# REVIEW ON DIFFERENT ALGORITHMS AT LOAD SIDE FOR SOLVING ENERGY MANAGEMENT PROBLEMS WITH MICRO GRIDS

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**Abstract:** In India generation of power is a smaller amount compared to energy consumption. Therefore energy wastage should be restricted. Electricity conservation is one of the troubles which need to be addressed with utmost significance in future. In these days energy plays the main role in all regions. India is the third biggest nation for power, however still it is slacking to take care of the demand in a compelling way. Now to achieve, this people must be aware of energy audit and management systems. Recently many countries, have adopted smart cities and smart metering program to cope up with the stress of developing population and limited infrastructure with combined results. The Indian government smart cities program to expand over hundred cities would require green strength control to make sure uninterrupted electricity supply to all residence preserve and commercial establishments. Providing required electricity to different sectors and to reduce the cost function are the two primary goals. In this paper we review latest algorithms, the need of energy requirements in India and how to minimize the cost function are to be addressed. This paper mainly concentrated the demand side objectives and how to balance the load in different environments with micro grids.

***Keywords:*** *Demand side management, micro-grid, cloud computing, energy audit, monitoring*.

## I. INTRODUCTION

In India generation of power is a smaller amount compared to energy consumption. Therefore energy wastage should be restricted. Electricity conservation is one of the troubles which need to be addressed with utmost significance in future. In these days energy plays the main role in all regions. India is the third biggest nation for power generation, however still it is slacking to take care of the demand in a compelling way [1]. In India due to enhancing the economic activities and population will also cause the power demand, when the country is already facing power shortage .As it is observed that the expansion in the request in the general public is expanding day by day and in this the emission of the carbon dioxide is moreover expanding because of the new wellsprings of era as opposed to renewable vitality.

Demand side management (DSM) can play a crucial role in reducing electricity demand and is widely implemented throughout the world. DSM is defined as the planning and implementation strategies designed to encourage consumers to improve energy efficiency, reduce energy costs, change the time of usage, or promote the use of different energy source. DSM is also called as Energy Demand Management (EDM) can be defined as a set of techniques that consist of a broad range of planning, implementing and monitoring of activities designed to encourage end users (consumers of electricity) to modify their load patterns of electricity consumption, mainly with a view to shift part of the consumption from peak demand period to non-peak demand period [2]. The main goal of demand side management is to encourage the consumer to use less energy during peak hours, or to shift the time of energy use to off-peak hours such as night time and weekends. Peak demand management not only decrease total energy consumption, but could be expected to reduce the need for investments in networks [3]. Use of energy storage units to store energy during off-peak hours and discharge them during Peak clipping and valley filling focus on reducing the difference between peak and off-peak load levels. Peak clipping is a direct load control technique. Load shifting is the most effective load management technique which shifts loads from peak time to off-peak time. Strategic load growth optimizes the daily response in case of large demand introduction beyond valley filling technique. Flexible load shape is related to the reliability of smart grid during peak hours [4] [5].Distribution generation attributes the DSM, rural electrification and utilization of renewable energy resources. Technology improvement, energy market liberalization, and environmental issues has encouraged the growth of distributed generation [6]. Nowadays, DSM technologies become increasingly popular due to the integration of information and communications technology and power system, resulting in a new term called Smart Grid.

The main objective of the DSM techniques is the peak clipping and reduction of system operational cost. Although the utilities are capable of offering different incentives to respective customers for direct control over selected loads by classifying the customers' loads, most of the methodologies used do not consider the criteria and objectives independently. Thus, it is difficult to employ these methods of DSM for future smart grids which aim to provide the customers with greater control over their energy consumption [7]. Advantages of DSM will include: Reduce overall cost of installed capacity, Ensure quality & reliability of supply, to reduce power blackout (power outage), to increase the system reliability, to Reduce the energy pricing, to avoid harmful gas emission to the environment, to reduce environmental pollution is shown in Fig. 2.1

1) DSM Activities: The basic DSM activities include Load management programmes: Redistribute energy demand to spread it more evenly throughout the day, e.g., load shifting programmes (reducing loads during periods of peak demand and shifting these loads to off-peak periods), and time-of use rates (charging more for electricity during periods of peak demand).[8][9] Conservation programmes: Reduce energy usage e.g., programmes to improve the efficiency of equipment, buildings, and industrial processes. Strategic load growth programmes: Increase energy use during some periods, e.g., strategies that encourage cost-effective electrical technologies that operate primarily during periods of low electricity demand.

