



Project Title:

Smart Energy and Occupancy Monitoring using LoRa and Computer Vision

Mentor:

Dr Raja Vara Prasad Y

Done by:

P HARISH RAGAVENDER (S20220020301)



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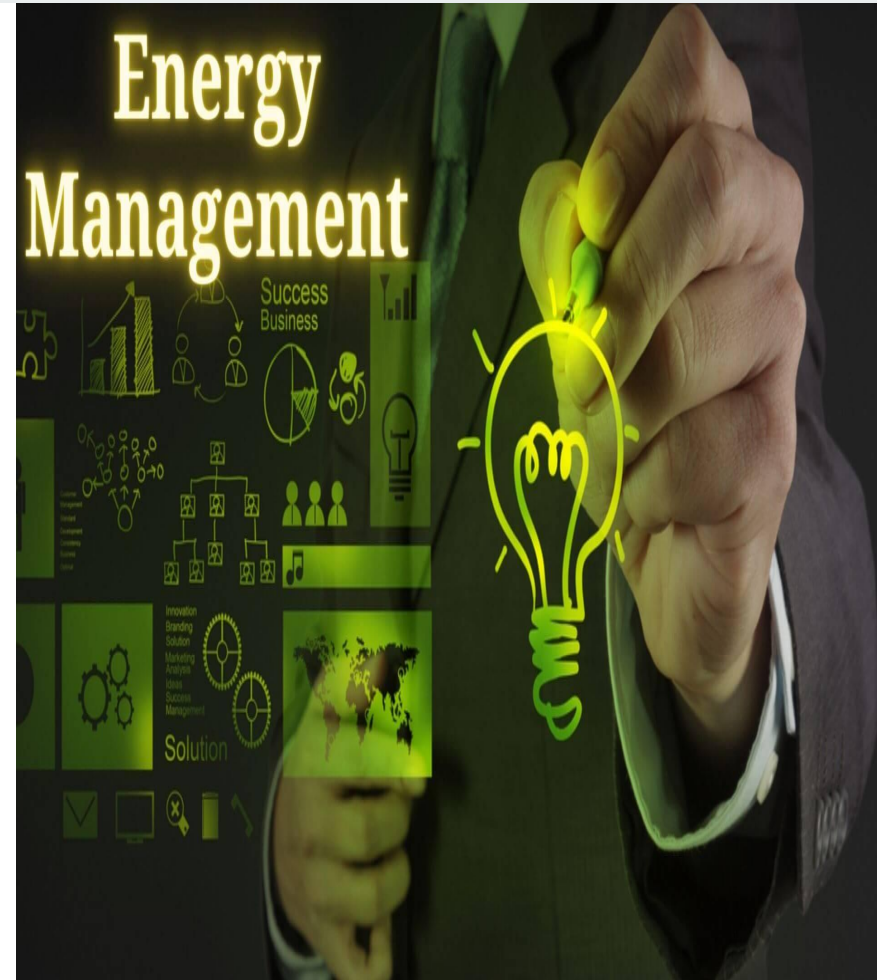
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1. Project Overview

- **Aim:**

Real-time monitoring of energy consumption and classroom occupancy using LoRa and Computer vision.

- **Key Areas:**

- Energy data monitoring in BH3, BH4 hostels and substation
- Student count detection using computer vision
- Unified dashboard with Real time monitoring, analytics and prediction



2. System Architecture

2.1 End-to-End Architecture

1. Energy Data Collection:

RS485-enabled energy meters transmit data via RS485 → TTL → LoRa (SX1262).

2. LoRa Node Units:

Each node (BH3, BH4, Substation) is powered by a **Raspberry Pi Zero 2W** connected to the LoRa module.

3. LoRa Receiver (IoT Lab):

A Central LoRa Receiver receives LoRa signals from all nodes and forwards them to the backend.

4. Backend Server:

A **Flask (Python)** server receives the data, processes it, and stores it in **Firebase Firestore**.

5. Dashboard Interface:

A responsive **HTML-based dashboard** displays real-time energy data, analytics, and predictions.

