Demand Side Management in Future Smart Grids: A Review

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Abstract—Demand Side Management (DSM) will play an important role in future smart grids as it will be based on bi-directional flow of data and power. It will manage the load in smart way. This paper presents a review of DSM and its various aspects in future smart grids. Paper covers smart metering, optimal load scheduling and cyber-physical power infrastructure.

Keywords- Smart Grid, Demand Side Management, Optimal Scheduling, Smart Meters, Cyber-Physical Power Infrastructure.

I. INTRODUCTION

Mankind has reached to new heights of prosperity and progress with several new and renewable forms of energy, however, conventional fossil fuels based energy resources are declining with alarming environmental concerns. In order to manage the use of natural resources in a smart way, we need to enhance the ratio of alternative renewable sources in primary energy mix along with better load management. It will ensure the sustainable development of mankind. Thousands of electrical and electronics appliances and equipment are working in our daily life. Some of them are very important to remain on all the time but some of these equipments may be used randomly. If we can limit our load and manage our household and office equipment in smart manner, we can reduce the consumption of electrical energy and thus ensuring peak load shaving.

Demand Side Management (DSM) deals with affecting the users’ energy consumption behavior through different schemes and incentives. This paper presents a review of DSM and its various aspects in future smart grids. Paper covers smart metering, optimal load scheduling and cyber-physical power infrastructure. Section II is dedicated for introduction of smart grid and section three presents the DSM review. Conclusions are drawn in section IV.

II. SMART GRID

The electric power grid is a highly interconnected system, considered by many as one of the 20th century’s greatest engineering feats [1]. Still, changing power supply and demand are motivating challenges in this system; this ongoing modernization is often called the “smart grid.” This process has many drivers, such as reliability and efficiency, and many potential benefits—for example, minimizing climate impact by making it easier to incorporate renewable energy sources such as geothermal and wind power, and increased consumer participation. The smart grid uses intelligent transmission and distribution networks to deliver electricity. This approach aims to improve the electric system’s reliability, security, and efficiency through two-way communication of consumption data and dynamic optimization of electric-system operations, maintenance, and planning.

[2] The electric grid is considered an engineering marvel; still a new kind of electric grid is being developed which comprises of additional features provided by the Information and Communication Technology (ICT). Smart Grid is characterized by a two-way flow of electricity and information with the incorporation of a smart energy meter. It supports the real time online electricity billing concept. Optimal scheduling of the appliances is proposed for efficient energy management of residential customers that promises a well-balanced load curve.

III. DEMAND SIDE MANAGEMENT

[3] In a smart grid network, demand-side management plays a significant role in allowing consumers, incentivized by utilities, to manage their energy consumption. This can be done through shifting consumption to off-peak hours and thus reducing the peak-to-average ratio (PAR) of the electricity system. In this paper, Authors have proposed a demand-side energy consumption scheduling scheme for household appliances that considers a PAR constraint. An initial optimization problem has been formulated to minimize the energy cost of the consumers through the determination of the optimal usage power and operation time of throttle able and shift able appliances, respectively. They say that the acceptance of consumers of these load management schemes is crucial to its success. Authors introduce an optimization problem which not only minimizes the energy cost but also minimizes the inconvenience posed to consumers. In addition to solving the proposed optimization problems in a centralized manner, two distributed algorithms for the initial and the multi-objective optimization problems are also proposed. Simulation results show that the proposed demand-side energy consumption schedule can provide an effective approach to reducing total energy costs while simultaneously considering PAR constraints and consumers’ preferences.
Furthermore in future, they have a plan to extend their work in several directions. Firstly they are willing to design dynamic pricing or other incentive schemes that can better manage the demand response. Secondly, they intend to extend their model system to scenarios where the stability of the power supply may be influenced by renewable energy sources in the system. In that case, new constraints can be added in the optimization problem to cover the unstable and intermittent characteristics of renewable energy sources. Lastly they want to design a real-time distributed energy management strategy for consumers to schedule their consumption individually when they only know the local knowledge of current demand conditions and the provided price plan.

