Project Requirements Document V2

Team Pina Colada | AgMonitor

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Introduction

Background

Installing solar and battery assets creates microgrids that can be managed independently. Solar energy can only generate power during the day, which often means that energy usage during the day is cheaper. Certain energy assets do not have to be activated all the time, so shifting their load is one strategy to optimize cost, reduce inefficiencies, and even avoid unnecessarily contributing to greenhouse gas emissions. However, knowing when to move usage can be difficult or an excessive burden. Thus, our project seeks to provide microgrid operators the relevant knowledge and foresight to smartly manage their resources.

Existing Solutions

In the current market, there are a few solutions that attempt to address this issue. Multiple companies like AgMonitor encourage shifting energy usage away from peak hours, indicating when they can potentially save on utility costs by either turning things off or changing when they turn on. This directly influences human behavior, which requires the customer to be involved in shifting energy usage. There is also currently research into smart charging and several pilot programs that attempt to implement smart charging programs, where grid information from the utility company is used to remotely manage when electric vehicles charge. These programs are not available to the wide public yet, and furthermore centralize control once again. Not to mention, a bottom-up approach from the microgrid perspective is better

able to capture specific energy generation and needs. Optimizing on the macrogrid from the utility perspective doesn't necessarily guarantee optimization on the microgrid. Tesla also provides a suite of energy software solutions including a microgrid controller that will coordinate and manage energy assets while having options for optimization and customizability. However, the Tesla microgrid controller currently only allows for load shedding (shutting down certain loads) instead of shifting which is more optimal for dynamic energy management.

Project Specification

Our objective is to make energy management easy for microgrid owners. We expect our users to range from business owners to homeowners. The project will specifically focus on creating a user-friendly tool that can effectively manage energy assets and variable load with minimal effort and knowledge required from the individual. This comes in the form of visually providing insights about a user's data and also allowing the user to integrate their assets into a controller that will autonomously optimize and manage the system. Real time optimization will also constantly balance potentially competing interests such as reducing cost, integrating more renewable energy, and maintaining resiliency in the grid by ensuring that bad weather or shut offs do not cause critical failures. Furthermore, we will provide a degree of customizability in controller functionality so that our project can be adaptable to user-specific scenarios. While we focus our project mainly around the usage of electric vehicles, we hope to be able to generalize our solution to multiple forms of variable load in the larger context of a microgrid.

Goals:

(i) Develop a web application to manage the impact energy storage (ES) and electric vehicle (EV) assets in the context of a micro-grid.

(ii) Implement an algorithm that maximizes the usage of local renewable energy and reduces the reliance on the California grid at times of peak load.

(iii) Validate the implementation of the web application on real-world use cases such as farms.

Assumptions

Our project makes a couple of assumptions. While historical data and statistics can be used to make predictions for utility grid generation and usage because of the scale, sufficient data might not exist at the microgrid level. Furthermore, there is an extremely wide range of data sources as different utility providers and manufacturers might provide data in different ways. Integrating these different data streams into our application is outside our scope, but we can assume that given enough resources and time we would be able to. For example, the utility API provides a way for us to potentially access utility data, but we choose not to integrate with this API due to time and cost considerations. We also design our project in a way that is generalizable to many different use cases, but we will focus on our current efforts on our testing sites and their existing third party technologies such as Tesla.

