Smart Home Energy Management System

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GitHub Link

Project Report

1. Project Vision

In this project, we designed and developed a Smart Home Energy Management System (SHEMS), that is, a system that helps homeowners efficiently manage their energy consumption and reduce electricity bills. A SHEMS integrates with various smart electrical devices, such as washers, refrigerators, and lights, to monitor and control energy usage. Our system stores past energy usage, thus allowing a user to understand their past energy usage and costs, and how they relate to their various appliances and appliance settings. Our applications allow users to register, log in, and list, add, and remove service locations and smart devices.

2. Project Implementation

2.1 Database Design

The SHEMS database is hosted by an energy provider. It enables users to sign up and manage multiple service locations, each with detailed information, including address, move-in date, square footage, number of bedrooms, and occupants. Customers can enroll smart devices at each location, specifying device type, model, and other relevant details. Enrolled devices continuously send data to the database, including events (e.g., status -on/off, settings changes) and energy consumption information.

2.2 Database Schema

Customer: Customer details like first name, last name, and email are stored here.
ServiceLocation: Records information about the locations of the User
DeviceModel: Contains details of Device types and their models.
EnrolledDevice: Tracks information about Device details enrolled at each Service location.
EnergyPrice: Stores energy details based on Zip Code, which varies per hour.
ModelEvent: Stores the list of events that each device has.
Notification: Logs activity of each device with its timestamp of occurrence.

Assumptions:

Each service location is owned by one User.
Events for devices are recorded each hour and Energy prices change each hour for its corresponding Zip code.

3. Tech Stack for the project:

Frontend Development:
We have utilized HTML, CSS, and JavaScript for building the front end of our application. Front-end validations are added for each functionality. We have implemented Responsive design principles to ensure optimal usability of applications across various devices and screen sizes. For the visualizations/charts to display statistics of Energy consumption and tips, we have utilized chart.js.
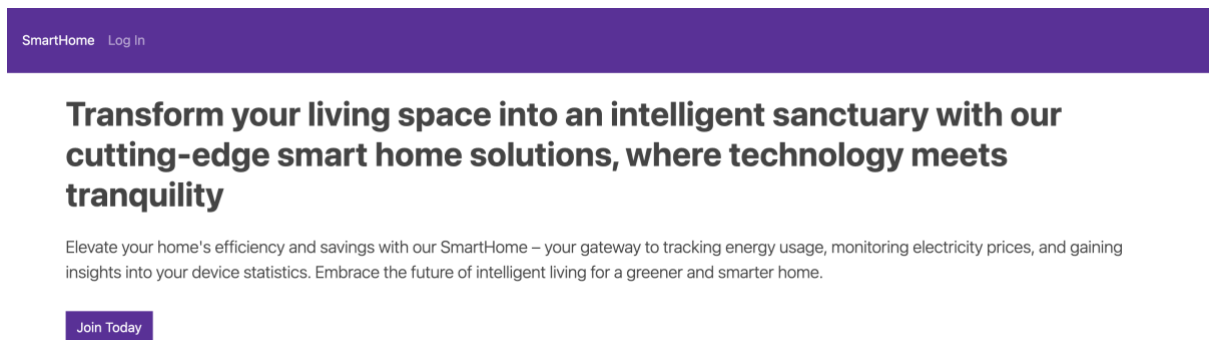
Backend Development:
We have utilized the Django Web framework to handle server-side logic and interact with the database.

