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**Topic of Research:** Demand Side Management in Smart Grid Environment for Optimal Energy Usage

## FINDINGS

The findings from this PhD thesis on Demand Side Management (DSM) in Smart Grid environments emphasize the effectiveness and potential of advanced optimization techniques and innovative methodologies in improving energy efficiency and sustainability. The study's application of particle swarm optimization (PSO) for scheduling home appliances demonstrated significant reductions in power costs, highlighting the efficiency of Time of Day (TOD) pricing over Marginal Cost Pricing (MCP). This optimization framework efficiently scheduled appliance operation times, integrating renewable energy sources for comprehensive load management.

The research also introduced a data-driven approach to demand side management in microgrids connected to electric vehicles (EVs), employing Genetic Algorithm and Sperm Swarm Optimization (GASSO). This method showed a reduction in reliance on conventional electricity during daytime, enhancing microgrid reliability and reducing greenhouse gas emissions. Integrating EVs into the main grid through vehicle-to-grid (V2G) technology further reduced power loss and improved renewable energy integration, underscoring the critical role of optimization in distributed generation.

An intelligent DSM paradigm incorporating renewable energy integration was proposed, leveraging fuzzy logic and a hybrid GA-PSO optimization technique. This system significantly reduced energy costs and improved overall efficiency, promoting consumer engagement and sustainable practices within smart grids. Additionally, the study highlighted the benefits of the vehicle-to-home (V2H) concept in residential microgrids, particularly under varying climate conditions. EVs supported renewable energy utilization, reduced grid dependency, and provided financial benefits to homeowners by optimizing energy storage systems.

Collectively, these findings contribute to the field of DSM in smart grids by showcasing the efficacy of advanced optimization techniques and the integration of EVs in reducing power loss and enhancing renewable energy use. The intelligent load management systems developed in this study empower consumers and foster an interactive, reliable grid. The research emphasizes the importance of economic efficiency and environmental sustainability, providing valuable insights and strategies for future advancements in energy management systems.

**Keywords:** Demand Side Management, Renewable Energy Integration, Microgrid, Smart Grid, Electric Vehicles