DEMAND SIDE MANAGEMENT

A Thesis submitted in partial fulfillment of the requirements for the Award of Degree of

Bachelor of Science in Electrical and Electronic Engineering

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Certification

This is to certify that this thesis entitled "**Demand Side Management**" is done by the following students under my direct supervision and this work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering. The presentation of the work was held on January 2020.

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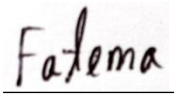

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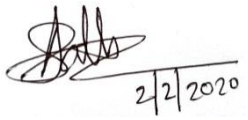

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Dedicated to

Our Parents

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List of Abbreviations

DSM	Demand side management
PURPA	Public Utility Regulatory Policies Act
EPRI	Electric Power Research Institute
DPDC	Dhaka Power Distribution Company
UHI	Urban heat island
EE	Energy efficiency
DR	Demand response
AC	Air conditioner
TV	Television

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ABSTRACTS

Energy crisis is a major problem in Bangladesh, not only Bangladesh it's a common problem all over the world. The consumption of electricity increasing highly day by day. To reduce electrical energy consumption there are some techniques like if the generation of electricity will be increased the consumption of electricity can be reduced. But increasing the generation of electricity involves creating new generating units or new power plant which is very cost effective and also destroyed the natural resources. Another method for reducing energy consumption is Demand Side Management. It is a process by which energy consumption can be reduced easily at a very low or no cost by using no energy resources. By using DSM technique carbon dioxide emission can be also reduced. In this thesis residential area Dhanmondi, Dhaka is taken for applying DSM method. Different types of DSM tools like Energy efficiency, Energy efficiency with solar system, direct load control, Time of use are used for reducing energy consumption. From the DSM tools 'Energy Efficiency With Solar System' is taken as the best method for reducing electrical energy consumption

CHAPTER 1

INTRODUCTION

1.1 Overview

Demand side management is most suitable for reducing energy consumption especially electrical energy consumption due to its characteristics. Not only this but also supplier and consumer can easily help to reduce electrical energy consumption using demand side management techniques. The world is largely dependent on electrical energy. Now a days electricity demand is increasing at a very high rate. For this reason various power plants and techniques are needed to create or production of electricity which are responsible for reducing natural resources. As we have not enough natural resources, the uses of these resources refers to change the climate and the whole natural system is fall into risk. Demand side management is a technique which helps to reduces energy consumption without using any resources and which is not make any change of climate.

1.1.1 History of demand side management

The American electric power industry originally relied heavily on foreign energy imports, whether in the form of consumable electricity or fossil fuels that were then used to produce electricity. During the time of the energy crises in the 1970s, the federal government passed the Public Utility Regulatory Policies Act (PURPA), hoping to reduce dependence on foreign oil and to promote energy efficiency and alternative energy sources. This act forced utilities to obtain the cheapest possible power from independent power producers, which in turn promoted renewables and encouraged the utility to reduce the amount of power they need, hence pushing forward agendas for energy efficiency and demand management [1]. The term DSM was coined following the time of the 1973 energy crisis and 1979 energy crisis. Governments of many countries mandated performance of various programs for demand management. An early example is the National Energy Conservation Policy Act of 1978 in the U.S., preceded by similar actions in California and Wisconsin. After that demand side

management was publicly introduced Electric Power Research Institute (EPRI) in 1980 [2].

1.1.2 Energy consumption in Dhaka city

Energy consumption in Dhaka city is very high compare to the other cities in Bangladesh. Energy is a burning issue for the twenty-first century Bangladesh. With the ever growing demand for energy to cope with a developing economy on one hand and the impact of climate change on the natural environment on the other, ensuring adequate supply of energy and its efficient use has become the key factor for sustainable development. With only 43% electricity coverage country wide, the capital city of Dhaka consumes almost 55% of total generated electricity, the largest share of which is claimed by its domestic sector according to the Dhaka Power Distribution Company Limited (DPDC). Land scarcity and high demand of housing units in this city led to a development trend Characterized by high-density building blocks without the provision of open space and greenery. These buildings are deprived of natural ventilation and lighting provisions and suffer from urban heat island (UHI) effect resulting in higher dependency on artificial lighting and air conditioning.

1.1.3 Energy consumption in the world

In the present situation no one can spend a single day without electricity. The demand of electrical energy of the whole world increasing highly compare to the past. Many countries uses less energy where many countries uses huge amount of energy. So the average energy consumption of the world is much. For this reason the natural resources are destroyed day by day. To reduce energy consumption and improve the efficiency of the whole system demand side management is the perfect method.

1.1.4 Effect of DSM technique

Demand side management is a technique where energy consumption is reduced by the supplier and consumer without make any change in atmosphere. Using this technique green house effect can be also reduced. DSM technique is not cost effective and more reliable and more easy compare to any other techniques. DSM method make balancing between energy consumption and production. So it is clear that there is no bad effect of demand side management technique.

1.2 Problem Statement

When got the topics about Demand Side Management didn't have any idea of this topics after a lot of study and getting help from the teacher had overcome this problem in a few days. After starting research got some problem with collecting data from residential area also overcome this problem by trying very hard. While doing graph in excel also had many problem but after a hard try overcome the problem as well. The main and the big problem faced at the residential area while collecting data

1.3 Objectives

The objectives of this thesis are

i.To investigate the mechanism of DSM

ii.To study about planning, implementing and monitoring activities of DSM

iii.To reduce energy consumption using DSM technique.

iv.To apply different type of DSM method.

v. To help consumers to reducing electricity bill.

1.4 Scopes

The main scope of this thesis is to reduce the energy consumption in distribution side. Essentially, it broadens the scope of planning to integrate the customer's needs and desires with the utility's goals. Here used some method like energy efficiency, time of use, direct load control and load shifting to reducing electricity consumption and improving the efficiency of the system. It also reduces transmission and distribution costs relative to a supply side resource. DSM increases diversity of energy sources.

