PEAK SHAVING IN MEEDC INCORPORATING MAJOR INDUSTRIAL CONSUMERS

Ramin Afshar
MEEDC – Iran
aramin2004@yahoo.com

Reza Bavafa Toosi
MEEDC – Iran
rbavafa@gmail.com

Ali Dargahi
MEEDC – Iran
a.dargahi.ir@gmail.com

ABSTRACT

In the current paper, the plan of operating reserve in industries is studied. This plan was conducted with the cooperation of industrial and manufacturing units in Mashhad Electrical and Energy Distribution Company (MEEDC). By accomplishing this plan, the amount of electricity use is declined during the peak hours and transferred to other hours of the day. With this peak shaving, plenty of flaws and defects such as power failures and rolling blackouts and the consequent economic loss and the dissatisfaction among consumers are prevented. So there is no need to build new power stations and spend a great deal of expenditure on supplying the load during peak hours.

INTRODUCTION

Nowadays, one of the challenges of the electric power industry is providing electricity during a peak period. The traditional solution is to establish new power stations and increase the capacity of electrical energy generation which, in fact, requires high investment costs as the resources are limited. The economical solution is the demand side management (DSM) through load management. To achieve this in the area of electrical energy which includes consumer power during on-peak periods especially peak hours, the industries of the country, thanks to their better management along with the short-term and mid-term actions taken, could contribute to the reduction of the difference between the peak and the base load. Therefore, based on the saving potential on consumer side, the idea of operating reserve plan in industries with the cooperation of industrial and manufacturing units was introduced with the aim of reducing the electricity use during the on-peak hours and transferring the load to other hours of the day. Ultimately, by conducting this plan and based on the predictions and the order coming from TAVANIR to reduce the load transmitted by power distribution companies all over the country, MEEDC succeeded in decreasing the load in peak hours by 23 MW. The present paper begins with a description of the value of Demand Side Management followed by an introduction to AMI systems and AMI meters. Then the monitoring software, communication network and the operating reserve plan have been discussed and in the end conclusion and economic consequences are presented.

1. DEMAND SIDE MANAGEMENT

Energy demand management, also known as demand side management (DSM), is the set of interconnected activities of the electric power industry and consumers in order to make the electricity use logical to achieve favorable utility with more efficiency and less expenses. As a result, both the supplier and the consumer of electricity would gain more benefit. However, it should be noticed that the goal of DSM is neither the reduction in generating electricity nor the decline in the level of welfare in the society but it is aimed to result in logical and sensible utility of electrical energy and the proper use which leads to maintaining the same, or even increasing, the level of generation and stabilizing the well-being of the society.

Normally the amount of electricity use among consumers is the same throughout the day and during some hours it is higher while in some others it's less and a high proportion of consumption happens in the early hours of evening. The reason for this increase in consumption would be the electrical appliances and lights coming into the circuit. With the growing use of cooling devices in summer, this rise in electricity use which is known as on-peak or peak hours changes its pattern from the early hours of the evening to the middle hours of the day. During other times like midnight, as a lot of electrical appliances are turned off, the electricity consumption dramatically falls. On the other hand, one of the characteristics of electricity is that in any moment the electricity generation should be proportional to the amount of consumer demand. Therefore, planning to provide electricity should be done in a way that could be responsible for the highest amount of electricity use in order to prevent any disorder in providing electricity for the consumers but due to the significant difference in using electricity during different hours of a day, part of the capacity of the facilities and equipment installed might be redundant and useless during off-peak hours which ultimately leads to the loss of national investments. Thus saving electricity during on peak hours and transferring the load to off peak hours could be of great importance [1].

2.1. Industrial load

Industrial load is defined as the load a consumer unit receives for generating one or a group of goods and similar industrial services. The structures of industrial load could be classified in five groups: light, the process of generation, heating and cooling, and other loads such

as fan, fountain, computers, etc.

