Energy limitations provide vulnerability to resource depletion attacks

- **Physical Access**: If an intruder is successful to obtain the physical access of a device in a smart home in some way, then he/she will be able to take out all the encryption keys and other sensitive information. Therefore, they become easy targets of tampering attacks.

3. Requirements

M	Must have
S	Should have
C	Could have
W	Won't have this time

3.1 User Requirements

Registration

F-UR1 **Register as home manager** **M**
Users shall be able to register as home managers and register their home.

F-UR2 **Register as home dweller** **M**
Users shall be able to register as home dwellers.

F-UR3 **Login** **M**
Users shall be able to sign in using their email and password.

F-UR4 **Logout** **M**
Users shall be able to logout of their account

Home Dweller Specific Functionalities

F-UR5 **Control IoT Devices** **M**
The user shall be able to switch on/off IoT devices

F-UR6 **IoT devices feedback** **S**
The user shall be able to get a comprehensive feedback on the various IoT devices in the home, such as battery level and energy consumption.

F-UR7 **Recommendations** **S**
The user shall get recommendations based on his usage to improve energy efficiency

F-UR8	**Sharing Statistics** Home dwellers shall be able to share statistics to social media.	C

Home Manager Specific Functionalities

F-UR9	**Detailed Data usage** Home managers shall be able to get a more detailed information on energy usage	M
F-UR10	**Register multiple homes** Home managers shall be able to register more than one home to their account.	S
F-UR11	**Compare data usage** Home managers shall be able to compare data usage of the different homes registered to their account.	C

Account

F-UR12	**Change login credentials** The user shall be able to change his email and password	M
F-UR13	**Delete account** The user shall be able to delete his account and all the data associated to that account.	M

3.2 System Requirements

Backend Software

NF-SR1	**Server OS** The backend server will be hosted on a Linux server.	S
NF-SR2	**Environment** The backend server will be running Python 3.6	S
NF-SR3	**Database** The backend database will be running PostgreSQL.	S
NF-SR4	**MVC Architecture** The system shall use a Model-View-Controller framework.	S

Frontend Software

NF-SR5	**Support multiple mobile platforms** The Mobile App shall support Android and iOS	M
NF-SR6	**Browser Support** The Web App shall be able to run across all widely supported web browsers.	M
NF-SR7	**Desktop App support** There shall be Windows, MacOS and Linux desktop apps for the system.	W

Security

NF-SR8	**Hashing passwords** The system shall hash passwords, such that no raw passwords are stored on the database.	M

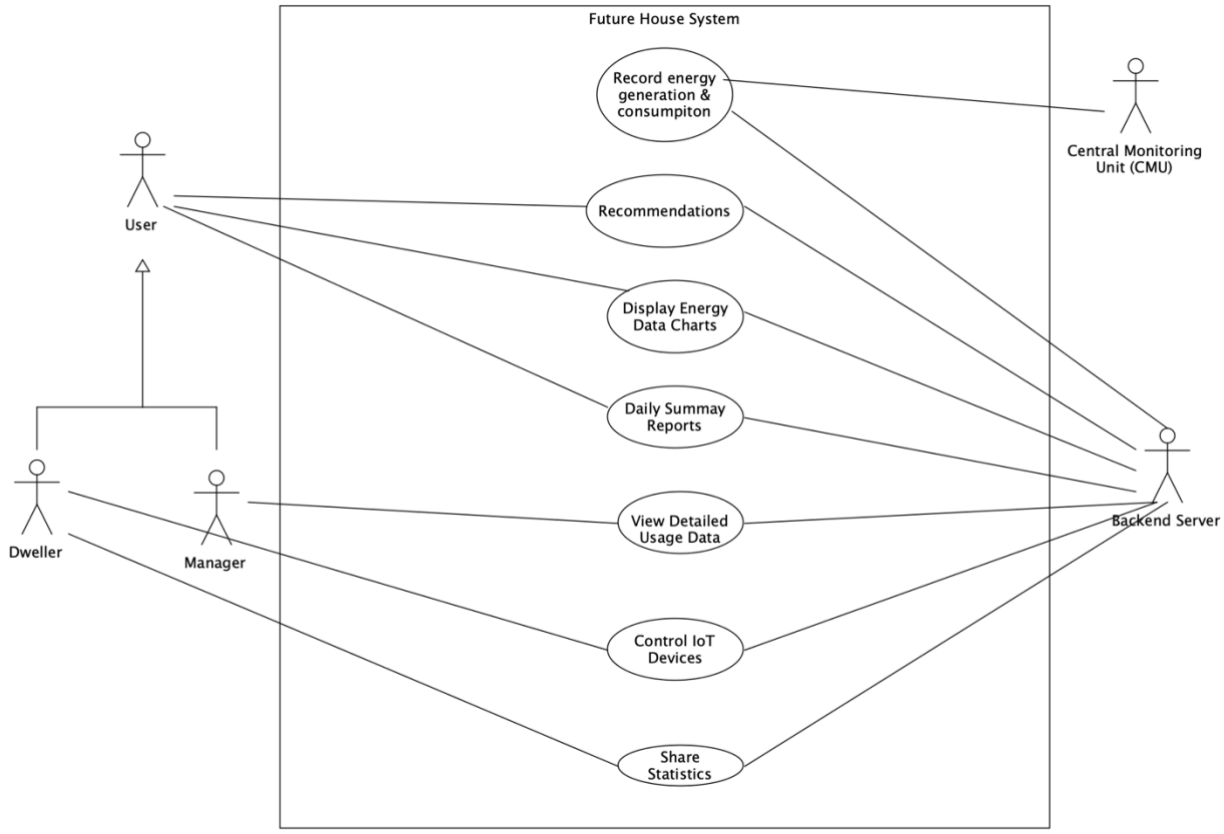
NF-SR9	**Auth Token** The system shall issue an Authentication token related to a particular user when a user successfully logs in and invalidate that token when the user logs out.	**M**
NF-SR10	**Password criteria** The system shall require passwords to be at least 6 characters long	**S**

Performance

NF-SR11	**Uptime** The system shall have an uptime of 99%	**S**
NF-SR12	**Transaction capacity** The system shall be able to handle a minimum of 1000 IOPS.	**S**
NF-SR13	**Responsiveness** The backend server shall have a latency of less than 300ms.	**S**
NF-SR14	**Multiple backend servers** The system shall have multiple backend servers around the world to provide the most optimum latency for every user based on his location.	**W**

