

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:

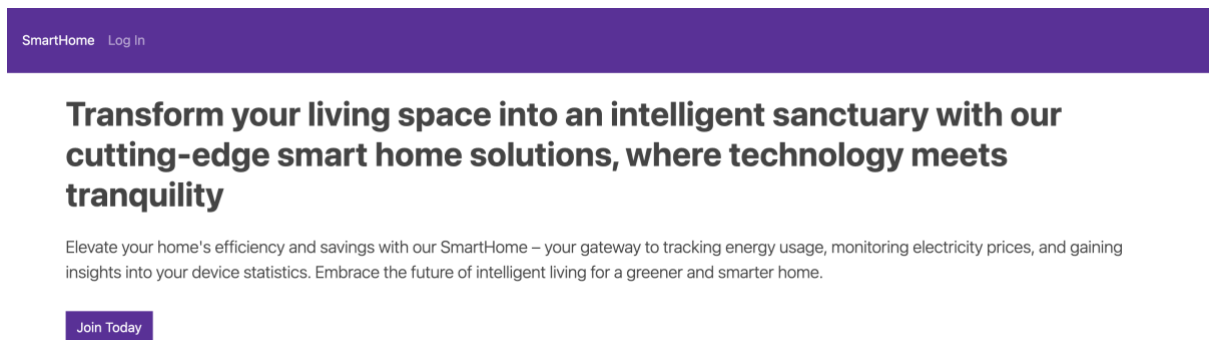
We have utilized the Django Web framework to handle server-side logic and interact with the database.

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.

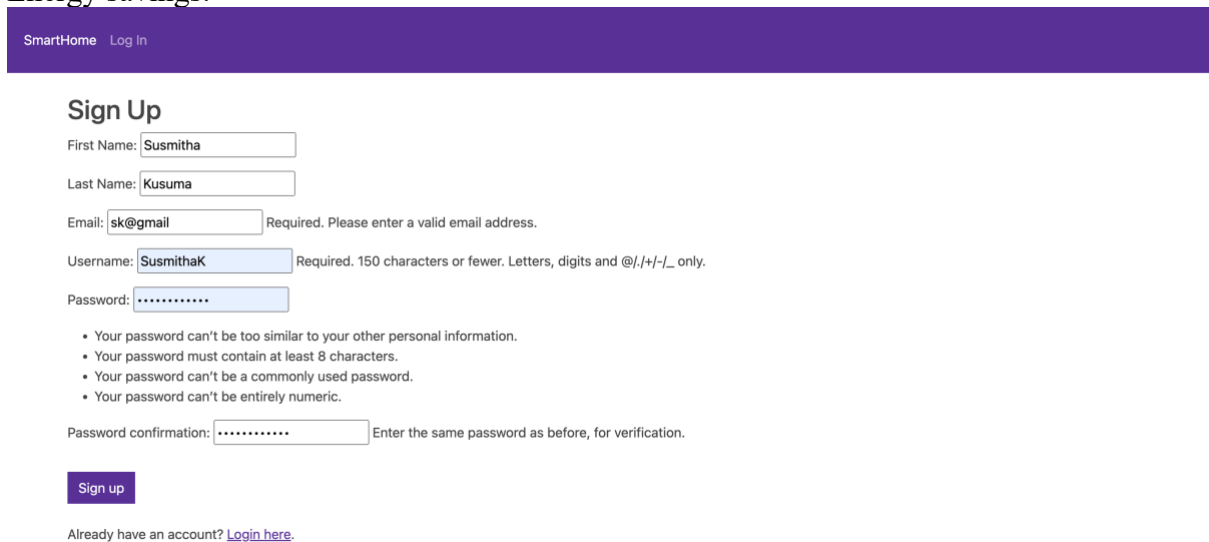
4. Features of the Application

4.1 New User Registration



The image shows the SmartHome application's home page. At the top is a purple navigation bar with 'SmartHome' and 'Log In' links. Below the navigation bar is a large heading: 'Transform your living space into an intelligent sanctuary with our cutting-edge smart home solutions, where technology meets tranquility'. Underneath the heading is a paragraph of text: 'Elevate your home's efficiency and savings with our SmartHome – your gateway to tracking energy usage, monitoring electricity prices, and gaining insights into your device statistics. Embrace the future of intelligent living for a greener and smarter home.' At the bottom of this section is a purple button labeled 'Join Today'.