2.2. Management of industrial loads

Load management involves activities which make the consumer change the time pattern of using electrical appliances or at least temporarily turn them off. These activities are conducted with the aim of peak shaving or shifting the load from peak to off-peak hours. The electrical industry is one of the infrastructures on which the economy, industrial development and providing social welfare rely. On the other hand, as a result of the considerable increase in using electricity, especially in the recent years, and by considering the shortages in providing the necessary resources in this field, it is essential to determine and implement the best solutions to make electricity use more efficient than before. In this case, industrial consumers that are enjoying a large share in electricity use could contribute to controlling and managing the electrical loads. The nature of electricity use in the area of industry gives it the ability to use less energy and load during peak hours and shift the peak consumption of electricity to an off-peak time. However, the sensitivity of industrial consumers to blackouts and power cuts is much more than other consumers. Thus it makes sense to move the industrial loads to a region where there is less possibility of power failures. Based on this necessity, applying the policies of demand side management in the area of industry seems to be crucial. Implementing the plan of load management leads to a more straight curve in consumption, modification and refinement of load factor, using the resources for generation more efficiently, better marketing operation and preventing unwanted power failures.

2.3. Peak clipping

Refers to the reduction of system peak loads, it is generally considered as the reduction of peak load by means of direct load control. Direct load control is most commonly practiced by direct utility control of customers' appliances. This can be achieved by the use of interruptible rates for large industrial and commercial customers, and by direct utility results in a reduction in peak system load and corresponding decrease in energy demand. Fig.1, shows the effect of peak clipping on the electricity demand.

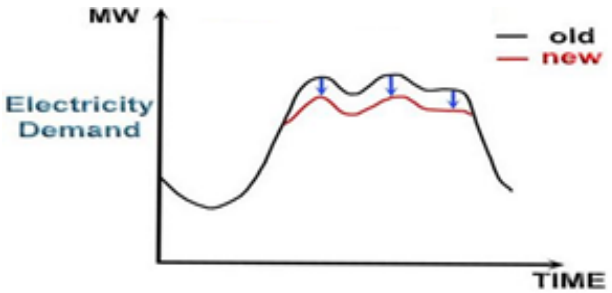

Figure1: peak clipping [2]

2.4. Peak shifting

Peak shifting involves shifting load from on-peak to off-peak periods. Customers are encouraged to shift their loads by methods such as time-of–use (TOU) rates. Some customers respond to TOU rates by changing their method of operation such as by having two work shifts instead of one and thereby spreading out their loads, or by changing technology. Peak shifting results in a reduction in peak load but does not necessarily cause a decrease in energy use. The utilities in Thailand have offered various TOU rates to large customers since the mid-1960s. However, further programs and incentives to customers may be necessary to achieve significant reduction in peak load. Fig.2, shows an example of peak shifting.

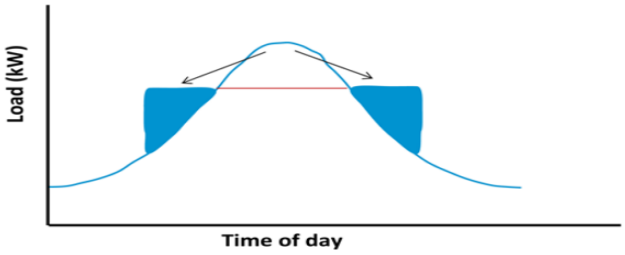

Figure2: peak shifting [3]

3. AMI systems

AMI system is in fact a developed infrastructure which collects information related to energy consumption by measuring the energy used by electricity consumers including household, commercial and industrial consumers and based on this information, provides the possibility of analysis, drawing load curves, reporting etc. The interface of AMI system gives us the opportunity of automatic meter reading and connecting or cutting the current of electricity for consumers. By achieving these purposes via AMI system, the cost of human force that was imposed on electricity distribution companies for entering the data of consumers' energy consumption is omitted from the list of the expenses of energy consumption management. The human force error in energy meter reading, the problem of inaccessible meter when the consumer is not present on the premises and other problems of meter reading by human force are among the issues the AMI system has overcome and these problems have been removed from the system of energy consumption management. The AMI system has a master station where the energy consumption data is collected, saved and analyzed in a database. This master station works through powerful analyzer softwares of the AMI system in order to send controlling or warning commands through interconnected grid to the controller equipment of the system. [4]

3.1. Advantages of AMI systems

3.1.1. Automatic meter reading

Automatic meter reading is one of the functions of AMI

system in order to control and manage the system. This program could be set so that any of the energy quantities including active energy (K wh) and reactive energy (k Varh) in any of the four tariffs, maximum demand in any of the four tariffs, the amount of voltage, current and the coefficient of instantaneous power of each phase (A, B and C), the instantaneous power of each phase (A, B and C) and also other parameters in different periods of time could be adjusted and then the automatic meter reading can be carried out online and the information would be sent to the master station. The time periods of meter reading could be adjusted as per minute, per hour, daily or even monthly.

