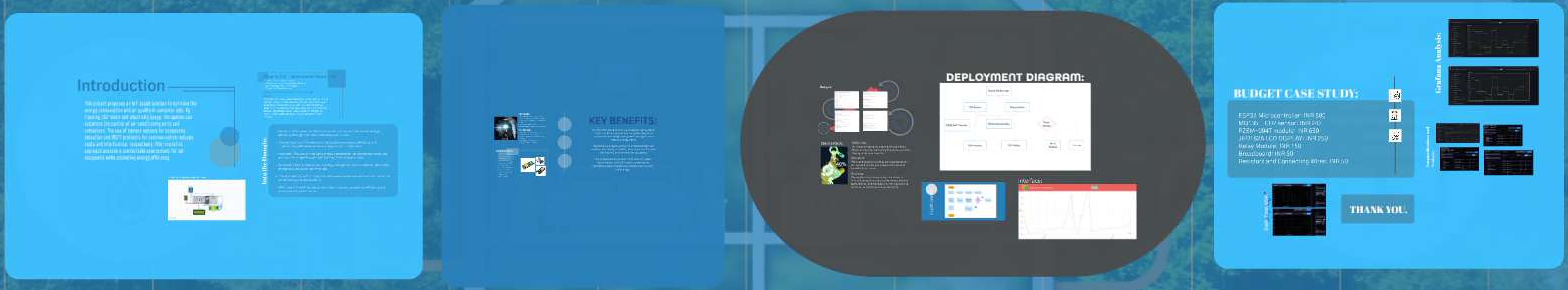
IOT – Based Automated Smart Lab

Harnessing IoT Technology for Sustainable Energy Use

Using ESP32 and CO2 sensor



Introduction

This project proposes an IoT-based solution to optimize the energy consumption and air quality in computer labs. By tracking CO2 levels and electricity usage, the system can automate the control of air-conditioning units and computers. The use of camera sensors for occupancy detection and MQTT protocols for communication reduces costs and interference, respectively. This innovative approach ensures a comfortable environment for lab occupants while promoting energy efficiency.

What is IOT – Automated Smart Lab?

The primary aim of this project is threefold:

1. Automated Energy and Co2 level Reading Over Android App.
2. Optimized and Cost-Effective Electricity Usage .
3. Occupancy and Air Quality Monitoring.

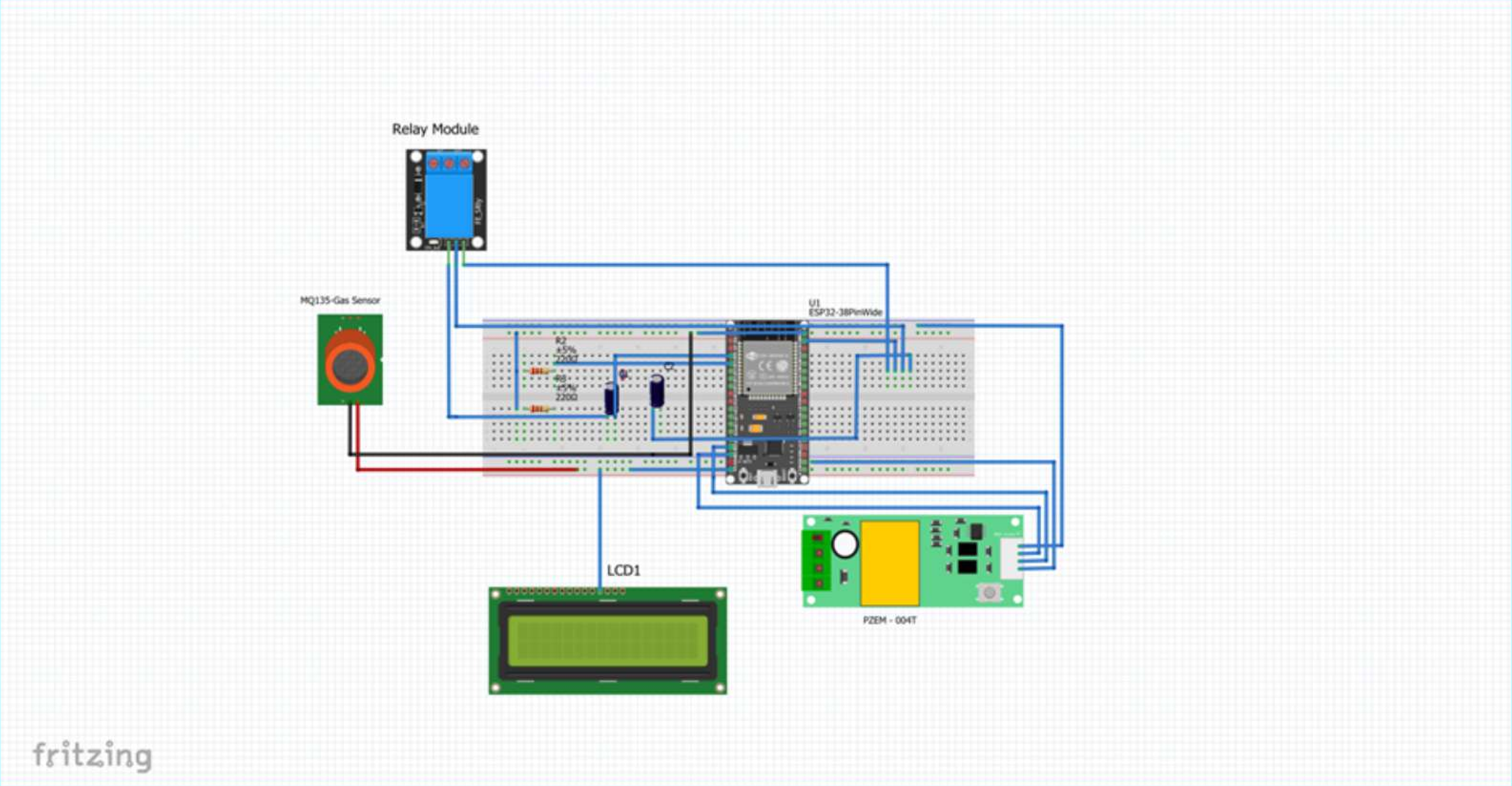
How we simulated this scenario, and the logic behind it:

Smart laboratories leverage advanced technology and sustainable practices to optimize operations and reduce environmental impact. Over a month, we will collect data on Mondays, Wednesdays, and Fridays, recording laboratory session counts, energy consumption, system usage, and CO2 levels. This data provides a comprehensive view of lab activities and their environmental footprint, guiding us towards creating a more efficient and eco-friendly laboratory.

