

A Review on Demand Side Management Solutions for Power Utilities

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ABSTRACT: Electricity is essential for our Economic growth and since it cannot be stored in bulk, it should be generated, distributed and consumed immediately. To meet the increasing electric consumption we require increase in the installed capacity. Another solution is the effective use of available capacity which is explained by DSM measures. Demand side management (DSM) is being increasingly adopted by utilities as a subprogram for huge investments and as a method of optimization and resources use. This paper basically introduces DSM, its types and proposes an algorithm for Load shifting from peak hours to off-peak hours thereby reducing the peak demand and giving economic benefit to consumers.

KEYWORDS: Demand side management, Load Scheduling Algorithm

I. INTRODUCTION

A. Concept of DSM

The term DSM was introduced in 1973 after an energy crisis which took place in USA[1]. It is also known as Energy Demand Management whose main objective is to lower the peak demand of the power plant. DSM provides benefit for both utilities and consumers. For utilities, it helps them to avoid the need of creating new power stations by shifting the load to off-peak hours. For industrial and domestic consumer it provides many ways to reduce their electricity bills by following the incentive plan as proposed by their utilities.

In India the energy efficiency programmes and DSM activities were started in the 1980s due to which various working groups were formed by Indian government to push the national energy efficiency efforts in 1983[2] and as a result, several industries had installed energy efficient motors, variable speed drives and efficient lighting. In India a major step towards DSM and energy conservation was taken in 2001 by framing an Energy Conservation Act [3]

Under this act, the Bureau of Energy Efficiency (BEE) was formed whose aim was to regulate and promote energy efficiency activities. In 2001, government decided to launch DSM in various states utilities by proposing a TOD tariff structure and incentives for energy efficient programs. Most of the states utilities have implemented TOD tariff for industrial and commercial consumers only.

But in case of residential sector less attention has been paid to launch TOD tariff structure. In fact it is bit complex to apply TOD structure for individual residential consumers in India. But, it is possible to use it for group of residential consumer e.g. housing societies, large educational institutes where large number of devices are available for control.

DSM includes anything which is done on the demand side of power system, ranging from exchanging old incandescent light bulbs to compact fluorescent lights (CFLs), now even LED bulbs and up to creating a sophisticated dynamic load management system.

DSM as an activity was utility driven in the past but now it is being seen more as consumer driven activity.

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B. Need of DSM

The power sector of India has tripled its production capacity, i.e. from 30,000 MW in 1981 to over 100,000 MW in 2001. Regardless of this growth, our power system is continuously struggling to overcome power shortages and poor power quality which continue to deteriorate the sector. In 2014-15, the Northern India actual peak demand deficit was 8.3% and expected to be same in the near future [4].

Installing new power plants is not the feasible solution to remove the gap between supply and demand. To cope with this problem demand side management (DSM) is the viable solution. DSM urges load management on consumer side with respect to time and amount of use so that there is overall reduction in the system peak. Proper execution of DSM activities provides great help in managing balance between demand and supply. Use of Time of day (TOD) tariff is one of the programs under DSM that helps large commercial and industrial consumers to use electricity efficiently.

II. OBJECTIVES OF DSM

The DSM objective is to reduce peak demand of electricity and promote energy efficient tasks. To reduce the over consumption in the electrical network and reduction in the peak demand can be achieved by

- Conservation of Energy
- Betterment of load curve

The DSM programs have the aim of maximizing the end use efficiency to avert/postpone the requirement of new generating capacity.

III. TYPES OF DSM PROGRAMS

Utilities tries to encourage consumers to change their demand profile by shifting demand towards the valley using various techniques available for reducing consumption and reducing peaks in the profile. Major DSM programs are:

- Energy Load Scheduling
- Energy conservation
- Financial benefits

A. Energy Load Scheduling

An increase in the purchase of electrical devices following a better standard of living creates a growing demand for energy in residential buildings. Improper use of these devices causes wastage of energy. One way of handling this is to provide feedback to consumers about their behaviour and another way is the demand side management. In order to accomplish load scheduling it should be kept in mind that user's comfort is not hindered. Meanwhile, loads which are not of user's basic comfort concern could be run at any time of the day considering the wastage constraints.

