ENERGY EFFICIENCY IMPROVEMENT FOR VILLAGES OF BANGLADESH THROUGH ENERGY AUDIT

A Project and 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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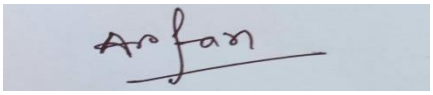
CERTIFICATION

This is to certify that this project and thesis entitled "**Energy efficiency improvement for villages of Bangladesh through energy audit**" 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 in October 2021.

Signature of the candidates



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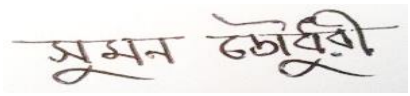

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APPROVAL LETTER

The project and thesis entitled "**Energy effiency improvement for villages of Bangladesh through energy audit** " submitted by **MD. Arfan Ahmed ,** ID: 171-33-3895 , Session: spring 2017 has been accepted as satisfactory in partial fulfillment of the requirements for the degree of **Bachelor of Science in Electrical and Electronic Engineering** in October 2021.

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My Parents

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Respected Teachers

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LIST OF ABBREVIATIONS

kWh	Kilowatt hour
Bbl	Barrel of oil
bcm	Billion cubic meters
toe	Tons of oil equivalent
MW	Megawatt
HFO	Heavy Fuel Oil
HSD	High Speed Diesel
EPBD	Energy Performance of Buildings Directives
HVAC	Heat, Ventilation, and Air Conditioning
SAP	Standard Assessment Procedure
HER	Heat Energy Rating
ERBM	Energy Rating Mark
EPA	Energy Performance Study
RMS	Root-mean-square
kVA	Kilo-volt-ampere
kW	Kilowatt
PF	Power Factor
kVAR	Kilo Volt Ampere Reactive
FL	Fluorescent Lamp
CFL	Compact Fluorescent Lamp
BDT	Bangladesh Taka
BLDC	Brushless Direct Current (motor)
BNBC	Bangladesh National Building Code
CRT	Cathode Ray Tube
LED	Light Emitting Diode
AC	Air Conditioner
LCD	Liquid Crystal Display

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ABSTRACT

There are 68038 villages in Bangladesh with an average of 232 households. In this thesis paper, I have effectively proved that there is a huge capability of energy saving in residential utilities by executing some energy protection measures on the biggest energy utilization equipment's such as lights, fan, television and refrigerators.

Bangladesh is a developing country and it is progressing at a fast speed on account of the extension in industries and innovations. However, the nation has been confronting conflict directly a significant energy emergency for a significant length of time to meet the developing requirements. The gap between energy interest and supply is increment day by day. One effecting approach to limit the gap between interest and supply energy audit is need to direct in villages in regular basis. Energy audit assists with discovering the loss, wastage and give space for improvements in usage. Main objective of my thesis is to improve energy utilization in village houses and other structure of our country by finding energy loss, provide methods and techniques through energy audit. In this thesis paper, I also focus on the energy saving opportunities and the potential to reduce energy consumption cost. This is done by replacing conventional lighting and other important equipment with more energy efficient appliances to increase the efficiency.

CHAPTER 1

Introduction

Electrical energy assumes a significant part in our everyday life. Electricity is a second source of energy, from the conversion of energy like coal, natural gas, oil and nuclear power. In our modern life it assumes a crucial part for monetary improvement of our country. In all economic sectors, like household and commercial, electricity demand is extensive and day by day demand of this energy is increasing rapidly. Yearly electric energy consumption in Bangladesh was 53.65 billion kWh, per capita this is an average of 329 kWh , oil consumption is 25,526 Bbl and natural gas consumption is 29.53 bcm [1]. In our country we reached maximum daily consumption 13014.00 MW in june 2021[2]. According to Bangladesh Energy and Mineral Resources Division in the year 2021, the total electricity demand in Bangladesh will be approximately 20,000 MW[3]. Presently in Bangladesh installed power generation capacity is about 22023 MW out of which 1768MW coal-based power plant; 11402 MW gas-based power plant; 6044 MW HFO based power plant; 1290 MW HSD based power plant; 230 MW hydro power plant; 1160 MW are imported and 129 MW solar based power plant as of july 2021[4]. By this measurements Bangladesh still far away from age of power to fulfill the day by day interest. And I noticed that our country mostly depend on natural gas for generating electricity and also day by day demand of natural gas increasing. I also noticed that mostly power plants are using fossil fuel for generating electricity, which are non-renewable . Presently a days numberous options are created as renewable energy sources such as solar, wind, tidal and geothermal. But there is no sustainable answer for decrease reliance on non-renewable energy sources.

Electricity user is expanded day by day, currently 92.2% of the population has access to electricity[5]. The government of Bangladesh also try to provide electricity whole nation as soon as possible. Bangladesh will require an expected 34000 MW of power by 2030 to support its monetary development of more than 7%[6].

In this situation, the least expensive and quickest solution for conquer all the energy demand is energy conservation and improvement of energy efficiency. Energy conservation represent decrease in energy utilizes by less energy service and energy efficiency improvement represent employments of less energy for a constant output. These two concept merged by energy audit.

1.1 Energy Audit

Energy audit alludes to distinguishing, explore and analyse energy efficiency potential, an energy is a significant technique for distinguishing such potential for energy efficiency measures and help to decrease their expenses. So the simple reason of energy audit is to analyse or investigate the system and as much as possible to decrease system energy consumption without affecting systems final output with improving systems efficiency. According to the energy conservation Act, 2001 of India, the term energy audit is defined as "the verification, monitoring and analysis of use of energy including submission of technical report containing recommendation for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption". Main objective of energy review is to upgrade the general energy utilization, to accomplish superior with minimal expenses, and save energy.

1.2 Problem statement

Now a days energy has turned to play important role in our society and it was a part and percel of our daily life. In this paper I will disscuss about related problem of energy utilization, energy reserves and energy related outflows.

There are 68038 villages in our Bangladesh with average 232 households[7]. Since the government of Bangladesh want to spread electricity to whole country, that's why this sector will be greatest purchaser of power/energy in Bangladesh. And households of entire country will enjoy the decent way of lives.

Our pioneers can design substitute devices for ordinary ones which will be effective regarding energy use. It will urge purchasers to make ceaseless and sensible social changes to diminish energy use. The innovation can also urge the consumers to work on their ability to monitor, track and manage one's energy utilization. Energy Audit is best approach to discover the method of progress in energy consumption for existing equipments.

1.3 Thesis Objective

The objectives of this thesis paper are to study the energy consumption of a village, get dependable information on energy consumption and how to work on efficiency by decreases energy use to have constant output. Also try to remove the energy loss, and find the access of energy savings opportunities, improving energy efficiency and analyse the possibility of cost reduction. However due to innumerable limitations and inadequacies of instruments, in this paper I will focus on the major consume equipments and the way of improvements of energy efficiency, which will be discussed in the following chapter.

1.4 Scopes

Bangladesh is a developing country and here energy generation and transmission cost are higher than any developed country. In our country almost 93% population has access to electricity and day by day demand of electricity has increased and the government of our country struggling to meet the need of the people. So that energy saving in houses, commercial building, industries can also play a vital role for our country to reach peoples energy demand. In this paper, I track down a superior energy saving way for consumers. It will help to decreases energy utilization cost and additional pressure on national energy generation. And it will also help to improve energy efficiency of village houses. By limiting energy utilization through this exploration will serve to decrease green house gas of earth. It will also help to paly a vital role for our economy.

1.5 Reasearch Methodology

The methodology is as follow

- In the starter stage visited many houses of a village and doing interviews and discuss with various people of the village.
- Then collecting all the load details with maximum demand and calculate the usage of load.
- Identifying the energy conservation alternatives which will affect at cost and energy saving.
- Collecting electrical bill from house owners.

1.6 Thesis Organization

This thesis is organized a follows

Chapter 1 have discussed the scenarios of energy generation , consumption and energy crisis of Bangladesh and also defined the Energy Audit.

Chapter 2 of this thesis paper will mainly discussed the importance of Energy Audit and basic steps to perform an energy audit for village houses.

Chapter 3 of this thesis paper has discussed about the calculations of energy audit analysis in terms of energy consumption cost.

Chapter 4 of this thesis paper has discussed about economic feasibility and payback period .

Chapter 5 discuss all the possibility of energy efficiency improvement.

And lastly Chapter 6 is conclusion part of this thesis paper.

CHAPTER 2

Significance of Energy Audit

2.1 Introduction

Bangladesh was a small country and most of the land of our country was flat and these are main reason we can't increase the power generation using renewable energy like hydro power or solar energy. Our country mainly depends on natural resources like oil, natural gas, coal etc for generating power and it is expensive to generate power in this way. Energy audit can be a successful method to discover the way to use energy efficiently. In this chapter I focus on the basic energy audit level, concept about lighting, electrical equipment and envelope audit.

2.2 Litareture Review

Day by day the demand of energy is increasing and shortage of energy is one of the major problem in the world. In Bangladesh, electrical energy/electricity is very costly. Because Bangladesh use natural resources like natural gases, oil and coal for generating electricity. Energy audit is play significant role for reducing consumption of energy and also regular maintenance of electrical equipments is help to save energy.

Now a days, Energy audit is become a place of interest for building experts and electrical engineer. Due to financial incentives for homeowner's, now energy audit became more popular. The real purpose of energy audit is minimize the energy consumption and its cost without affecting systems output and quality. Energy audit has become part of interest in respone to the energy crisis of 1973 and later years[12]

European Union Directive Building Conduct

European Union Directive on Energy Performance on Buildings was
proposed on 16th December 2002. Then it's became significant regions for future investigations on energy execution on structures. The main intention behind EPBD was to further develop the energy exhibitions on the structure thinking about indoor and outdoor conditions. EPBD referenced some necessity, for example, a blueprint of incorporated energy execution of a

structure, least utilization of machines, least prerequisites of energy execution in significant structures that are exposed to redesign, regular inspection of boilers and warmers additionally give energy efficiency certificates to the structures. One remarkable up-turn of EPBD is the essential public energy performance calculation method on the structures. And also the performance analysis is ensured the method of improvement, assessment and certification on HVAC installations[14].

