

PROBLEM

Industries often lack real-time, centralised insight into their energy usage. This stems from:

- Manual monitoring systems
 - Fragmented data collection
 - End of the month electricity bills
- Leading to Energy waste.

HYPOTHESIS

If industrial energy data can be measured, recorded, and analyzed comprehensively through a centralized, real-time system, then decision-makers will be better equipped to take targeted actions that improve energy efficiency, reduce carbon emissions, and contribute directly to Net-Zero sustainability goals.

“You cannot reduce what you cannot measure”

ENGINEERING GOAL

To develop a real-time, IoT-based energy monitoring system that:

- Collects and visualises energy data on a single platform
- Enables informed decisions for improved energy efficiency
- Promotes a sustainable future
- Provides backbone for future carbon trading

CURRENT LIMITATIONS AND ITS PROPOSED SOLUTION

Existing Approaches

- Manual energy audits
- Standalone energy meters
- SCADA based energy management systems

Problems with Current Systems

- Expensive or fragmented
- Dashboards primarily focus on solar energy data
- Neglect comprehensive carbon footprint tracking

Proposed Solution: AeiX

- IoT based monitoring solution using Raspberry Pi and ESP 32
- Enable real-time energy tracking
- Creates a low-cost, centralized monitoring system

METHODS AND PROCEDURES: BUILDING AeiX

System Design and Prototype

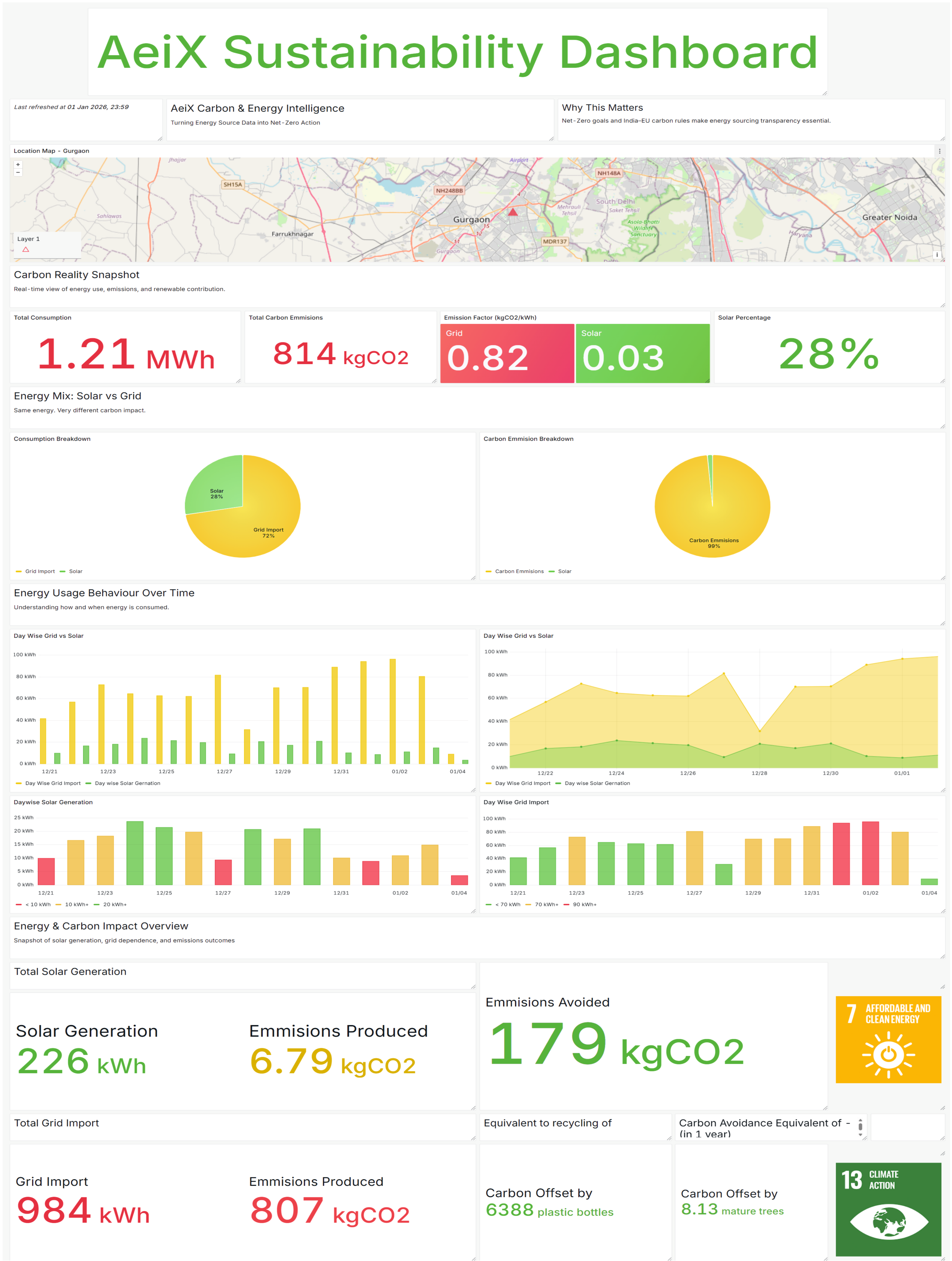
- Developed an IoT energy monitoring system
- Prototype built in two key parts:

- **ESP32 based energy logger:** Measure voltage and current, uploads data wirelessly
- **Raspberry Pi based Gateway:** Collects data from industrial meters via Modbus, processes it and displays on a live dashboard

Assembly and Integration

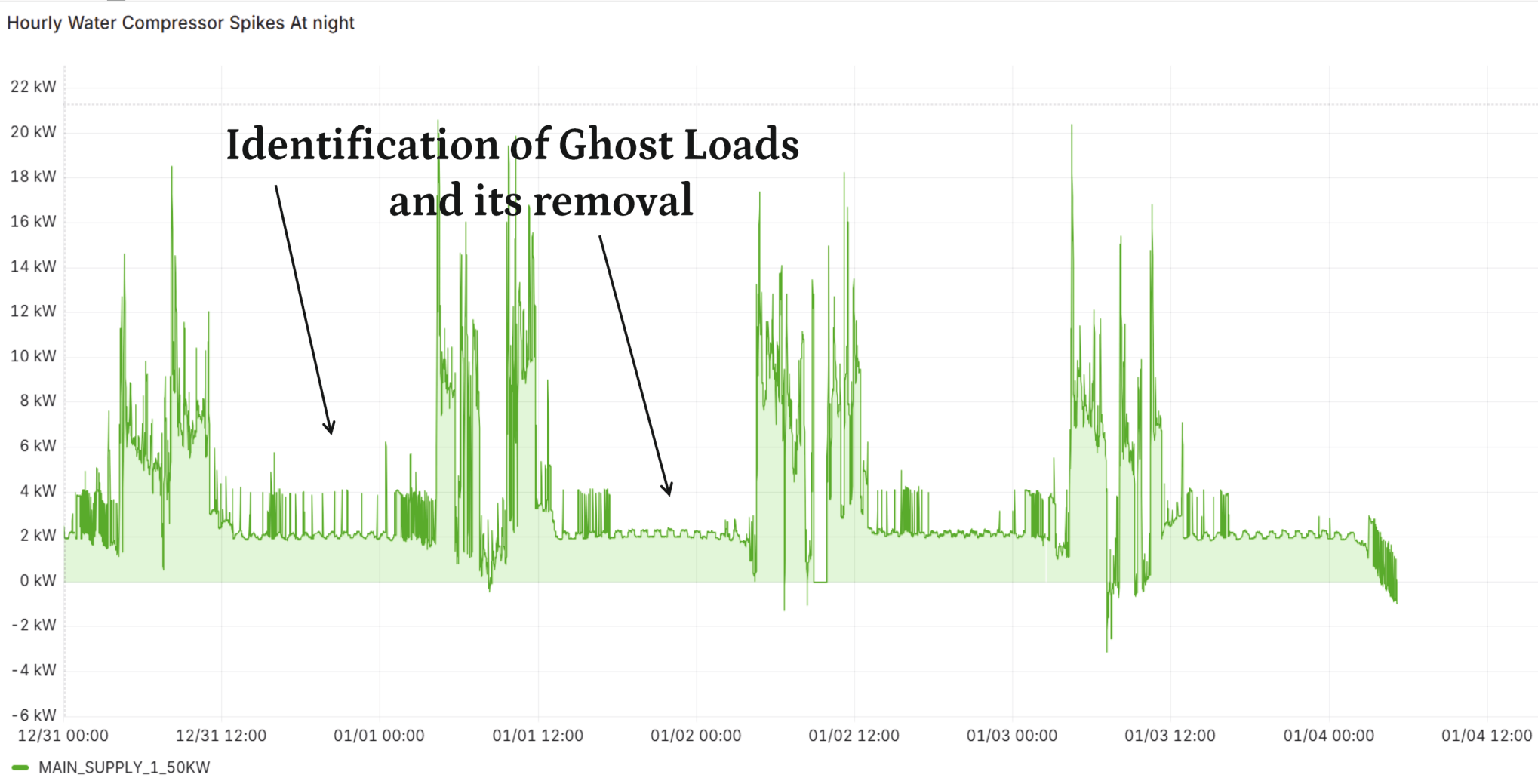
- Utilized a combination of sensors and micro-controllers
- Implemented MQTT communication protocols for data transfer
- Designed for continuous energy monitoring