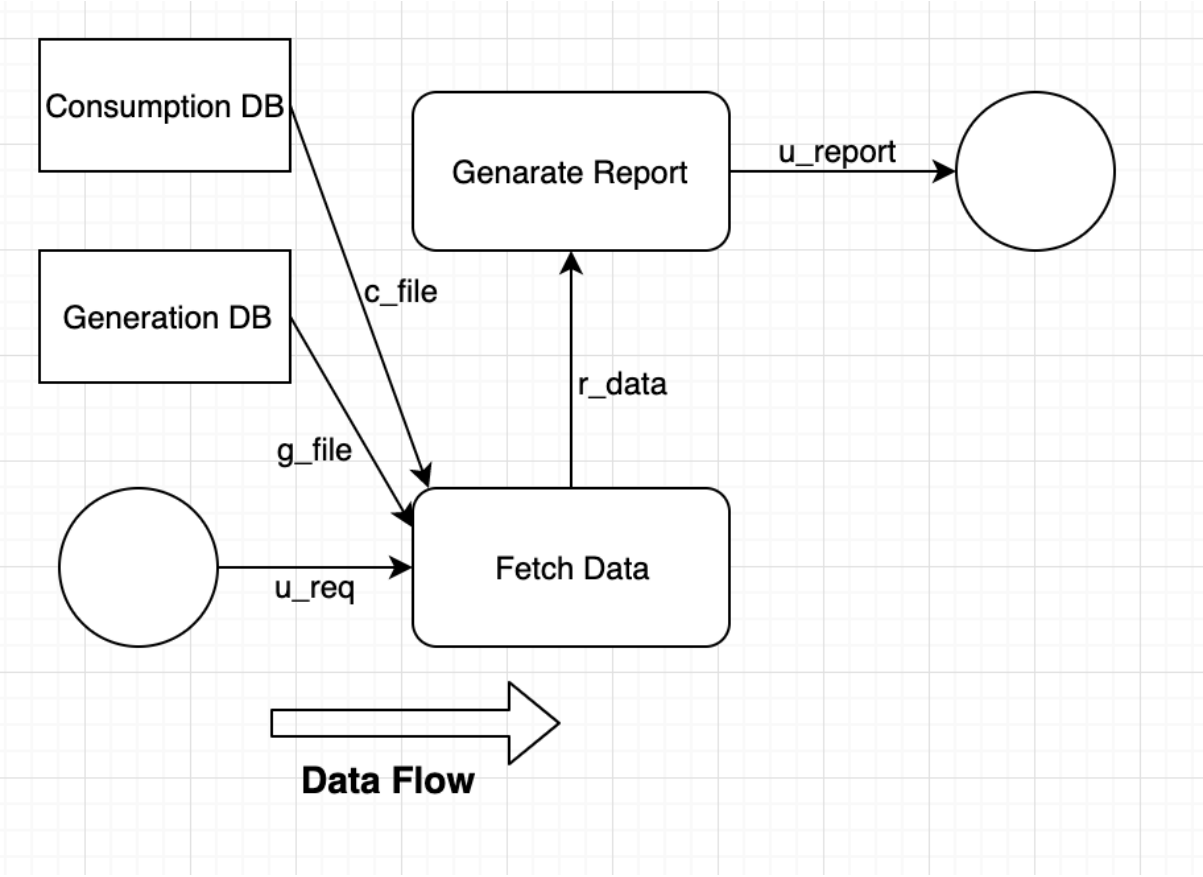
4. Appendices

4.1 Use case diagram

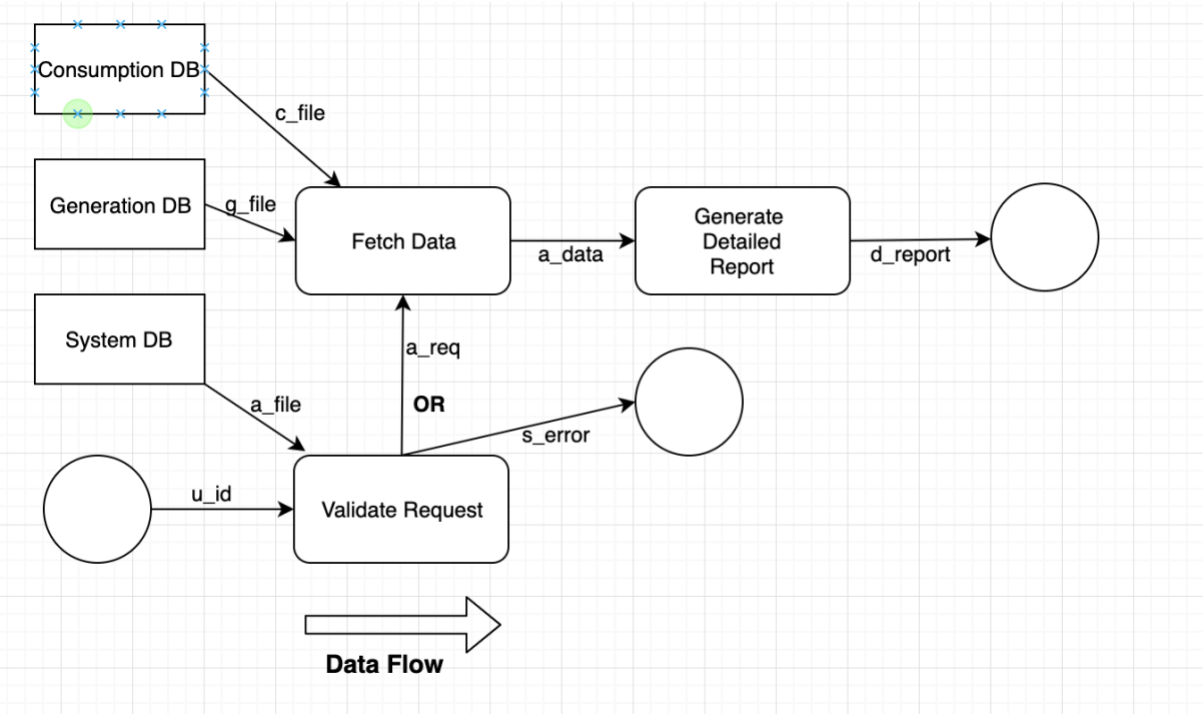


4.2 Data Flow Diagrams

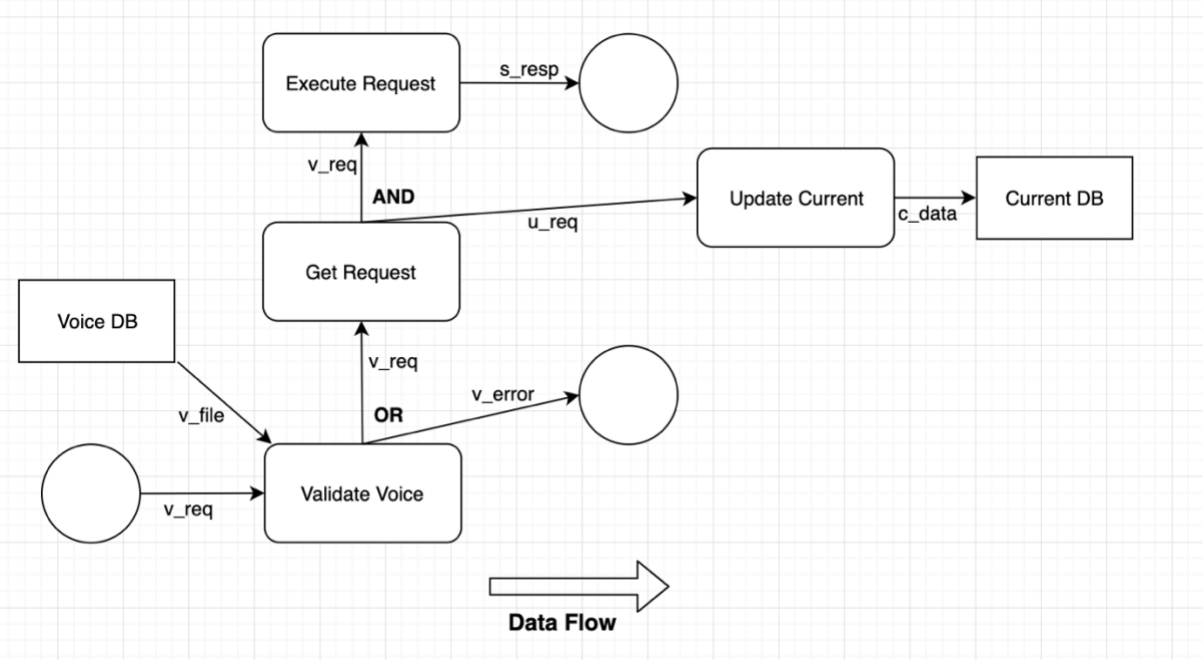
A. Report



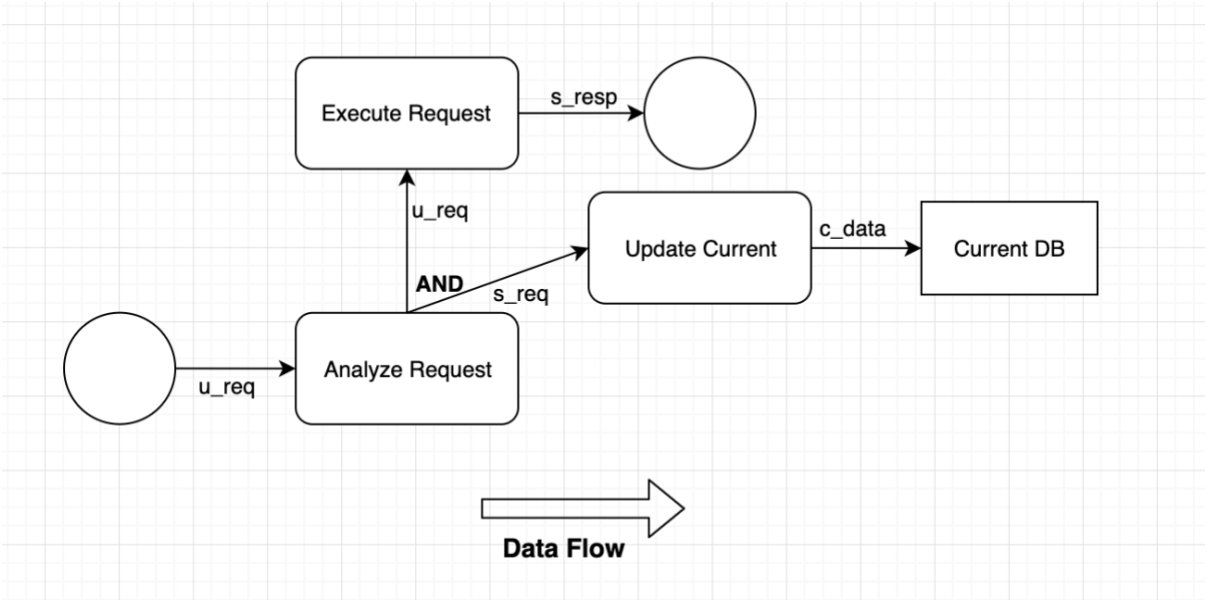
B. Manager Report



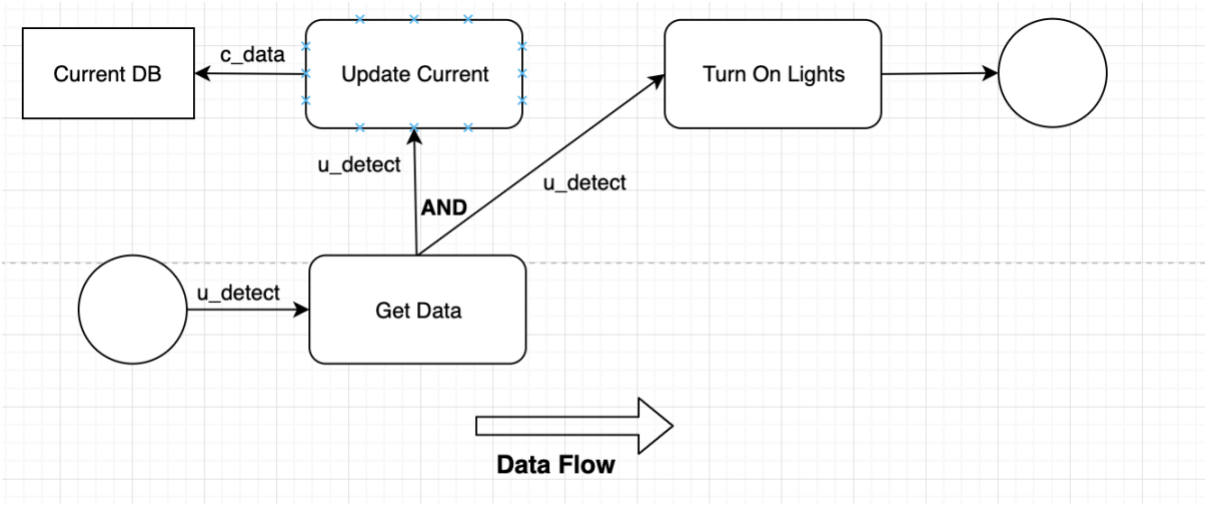
C. Voice Request



D. Normal Request



E. Motion Detect



Risk Analysis Document

L – Likelihood		C – Consequence	
A	Almost Certain	**A**	Severe
B	Likely	**B**	Major
C	Possible	**C**	Moderate
D	Unlikely	**D**	Minor
E	Rare	**E**	Trivial

Risk	Risk type	L	C	Indicators	Strategy type	Strategy
Student dropout	Project: People	E	B	The student may indicate that he/she would dropout	Mitigate	Reorganize team so that there is more overlap of work and therefore we understand more each other's work
Student illness	Project: People	D	C	Usually illness happens suddenly	Mitigate	The ill student can have less work while ill, and then can catch up later by putting in extra work.
Technology discontinued	Business: Technology	D	D	Software company announcement	Mitigate	Use open source frameworks, so our work won't be affected even if the technology is discontinued.
Natural Disaster	Project: People	E	A	Could happen without an indicator	---	In case of a catastrophic natural disaster that would lead to the termination of the project, nothing could be done.
Inability to meet deadlines	People: Estimation	C	B	Having several other deadlines in a short time period	Management	Re-evaluate current plan ASAP