System Architecture Overview
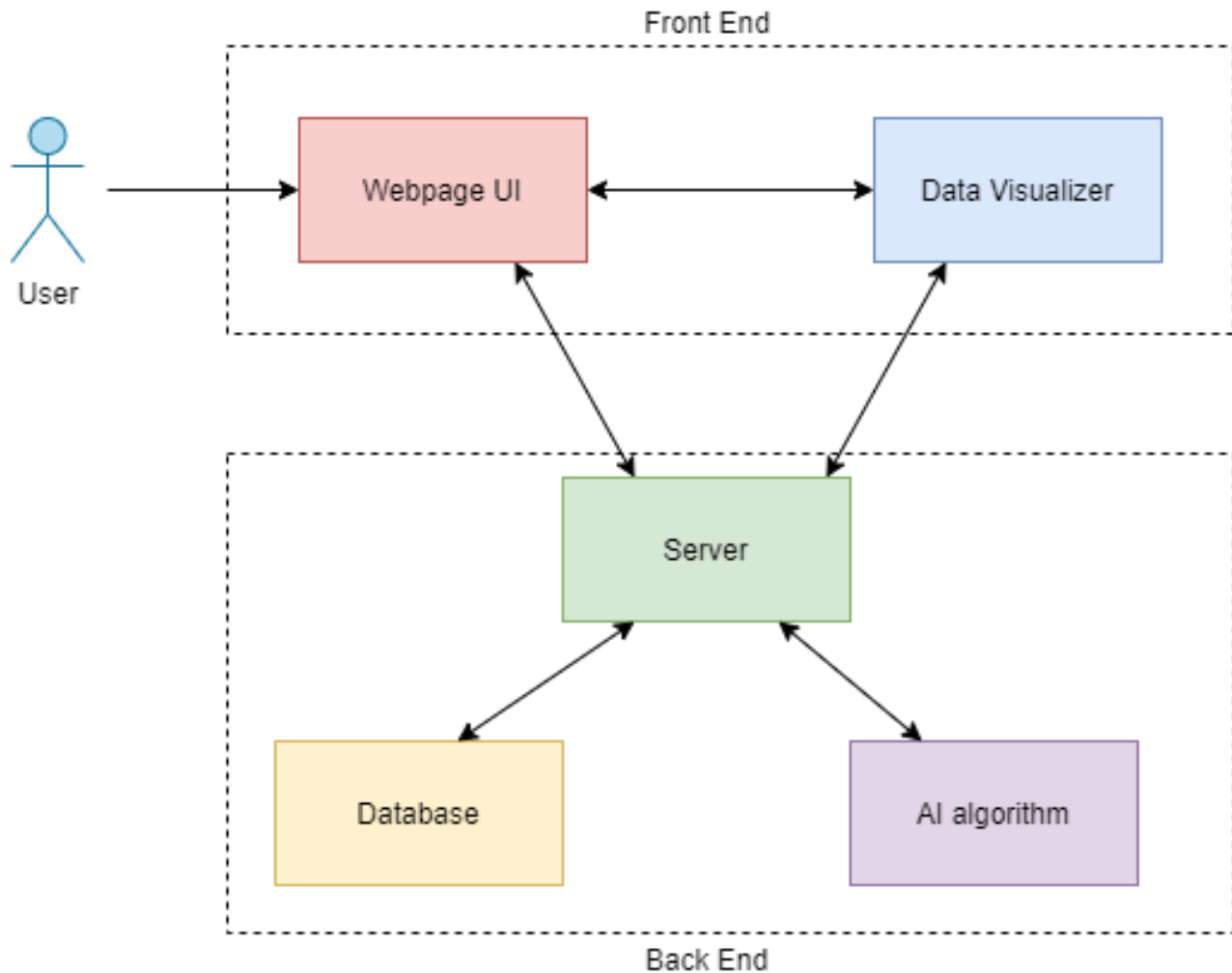
The diagram above shows a high-level architecture of our web application. The front end mainly contains the webpage user interface and the data visualizer Highcharts to display data visualization.

The user will be able to log in to the webpage to interact with the webpage UI. The user can upload the data and there will be a transformation in the backend that allows automated data processing. Then, the data will be stored in the database in the backend. The user will be able to visualize the categorical and quantitative data with the help of the data visualizer. By visualizing the data, the user can have a more vivid understanding of their energy consumption and usage. Furthermore, there will be an AI model in the backend connecting to the database that applies the algorithm to the user's data. The webpage UI will show the result of the AI

algorithm, therefore, the user can learn about what he/she could've done better to improve

efficiency on energy usage.

