

# **Disaggregation Plug Load Management Applications**

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ing Estimation: \$24.90/

### **Project Overview**

With the world's increasing dependence on technology, growing environmental concerns over energy sourcing in peaker plants (Figure 1), and the roll-out of Time of Use energy billing rates in California, it is imperative to minimize grid loads during peak demand hours and to minimize overhead costs to residents and businesses. This project aims to develop automation applications for various residential and industrial settings that allow users to audit and manage energy usage around a home/facility then make informed decisions on certain types of devices/appliances. By simulating a home environment, the authors test and refine the effectiveness of such system on real world scenarios



Figure 1: Concentration of energy sources in CA. Gases (pink, green, purple) are prevalent in populated areas (CEC).

### **Research Objectives**



- Present the energy usage data and actionable information provided by energy management authorities using IoT to empower users to save energy and minimize cost.
- Augment and extend contextual information using additional smart-home sensors.

Provide multiple modalities of access to target

Figure 2: Smart Meters are installed at each house in California by major utilities

different demographics while maintaining universality, resilience, and independence among applications.

#### **Developed Solutions**

These solutions were created to control devices and to audit, manage, and present energy usage

- PlugLoad Perceptoscope (iOS)
  - Spatial object tracking and object recognition via neural networks
  - Present energy data through AR graphs
  - Use analyzed summary data to suggest focus points and provide energy-saving tips
- CalPlug Energy Auditor (Google Asst., Alexa)
- Compatible with Android devices. Home speakers. Alexa enabled devices
- Uses natural language processing to determine requested actions
- Retrieves recent usage data to estimate energy bill for recommend savings options
- CalPlug Energy Stats (Web)
  - Displays both individual and aggregate energy data graphically in responsive UI.
  - Provides bill and usage estimation to offer possible efficient device sub, from provider
- Audit Bot (Slack, Discord)

ŜMARTENIT

Where the smart things are

- Targets Slack orgs, and Discord servers
- Follows common bot interface paradigms
- Notifies members of high energy demand
- Sends rebate options to user based on energy usage patterns of the user

#### Acknowledgements



Figure 3: Perceptoscope showing microwave usage data. Shows graph of recent instantaneous demand readings (A) and summarized usage data (B).

Helio! I am the CalPlug Energy Auditor What would you like me to do A Total energy usage, Device energy audit, Check for energy reb R

heck my total energy usas Throughout your whole house, you've been using around 7874.3 watts of ower for an average of around 1.0106 kilowatt-bours in the last 24 hours. At your current billing rate of 16 cents per kilowatt-hour, you're

paying around \$4.85 per month which is lower than the average in California Would you like to do omething else, like perform a devic energy audit?

Which device you want to check?

Figure 5: Alexa conversation illustrating

individual device auditing.

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Figure 4: CPEA conversation, Initial prompt (A), command to check total usage (B), usage data (C), and cost estimate(D).

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ing Estimation: \$40.22/Mont

**Developed Solutions (cont'd)** 

Processor Queue Figure 8: Architecture diagram for energy auditing systems

## **Conclusion & Future Developments**

These applications were developed successfully and are flexible to changes in backend structure, provided the application-layer protocol is maintained. Future developments include:

- Management of environment-based device automation.
- Implementation of user profile handling
- Further use of common IoT and data security measures

