International Journal of Scientific Research & Engineering Trends
Volume 5, Issue 4, July-Aug-2019, ISSN (Online): 2395-566X

A Survey on Demand side Management Various Requirements and Techniques

Navin Kumar Sah **Prof. Ashish Bhargaya**
Dept. of Power System
Bhabha Engineering Research Institute
Bhopal, MP, India

Abstract - **Electricity demand in India is steadily increasing as electrical loads grows and largely due to population growth, as well as due to government subsidies which may lead to prices much lower than actual production cost. This growth represents a challenge that requires India power generation Company to invest huge amounts of money every year, for the construction of additional generation capacity along with the reinforcement of transmission network to meet the consumption growth. Also the demand varies frequently throughout the day, causing a waste of a large part of the energy. So the optimum solution lies in altering the load shape in order to have a better balance between customer's consumption and power generation companies. Here detail survey of different demand side management (DSM) techniques was study. Here paper gives a brief review of research conduct by various other researchers in this field of DSM. Explanation of working architecture was also done.**

Index Terms- **Appliance Scheduling, Demand Side Management, Genetic Algorithm, Smart Grid, Energy Management.**

I. INTRODUCATION

In most of today's power systems, nuclear, hydro and fossil power plants provide the majority of energy production [1], [2], while peak consumption is matched by regulation plants and power exchange between grids. However, in the last two decades factors such as the increased global energy demand, speculation on fossil fuels, and global warming have generated a high interest in Renewable Energy Resources (RES) and Electric Vehicles (EVs). For example, in Denmark the wind power is planned to supply approximately 50% of the demand by the year 2020 [3].

In this context, power systems will have to face challenges such as accommodating a highly variable and less controllable distributed energy production, and reducing the peak demand. In order to avoid or delay large investments in grid infrastructures and storage facilities, already existing consumption units can be enabled with control capabilities.

Demand Side Management (DSM) is a promising technology for power balancing in future energy systems. A classification of control policies for DSM focusing on smart buildings, presented in this paper, can help with the selection of a DSM controller for a specific application, provide comparison criteria between technologies, and help in the standardization process. WBCSD2 estimates that in most countries buildings account approximately for the 30-40% of total energy consumption [4], therefore controlling buildings with Home Automa The World Business Council for Sustainable Development tion Systems (HAS) with remote control can enhance overall demand flexibility. It is assumed, in this context, that a smart building is equipped with controllable appliances and smart devices in order to enable flexible consumption. As many research projects have investigated different approaches to DSM in smart buildings, this paper presents an overview of selected DSM systems and proposes a classification for control schemes for Distributed Energy Resources (DERs).Load management programs involve reducing loads on a utility's system during periods of peak power consumption or allowing customers to reduce electricity use in response to price signals.

Such programs use mechanisms like interruptible load tariffs, time-of-use rates, real-time pricing, direct load control, and voluntary demand response programs. In response to the current power crisis, SDRC has issued a notice calling for the development of national time-of-use tariffs, with peak rates that could be in the range of two to five times higher than off-peak rates.

Load management programs can be effective in reducing peak demand, which in turn helps to reduce utility construction costs as well as lower electric rates. Yet load management programs are largely short-term responses that alone do not exhaust the cost-effective demand-side potential. The multiple long-term benefits that investments in energy efficiency can bring to the entire electric system are often overlooked. Combining load management programs with end-use energy

International Journal of Scientific Research & Engineering Trends
Volume 5, Issue 4, July-Aug-2019, ISSN (Online): 2395-566X

efficiency programs can heighten the effectiveness of both approaches and lead to the greatest demand reductions.

II.CONCEPT OF DEMAND-SIDE MANAGEMENT

The main objective of DSM is to change the energy end-use, i.e. to influence the energy consumption profile in order to reduce the overall cost of the consumed energy [4]. In other words, DSM represents the corresponding modification of the consumer's energy demand by applying various mechanisms mainly driven by the financial incentives. DSM related measures are often undertaken by the end consumer, but also can be initiated by the distribution utility itself. It usually includes actions such as increasing or decreasing load demand, shifting it from high to low tariff periods if variable tariff scheme is applied (e.g. moving the energy use to off-peak periods such as during the nights, weekends) etc. DSM can be applied through:

- Energy efficiency improvement
- Load management.

In the first place, improvement of the energy efficiency implies performing the same type of operations for less energy. These actions consider reduction of the energy use through implementation of energy efficient equipment (such as energy saving lighting devices, more efficient air conditioning units, circulation pumps etc) and they are focused to reduce the energy consumption and indirectly to reduce the peak demand. On the other hand, DSM can be achieved through the load management which this paper is focused on.

