⚡ EcoWatt – Smart Electricity Management System

EcoWatt is a real-time, smart electricity monitoring and control platform designed to help users **analyze**, **understand**, and **optimize** their power consumption using **IoT**, **data science**, and **remote automation**.

It empowers households and small buildings to make informed energy decisions, reduce power waste, and move toward a sustainable future. EcoWatt is especially aligned with **SDG 7: Affordable and Clean Energy**.

🎯 Objectives

- Provide real-time data on electricity usage.
- Detect overuse or underuse of individual devices.
- Notify users about unusual consumption patterns.
- Offer remote control (switch OFF/ON) capabilities.
- Promote responsible energy usage with actionable insights.

🧰 Tech Stack

- **Flutter + Dart**: Mobile Application (Android)
- **NodeMCU / ESP8266**: For real-time voltage & current sensing
- **MATLAB**: For dynamic visualization & classification (normal, overuse, underuse)
- **Firebase** or **ThingSpeak**: For data syncing and cloud storage
- **Python / JSON**: For backend simulations and dynamic analysis

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🔧 Hardware Setup

- NodeMCU or ESP8266
- Current Sensor (e.g., ACS712)
- Voltage Divider Circuit for safe voltage sensing
- Relay Module (to remotely switch devices ON/OFF)

- Power supply unit
- Mobile device with the EcoWatt app installed

📈 Project Flow

1. **Ideation**:
    - Targeted SDG 7 for sustainable energy.
    - Planned a tool to monitor, classify, and control power consumption.
2. **Design Phase**:
    - Hardware schematics created for current and voltage measurement.
    - Flutter UI designed for real-time insights and control.
3. **Development Phase**:
    - ESP8266 firmware developed for data acquisition.
    - Firebase used for real-time cloud sync.
    - MATLAB scripts built for dynamic voltage usage graphs.
4. **Testing & Simulation**:
    - Python-based simulations for various device behaviors.
    - Validated expected vs. actual power usage.
5. **Final Integration**:
    - All components integrated into the Flutter app.
    - Verified full system functionality end-to-end.
6. **Deployment**:
    - Mobile app successfully tested on Android.
    - Real-time device monitoring and control verified.

🔍 Features Breakdown

🔌 Real-Time Monitoring

- Continuously reads current and voltage of each connected device.
- Displays live values in the mobile app.

📊 Usage Classification

- Devices are categorized into three classes:
    - ✅ Normal Use: Green constant line
    - 🔵 Underuse: Blue sine wave
    - 🔴 Overuse: Red sine wave

📈 Dynamic Visualization (MATLAB)

- Sine waves and thresholds are plotted in real time.
- Overuse triggers visual alerts and notifications.

📥 Standard Ratings

- Built-in power rating library for common appliances (TV, AC, fan, switch, etc.)
- Compares actual vs. expected power

🔔 Smart Alerts

- Notify users when:
  - A device exceeds its standard power rating
  - Total power consumption crosses a defined threshold
  - Abnormal usage patterns are detected

📱 Remote Control

- Users can remotely switch off any device that is:
  - Overconsuming
  - Left on unnecessarily
- Prevents fire hazards and energy waste

🧠 Internal Logic

graph TD
A[Device Turned On] --> B[Voltage & Current Read by NodeMCU]
B --> C[Send Data to Firebase / ThingSpeak]
C --> D[MATLAB Processes & Visualizes Data]
D --> E[Compare with Standard Ratings]
E --> F{Normal or Not?}
F -- Normal --> G[Show Green Line]
F -- Underuse --> H[Show Blue Wave]
F -- Overuse --> I[Show Red Wave & Send Alert]
I --> J[User Takes Action via App]

📦 Future Improvements

- Add AI-based consumption prediction
- Voice-based assistant integration (Google Assistant, Alexa)

- Support for solar input tracking and auto cut-off
- Billing estimation based on real usage
- Open API for energy analytics dashboards

🚀 Why EcoWatt?

- Saves energy
- Reduces electricity bills
- Prevents damage from faulty devices
- Promotes smart & sustainable living
- Can scale for homes, offices, institutions

Complete Working Simulation has been done and tested with the name being NewEcowatt

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👥 Team

Developed by a team of 3 btech students during a 3-day hackathon focused on SDG 7 (Affordable and Clean Energy).