After the release of EU directive on performance of buildings; in terms of energy, many countries followed the rules such as UK, Denmark, Ireland, Netherlands, France, Belgium, and Germany[15].

Since 1995, for energy conservation, Standard Assessment Procedure (SAP) and building regulations-Part L (a section which states energy conservation of houses) are more necessary for new buildings in United Kingdom. SAP is principally worried on yearly expense of warming, lighting, building envelope protection, proficiency of warming and homegrown boiling water framework, the fuel costs influence the SAP ratting, which goes from 1-100. Standard Assessment Procedure doesn’t include location, utilization on home appliances and doesn't recommend for making buildings more energy effective. Statistics shows that, applying SAP on 17,000 houses per year, almost three million buildings can be audited[16].

In Europe, energy review and the ratting appraisal were first started by Denmark and they have given a benchmark to different states to proceed. They presented an obligatory energy analysis in 1985 and “Act on Promotion of energy and Water Conservation in Buildings” is revealed in 1996, which was officially permitted by authority on 1997. And this act was moving promoted many kind of audit, EM/EK and certifications on mainly industrial buildings. Every year around 45,000 to 50,000 audits are performed and energy utilization is estimated to drop close 20%, 70% for single family home[16]

Energy Rating Mark and Heat Energy Rating were presented in Ireland and was obligatory for recently build buildings in 1997 and later on in 1992. Energy Rating Mark is comprehensively utilized by fuel providers and house developers to give low energy utilization in the structure. It represents yearly CO2 discharge and utilization of energy while considering the yields of HVAC equipments that are the structures. And it also gives recommendation and prosperity of warming process, structure envelope and allot the savings[17].

EPA is the current guidelines of Netherland for buildings and EPA means Energy Prestatie Advise. And a new building was presented by Standard energy Performance. These are try to promote matter of energy conversations ang energy savings. They mainly concentrate on energy utilization for cooling, heating, lighting systems, fan and motor pumps[16].

Decree 2000-1153 is set-up by the Ministry of Housing and Transport of France so that all the new buildings follow with guidelines for new non-industrial buildings. Two techniques are presented for calculation motive while the buildings/ houses are keep following the rules and regulations. First one is a precise, intricate process, developed for expertise and the second one is for amateur, non-experts or for common people[19].

An enactment named "Energy Saving Decree" was embraced in the year 2001 and from 1982, Germany has started to work on energy efficiency. The two significant results from this enactment was-yearly energy utilization restricted to 7 liters of oil identical fuel for each m2 and compulsory substitution of old boilers. The letter began from 1978[16].

2.3 Basics of Energy Audit

Now a days energy audit plays an important role in energy sector and it will help us to reduce use of energy and also reduce electrical equipments cost. It also helps us to save electricity bill and we also can save our money. The quality of an auditor's work depend on his experience and also quality of energy audit depend on his experience and how much cash proprietor will spent. A building owner can get list of no cost or low cost recommendation from a simple energy audit which can be carried out by activities and support staff. For the large energy management program, we need advance energy audit. There are many energy services company, energy consultant and engineering farms in country which provide energy audit services. There are mainly three levels in energy audit process. And these levels are preliminary audit, standard energy audit and detailed energy audit.

2.3.1 Level 1: Preliminary Energy Audit

Preliminary audit is the straight forward kind of audit. This types of audit consist of meeting or interviews with site working personel, servey utility bills and other information briefly. We can also called it walk through audit and it was actual site inspection and gotten comfortable with the structure operation. And also discovering the energy waste areas and energy productivity improvement. In this audit level, auditor tries to find the place where can be used energy properly

and also tries to detect the place where the energy saving opportunities can be applied. This types of audit can't provide details of energy analysis.

2.3.2 Level 2: Standard Energy Audit

Expansion of preliminary audit is called standard energy audit. In this level of audit, we need to gether more detailed data about activity, it also incudes with profundity analysis of energy cost, usage and investigation of equpments. For assess the facilities the energy demand rate of the structure and energy utilizations profile, auditor need 12-36 month period for collecting utitlity. In this energy audit level, auditors conduct with electrical testing, various diagnostic testing, air flow testing & temperature measurement and also including lighting level assessment. Energy auditor also try to understand the major consumption of system. This kind of energy audit covered site explicit working expense saving and venture measures. For justify project implementation, they try to provide sufficient details. Collecting accurate data from site and also using energy engineering calculation, this kind of energy audit will be very helpful for saving energy and bills or cost.

2.3.3 Level 3: Detailed Energy Audit

Detailed energy audit is most extensive and complete review of energy. It also assesses the energy contribution for various interaction and gathering of quick information on explicit energy utilization. This kind of audit additionally called a comprehensive audit or technical analysis audit. It also develop the level 2 audit by giving a powerful model of energy use attributes of both the current facilities and all energy protection measures distinguished. Detailed energy audit gives point by point estimations of cost and saving with the significant report of certainty needed for significant speculation choices. Broad consideration is given to understanding working attributes of all the system which consume energy. For prepare detailed energy audit report, auditor collect all the required data of equipments & list of recommendation of energy saving with investment or non-investment.

These three levels of energy audit summarized in table 2.1

Auditing Levels	Activities
Level 1: Preliminary Energy Audit	1. site visit and collect the require data of equipments. 2. Analysis the minimal expenses or no-cost energy preservation measures. 3. Detect energy efficiency improvement potential.
Level 2: Standard Energy Audit	1. More detail servey. 2. Breakdown of energy use. 3. Analyse the cost and savings. 4. More detail interview with site staffs.
Level 3: Detailed Energy Audit	1. Field analysis with more details. 2. Calculate the bills and savings. 3. Including list of recommendation for making professional report.

Table 2.1:Three Levels of Energy Audit

2.4 Energy Audit Instruments

An Energy audit is a precise investigation of energy use and utilization. In an energy audit, the important part is mapping all the significant energy and recognize the energy loss regions, and saving potential. During an energy audit, auditor needs some of important instruments for quantified and accurate identification of energy loss or estimation of savings potential.

Some instruments are given below:

2.4.1 Electrical Power Analyer

These instruments are mainly used for measuring electrical parameters such as KW, KVA, Amp, KVAR, Hz, PF etc. And these instruments can measure harmonics.

2.4.2 Power Factor Meter

A power factor meter is an electric device which is utilized to quantified power factor of an electrical machines such as Ac motor, Dc motor, Transformer etc. This meter commonly has a calm on feature and it can make easy connection for connecting to the current carrying conductor.

2.4.3 Light Meter

Light meter is a device which measures amount of falling lights on a subject. Light meters are utilized in the overall field of architectural lighting configuration to proper installation and execution of a structure lighting system.

2.4.4 Infrared Camera

An infrared camera is a detecting device which use for finding the infrared energy emitted, transmitted or reflected by all materials at temperature above absolute zero. This device is multipurpose device and it is used for detecting overheated electrical conductors, connections, circuit breakers, transformers, motors and other pieces of electrical equipments. Infrared cameras are also costly piece of instruments.

2.4.5 Clamp on Ammeter

A clamp on ammeter is an instrument which used for measure the current flow through a wire without making any electrical connection. When we need to measure the current of any conductor, firstly we need to open up the clamp and then put it around the insulated conductor and the meter will read the flow of current of this conductor and we can see the results on dislplay.

2.4.6 Ultrasonic Flow Meter

An ultrasonic flow meter is kind of a flow meter which utilize sound waves to determine the speed of a fluid flowing in a line. It is also called non-contact measurement device. These meters are not suitable for work with drinking water or distill water and these are only work in applications of wastewater.

2.4.7 IR Thermometer

Ir thermometer is temperature measuring device which measure temperature quickly at a distance without touching the object. Ir thermometer has a lens to focus on objects infrared energy and then the energy convert into electrical signal and using this signal meter show the units of temperature on display.

2.4.8 Airflow Measurement Device

Airflow measurement device is a testing equipment which use for measuring the air velocity in duct. It can also detect the problems of air flow. There are many types of airflow measurement device such as hot-wire air flow meter, a vane air flow meter, a pilot tube air flow meter etc.

2.4.9 Safety Instruments

Firstly, for any audit visit a decent pair of safety glasses is absolutely essential and also hearing protectors are needed in noisy plant visit. And also need electrically insulated gloves for safety when electrical measurement will be taken and also when working around hot objects. We use these equipment to protect ourselves.

2.5 Electrical Audit

We use many electrical appliance in our daily life and these appliance make our work more easier. These appliance are required electricity to work. And we also use many electrical equipments for commercial and industrial work. Electrical audit means auditing any appliance or equipments which are use electrical power or electricity. In electrical audit, auditor try to save energy or consumption power of electrical appliance and it saves owner's money.

An electrical audit helps us to identify the wastage power and it causes use more electricity than necessary. By auditing we can fixed this problem and we can save our money. Electrical audit not only reduce the power consumption but also it ensure the safety of the system. And electrical audit is most important part of energy audit.

Now a days, peoples are totally dependent on technologies for making their lives easier. Almost all of the latest technologies are consume electricity. In short, we are totally dependent on electricity in our daily. Without electricity we can't thought. The more use of these equipment cause more consumption for electricity.

Sometimes we use many appliance in our home which consumes more electricity and it causes lead to the wastage of electricity. An electrical aplliances are consume more electricity when it get older and aplliances can not provide desired output. As a result, the consumer get the amplified electricity bills. By electrical audit, we can find the wastage area of appliances and also can fixed this problem for getting better output of appliances.

There are many people in our society who make mistakes unknowingly and also many peoples are careless. Sometimes many people make switched on for long time of electrical equipments and even they forget to switch off after their done of use. The electricity bills are totally depend on appliance using time. That means if we use electrical appliance for more time, we will get more electricity bills. So we will use these appliance only when it is necessary and also some electrical appliance are needed regular maintaince to decrease operational time and these can help to decrease the electricity bills.

