OPTIMIZATION OF THE ELECTRICAL POWER CONSUMPTION FOR THE DOMESTIC CONSUMERS USING CUTTING-EDGE TECHNOLOGY

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Abstract— the development in power sector of Bangladesh is relatively slow after liberation war in 1971.The supply of resources is always limited to meet the demand for fast growing population of this country and also the economic and political instability influence the growth of power sector as well. 48.5% people of Bangladesh get the opportunity to use electricity [1].Based on the types and brands of household appliances, the power consumption is different. Most of the household devices are not much energy efficient. The major objective of this project is to survey the electrical power consumption of the domestic consumers and to make comparison of power consumption and efficiency of same sized domestic appliances of different types. Data comparison chart has been made from the collected data. From the chart, proper efficiency, electric bills and monthly bills also calculated. A survey has been conducted in different area of Dhaka city to find out consumer average usage based on income of consumers. Survey data was analyzed to find out the demand of power and percentage of consumer home appliance usage in home. Also, load duration curve has been done to find out total load in home according to the seasonal basis using HOMER. By analyzing the survey results and secondary data, electrical power consumption has been optimized by the most energy efficient home appliance for the domestic users. Besides suggestion of the alternatively improved and energy efficient solution has been given.

Index Terms— Power optimization, Home appliance, Product Comparison, Common Home appliance efficiency, Load demand analysis, Homer software, Load demand forecast,Smart Distribution

1 INTRODUCTION

The development in power sector of Bangladesh is relatively slow after liberation war in 1971.The supply of resources is always limited to meet the demand for fast growing population of this country and also the economic and political instability influence the growth of power sector as well. 48.5% people of Bangladesh get the opportunity to use electricity [1]. The total capacity of our country is 8100MW while the total supply is 4392MW and peak supply is 5904MW (March 2013) where the peak demand is 6500MW. Till 2012 financial year, the electricity growth was 10% (average 7% since 1990). If this continues, total demand will be 14000MW within 2016 where the total supply will stand into 12000MW which is shown in figure 1.1. [1]. Due to shortage and unreliable power between demand and supply, sustainable economic growth has been constrained.

It has been observed that almost half of the electricity is consumed by the domestic appliances. Average household appliances such as Light, Fan, Refrigerator, Television, Radio, Stereo Players, Computers, Laptop, Air-conditioner, and Water pump, Cooking Devices etc. Based on the types and brands of household appliances, the power consumption is different. Most of them are not energy efficient. The goal of this thesis is to survey average household appliances power consumption and to reduce the power loss among them by introducing upcoming technology. Improving of the efficiency of household appliances will reduce the electricity bill of average household appliances. If the average power consumption of household appliances will reduce, the maximum demand will easily meet of a city as well as the country. In this project, consumers will be introduced with the most energy efficient household appliances for home.

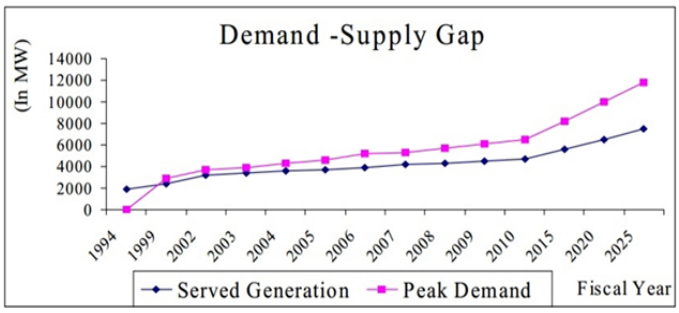

Figure 1.1: Demand-Supply Gap in power sector in Bangladesh

Optimization means finding an alternative way with the most cost effective or highest achievable performance under the given limited resources, by maximizing desired factors and minimizing undesired ones. In comparison, maximization means trying to achieve the maximum result without regard to cost or expense. Optimization of electrical power consumption means optimize the electrical energy consumption by using efficient technologies with cost effective way. Optimization of electrical power consumption can be done by using

efficient home appliances. The maximum demand can be decrease if the power consumption of home appliances will reduce.

2.1 Obejctive of This work

The main objective is to make a comparison of power consumption and efficiency of different household appliances and suggest the alternative improved energy efficient technology for domestic users. The primary objective of this thesis is to collect the data set of power consumption, their average usage, efficiency, monthly bills and initial costing of different household appliances according to their type and size. Comparison data set of each household appliance for their different types is made on the basis of the primary data. The secondary objective is to suggest the efficient and alternative path for the state of art home appliance which will reduce the energy cost as well as the energy demand and also suggest Smart Home Energy Management System which helps the consumers and the electrical energy providers to monitor report and also take action according to the report.