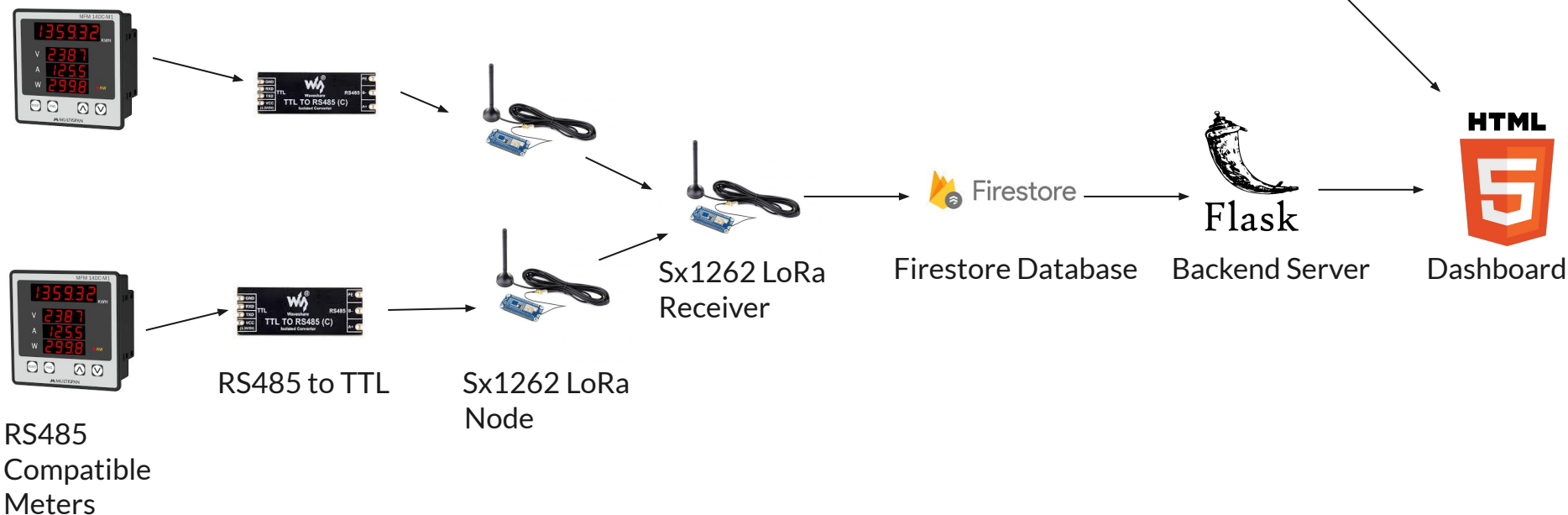
6. Computer Vision Model:

A **YOLOv11 Model**, hosted on **Google Colab**, detects student count in classrooms and pushes the data to Firestore and the dashboard.



System Architecture

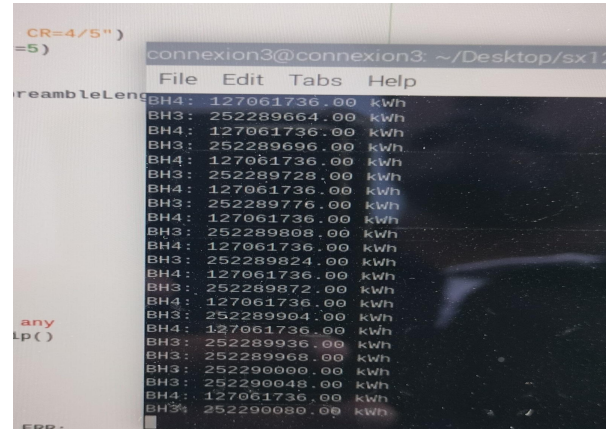
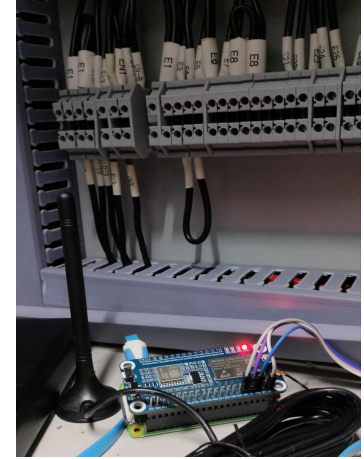
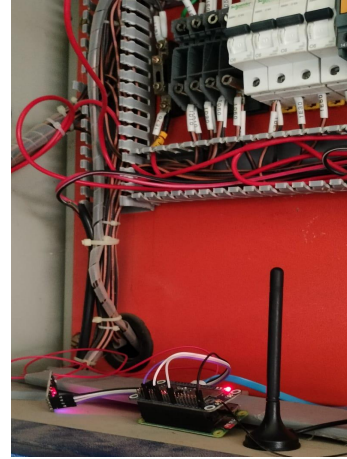
2.2 Architecture Diagram