High level diagram
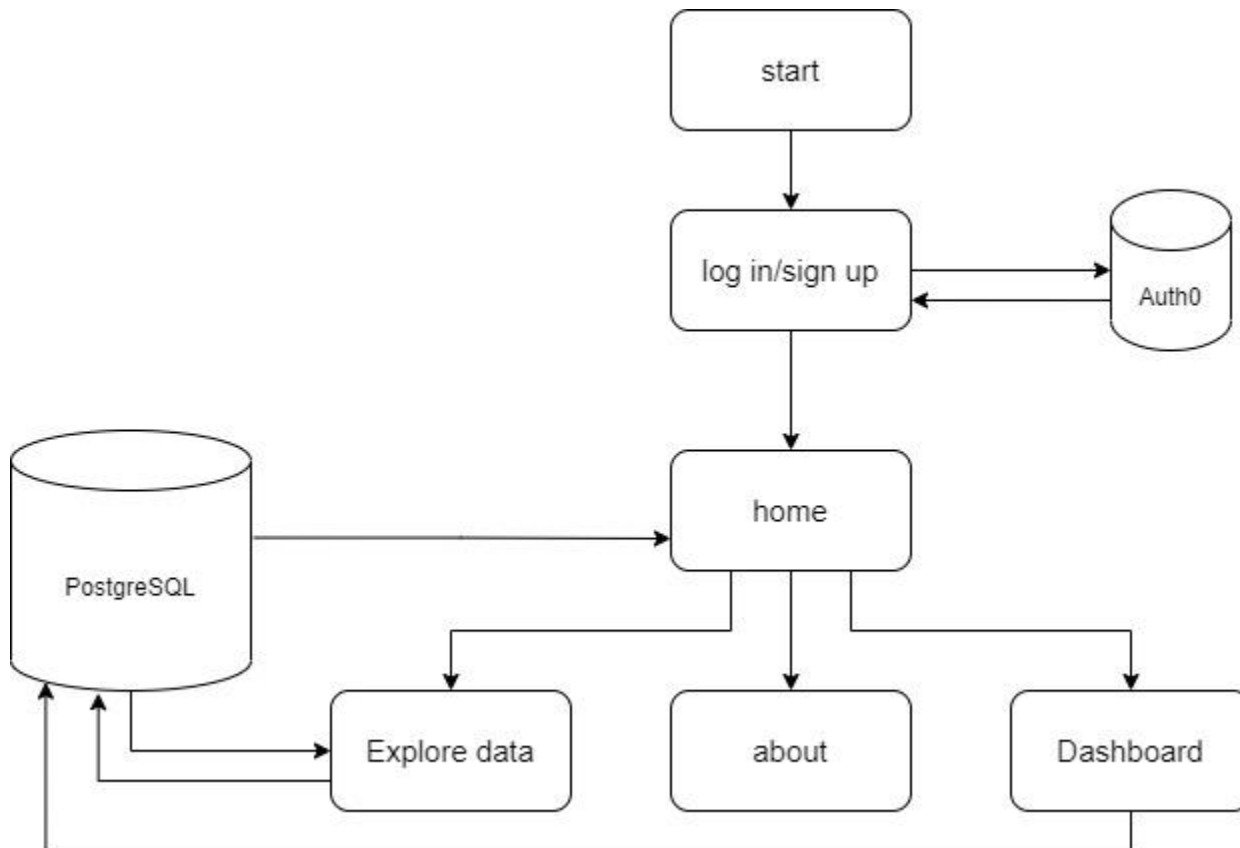
UI Mockups

Before Login (About) Page Mockup

Log In

Background

Installing solar and battery assets creates microgrids that can be managed independently. Solar energy can only generate power during the day, which often means that energy usage during the day is cheaper. Certain energy assets do not have to be activated all the time, so shifting their load is one strategy to optimize cost, reduce inefficiencies, and even avoid unnecessarily contributing to greenhouse gas emissions. However, knowing when to move usage can be difficult or an excessive burden, This can lead to inefficiencies in energy usage, waste money, and contribute to unnecessary greenhouse gas emissions depending on when power is used. . Thus, our project Optimizing usage requires operators to have the seeks to provide microgrid operators the relevant knowledge and foresight to smartly manage their resources.

Existing Solutions

In the current market, there are a few solutions that attempt to address this issue. Multiple companies like AgMonitor encourage shifting energy usage away from peak hours by sending price signals to the customer, indicating when they can potentially save on utility costs by either turning things off or changing when they turn on. This directly influences human behavior, which requires the customer to be involved in shifting energy usage. There is also currently research into smart charging and several pilot programs that attempt to implement smart charging programs, where grid information from the utility company is used to remotely manage when electric vehicles charge. These programs are not available to the wide public yet, and furthermore centralize control once again. Not to mention, a bottom-up approach from the microgrid perspective is better able to capture specific energy generation and needs. Optimizing on the macrogrid from the utility perspective doesn't necessarily guarantee optimization on the microgrid.

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Login Page Mockup

AgMonitor

Welcome

Log in to capstone-agmonitor to continue to Login.