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2.2 Future Scope of this Study

In this thesis, we surveyed electrical power consumption of different types of home appliances and suggested the alternate improved and energy efficient solution for those. There is a large opportunity of working in this area for the development of efficient usage of home appliances in future. A Smart Home Energy Management System can be solution of optimized energy usage which can provide prompt, convenient feedback on electrical energy use and save energy. The Smart Home Energy Management System will be divided into two parts, Smart Meter and Home Area Network (HAN) [8]. The Smart Meter will display cost of energy used and estimates of greenhouse gas emissions. Smart Meter will be connected to HAN which can monitor, control and optimize energy usage. There will be a two-way communications with the meter, one with the HAN and other with the Smart Grid which will give feedback to the main monitoring system [8]. Future scope of this study is to design a Smart Home Energy Management System (SHEMS) which will help to optimize the electrical power consumption of home appliances and ensure the best usage of them.

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2.3 Methodology

Energy efficiency is recognized as a key to achieving sustainable development in both industrialized and developing countries. The most optimum route to sustainable development of the energy system therefore is a "low energy path", meaning that nations should try "to produce the same level of energy service with as little as half the primary energy currently consumed" [World Commission on Environment and Development,1987][8].

In Bangladesh, as in other parts of the world, electricity for lighting contributes a large share to evening peak loads. Of the total connected load, 43% is consumed by households, mostly for lighting purposes [8]. Therefore, end use efficiency measures and programs centering on household electricity consumption could have substantial impacts. Some end use efficiency measures have been undertaken in Bangladesh. However, financial barriers, institutional rigidities and awareness continue to act as deterrents.

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2.4 Data Analysis

Electrical energy is consumed in a household for different purposes and to drive different devices such as electric lights, fans, television, radio/stereo players, air-conditioners, refrigerators, freezers, electric irons, ovens etc. Total energy consumed depends on the wattage of these devices and the amount of time that they are used every day.

This survey listed the different appliances used in the sampled households, the periods for which they are used and the wattages of the equipment. A weighted average of the number of devices, their usage time and wattage were calculated and recorded. Afterwards detailed estimations were categorized according to income levels and compiled into Tables for each of the survey areas, as example data for lights given below.

TABLE 1.1:CHART FOR DIFFERENT TYPES OF LIGHTS

Type	Incandescent	Halogen	Compact Fluroscent LAmp	LED (Ge-neric)
Power con-sumption (W)	60 W	42 W	13 W	9 W
Lumens	860	570	660	900
Lumens/watt	14.3	13.6	50.8	100
Color tem-perature (k)	2700	3100	2700	3000
Life spam (Hour)	2,000	3,500	8,000	25,000
Initial Cost-ing (TK)	360	360	360	360
Monthly Bills (5 TK/Unit)	108	75.6	23.4	16.2
Monthly Savings (TK)	0	32.4	84.6	91.8

Table 1.2: Power Consumptions of Different types of light with Different Lumens

Minimum light output (lumens)	Electrical power consumption (Watts)		
	Incandescent	Compact fluorescent	LED
450	40	9-13	4-9
800	60	13-15	10-15
1,100	75	18-25	Not available
1,600	100	23-30	Not available
2,600	150	30-52	Not available

From table 1.2 it is found that income below 19,999 number of CFL used 18 and Incandescent used 24. Income between 20,000 to 39,999 total numbers of CFL used 16 and Incandescent used 39.Income between 40,000-49,000 total numbers of CFL used 20 and Incandescent used 31 and above 50,000 total number of CFL used 16 and Incandescent used 22.

Similarly, comparison and survey chart have been found for different types of common home appliances like air-conditioner, TV, fridge etc. based on consumer income

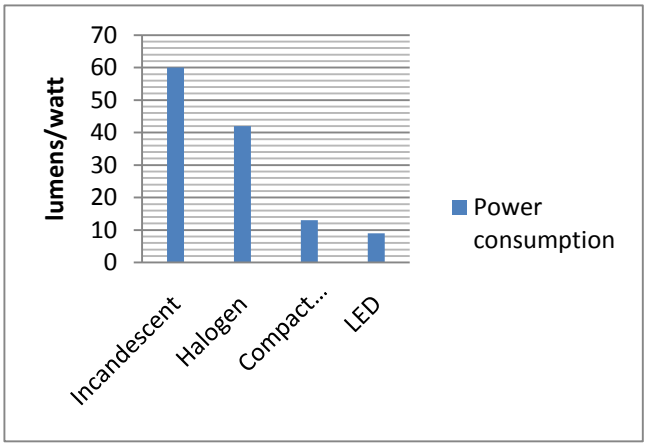

FIGURE 1.2:POWER CONSUMPTION OF DIFFERENT TYPE OF BULB

TABLE: 1.3 SUR VEY DATA FOR TOTAL NUMBER OF BULB USED IN A HOME.