[4] Demand side management (DSM) is an important technique for demand response (DR) system in smart grid networks. The DSM techniques traditionally have focused on minimizing electricity bill or peak load. More recent work reveals that users wish to reduce their electricity bills without sacrificing user convenience. Hence, waiting time has been introduced to reflect the user comfort for the DSM. Residents usually preferred that finish their work as soon as possible than less waiting time. These techniques have not taken previous usage pattern consideration, thus have been limited for use in home appliances. Authors proposed a system architecture and an algorithm for DSM referred to as user-friendly DSM (UDSM) using ICT. The UDSM is based on time-varying price information considering the following three-fold factors: electricity bill, usage pattern, and rebound peak load. This proposed algorithm is divided into two steps. In the first step, an objective function has been formulated based on electricity bill and usage pattern, and we minimize the electricity bill and maximize the usage similarity. In second step, there is an application of a load balancing algorithm to avoid blackout and to minimize rebound peak load. The algorithm is based on real data from Jeju Island’s smart grid test site, and experimental results validate the proposed DSM scheme shifts the operation to off-peak times and consequently leads to significant electricity bill saving and user satisfaction ratio.

In this paper, Authors emphasize on efficient automated demand-side management system of smart-grid. They design a convex optimization problem to satisfy demand-side management. The first object is to minimize electricity bill. And the second object is to follow usage pattern. Using convex optimization, they certify that it schedule devices by Demand-side management.

[5] Authors have proposed a fully distributed Demand-Side Management system for Smart Grid infrastructures, especially prepared to reduce the peak demand of residential users. Especially they use a dynamic pricing strategy, where energy tariffs are function of the overall power demand of customers. They give two practical cases: First is a fully distributed approach, where each appliance decides autonomously its own scheduling and second a hybrid approach, where each user must schedule all his appliances. Numerical analysis of these two approaches; show that these are characterized practically by the same performance level in all the considered grid scenarios.

Their proposed model uses a non-cooperative game theoretical approach, and demonstrates that this game is a generalized ordinal potential one under general conditions. Further, they propose a simple yet effective best response strategy that is proved to converge in a few steps to a pure Nash Equilibrium, thus demonstrating the robustness of the power scheduling plan obtained without any central coordination of the operator or the customers. Numerical results, obtained using real load profiles and appliance models, show that the system-wide peak absorption achieved in a completely distributed fashion can be reduced up to 55%, thus decreasing the capital expenditure necessary to meet the growing energy demand. The results demonstrate that the proposed DSM system represents a promising and very effective solution to reduce the peak absorption of the entire system and the electricity bill of individual customers in a fully distributed way.

[6] Demand side management (DSM) in electricity markets can improve energy efficiency and achieve environmental targets through controlled consumption. For the last decade or so DSM programs have registered significant results. However, detailed analysis of its real impact as observed by a large number of pilot studies suggests that such programs need to be fine-tuned to suit clearly identified conditions. This paper provides recommendations for the instruments to be used to prompt demand response with a view to maximizing energy and environmental efficiencies of various countries. It also suggests that different DSM models should be deployed depending on the specific generation mix in any given country. Beside the natural benefits from cross borders infrastructures, DSM improves the flexibility and reliability of the energy system, absorbing some shock on generation mix. We show efficiency increases with demand response but at a decreasing rate. So, according to rebound and report effects, simple DSM tools could be preferred. The analysis made in this paper recommends that relying on DSM can be an efficient tool to achieve part of EU environmental and energy objectives. More precisely, five main policy recommendations emerge from this paper

1- Adopting DSM tools would help to reach EU energy policy in terms of energy efficiency
2- Simplest DSM tools are often sufficient to improve significantly energy and environmental efficiencies, and to move towards European objectives.
3- Beside the benefit of cross-borders infrastructures, DSM tools would bring to all countries strong positive energy efficiency
4- DSM tools can provide additional solutions to counter balance the shortfall in generation due to the expected phasing-out of less acceptable power plants.
5- Avoiding a strong rebound effect with medium intensity DSM or diffuse load-shifting would help to preserve energy and environmental gains.
[7] The electric energy distribution infrastructure is undergoing a surprising technological evolution with the development of the smart grid concept, which allows more interaction between the supply and the demand-side of the network and results in a great optimization potential. In this paper, Authors have focused on a smart grid in which the demand-side comprises traditional users as well as users owning some kind of distributed energy source and/or energy storage device. By means of a day-ahead demand-side management mechanism regulated through an independent central unit, the latter users are interested in reducing their monetary expense by producing or storing energy rather than just purchasing their energy needs from the grid. They used a general energy pricing model, to manage the grid optimization design from two different perspectives: a user-oriented optimization and a holistic-based design. In the first case, they optimize each user individually by formulating the grid optimization problem as a non-cooperative game, whose solution analysis is addressed building on the theory of variable inequalities. In second case, they focus on the joint optimization of the whole system, allowing some cooperation among the users. For both formulations, they developed distributed and iterative algorithms providing the optimal production strategies of the users, along with their convergence properties. Among all, the proposed algorithms preserve the users’ privacy and require very limited signaling with the central unit.