We still use many appliances which emits carbon dioxide CO2 and other harmful gases. The main reason of global warming is emission of carbon dioxide and polluted air. So we have to stop using these equipments to save our environment and also we have alternative options of electrical appliances which are not harmful for our environment. We can easily maintain these appliances. And electrical audit will make the work place safer and better.

2.6 Lighting Audit

Now in Bangladesh almost 93% of population has access to electricity[8]. A large part of generated power are consumed by lighting loads and lighting loads are cosumed almost 25% to 35% of total generated power in the world[9]. Residential buildings and commercial buildings are consumed 20% & 30% recpectively for lighting loads[9]. Due to higher efficiency and higher lifetime for getting same luminous level, peoples are preferring Fluorescent Lamps and Compact Fluorescent Lamps for replacement of Incandescent lamp[9]. Compact Fluorescent lamps and Fluorescent lamps are required ballast and they are discharged lamps. For require lamp ignition and to limit the lamp current, ballast generates high initial voltage across lamp tube. There are two types of ballast and these are magnetic ballast & electronic ballast. Magnetic ballast has longer lifetime than electronic ballast, but electronic ballast are more efficient than magnetic ballast[10]. We can easily decrease the lighting energy use about 75% to 90% compared to conventional practice [10]. Auditor's also can discover the ways efficient utilize of electrical energy by energy auditing. This will help us to save electrical energy and electricity bills.

2.7 Envelope Audit

The limit between outdoor and indoor interior of the structure called structure envelope. The structure envelope components are roof, ceiling, exterior door, windows and exterior wall's. These structure can also be households. Household envelopes are most significant part of our audit.

Because we can save easily house owner's money by proper maintain and optimal envelope. losses of energy in structure envelopes or household envelopes is highly variable and it also depend on many factors and these are house/ building orientation, geographical locations, climate and structure type & age[11]. The structure or household envelope plays crucial part for cooling equipmens and lighting but it was not related with energy consumption or electricity bills directly.

The energy audit of the envelopes is particularly significant for residential houses. In fact, the energy use from direct state of warmth or from air invasion or exfiltration through building surfaces represents a significant bit (half to 80%) of the energy utilization. Upgrades of the structure envelope are regularly not financially savvy because of the way that adjustment to the structure envelope like supplanting windows, adding warm protection in dividers are normally extensively costly for commercial building . Envelope audit always ensure the integrity of structures overall condition and it also try to determine the way of energy saving. The dampness buildup is frequently more harming and exorbitant than the expansion in heat move since it can influence the underlying trustworthiness of the structure envelope.

Now a days electricity has become essential part of our daily life. We can't think of any work without electricity. Sometimes we unknowing use more electricity than we need and we pay more bills for it. We can easily decrease the consumption of electrical energy by evelope audit. For example many of commercial buildings and industries, we use air conditioner, electric fan which are larger size as compared to room size and larger size of fan and air conditioner consume large amount of electricity. If we install fan or air conditioner as compared to room, these fan or air conditioner will take less amount of electricity than before. And we also know that the reflection of walls and ceiling was always the intensity of light and as a result we got more or less of light. So we can develop our walls, ceiling, windows, doors and painting of walls by envelope audit and it will save owner's money.

In envelope audit , the most important parts are orientation and geographical location of building, residential houses & industries. We use many heating and cooling appliances at home for our comfort and also invest much money for it. Even investing lots of money, we donot get maximum efficiency and the main reason of this problem is walls, door, windows, ceilings are not properly insulated. We can easily sove this problem by envelop audit. So now we can say that envelope audit is much important for energy saving.

2.8 Summary

In this chapter I mainly focus on energy audit and it's three level. Then I discuss about it's important part which is instrument of energy audit. I also discuss about lighting audit, electrical audit and envelope audit and these are crucial part of energy audit and also using these how to save energy and energy bills.

CHAPTER 3

Auditing a Village of Bangladesh

3.1 Introduction

Firstly I develop my conception about energy efficiency improvement in village houses and other structures. My subsequent stage is to analyze and check total village energy utilization and its yield and also find the scope of improvement . Bangladesh has almost 68038 vilages and almost 62.6% population of Bangladesh live in rural areas[19]. As portion of my thesis, I visited one local village in Bangladesh. In this chapter, I will discuss about the audit process, data collection and energy consumption for a local village.

3.2 Local Village Auditing

First of all, the village I audited is a village in Kurigram district of Bangladesh which name was Taluk Kaloya. There are almost 200 houses and most of the people are farmer in this village. To begin the audit, I need some particular information about houses and other structures. So I visited almost 200 houses in this village and this houses are include with 2 to 4 bedrooms, one kitchen and one or two toilet. During the day, most of the people goes to work outside the home and only few people stay in home. In the afternoon or evening everyone gathers at home. So from the afternoon onwards, the electric load of the house continues. They use sunlight during the day to illuminate the house and at night time, they use electric lights. During summer time, they mostly use electric fan for cooling purpose and winter time, this types of load used lightly.

Firstly, I visited almost every house in this village and observed every house and other structure in a good way. Then I try to collect their monthly electricity bills and I carefully monitor each load in the house and note the amount of loads in my notebook. And I also try to know about how long runs each load of the houses per day. All of these values are helped me to determine the monthly electric energy use and also gives me an idea about overall electricity use per month. I also visit one mosque and notedown the amount of loads.

I observe all monthly electricity bills and saw that most of the houses has low electricity bill at winter season and the bills are higher at summer season. I find the reason behind the differences between electric bills. In Bangladesh, the environment was cold at winter season and this is the main reason for less use of fan and other cooling divices and it also the main reason for getting less amount of electricity bills. But in summer season, they use all of loads including cooling divices like fan and they are getting much electricity bills.

Again, I saw many houses which were attached to one house and another house and the doors and windows of the house are much smaller than it needs. Again I saw many houses with many big trees around them and The houses are covered with tree leaves. As a result, not enough air and sunlights can enter the house during the day and these are causes envelope losses.

3.3 Electrical Energy Utilization System

All the houses and other structure of "Taluk Kaloya" village received electricity supply from BREB distribution line. And the main connected

loads of this village are lights, fans, water pump, computer and television. Table of these connected loads are given below:

Sl No	Name of Appliance		Number of Appliance	Watts	Total Watts
01	Lights	CFL	763	32	24416
			55	18	990
			45	15	675
		Incandescent	122	60	7320
			66	40	2640
		LED	87	20	1740
			25	05	125
		Fluorescent Lamp	25	36	900
			128	75	9600

02	Fan	56”		136	80	10880
				122	85	10370
				114	90	10260
		36”		12	55	660
03	Computer			42	300	12600
04	Television	CRT	21”	58	120	6960
			14”	42	60	2520
		LCD	32”	16	110	1760
			22”	38	55	2090
		LED	32”	12	50	600
			22”	8	40	320
05	Refrigerator	380 Ltr		35	180	6300
		348 Ltr		42	165	6930
		240 Ltr		28	130	3640
		198 Ltr		16	109	1744
06	Water Pump	1 HP		26	746	19396
		1.5 HP		28	1119	31332
		3 HP		8	2238	17904
		5.5 HP		6	4103	24618
Total Connected Electric Load						212946 Watt

Table 3.1: Connected Loads

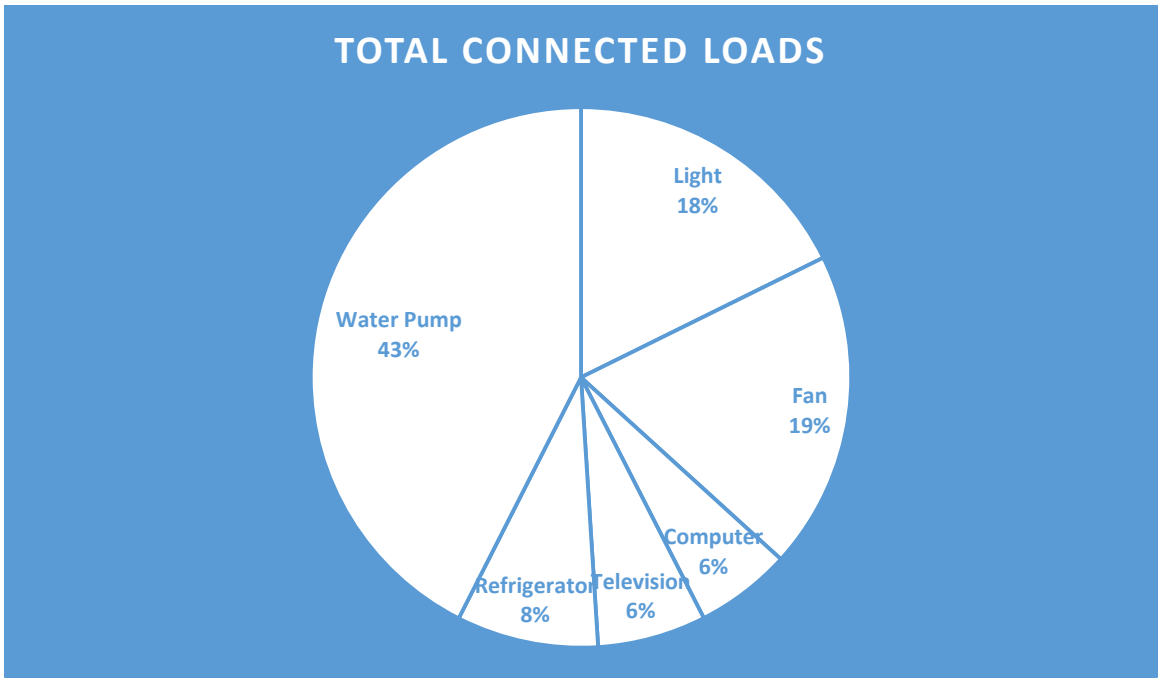


Figure 3-1: Total Connected Loads

Here, water pump contains 43% of total loads, Light contains 18% , Computer contains 6%, Television contains 6%, Fan contains 19% and refrigerator contains 8% of total loads. Here the percentage of the pump is higher, because here I mention the pump used to irrigate the land along with the pump used at home.