Email address

Password

Forgot password?

Continue

Don't have an account? **Sign up**

OR

G Continue with Google

Profile Page Mockup

jiaweiyu2009

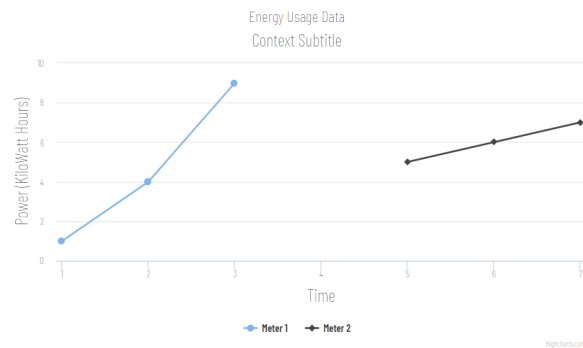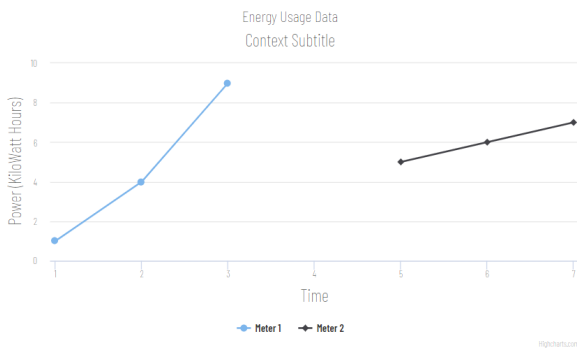## jiaweiyu2009

Username : jiaweiyu2009

Email : jiaweiyu2009@gmail.com

Submit

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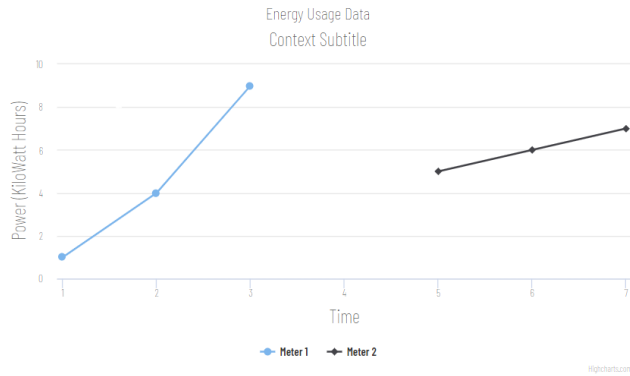
Home Page Mockup

Home Page

Energy Usage Data
Context Subtitle

Energy Usage Data
Context Subtitle

Meter 1   Meter 2

Meter 1   Meter 2

Highcharts.com

Highcharts.com

Recommendations

Content

Explore Page Mockup

Explore Data Page

Energy Usage Data
Context Subtitle

Dashboard Page Mockup

Assets

74%
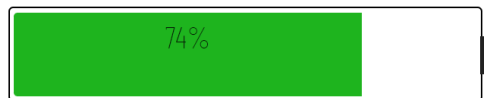
Variable Control

Tesla

Settings for Tesla

Pump

AC

Functional Requirements

1. As a potential customer, I can find a brief digest about the software to understand the product.

- Tasks: https://trello.com/c/WFqEMKFG/20-about-page

- Scenario 1: When a user loads the webpage, intro details about the product are displayed.

- Scenario 2: When a user logs in, they can find this info in the about page.

2. As a new user, I can sign up for a new account at the homepage.

- Tasks: https://trello.com/c/2JAJHMJ6/23-signup-functionality

- Scenario 1: User clicks the signup button at the homepage to sign up for a new account.

- Scenario 2: User clicks the login button to login subsequently if they signed up successfully.

- Scenario 3: User clicks the login button to login subsequently will error if signed up incorrectly.

3. As a customer user, I can log in and log out on the website to ensure my personal data is secure.

- Task: https://trello.com/c/9nTDucC7/4-login-logout-page

- Scenario 1: User successfully logins to the website can access account-specific details.

- Scenario 2: User puts in incorrect credentials and it errors on attempted login.

- Scenario 3: User clicks logs out and removes the ability to access account-specific details.

4. As an internal developer, I can upload a CSV file of data so I can use the data for optimization.

- Tasks: https://trello.com/c/8Cwl5ZWp/24-csv-upload

- Scenario 1: User uploads correctly formatted CSV file and data is stored internally.