1.5 Research Methodology

In this thesis DSM technique was used to reduce energy consumption. Necessary data or information should be collected from residential houses as needed. Using these, load curve can be developed. Then different type of DSM tools or method can be used. After applied four DSM tools it was found that each method can be save energy or electricity bill but it was also found that if Energy Efficiency method with solar system (renewable energy) is used the result after calculation is more efficient.

1.6 Thesis Outline

This thesis is organized as follows:

Chapter 1: Overview, Energy consumption in Dhaka city, Energy consumption in the world, Effect of DSM technique, Problem statement, Objectives, Scopes, Research Methodology, Thesis Outline.

Chapter 2: Demand side management, approach to DSM, summary.

Chapter 3: Introduction of literature reviews, Electrical energy consumers in Dhaka, Load management, List of Residential loads, Summary.

Chapter 4: Introduction of analysis, daily energy usages, Impact of DSM tools, summary.

Chapter 5: Introduction of result, result, result after using DSM tools, summary.

Chapter 6: Conclusion, Limitation of the work, future scopes of the work

CHAPTER 2

CLASSIFICATION OF DSM

2.1 Demand side Management

Demand Side Management is a mechanism to influence customer's capability and willingness to reduce electricity consumption. In DSM system there is no use in outer source like power plant. So there is no bad effect of the natural resources and the climate is not change after using this technique. DSM is used by utilities to control the loads
in order to achieve a better overall network performance and to obtain a better match between the available supply and the consumer demand, so that their connection to the grid is scheduled according to the availability or cost of power. In other words, DSM is the implementation of those measures that help the consumers to reduce energy
consumption and cost. Climate change and energy security issues are increasingly moving to the forefront of the political agenda. Historically, there has been a concentration on supply side solutions, but in the face of current high investment costs for many lower carbon power options and the variability of preferred options, such as wind power, energy utilities are looking for alternative ways to meet the growing pressures from governments, stakeholders and the public. Alternative solutions include energy storage, cross-border interconnections and DSM. Most storage technologies are in the early stages of development and interconnections increase the dependence on foreign energy supplies. Hence, there is great potential for DSM to play an important and complementary role [3].

2.2 Approach to DSM

Demand Side Management can be divided into two parts, Demand response (DR) and Energy Efficiency. Demand response means voluntarily reducing demand. No modification is done on the consumer's side. For the market and for energy system

demand response is more essential. On the other hand energy efficiency is the method which main concern is to save energy by using energy efficient appliances. Energy efficiency (EE) is divided into energy efficiency and energy efficiency with solar system and demand response included time of use, direct load control and load shifting. So it is clear that whole DSM system can be divided into five parts. All of the DSM tools are given to the following figure 2.1.

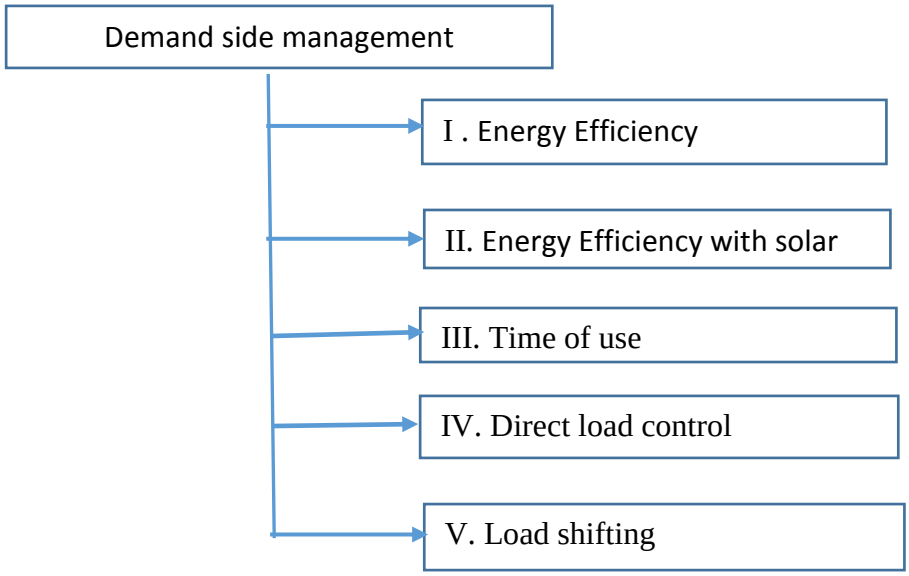

Fig 2.1 Different types of DSM tools

Figure 2.1 shows the different types of demand side management tools.

I . Energy Efficiency

Electrical efficiency is a demand side management tool. In this method normal home appliances can be replaced by energy efficient appliances by reducing electrical energy. On the other hand, Energy efficiency simply means using less energy to perform the same task – that is, eliminating energy waste. The main target of this method is to save electricity bill. There are many benefit of this tool such as: reducing greenhouse gas emissions, reducing demand for energy imports, and lowering our

costs on a household and economy-wide level. Energy conservation can also be included as a part of energy efficiency method. In this method some home appliance are used and these appliances are used in every house and consumer can easily apply this method so there is no needed to control this method of the supply side which reduces the extra pressure of the supplier. The energy efficient appliances are not very costly so consumer can easily replace the normal home appliances like light, fan with energy efficient appliances.

II. Energy efficiency with solar system

This method is works like energy efficiency method. In this method some home appliance are replaced by energy efficient appliance and some of the energy efficient appliance like light, fan are replaced by solar light and fan. This tool is more efficient than any other DSM tools. Consumer can easily use this method which helps to save electricity bill. In this method solar system is needed and the solar system is dependent on the energy source of the sun so there is no need external or other source for charging the battery. The battery is store energy from the sun all day long and gives the efficient result for reducing energy consumption.