Into the Domain:

- Siemens: Offers smart lab technologies for building automation and energy efficiency through their Smart Infrastructure division.
- Johnson Controls: Provides smart lab solutions enhancing efficiency and sustainability with advanced data analytics and IoT integration.
- Honeywell: Focuses on managing energy consumption, environmental conditions, and security in labs through their Building Technologies division.
- Schneider Electric: Specializes in energy management and automation, optimizing energy use and sustainability in labs.
- Thermo Fisher Scientific: Integrates data management and automation to enhance lab efficiency and sustainability.
- IBM: Uses IoT and AI to create smart labs, improving operational efficiency and environmental performance.

CIRCUIT DIAGRAM- using FRITZING



KEY BENEFITS:

By monitoring and controlling the power consumption of air-conditioning units and computers based on occupancy and usage, the system can significantly reduce energy waste.

Tracking CO2 levels allows the system to maintain optimal air quality in the lab, ensuring a comfortable and healthy environment for occupants.

The system provides real-time data on power consumption and CO2 levels, allowing for immediate adjustments and remote control via a mobile app.

Components

1. ESP32 WiFi Module
2. MQ135 - CO2 sensor
3. PZEM-004T module
4. 16x2 LCD Display
5. Potentiometer 10K
6. Resistor 10K
7. Resistor 100ohm
8. Capacitor 10uF
9. Connecting Wires
10. Breadboard
11. Relay Module

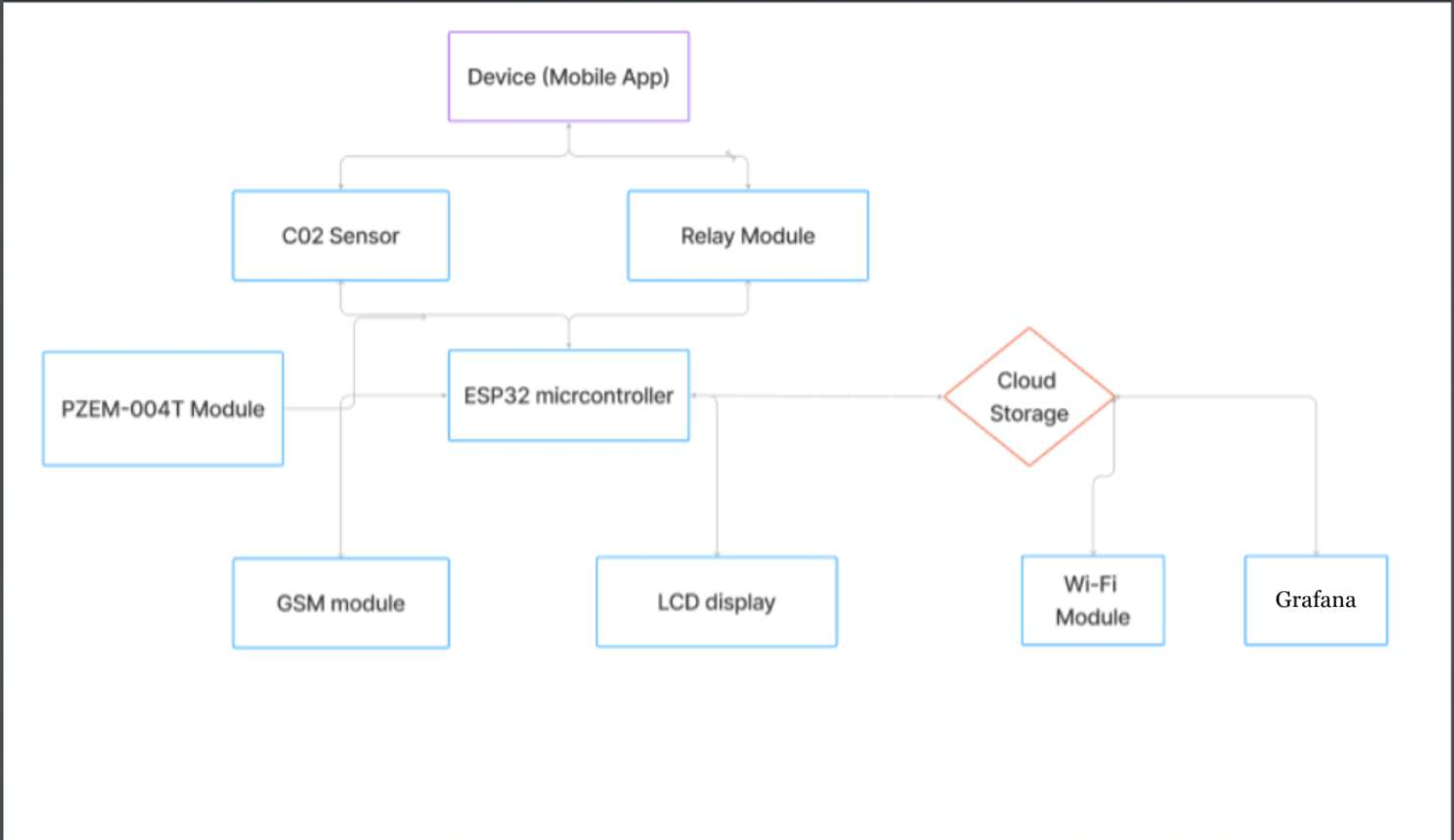
FEATURES:

- Monitoring energy consumption
- Setting energy conservation goals
- Vizualisation of energy consumption data
- Alerts and Notifications
- Monitoring of carbon dioxide levels

Threshold:

- Define CO2 thresholds based on acceptable air quality levels.
- Good air: Below 800 ppm (parts per million)
- Moderate air: 800-1000 ppm
- Poor air : Above 1000 ppm

DEPLOYMENT DIAGRAM:



TECH STACK:

ARDUINO:

We intend on using the arduino IDE and ESP32 Microcontroller for controlling the sensors and the display in the smart monitor.