Poor communication	Project: People	D	B	Poor relationships amongst team members	Monitor	Monitor and resolve any conflicts among team members.
Specifications change	Product: Requirements	E	B	An announcement from the project Co-Ordinator	Management	Although very unlikely to have changes in the specifications mid-project, but we would re-evaluate our plan in case that happened.
Management change	Business: Organization	E	E	An announcement that we would have a new manager	Mitigate	Having a new line manager won't affect our plan of work.
Buggy software	Project: People	C	A	Discovering bugs while testing	Management	Have more people to focus on the buggy part till the issue is resolved.

Server crash	Business: Technology	E	A	An announcement from the service provider	Mitigate	We will be deploying our backend server on AWS, which have an uptime of over 99%.

Usability Document

Table of Contents

1. Introduction

1.1. Aims & Objectives

This document describes the UI design decisions of the Future House System as well as the usability experimental plan responses, results and conclusion.

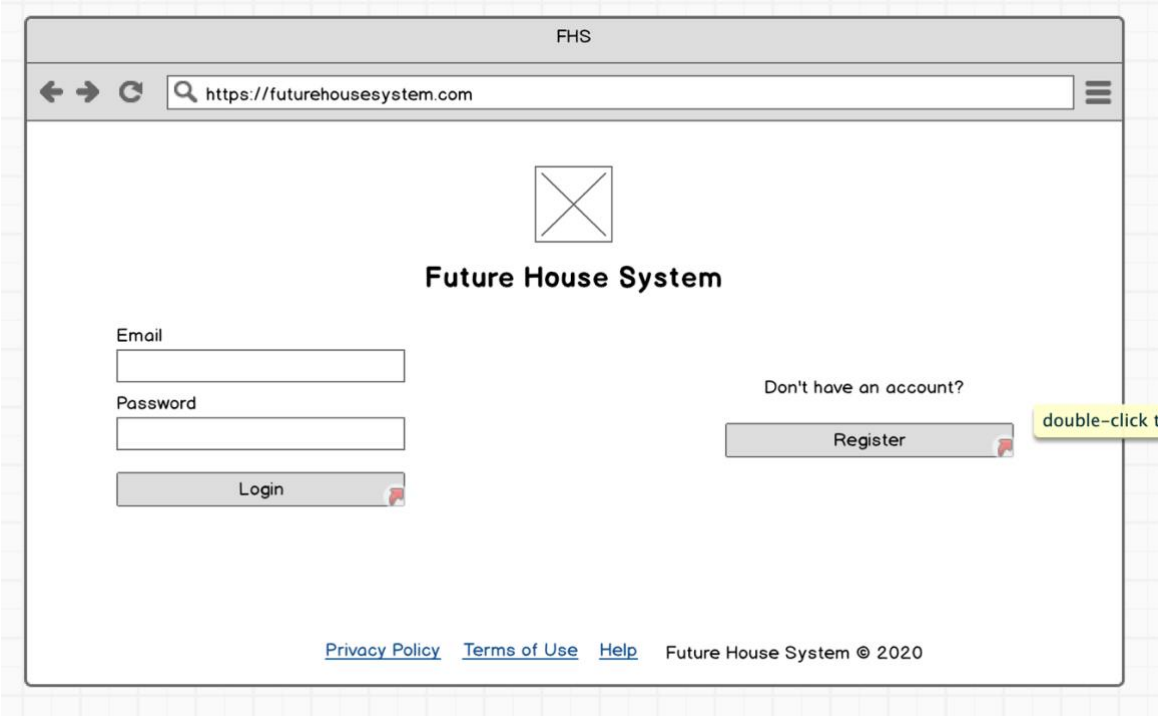
2. Design decisions

2.1. Overview

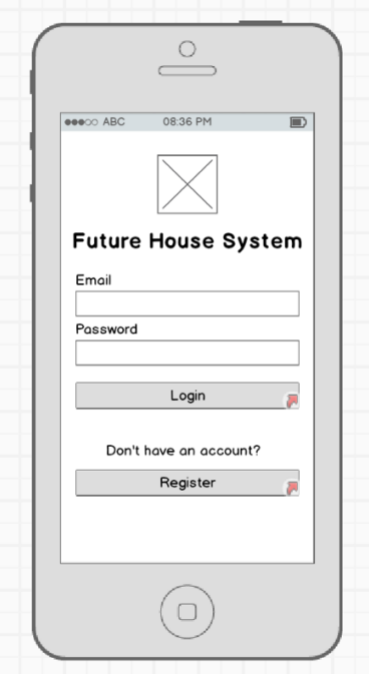
The first thing we needed to consider when making the design decisions, is who will be using our product. Our product will be used by people of all ages: children, adults and elderly, so we needed to focus on making the design not complex and the most usable possible. The following sections shows some mockups of our design for both Mobile and Desktop, along with some design explanation for each mockup.