III. Time of use

Time of use is another DSM tool. Instead of a single flat rate for energy use, variable price is providing in this method. Time-of-use (TOU) pricing is a variable rate structure that charges for electrical energy depending on the time of day and the season the energy is used. Time-of-use rate plans at all other times will be lower than the peak rate. When the demand is high the price of electricity should be high when demand is low price should be low [8].

IV. Direct load control

Supplier can control the supply of electricity directly in direct control method. If any consumers uses more amount of energy than needed during pick hour supplier can limit that consumer's consumption. Not all the devices are suitable for direct load control. Devices like refrigeration load, heating and cooling devices are suitable for

this. Maximum interruption time can be from 30 minutes to 1 hour and it can be applied for 2-3 times a day. The impact should be small such that it should not be noticed by the consumers [5]. Consumers have no control of this method.

V. Load Shifting

It is the process of shifting load from peak-hours to off-peak hours. In load shifting method load is shifted but it does not make any change in the amount of consumed energy. Demand Side Management programs using load shifting techniques show good potential for reducing the peak loads in the network demand pattern. The aim is to increase the efficiency of the system. By shifting load from peak hours to off peak hour users can easily save money.

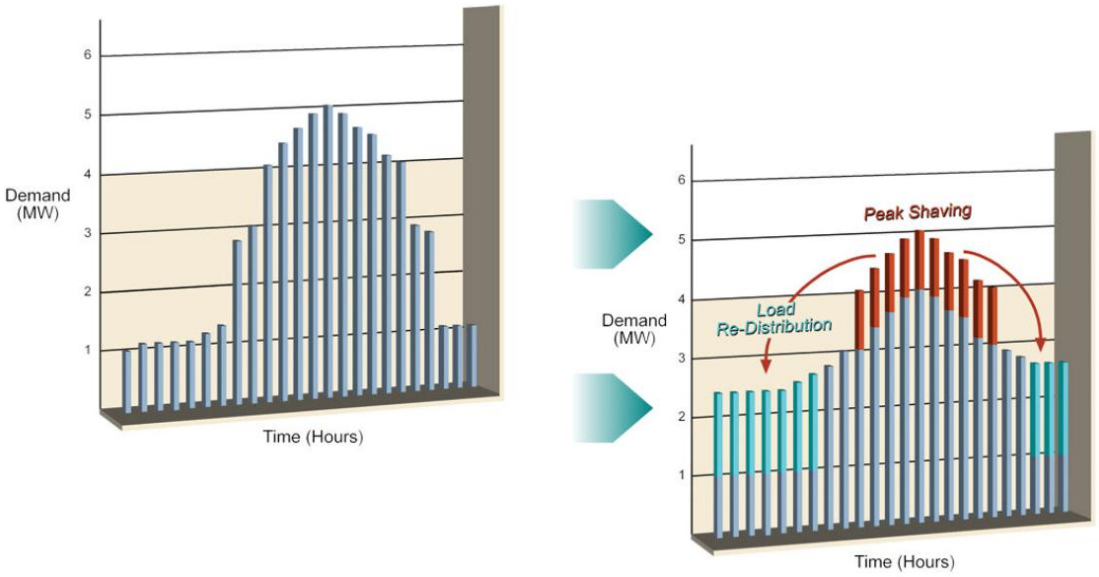

Fig 2.2 Load shifting curve [6]

Figure 2.2 shows the load shifting curve. From the curve the load is shifted from peak period to off peak period. Peak period usually involves higher price of electricity than that during off-peak. So, users can save money by shifting load from peak period to off-peak period. Encouraging consumers to shift their load is done by encouraging consumers or implementing electronic messaging service that reminds consumers about load shifting.

2.3 Summary

In this chapter demand side management technique is discussed. Beside this different types of demand side management tools are also given.

CHAPTER 3
LITERATURE REVIEWS

3.1 Introduction of literature reviews

In the present situation of the world the demand of electricity growing highly. Moreover, the increase of electricity demand by the end-users reduces the reliability, stability and safety of the electricity distribution [7]. Some additional factors enforcing development of new generation grid are the increasing both population and energy demand, global climate change, hardware failures, energy storage problems, reduction in fossil fuel, needs for two-way energy dispatching, electricity production capacity, limitations, and flexibility problems [8]. Demand Side Management (DSM) is a set of techniques applied on the consumer's side to reduce energy consumption. Demand side is the side that demands for electrical energy. The side can be residential, industrial or commercial. DSM issued by utilities to control the loads in order to achieve a better overall network performance and to obtain a better match between the available supply and the consumer demand, so that their connection to the grid is scheduled according to the availability or cost of power. In other words, DSM is the implementation of those measures that help the consumers to reduce energy consumption and cost [9].

3.2 Electrical Energy Consumers in Dhaka

Maximum Electrical energy used is mainly three sector, residential, industrial and commercial. Here residential consumer means that the users under residential area in Dhaka. There are various types of load in residential sector like light, TV, fan, refrigerator, motor, water heater, washing machine etc. A huge amount of electrical energy consumed by residential consumers. A large number of industry situated in Dhaka city. The industrial users used much electrical energy in the industry. Beside these commercial users are also consumed energy. Among those three consumers

residential consumers used more electrical energy. From the following figure 3.1 it is cleared.