3.1.2. Remote controlling

By using remote controlling function in AMI system the electricity current of consumers could be connected or cut from the center. One of the other controlling functions of AMI system is that, based on an energy consumption management program, the amount of the load for consumer could be restricted.

3.1.3. Automated warning

The AMI system recognizes the unusual events and sends warning messages to the user in this respect. Some of the approaches being applied in order to warn include sending SMS to the person in charge, sending Email to the system admin, alarm equipped with light and siren installed next to the meter, automated warning to the user of AMI system in Control center.

3.2. AMI meters

One- and three-phase AMI modular meters can register the information related to energy and maximum demand in four tariffs as well as the amount of voltage, current, the coefficient of instantaneous power along with the parameters of network quality. Also, these meters could recognize any type of tampering and warn the Control Center automatically while they record it in the meter events file. One of the other characteristics of AMI meters is using the communication protocol DLMS / COSEM in GPRS, RS 485, PLC GSM modem and optical port. This protocol based on the standard IEC 62056 facilitates the transmission of information in the communication environment between the meter and the equipment of AMI system in a highly secure and organized way. One of its usages is to protect the data related to automated meter reading (sending a message) and remote controlling (receiving the message) of the meter. The benefits gained by using the protocol is that the hackers could not have access to the information on the system as no unknown user would be able to enter and hack the system.

DLMS/COSEM protocol is implemented in all communication parts of AMI system which provides the possibility of connecting different meters as well as the secure maintenance of information on the meters. Only users with approved password can have access to the information of the system.

3.3. Monitoring software

The AMI system software provides the possibility to set parameters, and also register and analyze the information. This collection involves data analyzing and processing tools, statistical analysis, reporting, drawing graphic charts for the system admin.

By using this software, system management, data collection and analysis, records management, remote management, load control management and the maintenance of equipment could be accomplished. Other capabilities of AMI system software include automatic meter reading, remote controlling, automatic warning, the analysis of waste in power transmission line, load control management and the possibility of defining different levels of access to the options and information on the software.

3.4. Communication network

Communication networks are among the infrastructures of AMI system which provides data transmission. This network has a two-way structure which means the collected data from the meter and the commands of the control center are sent through the same network. As it has been mentioned before, since the meters are modular, any of the communication networks might be used. In other words, the network could be chosen based on the environmental equipment and facilities and the available communication infrastructures.

Communication networks of AMI system include:

GPRS/GSM, Zigbee network (for sending and displaying the messages or warnings from the Control Center (Master Station) on In-Home Display units (IHD)

Local Wireless networks (Wimax/WiFi, WLAN), PLC (DLC), Ethernet, PST, RS485

4. The operating reserve plan for industries

The idea of operating reserve plan for industries with the cooperation of industrial and manufacturing units was introduced with the aim of reducing the electricity use during peak hours and transferring the load to other hours of the day. Due to the increase in cooling loads during hot seasons of the year, the peak time in the day has overtaken the night peak time. As a result, the peak period has been transferred from 19 - 23 to 11 - 15. Therefore, industries are planning to decrease the load during peak hours. In other words this method is used as virtual power station when load management is needed. To do this, when the load is increasing, industries reduce the consumption with the cooperation of Mashhad Electricity Distribution Company and prevented the technical problems in the interconnected grids and the economic consequences. Based on some incentive policies, this plan was offered to 131 industrial units with a contract power of one megawatt and higher, and 42

industrial units with the power of 400 kilowatts. From this group only 87 units decided to cooperate. However industries with high sensitivity like seasonal industries were excluded from this scheme.

According to this plan all industrial units were supposed to reduce the load by 25% during peak hours, which were programmed 11 - 15 and 18 - 22 here for the two months of July and August. To accomplish the project, preparing the appropriate conditions in order to monitor and inform all the industrial units and plan accurately was needed which was achieved by the proper actions taken in different stages of the process.

The first step was to hold a meeting to organize the methods and approaches of implementing the whole the scheme with the senior administrators of the organization. Then different work groups were formed on the whole process of conducting this project was examined. These workgroups included strategic work group with the senior managers of the organization, dispatching work group, debt collecting and Ranir, meter installation, IT, demand site management with the demands of the east and west of Mashhad. Afterwards, creation and designing the flow chart of the operative process was carried out as it is shown in Fig. 3.