Load categorization is the first thing done in Energy load scheduling. In this, home appliances are initially divided into three categories, i.e. devices with real time energy consumption, devices with periodic non real-time energy consumption, and devices with non periodic non real time energy consumption [5]. The use of first category of devices is directly related to customer behavior, which means that after the customer turns them ON, the device must be energized until they are turned OFF by the user itself. The energy scheduling of these types of devices cannot be done and they must run immediately to meet customer requirements. Fans Lights, PC's, and television are some examples. The energy consumption of second type of devices is periodical and of fluctuating nature. Refrigerators and Air conditioners are some examples. Their scheduling can be done based on the set value of temperature i.e., they need to switched ON only when the temperature violates the upper and lower limits. Battery devices such as laptops shall also be considered under

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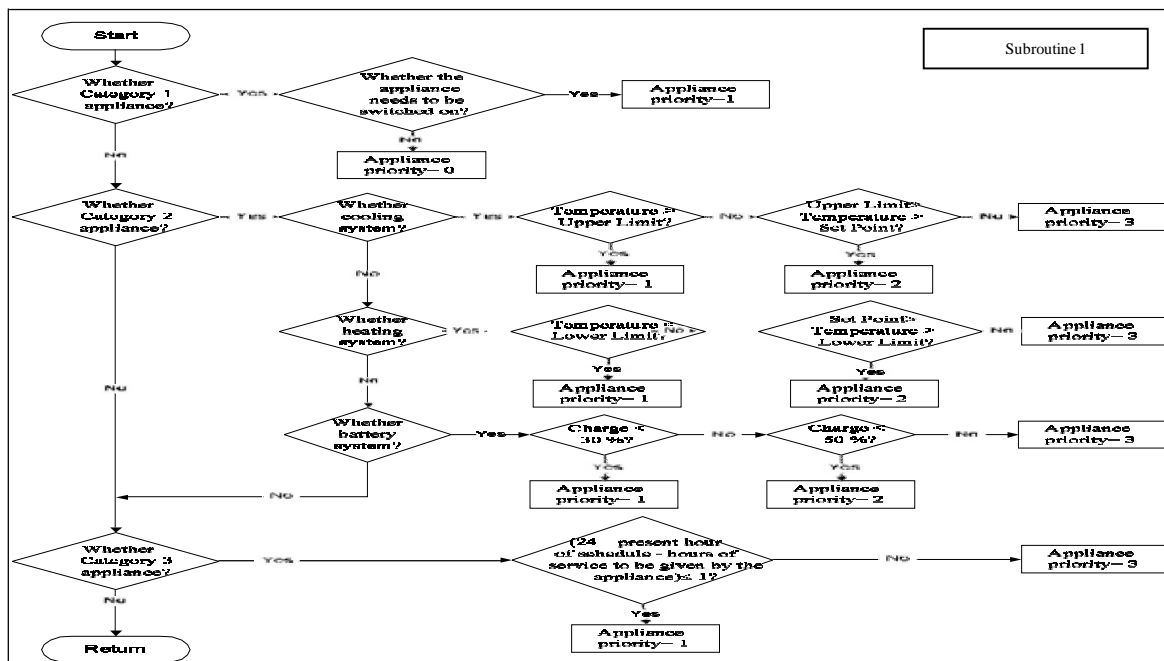
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this category. The third type of devices takes up energy non-periodically and does not have any particular time to run. However, they must serve their purpose before certain time period. PHEV and pool pumps devices come under this category. The first category of devices cannot be controlled as they provide for the basic necessities of life but second and third category of devices are schedulable loads and hence are exploited in the development of scheduling algorithm.

Fig. 1 shows the flow chart depicting subroutine for priority allocation for the different categories of devices.

So based on the priority of the devices, above algorithm can be used to shift the load to off-peak hours in order to avoid peak demand which in turn increases the stability of the system.



B. Energy conservation

In India, we are not able to meet the power demand of many sectors of our economy, in fact we have to perform load shedding and power cut to meet our existing demand. This problem is not likely to be solved in the near future. Load scheduling methods, however helps us to reduce the peak demand by shifting the load towards the valley without even decrease in the total consumption. So these methods are not the only solution to the problem. Setting up a new power plant in India is not easy because of lack of resources and funds and also it requires more time.

A. Lighting

Lighting is the significant part of the energy consumed in all sectors particularly during the peak demand. Lighting load consumes about 50% of the total consumption in commercial areas and 10% in industrial areas. Electricity wastage due to unnecessary lighting should be reduced by taking little measure wherever it is possible. Various places where there is a way to save energy are:

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Colleges and Industries

Huge amount of electricity is wasted in educational institutes. So we need to ensure that the electrical appliances used in the institutes are regulated and there is a proper installation of sensors and automatic switching system in order to save electricity.