Load management [1] includes all the measures intentionally undertaken with the aim to influence the energy consumption/load profile in such a way to alter (usually to reduce) the peak demand or total energy consumption over a certain period of time. In other words, it includes redistribution of energy demand in order to spread the energy consumption evenly throughout the given period (on a daily or seasonal basis). It is directly focused on reduction of the peak demand and may or may not result in decrease of total energy consumption. Therefore, it could be stated that load management considers any reactive or preventive intentional modification of the energy consumption pattern with the aim to influence the timing, level of instantaneous demand or total energy consumption [4].

It can be achieved by applying various actions of controlling, curtailing or shifting the load. In other words, desired load shape influence can be achieved depending on the applied load management mechanism. Apart from the load management related actions, DSM includes all the measures undertaken by the end consumer and/or utility in order to consume the energy more efficiently and subsequently to reduce the cost of the consumed power. Looking from the broader perspective, the DSM measures can also consider providing the additional power supply such as by implementation of the RES elements based on which the load demand could be met along with the reduced cost of the energy consumption. From the perspective of the DSM application, it is important first to identify and appropriately categorise the type of the end-use load. The end-use load (electricity, heating and cooling load) could be driven by the various building systems, such as air conditioning system, lighting system or any other piece of equipment installed at the site. With respect to the mentioned, the load can be categorised according to the following [4]:

- Critical load – should not be influenced (typically power supply of fundamental operation),
- Curtail able load – could be reduced (the temperature set-point of the air conditioning system could be lowered during periods of high electricity price or if contracted peak consumption is being approached),
- Reschedulable load – could be shifted (forwards or backwards) in time (pre-cooling of a building can be performed early in the morning before there is an actual cooling demand).

Having in mind the above listed categories, identification of the curtail able and reschedulable load is a prerequisite in order to select and apply suitable DSM measure.

III.ARCHITECTURE OF DSM

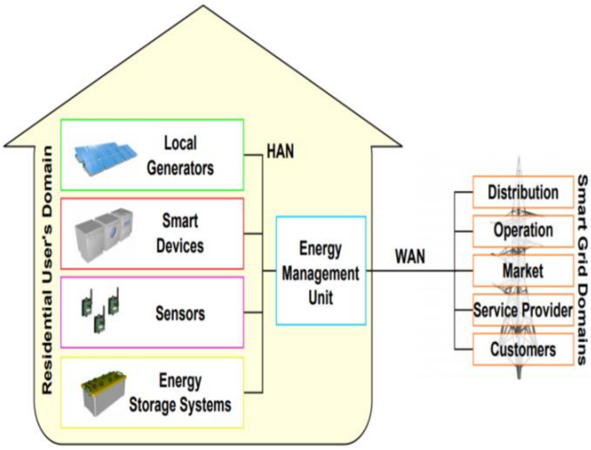

Figure 1 Architecture of demand-side management frameworks.

Architecture and Components of DSM Frameworks Demand-side management frameworks are designed to optimally manage the electric resources of users through a specific architecture, shown in Figure 1, composed of the following basic components:

1. Local generators- local energy plants (e.g., photovoltaic (PV) plants) that generate electric energy that can be either used locally or injected into the grid.

2. Smart devices- electric appliances that are able to monitor themselves, thus providing data, such as their energy consumption and that can be remotely controlled [17].

3. Sensors- used to monitor several data of interest, such as the user's position within the house, temperature and light [18]. Moreover, in the case of traditional devices, power meter sensors [19] can be used to monitor and control these appliances.

4. Energy storage systems- are storage devices that allow the DSM system to be flexible in managing electric resources.

5. Energy management unit (EMU)- exchanges information with the other elements of the system and manages the electric resources of users based on an intelligent DSM mechanism. Specifically, this mechanism has to define the schedule of appliances, the operating plan of ESSs and the demand and supply profiles (i.e., when to buy and inject energy into the grid). In the case of multi-user architectures, all of the EMUs of users are connected to a central server, which coordinates the consumers.

6.Smart grid - Domains the distribution, operation, market, service provider and customer domains of the smart grid described in Section 1. A utility company, which is part of the market domain, supplies electric energy to users from whom it receives payments according to energy tariffs. Eventually, also, a profit-neutral entity, called the independent system operator (ISO), can be introduced, which stands between suppliers and customers. The ISO procures electricity from suppliers and sells it to users with the goal of matching supply and demand. All of the components of the architecture are connected through a communication infrastructure. Specifically, one or more home area networks (HANs) are used to interconnect the elements that are within the customer's domain.

