Project Proposal: Energy Consumption Advisor Agent

Team Members

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Summary

We propose developing an Energy Consumption Advisor Agent that helps households manage electricity usage under time-of-use (TOU) pricing and monthly energy budgets. The agent will monitor appliance usage such as EV charging, dishwasher, washer/dryer, and HVAC systems within comfort bounds. Using artificial household energy usage profiles, TOU tariffs, and user-defined constraints (kWh/month usage constraints), the agent will perceive current usage and deadlines, decide on the best scheduling strategy (e.g., greedy heuristics), and suggest appliance schedules and HVAC settings. A Streamlit application will be used to demonstrate via dashboard the agent's scheduling, budget tracking, and cost savings compared to baseline scenarios.
With the rise of energy costs in households and environmental concerns due to wasting electricity, our proposal aims to help with these problems that are currently going on in the world. Our goal is to be able to successfully develop this program that can optimize a schedule to reduce the use of electricity and costs. Our project also demonstrates how AI can be used to help with these real-world problems by managing electricity usage more efficiently.

Core Design

Our project uses a day-ahead rolling planner. The agent looks at the current state of a household (i.e. which appliances need to run, how much energy has been used, current TOU prices), and decides on the best schedule for the next 24 hours. We model this process using a Markov Decision Process (MDP). States represent a household's status (i.e. energy usage, temp, deadlines). Actions are scheduling choices, like **Dishwasher_Start** or **Thermostat_Decrease**. Rewards reflect electricity cost and user comfort. A constraint controller makes sure hard rules like staying withing temperature limits are not broken. A heuristic scheduler helps the agent find near optimal schedules based on energy prices and user settings. A budget controller to compare month to date kWh trajectory and tighten or relax daily caps.

In addition, we are adding a reasoning and explanation module so the agent can describe why it made certain choices (i.e. "The dryer was scheduled at 10 p.m. to avoid the peak TOU charges from 7-9 p.m.). These explanations are generated using rule-based logic linked to the agent's decision variables. For each scheduling action, the system stores the key reasoning factors and then maps them to short natural-language templates. The explanations will be displayed alongside each action in the dashboard for users to see the reasoning process behind each action.

Performance Measure	- Minimize daily/total cost - Stay under monthly kWh budget - Maintain comfort bounds (HVAC) - Minimize user disruption - 0 missed appliance deadlines- limit schedule churn - planner completes in < 5 s for a 24-hour horizon. - Explanations are clear
Environment	- Household with flexible loads (EV, washer, dryer, dishwasher) - HVAC system with comfort ranges - Time-of-use tariffs
Actuators	- Schedule appliances start/stop times - Set EV charge rates - Adjust HVAC setpoints within comfort bounds
Sensors	- Time-of-use prices - Current usage & month-to-date kWh – Appliance deadlines and user preferences – comfort bounds

Expected Outcomes

A fully functional Energy Consumption Advisor Agent that demonstrates an ability to reduce electricity costs while staying under a user-specified monthly kWh budget. The agent will schedule appliances to avoid high TOU prices, adapt daily usage to meet monthly caps, balance cost savings with user comfort bounds, and include explanations for each scheduling decision.

In our final presentation, we will demonstrate the Streamlit app dashboard with daily schedules, budget tracking, side-by-side comparisons of baseline vs. agent-involved energy use, and metrics such as cost savings percentage.

Realistic target:

- ≥ 15% cost reduction vs. a baseline; 0 missed deadlines; 0 comfort violations; monthly budget within ±2% Magin of error.

Best-case:

- 20–30% cost reduction, stable schedules, and explanations users rate as clear (≥ 4/5) in a quick check.

Evaluation Plan:

- Baselines: (a) immediate starts, (b) fixed windows, (c) greedy cheapest-slot (no budget controller).
- Scenarios: week-long sims with weekday/weekend TOU, tight vs. loose EV deadlines, and comfort-bound sensitivity.
- Reported metrics: % cost saved, budget errors, comfort/deadline violations, schedule churn, runtime.

Scope & Risks:

- Scope: single household; day-ahead rolling; no hardware control; solar is stretch.
- Risks & mitigations: MILP too slow → coarser time steps + warm-starts + heuristic fallback; unrealistic bounds → calibrate and run sensitivity analysis.