- Scenario 2: User uploads incorrectly formatted CSV and site throws error.

5. As a user, I can download a CSV file of data (after data-cleaning).

- Tasks: https://trello.com/c/1eRquGCh/9-csv-download

- Scenario 1: A user can download CSV files for cleaned data from the system.

- Scenario 2: User can select a subset of data to download.

6. As an internal engineer, I can transform customer data to provide data processing for convenience.

- Tasks: https://trello.com/c/USXlzsBk/19-data-cleaning

- Scenario 1: Internal process data cleans to remove erroneous/missing data from the system.

- Scenario 2: Internal process applies appropriate data transformations based on user selection.

7. As a customer user, I can see my energy data usage summary on the home page after I logged in.

- Tasks: https://trello.com/c/kAYJcB3u/18-home-page

- Scenario 1: User can see their consumed/produced energy data over the past 7 days.

- Scenario 2: User cannot edit the summary graphs nor configure settings on the home page.

8. As a data scientist, I can look into and edit my raw data for my energy usage to correct errors.

- Tasks: https://trello.com/c/IuXG1xg9/25-react-datagrid-functionality

- Scenario 1: User can self-edit raw data on frontend and save, with disclaimers of editing.

- Scenario 2: Newly edited data should reload into dashboards and save on the backend.

9. As a customer user, I can explore my energy data for a better understanding of my energy usage.

- Tasks: https://trello.com/c/5pKUhrds/19-explore-page

- Scenario 1: User interacts with the visualization tool and changes the zoom of the dashboard.

- Scenario 2: User can select subsets of data to explore with the visualization tool.

- Scenario 3: User can select how to visualize their selected subsets of data (if valid).

10. As an internal engineer, I can find an algorithm to help users optimize their microgrid effectively.

- Tasks: https://trello.com/c/EzOVcL8J/23-ai-literature-review

- Scenario 1: Some algorithm that is not applicable to our context is omitted from the shortlist.

- Scenario 2: Algorithms that show potential are added to a shortlist for further consideration.

11. As a developer, I can provide improvements to customers' energy usage from their historical data.

- Tasks: https://trello.com/c/1lEh6fRP/25-ai-algorithm-implementation

- Scenario 1: Users see how to optimize their energy usage on the summary page.

- Scenario 2: For incorrect data, users will see an error that the algorithm is not working.

12. As a customer user, I can opt into receiving notifications for energy optimization recs.

- Tasks: https://trello.com/c/JrotYf1d/26-optimization-recommendations

- Scenario 1: User opts for emails and receives a digest based on their set interval.

- Scenario 2: User opts for texts and receives a digest based on their set interval.

13. As a customer user, I can configure different assets to correctly align consumption/usage data.

- Tasks: https://trello.com/c/a7tPReEf/41-user-asset-configuration

- Scenario 1: User can select the asset type of an added asset to signify properties it will have.

- Scenario 2: Users can add asset specific information to provide site functionality given assets.

14. As a customer user, I can see the percent of power each asset consumed/generated.

- Tasks: https://trello.com/c/C8hD12AP/28-asset-health

- Scenario 1: User can see a list of assets and their consumption/production snapshot.

- Scenario 2: User can click into each asset and explore data generated by an individual asset.

15. As a customer user, I can add constraints to the optimizations to prevent not applicable recs.

- Tasks: https://trello.com/c/fkHaqeYW/29-optimization-constraints

- Scenario 1: User specifies valid times for specific assets to restrict the algorithm.

- Scenario 2: User specifies invalid times for specific assets to restrict the algorithm.

16. As a customer user, I can configure my profile page.

- Tasks: https://trello.com/c/tDOIdTZC/21-add-user-profile-dropdown-and-pages

- Scenario 1: Users can change their display name and permanently save it internally.

- Scenario 2: Users cannot change or access other people's profiles.

17. As an internal developer, I can integrate Tesla Powerwall data into our existing database.

- Tasks: https://trello.com/c/4NGnbaiQ/12-tesla-powerwall-integration

- Scenario 1: User can link Tesla Powerwall to pull data into our product.

- Scenario 2: User can see Tesla Powerwall data when doing data exploration.