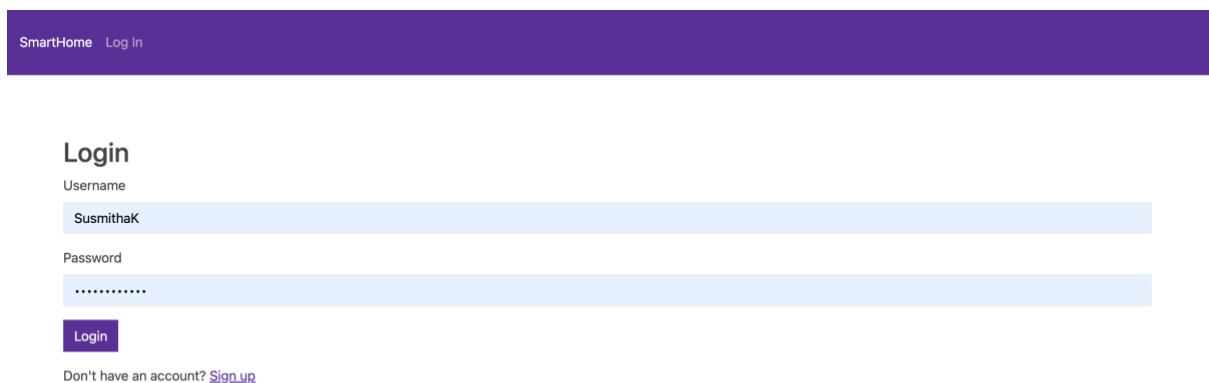
Upon Landing on the Home page, the User clicks on the Join Today button to start their Energy savings.



The image shows the SmartHome application's sign-up page. It has the same purple navigation bar as the home page. The main heading is 'Sign Up'. Below the heading are several input fields: 'First Name' (filled with 'Susmitha'), 'Last Name' (filled with 'Kusuma'), 'Email' (filled with 'sk@gmail'), 'Username' (filled with 'SusmithaK'), and 'Password' (filled with dots). There are also some validation messages: 'Required. Please enter a valid email address.' for the email field, and 'Required. 150 characters or fewer. Letters, digits and @/./+/-/_ only.' for the username field. Below the password field is a list of password requirements: 'Your password can't be too similar to your other personal information.', 'Your password must contain at least 8 characters.', 'Your password can't be a commonly used password.', and 'Your password can't be entirely numeric.' Below this list is a 'Password confirmation' field (filled with dots) and a message: 'Enter the same password as before, for verification.' At the bottom of the form is a purple button labeled 'Sign up'. Below the button is a link: 'Already have an account? [Login here.](#)'

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

4.2 User Login



The image shows the SmartHome application's login page. It has the same purple navigation bar as the home page. The main heading is 'Login'. Below the heading are two input fields: 'Username' (filled with 'SusmithaK') and 'Password' (filled with dots). Below the password field is a purple button labeled 'Login'. Below the button is a link: 'Don't have an account? [Sign up](#)'

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

4.3 Welcome Page/ Home Page

SmartHome Profile Service Locations Log Out

You have successfully logged in

Transform your living space into an intelligent sanctuary with our cutting-edge smart home solutions, where technology meets tranquility


Elevate your home's efficiency and savings with our SmartHome – your gateway to tracking energy usage, monitoring electricity prices, and gaining insights into your device statistics. Embrace the future of intelligent living for a greener and smarter home.

Welcome Susmitha Kusuma!