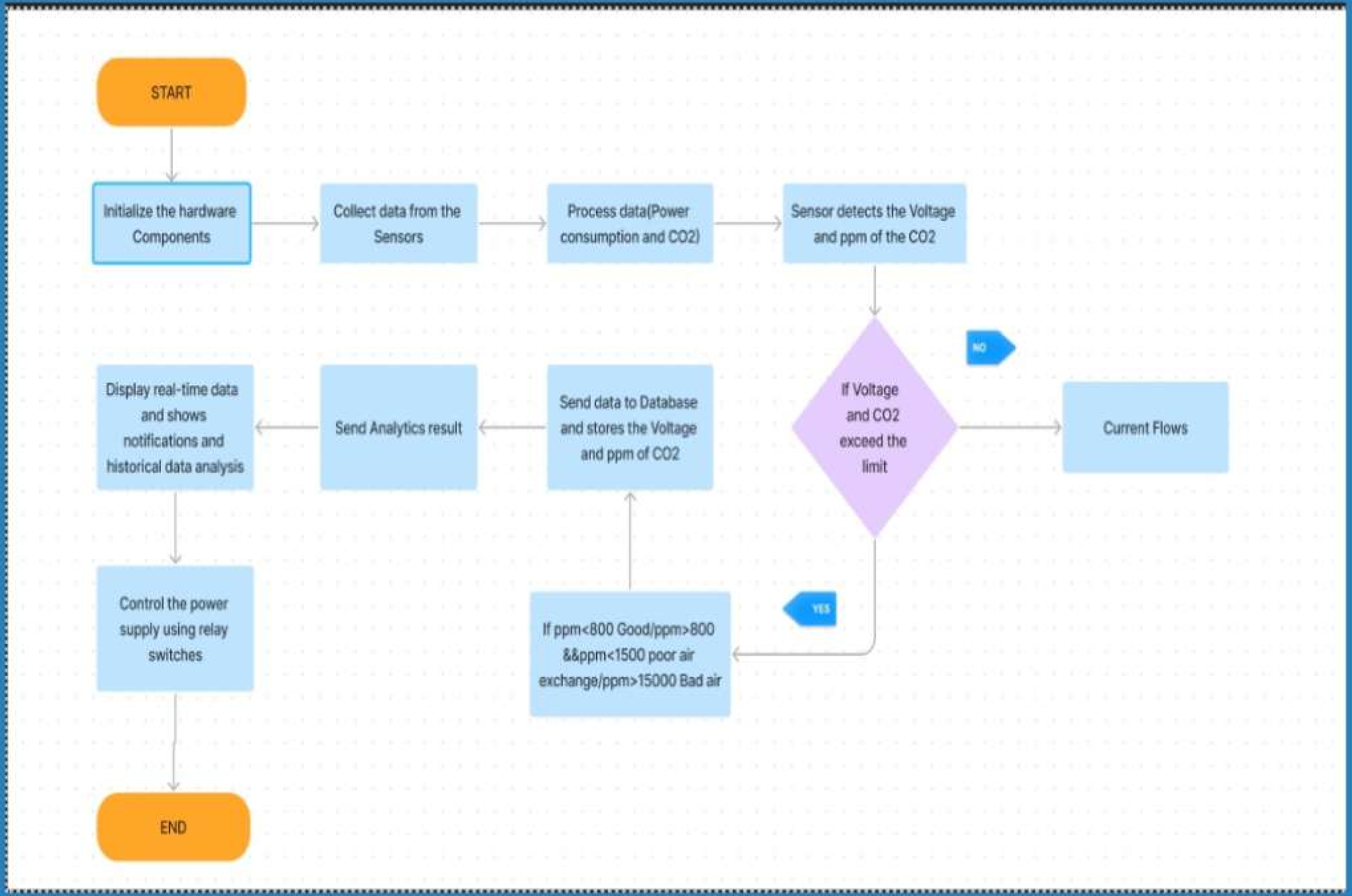
InfluxDB:

We intend to use InfluxDB as our cloud backend.It will be used to store and analyse the data sent from the smart meter.

Grafana:

We use Grafana to analyze the data stored in InfluxDB, enabling us to visualize trends, monitor performance, and make data-driven decisions to enhance lab efficiency and sustainability.

FLOW CHART:


START
Initialize the hardware Components
Collect data from the Sensors
Process data(Power consumption and CO2)
Sensor detects the Voltage and ppm of the CO2
If Voltage and CO2 exceed the limit
NO
Current Flows
YES
If ppm<800 Good/ppm>800 &&ppm<1500 poor air exchange/ppm>15000 Bad air
Send data to Database and stores the Voltage and ppm of CO2
Send Analytics result
Display real-time data and shows notifications and historical data analysis
Control the power supply using relay switches
END

