Real-Time EcoHouse PV Monitoring Dashboard
An Extensive Prototype

Raihan Karim Ishmam

February 14, 2026

1 Overview

This paper walks through a prototype real-time photovoltaic (PV) monitoring platform designed for EcoHouse environments. The system provides an interactive web-based interface for visualizing live electrical and environmental data. It presents key performance indicators, live trends, system insights, and recent measurements in a structured and readable format.

At this stage, the system operates on synthetic data rather than physical PV hardware. The live feed is generated using the `datagen.py` script, which continuously simulates temperature and power readings to emulate a real photovoltaic system.

2 Motivation and Context

Real-time PV monitoring enhances operational awareness and system reliability in renewable energy environments. IoT-based PV monitoring architectures emphasize continuous streaming and visualization of key electrical and environmental parameters to improve performance assessment and fault detection [1, 4]. These principles informed the design, focusing on clarity, responsiveness, and extensibility while maintaining architectural simplicity.

3 Design and Feature Overview

The dashboard centers around clear real-time performance visualization. The interface displays temperature (°C), instantaneous power (W), rolling average power, and the most recent update timestamp as key performance indicators. These metrics provide immediate insight into system behavior.

Dynamic time-series charts track temperature and power evolution over time. An insight panel interprets values into human-readable system states such as temperature stability, power fluctuations, or feed health. A recent data table presents the newest records first to maintain transparency of the live stream.

3.1 Design Rationale: Monitoring Power and Temperature

Monitoring both electrical output and module temperature is fundamental for evaluating photovoltaic performance. Electrical power directly represents energy production, while module temperature significantly influences efficiency. Research demonstrates that increased PV module temperature reduces maximum power output due to semiconductor material characteristics and internal recombination losses [2, 3]. Temperature monitoring is also important for operational safety and degradation prevention [5]. By integrating both metrics, it provides a more complete real-time assessment of PV behavior.

4 Architecture and Implementation

The development consists of two primary components:

Data Generator (`datagen.py`): Simulates live PV sensor data by continuously appending timestamped temperature and power values.

Dashboard Application (`dashboard.py`): Built using Streamlit, it consumes the data stream and renders real-time visualizations, KPIs, and system insights.

This producer-consumer architecture mirrors practical IoT monitoring systems while remaining lightweight and suitable for prototype deployment.

5 System Interface Visualization

Figure 1 shows the implemented monitoring interface. The dashboard displays real-time key performance indicators, live time-series trends, insight alerts, and a recent data feed. The interface operates on synthetic data generated by the `datagen.py` script.

6 Getting Started and Run Instructions

To execute the start-up of the prototype, follow the steps below.

1. Create and activate a Python virtual environment

```
python3 -m venv venv

# macOS/Linux
source venv/bin/activate

```

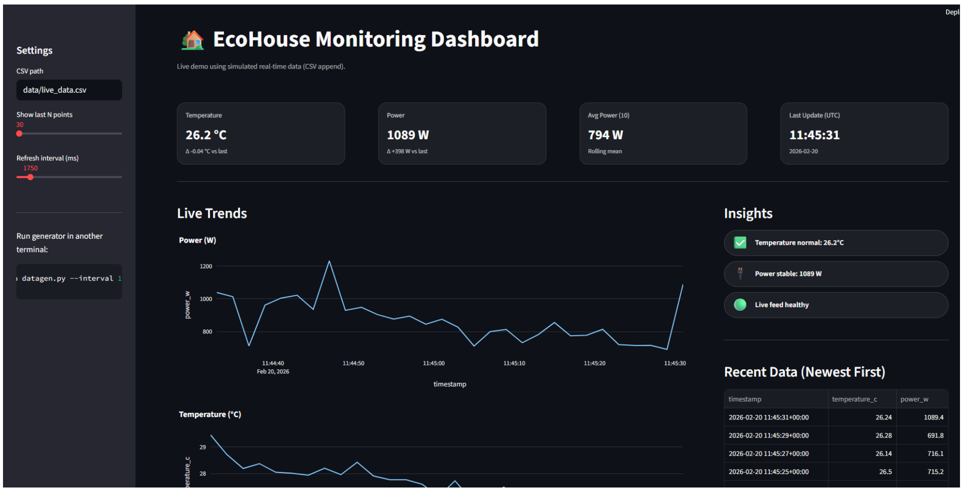

Figure 1: The interface demonstrating Real-Time Monitoring

```
# Windows (PowerShell)
venv\Scripts\Activate.ps1
```

2. Install dependencies

```
pip install -r requirements.txt
```

3. Start synthetic data generation

```
python datagen.py
```

This script continuously generates simulated PV temperature and power readings.

4. Launch the dashboard

```
streamlit run dashboard.py
```

The dashboard will open in a browser window and begin visualizing the incoming synthetic data.

Important: Run `datagen.py` before launching the dashboard to ensure data availability.

7 Limitations and Future Extensions

This prototype does not yet include long-term historical storage, PV generation versus grid separation, battery monitoring, authentication, cloud deployment, or predictive analytics. Future development will focus on hardware integration, database-backed persistence, and intelligent forecasting models.

8 Conclusion

In this development we aim to demonstrate a structured and extensible approach to real-time photovoltaic monitoring within EcoHouse environments. While currently operating on synthetic data, the architecture directly supports transition to real sensor integration and advanced analytics.

References

[1] TEM Journal (2024). Real-Time Monitoring of Photovoltaic Systems and Control.

[2] Skoplaki, E., and Palyvos, J. (2013). Temperature Dependent Photovoltaic Efficiency and Its Effect on PV Production. *Energy Procedia*.

[3] MDPI Energies (2025). Impact of Temperature Distribution on Photovoltaic Generation.

[4] Econjournals (2020). Effects of Solar Irradiance and Cell Temperature on PV Performance.

[5] GAIMC (2025). Optimizing Solar Power Plant Efficiency and Safety through Temperature Monitoring.