II. RELATED WORK

Danish et al. in [5], present HEMS model based on heuristic algorithm BSPO. The aim of the authors is to minimize the electricity cost while considering user comfort. Authors in [6], present a generic model of DSM in order to optimize energy consumption in the residential sector. In a home environment, energy management controller (EMC) is used to control energy consumption of the appliances during peak hours.

In [7], authors propose a comprehensive model for energy management in homes with multiple appliances. The proposed model consists of six layered architecture and each layer is connected with other in order to achieve better results in terms of cost reduction and PAR.

In [8] provides a comprehensive study of WDO technique, the basic concepts, structure its variants, and its application in electro magnetics. A numerical study is presented using uni-modal and multi-modal test functions and results of WDO and other optimization techniques, including GA, BPSO, and differential algorithm (DE).

In [9] proposes a novel approach of DSM with the integration of RESs. The energy provider inspects the load profile and the price of the electricity. Authors aim to reduce the deviation of average load energy demand by scheduling the energy consumption and storage devices. To solve scheduling problem, authors model the energy consumption and storage as a non-cooperative game.

In [10], authors demonstrate the electricity load scheduling problem for multi-resident and multi-class appliances using problem ladson generalized bender algorithm while considering energy consumption constraint. The main objective of the study is to protect the private information i.e., energy consumption profile of the residences and maximize the users satisfaction.

In [11] give an insight of scheduling the energy management in the residential sector and propose two horizon algorithms. The proposed algorithms are efficient to reduce electricity cost with less computational time. Moreover, authors also discuss the implementation of proposed algorithms and challenges related to its implementation.

Di Somma et al. in [12], present stochastic programming model for the optimal scheduling of distributed energy resources system. The main aim of the study is to reduce energy cost and CO_2 emission while, satisfying time-varying user demand.

In [13], provides an improved HEMS architecture considering various categories of appliances in the home. Multi- time scale optimization is formulated in order to schedule energy consumption of appliances. A predictive model-based-heuristic solution is proposed and its performance is compared with benchmark algorithms.

III.TECHNIQUES OF DSM

Distribution system supply-demand management, system congestion and loss minimization are dealt with effectively using Evolutionary algorithms and swarm intelligence techniques [14]. Modern heuristics or artificial intelligent based optimization techniques try to simulate living organisms (human) behavior. These intelligent-based tools present a better, faster and accurate solution to an optimization problem than the existing conventional (classical or traditional) optimization techniques [15]. The mimicking behavior of living organisms by the algorithms when simulated on a computer environment is known as artificial intelligent. These artificial intelligent-based tools provide the utilities' engineers with innovative solutions for efficient analysis, optimal operation and control, and intelligent decision making [14]. Hence, some artificial intelligent-based optimization techniques used recently for optimal demand-side management and system congestion; and optimal decision making problems in DSM are briefly explained below:

Genetic Algorithm (GA) "Genetic algorithm (GA) is a search algorithm that based on the conjecture of natural selection and genetics. The features of a genetic algorithm are different from other search techniques in several aspects. Firstly, the algorithm is a multipath that searches many peaks in parallel, hence reducing the possibility of local minimum trapping. Secondly, the GA works with a coding of parameters instead of the parameters themselves. The coding of the parameter will help the genetic operator to evolve the current state with minimum computations. Thirdly, the GA evaluates the fitness of each string to guide its search instead of the optimization function" [16]. The GA work with a population of individuals represented by bit strings and modifies the population with random search and competition [17].

Particle Swarm Optimization (PSO) Particle Swarm Optimization (PSO) is an exciting new methodology in evolutionary computation that is somewhat similar to the genetic algorithm in that the system is initialized with a population of random solutions [16]. PSO is a population-based search algorithm, which solely depends on the behavior of the flock of birds or schooling of fish. "In PSO, a number of particles are randomly generated to form a population and are discarded, like in GA. The search behavior of a particle is therefore influenced by that of other particles within the swarm. PSO can be said to be a kind of symbiotic cooperative algorithm" [17]. PSO has been found to be extremely effective in solving a wide range of engineering problems [16].

Ant Colony Optimization (ACO) Ant Colony Optimization (ACO) is based on foraging techniques of real ant colonies. ACO tool mimic the behavior of real ants. "Real ants are capable of finding the shortest path from food sources to the nest without using visual cues. They are also capable of adapting to changes in the environment, e.g, finding a new shortest path once the old one is no longer feasible because of a new obstacle. Studies by ethnologists reveal these, such capabilities are essentially due to what is called "Pheromone trails," which ants use to communicate information among individuals regarding the path and to decide where to go" [16]. ACO algorithm is a tool that tries to find the shortest path from point A to point B by mimicking real ants' situation that finds the shortest path between the food source and nest without any visual, central and active coordination mechanism.