2) Planning and Implementation of DSM: In order to effectively balancing the supply demand requirements we need efficient planning and implementation steps explained through flow chart shown in Fig 1.1.

I. Develop model for Demand forecasting by end-use is an essential pre-requisite for effective DSM planning and implementation. Mid- and long-term forecasts of power demand variations play a vital role in the development of a DSM programme. Demand forecasting is an exercise that every electricity-generating company should carry out regularly in order to assess its future equipment requirements.

II. Undertake Load/ Market Research to identify end-use patterns and market barriers to design effective DSM programmes it is important to know how electricity is consumed and what barriers are preventing customers from using efficient technologies [10]. Load research should be undertaken to estimate load curves for each sector or region, using local sub-metering, customer bill analysis and surveys. Major areas of interest to DSM programmes include the residential, commercial, industrial, and public utility sectors. Market research is needed to understand the target sector, identify barriers and evaluate possible solutions.

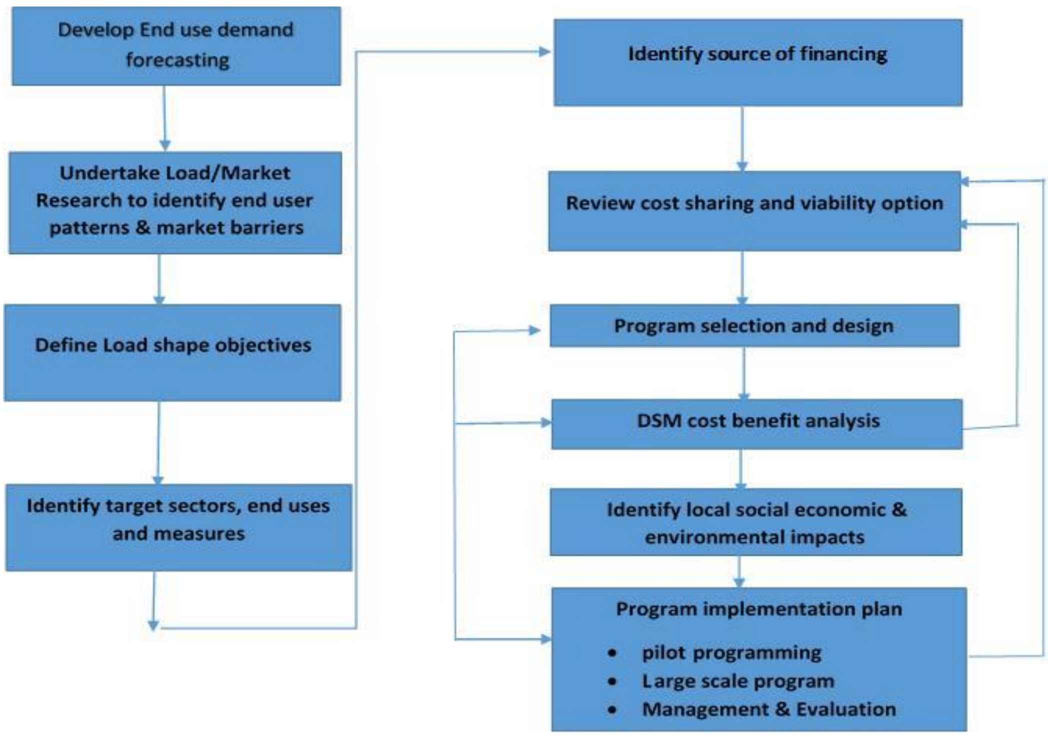



*Fig. 1.1 Flow chart of planning and implementation in DSM*

III. Define load-shape objectives: Reduction in peak demand, controlling the equipments, controlled tariff rate, increasing load during off peak hours, Building off peak loads.
IV. Identify target sectors, end-users, and measures the gathered information is normally useful in determining a typical load curve for each end-use. Find out load-curve management objectives. Choose sectors and end-users whose power consumption is high and peak loads, or will do so in the future. Select DSM measures which will have the largest impact on peak demand and electricity use.