Street Lighting

Street lighting in India should be equipped with LDR circuits that automatically switch OFF the lights when Sun rises thereby saving the energy because lights are not switch off at the proper time. Another solution is the replacement of traditional incandescent lamps. These bulbs converts most of the energy into heat and only few percent(around 3-5%) is converted into light.

Festive seasons

During festival seasons, marriages and parties huge amount of energy is wasted due to inefficient lighting system. So there is a need to aware the people about energy crises and motivate them to use efficient lights instead of unnecessary decorative light. One simple solution is to promote daytime function rather than night.

Furthermore, following measures can be taken for conservation of electricity:

- Use of CFL instead of incandescent lamps.
- Use of electronic ballast instead of choke.
- Printing wall with bright colors as it reflect more light.
- Use of Sunlight rather than artificial lighting.

B. Industrial and Agricultural sector

Around 23% of total power generated is consumed by the pumping loads in agricultural sector. Industries in India consume about 50% of total power generated, out of which motor drives consume 65% of power. Therefore main actions should be taken in these sectors. Following steps can be taken to reduce consumption in these sectors:

Variable speed drives

In spite of large improvement in induction motors, there is a need to use variable speed drives. Use of these motors can largely reduce the energy consumption because of the following reasons:

Torque \propto (speed)²
Power \propto torque*speed

i.e. Power \propto (speed)³

So if a pump is running at half of its speed, output gets reduced to square of its speed but power consumption is reduced much more.

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Efficient Induction motors

More than 90% of industrial applications include running of induction motor operating at 85% of full load efficiency. We need to replace these motors with new on operating at 90-92% efficiency. However, these motors are bit costly but their less consumption of power compensates for its cost.

Power factor

Most machines in industries operate at low lagging power factor. Lower the power factor, highest the energy consumption. In order to reduce the power consumption, we must install power factor correction instrument with the load that is responsible for low power factor.

C. Financial Incentive programs

In this program, consumers are charged at different tariff at different times of a day for their energy use[6]. Utilities should offer prices that motivates consumer to use electricity when there is a base load time. High unit rate during peak load time, average rate per unit during base load time and discounted rate per unit if consuming energy during low demand period. This type of scheme should be employed. Steps required to implement this program are discussed below:

- Units of energy used during peak load should be charged highest rate, average rate per unit during base load period and discounted rate per unit during low demand period; hence there should be distinguishable difference between peak load, base load and low demand periods.
- However, some consumers are ready to pay high unit rate during peak load time but still they should not allowed to use energy more than predefined KW say as per their sanctioned limit.
- Time period for which consumers use energy.
- Sum up all the units consumed in a fixed time say one month.
- As Consumer's are the that ultimately use energy, hence he should be able to easy understand the load period i.e. whether peak load, base or discounted load time.

IV. BENEFITS OF DSM

DSM results in lower peak demand and greater saving of electrical energy. Ultimate advantage to consumer, utility and societies are:

- Postpone the need for construction of new power plant.
- Defer high investment to setup transmission and distribution networks.
- Reducing electrical system emergencies.
- Reduces the number of blackouts.
- Less stress on power plant that in turn reduces local air pollution.
- Less stress on plant results in removal of harmful green gas emissions.
- Low cost of generation per unit.
- Network reliability is improved.
- Power plant requires less maintenance.
- Reduction in consumer's electricity bill.
- Enhances the national energy security by reducing the dependency on import of fuel.
- Creation of long term jobs due to new innovative technology.

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V. OBSTACLES IN IMPLEMENTING DSM PROGRAMS

- Since electricity price level and its structure are mainly established by government especially electrical price structure. Hence regional political situation play a major role to decide the policies.
- Government as driving force is responsible for implementation of DSM programs, but their supporting policies and regulation lag behind the practical situation.
- Low awareness of energy efficiency and DSM programs.
- Most of customers are less literate, therefore, not able to understand the future problems.
- Since energy efficient appliances and control drives are costly than standard appliances, hence consumers prefer not to buy costly appliances
- Lack of the communication and trust between utilities and consumers.
- Lack of energy audits hence companies fails to collect reliable information on their current operations.
- Lack of available funds for research and experimental work.

VI. CONCLUSION

DSM has changed the thinking of construction a new power plant to meet the demand. DSM optimization is now being used to control electricity bills of various residential, industrial and commercial users. DSM not only improves the power consumption efficiency but also reduce the energy demand. It is an important method of using available energy resources in a more efficient way. DSM applied to electrical power system can reduces chances of blackouts, mitigate system emergencies, and increase system reliability, reduce energy prices, reduce dependency on imports of fuel and finally contributing to better environment.

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