18. As a customer user, I can compare Tesla Powerwall data and the optimization differences.

- Tasks: https://trello.com/c/K21nL0XN/30-tesla-powerwall-comparison

- Scenario 1: If the real-time powerwall trends are expected, no notifications need to be sent.

- Scenario 2: If real-time powerwall trends differ, dynamically optimize and notify the user.

19. As a user, I can add/delete assets on the dashboard so I can control assets I want to optimize.

- Tasks: https://trello.com/c/hTW7zpkt/27-asset-selection

- Scenario 1: The user can add a new asset on the dashboard.

- Scenario 2: The user can delete existing assets on the dashboard.

20. As a user, I can link my variable assets so its charging/discharging is automatically controlled.

- Tasks: https://trello.com/c/BZUDkAn2/28-automatic-asset-configuration

- Scenario 1: Users configure variable load assets for auto control by our optimizations.

- Scenario 2: Should our algorithm fail, they default to a manually configured setting.

## Nonfunctional Requirements

- The system should be secure so credentials cannot be easily stolen.

- The system should maintain data integrity and privacy for users to trust the platform.

- The system should be organized in the backend so data storage is efficient.

- The system should be fast to allow for seamless data visualization analysis.

- The system should clearly disclose disclaimers for algorithmic predictions.

- The system should be able to support 1000 users.

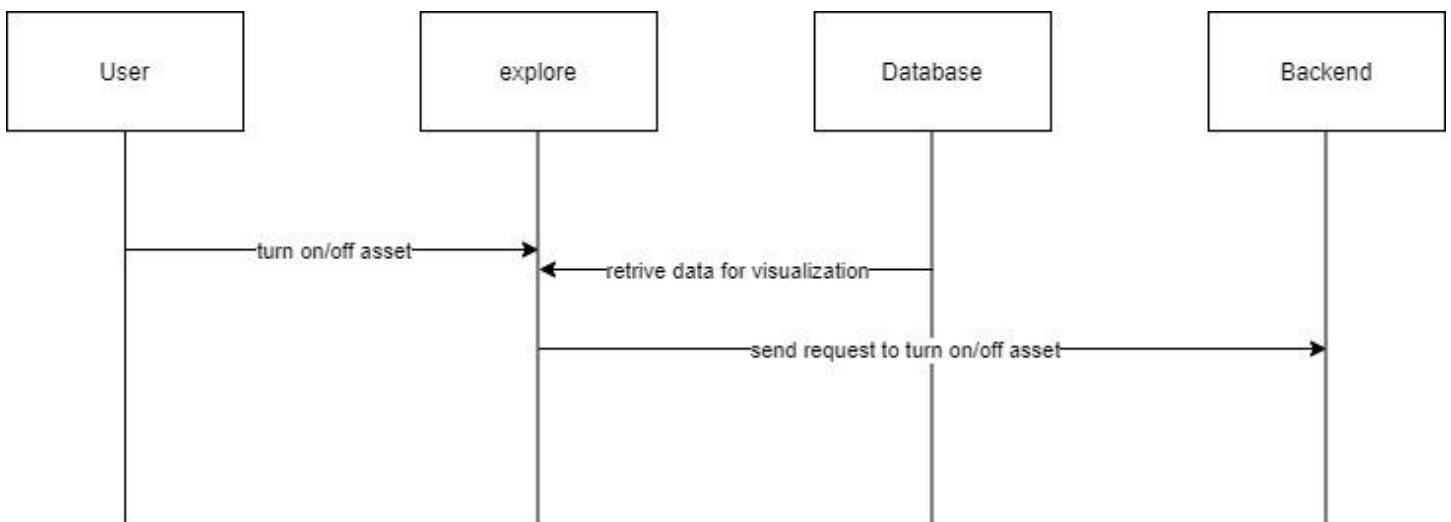- The system should be able to support 1 GB of data per user.