2.2. Mockups

2.2.1 Login (Index) screen



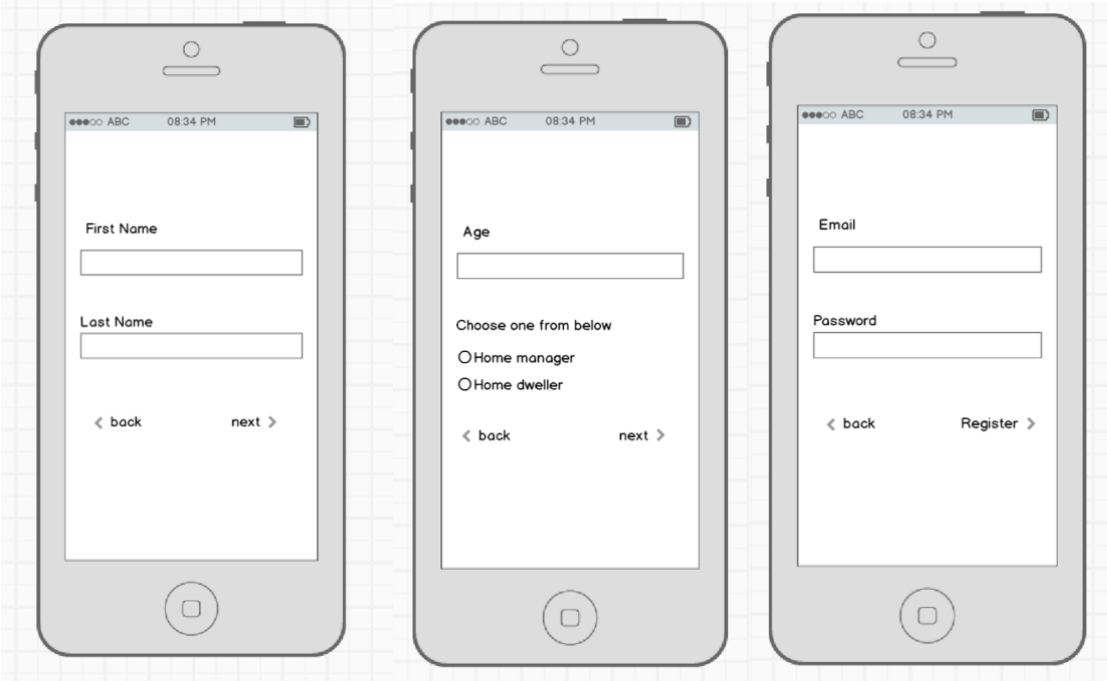
The login screen is a very simple one. The screen is divided into four corners. The logo and the name of the system is shown at the top corner of the screen. Input fields for email and password are shown on the left corner, and a register button on the right corner. The bottom corner contains links to help section, privacy policy section and terms of use section.



The mobile login screen is also similar in simplicity, but in a vertical alignment.

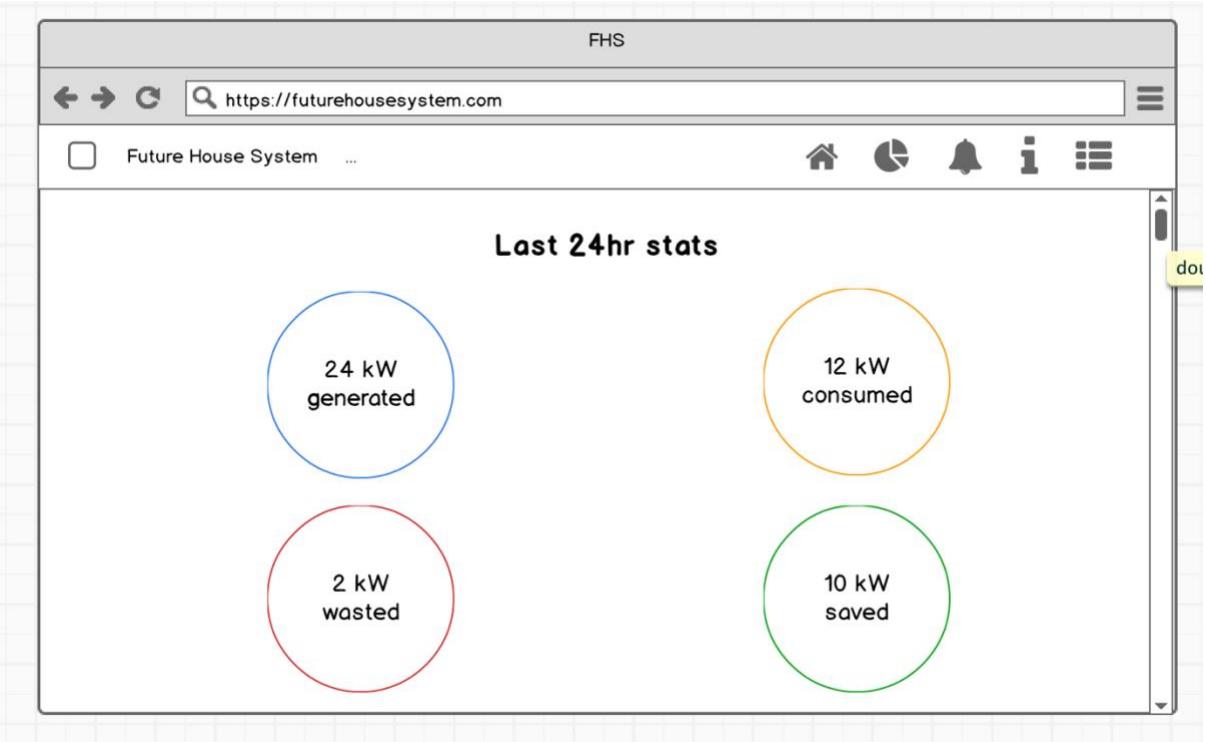
2.2.2 Register screen

In the register screen the user is asked for 6 inputs: first name, last name, age, email, password and whether he/she is a Home manager or a Home dweller.

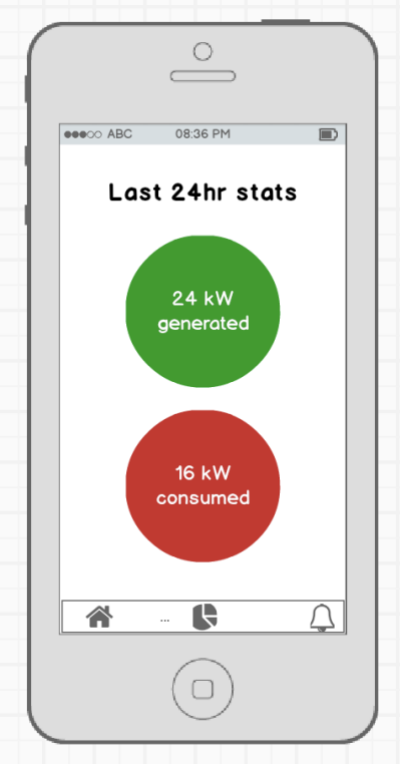


Registering on mobile is composed of 3 screens instead of 1 screen for more clarity on the mobile's smaller screen.