3.4 Calculations

The village name was Taluk Kaloa and I almost visited all of houses , mosque and other structure of this village. I tried my best for getting actual power consumption rating of all appliances and I also talked with house owner to know about how much time they run all of these appliances. They told me that the lights of bedroom on 6pm to 11pm, kitchen lights on 6pm to 10pm, the house yard lights are on from 6pm to 5am and lights of the toilet are on for only one hour. Lighting Loads of this village are given Below:

	Types of light	Number of lights	Monthly Energy Consumption (kwh)	Annual Energy Consumption (kwh)	Rate Per Kwh (BDT)	Monthly Lightling Cost (BDT)	Yearly Lighting cost (BDT)
Room	CFL (32W)	464	2227.2	27097.6	6	13363.2	162585.6
	Incandescent(60 W)	52	468	5694	6	2808	34164
	LED (20W)	60	180	2190	6	1080	13140
	FL (36W)	25	135	1642.5	6	810	9855
Kitchen	CFL (32W)	139	533.76	6494.08	6	3202.56	38964.48
	Incandescent (60W)	45	324	3942	6	1944	23652
	LED (20W)	16	38.4	467.2	6	230.4	2803.2
Toilet	CFL (18W)	55	29.7	361.35	6	178.2	2168.1
	CFL (15W)	40	18	219	6	108	1314
	Incandescent (40W)	62	74.4	905.2	6	446.4	5431.2
	LED (05W)	25	3.75	45.625	6	22.5	273.75
House yard	CFL (32W)	144	1520.64	18501.12	6	9123.84	111006.7
	Incandescent(60 W)	25	495	6022.5	6	2970	36135
	LED (20W)	4	26.4	321.2	6	158.4	1927.2
Mosque	CFL (32W)	12	34.56	420.48	6	207.36	2522.88
	LED (20W)	7	12.6	153.3	6	75.6	919.8
Mosque Toilet	CFL (15W)	5	2.25	27.375	6	13.5	164.25
	Incandescent (40W)	4	4.8	58.4	6	28.8	350.4

Mosque Outside	CFL (32W)	4	42.24	513.92	6	253.44	3083.52
Total Cost						37024.2	450461.08

Table3.2: Data of Lighting Loads

In this table, I include two mosque lighting loads of this village. The total monthly energy consumption of CFL(32W), CFL(18W), CFL(15W), Incandescent(60W), Incandescent(40W), LED(20W) and LED(05W) are 4358.4kwh, 29.7kwh, 20.25kwh, 1287kwh, 79.2kwh, 257.4kwh, 3.75kwh. The monthly lighting cost are BDT 26150.4 for CFL(32W), BDT 178.2 for CFL(18W), BDT 121.5 for CFL(15W), BDT 7722 for Incandescent(60W), BDT 475.2 for Incandescent(40W), BDT 810 for FL(36W), BDT 1544.4 for LED(20W) and BDT BDT 22.5 for LED(5W). The total monthly lighting cost is BDT 37024.2 and annual lighting cost is BDT 450461.08.

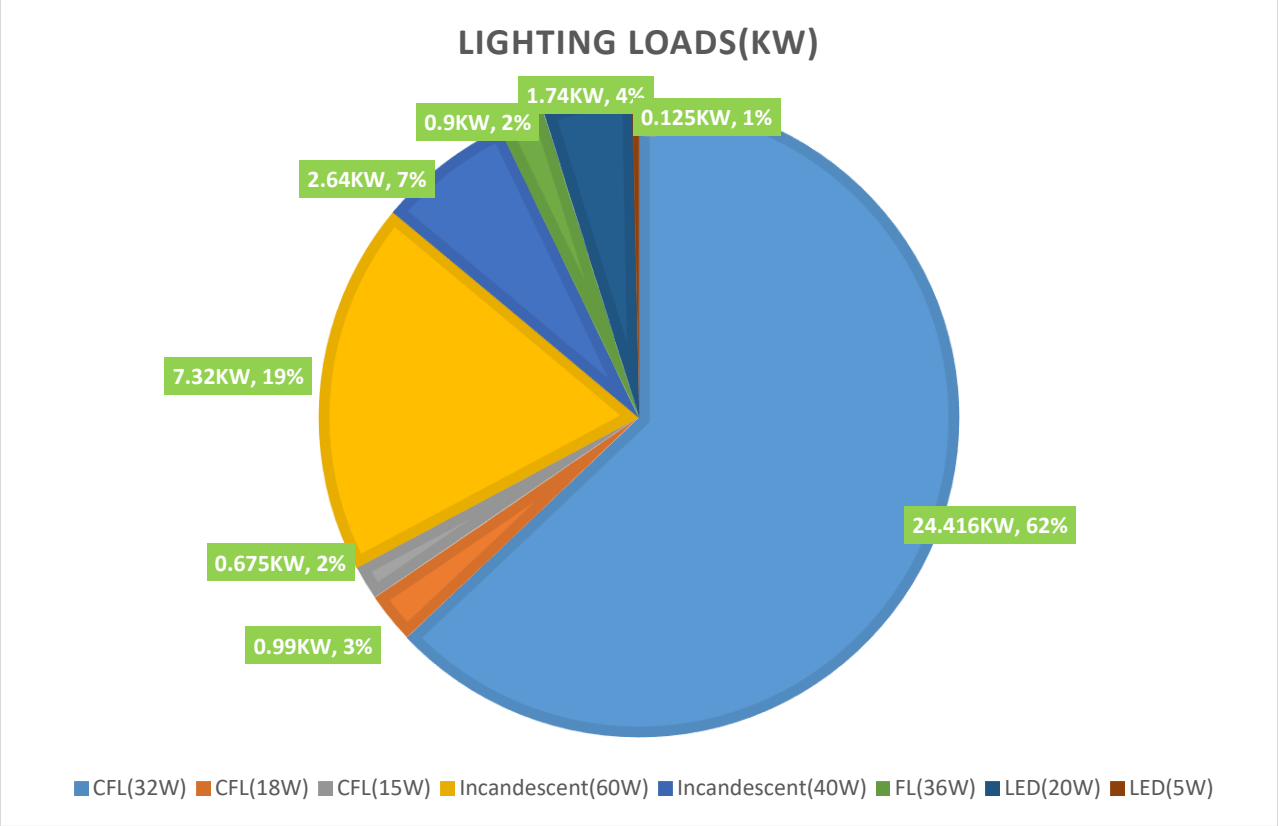


Figure 3-2: Total Lighting Loads

Figure 3.2 show the total lighting loads of Taluk Kaloa village where CFL(32w) lights has 62%, CFL(18W) light has 3%, CFL(15W) light has 2%, Incandescent(60W) light has 19%,

Incandescent(40W) light has 7%, FL(36W) light has 2%, LED(20W) light has 4% and LED(5W) light has 1% of power consumption from total power.

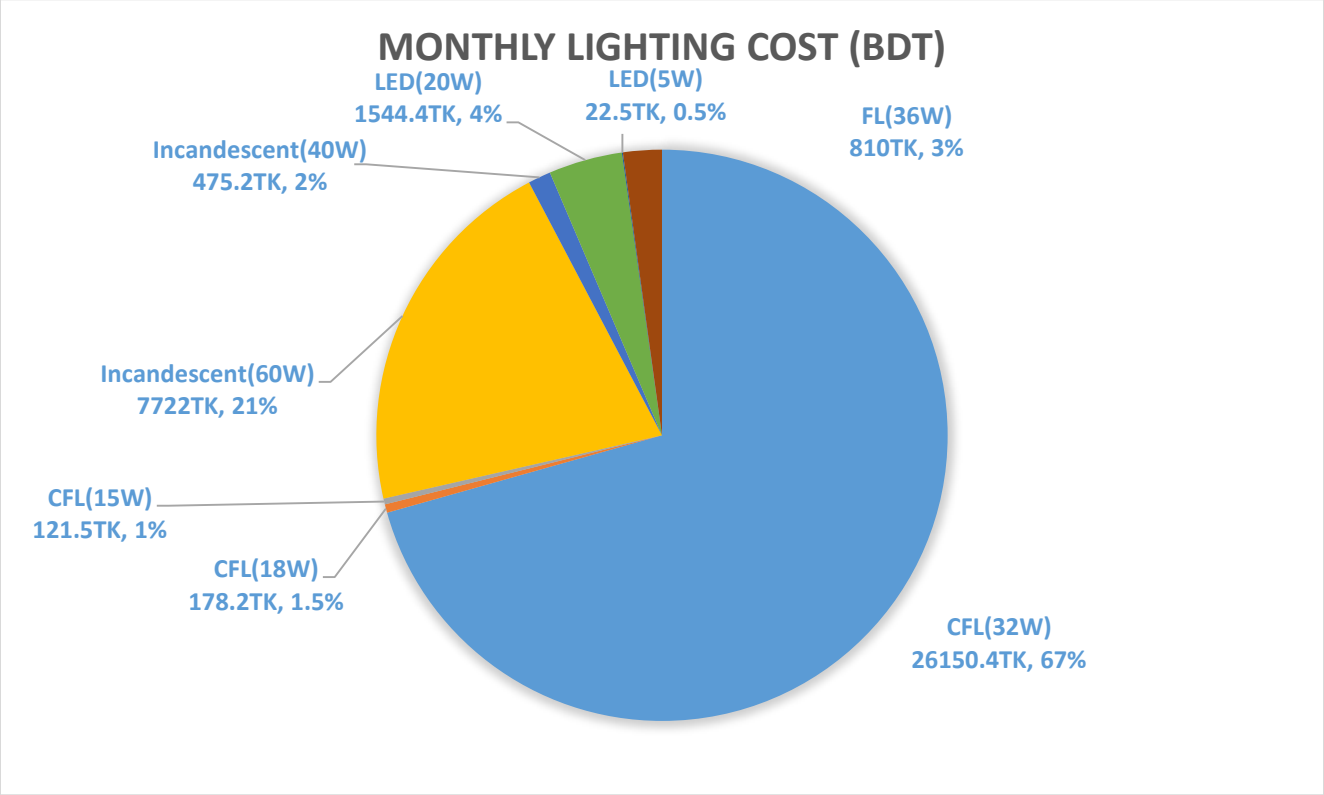


Figure 3-3: Monthly Lighting Cost

From figure 3.3, we can see that CFL(32W) was responsible for 63% lighting cost which is highest lighest monthly lighting cost and also Incandescent(60W) was responsible for 21% lighting cost which was second monthly lighting cost. Incadescent lights are consumes more electricity than CFL lights. Then CFL(18W), CFL(15W), Incandescent(40W), FL(36W), LED(20W) and LED(05W) are responsible for 1.5%, 1%, 2%, 3%, 4% and 0.5% lighting cost respectively.

