"ENERGY ASSESMENT AND POSSIBILITY OF INSTALLING 3kWp SOLAR SYSTEM AT DIU CSE BUILDING"

A Thesis submitted in partial fulfillment of the requirement 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 **“ENERGY ASSESMENT AND POSSIBILITY OF INSTALLING 3kWp SOLAR SYSTEM AT DIU CSE BUILDING”** is done by the following students under my direct supervision and this work has been carried out by them in the field work 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.

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Not anyone else it is our parent's prayer which bring us there. To our beloved family we would like to give them profound love and gratitude for inspiring, supporting and always encouraging us.

Dedicated to

Our Beloved Parents
&
Teachers

ABSTRACT

The consumption of energy has risen gradually over the year as the Urbanization happening rapidly, so the efficient use of energy is one of the biggest concern nowadays. The built environment is also responsible for around 40% of the global energy demand. Changes has been made to make any commercial building more energy efficient .Understanding the use of energy in any commercial building requires a closer insight into the amount of energy consumed and their ways of consumption. The most effective technique to obtain such level of understanding would be to perform an energy assessment. CSE building of Daffodil International University is an 11 storied building with a basement and perking area allocated with two lifts which is used for office work and computer laboratories. Its commercial building but DIU using it as an academic building in rent. The front of the building is west facing. Ground floor used as a lounge area ,level 1&2 used as classroom, level 3 to 6 made up for official work and rest of the floor made up for computer lab. This building energy consumption is based on 100% electricity and water, no gas is used in this building.

As part of the building master plan our team conducted an ASHRAE level 1& level 2 energy audit to identify several energy conservation opportunities at the building. After completion of the inspection, we are confident enough that CSE building of daffodil international university has several no cost/low cost energy conservation opportunities it can pursue.

From December 2017 to November 2018, this building spent BDT 2836555 for electricity and April 2017 to March 2018 they spent BDT 190826 for water, their total utility cost was BDT 3027281 .in September 2018 they used maximum electric energy and it costs BDT 448209 and in July 2018 they used electricity which cost BDT 156525. This trend clearly shows that they misuse the electrical energy in September 2018 but if they focused on July 2018, they must use electricity efficiently and can continue the same practices to reduce their utility cost approximately 33.78% of the total electricity consumption throughout the year 2018. It is anticipated that cost of electricity will increase over time. If the cost increase the projected savings will increase correspondingly. These savings can be re-invested in capital improvement of the building, such as replacement of Electrical equipment to the more energy efficient equipment.it is expected that the building can save enough money by replacing these equipment.

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LIST OF ABBRIVIATIONS

CSE	*Computer Science & Engineering*
ASHRAE	*American Society of Heating, Refrigerating, and Air-Conditioning Engineers*
PDB	*Power Development Board*
BNBC	*Bangladesh National Building Code*
BTU	*British Thermal Unit*
CFL	*Compact Fluorescent Lamp*
CFL	*Compact Fluorescent light*
CFM	*Cubic Feet per Minute*
CRT	*Cathode Ray Tube*
EER	*Energy Efficiency Ratio*
EPA	*Energy Power Agency*
EPB	*Energy Performance of Buildings*
EPBD	*Energy Performance of Buildings Directive*
ERBM	*Energy Rating Mark*
ESCO	*Energy Services Companies*
FL	*Fluorescent Lamps*
FL	*Fluorescent light*
HER	*Heat Energy Rating*
HFO	*Heavy Fuel Oils*
HID	*High Intensity discharge lamp*
HPSL	*High Pressure Sodium lamp*

HVAC	*Heating Ventilation Air Conditioner*
kWh	*Kilo Watt Hour*
LCD	*Liquid Crystal Display*
LED	*Light Emitting Diode*
LPSL	*Low Pressure Sodium Lamp*
LRV	*Light Reflection Value*
SAP	*Standard Assessment Procedure*
SEER	*Seasonal Energy Efficiency Ratio*
SPV	*Solar Photovoltaic*

CHAPTER 1

INTRODUCTION

1.1 Introduction

Electrical energy is one of the most essential parts of our modern life. Electricity is the major source of power for most of the country's economic and infrastructural growth. In all economic sectors household and commercial demand for electrical energy is increasing day by day. This demand is driven by such important factors as industrialization, extensive urbanization, population growth, rising standard of living and even the modernization of the agricultural sector. Global Primary energy consumption grew at a rate of 2.9% last year, almost double its 10-year average of 1.5% per year, and the fastest since 2013.

Bangladesh has a very limited energy reserve; small amounts of oil, coal and countable natural gas reserves. . Most of our energy is supplied by fossil fuel or crude oils, both are non-renewable. Although many alternatives such as wind, solar, geo-thermal, tidal wave and biomass energy concepts has developed as renewable sources; no sustainable solution to reduce dependency on fossil fuel has developed yet. The country suffers an internal energy struggle, as about 93% of the country's power producing thermal plants are gas-based, but the gas is also needed for the industrial sector. Therefore, the country has to -continuously- make some compromises between power production and developing the industrial sector.