[8] Demand-Side Management (DSM) refers to programs that aim to control the energy consumption at the customer side of the meter. Different techniques have been proposed to achieve this. Perhaps the most popular techniques are those based on smart pricing (e.g., critical-peak pricing, real-time pricing). The idea, in a nutshell, is to encourage end users to shift their load consumption based on the price at a particular time (e.g., the higher the price, the less number of electric appliances are expected to be turned on). Motivated by these techniques (e.g., a strong positive correlation between the number of appliances being used and the electricity cost), Authors propose the use of stochastic evolutionary based optimization technique, Evolutionary Algorithms, to automatically generate optimal, or close to optimal, solutions that represent schedules to charge a number of electric vehicles (EVs) with two goals: one is that each EV is as fully charged as possible at time of departure, and second to avoid charging them at the same time, whenever possible (e.g., load reduction at the transformer level). Instead of using a price signal to shift load consumption, we achieve this by considering what all the EVs might do at a particular time, rather than considering an interaction between an utility company and its user, as normally adopted in DSM programs. They say that exploiting the interaction of these EVs is crucial at achieving excellent results because it carries the concept of smart pricing (e.g., balance energy usage), which is highly popular in DSM systems. Thus, the main contribution of this work is the idea of load shifting, borrowed from smart pricing methods, implemented in an evolutionary-based algorithm to automatically generate optimal solutions. In order to establish their proposed idea, they used a dynamic scenario, where the state of charge of each EV is different for every day of 28 days testing period. The results are highly encouraging. It shows that how it is possible to almost fully charge the EVs at the time of departure while at the same time it is possible to reduce the load consumption at the transformer level which is reflected in the reduction of peak to average ratio of load demand, which is a desired feature in smart grids. Moreover authors are planning to extend this work considerable i.e. they used a discrete valued representation in this Evolutionary Algorithm that indicates the (nearly) optimal scheduling that each EV should follow for a period of time to be as much charged as possible while reducing the transformer load.

[9] According to the Author “The electrical power system is now one of the most critical components of the infrastructure on which modern society depends”. It delivers electrical energy to industrial, commercial and residential consumers, meeting an ever-growing demand. To satisfy both the increasing demand for power and the need to reduce carbon emissions, we need an electric system that can handle these challenges in a sustainable, reliable and economic way. Development of Smart Grid technologies is accelerating, however the potential of the Smart Grid opportunity for solution providers is still unclear. Smart meters are often the first application deployed in the implementation of a Smart Grid, consequently, it is expected that in 2014 the numbers of Smart meters deployed reach 30 million. Furthermore, it is estimated that the global market potential for Smart Grid solution providers and equipment manufacturers will total somewhere between $15 billion and $3 billion annually by 2014, splitting the value along three main business segments: grid applications, advanced metering infrastructure and customers applications. Authors presented a possible application of software agents in the Smart Grid. By extending the Smart Home model to the level of an entire neighborhood, it should be possible to implement an agent-controlled Micro grid. As future work they will further develop the model presented in this paper by aggregating to the Smart Home model the micro generation system and the evolve the control system and the communication protocol between smart entities. The daily execution shift will be explored in future work, in a reward and penalty approach the appliance can be encouraged to operate in the daily execution shift in exchange of receive a reward, otherwise, the appliance can be free to choose operate in other daily shift however a penalty will be applied. They intend to study the different users’ profiles to understand the kind of customization that the smart system should perform to balance the demand considering the energy variation in the grid.
This Paper provides a new and nice work on Demand Side Management: Towards a Smart Cyber-Physical Power Infrastructure. According to authors the smart grid is becoming one of the fundamental cyber-physical systems due to the employment of information and communication technology. In the smart grid, demand-side management (DSM) based on real-time costing is an important tool for improving the reliability of the grid. Electricity retailers in the smart grid can procure electricity from various supply sources, and then sell it to the customers. Therefore, it is critical for retailers to make effective procurement and price decisions. In this paper, researchers propose a new game-theoretical decision-making scheme for electricity retailers in the smart grid by using real-time costing. In this model authors analyze the interactions between the retailer and electricity customers as a four-stage game. In the first three stages, the electricity retailer, as a leader, makes decisions on which electricity sources to procure electricity from, how much electricity to procure, and the optimal retail price to offer to the customers, to maximize its profit. In the fourth stage, the customers, who are the followers in this game, adjust their individual electricity demand to maximize their individual utility. Simulation results show that the retailer and customers can achieve a higher profit and higher utility using decision-making scheme. They analyzed that the system parameters affect the procurement and price decisions in the proposed decision-making scheme.