I will show the calculation of electrical equipment in the next step. The calculation of electrical equipment is shown below:

Eqp. Name		Watt Rate	Quantity	Monthly Energy Consumption (kwh)	Monthly Energy Cost in BDT
Fan For House	56”	75	113	3559.5	21357
		80	119	3998.4	23990.4
		85	122	4355.4	26132.4
		90	106	4006.8	24040.8
	36”	55	12	277.2	1663.2
Fan For Mosque	56”	75	15	101.25	607.5
		80	17	122.4	734.4
		90	8	64.8	388.8
Computer		300	42	1890	11340
Refrigerator	380Ltr	180	35	1512	9072
	348Ltr	165	42	1663.2	9979.2
	240Ltr	130	28	873.6	5241.6
	198Ltr	109	16	418.56	2511.36
Water Pump	1 HP	746	26	581.88	3491.28
	1.5 HP	1119	28	939.96	5639.76
	3 HP	2238	8	4296.96	25781.36
	5.5 HP	4103	6	5908.32	35449.92
TV	CRT	120 (21”)	58	1044	6264
		60 (14”)	42	378	2268
	LCD	110 (32”)	16	264	1584
		55 (22”)	38	313.5	1881
	LED	50 (32”)	12	90	540
		40 (22”)	8	48	288
Total Cost					BDT 220246

Table 3.3: Data of Electrical Equipments

I talked many people who live in Taluk Kaloa village to know the operating hours of electrical equipments which mentioned in table 3.2 and table 3.3. The operating times of electrical equipments in village houses are such as fans are stay on for 14 hour, computers are on 5 hour, refrigerator stay on for 24 hour and water pump 1hp &1.5 stays on for 1 hour. A good condition compressor of a refrigerator runs 8 hour only per day. So, I mention 8 hour operating time for refrigerator in table 3.3. Since I collected this data at the end of March and the beginning of April month, at that time many of water pumps are used for irrigate the land and I find out that they keep running water pump for 8 hour per day. And they also told me fan of mosque are on for only 3 hour per day. Considering their electricity bills, I saw that each house uses up to 300 units of maximum electricity and their unit rates of electricity is 6 taka per kwh. So I choose 6 taka as unit rate.

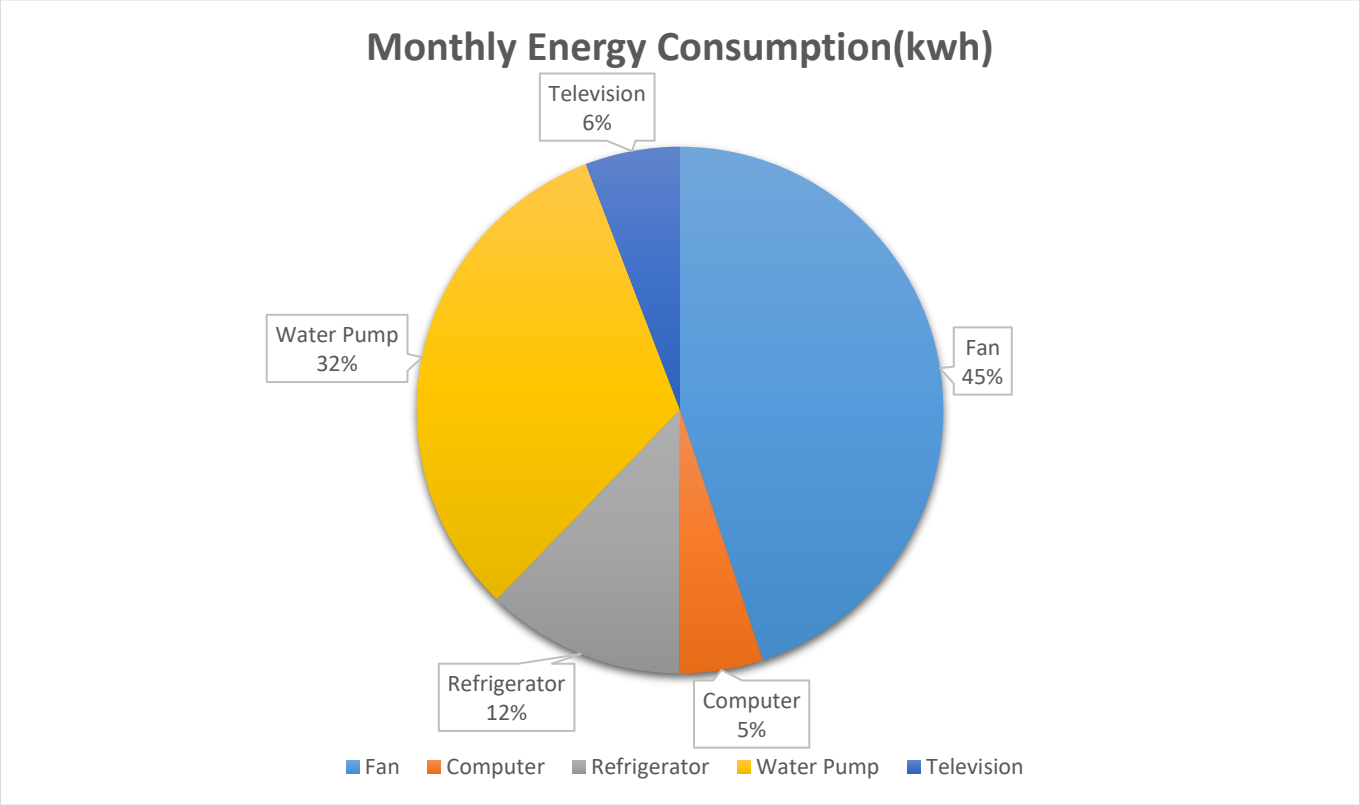


Figure 3-4: Monthly Energy Consumption

We can see from the pie chart that most of the electricity is consumed by the fan which is 48% of total consumption of electricity. Then the water pump consumes 34% of total electrical energy, television consumes 6%, refrigerators consumes 13%, Computer consumes 5% respectively.

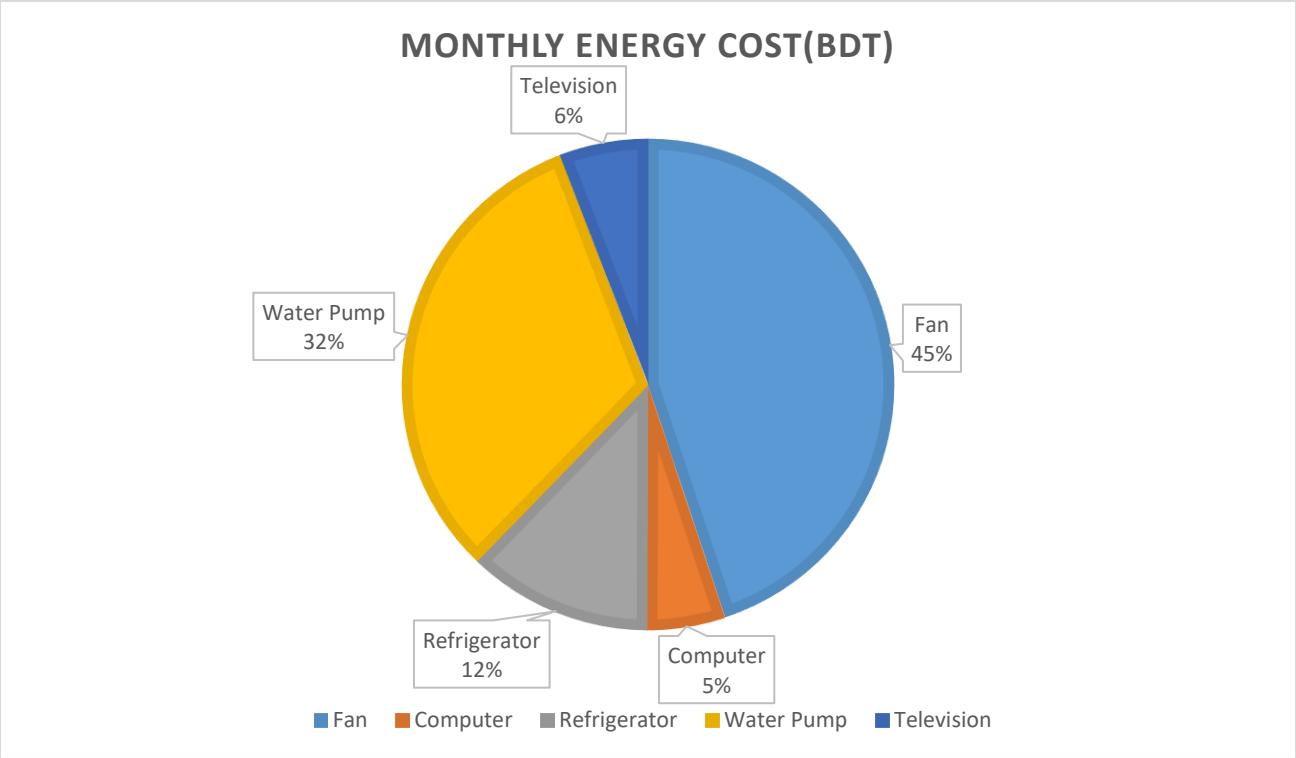


Figure 3-5: Monthly Energy Cost

From figure 3.5, we can see that 48% of energy cost from fan, 34% of energy cost from water pump, 13% of energy cost from refrigerator 6% of energy cost from television and 5% of energy cost from computer respectively. Here I got BDT 98914.5 energy cost from fan, BDT 11340 energy cost from computer, BDT 26804.16 energy cost from refrigerator and lastly BDT 70362.72 energy cost from water pump.