2.2.3 Home screen

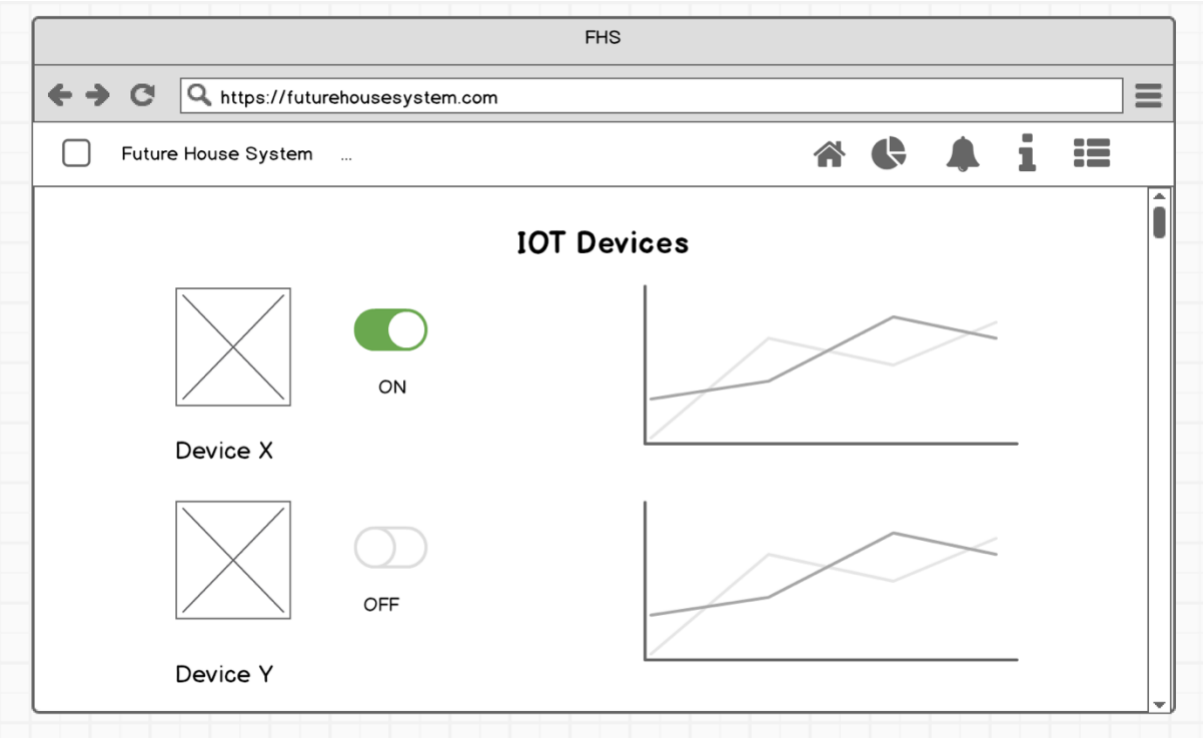


The first thing that will be shown to the user on the home screen is the last 24 hours stats. The user will be shown in kilo Watts the electric power generated, consumed, wasted and saved. The user can navigate to different screen from the top right corner.

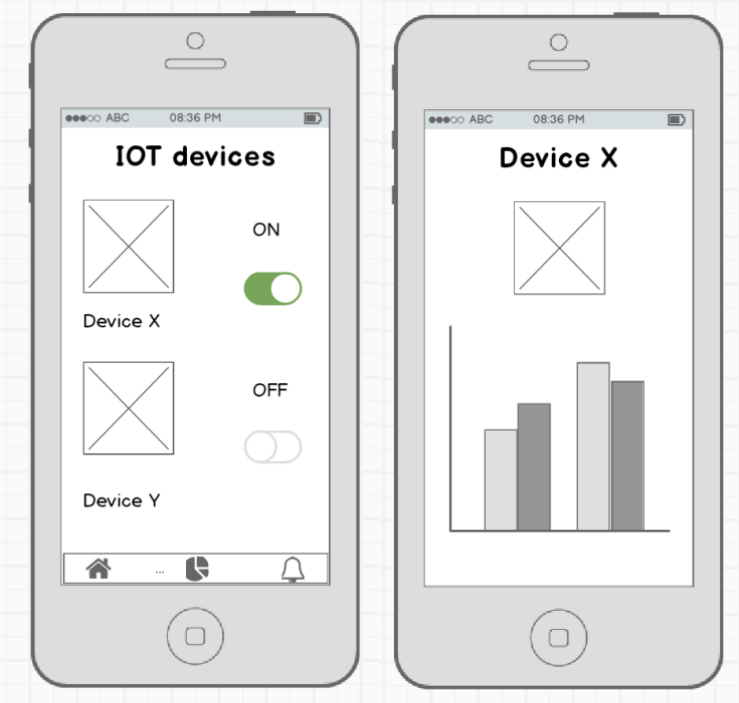


On mobile, the stats will be shown in a vertical manner. The navigation bar will be located at the bottom of the screen.

2.2.4 IOT screen

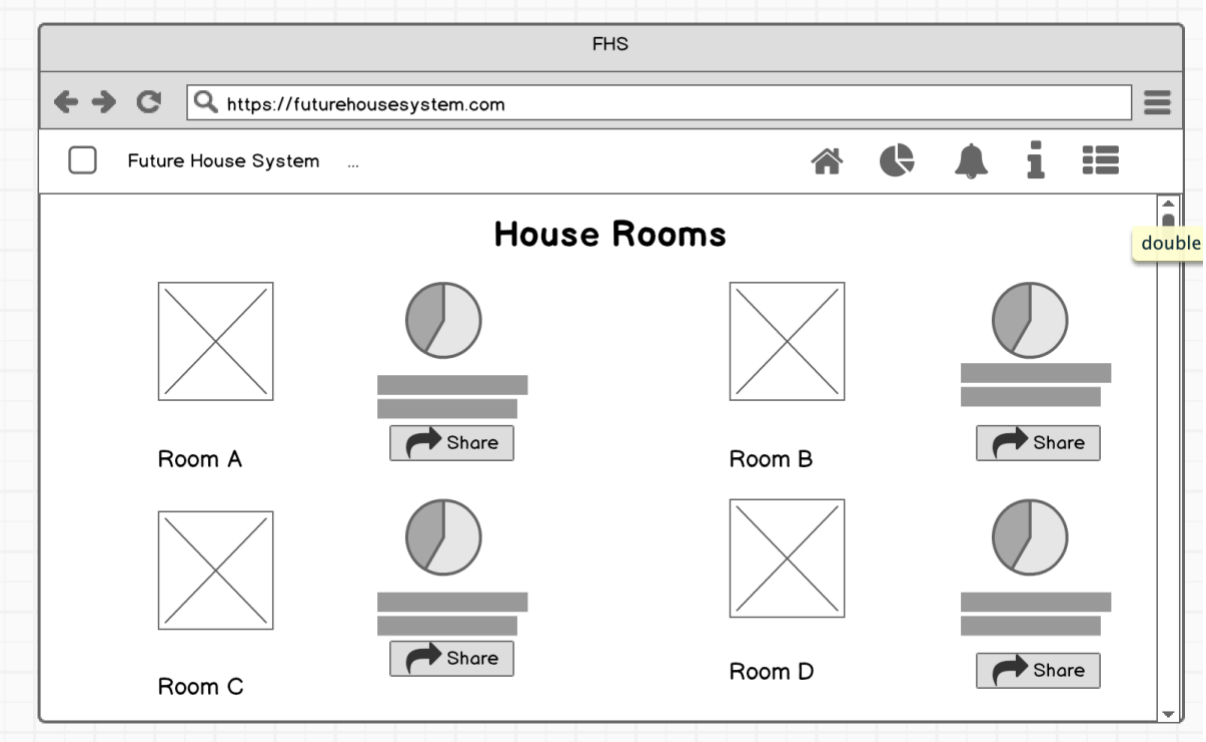


In the IOT devices screen, a picture of every device will be shown, and a switch to control the device. Next to every IOT device a graph will be shown to give the user more insight into the device's usage of electric power.

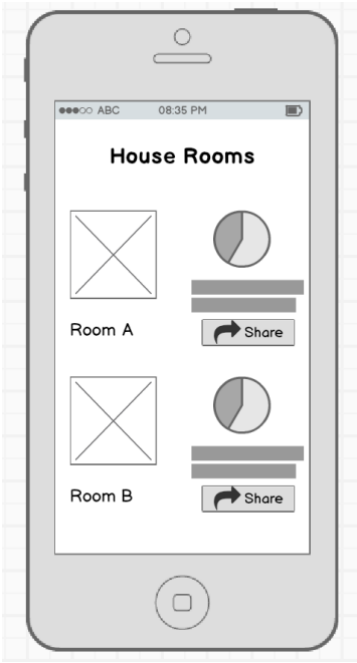


On mobile, similarly the user can control IOT devices, and also can click on any IOT device to get more info about it and graphs showing the device's usage of electric power.