Household Income (Tk.)	Number of households surveyed,	Total number of Bulb used in a home	∑ x
Below 19,999	13	3 + 4 + 4 + 5 + 2 + 3 + 3 + 3 + 3 + 2 + 2 + 4 + 4	42
20,000-39,999	17	3 + 3 + 4 + 4 + 5 + 3 + 4 + 4 + 3 + 5 + 3 + 4 + 5 + 4 + 4 + 3 + 3	64
40,000-49,000	12	4 + 4 + 3 + 5 + 6 + 6 + 4 + 4 + 5 + 3 + 3 + 4	51
50,000-Above	8	7 + 6 + 5 + 4 + 5 + 6 + 4 + 7	44

From table 1.3 it is found that income below 19,999 the highest number of bulb used is 5, income from 20,000 to 39,999 the highest number of bulb used is 5, income from 40,000 to 49,000 highest number of bulb used is 6 and income above 50,000 total number of bulb used is 7.

TABLE 1.4: SURVEY DATA FOR NUMBER OF TYPES OF BULB USED IN HOME

Household Income (Tk.)	Number of households surveyed	Total number of home appliances used			
		CFL	LED	Halogen	Incandescent
Below 19,999	13	18	0	0	24
20,000-39,999	17	16	0	9	39
40,000-49,000	12	20	0	0	31
50,000-Above	8	16	0	6	22

From table 1.4 it is found that income below 19,999 number of CFL used 18 and Incandescent used 24. Income between 20,000 to 39,999 total numbers of CFL used 16 and Incandescent used 39.Income between 40,000-49,000 total numbers of CFL used 20 and Incandescent used 31 and above 50,000 total number of CFL used 16 and Incandescent used 22.

Similarly, comparison and survey chart have been found for different types of common home appliances like air-conditioner, TV, fridge etc. based on consumer income.

2.5 Result

Some typical loads in a home are assumed and the load curves are calculated according to the usage of the home appliances. Load duration curve is important for this thesis to find out the peak load of a home. It helps to find and compare demand and supply gap in a home. It also helps to find out average and maximum peak of load

For a typical home the load is calculated for two season, summer and winter. Because there are huge difference between the usages of home appliances in these season.

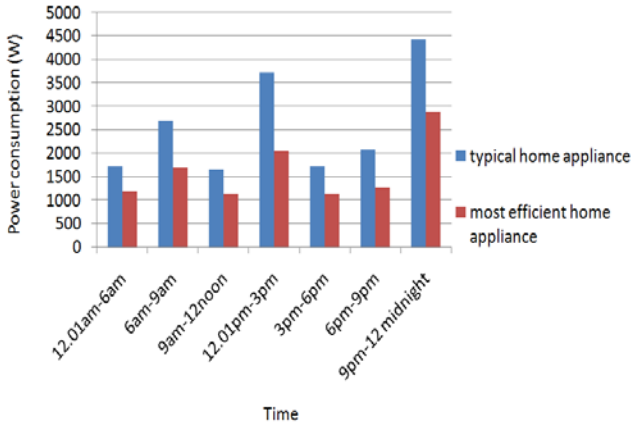

Figure 1.3: Forecasted Maximum Daily Demand Comparison between typical and most energy efficient home appliances during summer

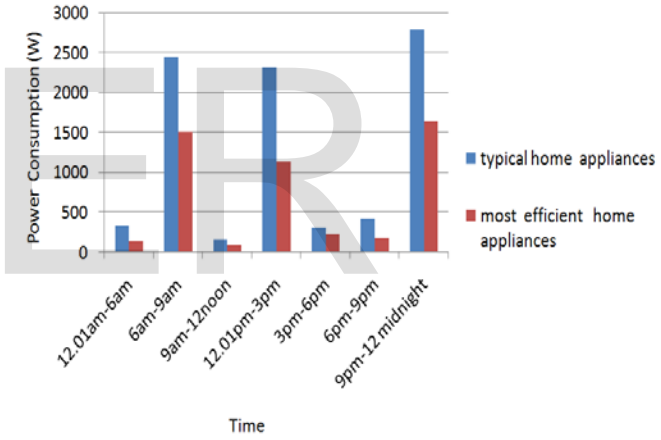

Figure 1.4: Forecasted Maximum Daily Demand Comparison between typical and most energy efficient home appliances during winter

Load duration curve is done according to data collected for common home appliances. The total number of 10 houses power consumption data considered to do a load curve. The load curve is done for two types of appliance one is typical and another is most efficient technology.