REAL TIME DATA



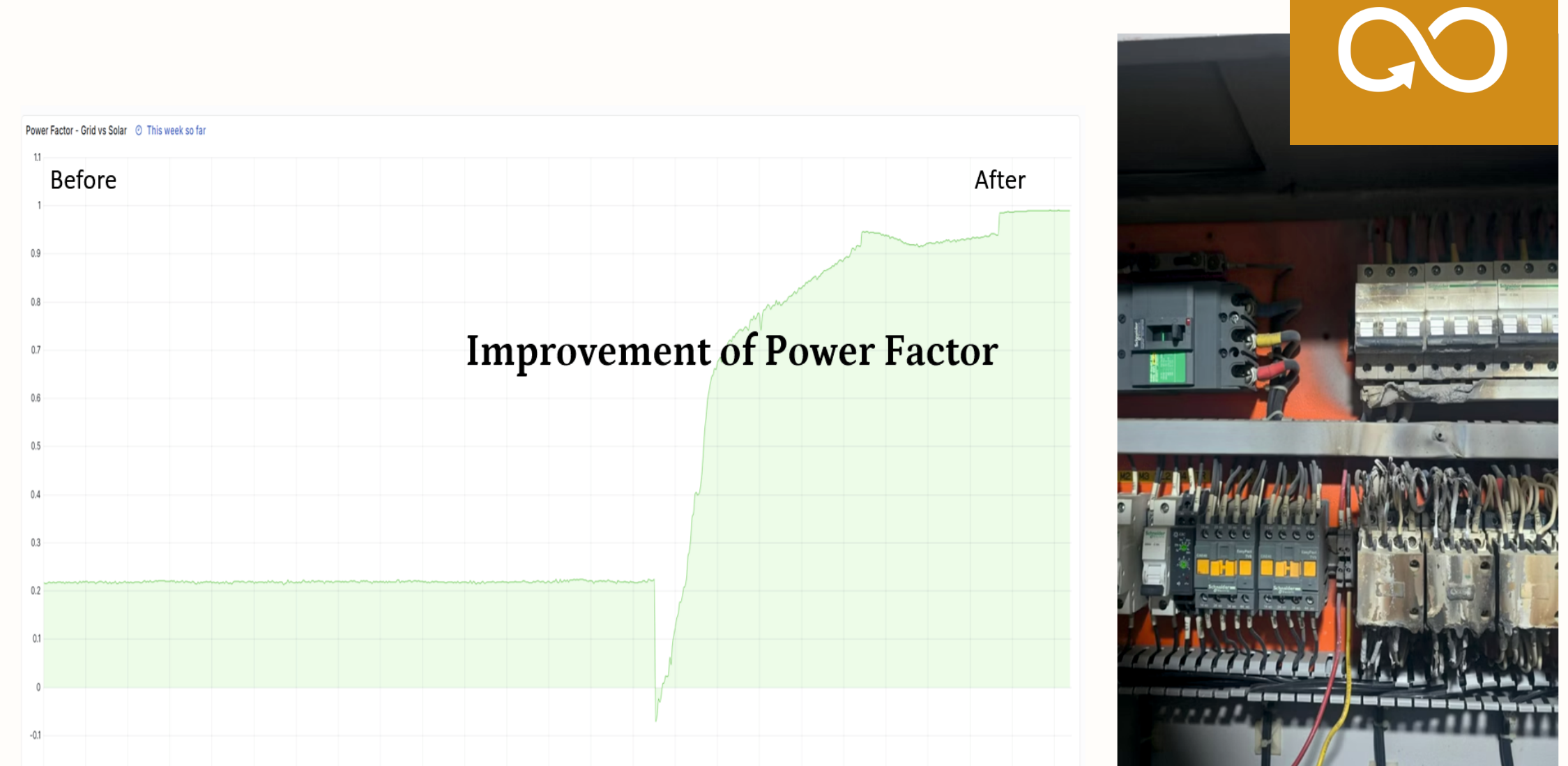
IMPACT

Impact – Ghost Loads



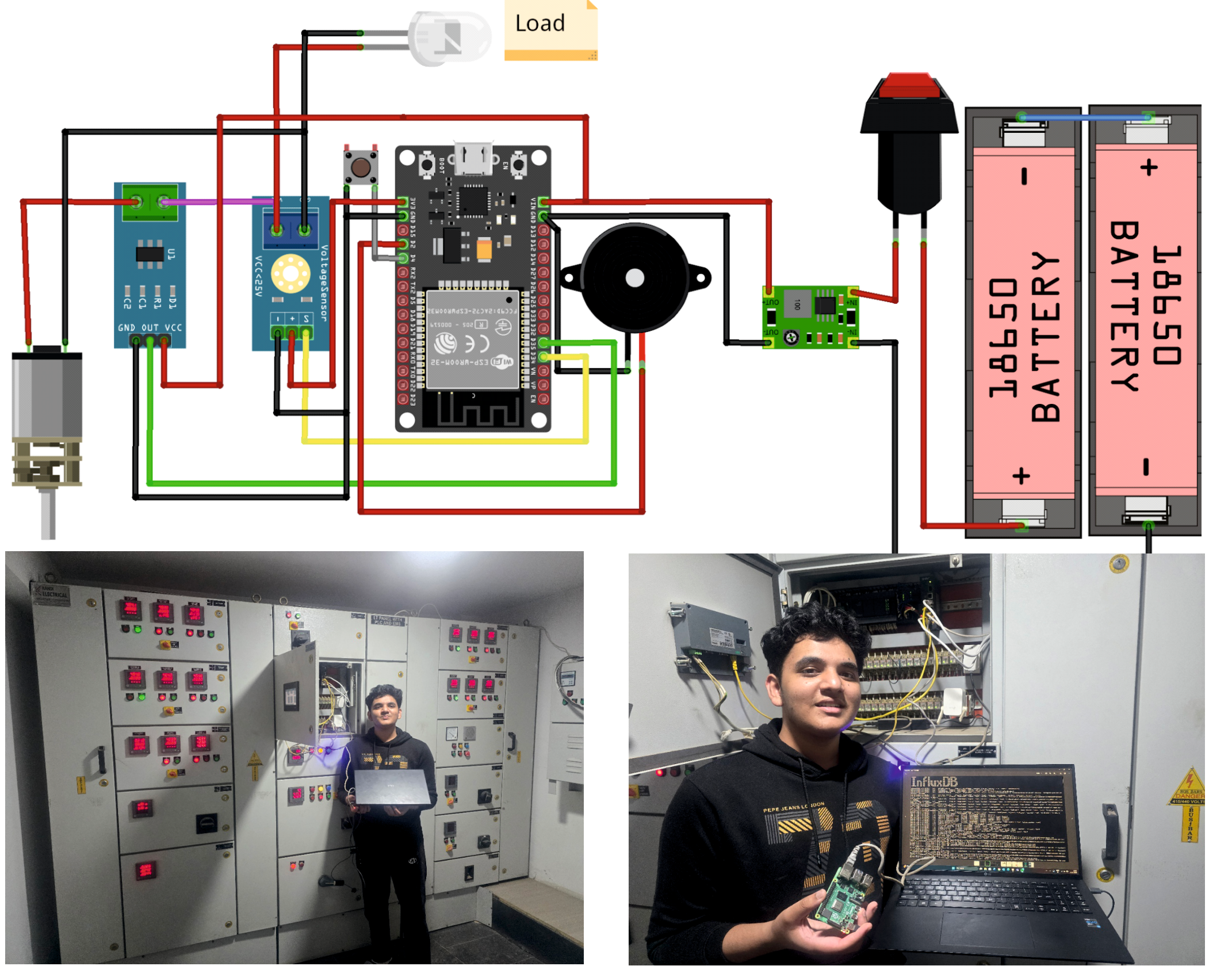
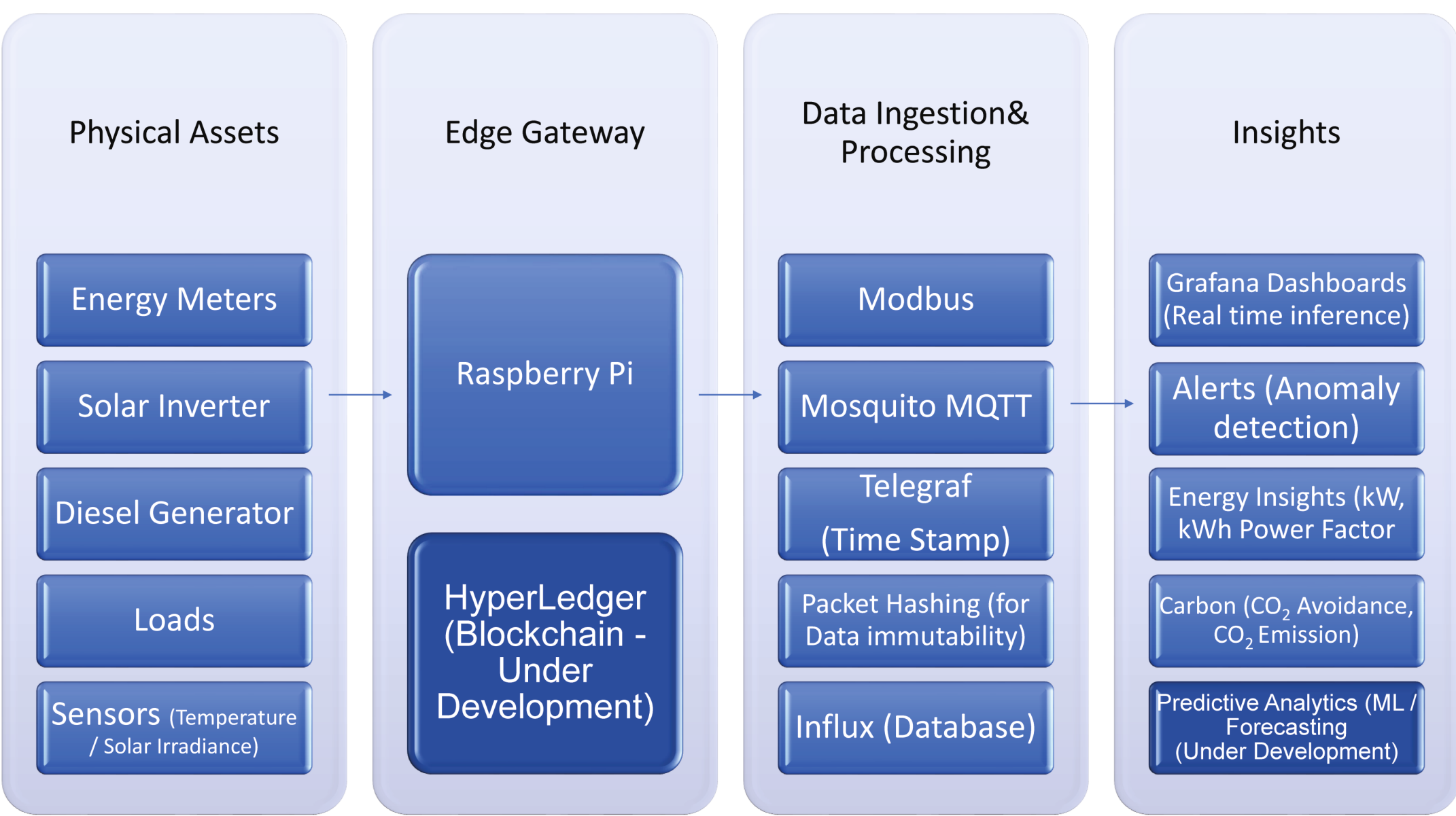
Night Energy Consumption & Savings (SDG 12) - AeiX Impact		
Night Time window - 18:00 pm - 04:00 am (10 hr)		
Before AeiX (Baseline)		
Component	Calculation	Energy
Base night Load	2 kWh x 10 hr	20 kWh
Ghost Load (Air Compressor Peaks)	2 kWh (5 min x 9 peaks)	1.5 kWh
Total Night Consumption		21.5 kWh
After AeiX (Optimized)		
Base night Load only		20 kWh
Savings Achieved		
Metric	Value	
Night Energy Saved	1.5 kWh / night	
Reduction (%)	7.50%	