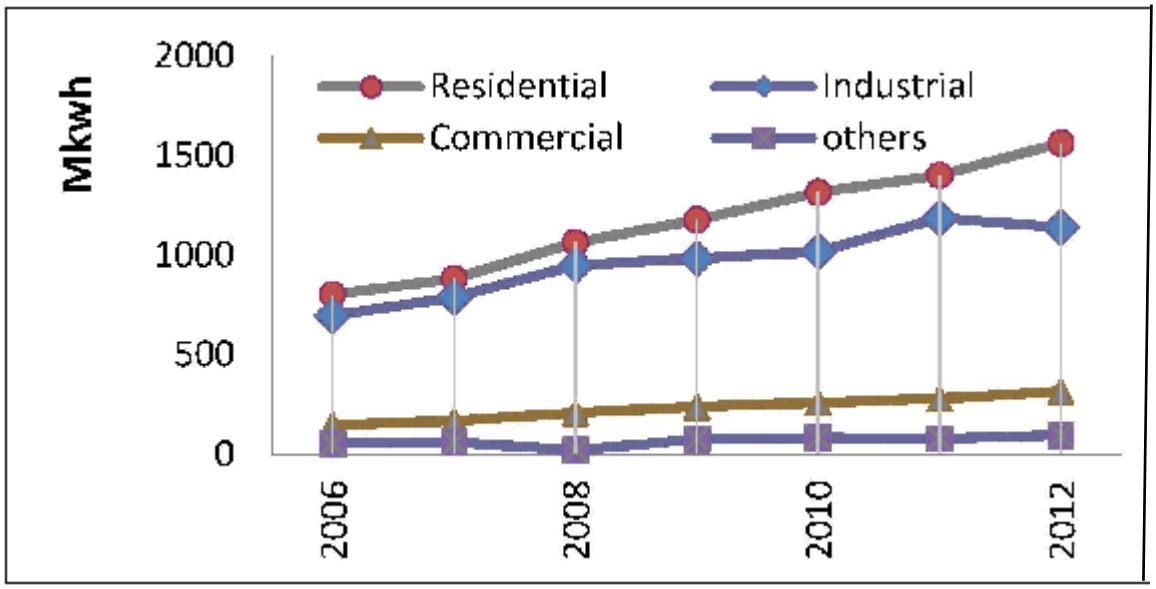

Fig 3.1. Consumption of electrical energy of different consumers in Dhaka [10]

Figure 3.2 shows the electrical energy consumption of different consumers in Dhaka city.

3.3 Load Management

Management of load refers the balanced condition between the demand of electricity and the supply of electricity. The target of load management is to control and reduce peak demand. The meaning of load management and energy conservation are not same. The load management technique is designed to reduce demand or reduce consumption of energy, whereas energy conservation refers to save energy or reducing usage over the entire period. There are several method under load management.

3.3.1 List of Residential Loads

There are various types of loads in residential houses such as light, fan, air conditioner, refrigerator, television, motor, oven, iron, heater and so on. Some of those loads can be shifted from peak hours to off peak hours where some loads cannot be shifted. Some loads can be replaced by energy efficient appliances. According to types of load different demand side management tools are applied.

Table 3.1. Different types of residential loads

Appliances	Power(W)
Air conditioner	1500
Refrigerator	300
Television	200
Fluorescent lamp	40
LED bulb	15
Fan	75
Water pump	750
Iron	3000
Washing machine	1500

Table 3.1 shows the different types of loads which are generally used in residential houses. These loads are not the all loads in a house. Beside these loads there are many others load in a house. But the listed loads are the common loads in every house in residential area. From these, some loads consumed large portion of energy where some types of loads are consumed less energy.

3.4 Summary

This chapter discussed about different type of consumers of electrical energy consumption in Dhaka. Also gave an overview about load management and difference between load management and energy conservation. Then showed a table of various types of residential loads, which are generally used in every house.

CHAPTER 4

ANALYSIS

4.1 Introduction of analysis

For analyzing, 20 residential buildings in Dhanmondi, Dhaka have been taken. After collecting Data from the buildings different types Demand Side Management tools were applied. Every houses has minimum one refrigerator, four or five fan and ten to twelve light. A huge number of energy consumed by these loads. Refrigerator/fridge is kept on in all day long. Beside this another loads are keep on in different period in a day. Load curve have been developed by applying DSM tools. Each tools give different result for same data because every tool contains own characteristics.

4.2 Daily Energy Usages

Different types of appliances are used in a house. Some appliances contains more power in watt and some are not. Some loads like fridge, light, fan are consumed a huge amount of energy because these type of loads are kept on during a long time period in a day. Water pump consumed much energy but it is kept on when needed. Like this iron and blender is not consumed more energy though they rated as much power in watt because these appliance are not use daily and not use for a long period. These loads are used when needed.

Table 4.1 Energy usages in a day of a house

Appliance	Quantity	Power (watt)	Duration (h)
Light	10	40	12
Fan	5	75	14
TV	2	200	7
AC	1	1500	3
Fridge	1	300	24
Iron	1	1200	1
Computer	2	500	1
Water pump	1	750	4
Blender	1	200	1

Table 4.1 shows the energy usages in a day of a house. From the table it is notify that different types of appliances are used in a certain period in a day which capacity are not same. If the usages of the appliances are increases the energy consumption will also increases. Then the load curve is also changed. So according to usages of the appliances the energy consumption will be vary. The daily energy consumption of a house by various appliances are given in the following figure.