IV.CONCLUSION

The aim of demand-side management (DSM) in the electric power distribution network is to manage congested systems and balance supply-demand at operating conditions thereby reducing systems losses, system reliability improvement and voltage stability. In this paper a deep study of different techniques with their requirement are done. In those techniques different features of of demand side was also explained with their utilization for developing a efficient algorithm. Paper has given brief explanation of the architecture of the DSM. In future dynamic and fast algorithms need to be develop by using some genetic concept which reduce overall load cost.

REFERENCES

1. Hanieh khalilian, student member, ieee, and ivan v. Bajic video "watermarking with empirical pca-based decoding" ieee transactions on image processing, vol. 22, no. 12, december 2013.
2. Paweł korus and andrzej dziech efficient method for content reconstruction with self-embedding ieee transactions on image processing, vol. 22, no. 3, march 2013
3. tamanna tabassum, s.m. mohidul islam "a digital image watermarking technique based on identical frame extraction in 3-level dwt" vol. 13, no. 7, pp. 560 –576, july 2003.
4. Nörstebö V.S., Demiray T. H. et al., EPIC-HUB Deliverable D1.3 - Performance indicators, 2013.
5. Mahmood, D.; Javaid, N.; Alrajeh, N.; Khan, Z.A.; Qasim, U.; Ahmed, I.; Ilahi, M. Realistic scheduling mechanism for smart homes. Energies 2016, 9, 202, doi:10.3390/en9030202.
6. Khan, M.A.; Javaid, N.; Mahmood, A.; Khan, Z.A.; Alrajeh, N. A generic demand-side management model for smart grid. Int. J. Energy Res. 2015, 39, 954–964.
7. Mahmood, A.; Baig, F.; Alrajeh, N.; Qasim, U.; Khan, Z.A.; Javaid, N. An Enhanced System Architecture for Optimized Demand Side Management Smart Grid. Appl. Sci. 2016, 6, 122, doi:10.3390/app6050122.
8. Bayraktar, Z.; Komurcu, M.; Bossard, J.A.; Werner, D.H. The wind driven optimization technique and its application in electromagnetic. IEEE Trans. Antennas Propag. 2013, 61, 2745–2757.
9. Wang, J.; Li, Y.; Zhou, Y. Interval number optimization for household load scheduling with uncertainty. Energy Build. 2016, 130, 613–624.
10. Moon, S.; Lee, J.W. Multi-Residential Demand Response Scheduling with Multi-Class Appliances in Smart Grid. IEEE Trans. Smart Grid 2016, PP, 1, doi:10.1109/TSG.2016.2614546.
11. Beaudin, M.; Zareipour, H.; Bejestani, A.K.; Schellenberg, A. Residential energy management using a

two-horizon algorithm. IEEE Trans. Smart Grid 2014, 5, 1712–1723.

12. Di Somma, M.; Graditi, G.; Heydarian-Forushani, E.; Shafie-khah, M.; Siano, P. Stochastic optimal scheduling of distributed energy resources with renewables considering economic and environmental aspects. Renew. Energy 2018, 116, 272–287.
13. Ferruzzi, G.; Cervone, G.; Delle Monache, L.; Graditi, G.; Jacobone, F. Optimal bidding in a Day-Ahead energy market for Micro Grid under uncertainty in renewable energy production. Energy 2016, 106, 194–202.
14. Yu, Z.; Jia, L.; Murphy-Hoye, M.C.; Pratt, A.; Tong, L. Modeling and stochastic control for home energy management. IEEE Trans. Smart Grid 2013, 4, 2244–2255.
15. Sheeba, M., Kumari, S., Shanthi, A. P. and Maheswari, V. U. "Computational Intelligence Techniques for Efficient Power Distribution and Consumption: A Survey," Journal of Theoretical and Applied Information Technology, Vol. 62, No. 2, 2014. Pg. 371 – 379.
16. Divya, M and Bindu, R. "Ant Colony Optimization Method Applied to Distribution Network Reconfiguration", International Journal of Advanced Research in Computer and Communication Engineering, Vol. 2, Issue 10, October 2013.
17. Badar, A., Umre, B.S. and Junghare, A.S. "Study of Artificial Intelligence Optimization Techniques Applied to Active Power Loss Minimization," IOSR Journal of Electrical and Electronics Engineering, 2014. Pg. 39 – 45.
18. Lee, Y.K. and EI-Sharkawi, M.A. "Modern Heuristic Optimization Techniques: Theory and Applications to Power Systems," Institute of Electrical and Electronics Engineers Inc., Published by John Wiley & Sons, Inc., Hoboken, New Jersey, 2008.