2.2.5 House rooms screen

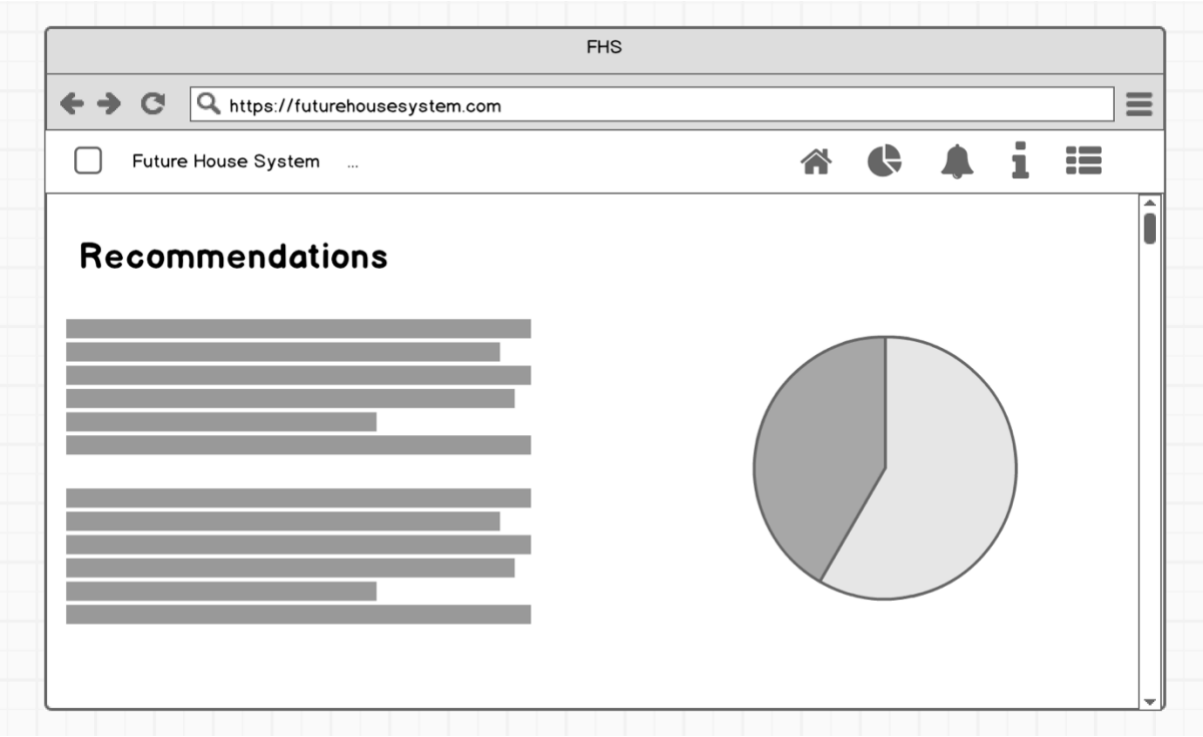


In the House rooms screen, a picture of every room will be displayed along with a pie chart showing some statistics about power usage and more info beneath it. Also, a share button will be there to allow the user to share the statistics to different social media.



On mobile it will look similar, but again in a vertical manner.

2.2.6 Recommendations screen

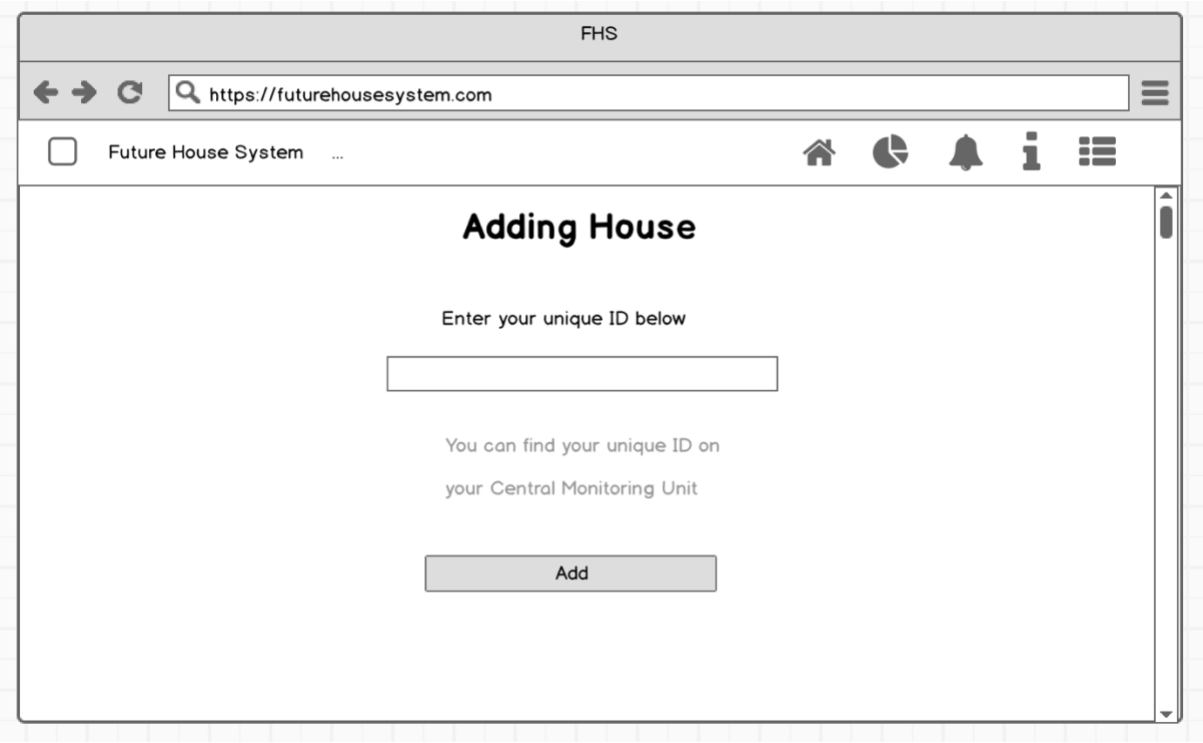


The recommendations screen will show the user some recommendations based on his/her usage on the left side of the screen and support those recommendations using graphs and charts on the right side of the screen.

2.2.7 No house screen

When the user has not added/registered yet a house with his account, a screen will be displayed on the home page having a big button asking the user to add a new House.

2.2.8 Adding house screen



On the “Adding house” screen which the user can reach by clicking the button in the “No house” screen, a big input field will be displayed asking the user to enter his unique ID which is associated with the Central Monitoring Unit, and beneath it a big “Add” button to add/register the house.

3. Experimental plan

3.1 Experimental method

The experimental method we used is a “Usability” study rather than an “Experimental” study. We observed the participants actions, and how they interacted with the different screens we present to them. The main objective of the testing plan is to test the usability of the user interface of the Future House System in order to get some feedback on whether the design is good or bad, and how easy it is to use the application.

Data Collection

The data was collected in compliance with GDPR. No personal information was obtained from the subjects at all. Every subject was given an ID. This means that the data is “Anonymous and unlinked” by GDPR standards. Data was collected through the pre-questionnaires and post questionnaires, in addition to our observations.

Testing Protocol

During testing the participants, we followed the following protocol:

1. Welcome the participants and explain to them aim of this session which is to try out some of the features of a prototype app which aims to provide control system over a solar powered house.
2. Give the participants more insight into the system’s main functionalities.
3. Explain to the participants how the test will be run, and that all their responses will stay anonymous.
4. Ask the participants to answer the prequestionnaire.
5. Start testing: show the participants several mock-up screens asking some to describe what they see on each screen in addition to other questions specific to every screen.
6. Ask the participants to answer the postquestionnaire, then thank them for participating.

3.2 Responses Details

3.2 Result analysis

3.4 Conclusion

4. Appendices

4.1. Usability testing test plan

1. Objectives

We are testing the usability of the user interface of the Future House System in order to get some feedback on whether the design is good or bad, and how easy it is to use the application.

2. Participants

Future House System will be used by people of all ages, but all our subjects will be at least 18 years old.

3. Task Scenarios

- What they see:

  We will show the participants some mock-ups and get feedback from them on what they think is displayed on the mock-up screen.
- Task 2 – Perform some tasks:

  We will ask the participants to perform some tasks through the mock-ups, for example: “If you want to create a new account where can you click?”.