After the operative process was determined, AMI meters were ordered and six groups of east and west of Mashhad city were equipped to install the meters, and some phone SIM cards were purchased and installed. Instantaneous status of consumed load for each manufacturing unit was recorded. In the next stage, a bridge connecting dispatching and demand side management office to the industrial units was needed so a system for sending text messages and emails and in case phone connection was provided. In order to make sure about the results and predicting the load, the load of each industrial unit was cut just by 2 pm the day before the cooperation and the reduction of the load was done. In this plan, estimation and prediction of the load consumption need was carried out by the electricity market every day during July and August and in case of shortages of load, sharing was done according to the amount needed for the operating industries in order to reduce the load.

As the actions mentioned above were taken, two operators were monitoring the trend of reduction instantaneously through the AMI monitoring software and in case there was not enough reduction in a unit, they were informed and incentive discounts were considered for those cooperating units to be applied in their utility bills by RANIR (Fig. 4).

Finally by implementing the plan and according to the predictions made and the order from TAVANIR to all electricity distribution companies in the country to reduce the load, MEEDC was able to reduce the load by 23 MW during peak hours and prevent problems such as power failures and rolling blackouts which might lead to some economical loss and to dissatisfaction of consumers, without establishing new power stations and spending a great deal of expenditure on providing the load during the peak time.