3. Hardware Setup

1. LoRa Node Setup

- Installed in BH3, BH4, and Substation
- Components used:
 - Energy Meters with RS485 pins
 - RS485 to TTL Converter
 - LoRa SX1262 Module
 - Raspberry Pi Zero 2W
- Configured as single LoRa nodes



Hardware Setup

2. LoRa Receiver Setup

- LoRa Receiver Setted up in IoT Lab
- Components used:
 - LoRa SX1262 Module
 - Raspberry Pi 4
- Configured as single channel Gateway
- Receives data from all three LoRa nodes
- Uploads to Firestore



```
? Begin LoRa Radio
? Set frequency to 868 MHz
? Set RX gain to power saving
?? Set modulation: SF=7, BW=125kHz, CR=4/5
? Set packet parameters
? Set sync word to 0x3444

-- ? LoRa Receiver Ready --

? Received: BH3: 253100560.00 kWh
? Data stored for BH3: 253100.56 kWh at 2025-07-10 16:43:53.401176
? Received: BH3: 253100592.00 kWh
? Data stored for BH3: 253100.592 kWh at 2025-07-10 16:44:03.448560
? Received: BH3: 253100608.00 kWh
? Data stored for BH3: 253100.608 kWh at 2025-07-10 16:44:13.483736
? Received: BH3: 253100640.00 kWh
? Data stored for BH3: 253100.64 kWh at 2025-07-10 16:44:23.526328
? Received: BH3: 253100672.00 kWh
```


4. Database Setup

Database Used: Firebase Firestore

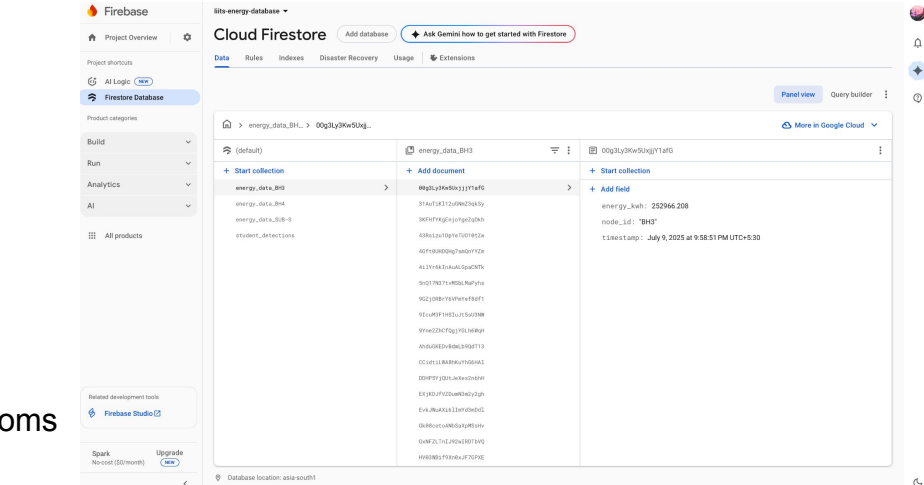
Collections Created:

- **energy_data_BH3** – energy logs from BH3 hostel
- **energy_data_BH4** – energy logs from BH4 hostel
- **energy_data_SUB-S** – energy logs from Substation
- **student_detections** – student count data from classrooms

Document Structure (Example - BH3):

- **energy_kwh:** Energy consumed in kWh
- **node_id:** Identifier for the location (e.g., 'BH3')
- **timestamp:** Date and time of data entry