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

4.4 Profile Page for the User

SmartHome Profile Service Locations Log Out



Susmitha Kusuma
sushi.kusuma@gmail.com

Edit profile

View Service Locations

View User Energy Usage

Delete profile

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

4.5 Edit Profile

SmartHome Profile Service Locations Log Out

First name:

Last name:

Email address:

Submit

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



Add New Service Location

AptUnit:

Enter the Apartment unit of the building


Street Name:

State Name:

ZipCode:

Enter the zipcode

AptName:

MoveInDate: 

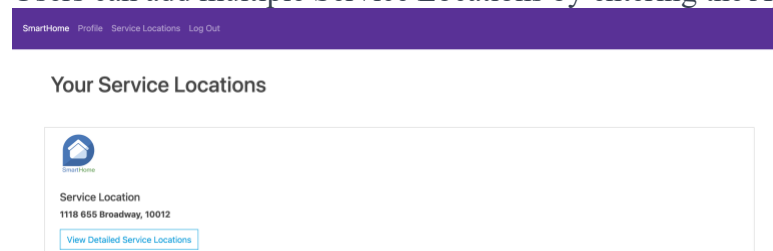
SquareFootage:

No of bedrooms:

No of occupants:

[Save Location](#)

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



4.8 Edit Service Location

[SmartHome](#) [Profile](#) [Service Locations](#) [Log Out](#)

AptUnit:

Enter the Apartment unit of the building

Street Name:

AptName:

MoveInDate:

SquareFootage:

No of bedrooms:

No of occupants:


Submit

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

4.9 View Service location details

[SmartHome](#) [Profile](#) [Service Locations](#) [Log Out](#)

Service Location Details



1118 655 Broadway, 10012
Move-in-date: 2022-02-21
Area: 678
Bedrooms: 4
Occupants: 3

View Energy Usage

View Devices Installed

Add Devices

Edit Service Location

Delete Service Location

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


4.10 Delete Service location.

[SmartHome](#) [Profile](#) [Service Locations](#) [Log Out](#)

Service location is deleted.

Please Add Service Locations to track electricity usages!

Add New Service Location



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

4.11 Add Devices

SmartHome Profile Service Locations Log Out

- This field is required.

Device model

Submit

✓ Select Device Model

Bulb -- Philips

Washer -- Bosch

Refrigerator -- LG

Refrigerator -- SN01

Bulb -- Havells 4323

Washer -- IBM 1489

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

4.12 View Enrolled Devices

SmartHome Profile Service Locations Log Out

Devices Enrolled Details

Appliances

Washing

Drying

Washing

Washer

Dryer

Dishwasher

Appliances

Washing

Drying

Washing

Washer

Dryer

Dishwasher

Appliances

Washing

Drying

Washing

Washer

Dryer

Dishwasher

LG-01 Refrigerator

Delete Device

View Device Energy Usage

Bosch 100 Washer

Delete Device

View Device Energy Usage

Philips 100W Bulb

Delete Device

View Device Energy Usage

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

4.13 Delete Enrolled Devices

SmartHome Profile Service Locations Log Out

Device deleted successfully.

SmartHome Profile Service Locations Log Out

Devices Enrolled Details

Appliances

Washing

Drying

Washing

Washer

Dryer

Dishwasher

Appliances

Washing

Drying

Washing

Washer

Dryer

Dishwasher

Bosch 100 Washer

Delete Device

View Device Energy Usage

Philips 100W Bulb

Delete Device

View Device Energy Usage

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.



Device Energy Stats

Start Date:

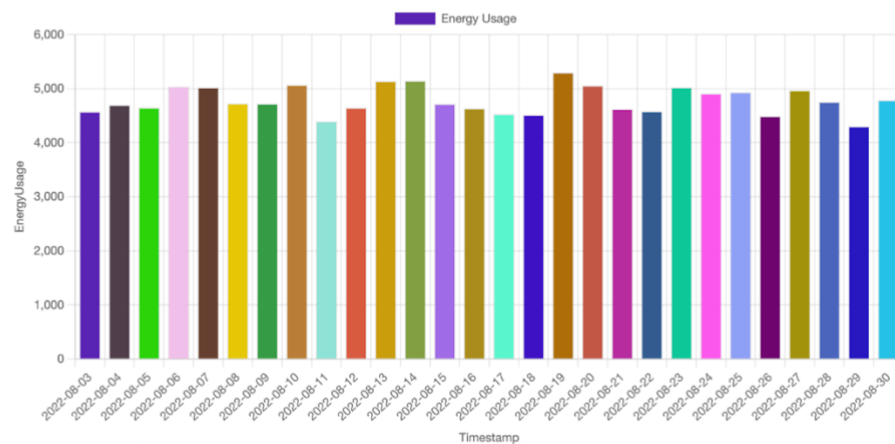
End Date:

Cumulative: ☐

[Show Stats](#)



Bar Chart



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



Device Energy Stats

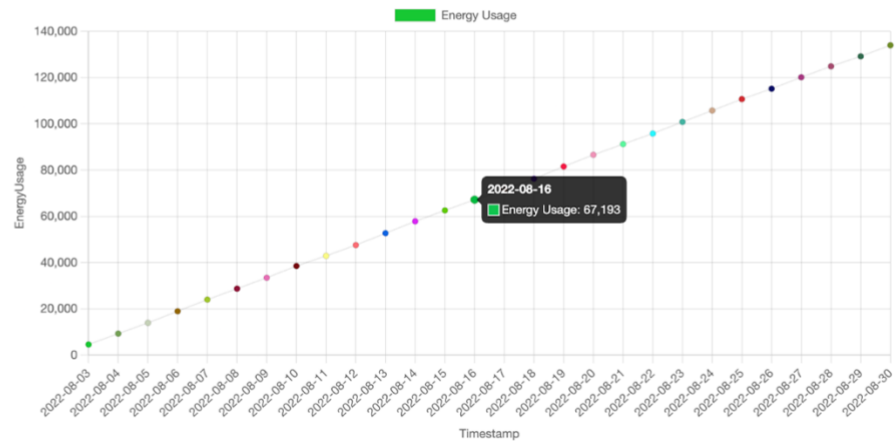
Start Date:

End Date:

Cumulative: ☒

[Show Stats](#)