V. Identify sources of financing in any DSM program, financing is needed for individual projects undertaken by participants [12]. Utilities may also require financing to cover administrative costs and cost sharing investments. Government/public fund is required.

VI. Review Cost Sharing and Viability Options Cost sharing in a DSM program should try to maximize viability for each partner (participant, utility, and government).If existing tariffs are below the marginal cost of new power supply options, it is financially viable for the utility to share in the cost of the efficient technology and exploit participation in the program . The wider the differences between tariffs, the higher the utility investment can be, which in turn leads to a higher participation rate.

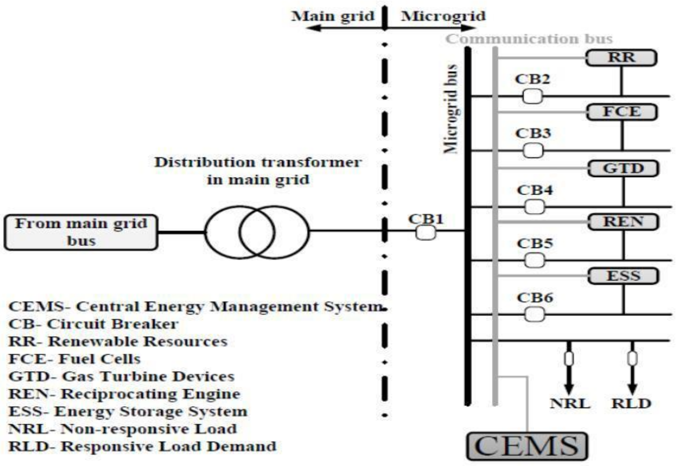
VII. Program Selection and Design Identifying: a list of programs for each customer class and formation of brief report corresponding to that program Uniform reporting format is required.
VIII. DSM Cost/Benefit Analysis Based on the case study /measurement Calculation of financial interest.

IX. Identify Local Socio-Economic and Environmental Impacts Most DSM programs provide indirect economic and environmental benefits as well as reducing emissions and other impacts from power supply facilities.

X. program Implementation Plan Implementation of any DSM program requires a core DSM staff or cell within a power utility to develop a plan.

## II. CONCEPT OF MICRO GRID SYSTEM

A typical configuration of a Micro Grid (MG) is shown in Fig 2.1. It consists of a group of radial feeders, a point of common coupling, responsive and non-responsive loads and micro-sources Since high penetration of renewable energy and storage devices are expected to be employed in the MGs, their stable operation through frequency and voltage control an important issue for the future power system [13].




| Customer Benefits | Utility Benefits | Societal Benefits |
|---|---|---|
| Satisfy electricity demands | Lower cost of service | Reduce environmental degradation |
| Reduce / stabilize costs or electricity bill | Improve operating efficiency, flexibility | Conserve resources |
| Maintain / improve lifestyle and productivity | Improve customer service | Protect global environment |

*Fig 2.1 The basic Micro grid architecture.*

This goal can be obtained by balancing the generation and load demand in real time, the uncertainly of the operation increases with any failure of the generation systems and unpredictable load variations. Storage devices (such as batteries) are usually available to match generation and load demand instantly, but their capacity is limited because of their costs. In addition, demand response (DR) might be available for balancing service MG can significantly improve the efficiency of energy production to maintain the balance between power generation and load demand mostly at the distribution level. It is also desired to obtain reckonable reduction in environmental emissions and increased power quality through MGs. In concentrated and grid connected MG, the fluctuations of load demand results in frequency problems and reactive power fluctuations, but the feeding of electricity can decrease or increase in accordance with the demand. That is because; these systems obtain part of their energy from technologies that are controllable and dispatchable. In recent years, application of substitute energy sources such as wind, biomass, solar, hydro and etc. has become more common as the result of continuous increase of the need for more reliability, better power quality, higher flexibility, lower electricity price and less environmental effects.

In other words, in recent years, distributed generation sources such as PV, micro turbines, fuel cells and energy storing sources have significant role in generating electricity more economically and with lower carbon emission. Meanwhile, the high penetration of DGs in the grid have created new challenges about safe and effective use of these systems in power grids [14]. The challenges can be removed to some extent by applying MGs that are defined as a set of DGs, electrical loads and generation sources connected to each other. In this regards, methodologies that are continuously improving are implemented for the management and control of MGs performance to make these grids more optimized and effective. In the other hand, severe need is felt for presenting algorithms for implementing more precise scheduling of energy sources in the MGs by including different objectives such as reducing production cost, increasing the profit of the generators, reducing environmental pollutions and etc. So far many research works on MG system performance scheduling under various loading conditions by considering different objectives have been developed.