Output:

```
Connecting to WiFi.
Connected to WiFi network with IP address: 192.168.21.130
---- Data for Day 1 of Week 1 ----
Systems used: 72
Amperage per system: 0.14
Air quality: >1000 ppm (Poor Air Quality)
CO2 level: 1097
Total power consumed: 2160.00
---------------------------------------
HTTP Error
---- Data for Day 2 of Week 1 ----
Systems used: 60
Amperage per system: 0.14
Air quality: >700 ppm (Medium Air Quality)
CO2 level: 850
Total power consumed: 1800.00
---------------------------------------
HTTP Error
---- Data for Day 3 of Week 1 ----
Systems used: 15
Amperage per system: 0.14
Air quality: <700 ppm (Good Air Quality)
CO2 level: 427
Total power consumed: 450.00
---------------------------------------
```

```
---------------------------------------
HTTP Error
---- Data for Day 1 of Week 2 ----
Systems used: 0
Amperage per system: 0.14
Air quality: <700 ppm (Good Air Quality)
CO2 level: 497
Total power consumed: 0.00
---------------------------------------
HTTP Error
---- Data for Day 2 of Week 2 ----
Systems used: 70
Amperage per system: 0.14
Air quality: >1000 ppm (Poor Air Quality)
CO2 level: 1117
Total power consumed: 2100.00
---------------------------------------
HTTP Error
---- Data for Day 3 of Week 2 ----
Systems used: 15
Amperage per system: 0.14
Air quality: <700 ppm (Good Air Quality)
CO2 level: 549
Total power consumed: 450.00
---------------------------------------
```

```
---- Data for Day 1 of Week 3 ----
Systems used: 25
Amperage per system: 0.14
Air quality: >1000 ppm (Poor Air Quality)
CO2 level: 1061
Total power consumed: 750.00
---------------------------------------
HTTP Error
---- Data for Day 2 of Week 3 ----
Systems used: 0
Amperage per system: 0.14
Air quality: <700 ppm (Good Air Quality)
CO2 level: 631
Total power consumed: 0.00
---------------------------------------
HTTP Error
---- Data for Day 3 of Week 3 ----
Systems used: 30
Amperage per system: 0.14
Air quality: >700 ppm (Medium Air Quality)
CO2 level: 849
Total power consumed: 900.00
```

```
---- Data for Day 1 of Week 4 ----
Systems used: 40
Amperage per system: 0.14
Air quality: >700 ppm (Medium Air Quality)
CO2 level: 783
Total power consumed: 1200.00
---------------------------------------
HTTP Error
---- Data for Day 2 of Week 4 ----
Systems used: 50
Amperage per system: 0.14
Air quality: >700 ppm (Medium Air Quality)
CO2 level: 733
Total power consumed: 1500.00
---------------------------------------
HTTP Error
---- Data for Day 3 of Week 4 ----
Systems used: 20
Amperage per system: 0.14
Air quality: <700 ppm (Good Air Quality)
CO2 level: 626
Total power consumed: 600.00
---------------------------------------
```

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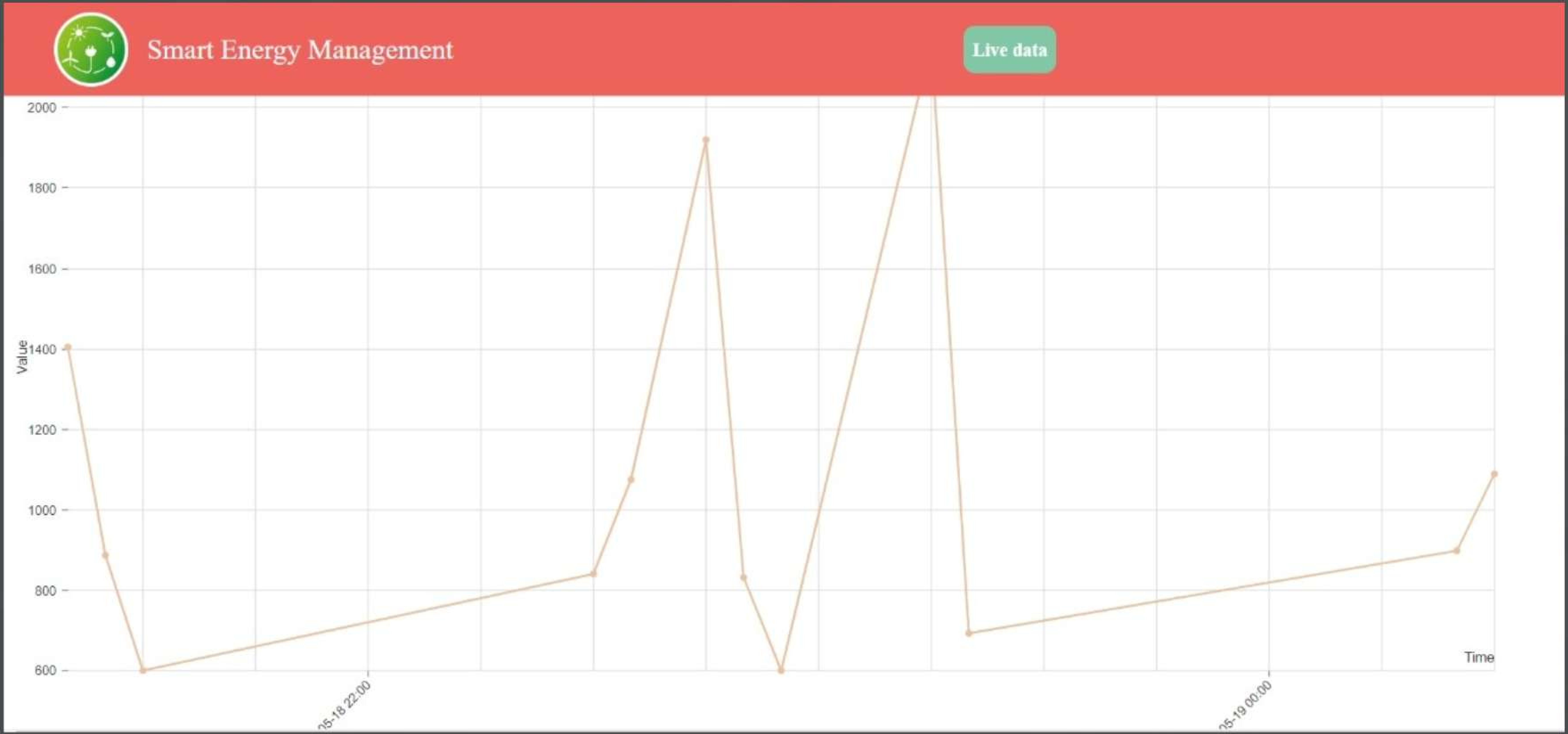
Graph Visualization:

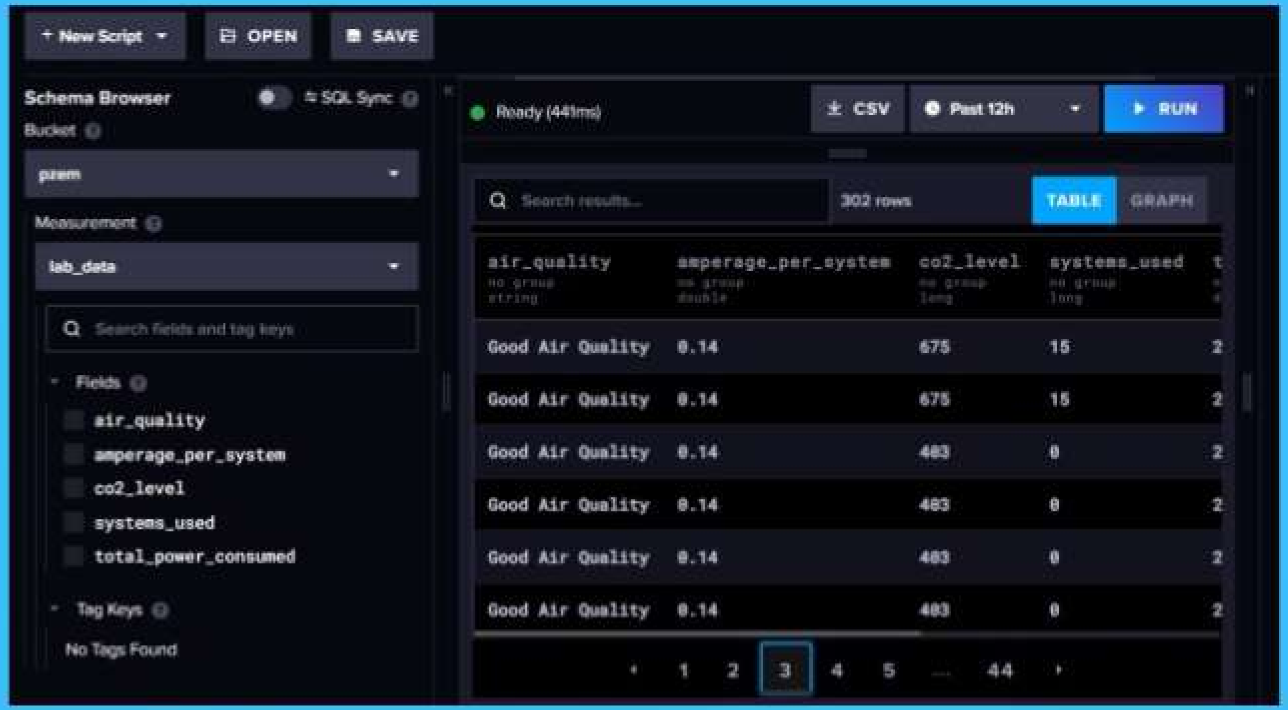
Interface:

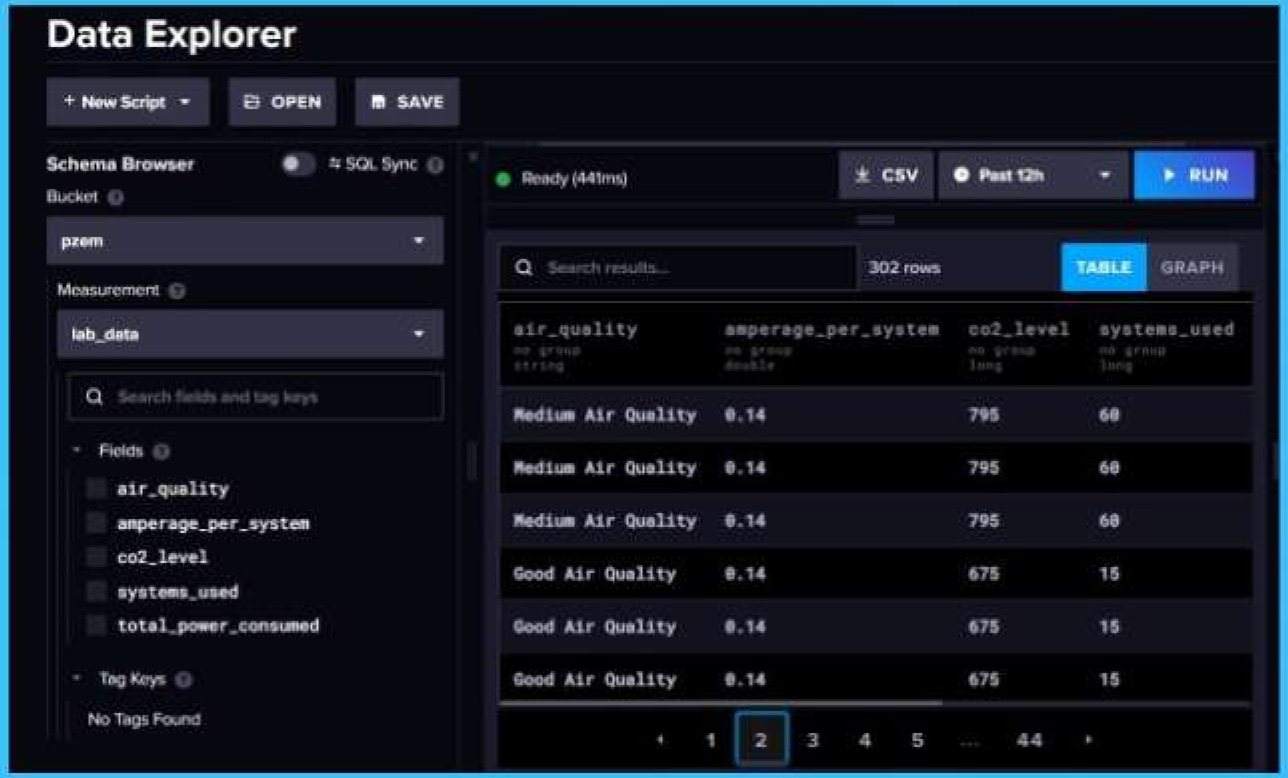


Smart Energy Management
Live data
2000
1800
1600
1400
1200
1000
800
600
Value
Time
05-18 22:00
05-19 00:00

Grafana Analysis:

Outputs(database and Analysis:





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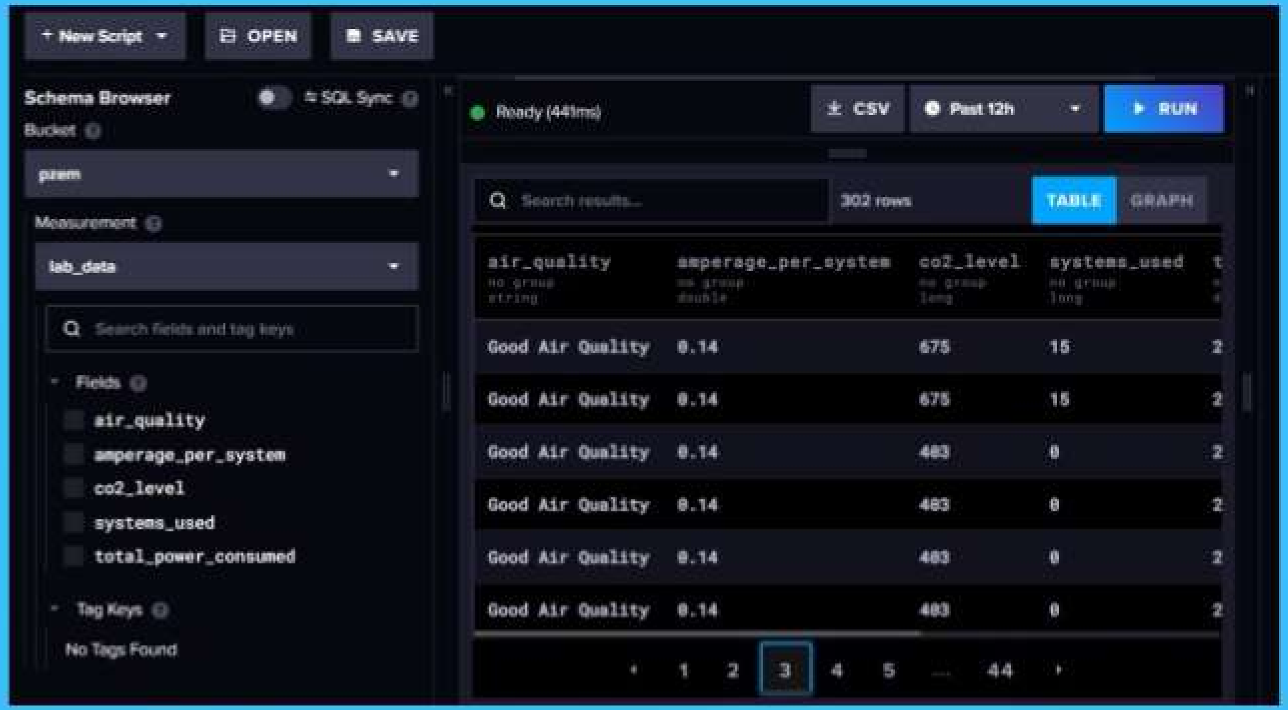