Data Flow: LoRa Receiver → Firestore via Flask API



| | | |
|---|----------------------|--|
| energy_data_BH3... > 00g3Ly3Kw5UxjijY1afG | | |
| (default) | energy_data_BH3 | 00g3Ly3Kw5UxjijY1afG |
| + Start collection | + Add document | + Start collection |
| energy_data_BH3 | 00g3Ly3Kw5UxjijY1afG | + Add field |
| energy_data_BH4 | 31AuT1K112uGmZ3qK5y | energy_kwh: 252966.208 |
| energy_data_SUB-S | 3KFHYKgeNj0tgeZqDkh | node_id: "BH3" |
| student_detections | 43Rs1zu1DpYeT010tZw | timestamp: July 9, 2025 at 9:58:51 PM UTC+5:30 |
| | 4Gft8UHDQhg7smQnYYZm | |
| | 41Yr6kInAuALGpaCNTk | |
| | 5nQ17N37cvMSBLMaPyhs | |

5. Dashboard Setup

1. Dashboard Navigation

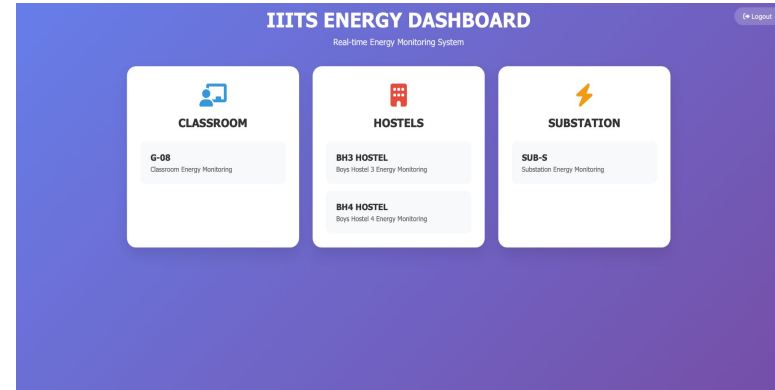
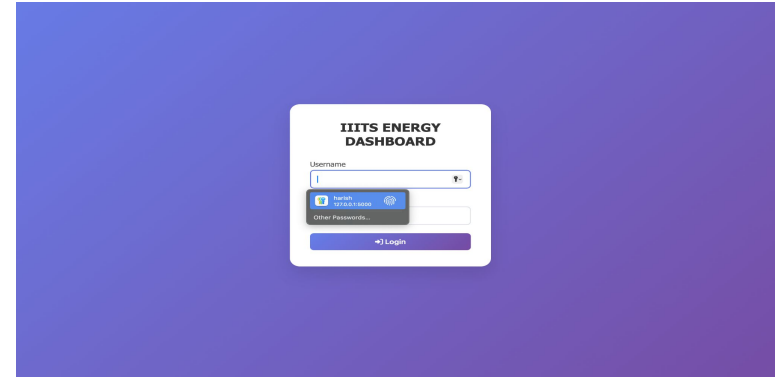
- Login Page (Authentication)
- Navigation: Classroom, Hostels, Substation