## III. ENERGY MANAGEMENT SYSTEM

Modern energy management and control systems could help to shrink the cost of energy. However, they are applied either in a complex manner or a too simple way to achieve the desired goal [15].To maximize energy savings, minimize related costs and obtain a quick payback in MG systems, it is vital and most desirable to optimally operate an aggregated number of micro sources to achieve the lowest possible production cost. In a MG, this can be achieved by applying optimization methods and adjusting the generators output to minimize the production costs. The optimization procedure may interact with public network information. It is also desired for the EMS to adapt itself in real-time to any changes in the types and capacity of the generation and storage assets without any manual modification in the EMS [16]. Other objectives of the EMSs are maximizing the benefit of MG operation (equivalently minimizing the cost of operation) minimizing the emission, maximizing the lifetime of assets increasing the reliability of the MG or a combination of multiple objectives as a multi-objective EMS. The EMSs fall in two different categories: central energy management system (CEMS) and distributed energy management system (DEMS) [17] [18]. There are certain merits and demerits for each one as reviewed in this paper. Effective energy management can provide the necessary optimal and sustainable energy supply with maximum ability. Furthermore, given the intermittent nature of renewable energy resources, EMS should be able to and the best solution to supply consumers quickly and continuously from time to time. In general, gradient-based optimal EMSs are too slow to be used for real-time energy management problems.

## IV. LITERATURE REVIEW

Short term economic dispatch is a very important choice in the modern energy management systems and by using it the system performance cost can be reduced. It is demonstrated that demand response as a very important energy source which it must be paid attention to such as generating sources and ES sources to optimize the system performance. Distributed energy resources (DER) s significantly increase the number of variables that must enter the economic dispatch problem [19]. So, it is necessary to present new methodologies for improving the efficiency of these methods. For presenting these methodologies, very fast and adequate response must be considered for the optimization problems with a lot of variables. Deterministic optimization techniques [20] need significant calculations and also the execution time of these methods is not compatible with short-term scheduling. So, it is necessary to use alternative methodologies which have the fast response for multi-variable optimization problems [21]. Intelligent competitive techniques called meta heuristic methods inspired from biological process can provide this desired characteristic [22]. The main objectives of DSM program is minimizing mismatch between fed power and load during consumption peak by changing the system load curve [23]. The variation of system load curve can be obtained through both the distribution system facilities and end-use customers. Different authors were concentrated on this problems to tackle the issues faced by customers during peak hours of energy consumption and developed algorithms. In this paper we present some of the latest algorithms and their limitations.

Sirus Mohammadi .et.al. [24]. In this paper authors proposes a probabilistic way to deal with taking instability in the market costs, the heap request and the electric power era of the WT and PV units to optimize the OM of the MGs. The proposed techniques were applied to a typical MG which operates in grid-connected mode and equipped with storage devices. The OM problem of the MG is solved and analyzed in both the deterministic and probabilistic manner. The problems with this algorithm is as follows it is slow in convergence and easily gets trapped in local optimum for multimodal problems. In addition, the updates solely depend on current performance and no memory on previous best solutions and performances are kept. That may lead to losing better solutions. Furthermore, since the parameters are fixed, the search behavior remains to be the same for any condition in all iterations.

An optimal power control strategy has been proposed by Waleed Al-Saedi et.al. [25] For an autonomous micro grid operation. The control strategy utilizes two control loops: the inner current control loop, and the outer power control loop. A PSO algorithm is incorporated in the (V-f) power control strategy in order to implement real-time self-tuning, especially when the micro grid is islanded from the grid. The simulation results show that the proposed controller offers fast dynamic response and achieves a satisfactory level of harmonics distortion. The optimization method in accordance with GSA approach has been introduced by Mousa Marzband, et.al. [26]. to minimize the production cost as well as to increase the system efficiency. A strategy for smart grid has been developed to shift the load according to the power generation by renewable and non-renewable sources. This solution has been implemented experimentally over the IRECs MG system. Its performance and efficiency has been verified by using different scenarios. The priority index for consumers to participate in LEM has been considered based on the offer by them and minimizing objective function. The obtained results revealed the improvement of the overall system operation in comparison to MCEMS. The experimental and simulation results have shown that the increase in the percentage of the load shifting not only yield more flexibility to the system but also cause the use excess of generated energy. Moreover, it has been observed that the system efficiency in finding the best approach would lead to maximize the usage of the power generated by renewable sources. In addition, consumers have participated in DR with high priority index could be supplied with less cost.

