SMART INDIA HACKATHON 2025

TITLE PAGE

- **Problem Statement ID –** *SIH25051*
- **Problem Statement Title-** *Renewable Energy Monitoring System*
- **Theme-** *Renewable/Sustainable Energy*
- **PS Category-** *Hardware*
- **Team ID-**
- **Team Name :** *Eco Trackers*

Eco Trackers

IDEA TITLE

SMART INDIA HACKATHON 2025

Proposed Solution :

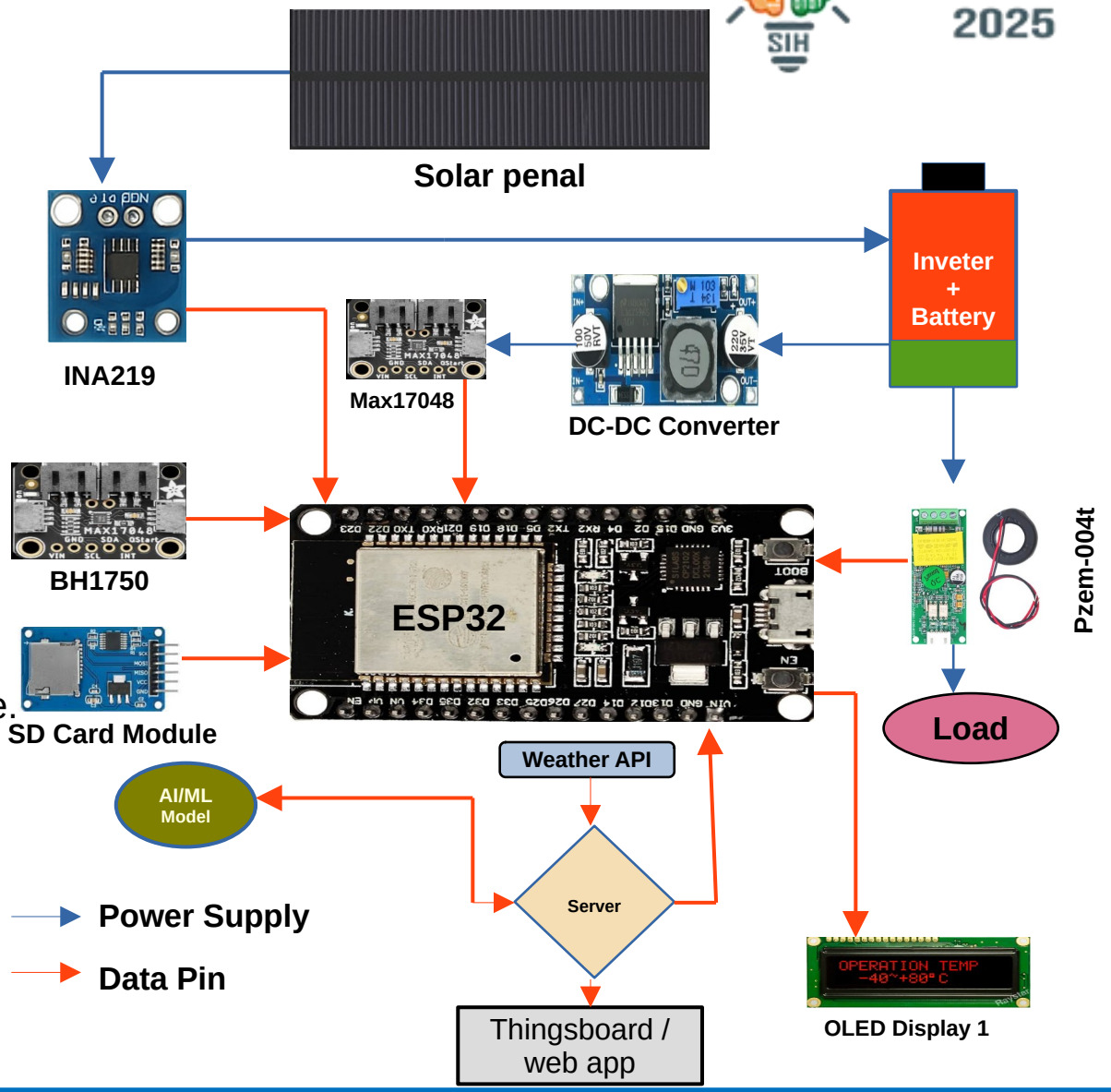
- IoT-based **Renewable Energy Monitoring System** designed for microgrids.
- It continuously tracks **solar generation**, **battery health**, and **load consumption**.
- A **cloud-based dashboard** allows **remote monitoring** and control.
- The system provides **fault detection** with instant **alerts** to prevent failures.
- All data is securely stored on the **cloud** for predictive analytics and **future analysis**.