Database:
For our database, we have chosen PostgreSQL, a robust and reliable object-relational database system. With PostgreSQL, we also benefit from its comprehensive indexing strategies and full-text search capability, which are crucial for delivering fast and efficient data retrieval.
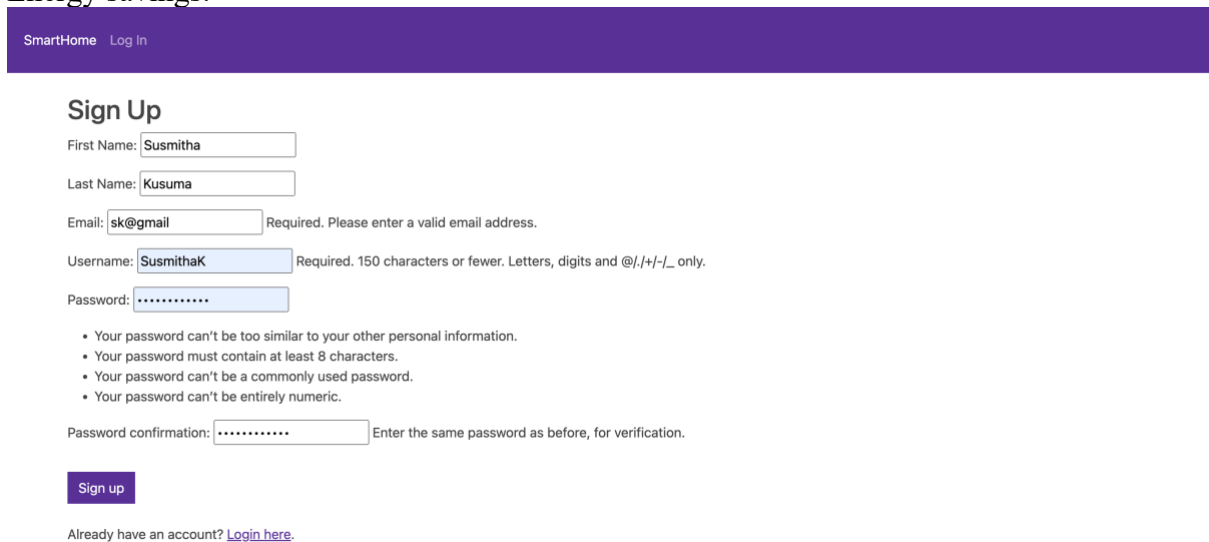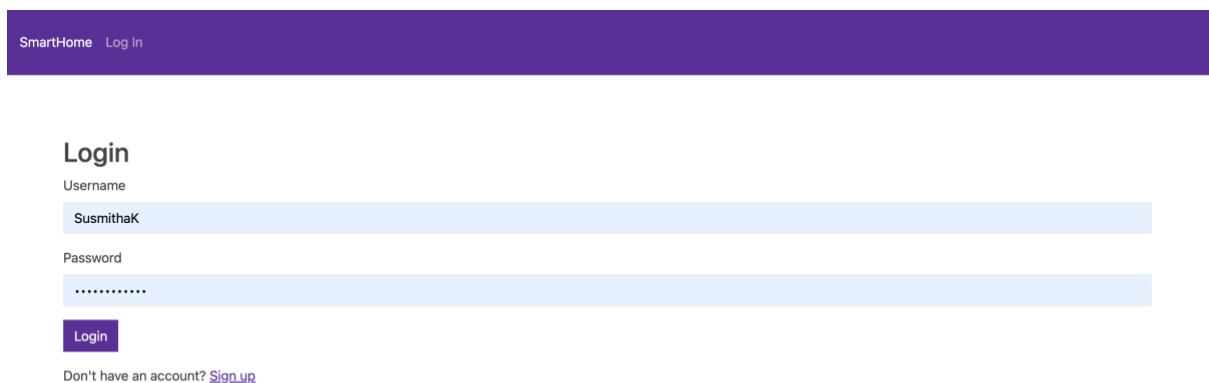
4. Features of the Application

4.1 New User Registration

Upon Landing on the Home page, the User clicks on the Join Today button to start their Energy savings.

Then the user lands on the SignUp page to register for the SHEMS app.

4.2 User Login

Registered Users log on to the application by entering Username and Password.

4.3 Welcome Page/ Home Page

After the login, the User is welcomed with their First Name and Last Name.

4.4 Profile Page for the User

Profile Page of the user allows them to Edit and Delete Profile

4.5 Edit Profile

User can edit their First name, last name, and Email address from this page.

4.6 Delete Profile

Are you sure you want to **delete this account ?**

Confirm

When user try to delete their profile, they will be prompted with "Are you sure you want to delete this account?"

4.7 Add Service Location

SmartHome   Profile   Service Locations   Log Out

Add New Service Location

AptUnit: 1118
Enter the Apartment unit of the building

Street Name: 655 Broadway
State Name: New York
ZipCode: 10012
Enter the zipcode
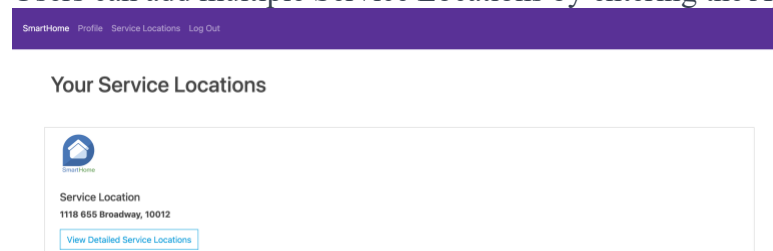
AptName: My Home
MoveInDate: 02/21/2022
SquareFootage: 678
No of bedrooms: 4
No of occupants: 3
Save Location

Users can add multiple Service Locations by entering the AptName and other details.

