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A CRITICAL STUDY ON ENERGY MANAGEMENT FRAMEWORK

CANDIDATE NAME = SHILPA SARAF
DESIGNATION = RESEARCH SCHOLAR SUNRISE UNIVERSITY ALWAR
GUIDE NAME = DR. SONAL SINGLA
DESIGNATION = ASSOCIATE PROFESSOR SUNRISE UNIVERSITY ALWAR

ABSTRACT

The demand for energy continues to rise alongside global economic growth and urbanization, leading to increasing environmental concerns and resource constraints. In response, the development of effective energy management frameworks has become crucial for optimizing energy usage, enhancing energy efficiency, and mitigating environmental impacts. This abstract presents a comprehensive overview of an integrated energy management framework designed to address these challenges and promote sustainable resource utilization. The proposed energy management framework leverages the latest advancements in data analytics, artificial intelligence, and smart technologies to monitor, control, and optimize energy consumption across various sectors. It aims to provide decision-makers with real-time insights into energy consumption patterns, demand trends, and potential areas of improvement. By integrating data from smart meters, IoT sensors, and energy management systems, the framework offers a holistic view of energy utilization at different scales, from individual buildings to entire cities.

Keywords: - Energy, Economic, Management, Power, Decision-maker.

I. INTRODUCTION

This chapter suggests an energy management framework with a brand-new target function for home power distribution systems that may plug in electric vehicles. We demonstrate a typical home radial distribution network with local renewable-based power systems and electric car owners. Based on the information gathered from Calicut, Kerala, India, a thorough case study has been undertaken. The best results are derived using the mixed integer linear programming optimization approach for scheduling residential loads. To assess the acquired ideal outcomes, techno-economic parameters, including DAIE, DAEE, DADE, ACE, ADEE, DAEL, and DASH, are employed. DADE, ADEE, and DASH are three of the seven factors that are newly suggested in this thesis. The case study findings are contrasted with the typical goal functions mentioned in the literature. For the comparison, the average rank ranking technique is utilized. For residential customers, a way has been created to change the current block rate pricing to the ToD tariff. With the aid of this tariff conversion, the customary objective function in the techno-economic comparison that is based on energy costs may be evaluated successfully. On the findings of the load scheduling, several parameters are subjected to sensitivity analysis. At the conclusion of this chapter, the benefits of the suggested goal function presented in the framework for energy management are explored.

II. PROPOSED OBJECTIVE FUNCTION

Customers are encouraged to generate power locally using renewable resources, store it in batteries for electric vehicles, etc. However, the intermittent nature of the electricity produced by renewable energy sources and the possibility that an EV battery may not always be present in the house make the support of the utility grid for residential consumers necessary. The management of local sources accessible at the consumer side with an external electrical network has been documented in the literature using a variety of approaches with distinct aim functions. In this thesis, a novel objective function for residential energy distribution systems connected to electric vehicles is developed with the goal of addressing the drawbacks of current objective functions as stated in the literature analysis. This objective function is intended to benefit both utility companies and consumers. The idea of energy self-sufficiency served as the foundation for the suggested goal function. A consumer may be considered energy self-sufficient if they want to control their demand by using their own production with the least amount of energy exchange with the external electrical network.

- **Benefits for the residential consumer**

The key advantages that the suggested goal function offers to the home customer are covered below.

1. Lessens the amount of energy that is exchanged with the utility grid, making the customer energy independent.
2. More renewable energy may be used by their own loads as they are using more renewable energy to suit their own needs.
3. Encourages installation of renewable power plants with maximum capacity, which is required to satisfy the majority of domestic load requirements. This might result in greater financial savings when installing small-scale renewable energy sources at home.

- **Benefits for the utility grid**

1. The utility grid's primary advantages according to the suggested goal function are listed below.
2. As residential consumer exports decline, energy penetrations into low voltage distribution networks become less unpredictable.
3. There will be less enforcement to restrict energy penetrations from the residential sector, which will improve consumer understanding of the promotion of renewable energy programs.

III. SYSTEM UNDER STUDY

Residential customers are often divided into Low Income Groups (LIG), Middle Income Groups (MIG), and High Income Groups (HIG) based on their respective income levels. Residential users who own electric cars and rooftop solar PV systems are the subject of the study effort that is being suggested. These amenities can currently only be owned by HIG residential customers in India. A home customer served by a radial distribution network is taken into consideration in order to illustrate the energy management framework with the suggested goal function, as shown in Fig. 1. At Inter Connection Points (ICP), it is expected that several home users are linked to the same distribution network and that they each independently use the same energy management framework. At the Point of Common Coupling (PCC), the feeder is

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also linked to the secondary of the distribution feeder. In this analysis, the utility grid, EVs, critical loads, suitable loads, rooftop solar PV plants, and critical loads are all taken into account.