In order to strengthen the proposed concept researchers say that in a retail electricity market, retailers need to procure electricity from various electricity sources with different characteristics and then sell it to customers. Therefore, retailers need to make effective decisions about electricity sources, the electricity amount they procure and the price to offer to the customers. In the smart grid, real-time pricing DSM will be widely used to dynamically changing or shifting the electricity consumption, and new electricity supply resources might advert. Retailers need to consider the new characteristics of the smart grid when they make market decisions.

In this paper researchers have presented a unique concept of Decentralized demand side management of plug-in hybrid vehicles in a Smart Grid Researchers predict that in 2030, around 30% of all vehicles in Belgium will be plug-in hybrid electric vehicles (PHEVs). As most of PHEVs are charged after working hours, the existing peak load in the evening will increase significantly. Large peak loads cause more expensive production and can even damage the electricity infrastructure.

In a Smart Grid, the charging of PHEVs can be controlled to reduce peak load by efficient demand side management. The authors have presented a multi-agent solution against an optimal quadratic programming (QP) scheduler solution. Simulations show that a QP scheduler is able to optimally flatten peak loads while sufficiently charging the PHEV batteries.

However, this solution is unfeasible in practice but the MAS solution proves to be scalable and adaptable to incomplete and unpredictable information while peaks are still reduced with efficiency up to 95% compared to the QP scheduler.

Figure 1: Optimal energy reservation.

In this paper, MAS is proposed which is able to dynamically adapt to PHEV behavior.

Two different coordination strategies are developed that take into account less data than the central scheduler; the energy limiter only uses predictions about loads, while the power limiter doesn’t use any forecast data. According to the author this paper is a first initiative in comparing demand side management solutions for PHEVs. Future work will consist of, but will not be limited to Scenarios, Scheduler and Scalability.

In this paper author has presented the theory of Load decomposition and applications of Demand side Management in Smart Grid. The authors have used Scottish Medium Voltage (MV) distribution networks for measurement of Active and reactive power demands and correlated variations in demands with the short-term and long-term variations of temperature.

This methodology is illustrated by authors with the example of the total network demands (sum of the demands at all monitored bulk load supply points), with the analysis presenting several metrics and indicators for quantifying and correlating temperature-demand dependencies during the course of one calendar year. The authors gives an idea for decomposing aggregate network demands into the temperature-dependent loads (e.g. thermal heating or cooling loads) and temperature-independent loads, providing an important information for the application of the “smart grid” functionalities, such as demand-side management, or balancing of variable energy flows from renewable generation.
Some results for the load decomposition of the thermal electricity demands in Scotland, UK are presented in this paper. The results give more detailed analysis of the reliance of heating and cooling demands on temperature variations over the different sequential scales (annual, seasonal, daily and hourly), allow to study these effects in the context of “smart grid” and DSM applications on it. The results are of particular importance for the implementation of “smart grid” DSM functionalities in the residential and commercial sectors, as they may provide real-time estimation of the expected heating and cooling demands based on weather/temperature forecasts, or for the long term planning of the electricity sector.

[13] In this paper author has given an idea of using Repeated Game Framework for DSM in future Smart Grid. In this DSM model, the interaction between interested and foresighted consumers as a repeated energy scheduling game proves that the stationary strategies are suboptimal in terms of long-term total billing and discomfort costs. Moreover they propose a new framework for determining optimal non stationary DSM strategies, in which consumers can choose different daily power consumption patterns depending on their preferences, routines, and needs. As a direct outcome of the non-stationary DSM policy, different subsets of consumers are allowed to use power in peak times at a low price. The subset of consumers that are selected daily to have their joint discomfort and billing costs minimized is determined based on the consumers’ power consumption preferences as well as on the past history of which consumers have shifted their usage previously. The proposed strategies in this paper are said to be considerably incentive-compatible. Simulations confirm that, given the same peak-to-average ratio, the proposed strategy can reduce the total cost (billing and discomfort costs) by up to 50%.