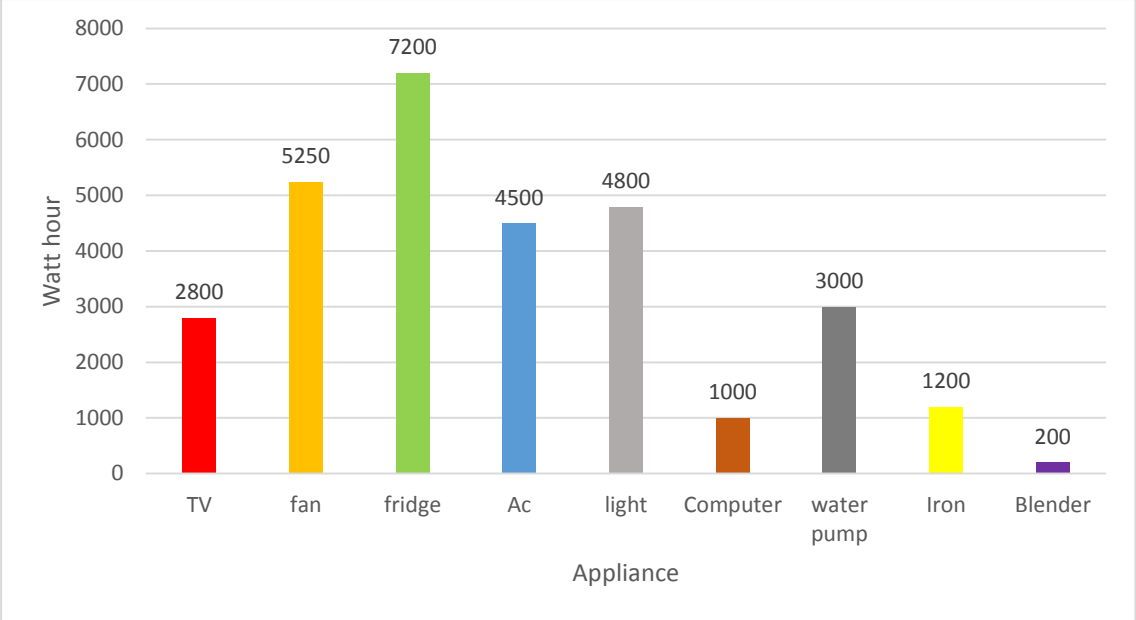

Fig 4.1 Daily energy consumption by various appliance

Figure 4.1 shows the energy consumption by various appliance of a house in a day. From the figure it is clear that fridge consumed maximum energy in a day because it is kept on 24 hours. On the other hand light and fan are also consumed a large amount of energy cause the quantity of these two elements are more compare to the others. Air conditioner consumed more electrical energy if it turn on a several time in a day. But another loads except refrigerator, light, fan, air conditioner consumed small amount of electrical energy compared to those types of loads. The usages of all appliances can be change with season. For example fan is not use in winter season which consumed a huge amount of energy in summer. So energy consumed can be varied with season.

4.3 Impact of DSM tools

A big amount of energy is consumed every day all over the world. The consumption of energy especially electrical energy growing highly rated than production. So if the alternative way for reducing energy consumption is not build up the whole world faces a dangerous problem. Demand side management can be that alternative process for reducing energy consumption. There are different types of DSM tools which plays an important role for reducing energy consumption in different way. A large number

of electrical energy can be saved by using these DSM tools. Some loads like TV, fan can be replaced, some loads such as refrigerator, ac can be used in direct load control method whereas some loads can be shifted in a certain period of a day.

4.3.1 Impact of Energy Efficiency

Energy efficiency is a one kind of DSM tool which is used to reduce electrical energy consumption and also improve the electrical efficiency. In this process some home appliances like light, fan and television are replacing by energy saving appliances. Fluorescent lamp of 40W have been replaced by energy saving LED bulb of 15W, fan have been replaced by energy efficient fan of 31W and TV of 200W replaced by LED TV of 48W. After applying this method the final load curve is given in the following. Here given the load curve of a house in watt hour using energy efficiency for a single day.

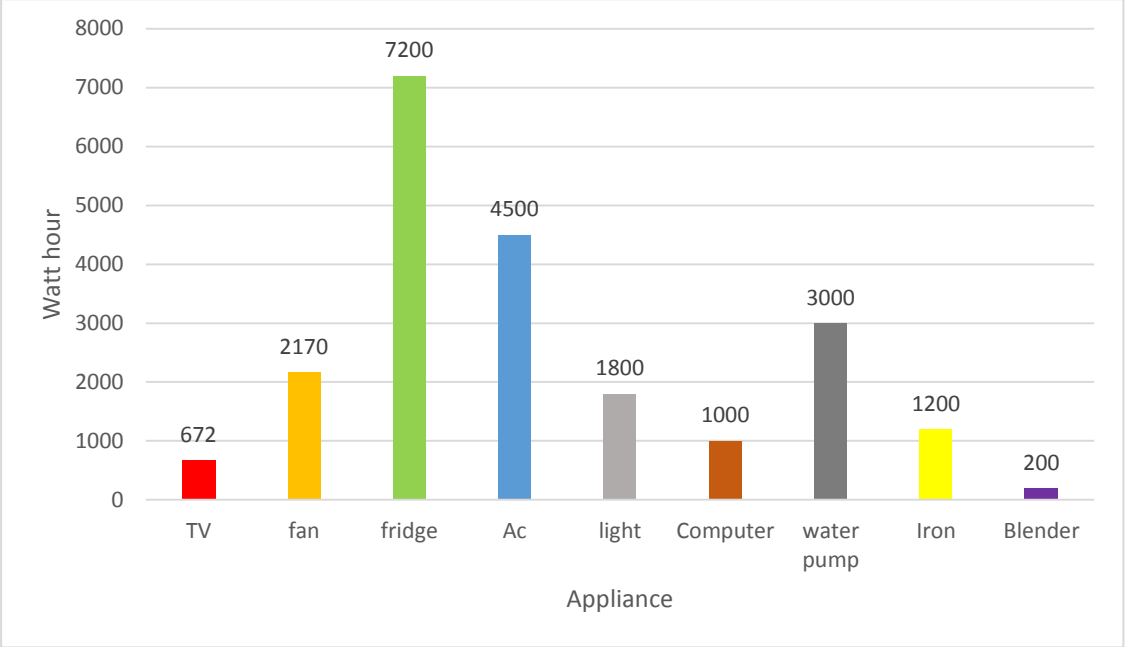

Fig 4.2 load curve after using energy efficiency method

Figure 4.2 shows the daily load curve after applying energy efficiency method. Using this method electrical energy can be saved daily.