System Models

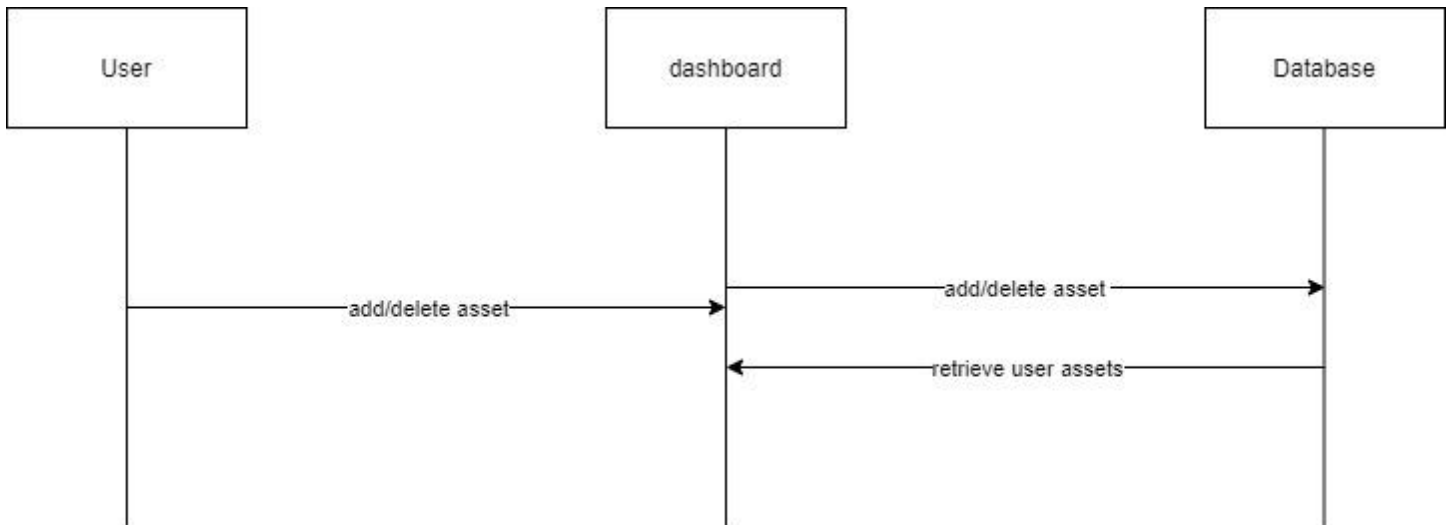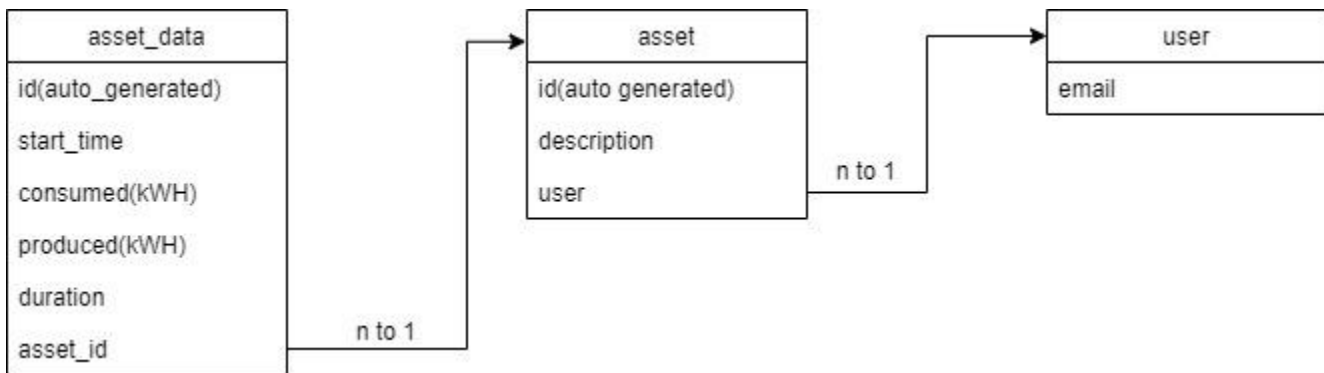## Overview:
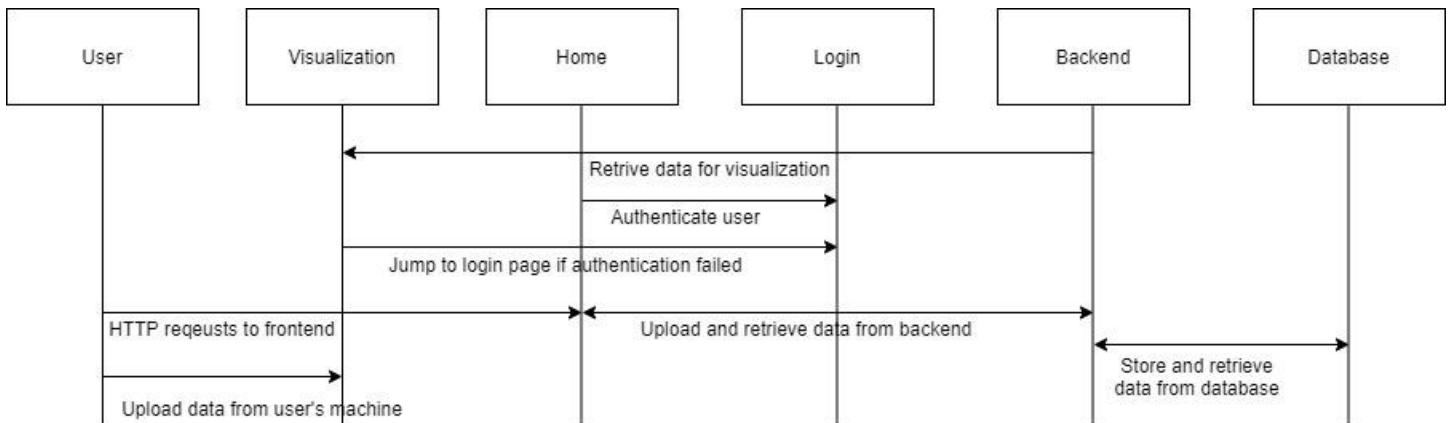
Home:
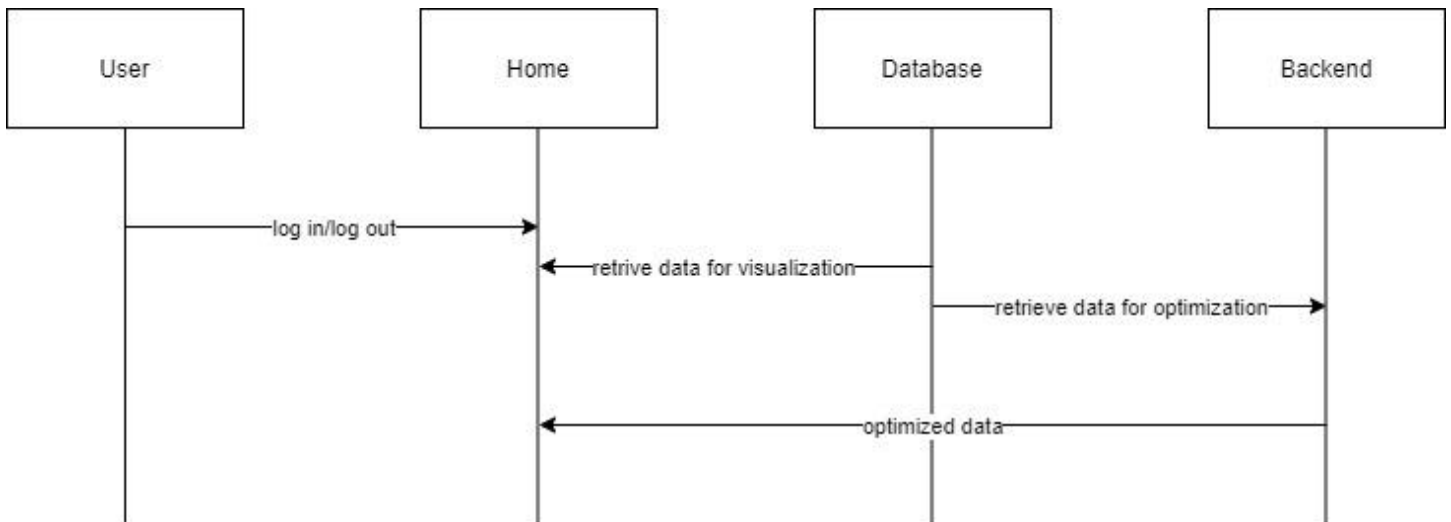
Explore:

Dashboard:

UML (Postgres Schema Diagram)

Appendices

Technologies Applied

    a. Frontend:
- ReactJS
- HighChart
- React Datagrid

    b. Backend
- Django

    c. Database
- PostgreSQL

    d. REST API
- Tesla API

e. User authentication:
- GoogleAuth(Auth0)

f. Deployment platform
- Heroku