Additionally, the comparison of outcome their model with existing mechanisms, the performance of the proposed mechanism is much less sensitive and thus much more forceful to system parameters such as the consumer heterogeneity and the length of the peak time.

[14] In this paper, authors provided a comprehensive overview on the applications of game theory in smart grid networks. The smart grid applications were carefully drawn from a broad range of problems spanning emerging areas such as micro grids, demand-side management, and communications. In each area, they identified the main technical challenges and presented an elaborate discussion on how game theory can be applied to address these challenges. Moreover, they proposed several future directions for extending these approaches and adopting advanced game theoretic techniques, so as to reduce the gap between theoretical models and practical implementations of future smart grids. They mention that game theory has a strong potential to provide solutions for pertinent problems in smart grids but also faces many design challenges. They also mentioned that many of the existing works had focused on classical static non cooperative games. Hence, for future works, it is of interest to investigate dynamic game models (both in cooperative and non-cooperative settings) and their applications in smart grid systems. The motivation for studying dynamic models stems from the pervasive presence of time-varying parameters in smart grids such as generation, demand, among others. In this context, dynamic game theory could be a cornerstone for capturing these parameters and designing better algorithms for improving the economical and technical aspects of future smart grids.

Beyond dynamic games, it is also of interest to further investigate applications of Bayesian games in smart grids. Bayesian games are a type of non-cooperative games in which the players have very limited information on the objective functions and strategies of their opponents. Given the large scale nature of the smart grid, the involved players in any game model might face several technical difficulties in estimating the exact strategies or objectives of the other players.

![An illustration of a cooperative micro-grid model](image)

Furthermore Author say that the future work can investigate two important aspects of data injection in smart grids: firstly the use of dynamic zero sum non cooperative games for modeling the interactions between a smart grid operator and a data injection attacker, and secondly the use of non-cooperative games, in conjunction with cooperative games, for studying coordinated data injection attacks and corresponding defense strategies. Finally, this paper presented a comprehensive overview on the potential of applying game theory within future smart grid systems. Clearly, game theory will constitute a strong tool for designing future smart grid systems that can fulfill the promise of a completely integrated solution and satisfy the “sense, communicate, computer, control” paradigm.
In the future smart grid, both users and power companies can potentially benefit from the economical and environmental advantages of smart pricing methods to more effectively reflect the fluctuations of the wholesale price into the customer side. In addition, smart pricing can be used to seek social benefits and to implement social objectives. To achieve social objectives, the utility company may need to collect various information about the users and their energy consumption behavior, which can be challenging.

In this paper, authors propose an efficient pricing method to tackle this problem. They assume that each user is equipped with an energy consumption controller (ECC) as part of its smart meter. All smart meters are connected to not only the power grid but also a communication infrastructure. This allows two-way communication among smart meters and the utility company. They have modeled each user’s preferences and energy consumption patterns in form of a utility function.

Based on this model, a Vickrey-Clarke-Groves (VCG) mechanism has been proposed which aims to maximize the social welfare, i.e., the aggregate utility functions of all users minus the total energy cost.

Their design requires that each user provides some information about its energy demand. In return, the energy provider will determine each user’s electricity bill payment. Finally, they verify some important properties of our proposed VCG mechanism for demand side management such as efficiency, user truthfulness, and non-negative transfer. Simulation results confirm that the proposed pricing method can benefit both users and utility companies.

They also mentioned that the proposed VCG mechanism improved the performance of the system by encouraging users to reduce their power consumption and shift their loads to off-peak hours. The proposed VCG mechanism significantly reduces the communication overhead. The simulations confirmed that by using VCG mechanism, in addition to maximizing the social welfare, the energy provider will benefit as well. The ideas developed in this paper can be extended in several directions. For example, a system with multiple energy providers can be considered. The effect of malicious users can be explored as well.

This paper presents the operation of an Electrical Demand-Side Management (EDSM) system in a house containing solar system. According to the author, use of EDSM is one of the most important action lines to improve the electrical efficiency of grid station.