Impact – Capacitor Panel (Power Factor)



Power Factory Penalty Impact (Before vs After AeiX)		
Utility Billing Condition		
Utility PF threshold: 0.90		
Penalty applied when PF < 0.90		
Before AeiX (Baseline) - Penalty Applicable		After AeiX (Optimized) - Penalty Eliminated
Parameter	Value	Value
Average Power Factory	0.25	0.95
Utility PF threshold	0.90	0.90
PF Status	Below Limit	PF Complaint
Utility Action	PF Penalty Applied	No Penalty
Typical Penalty Rate	5% of Energy Bill	
Monthly Energy Bill	₹ 25,000	
Monthly PF Penalty	₹ 1,250	₹ 0

DESIGN & ARCHITECTURE



KEY PROJECT OUTCOMES

Driving Smarter Energy Decisions

Enhanced Visibility

Real-time, IoT-based monitoring provides superior visibility and accuracy compared to manual audits.

Pattern Discovery

Continuous data collection reveals critical energy usage patterns and peak loads often missed by periodic measurements.

Optimization Support

Centralized, real-time monitoring proves more effective for identifying inefficiencies and supporting energy optimization efforts.

CONCLUSIONS

- This project demonstrates a smart, data-driven energy monitoring framework that integrates IoT and blockchain into one unified system.

- Prototype on ESP32-based asset monitoring and final deployment of the same using R-Pi for a scalable real-time monitoring of energy assets.

- By automating data collection and ensuring integrity through blockchain, the system enables accurate energy and carbon insights.

- This forms a strong foundation for future Energy Management Systems, carbon-credit validation, renewable prioritization, and Net-Zero compliance.

FUTURE DIRECTION

