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DEMAND SIDE MANAGEMENT AND DEMAND RESPONSE FOR OPTIMAL ENERGY USAGE: AN OVERVIEW

KEY WORDS: Demand response; demand side management; residential sector

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ABSTRACT

Being more than a decade old idea, the Demand-side management (DSM) is among the most vital part of the modern smart grid. DSM enables the utilities to minimize the gap between the supply and the demand by optimizing their pattern of user loads. At the same time, it helps them in achieving economic and energy efficient systems by reducing the peak to average (PAR). The implementation of DSM programs by the utilities could help them in improving their reliability, power quality, energy, and system efficiency. On the other hand, customers could be use it to improve their load profile, reduce the peak demands, save energy, and motivate them use more and more renewable energy. Thus, both the utilities and the consumers get benefitted by the implementation of DSM program in the smart grid. This study tries to understand the application of energy efficient policies and the demand response techniques with various DSM strategies. The study mainly focuses on the various characteristics that would lead to effective implementation of DSM programs with particular attention of the residential energy demand. Also, there will be a focus on enhancement of energy efficiency leading to more effective policy responses. The researchers could find this study very helpful as it could be employed to maximize the utility profits, the total load factor, peak demand and also minimize the consumer usage bills.

INTRODUCTION

With the ever-increasing energy needs and complexity of systems, the need for demand response programs has become an important part of modern-day smart grid for efficient energy utilization. DSM techniques could encourage the consumers to reduce electricity bills and use the energy more efficiently by optimizing their energy usage.

Over the last few decades, policies and initiatives aimed at reducing energy demand have been used to address concerns such as rapid growth of power demand and the need for an economical, and secure power supply [1].

Thus, the demand related policies targeting the energy usage pattern and the impact quantities make for the demand related policies and comprise of mainly two things i.e., the demand side response (DSR) and the energy efficiency policies. The application of these programs in the modern smart grid help in reducing the infrastructural investments, increasing the energy security, reducing the ecological impact and additional benefits.

In addition to the above, the restructuring of the electric grid network by integrating the renewable based energy to the grid in order to support the demand side management leads to more complexity in the analysis because to the new relevant constrains [2].

A vital role is played by the residential customer base in the energy demand and for the better customer satisfaction, the application of DSM programs becomes necessary. There are numerous benefits of integration of demand response programs in the smart microgrid.

Both the utilities and the customers get benefitted financially by the emerging energy market. The distribution energy performance could be enhanced by the integrating the renewable energy and its proper utilization in the distribution network with the help of the demand response management [3,4,5].

The advantages of the demand side management based on various parameters could be summarized in the Figure 1.

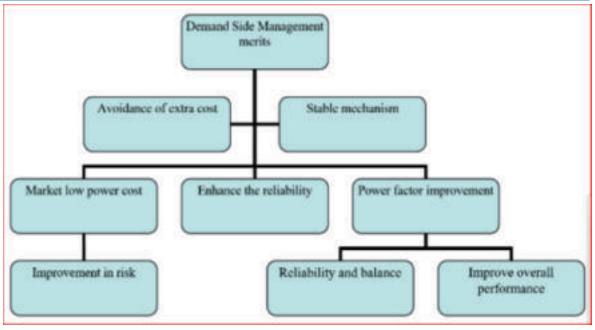

Figure 1: Merits of DSM techniques

As illustrated by [6], according to a latest survey, the residential sector's total energy consumption is nearly 20 – 30 % of the world's total energy requirement.

This article presents a survey on demand response plans in residential sector. The main characteristics of the energy demand of residential sector are given in the section 2. The constraints to the efficient energy utilization in residential segment are given in section 3. Section 4 gives an account of various demand response schemes. Section 5 gives an insight of possible future work on the given subject and conclusions are given in Section 6.

Characteristics Of The Energy Demand Of Residential Sector

The key objective of the demand response is the motivation of the customers to consider the alteration of their usage pattern of the energy, thus, making the overall system efficient by varying the overall system response. Presently there are numerous demand response schemes which could be classified broadly either into price-based or incentive-based DR schemes. Few of these DR schemes could be called with different names [5,6,7,8] like economic and emergency-based DR schemes, marked led and system led DR schemes, indirect and direct DR schemes.

Obstacles To Achieving Efficiency In Residential Energy Sector

As a market failure point of view, poor data, the lack of a market that do not respect the client's best interests are the major impediments. Second, from a market barrier standpoint, the enormous proportion of investment cost to total savings on energy. Low energy issues are two important roadblocks to overcome in the approach of behavioral economics. Apart from the aforementioned issues, successful DSM implementation in the home energy sector must also overcome political and institutional obstacles.

Demand Response Schemes

In case of price-based DR schemes, the utilizes generally offer the customer different charges for various period slots which motivates the customers to change their usage patterns and thus reduce their bills by going for economic usage patterns. Such DR schemes consist of Time of Use (ToU), Real-Time-Pricing (RTP) and Critical Peak Pricing (CPP). The CPP DR scheme is based on static rates and could either be non-dispatchable and dispatchable. On the other hand, TOU DR scheme and the RTP DR scheme are based on variable rates and both of them are non-dispatchable. All the above demand response schemes are implemented on customer side [9,10,11]. Though these schemes are very effective in achieving their purpose and primarily reducing the customer side bills, there still are some limitations to these DR schemes and there is a room for further research in this field.

Now, in case of incentive-based DR schemes, customers are attracted to change their energy usage patterns by offering them incentives for consumption at particular time slots. These incentives encourage the consumers to achieve overall efficiency in the energy usage by changing their usage patterns and in the end reducing their bills. These incentive-based DR schemes mainly include demand bidding schemes, interruptive tariff rates, direct load control schemes and emergency programs. All the above incentive-based DR schemes except demand bidding program are based on static rates while all of them are dispatchable. Among these four DR schemes, demand bidding and interruptive tariff rates are implemented at the customer side while the remaining two schemes are implemented at utility side. These incentive-based DR schemes have their own merits and demerits and working on their demerits have a future scope in research [5].

For achieving the demand response schemes the load planning and scheduling are very essential. There are mainly two types of customer loads, i.e., the shiftable and non-shiftable loads, depending on the nature of the load type. Three types of control strategies are commonly used to regulate DR systems, depending on the situation: hierarchical, centralized and distributed [12,13].

The successful deployment of DR relies on information & communication technology (ICT). As a preventive precaution and protection to improve quality of power, dependability, and reduce the likelihood of blackout incidence. The two-way communication lets both consumers and utilities cooperate for improved load management by providing information about DR events [5,14,16].

Future Research Work

I. New methodologies must be investigated from a variety of perspectives in the residential DSM application.
ii. Even though various optimization strategies for DSM concerns have been developed in recent years, many new issues have arisen as a result of the rapidly changing power environment in the residential sector.
iii. Lower electricity costs, and emissions reductions will all be significant DSM goals.
iv. In recent years, individual analysis with a small cluster have received a lot of attention. In the future, objective functions representing grid challenges like decreasing customer top demand, limiting network losses and corresponding delivery group to the grid should be included in future study
v. Allowing users to participate in market operations by feeding surplus energy from installed DERs back to the grid could be a promising area for future growth.

CONCLUSION

The following conclusions could be drawn from this review study.

i. The future plan focuses mostly on load unstable strategies to plan loads that could handle a diversified load.
ii. Improving the communication structure, measurement for AMI schemes in smart home is required to successfully use DSM approaches.
iii. In dynamic electric price situations, the load outline has a significant influence on the power management scheme, resulting in total low power consumption.
iv. During the analysis and formulation, issues in security in smart grid-based DSM must be taken.

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