CLASSROOM - G-08

HOSTELS - BH3 HOSTEL, BH4 HOSTEL

SUBSTATION - SUB-S

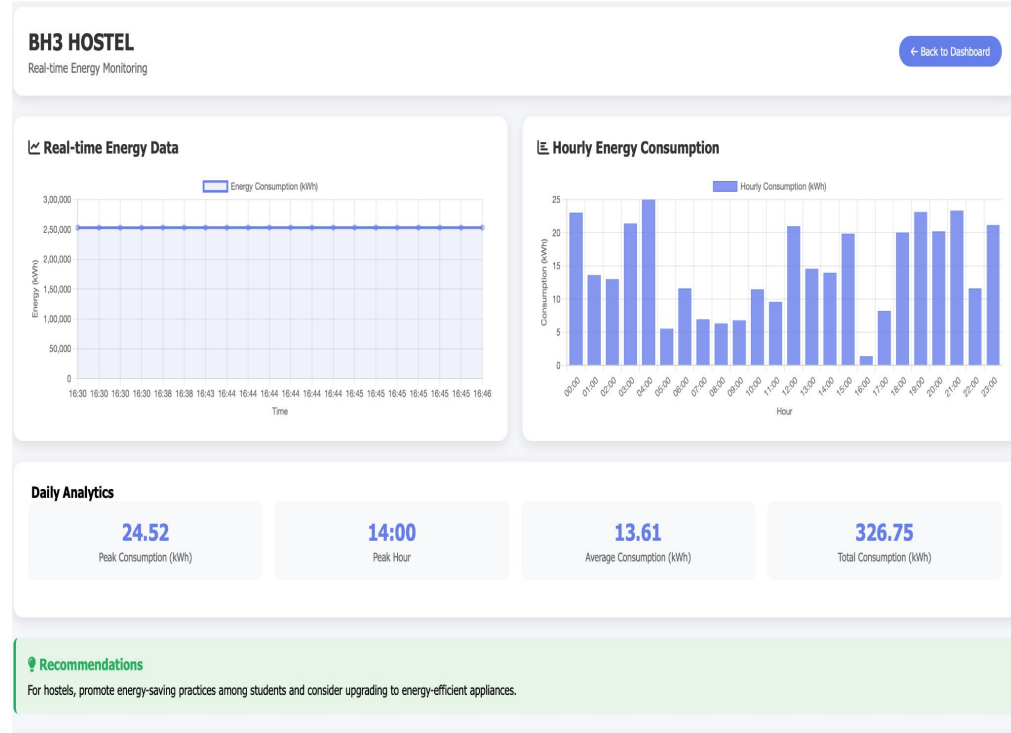
- User can navigate and logout smoothly



Dashboard Setup

2. Energy Analytics Per Block

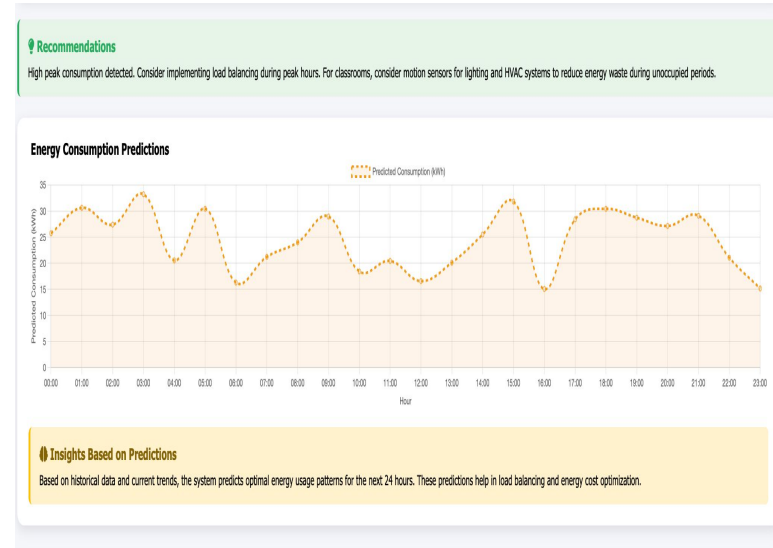
- **BH3, BH4 & Substation:**
 - Real-time energy data
 - Hourly Energy Consumption
 - Daily analytics:
- Peak hour
- Peak consumption
- Average consumption
- Total consumption
 - **Recommendations**



Dashboard Setup

3. Energy Consumption Predictions

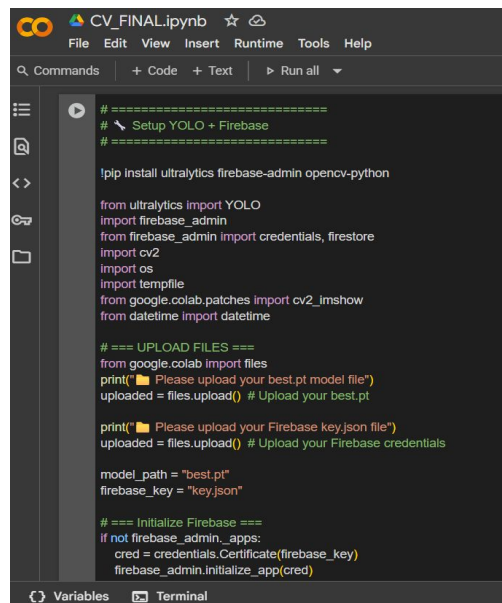
- Uses historical data to predict next 24-hour usage
- Model designed (Time Series Forecasting)
- Frontend integrated
- Backend integration of model pending
- Insights generated from predicted values