After that it was time for envelope audit. I found some more problems while auditing. I have seen many houses that have smaller doors and windows than they need. Again, there are many big trees around many houses and the houses are surrounded by tree leaves. And adequate sunlight and air cannot enter the room .As a result, many people keep the lights on during the day and also the fan has to run more than needed. And they will get much electricity bills.

3.5 Analysis in Terms of Electrical Energy Cost

I collected the data at the end of March and the beginning of April. March and April months are summer season in Bangladesh. Cooling equipments are used more in summer season. In March and April, farmers use many water pumps to irrigate their crops and these water pumps consume a lot of electricity. As a result, the total electricity bill of the village increased during this time as compared to other months. I got monthly electricity cost BDT 244445.58 which is close to Taluk Kaloa village electricity bills.

3.6 Comments

There were a lot of electrical equipments that I didn't measure their power utilization. These kind of equipments are classified as miscellaneous as far as energy utilization. For example mobile charger. Mobile's charge depends on our daily mobile usage. As a result, it is difficult to say how much electricity the mobile will consume every day. But still usage of mobile phone increase electricity bills.

3.7 Summary

We need huge data collection for doing energy audit and energy audits are time-consuming. I visited many houses and other structure for getting proper data collection of 'Taluk Kaloa' village. After getting data, I try to identify the energy cost of different types of connected loads on their individual energy consumption. In this chapter, I also show some pie chart of connected loads and their monthly energy consumption. I also calculate the in terms of energy use based on location and try to analysis electrical energy cost and limitation of the work.

CHAPTER 4

Study of Economic Feasibility

4.1 Introduction

The fundamental objective of our energy review is to save the energy and cash. By proper energy audit we will be able to reduce our national energy demand and it will also increase the energy efficiency. Again energy audit also can help to reduce the electricity bills. In this chapter I will try to discussed about lighting equipments, electrical equipments and also try to give some tips of energy savings.

4.2 Lighting Considerations

Lighting Loads are consumed more than 30% of total electrical energy in Bangladesh[20]. It differs from one spot to another and from one area to another yet it needs to furnish an appropriate condition with desired level of illumination. We should be planned the system in a such way that the system will consume less amount of energy and it will provide desired level of illumination with required level of output. Bangladesh is a developing country, for better improvements it needs to look toward energy efficient technologies due to lots of factors[21]. Exchanging toward energy saving light advancements can save considerable sum of energy. In our country, fluorescent lights and incandescent lights are mostly used [20]. Currently Compact Fluorescent lights are used widely and these lights are available everywhere with differents colour,lumens and watts. The utilization of CFL lights can be found in the most of residential areas, shopping malls, industries, commercial buildings, Universities etc. Other kind of lamps like High Pressure Sodium lamps (HPSL), Halogen Lamps (HL) and Low Pressure Sodium Lamps (LPSLs) are also available in local market. At present new technology bulbs have come in the market which knowns as Light Emitting Diode(LED) and reduce 30% of energy consumption[22].

4.2.1 Incandescent Lights

Figure 0-1: Incandescent Lamp

Incandescent lights are most usually utilized light sources over the past
one and half decade also called the ‘Edison Bulb’[21]. At the point when current went through a diluted filament of tungsten wire then the wire gets warmed up and emits the lights. This light has low efficiency because most of its energy is expended to generate heat when the current passes through the tungsten wire. Incandescent light take only 5% of input energy to convert output as visible light and almost 90% of the input energy released as heat. Incandescent lights are cheapest light and it mostly used in rural areas of Bangladesh.

4.2.2 Fluorescent Lamps

Figure 0-2: Fluorescent Lamp

Fluorescent bulbs are quite possibly the best advancements of the light industry. These lamps are consumed less amount of energy to produce required amount of lights. A 60w incandescent lamps gives the same amount of light as a 15w FL lamp[21]. The alternating current inflames vapors of mercury inside of this lamp. The gas assists with emitting light which hits the Fluorescent material, found inside the inward piece of the tube. This causes a delicate sparkle of light and their efficiencies are very acceptable[20]. Fluorescent lights are likewise one of the widely utilized light in the commercial buildings and industries and 5w to 40w range of fluorescent lamps are available in the market.

4.2.3 High Intensity Discharge Lamps

Figure 0-3: High Intensity Discharge Lamp

High intensity discharge lamps mostly use for outdoor and external lighting, where lamps are needed to work extended period of time. HPSL lamps are viewed as source of lights. These lamps also can generate amber colour and these lamps mainly use for street lighting purpose[20]. We can also use LPSL for outdoor purpose and they also can generate copper golden colour.

4.2.4 Compact Fluorescent Lamps

Figure 0-4: Compact Flurescent Lamp

The use of CFL lamps has been increasing in Bangladesh since few years. These lamps are replaced the old fluorescent lamps and incandescent lamps in urban areas of Bangladesh. It is viewed as outstanding amongst other technical developments in the lighting industries. It has 10 times longer lifetime than incandescent bulbs[21]. Compact fluorescent lamps are consumed very less amount of electrical energy than Fluorescent and Incandescent lamps.

4.2.5 LED Lamps

Figure 0-5: LED Lamp

The LED lamps are also known as solid state lighting innovation. It transmits light from a piece of semiconductor made of emphatically and contrarily charged segment. The light is emanated as the electrons moves inside the semiconductor from negative to positive layer[21]. If we replace all the CFL and FL type lamp to led lamp then we can save large amount of energy. Because LED

lamps can save 50% of input energy with same output. There are commonly used two kinds of chip and these chip are the 5mm LED chips and the high-output chip on board. The 5mm LED has low light yield and needs legitimate warm way that is fundamental for keeping up with the LEDs junction temperature. The high-output chip on board also known as the current decision for lighting since it offers far prevalent radiant yield just as having legitimate warm way for directing the LEDs junction temperature.

A comparison table for different types of bulbs is given below:

Feature of lights	Incandescent	CFL	LED
Life span of a typical bulb	1,200 hours	10,000 hours	50,000 hours
Watts per bulb	60W	14W	7W
Cost Per bulb	30-50 BDT	100-350 BDT	200-250 BDT
Tuns on instantly?	Yes	Slight delay	Yes
Durability	Fragile	Fragile	Durable
Heat Emissions	High (85 BTU's/hr)	Medium (15 BTU's/hr)	Low (3 BTU's/hr)
Hazardous material	None	5mg of Mercury bulb	None
Replacement Frequency	40+	5	1

Table 4.1: Comparison of Features for different types of light

A survey was conducted in several houses of Taluk Kaloa village to obtain what types lamps they used and it is a village in Kurigram district of Bangladesh. Table 4.2 shows the information about different types of lamps that we audited. In this table, we include all types of lamp in houses and other structure of this village.

Village	Total Number of CFLs (W)	Total Number of Incandescent Lamp(W)	Total Number of Fluorescent Lamp(W)	Total Number of LED Lamps (W)
Taluk Kaloa	763-(32W) 55-(18W) 45-(15W)	122-(60W) 66-(40W)	25-(36W)	87-(20W) 25-(05W)

Table 4.2: Data of Lamps

We find some problem during village auditing. We saw many low quality lighting products. We ask them why they use that? They told us these lighting products are cheap but these product has no warranty and guarantee. These products are disabled within one to two months of use. We try to understand them to don't buy these low quality product.

4.3 Retrofit

Retrofit is the way that replace the wasteful and inefficient lighting system with further developed and high efficiencies systems. Retrofits additionally relies on different boundaries like arrangements and guidelines, inhabitant's assumptions, house specification and other components . We have considered the above issues that if we replace all types of bulbs with LED bulb, we will get better output with better improvement of efficienecy. The replacement of common typical bulbs by LED bulbs is given below:

Type of Lamps		Replacement	
CFL	32 (W)	20(W)	LED
	18(W)	10(W)	
	15(W)	7(W)	
Incandescent	60(W)	10(W)	
	40(W)	7(W)	
Fluorescent	36(W)	16(W)	LED Tube Lights

Table 4.3: Replacement of Typical Lamps By LED Lamps

4.4 Electrical Equipments Consideration

Electrical equipments are consumed more electricity than lighting loads and these electrical equipments are responsible for most of the electricity bills. The normal electrical equipments

utilized in village households are ceiling fan, stand fan, refrigerator, television and computer etc. Currently, due to the development of technology, updated versions of almost all electrical equipments are available in the market and these update version of electrical equipments are consumed less electrical energy than old version. We should use these new versions of electrical equipment to save electrical energy and costs.

4.4.1 Fan

A fan is an electrical machine which use for progression of air. A fan comprises of a turning arrengement of vanes or blades, Which helps the wind to flow from top to bottom. When a fan rotates it rotates in a circle of a certain diameter. The diameter of this circle is determined according to the size of the fan's blades. Again, the size of the fan should be determined according to the size of the room and it will make fan more efficient. According to the size of the room, the size of the fan's blade are room less than 80 sq ft required fan blade size 24”-42”, 100-150 sq ft room required fan blade size 44”-50”, 150-300 sq ft room required blade size 52”- 60” and greater than 300 sq ft room required blade size 62”. Again we need to about CFM. CFM means cubic per minute. For reducing cooling cost, we need to select higher CFM which should be at least 6000-7000 CFM. For require CFM for a room is given below:

Volume of the room, V = Square feet of the floor × room height in feet.