How to Addresses the Problem :

- Provides real-time monitoring of solar and battery performance.
- Predicts solar generation (1–2 hrs ahead) to optimize usage.
- Sends alerts for battery health, fast drain, and panel underperformance.
- Helps in cost estimation and load prioritization for efficient energy use.

Innovation & Uniqueness :

- Low-cost IoT-based solution.
- Easy-to-use dashboard (mobile/web).
- Future-ready for AI/ML-based energy prediction.
- Credential storage in SD card adds offline reliability for remote/rural deployment.



Eco Trackers

TECHNICAL APPROACH

SMART INDIA HACKATHON 2025

Hardware:

1) **ESP32 :** Main controller, collects sensor data and uploads via Wi-Fi & MQTT.
2) **PZEM-004T :** Measures AC voltage, current, power, and energy.
3) **BH1750 :** Light sensor to measure sunlight level for solar prediction.
4) **INA219 :** Measures DC voltage & current (battery and load).
5) **Li-Ion Battery 3.7V 2500mAh :** Power supply for ESP32 and sensors.
6) **DC to DC Buck Converter :** Steps down voltage for safe operation.
7) **OLED Display :** Show sensor faults and battery %.
8) **Solar Plate 6V 60mA :** Generates solar energy to charge the battery.
9) **SD Card Module :** Stores system data for offline use.
10) **Max17048 :** Used for bettery health(Real time Percentage).

Software :

- **Arduino IDE / PlatformIO** – For programming ESP32 microcontroller.
- **MQTT Protocol** – For communication between ESP32 and cloud server.
- **ThingsBoard / Custom Web Dashboard** – For real-time data visualization and control.
- **Open-Meteo Weather API** – For solar prediction using weather data.
- **Google Sheets / Excel / Database** – For storing and analyzing collected data.
- **Cloud Platform (AWS / Firebase / Local Server)** – For hosting data and dashboard.

Language :

- **C / C++** – For programming the ESP32 microcontroller on Arduino IDE.
- **Python** – For data analysis, cloud integration, and backend scripts.
- **JavaScript (with HTML & CSS)** – For custom web dashboard and data visualization.
- **SQL / NoSQL** – For storing project data on cloud or local database.

Eco Trackers

FEASIBILITY AND VIABILITY

SMART INDIA HACKATHON 2025

Feasibility:

- Low-cost IoT hardware (ESP32, sensors, solar panel) makes it affordable and scalable.
- Works in both urban and rural areas due to cloud + offline SD card storage.
- Easy to deploy and maintain with minimal technical skills.
- Supports future upgrades like AI-based prediction and smart grid integration.

Challenges:

- Internet dependency in remote areas may cause delays in data upload.
- Sensor calibration issues can affect accuracy of monitoring.
- Battery limitations during cloudy/rainy days may reduce reliability.
- Battery limitations during cloudy/rainy days may reduce reliability.

Solutions:

- Use offline SD card storage and sync data when internet is available.
- Impleament regular sensor calibration and fault alerts.
- Add backup power source (larger battery / hybrid energy input).
- Use data optimization to reduce network bandwidth requirement.
- Apply data encryption and secure authentication for cloud security.

Eco Trackers

IMPACT AND BENEFITS

SMART INDIA HACKATHON 2025

Impact:

- Reliable microgrid management.
- Helps rural areas achieve 24/7 Monitoring.
- Promotes renewable energy adoption.
- Supports smart city and rural electrification initiatives.
- Improves decision-making with real-time energy insights.

Benefits:

- Social: Energy access for all.
- Social: Better quality of life in remote areas.
- Economic: Cost-efficient energy management.
- Economic: Reduces dependency on expensive diesel generators.
- Environmental: Reduced carbon footprint.
- Environmental: Encourages clean and green energy usage.

Eco Trackers

RESEARCH AND REFERENCES

SMART INDIA HACKATHON 2025

- ThingsBoard IoT Platform Documentation – For cloud integration and data visualization
- IEEE Papers on Smart Microgrids and IoT Energy Monitoring – For technical research and best practices
- Government of India Renewable Energy Policies & MNRE Guidelines – For compliance and policy alignment
- LoRaWAN Documentation – For long-range wireless communication in rural areas
- SD Card Data Logging Tutorials (ESP32) – For local storage implementation
- Machine Learning in Energy Prediction (Research Articles) – For future AI/ML integration in energy forecasting
- Link github : https://github.com/Saurabh8232