UC SANTA BARBARA AgMonitor

SmartGrid

Kaiwen Li, Alex Mei, Jasun Chen, Jayden Yu, Yuyuan Wang | Advisors: Thomas Kuo, Olivier Jerphagnon

Motivation

- Power shutoffs are frequent, impacting millions of customers yearly.[1]
- Solar+Storage systems provide a cost-effective way to weather power shutoffs.[2]
- Used efficiently, Solar+Storage can reduce greenhouse emissions to fight climate change.
- Current microgrid auto-management tools are based on human-engineered heuristics, which lack the flexibility to provide personalized recommendations.[3]

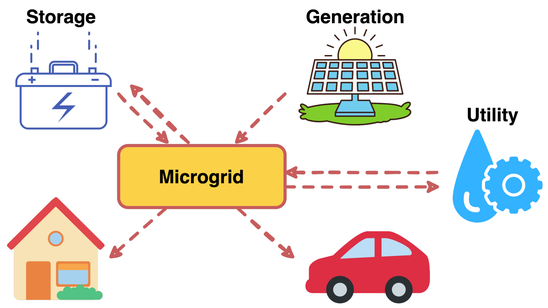
Research Questions

- What should the battery threshold be?
- How should you schedule flexible loads?

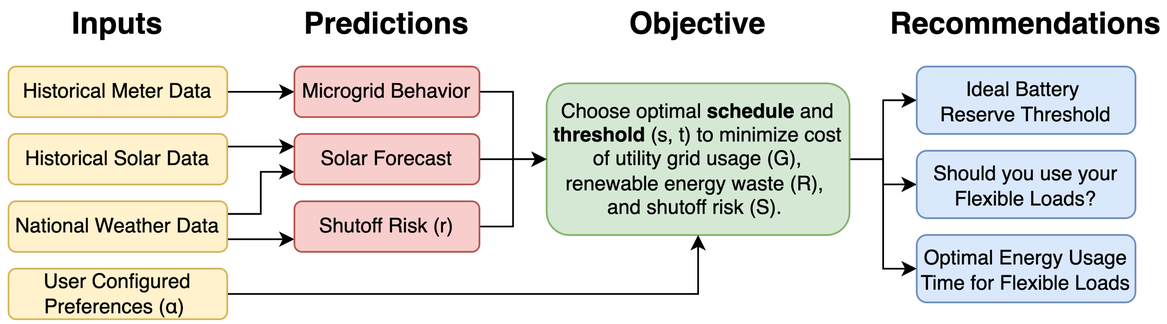
Solution

- Interpretable AI-optimized personal energy management recommendations.
- Historical microgrid usage visualization.