Roof-top solar PV plant

The home customer under consideration has a solar PV system on their roof. An inverter module is used to support the plant and distribute solar PV plant electricity to AC loads. The power plant's maximum and lowest outputs are represented by PRE(max) and PRE(min), respectively. The inverter module is expected to have the capacity to distribute all the electricity generated by the solar PV system.

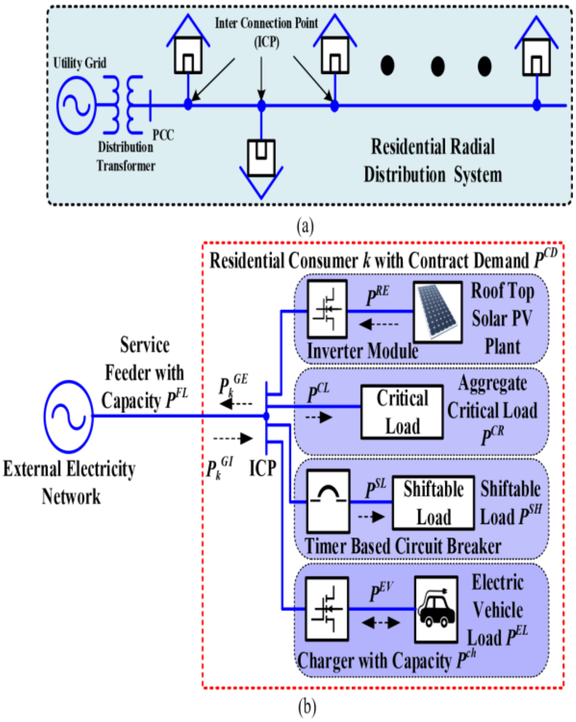

Fig. 1 System under study (a) Radial distribution feeder with residential consumers

Critical loads

The home consumer's total critical loads are shown as PCR, whereas the actual served load is shown as PCL. The energy management system is unable to handle all of the consumer's important loads if PCL > PCR. According to the preferences of residential customers in the High Income Group, the important loads are categorized.

Shiftable loads

PSH is the amount of shiftable load that needs to be supplied, and PSL is the amount of shiftable load that has already been provided, therefore PSL PSH. The energy management framework aims to fully satisfy the shiftable load in accordance with the consumer's predetermined preferences.

Electric vehicles

For the domestic user, charging the EV battery might be seen as an energy-intensive load. A power electronic converter-based charger unit with a capacity Pch is used to charge the electric vehicle battery. The beginning and ending times when the electric vehicle (EV) is accessible at home for charging are represented by tSev and tEev, respectively.

External electricity network

With the use of an external electrical network, such as a utility grid, the home consumer is able to satisfy their energy needs and export any excess energy that is not being used. Let PFL and PCD represent, respectively, the contract demand of the customer with the utility company and the capacity of the distribution feeder.

IV. CONCLUSION

In conclusion, the presented abstract highlights the significance of an integrated energy management framework as a powerful tool for addressing the growing challenges of energy consumption, efficiency, and environmental sustainability. With the rising global demand for energy, it has become imperative to develop robust solutions that

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optimize resource utilization, minimize environmental impact, and ensure long-term energy security.

The proposed framework, leveraging cutting-edge technologies like data analytics, artificial intelligence, and IoT, offers a comprehensive approach to energy management. By collecting real-time data and analyzing historical patterns, the framework enables accurate predictions of energy demand, fostering proactive strategies to optimize energy consumption during peak periods. Additionally, the incorporation of energy optimization techniques, such as demand response and energy storage integration, contributes to grid stability and cost reduction.

Moreover, the integration of sustainability principles, including the utilization of renewable energy sources, further reinforces the framework's positive impact on the environment. By reducing carbon emissions and promoting eco-friendly practices, the framework aligns with global efforts to combat climate change and achieve a greener, more sustainable future.

The successful implementation of this integrated energy management framework holds great promise in a wide range of sectors, from individual buildings and industries to entire cities and nations. By empowering stakeholders with actionable insights and decision support, the framework enables informed choices to achieve energy efficiency goals, reduce operational costs, and enhance overall environmental responsibility.

In conclusion, this abstract underscores the potential transformative role of an integrated energy management framework in shaping a more sustainable, energy-efficient, and resilient world. By fostering collaborative efforts between various stakeholders, including governments, businesses, and communities, we can collectively work towards a brighter, greener, and more prosperous future for generations to come.

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