Here we assume a typical home has six lights, four fans, one refrigerator, one T.V and one water pump.

Among these houses we consider five house use A.C.

Total no of House: 10
Total no of people: 50

Table 1.5: Connected load for typical appliances

Appliance	No of appliance	Power ratings	Total Power
Light	6	60 w	360
Fan	4	120 w	480
Refrigerator	1	54.3 w	54.3
T.V	1	88.56 w	88.56
Water Pump	1	2200 w	2200
			3.18 KW

Table 1.6: Connected load for latest technology

Appliances	No of appliance	Power ratings	Total Power
Light	6	9 w	54
Fan	4	40 w	160
Refrigerator	1	37.8 w	37.8
T.V	1	38.8 w	38.8
Water Pump	1	370 w	370
			0.6606 KW

Total Load connected for Home:

There is 1 AC on average of every 10 houses (For typical) = (5*1400) =7000 W=7KW

(For most efficient technology) = (5*980) = 4.9KW

For Typical appliances= (50*3.18) +7 = 166 KW

For Latest technology appliances= (50*0.6606) + 4.9 = 37.9 KW

2.6 Load Curve

THE LAOD CURVE HAS BEEN DONE IN HOMER SOFTWARE ACCORDING TO COLLECTED DATA FROM COMMON HOME APPLIANCES FOR 24 HOURS IN 12 MONTHS.

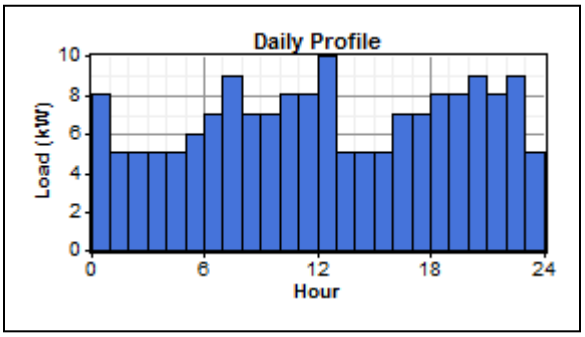

Figure 1.5: Load curve duration for typical home appliances from October to February

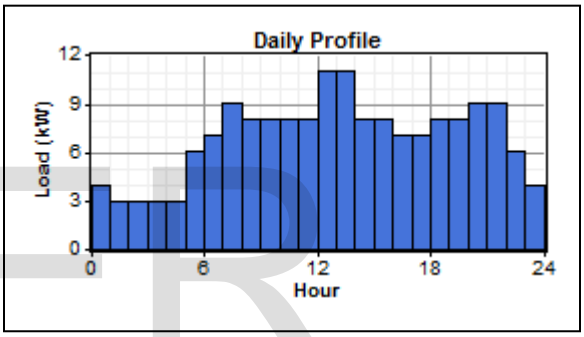

Figure1.6: Load curve duration for typical home appliances from March to September

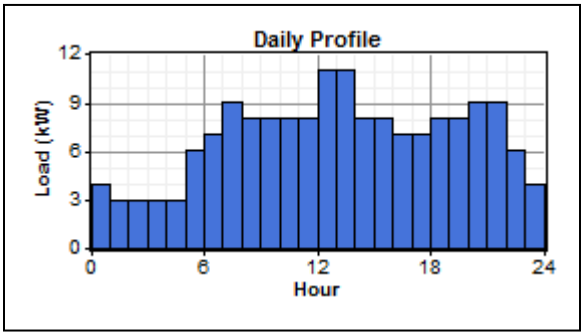

Figure1.7: Load curve duration for efficient home appliances from March to September

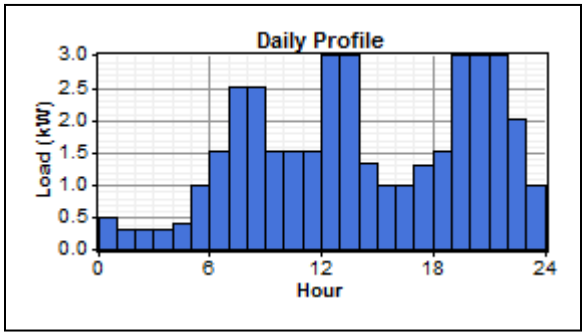

Figure1.8: Load curve duration for efficient home appliances from March to September

2.7 Conclusion

By analyzing the survey results and secondary data, electrical power consumption has been optimized by the most energy efficient home appliance for the domestic users. Energy managements for home mean maintaining energy efficient load in home. For smart energy management system in home data collection and load curve in this thesis can be useful. A Smart Home Energy Management System can be good solution for the usage of energy in optimized way which can provide reliable, quick feedback on electrical energy use and save energy as well as minimize electric bills.

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