Then multiply it by 30 or 60 air charges per hour and divided by 60 to get the required CFM.

$$CFM = \frac{V * 30\ or\ 60}{60}$$

Again, if we install proper size of fan in proper position, we can make fan more efficient. The length of drop rods and different ceiling heights are given below:

Ceiling Height (feet)	Drop Rod
9	12
10	18
11	24
12	36
13	48

Table 4.4: Length of Drop Rod for Different Heights

4.4.2 Refrigerators

A refrigerator is a home apparatus comprising of a thermally protected compartment and a warmth pump that moves heat from its inside to its outside climate so its inside is cooled to a temperature underneath the room temperature. The refrigerator keeps our food very fresh. Nowadays refrigerators have become our daily companion. When we audited, we saw a lot of fridges that were brought before the 2010 and these refrigerators are quite old. Then there are some refrigerators that have been repaired a few times. Because these refrigerators are quite old and have been repaired several times, they consume more electricity than they need. As a result, we get higher electricity bills.

4.4.3 Computer Monitor & Television

There are many types of computer monitors and television. These types are CRT, LCD, LED etc. Each of these types of monitors and televisions consumes different amounts of electrical energy. CRT was oldest invention and CRT monitor & television consumes more electricity than others. LCD montor & television consume less electrical energy than CRT television and monitors. LED monitors & television consume less electrical energy than CRT & LCD. And LED monitors & televisions are more efficient than CRT and LCD[23,24]. ENERGY STAR* rated television and monitor's depend on their resolutions or megapixels for energy consumption and the most extreme consumed energy in on mode for different resolution is determined by the two criteria specified in ENERGY STAR* site[25].

Criterion1

In order to be ENERGY STAR* certified maximum active mode power must not exceed the equation: $Y= 38X + 30$, where X is the number of megapixels in decimal from and Y is rounded up to the nearest whole number and expressed in watt.

Criterion2

If $X<1$ then $Y=23$ and if $X>1$ then $Y=28X$, where X is the number of megapixels in decimal from and Y is rounded up to the nearest whole number and expressed in watts.

4.4.4 Water Pump

A water pump is a machine used to expand the pressing factor of water to move it starting with one point then onto the next. Current water pumps are utilized all through the world to supply water for civil, mechanical, rural, and private employments. Water pump likewise are utilized to

move wastewater in sewage treatment plants. Water pumps are divided into different categories depending on their power. We found a lot of water pumps when I did the audit. Some of these were for fetching water at home and again there was some water pumps to irrigate the crops of the land.

4.5 Savings on Lighting

In previous chapter we discussed about lighting loads. Now we will discuss about savings on lighting.

For Houses,

There are many lamps that have the same power but they have different working hours in different places. Here will be the calculation of the light of the bedroom of all the houses in the village. Now I will replace CFL bulb by LED. Thus, I calculated the saving by replacing the most efficient lamps that are available now and our calculation method is[26],

Wattage of CFL lamp= 32 W

Wattage of LED lamp= 20W

Wattage difference=(32-20)= 12W

Number of lamps=464

Saving Wattage= $\frac{464*12}{1000}$= 5.568 KW

Average working hour= 5 hours

Total number of days= 365 Days

Unit Saving=(5.568*5*365)= 10161.6 KWH

Electricity Cost=(10161.6*6)= **BDT 60969.6**

Incandescent lamps should be replaced by LED Lamps. There are 52 incandescent (60w) lamps which will replaced by 10W LED lamps.

Wattage of Incandescent Lamps= 60W

Wattage of LED lamps= 10W

Wattage Difference=(60-10)= 50W

Number of Lamps= 52

Saving Wattage= $\frac{52*50}{1000}$= 2.6 KW

Unit Saving=(2.6*5*365)= 4745 KWH

Electricity Cost= **BDT 28470**

Similarly for Flurescent(36W) lamp replaced by LED(16W)

Saving electricity cost=**BDT 5475**

For Kitchen, I will be replaced CFL(32W) lamps by LED(20W)

Wattage of CFL lamp= 32 W

Wattage of LED lamp= 20W

Wattage difference=(32-20)= 12W

Number of Lamps= 139

Saving Wattage= $\frac{139*12}{1000}$= 1.668 KW

Average working hour= 4 hours

Total number of days= 365 Days

Unit Saving=(1.668*4*365)= 2435.28 KWH

Electricity cost= **BDT 14611.68**

I will also replace kitchen's incandescent (60W) lamps by LED(10W) lamps.

Wattage of Incandescent lamp= 60W

Wattage of LED lamp= 10W

Wattage difference=(60-10)= 50W

Number of Lamps= 45

Saving Wattage= $\frac{45*50}{1000}$= 2.25 KW

Unit Saving= 3285 KWH

Electricity Cost= **BDT 19710**

For toilet, we will replace CFL(18W), CFL(15W) & Incandescent (40W) by LED(10W), & LED(7W).

Wattage of Incandescent lamp= 40W

Wattage of LED lamp= 70W

Wattage difference=(40-7)= 33W

Number of Lamps= 62

Saving Wattage=$\frac{62*33}{1000}$= 2.046 KW

Electricity Cost=(2.046*1*365*6)=**BDT 4480.74**

Similarly, CFL(18W), CFL(15W) replaced by LED(10W) & LED(7W) and saving electricity cost=**BDT 1664.4**

In House yard, I will replace CFL(32W) & Incandescent (60W) by LED(20W) & LED(10W).

So, Saving electricity cost= **BDT 71740.02**

In Mosque, I will replace CFL(32W) by LED(20W) and saving electricity cost=**BDT 946.08**

For toilet of mosque, we will replace CFL(15W) & Incandescent(40W) by LED(7W). Saving electricity cost= **BDT 376.68**

For Mosque outside, We will replace CFL(32W) by LED(20).

And Saving electricity Cost= **BDT 1156.32**

Total annual lighting saving for Taluk Kaloa village=**BDT 209,600.52**

After replacement with LED, We can save=$\frac{\text{BDT } 209600.52}{\text{BDT } 450461.08}$*100

=**46.53%**

4.6 Saving from Electrical Equipment

Terminologies used for calculation of saving from electrical equipment.

Qf= Quantity of Fan

Qm = Quantity of Monitor

Qt= Quantity of Television

Qr=Quantity of Refrigerator

WHd= Working hours per day

WDm= Working days per month

U= Unit cost of electricity for houses

P($exist$) = Power rating of existing appliance

P($star$) = Power rating of ENERGY STAR* rated appliance

P (Con. $exist$)= Power consumption of existing appliance

P*(Con) = Power consumption of ENERGY STAR* rated appliance

P = Saving in Power consumption

Saving from replacement of village houses conventional fan by energy star rated fan[27].

Qf	113	119	122	106	12
WHd	14	14	14	14	14
WDm	30	30	30	30	30
U	6	6	6	6	6
P(exist)	75	80	85	90	55(36”)
P(star)	52	52	52	52	40
P(con. Exist)	75*113	9.52 KW	10.37KW	9.54KW	0.66KW

	=8475W =8.475KW				
P*(Con)	52*113 =5876W =5.876KW	6.188KW	6.344KW	5.512KW	0.48KW
P	2.599KW	3.332KW	4.026KW	4.028KW	0.18KW
Monthly Cost Saving	**BDT 6549.48**	**BDT 8396.64**	**BDT 10145.52**	**BDT 10150.56**	**BDT 453.6**

Table 4.5: Saving from Energy Star Rated Fan

Total saving from Fan=BDT 35695.8

And For Mosque

Qf	15	17	8
WHd	3	3	3
WDm	30	30	30
U	6	6	6
P(exist)	75	80	90
P(star)	52	52	52
P(con. Exist)	1.125KW	1.36KW	0.72KW
P*(con)	0.78KW	0.884KW	0.416KW
P	0.345KW	0.476KW	0.304KW
Monthly Cost saving	**BDT 186.3**	**BDT 257.04**	**BDT 164.16**

Table 4.6: Saving From Energy Star Rated Fan of Mosque

Total saving from fan= BDT 607.5

Saving from replacement of conventional refrigerator by energy star rated refrigerator[28].

Size	380 ltr	348 ltr	240 ltr	198 ltr
Qr	35	42	28	16
WHd	8	8	8	8
WDm	30	30	30	30
U	6	6	6	6
P(exist)	180	165	135	109
P(star)	125	125	111	88
P(con. Exist)	6.3KW	6.93KW	3.78KW	1.744KW
P*(con)	4.375KW	5.25KW	3.108KW	1.408KW
P	1.925KW	1.68KW	0.672KW	0.336KW
Monthly Cost Saving	**BDT 2772**	**BDT 2419.2**	**BDT 967.68**	**BDT 483.84**

Table 4.7: Saving from Energy Rated Refrigerator

Total saving from refrigerator= BDT 6642.72

Saving from the replacement of conventional computer monitor by energy star*rated computer monitor[27]:

Qm= 42

WHd= 5 hour

Wdm= 30 days

U=BDT 6

P(exist)= 50W

P(star)= 25W

P(con. Exist)= 2.1KW

P*(Con)= 1.05KW

P= 1.05KW

Monthly Cost Saving= BDT 945

Saving from replacement of CRT & LCD TV by LED TV[29].

TV	CRT		LCD	
Size	21”	14”	32”	22”
Qt	58	42	16	38
WHd	5	5	5	5
WDm	30	30	30	30
U	6	6	6	6
P(exist)	120W	60W	110W	55W
P(LED)	38W	19W	50W	40W
P(con. Exist)	6.96KW	2.52KW	1.76KW	2.09KW
P(LED. Con)	2.204KW	0.798KW	0.8KW	1.52KW
P(saving)	4.756kw	1.722KW	0.96KW	0.57KW
Monthly Cost Saving	**BDT 4280.4**	**BDT 1549.8**	**BDT 864**	**BDT 513**

Table 4.8: Saving from LED TV

Total saving from Television= BDT 7207.2

Total Monthly Saving from electrical appliances= **BDT 51,098.22**

After replacement of electrical appliances I got **23.20%** saving.