4.3.2 Impact of energy efficiency with solar system

This process is also the energy efficient process but in this system some energy efficient light and fan can be replaced by the solar fan and light. Here 10 lights and 5 fans are used. If three lights and two fans are replaced by the solar fan and light the consumption of electrical energy can be more reduced. After applying energy efficient method with solar system the resulted load curve is given in bellow. As only light and fan are used in this case so there is no effect on the other appliances.

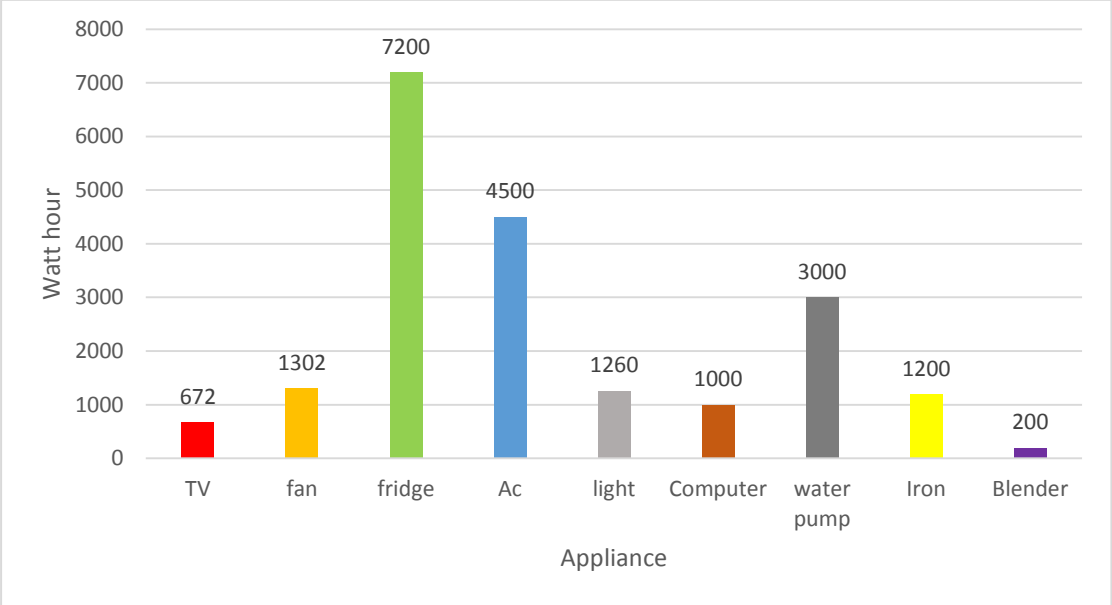

Fig 4.3 load curve using solar with energy efficiency tool

Figure 4.3 shows the load curve of a house after applying energy efficiency method with solar system. From the curve it is clear that fan and lights are consumed a small amount of energy. If this method is used of a house the electricity bill can be reduced at much rated compare to the any other method. The sun power or the energy of sun is needed in this method. So if the consumers use this method maximum amount of energy can be saved.

4.3.3 Impact of time of use

Time of use is another tool of demand side management. According to this method electrical energy consumption can be reduced if the price of electricity is increased when the demand of electricity is high and when the demand is low the price of electricity should be low. If this tools can be applied in winter season the electricity bill will reduced because the demand of electricity is lower in winter season.

4.3.4 Impact of direct load control

In direct load control method supplier can be control the supply. For this reason some loads like fridge and ac can be kept off for a certain period in a day by the supplier. As the time period is very short the appliances are not affected. The electrical energy consumption is high at night of a house. Here AC is turned off for half an hour at night and fridge is also kept off for 30 minutes at night and 30 minutes at day. After applying this DSM tool the load curve is shown in figure 4.4