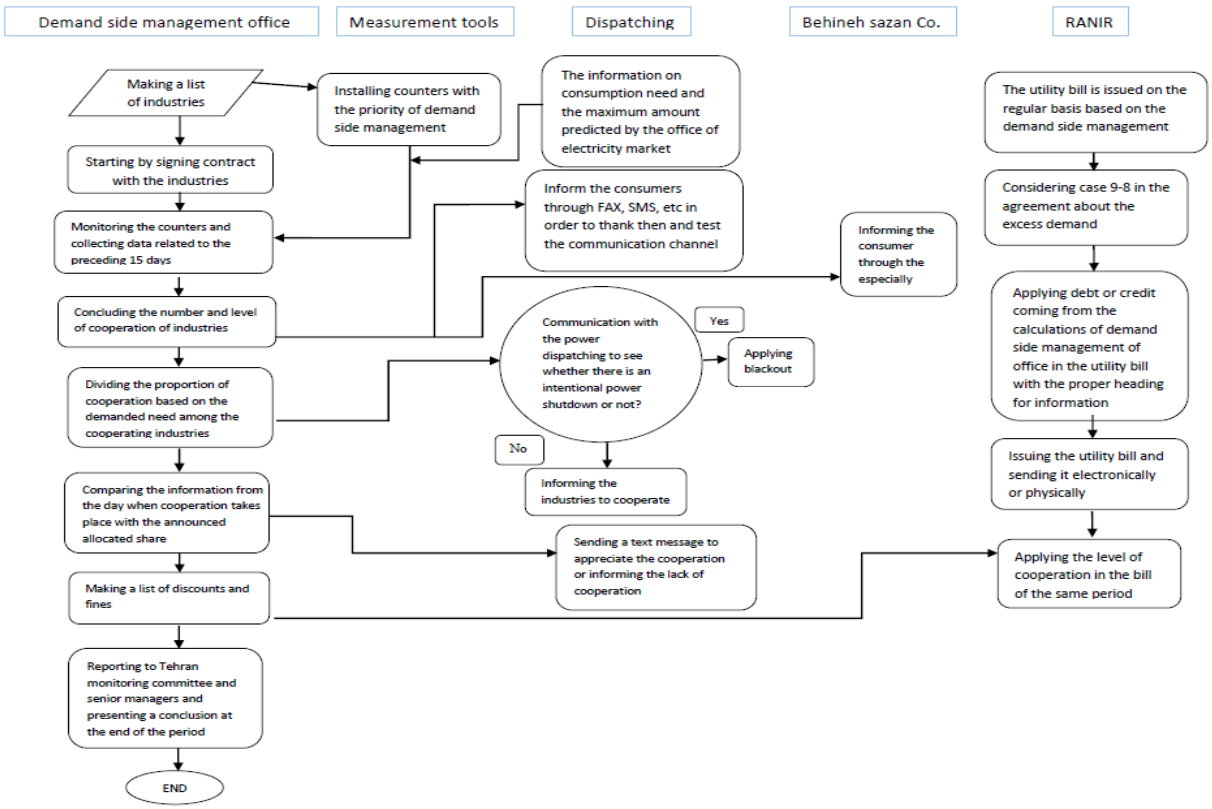

Figure 3: the procedure for operation reserve plan in industries

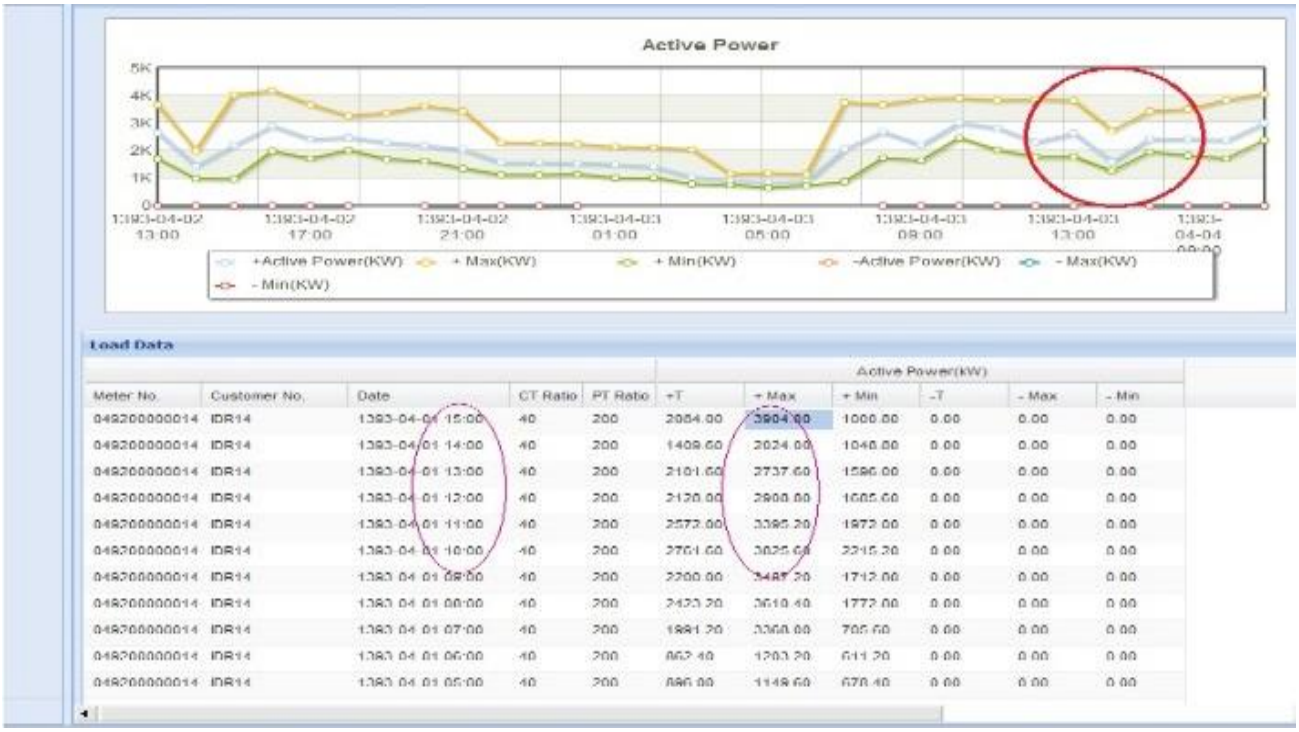

Figure 4: online monitoring software

5. Conclusion and economic results

In this paper operating reserve plan for industries was studied in order to solve one of the biggest challenges in the electric power industry, which is supplying electrical energy needed for the peak periods. This plan has been implemented with the cooperation of industrial and manufacturing units with Mashhad electricity Distribution Company. By accomplishing this program, the electricity use during peak hours was decreased and transferred to other hours of the day. With this peak shaving, plenty of flaws and defects such as power failures and rolling blackouts and the consequent economic loss and the dissatisfaction among consumers were prevented while there was no need to build new power stations and spend large amounts of money to provide the load during peak hours. Based on some incentive policies, this plan was offered to 131 industrial units with a contract power of one megawatt and higher, and 42 industrial units with the power of 400 kilowatts. From this group only 87 units decided to cooperate. Data collection was carried out by using AMI meters and was controlled online by two operators in the dispatching center using the AMI monitoring software and load reduction was organized through the SMS system or by using emails and phone calls. By implementing the plan and according to the predictions made and the order from Tavanir to all electricity distribution companies in the country to reduce the load, MEEDC was able to reduce the load by 23 MW during peak hours.

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