4. Metrics

- Time spent to determine what they see on the mock-up screen (quantitative – objective).
- Success rate of knowing what is displayed on the mock-up screen correctly (quantitative – objective).
- Ratings given by participants in the questionnaires (quantitative – subjective).

5. Questions

Before, during and after testing we will ask the participant the following questions:

- Do you consider yourself experienced with using technology?
- What do you think of the design of that screen?
- Do you think that part of the screen is useful?

- What do you think of the overall design and usability of the application?

Remember to say something like this with each new subject:

I'll ask you to look at the various screens and describe what you see, and I will ask you to complete a few simple tasks. I'll be taking notes to record your feedback and actions but my notes won't identify you and they will be completely anonymous. Following this we will ask you to complete an anonymous questionnaire to collect your general comments/feedback on the app. There are no right or wrong answers, and your interpretation of the information presented will be very useful in improving the design. Please tell the facilitator if you wish to stop at any time.

4.2 Mock-up testing protocol

Facilitator initials:
Session number:

iSneeze

Future House System testing protocol

20 November 2019

Heriott Watt University

Notes for facilitator
Please read through the aims and introduction with the participant and take notes alongside each of the questions to record the session. Please use a new protocol sheet for each participant and record your name and session number on the top right corner. In your notes please record the participant's responses and any issues they may have had in completing the tasks.

Aim
The aim of this session to try out some of the features of a prototype app which aims to provide control system over a solar powered house. The app is in early developmental stage and your input will be used to improve the functions and the way that the information is presented.

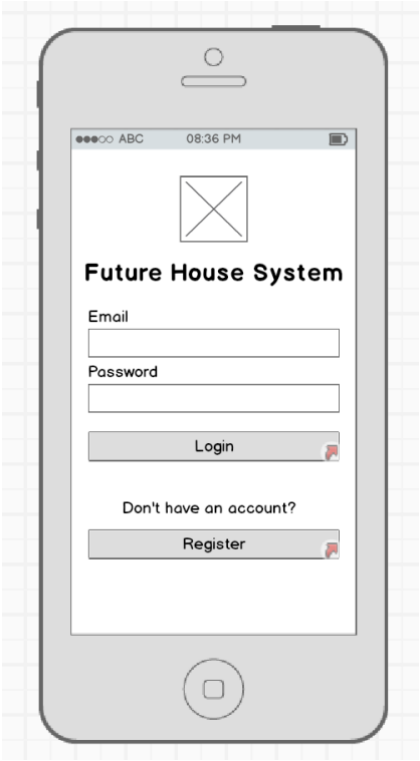
Introduction

The control system will record the energy consumption and generation in a House, and display these information to user inside the app in the form of different charts, as well as provide control over IoT devices in the house, give some recommendations based on the user's usage to improve the energy efficiency inside the house.

I'll ask you to look at various screens, both mobile and desktop, and describe what you see, and I will ask you to complete a few simple tasks. I'll be taking notes to record your feedback and actions, but my notes won't identify you and they will be completely anonymous. Following this we will ask you to complete an anonymous questionnaire to collect your general comments/feedback on the app. There are no right or wrong answers, and your interpretation of the information presented will be very useful in improving the design. Please tell the facilitator if you wish to stop at any time.

Let's begin.

1. Login screen



a) Can you describe this screen?

b) What are the steps you would follow to login?

2.1 Register Screen 1

a) What would you do on that screen?

2.2 Register screen 2

a) Can you describe that screen?

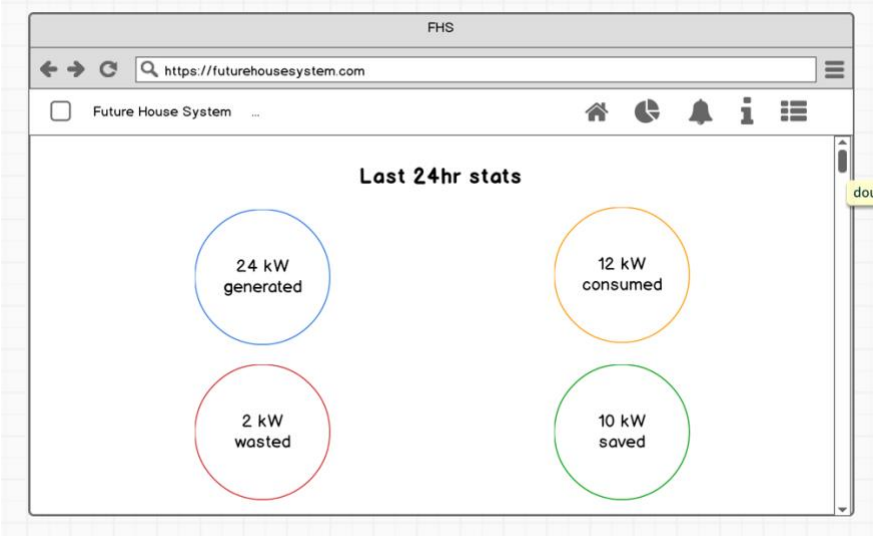
b) When would you choose a Home manager and when would you choose a Home dweller?

2.3 Register screen 3

a) How would you go back to change your age?

b) Where should you press after filling all the fields?

3. Home screen

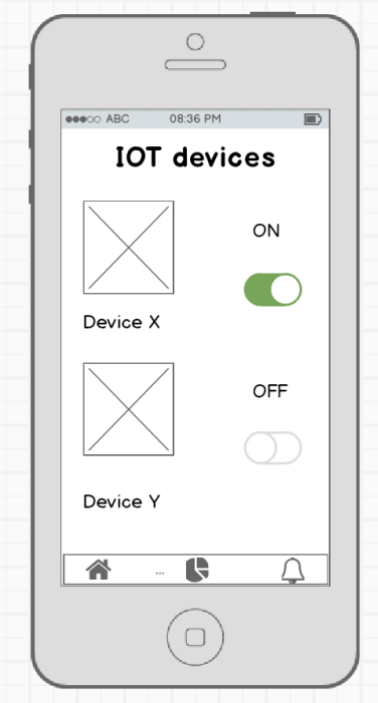


a) Can you describe the screen?

b) How much energy was generated in the last 24 hours?

c) What do you think every element of the top navigation bar do?

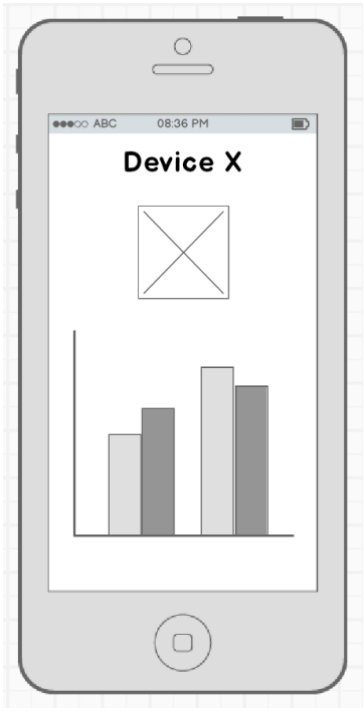
4. IoT screen



a) Can you describe this screen?

b) How would you turn on Device Y?