Ahmer Arif .et.al. [27]. present a strategy to integrate DSM and economic dispatch for renewables in a localized setting. In our strategy, user preferences and generation capacity are set as constraints of the system. With these constraints, an optimization objective function is constructed from the cost of generation for each unit for each hour. Afterwards, a genetic algorithm is used to find the optimal solution for the problem. Collects preferences of demand data from consumers and costs of energy of various sources. It then finds the optimal demand scheduling and energy generation mix for the given time window .Amir-Hamed Mohsenian-Rad et.al. [28]. use game theory and formulate an energy consumption Scheduling game, where the players are the users and their consumption in the daily schedules of their household appliances and loads. It is assumed that the utility company can adopt adequate pricing tariffs that differentiate the energy usage in time and level. The proposed distributed demand-side energy management strategy requires each user to simply apply its best response strategy to the current total load and tariffs of 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. Simulation results prove 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.

Henry Chen, et.al. [29]. In this paper, we develop three novel distributed algorithms for autonomous DSM scenario, which enable the selfish consumers to optimize their own energy payment through scheduling their future energy consumption. The key contributions of for the considered DSM scenario, an aggregative game are first formulated to model the strategic behaviours of the selfish consumers. We adopt the instantaneous load billing scheme to effectively convince the consumers to shift their peak-time energy consumption and fairly charge the consumers. In this paper, authors are interested in a practical polynomial energy price model instead of the general energy price model also considered. Since the polynomial model has been widely adopted in power systems .Considering the alternative situation without a central unit but where the consumers are connected and they exchange their estimated information with others, we develop a distributed agreement - based algorithm, by which the consumers can achieve the NE of the formulated game through exchanging information with their immediate neighbours. Although information exchanges are necessary between the consumers in this algorithm, no private information is shared between the consumers, thus effectively protecting the consumer's privacy. Moreover, the parameters of this algorithm can also be chosen without knowing the systems arguments a priori. Although the central unit is not necessary for the aforementioned agreement-based algorithm, synchronization between the consumers and harmonization in terms of algorithm step sizes are still required, which are challenging in very large networks. Motivated by this, we develop a distributed asynchronous gossip-based algorithm for computing the NE of the formulated game without the need of a central unit.

Tascikaraoglu A., *et.al. [*30]. proposed the smart grid concept can be defined as the next-generation electrical grid that utilizes advanced control and communication components in order to optimize the energy generation, distribution and consumption. Energy efficiency, power quality and system reliability can be improved by using multiple tools of smart grid such as advanced meters, two-way communications and intelligent control equipment. In addition, the smart grids have the potential of exploiting renewable sources as well as providing the required infrastructure for electric and hybrid vehicles. Due to the mentioned benefits, smart grids also play a vital role in reducing the emissions of greenhouse gases (carbon dioxide, methane and nitrous oxide). However, most of these DSM-based approaches have dealt with the problem from the Perspective of power system.

The consumers are informed about the present or past energy wastages thanks to the advanced tracking and monitoring systems and hence a better aware of energy usage is intended. Then, apart from the former literature studies, the real time power forecasts of WT and solar PV panels are considered in the system in order to determine an efficient energy management plan in a domestic environment. The results obtained could also be improved by further adding various features to the system. For instance, many appliances continue to consume a small amount of energy when they are currently not in use (stand-by mode). Unlinking these appliances from the grid during the night times, working hours or the vacation period with a minor modification in the algorithm could probably decrease the energy wasting.