The combination of EDSM and Photo Voltaic Generation performs a new control level in the local electric behavior and allows new energy possibilities.

The house used as test-bed for the EDSM system owns a PV generator, a lead-acid battery storage system and a grid connection.

The electrical appliances are controlled from a computer. The EDSM is implemented by a control system which schedules the tasks commanded by the user. By using the control system, author tried to define the house energy policy and improve the energy behavior with regard to a selected energy principle, self-consumption.

According to author EDSM system favors self-consumption with regard to a standard user behavior and reduces the energy load from the grid.

The combination of EDSM and PV generation allows the use of local control techniques and achieves energy efficient levels.

Self-consumption is the distributed energy implementation, as consumption is also a source of generation at same place. This electrical system reduces the transport losses and the energy demand to the grid.

An EDSM with PV generation can have different energy standards and operation policies. The experiments presented in this paper pursue the principle of “maximizing the PV energy consumption.

Authors say that by using this principle, they found that the local consumption of PV energy increases with regard to the PV energy delivered to the grid.

With this operation policy, the load of the grid gets reduced. Additionally, the system allows reduction in peak hours demand and as well as the variation of generation.

The cost of the discussed system equipped with generation, storage and consumption is not small. In order to study the energy behavior of this system, author defined two different coefficients:

1- Self-Consumption Coefficient (\(C_S\))
2- Energy Coefficient (\(C_E\))

First coefficient relies on the self-consumption integrity, while the second coefficient evaluates the size of system.

In this Paper the authors have presented the role of Demand Response, Intelligent Energy Systems, and Smart Loads in Demand Side Management.

According to author energy management means to optimize energy system. Demand Side Management (DSM) is a range of measures to improve the energy system at the side of consumption. It starts from improving energy efficiency by using better materials, over smart energy tariffs with incentives for certain consumption patterns, and ends on sophisticated real-time control of distributed energy resources.

This paper gives a synopsis and taxonomy for DSM, analyzes the various types of DSM, and gives a view on the latest demonstration projects in this domain. It is mentioned by the author that despite of increased efficiency of electric devices, consumption is steadily rising some percent every year.
Generation might not be a problem but it is the grid’s capacity that makes many relevant people worry. Especially new and ambitious projects, like Deser-Tec (extensive solar power stations in Northern Africa to supply power to Europe), and large offshore wind parks in the Northern Sea, raise questions about the transport of energy. The grids might soon face their limits, and intelligent Demand Side Management (DSM) is one way to stretch these limits a bit further. DSM also promotes distributed generation: In order to avoid long-distance transport, locally generated energy could be consumed by local loads, immediately when it is available. According to the author the main advantage of DSM is that it is less expensive to intelligently control a load, than to build a new power plant or install some electric storage device.

Fig. 4. The consumer-to-grid project puts the human back into “the loop.”

In this paper, authors presented an autonomous and distributed demand-side energy management system among users having advantage of a two-way digital communication infrastructure which is envisioned in the future smart grid. They formulated an energy consumption scheduling game, where the players are the users and their strategies are the daily schedules of their household appliances and loads. They assumed that the utility company could adopt adequate pricing tariffs that differentiate the energy usage in time and level. They showed that for a common scenario, with a single utility company serving multiple customers, the global optimal performance in terms of minimizing the energy costs is achieved at the Nash equilibrium of the formulated energy consumption scheduling game. The proposed DSM strategy requires each user to apply its best response strategy to the current total load and tariffs in the power distribution system. The users can maintain privacy and do not need to reveal the details on their energy consumption schedules to other users. They also showed that users have the incentives to participate in the energy consumption scheduling game and subscribing to such services. Simulation results confirm that the proposed approach can reduce the peak-to-average ratio of the total energy demand, the total energy costs, as well as each user’s individual daily electricity charges.

The block diagram given below illustrates the author’s concept.

Fig. 6. Block diagram of smart grid system composed of an energy source, users, a distribution power line, and a local area communication network.
IV. REVIEW CONCLUSIONS

We have critically reviewed above stated papers and found all of them fascinating and significantly contributing towards smart use of energy by introducing Demand Side Management in different ways and forms.

In order to conserve the natural resources of energy the need of the hour is to reduce the use of electrical energy or use it smartly and efficiently.

We all can contribute by involving ourselves in managing of our energy needs.

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