Microgrid Setting



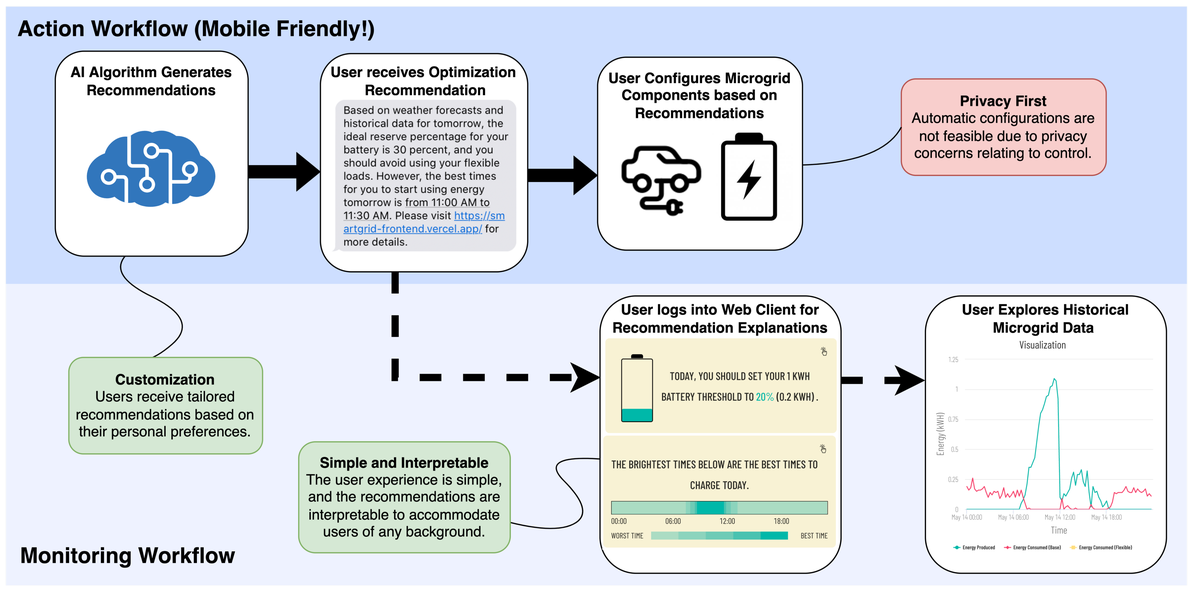
AI Optimization Deep Dive



$$Cost(s,t) = \alpha_1\lambda_1 G(s,t) + \alpha_2\lambda_2 R(s,t) + \alpha_3\lambda_3 S(p(s,t))$$

$G(s,t)$ computes the normalized cost of utility grid usage by schedule s and threshold t.
$R(s,t)$ computes the normalized cost of renewable integration waste by schedule s and threshold t.
$S(p)$ computes the cost of a power shutoff using shutoff risk and backup power $p(s,t)$.
α_i, λ_i are hyperparameters based on user preferences and mathematical optimization respectively.

- Methodology: linear combination of features for model simplicity and interpretability.
- Training: finetune hyperparameters λ_i using historical data.
- Recommendations: minimize cost with respect to schedule and threshold.



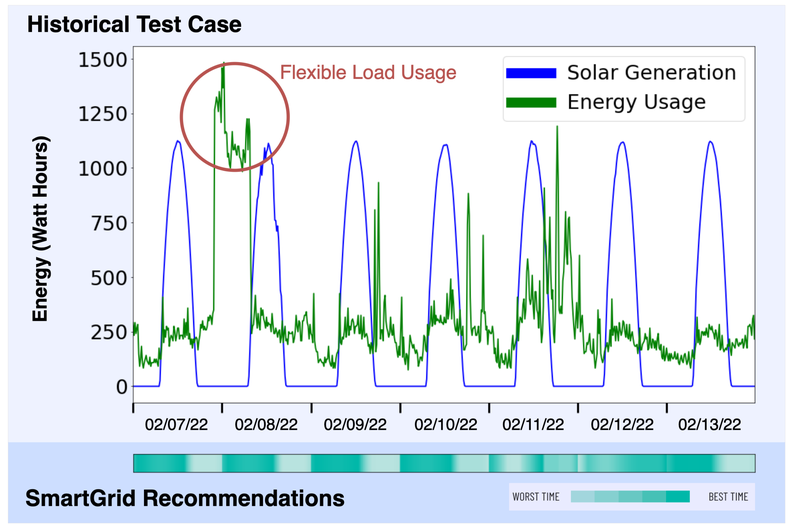
Results

- We define the following evaluation metric for energy usage:

$$SelfSufficiency = 1 - \frac{utility_{consumed}}{total_{consumed}}$$

	Self Sufficiency
Current Utilization	91.9%
Smart Grid	98.5%*
Theoretical Optimal	100.0%

*average expected performance over a week



Technologies

heroku docker django PostgreSQL

1. nytimes.com/2019/10/23/business/energy-environment/california-power.html
2. energy.gov/eere/solar/solar-integration-solar-energy-and-storage-basics
3. tesla.com/support/energy/tesla-software/microgrid-controller