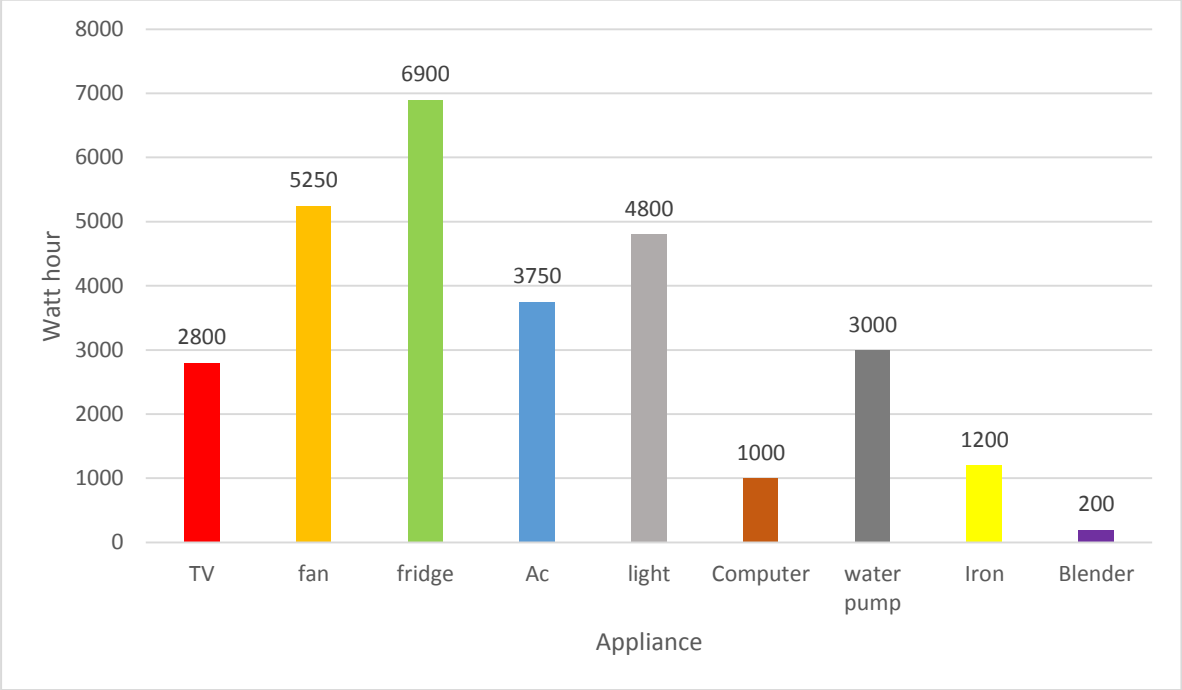

Fig 4.4 Daily energy consumption load curve using direct load control

Figure 4.4 shows the daily energy consumption load curve after applying direct load control method. From the curve it is noticed that a little portion of energy is saved by the fridge and air conditioner compared to the previous load curve. But if this small portion of energy can be saved daily, after many days this small amount of energy is converted into a large amount of energy which helps to reduced energy consumption. Consumers cannot control this method so the supplier can easily maintain this method. The consumers cannot use extra loads which are not needed. So energy consumption is reduced easily by the supplier and the consumers can save electricity bill.

4.3.5 Impact of load shifting

Load shifting is a process where some loads can be shifted from peak hours to off peak hours. Load shifting is also a DSM tool. According to this method total energy consumption cannot be changed but using this method the efficiency of the system can be improved and when energy consumption is comparatively high some loads like heater, water pump can be shifted to the portion where energy consumption is low. Applying this method water heater and water pump can be shifted to off peak hours (11:30pm-6am) from peak hour (5pm-11pm) and using this method there may be balancing condition between peak hours and off peak hours. Though load shifting method do not reduced the energy consumption directly but consumers can easily reduce peak hour cost by using load shifting method which help the consumers to save money and reduced the pressure of peak period. In demand side management system load shifting tool is used to show good potential for reducing the peak loads. By bringing both supply and demand to the possible low value the aim is to increase the efficiency of the system and reduces the loads from peak hours.

4.4 Summary

In this chapter firstly focused about daily energy consumption of residential houses by various home appliances and given a table of daily energy usages of a house. Then discussed about the impact of different types of demand side management tools and showed various energy consumption load curve applying DSM tools.

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 Introduction of result

After applying various types of demand side management tools final results are calculated. For calculation collected data from residential houses are taken. Here results are calculated in unit system of a house using various home appliance. One unit is equal to 1 kWh. Previous energy consumption load curve values are needed for calculation. As different types of DSM tools like energy efficiency, energy efficiency with solar system, direct load control are used for calculation, so the resulted values after calculation should be also different. After calculation the difference or comparison between the DSM tools and before using DSM tools will be given. Mostly common appliances are used for calculation which are daily used in every house. For energy efficient method light, fan and television are used, for energy efficient with solar system method light and fan are used, for direct load system method refrigerator and air conditioner are used and for load shifting method water pumped is used here. Only in load shifting method no energy consumption is reduced but load is distributed from peak period to off peak period which helps consumer to save money. As the DSM method is not cost effective and external source or power plant are not needed, the result after using this method is also very efficient. Here the calculation is done only based on the collected data from residential area Dhanmondi, Dhaka. But this calculation may be used in every sector based on the data.

5.2 Result

One house is considerate as reference from Dhanmondi 32 residential area, Dhaka. Result is obtained before using DSM tools and also after applying DSM tools. After calculation the final result is given in unit system. Then which method reduced how much energy consumption also given with percentage. The result may be varied according to the loads. If the number of appliances or loads are increases or decreases and the usages of these loads are increases or decreases the resulted values are changed.

One unit = 1kWh

1kWh = (watt*hour)/1000

Daily average energy consumption of a house,

Calculation before using DSM tools:

Energy consumption for light: Here 10 lights of 40W are taken which are kept on for 12 hours

So, daily energy consumption by light,

= 40W*10*12h

= 4800Wh = 4800Wh/1000

= 4.8kWh or 4.8 units

Energy consumption for fan: 5 fans of 75W kept on for 14 hours.

Daily energy consumption by fan,

= (5*75W*14h)/1000

= 5.25 units

Energy consumption for AC: 1 AC of 1500W is kept on for 3 hours

Energy consumption by AC,

= (1*1500W*3)/1000

= 4.5 units/day

Energy consumption for TV: 2 TV of 200W are used which kept on for 7 hours

Daily energy consumption by TV,

= (2*200W*7h)/1000

= 2.8 units/day

Energy consumption for fridge: 1 fridge of 300W is used which is kept on 24 hours.

Daily energy consumption by fridge,

= (300W*24h)/1000

= 7.2 units/day

Energy consumption for water pump: one water pump of 750W is kept on for 3 hours.

Energy consumption by water pump,

= (750W*4h)/1000

= 3 units/day

Energy consumption for computer: 2 computers of 500W is used for 1 hour.

Energy consumption by computer,

= (2*500W*1h)/1000

= 1 unit/day

Energy consumption for iron: 1 iron of 1200W is used for 1 hour.

Energy consumption by iron,

= 1200W*1h/1000

= 1.2 unit/day

Energy consumption for blender: one blender of 200W is kept on for 1 hour.

Energy consumption by blender,

= 200W*1h/1000

= .2 unit/day

Table 5.1 Daily energy consumption before using DSM tools

Appliance	TV	FAN	AC	FRIDGE	LIGHT	WATER PUMP	COMPUTER	IRON	BLANDER
Unit	2.8	5.25	4.5	7.2	4.8	3	1	1.2	.2

Table 5.1 shows the daily average energy consumption of a house before using DSM tools. Some appliances are used in energy efficient method and energy efficiency with solar system, some are used in direct load control method and some are used in load shifting method.

