Smart Home Energy Scheduling Using MATLAB-Based DSM Optimization

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Abstract—**The rapid growth in electricity demand and the increasing integration of renewable energy sources require smart and efficient utilization of electrical power. This project presents a Demand-Side Management (DSM) program for residential consumers using an optimization-based approach. The system schedules household electrical loads dynamically according to electricity tariff variations, user preferences, and available renewable power. MATLAB-based optimization algorithms are used to minimize electricity cost and peak load while ensuring user comfort. The proposed smart scheduling mechanism helps reduce energy bills, improves load balancing on the grid, and enhances sustainability in modern smart grid environments.**

I. INTRODUCTION

Modern smart grids emphasize efficient energy utilization, reliability, and integration of renewable energy. Traditional power consumption patterns lead to peak load challenges, energy wastage, and increased electricity cost. Demand-Side Management (DSM) is a strategic approach that influences consumer energy usage patterns to achieve better load distribution. The DSM system enables the shifting of flexible loads from peak periods to off-peak periods by applying optimization-based load scheduling.

This project focuses on developing an Optimization Algorithm-Based DSM Program for residential households. MATLAB simulation is used to analyze load shifting efficiency, electricity cost savings, and reduction of peak demand.

II. LITERATURE SURVEY

Author / Year	Method / Technique Used	Key Contribution	Gap Identified
Pal & Bandyopadhyay (2019)	TOU Pricing + Load Scheduling	Reduced peak demand in residential grids	Comfort constraints not fully addressed
Siano (2020)	Optimization-Based DSM	Improved grid reliability	Limited renewable prediction accuracy
Ali et al. (2021)	Genetic Algorithm for DSM	Improved scheduling efficiency	Higher computation time
Kumar & Verma (2022)	MILP-Based Smart Home Scheduling	Achieved cost reduction	Battery integration not considered
Patel & Shah (2023)	Hybrid Optimization DSM	Enhanced peak reduction and renewable use	Real-time simulation still challenging

III. PROBLEM IDENTIFICATION

- Increasing peak demand during high-load hours causes instability in power systems.
- Traditional consumers are unaware of dynamic pricing, leading to higher electricity bills.
- Renewable energy availability is variable and often underutilized.
- Manual load control lacks efficiency and leads to uneven load profiles.

IV. OBJECTIVES

1. To develop an efficient DSM scheduling algorithm for residential loads.
2. To minimize total electricity cost based on time-of-use pricing.
3. To reduce peak load demand and enhance grid stability.
4. To efficiently utilize renewable energy sources (if available).
5. To validate the proposed model using MATLAB simulation.

V. METHODOLOGY

Step-by-Step Process:

1. Collect power consumption data of household electric appliances.
2. Categorize appliances (Essential / Flexible / Deferrable).
3. Obtain Time-of-Use (TOU) tariff data.
4. Apply optimization algorithm to schedule flexible loads.
5. Implement and simulate the system in MATLAB.
6. Compare pre-DSM and post-DSM performance.

Key Equation (Cost Calculation):

$$\text{Total Cost} = \sum_{t=1}^{T} P(t) \times C(t)$$

Where:

- $P(t)$= Power consumed at time interval t
- $C(t)$= Tariff rate at time interval t

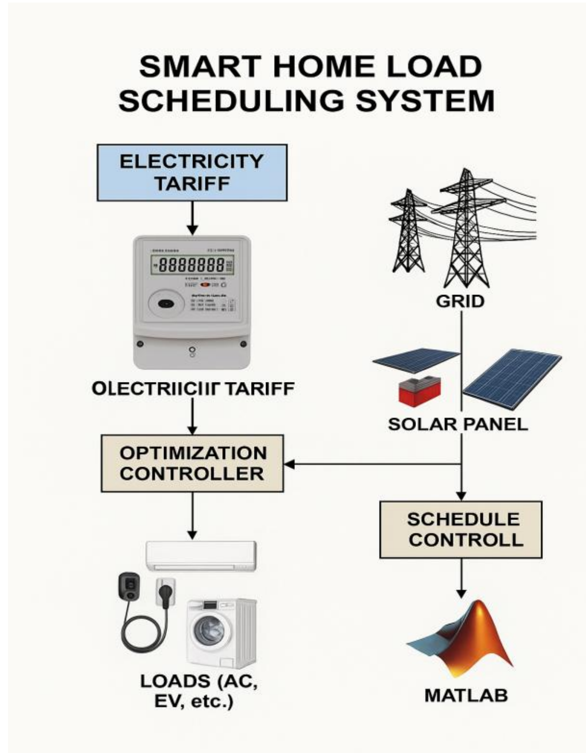
Load Optimization Objective:

$$\min(\alpha \cdot \text{Total Cost} + \beta \cdot \text{Peak Demand})$$

Where $\alpha$and $\beta$are weighting factors.

VI. BLOCK DIAGRAM

Smart Home Load Scheduling System



VII. SIMULATION DIAGRAM

(To be drawn in MATLAB Simulink or MATLAB flowchart style)

It includes:

- Input load profiles
- Tariff signal
- Optimization block
- Controlled load output

VIII. SIMULATION RESULT

- The optimized schedule shows shifting of flexible loads from peak-hour to off-peak-hour.
- Reduction in energy cost observed compared to traditional load usage.
- Peak load curve becomes smoother after DSM implementation.

Example Result Statement:

Parameter	Before DSM	After DSM
Daily Energy Cost	High	Reduced
Peak Demand	High	Lower
Load Profile	Uneven	Balanced

IX. JUSTIFICATION

The proposed DSM system effectively reduces electricity cost and peak demand using MATLAB-based optimization. This demonstrates practical feasibility and improves grid efficiency without affecting user comfort. Thus, the approach is justified technically, economically, and environmentally.

X. CONCLUSION

The project successfully demonstrates a Demand-Side Management scheduling program that optimizes residential load usage. Optimization algorithms effectively shift flexible loads to low-tariff periods, reducing total energy cost and peak load stress on the grid. MATLAB simulation results verify the performance of the proposed model.

XI. FUTURE SCOPE

- Integration with real-time IoT-based smart meters.
- Addition of Machine Learning for load forecasting.
- Integration of rooftop solar and battery storage systems.
- Cloud-based dashboard for user-friendly monitoring.
- Expansion to community-level smart microgrid DSM.