Ghasemi, H. Shayeghi *et.al*. [31]. In this paper the authors are proposed new class of algorithms for forecasting price and demand, the algorithm is divided into three parts. The first part employs a new Flexible Wavelet Packet Transform (FWPT) to decompose a signal into multiple terms at different frequencies, and a new feature selection method that employs Conditional Mutual Information (CMI) and adjacent features in order to select valuable input data. The next part consists of a novel Multi-Input Multi-Output (MIMO) model based on Nonlinear Least Square Support Vector Machine (NLSSVM) and Autoregressive Integrated Moving Average (ARIMA) in order to model the linear and nonlinear relationship between price and load in two stages. The final part employs a modified version of Artificial Bee Colony (ABC) algorithm based on time-varying coefficients and stumble generation operator, called TV-SABC, in order to optimize NLSSVM parameters in a learning process. Priya, Shaveghi *et al*. [32]. Present Game-theoretic approach to optimize ToU pricing strategies (GT-ToU). Utility functions of the company for n users are designed, and Nash equilibrium is obtained using backward induction.

Table. 4.1 various algorithms, advantages and their limitations

| ***S.No*** | ***Author*** | ***Type of algorithm*** | ***Area of application/ parameters*** | ***Advantages*** | ***Limitations*** |
|---|---|---|---|---|---|
| 1. | Sirus Mohammadi | Adaptive Modified Firefly Optimization algorithm | Power generation of the wind farms, in PV cells, cost measures, load demands. | Solved optimal power management problem. | Slow in convergence, easily gets trapped for multimodal problems, no memory, parameters are fixed irrespective of load conditions. |
| 2. | Waleed Al-Saedi | Particle swarm optimization | It is well suited for solving continuous and non-convex optimization problems Power quality measurement for autonomous micro grid | Low harmonic distortion, fast dynamic response. | Cannot work with scattering and non-coordinate systems |

| | | | | | |
|---|---|---|---|---|---|
| 3. | Mousa Marzband .et.al | Gravitational search algorithm(GSA) | Along with optimization used to minimize production cost and to increasing the efficiency | Peak Consumption reduction, electricity generation cost minimization. | Feasible for only limited load conditions only. |
| 4 | Ahmer Arif · Fahad Javed · Naveed Arshad | a genetic algorithm-based approach | This algorithm can be applied on an individual consumer level. | minimizing energy costs to the micro-grid's consumers While meeting their time-based requirements. it assists energy suppliers by determining the optimum configuration of Generational facilities to meet the stipulated demand. | Not implemented Constraint-capturing Mechanisms. |
| 5. | Amir-Hamed Mohsenian-Rad, Vincent W. S. Wong | Game-Theoretic Energy Consumption Scheduling | To minimize the cost of energy and to balance the total residential load when multiple users share a common energy source. | Can reduce the PAR, the energy cost, and each user's daily electricity charges. | focused only on residential load control not suitable for commercial Loads. |
| 6. | Henry Chen, Yonghui Li, Raymond H | An Aggregative Game Approach | This instantaneous Load billing method can minimize the whole grid energy cost. | No private information is required to exchange between consumers. can quickly converge to the NE of the formulated game and efficiently convince the consumers to shift their on-peak consumption | It is not primarily an empirical tool |
| 7. | A.Tascikaraoglu, A.R. Boynuegri | Based on forecasting of residential renewable sources | A real smart home with renewable energy sources and storage systems is examined | Improvements in terms of the energy cost | Temperature at the smart home keeps low level always. Peak load shifting and valley filling not addressed. |
| 8. | A. Ghasemi, H. Shayeghi, Moradzadeh | Novel hybrid algorithm (new modification for standard artificial bee colony optimization) | For simultaneous forecast of price and demand | The shape of load profile is modified and the expected spike and valley terms are removed | Average computational time is more |
| 9. | B. Priya Esther, K. Sathish Kumar | Game theoretic approaches ,optimization techniques | Mainly focused on residential sector | Load shape adjustments With demand | Less convergence. |
| 10. | A. Ranjini and B. S. E. Zoraida | Energy consumption scheduling algorithm | Household applications | Optimal scheduling of appliances | Not feasible if load varies. |

## V. CONCLUSION AND FUTURE SCOPE

Demand side electricity management (DSEM) is an encouraging research field in micro grid based power distribution system, because of its wide application. The main focus of this study is to develop programming model for balancing both electricity demand and supply for future requirements. Economic dispatch tries to reduce cost according to available demand and DSEM tries to manage demand to reduce cost. Finally, we strongly say that this paper will give directions for solving above mentioned problems up to some extent.

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