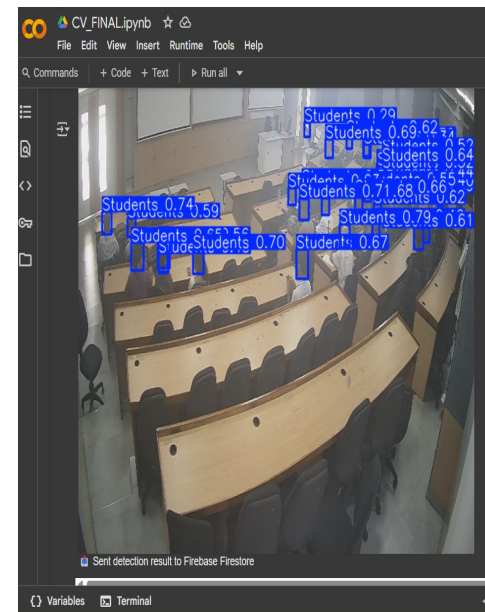
6. Occupancy Detection

Student Count using YOLOv11

- CV model detects number of students in classroom (e.g., G08)
- YOLOv11 based real-time inference
- Hosted on Google Colab
- Results sent to Firebase
- Displayed on dashboard under "Classroom > G08"



```
# =====  
# Setup YOLO + Firebase  
# =====  
  
!pip install ultralytics firebase-admin opencv-python  
  
from ultralytics import YOLO  
import firebase_admin  
from firebase_admin import credentials, firestore  
import cv2  
import os  
import tempfile  
from google.colab.patches import cv2_imshow  
from datetime import datetime  
  
# === UPLOAD FILES ===  
from google.colab import files  
print("📁 Please upload your best.pt model file")  
uploaded = files.upload() # Upload your best.pt  
  
print("📁 Please upload your Firebase key.json file")  
uploaded = files.upload() # Upload your Firebase credentials  
  
model_path = "best.pt"  
firebase_key = "key.json"  
  
# === Initialize Firebase ===  
if not firebase_admin._apps:  
cred = credentials.Certificate(firebase_key)  
firebase_admin.initialize_app(cred)
```



G-08 CLASSROOM

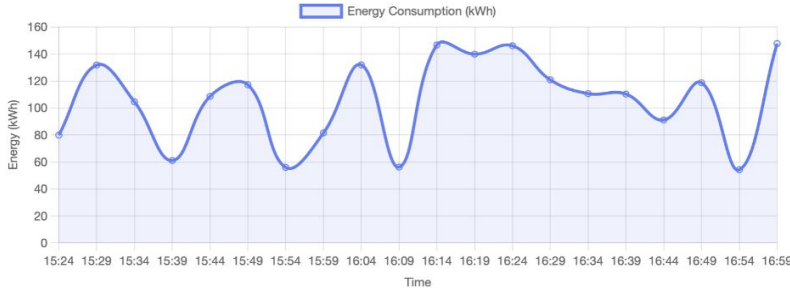
Real-time Energy Monitoring

[← Back to Dashboard](#)

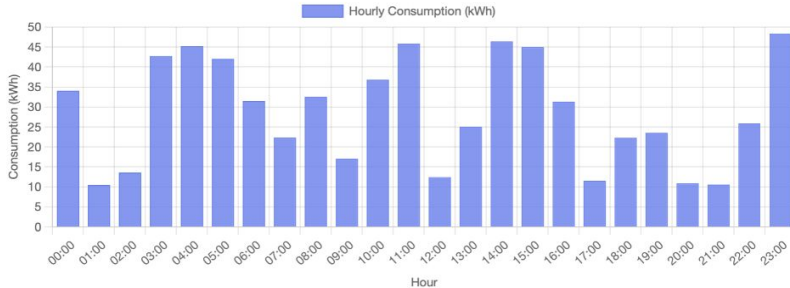
 Number of Students

44

Real-time Energy Data



Hourly Energy Consumption



Daily Analytics

47.5

Peak Consumption (kWh)

14:00

Peak Hour

23.8

Average Consumption (kWh)

571.2

Total Consumption (kWh)

7. Conclusion



- Successfully built a complete energy and occupancy monitoring system
- Integrated LoRa, CV, and web tech for a smart campus
- Provided insights and predictions for energy optimization
- A scalable solution for smart infrastructure



THANK YOU