Line Chart



4.3 We have implemented charts based on Service Locations

Service Location Energy Stats

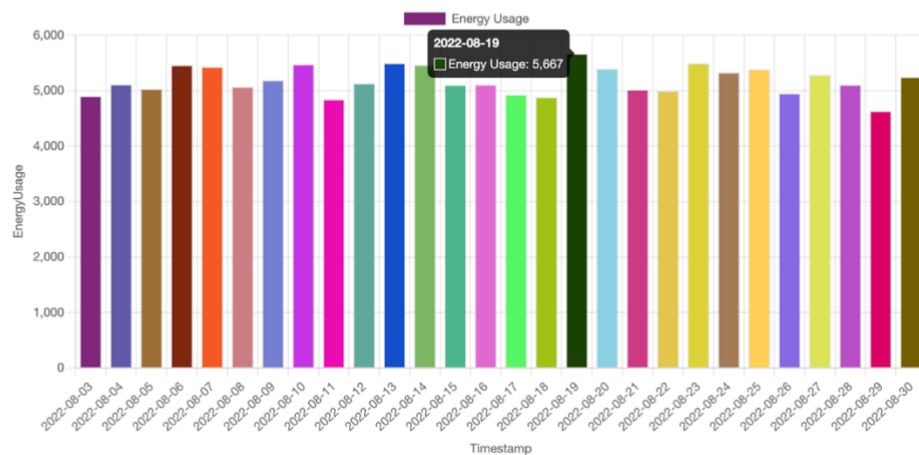
Start Date: 08/03/2022

End Date: 08/30/2022

Cumulative: ☐

Show Stats

Bar Chart



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

SmartHome Profile Service Locations Log Out

Service Location Energy Stats

Start Date: 08/03/2022

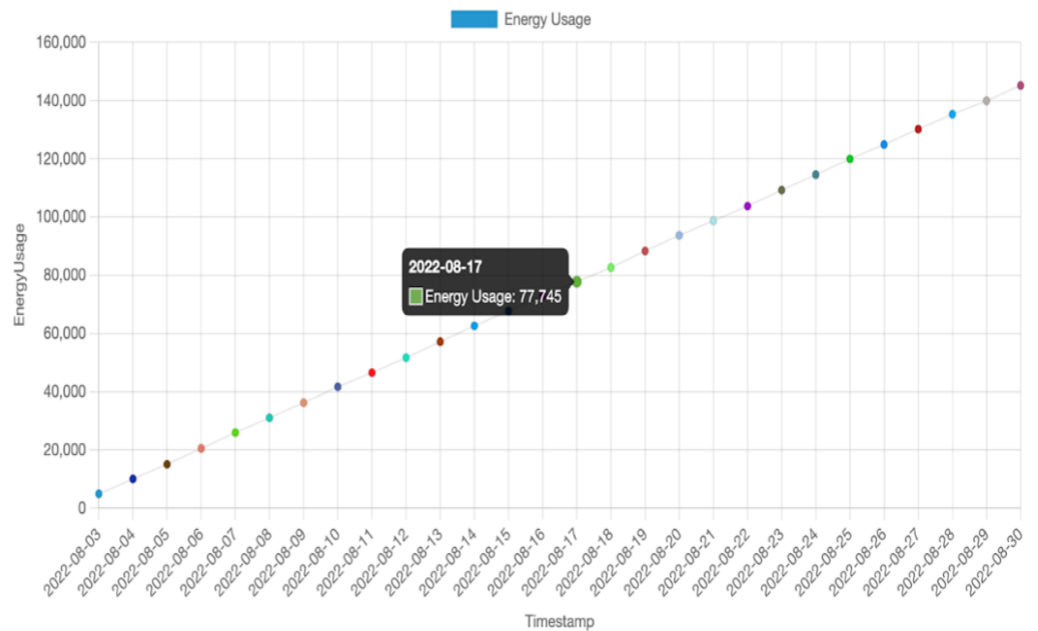
End Date: 08/30/2022

Cumulative: ☒

Show Stats

SmartHome Profile Service Locations Log Out

Line Chart



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



Pie Energy Stats

Start Date:

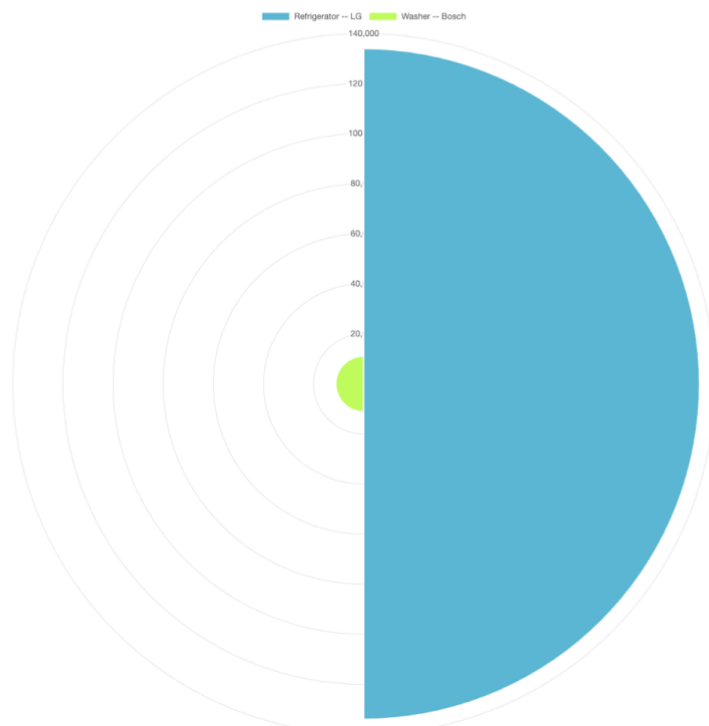
End Date:

Cumulative: ☐

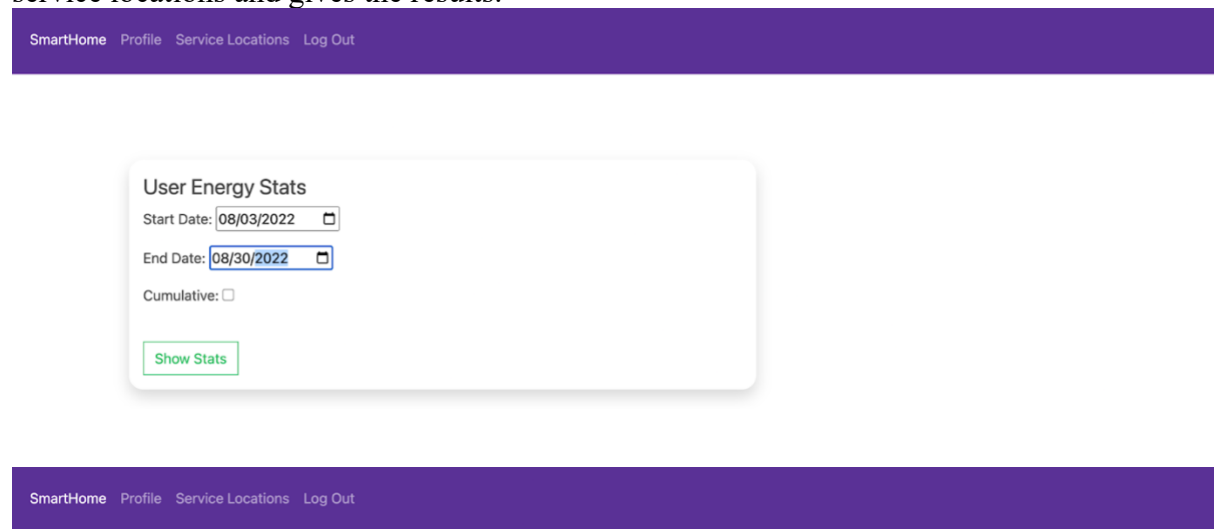
[Show Stats](#)



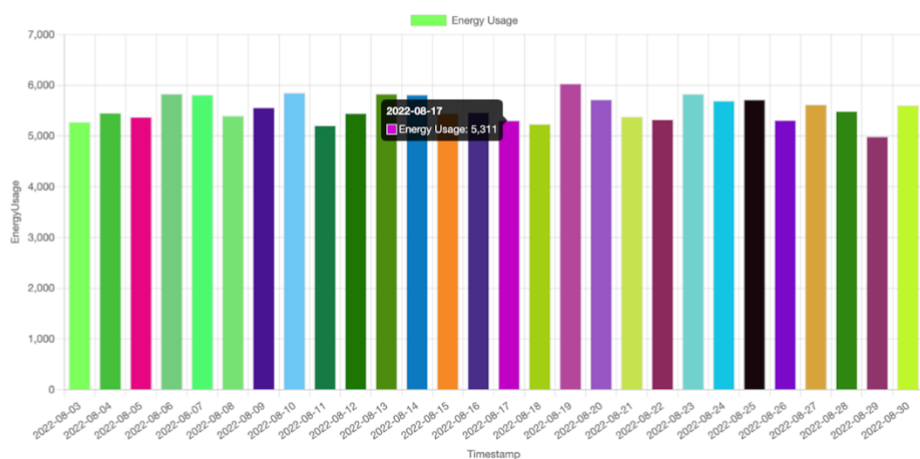
Polar Area Chart Example



4.6 We have implemented charts for User Energy Consumption which considers all their service locations and gives the results.



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

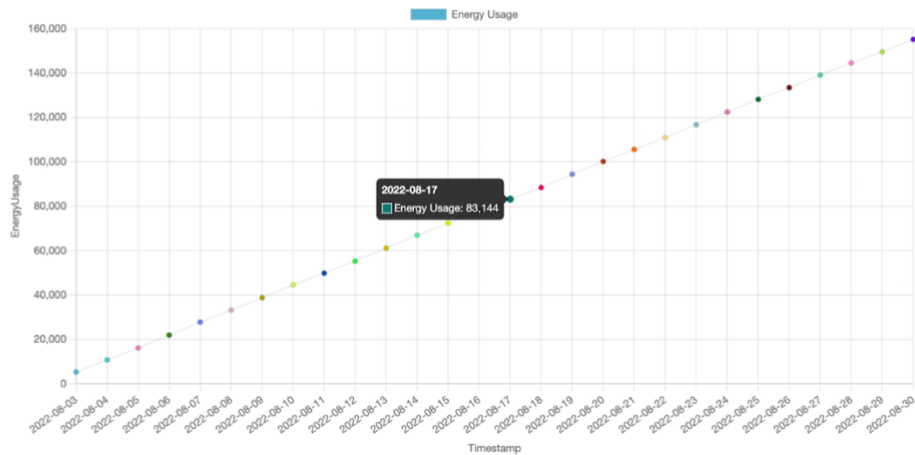
Start Date: 08/03/2022

End Date: 08/30/2022

Cumulative: ☒

Show Stats

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.