What should the battery threshold be?

How should you schedule flexible loads?

**Research Questions**

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

**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

**Solution**

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

**Microgrid Setting**

- **Storage**:
- **Generation**:
- **Utility**:
- **Base Load**:
- **Flexible Load**:

**AI Optimization Deep Dive**

**Inputs**

- Historical Meter Data
- Historical Solar Data
- National Weather Data
- User Configured Preferences (α)

**Predictions**

- Microgrid Behavior
- Solar Forecast
- Shutoff Risk (r)

**Objective**

Choose optimal schedule and threshold (s, t) to minimize cost of utility grid usage (G), renewable energy waste (R), and shutoff risk (S).

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

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(s, t)) computes the cost of a power shutoff using shutoff risk and backup power p(s, t).

\(\alpha_i, \lambda_i\) are hyperparameters based on user preferences and mathematical optimization respectively.

- **Methodology**: Linear combination of features for model simplicity and interpretability.
- **Training**: Finetune hyperparameters \(\lambda_i\) using historical data.
- **Recommendations**: Minimize cost with respect to schedule and threshold.

**Results**

We define the following evaluation metric for energy usage:

\[
Self\text{Sufficiency} = \frac{\text{utility consumed}}{\text{total consumed}}
\]

- **Current Utilization**: 91.9%
- **Smart Grid**: 98.5%*
- **Theoretical Optimal**: 100.6%

*average expected performance over a week

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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