SmartHome   Profile   Service Locations   Log Out

Your Service Locations

SmartHome

Service Location
1118 655 Broadway, 10012
View Detailed Service Locations

4.8 Edit Service Location

Users can Edit the Service location and the changes are reflected on the other pages of them.

4.9 View Service location details

Details of the Service Locations are displayed along with the facility to add Devices.

4.10 Delete Service location.

Service Location of the User is deleted and prompts the user to add a new Service location.

4.11 Add Devices

Users can add specific Device Types and device models to their Service location.

4.12 View Enrolled Devices

Users can view a list of the devices enrolled for each of their service locations.

4.13 Delete Enrolled Devices

As we see the LG-01 refrigerator device is unenrolled at this service location by the User.

4. Visualizations Implemented

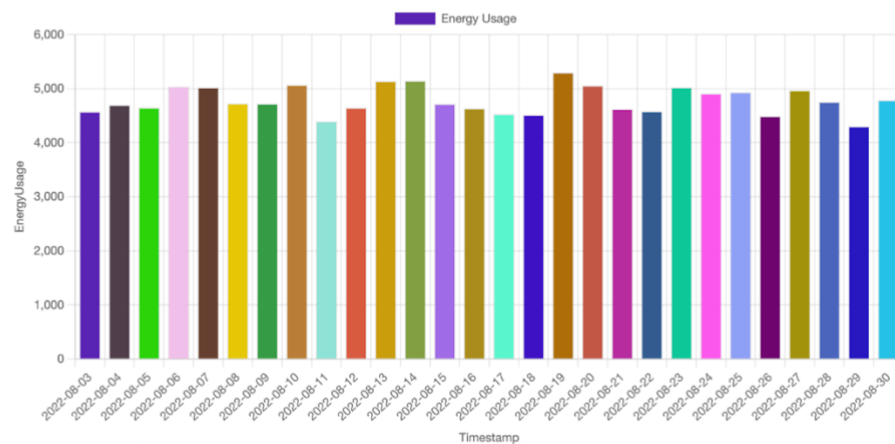4.1 We have implemented charts for Device-level Energy consumption.

4.2 We have implemented charts for Device-level Energy consumption. (Cumulative)

Line Chart
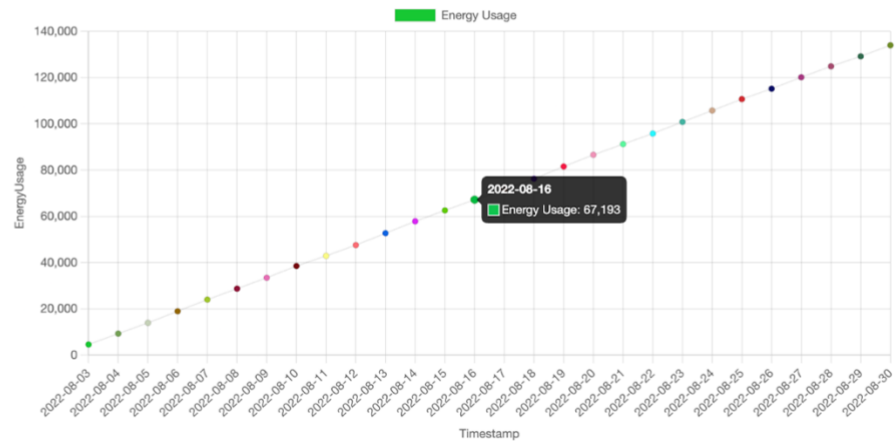
4.3 We have implemented charts based on Service Locations