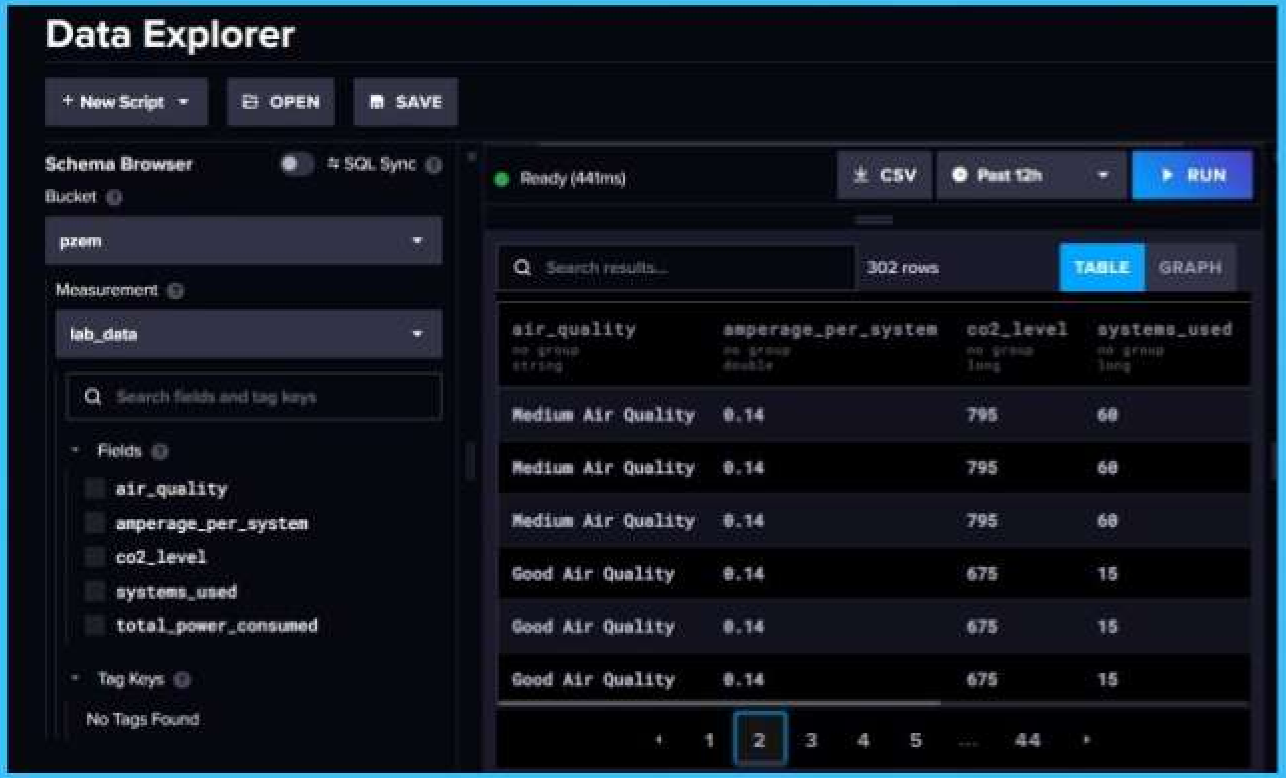

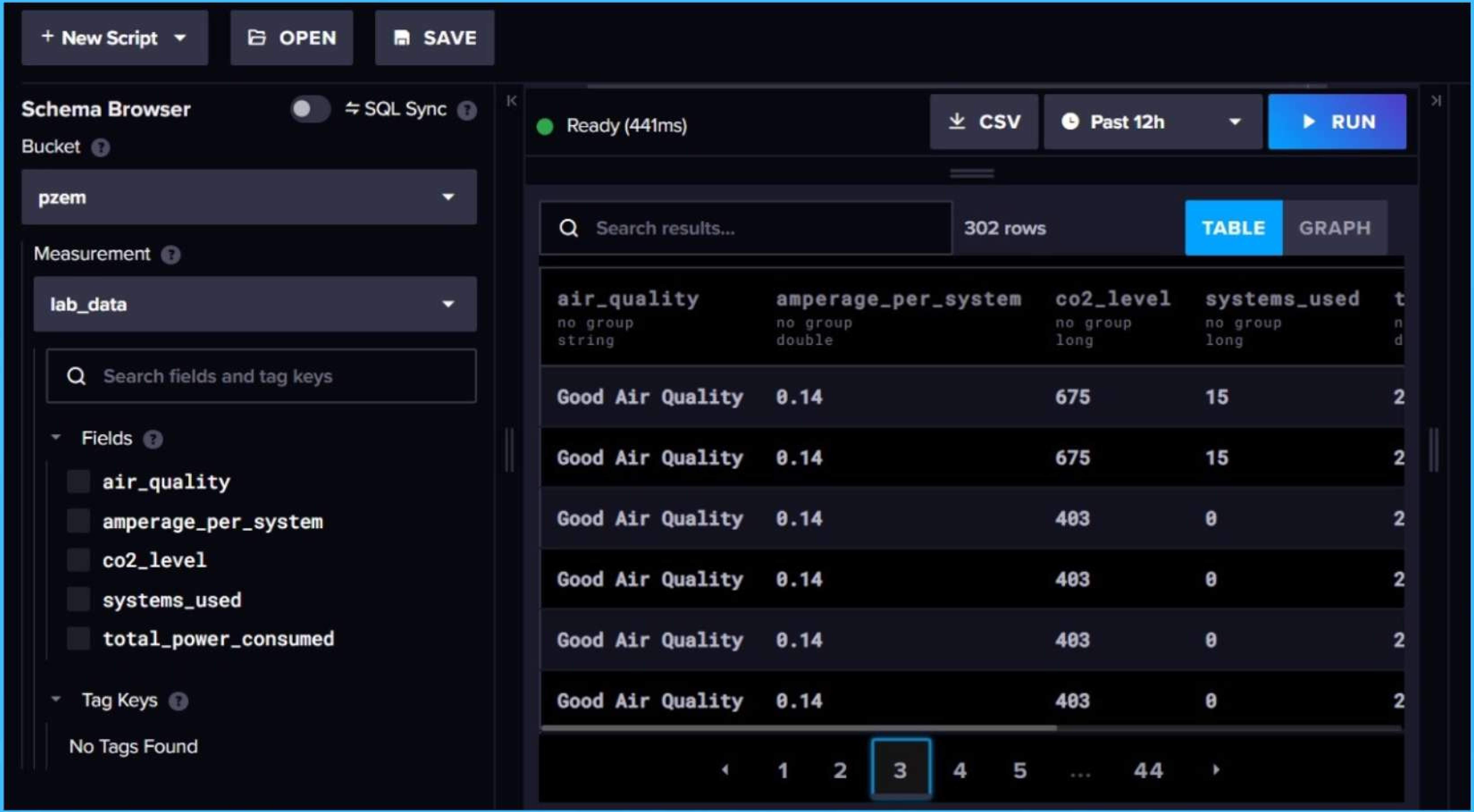
+ New Script
OPEN
SAVE
Schema Browser
SQL Sync
Bucket
pzem
Measurement
lab_data
Search fields and tag keys
Fields
air_quality
amperage_per_system
co2_level
systems_used
total_power_consumed
Tag Keys
No Tags Found
Ready (441ms)
CSV
Past 12h
RUN
Search results...
302 rows
TABLE
GRAPH
air_quality no group string
amperage_per_system no group double
co2_level no group long
systems_used no group long
Good Air Quality 0.14 675 15
Good Air Quality 0.14 675 15
Good Air Quality 0.14 403 0
Good Air Quality 0.14 403 0
Good Air Quality 0.14 403 0
Good Air Quality 0.14 403 0
1 2 3 4 5 ... 44