Total average energy consumption per day of a house,

= (4.8+5.2+4.5+2.8+7.2+3+1+1.2+.2) units

= 29.9 units

This is the value of daily average energy consumption before applying DSM tools.

5.2.1 Result after using DSM tools

Here, energy efficiency, energy efficiency with solar, direct load control and load shifting method are used for calculation. Each tool gives the different result after calculation.

Calculation after using energy efficiency method

After applying energy efficiency method daily average energy consumption values are given. Light, fan and TV are used in this method. Light of 40W replaced by energy efficient LED bulb of 15W, replacement of fan of 75W with energy efficient fan of 31W and TV of 200W with 48W.

Daily average energy consumption by energy efficient light,

= (10*15W*12h)/1000

= 1.8 kWh

= 1.8 unit

Daily energy consumption by energy efficient fan,

= (5*31W*14h)/1000

= 2.17 units

Daily energy consumption by energy efficient TV,

= (2*48W*7h)/1000

= .672 unit

Total energy consumption after using energy efficiency method,

= (1.8+2.17+.672+4.5+7.2+3+1+1.2+.2) units

= 21.74 units/day

Calculation after using energy efficiency with solar system

Only light and fan are used for calculating this method. From 10 energy efficient lights 3 lights are replaced by solar lights and 2 fans are replaced by solar fan out of 5 energy efficient fans.

Daily energy consumption by light,

= (7*15W*12h)/1000

= 1.26 units

Daily energy consumption by fans,

= (3*31W*14h)/1000

= 1.3 units

Total energy consumption after using energy efficiency with solar system,

= (1.26+1.3+.672+4.5+7.2+3+1+1.2+.2) units

=20.33 units/day

Calculation after using direct load control

Using direct control method AC is kept off for 30 minutes and fridge is kept off for 1 hour in a day.

Daily energy consumption by fridge after using direct load control,

= (300W*23h)/1000

= 6.9 units

Daily energy consumption by air conditioner after using direct load control,

= (1500W*2.5h)/1000

= 3.75 units

Total energy consumption after using direct load control method

= (6.9+3.75+2.8+4.8+5.25+3+1+1.2+.2) units

= 28.9 units/day

Calculation after using load shifting method

In this method load is shifted from peak hour to off peak hour but total energy is not changed. Peak period contains higher cost of electricity compare to the off peak period. If water pump is shifted for half an hour from peak hour to off peak hour,

Energy shifted by water pump,

= 3-(750*3.5)/1000

= .375 unit

Table 5.2 Comparison between without DSM tools and DSM tools

Without DSM Tool	Energy efficiency Method	Energy Efficiency with solar system	Direct load control	Load shifting
Total energy consumed per day = 29.9 units	Total energy consumed per day = 21.74 units	Total energy consumed per day = 20.33 units	Total energy consumed per day =28.9 units	Total energy Shifted per day = .375 units
No energy saved	Energy saved = (29.9-21.74) = 8.16 units/day	Energy saved = (29.9-20.33) = 9.57 units/day	Energy saved = (29.9-28.9) = 1 unit/day	.375 unit shifted from peak hour to off peak hour

Table 5.2 shows the comparison between DSM tools and without DSM tools. From the table it is clear that after using DSM tools a large number of energy is saved. Now if the result are given with percentage after using Energy Efficiency method 27.29% of daily energy consumption can be reduced. Using energy efficiency with solar system method 32.01% energy consumption can be reduced of daily energy consumption. 3.34% energy can be saved using direct load control method.

5.3 Discussion

Different type of demand side management tools are used for saving energy. From the calculation it is easily said that among all the DSM tools energy efficiency with solar system is much more preferable just because in this method more energy can be saved in a day. In this method total number of 9.57 units are saved among 29.9 units in a day. Using this method consumers can be save more money and can reduce extra electricity bills which improve the overall electrical efficiency of the system and also reduces the pressure of the supplier to fulfill the consumers demand.

5.4 Summary

This chapter discussed about result and calculation of different DSM tools. After the calculation comparison between DSM tools and without DSM tools are given. Finally among all the DSM tools energy efficiency

CHAPTER 6

CONCLUSIONS

6.1 Conclusions

Different types of DSM tools: Energy efficiency, Energy efficiency with solar system, Direct load control, Load shifting are used in this thesis. After applying those method it is seen that energy can be saved by using all of the tools. But among those DSM tools, Energy efficiency with solar system method gives the better result. By using this method a large portion of energy can be saved easily by replacing some energy efficient appliance with solar appliances. 32.01% of daily energy consumption can be reduced by using this method. So to reduce energy consumption this method should be given priority. Using Energy efficiency method 27.29% energy can be saved whereas by using direct load control method 3.34% of daily energy consumption can be reduced. Beside these by using demand side management tools carbon dioxide emission can also be reduced. Though there are several techniques for reducing and saving energy, each technique is costly and most of the techniques increase the dependence on foreign country which is burden for government. Demand side management is the only mechanism which contains a little or no cost and gives the better and efficient result. So it is easily say that DSM is better than any other technique and carries good potential for reducing energy consumption.

6.2 Limitations of the Work

In our work there is a few limitation. Energy efficiency with solar system is a method where solar system is used with energy efficiency method. So season wise it may be change. As solar battery is store energy from the sun, so for rough weather like rainy season and winter season when sun is not rise for a long period the solar system will not give the expected result. In this system energy is storage by solar battery from the

sun only day. Beside these as we developed load curve based on collected data from residential area there may be some error in the curve.

6.3 Future Scopes of the Work

Future scopes involves DSM for commercial and industrial users, load shape management, solar system, peak and off peak pricing.

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