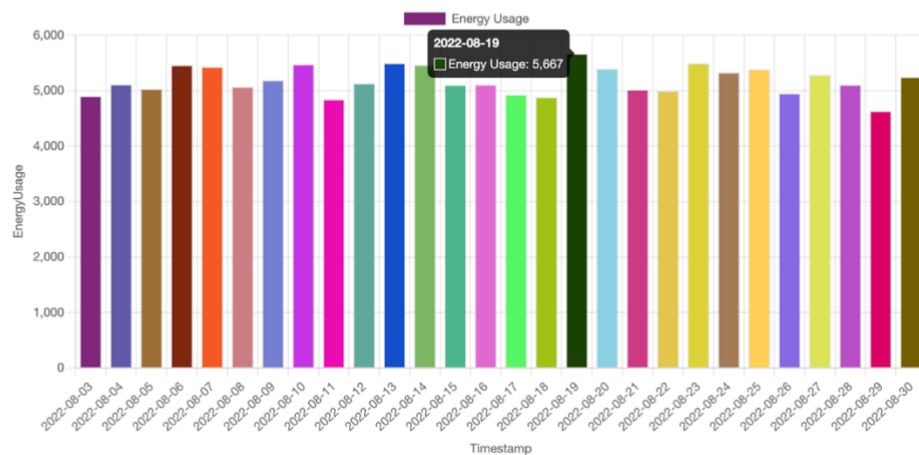### Service Location Energy Stats
Start Date: 08/03/2022
End Date: 08/30/2022
Cumulative: ☐

Show Stats

Bar Chart

4.4 We have implemented charts based on Service Locations (cumulative)

4.5 We implemented a Pie Chart for Energy Consumption on Each device.

SmartHome   Profile   Service Locations   Log Out

Pie Energy Stats
Start Date: 08/03/2022
End Date: 08/30/2022
Cumulative: ☐

Show Stats

SmartHome   Profile   Service Locations   Log Out

Polar Area Chart Example

4.6 We have implemented charts for User Energy Consumption which considers all their service locations and gives the results.
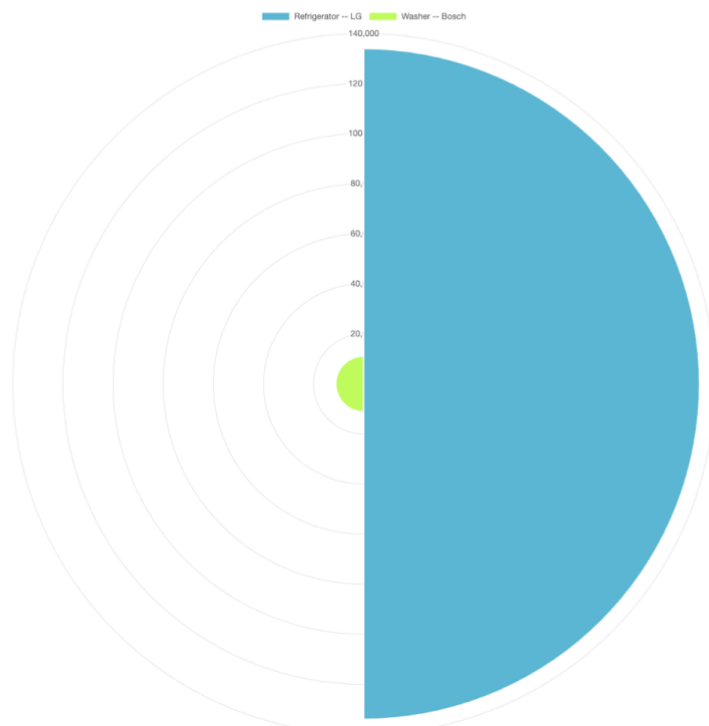
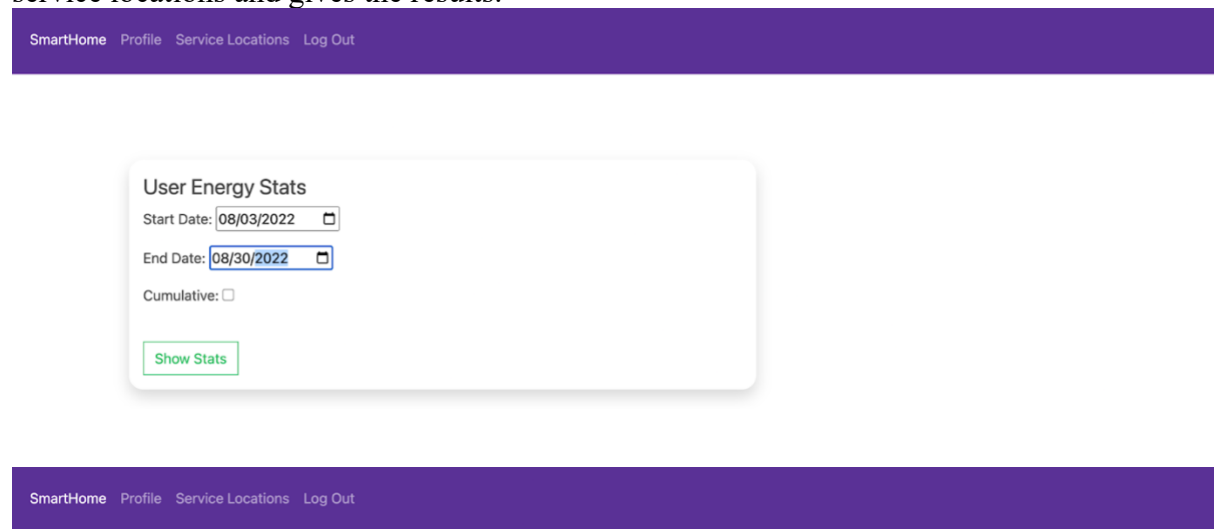**User Energy Stats**
Start Date: 08/03/2022
End Date: 08/30/2022
Cumulative: ☐