Schema Browser
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No Tags Found
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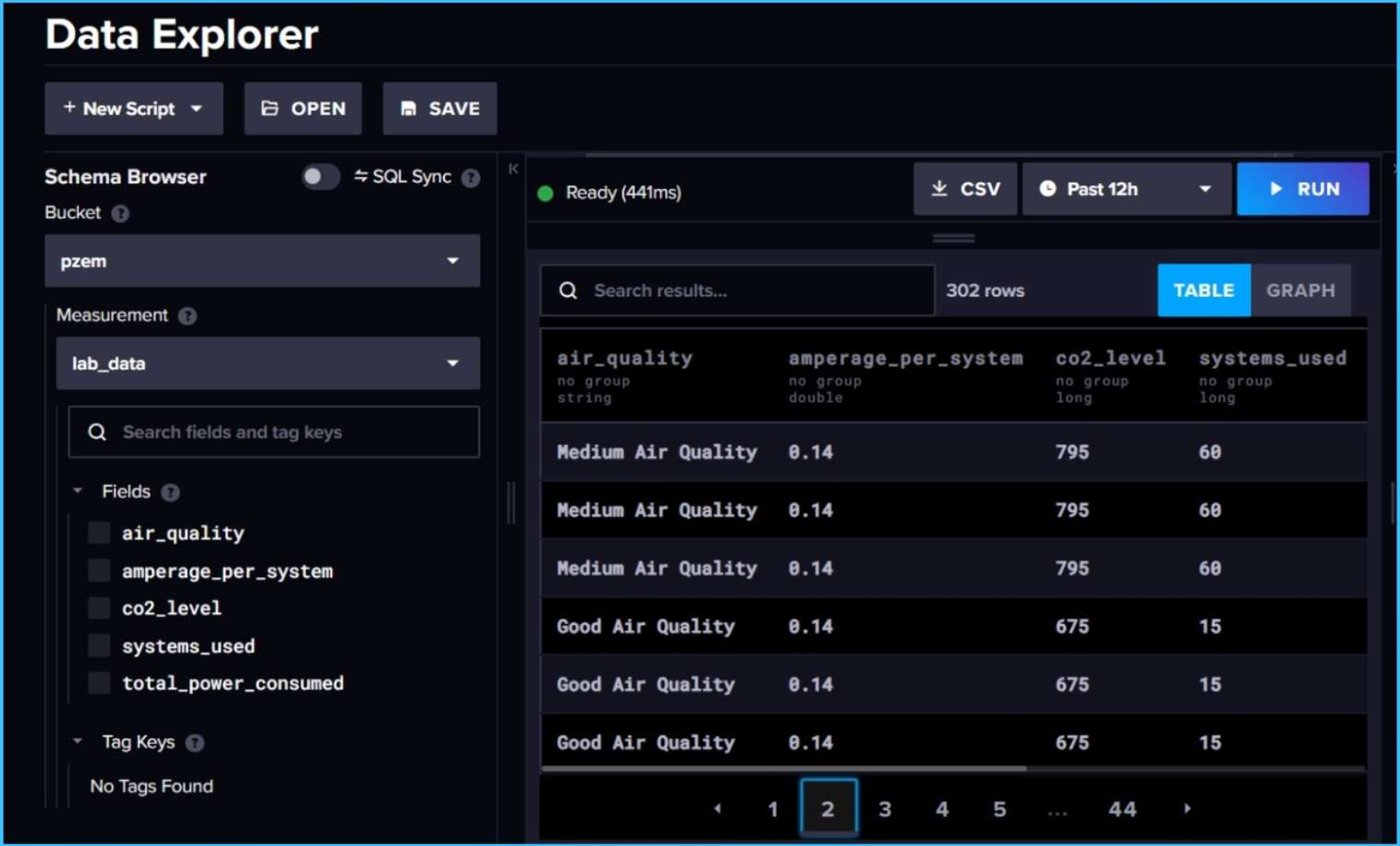
CSV
Past 12h
RUN
Search results...
302 rows
TABLE
GRAPH
air_quality no group string
amperage_per_system no group double
co2_level no group long
systems_used no group long
Good Air Quality 0.14 464 0
Poor Air Quality 0.14 1165 70
Poor Air Quality 0.14 1165 70
Poor Air Quality 0.14 1165 70
Poor Air Quality 0.14 1165 70
Poor Air Quality 0.14 1165 70
1 ... 36 37 38 ... 44


Data Explorer
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Past 12h
RUN
Search results...
302 rows
TABLE
GRAPH
air_quality no group string
amperage_per_system no group double
co2_level no group long
systems_used no group long
Medium Air Quality 0.14 795 60
Medium Air Quality 0.14 795 60
Medium Air Quality 0.14 795 60
Good Air Quality 0.14 675 15
Good Air Quality 0.14 675 15
Good Air Quality 0.14 675 15
1 2 3 4 5 ... 44

Search or jump to...
ctrl+k
Home › Dashboards › pzem
Add
Share
2024-05-19 00:20:27 to 2024-05-19 00:26:34
Home
Starred
Dashboards
Playlists
Snapshots
Library panels
Public dashboards
Reporting
Explore
Alerts & IRM
Testing & synthetics
Infrastructure
Application
Frontend
Connections
Add new connection
Collector
Alloy
Data sources
Panel Title
2024-05-19 00:20:49
systems_used 72
amperage_per_system
systems_used
Panel Title
co2_level
total_power_consumed

BUDGET CASE STUDY:

ESP32 Microcontroller: INR 500
MQ135 – CO2 sensor: INR 245
PZEM-004T module: INR 650
JHD162A LCD DISPLAY: INR 250
Relay Module: INR 150
Breadboard: INR 50
Resistors and Connecting Wires: INR 50

THANK YOU.