4.7 Payback Period

Payback period=Total net investment/ net annual saving.

4.7.1 Payback period for Lighting

Name of Lamps		Lamp Price per piece	Investment In BDT
LED	20W	BDT 450	(763*450)=BDT 343350
	16W tube	BDT 400	(25*400)=BDT 10000
	10W	BDT 300	(177*300)=BDT 53100

	7W	BDT 250	(111*250)=BDT 27750
Total Investment			BDT 434200

Table 4.9: Investment for Lighting

So, payback period for lighting system= 434200/209600.52= **2.07 years**

4.7.2 Payback period for Electrical Aplliances

Name Of Appliances		Price in BDT per Piece	Investment In BDT
Fan	Qty=500 Size=56”	BDT 4200	BDT 2100000
	Qty=12 Size=36”	BDT 3500	BDT 42000
Computor Monitor Qty= 42		BDT 17000	BDT 714000
Television	22” Qty=138	BDT 20000	BDT 2760000
	32” Qty=16	BDT 25000	BDT 400000
Refrigerator	380 ltr Qty=35	BDT 55000	BDT 1925000
	348 ltr Qty=42	BDT 47000	BDT 1974000
	240 ltr Qty=28	BDT 35000	BDT 980000
	198 ltr Qty=16	BDT 23000	BDT 368000
Total Investment			BDT 1,1263000

Table 4.10: Investment for Electrical Equipments

So, Payback period for electrical appliances= **4.2615 years**

4.8 Summary

The target of an energy audit is to identify energy losses and the method of energy saving opportunities. In this chapter, I try to show the saving from different types of lamps and electrical

equipments. And also try to show how to replace efficient types of light for existing inefficient light and replace equipment's with STAR rated electrical equipment's. This chapter mainly based on feasibility of energy savings and the way of the replacement for efficient energy consumptions.

CHAPTER 5

Improvement of Energy Efficiency

5.1 Introduction

In present world, the consumption of energy is increasing day by day. At present, we use many devices for making our work easier in home, office and industrial work and these devices consume electrical energy for work and we also waste lots of energy unknowingly. In the other word, the importance of energy is much more in our daily life. Energy efficiency promises to use less amount of energy to bring same output and it also eliminate the wastage energy. It can bring huge monetary, social and natural advantages. It also helps to decrease the emissions of greenhouse gases, interest of energy imports and bringing down energy expenses on a household. I find some way to to make village houses more efficient in this chapter.

5.2 Performance of Home Appliances

Most important part of energy audit is checking performance of appliances. There are many cheap home appliances in the market and people buy these because of low price and performance of these equipments are very low which consume more electricity. I find many home appliances in village houses which consume more electricity and those gives less output. Some of home appliances like as ceiling fans, lights and refrigerators are old model and they are not capable to give high performance. We should change these low performing and less efficient aplliances to decrease energy consumptions and It will help them to save their energy bills.

5.3 Operational Time

Operational time is play important role for reducing energy consumption. In Bangladesh, energy consumption in peak hour and off peak hour are different. Peak hour is the time when the power consumption was very high and power consumption was low at off peak hour. The people who live in village need to know about peak hour and off peak hour. If they try to use less load at peak hour, it will help them to decrease the power consumption and they can save their money.

5.4 Use of Solar System

All the people of the village use BREB electricity lines to meet their electricity needs. Now they can reduce their power consumption cost by installing the solar system and it just cost money to buy and install then we can get energy free.They can use their necessary loads like fans, lights at peak hour using this solar system without cost.

5.5 Energy efficiency Technologies for Village Homes utilities

Technologies are updated day by day and many equipments equipped with new technology is available in the market. But in most of the village houses, still use low efficient home utilities and these equipments are old model and also they consume more electricity. So, they should upgrade their equipments to STAR rated equipments and STAR rated equipments are energy efficient and eco friendly. It will also help them to decrease the energy consumption & energy cost in village houses. And using of these energy efficient technologies are beneficial for house owner's and our country.

5.6 Field Saving Opportunitites

I find out some energy saving opportunities during energy audit which will help to reduce energy consumption. And these energy saving opportunities are given below:

5.6.1 Lighting

- Install LED to replace incandescent, fluorescent and Compact fluorescent.
- Use moderate lighting according to location.
- Try to use sunlight at day time.

5.6.2 Fan

- Always install correct size of fan.
- Use star rated and energy saving fans.
- Keep fan clean at all the time.
- Periodically maintain proper maintenance.

5.6.3 Water Pump

- Always install correct size and correct rating pump.
- Do not run the pump unnecessarily.
- Always try to operate pump in off peak hour.

- Determine the size of the pipeline according to the size of the pump.

5.6.4 Refrigerator

- Install STAR rated and energy efficient model refrigerator.
- Always keep the door closed.
- Store food properly.
- Do not store hot food.

5.7 Best Practice

For getting high efficiency and less energy consumption cost, the people of the village have to do proper maintenance the electric equipments of their houses. They can also proper use of sunlights at day time and also try to use heavy loads at off peak hour. It will help them to reducing energy consumption.

5.8 Summary

In this chapter, I try to recommend some methods to make village houses energy efficient. I also try to explain the subject of peak hour and off peak hour here and also recommended the solar system which help them to reducing energy consumption for various load. Again, they can save huge ammout of energy and energy consumption cost with constant output by following some best practices.

CHAPTER 6

Conclusion

At present the utilization of electrical energy is increasing day by day and developing & under developing countries electrical energy demands are so high. Electrical energy has become the key for development of a country. Most of the countries use natural resources for generating electrical power/energy. But a common phenomenon is high price of natural resources and this is the main reason for the increase in electrical generation cost. If the generation cost increases then the tariff rate will also increase and it will affect our monthly energy bills. In spite of the fact that, energy audit doesn't give the specific answer for lessen the utilization however on the other hand it gives a few chances to further developing our use which may lead to a decent extent of saving. I use small scale audit calculation and strategies to complete this audit and this audit may not applicable for large scale audit like industrial audit. I predominantly focused on village houses loads with the target of calculating energy losses, planning a real retrofit situation, ascertaining the potential power saving and lastly the compensation period. My investigation portrayed that sensible measure of energy can be saved if the energy audit is performed appropriately.Because of some limitations and inadequate measuring equipments I was unable to think about numerous factors, for example, penetration rate, fenestration variables and others. Utilization of water is one of the significant elements for a structure which contributes in the electrical bill. Ensuing investigations in this location may bring about idealistic reserve funds. And extra exploration and information is needed to create better outcomes and can devise a successful technique to conserve energy. Due to lack of operation time and data, I just try to calculate highest number of equipments in village houses in this chapter.There are also lots of further scopes of our work to direct in future, which may incorporate thinking about fenestrations, enhancements in penetration and ventilation rate, estimations of warmth stream because of conduction of material for windows, expanding engine efficiencies for water pumps. It is noteable that, the significant of carbon emissions and carbon footprint will be decreased by conservation of each kilowatt of energy. In this way, for a feasible climate and to contribute towards carbon neutrality, it is particularly significant to present energy

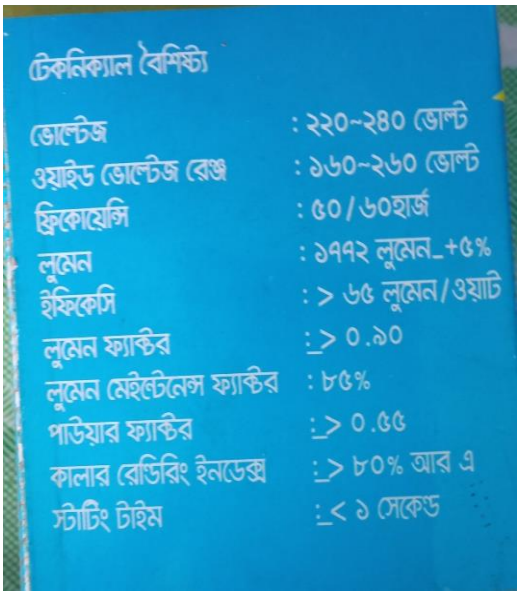
audit in each area with few changes in existing framework to cut the developing interest in Bangladesh. If our government make policies for all industries, commercial building and also for all houses undergo with energy audit then it will definitely enhance our economical standing in world market.

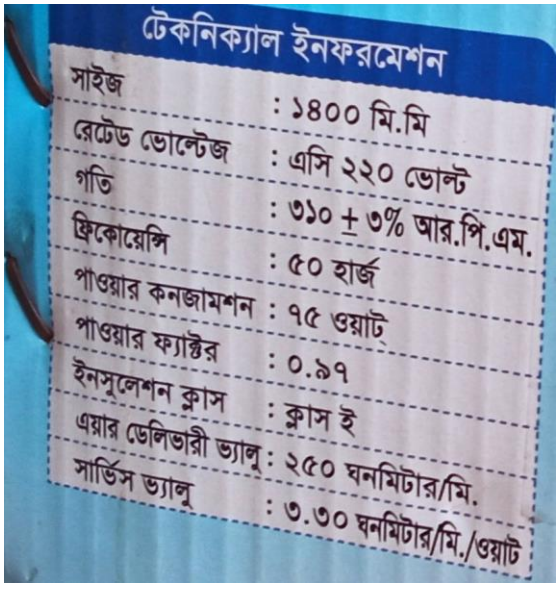
Appendix A

Some electricity bills of Taluk Kaloa village houses:

Appendix B

Watt rating of some electrical equipments:





Appendix C

Figure 1: CFL Bulb

Figure 2:LED Bulb

Figure 3: Incandescent Bulb

Figure 4: FL Tube

Figure 5: Refrigerator

Figure 6: CRT 21” TV

Figure 7: Water Pump

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