Show Stats

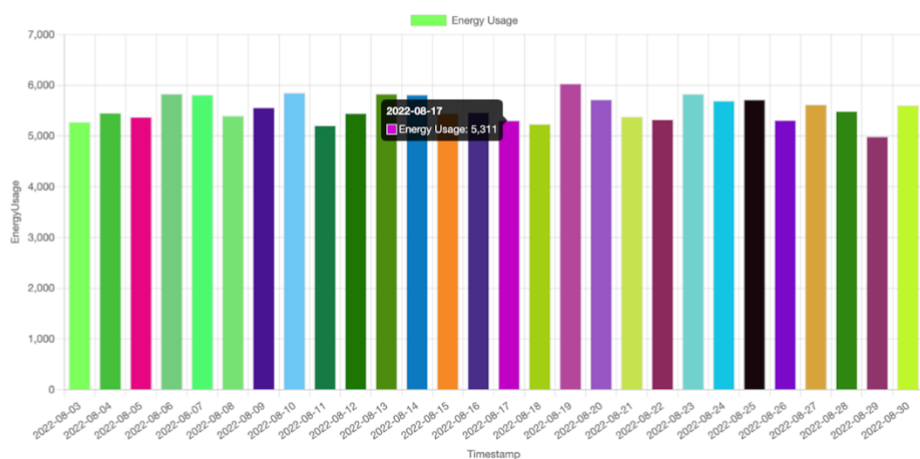## Bar Chart

4.7 We have implemented charts for User Energy Consumption which considers all their service locations and gives the results. (Cumulative)
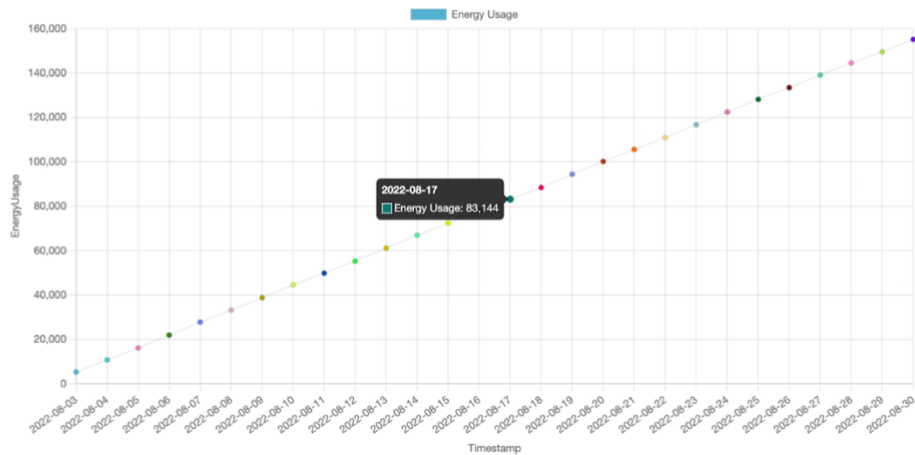
User Energy Stats
Start Date: 08/03/2022
End Date: 08/30/2022
Cumulative: ☑

Show Stats

12

Line Chart

5. Conclusion

The implementation of the web application is a key achievement for the SHEMS project. It puts detailed energy data management into the hands of homeowners. With easy-to-use interface and helpful analytics, it's designed to help users make smart choices about their energy use. This helps them live in a way that's better for the environment and their wallets.

6. Extra credits work:

- Added Cumulative filter feature for every chart that is implemented across different levels for device, location, user level energy usage.
- Implemented frontend and backend validations for all input fields on the application.
- Added Admin feature so that they can manage User actions across all pages on the application.
- During the demo we presented how our application guards cross-site scripting, SQL injections and Concurrency.