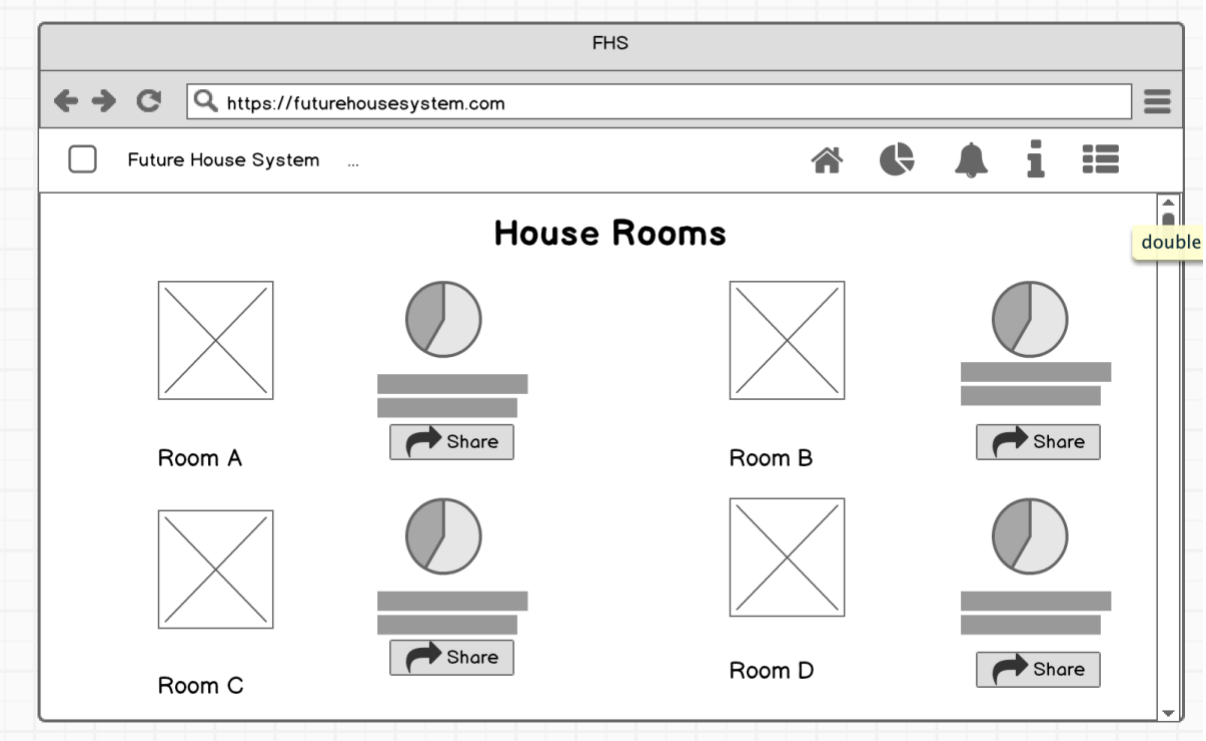
5. IoT details screen



a) What do you think is displayed on the screen?

b) How do you think you can get to that screen from the previous screen?

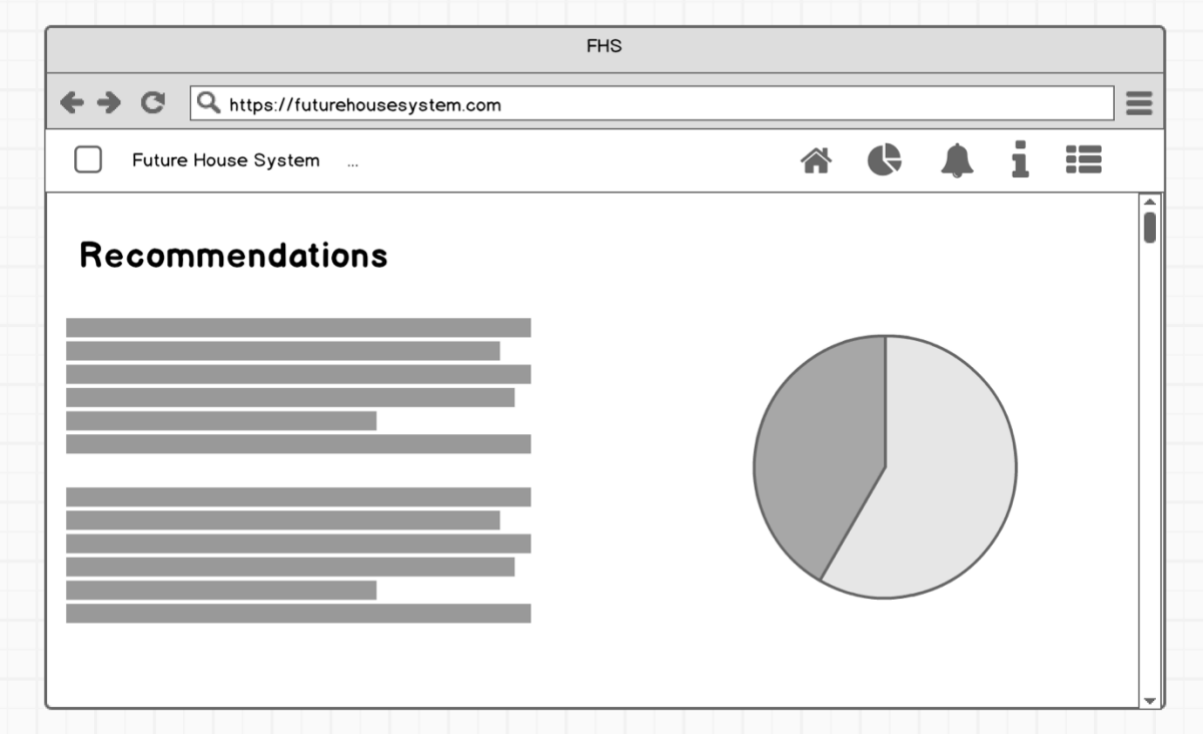
6. House rooms screen



a) What do you think is displayed on the screen?

b) Where would you click to share this information to another app?

7. Recommendations screen



a) Can you describe that scree?

8. No houses screen

a) Can you describe that screen?

b) What can you do on that screen?

9. Adding new house screen

a) Can you describe that screen?

b) Where can you find your unique ID?

OK, that's our short test complete. I'll now set up the questionnaire for you to complete. This is intended to gather some more general feedback on the app. It should only take 5-10 minutes to complete, and then you are done.

4.3 Blank Pre-Questionnaire

Future House System Application Pre-Questionnaire

For all the following questions tick only one answer:

1. Age
    - 18-29
    - 30-49
    - 50+

2. Gender
    - Male
    - Female

3. Do you consider yourself experienced with technology?
    - Yes
    - No
    - Not sure

4. Have you ever used a House Control System application before?
    - Yes
    - No

4.4 Blank Post-Questionnaire

Future House System Application Post-Questionnaire

Thank you for participating in this usability testing. Please take the time to answer the following questions.

On a scale from 1 to 5, 1 being “Strongly Disagree” and 5 being “Strongly Agree”, answer the following questions:

1. I think I would enjoy using this app.

   Strongly Disagree 1 2 3 4 5 Strongly Agree

2. This application has a good design.

   Strongly Disagree 1 2 3 4 5 Strongly Agree

3. I found this application unnecessarily complex.

   Strongly Disagree 1 2 3 4 5 Strongly Agree

4. I would imagine that most people would learn to use this app very quickly.

   Strongly Disagree 1 2 3 4 5 Strongly Agree

5. I was able to describe every screen with confidence and ease

   Strongly Disagree 1 2 3 4 5 Strongly Agree

6. I think I would need the support of a technical person to be able to use the app.

   Strongly Disagree 1 2 3 4 5 Strongly Agree

7. I think I would be using this app frequently

   Strongly Disagree 1 2 3 4 5 Strongly Agree

8. The overall experience with this app was enjoyable.

   Strongly Disagree 1 2 3 4 5 Strongly Agree

9. What did you like about this application?

……

……

10. What did you not like about this application?

……

……

11. What do you think can be improved in this application?

……

……

That’s the end of the questionnaire. Thank you for participating with us.

4.5 Blank consent form

Future House System
Heriot-Watt University

Consent to Act as a Subject in an Experimental Study

Principal Investigator: Omar, Ibrahim, Mahmoud, Harshan, Malek, Arathi

Description: The purpose of this study is to study the usability of the user interface of the Future House System.

There are minimal risks for you to participate in this study. All personal information will be kept confidential in a secure filing cabinet or in password-protected computer directories. Your participation will not affect how well you do in your courses (if you are a student) or affect your relationship with the university in any way

You are free to decline to participate in this study. Should you decide to participate, you are free to end your participation at any time. Such a decision by you will not adversely affect or alter you status with the university in any way.

Voluntary consent: I certify that I have read the preceding and that I understand its contents. Any questions I have pertaining to the research have been and will be answered by the team. My signature below means that I have freely agreed to participate in this study, and that I agree to the publication of the results for scientific purposes and to the distribution of the recordings and transcripts of the sessions for research purposes so long as my identity is not revealed.

_____ _____ _____

Date Subject Signature
Inv. Initials

Investigator's certification: I certify that I have explained to the above individual the nature and purpose, the potential benefits, and possible risks associated with participation in this research study, have answered any questions that have been raised, and have witnessed the above signature.

_____ _____

Date Investigator Signature