In Bangladesh As of 2015, 92% of the urban population and 67% of the rural population had access to electricity [1]. As of 2018 about 90% of the total population had access to electricity according to Bangladesh power development board (BPDB). Bangladesh will need an estimated 34,000 MW of power by 2030 to sustain its economic growth of over 7 percent. The maximum demand of electricity is increased to 14,014 MW in 2018 which is 151.6% increased in a time period of 10 years (2008-18) [1]. According to Bangladesh power development board (BPDB) the maximum peak generation was 10,958 MW. in FY-2018 the installed power generation capacity is about 15,953 MW, out of which 9,413 MW (61%) is generated by gas power plant, 3,443MW (22%)

from furnace oil, 1380MW (6.49%) from diesel , 230MW (1%) from hydro, 524 MW(3%) from coal and 660MW (4%) are imported as of annual report 2017-18 [1]. in spite of this Bangladesh still suffers from major shortage of electricity generation to satisfy the daily demand. A long term master plan of electricity generation against the demand up to 2030 has been incorporated in the PSMP 2016. Under the plan generation capacity requirement in 2021 will be 24000 MW against the demand of 20000 MW and in 2030 generation capacity will be 39000 MW against the demand of 33000 MW.

Bangladesh has small reserves of oil and coal, but very large natural gas resources. Commercial energy consumption comes mostly from natural gas (around 66%), followed by oil, hydropower, coal and non-commercial energy. Bangladesh has planned to produce 10% of total power generation by 2020 from renewable energy sources like wind, waste, and solar energy. The country plans to increase its renewable energy share to 17% by 2041 under its Intended Nationally Determined Contribution (INDC) commitment to reduce greenhouse gas emissions by 5% until 2030 [2].

According to the Bangladesh's Power Sector Master Plan 2016 (PSMP–2016), the country has the potential to generate a combined 3.6 GW of electricity from renewable energy sources [1]. Another research has estimated that the potential from wind power alone stands at 20 GW. Government has also taken energy efficiency and conservation program for reducing the growing energy demand. In this situation, the cheapest and fastest solution to overcome all the energy demand is energy conservation and improvement of energy efficiency. Energy conservation means reduction in energy usage by less energy service and energy efficient means less energy for a constant output. Although, the two concepts differed from each other but can be merged together by Energy Audit. Audit is an assessment, survey and analysis of energy conservation in a building, to reduce the consumption of energy in an efficient way without having the adverse effect on output. Energy audit is one of the most fundamental method to save energy bills and national energy resource of a country.

1.2 Objectives

The objectives of this audit work are-

- To study the energy consumption in commercial building, get reliable knowledge of energy consumption and how to improve the efficiency by reducing energy uses to have constant output.
- To eliminate the energy loses and find out the opportunities to prevent loss and reduce energy cost.
- To design the single line diagram of electrical load in the building

1.3 Scopes

A least developed country like Bangladesh, which has a population over 164 million and greatly relies upon natural resources for power generation; energy audit can be an effective tool to adopt a comprehensive energy management system.

The energy consumption issue has been a growing interest across the least developed and developed country around the globe because of its immediate impact on production cost and also because of its considerable impact on environmental sustainability, which is the biggest issue faced by mankind at present.

In continuation of energy conservation energy audit is the first steps, we intended to measure the energy efficiency of various types of building around the country and find out the most effective way to save the electricity, which is one of the biggest crisis in the country because of growing demand.

1.4 Research Methodology

The methodology of this audit work are as follows:

- The preliminary phase involved information gathering from log book data sheets, historical data, drawing, literature and through interview and discussion with operating personnel and electrical technician.
- Current operating data for key parameters influencing energy efficiency were obtained from control panels.
- Specific energy conservation opportunities were identified, along with technical and economic feasibility analysis.
- We did level 1 & level 2 audit of CSE building, DIU. firstly our audit team physically visited this building for taking all the information of whole building .we took each floor size with specific electrical appliances .for comparison we collected 1 year electricity and water bill copy.

1.5 Audit work outline

This audit work is organized as follows:

Chapter 1 we have discussed the scenarios of overall energy crisis and subsequent energy studies. Chapter 2 on this thesis paper will mainly discuss the significance of energy audit and the basic steps to perform an energy audit for a building.
Chapter 3 Building analysis and review
Chapter 4 Building utility analysis and review the actual data of the building.
Chapter 5 Possibility of installing 3kWp solar plant
Chapter 6 Conclusions

CHAPTER 2

LITERATURE REVIEWS

2.1 Introduction

For saving energy bills and to conserve national energy resources of a country energy audit is considered to be one of the fundamental and necessary process. Least developed country like Bangladesh are mainly depending upon natural resources for power generation, which has a population over 164 million, Energy audit can be an effective way to find the way to use the energy efficiently. This chapter focus on basic energy audit level, concept about lighting, Electrical equipment and envelope audit.

2.2 Energy audit definition

The purpose of an energy audit (sometimes called an “energy assessment” or “energy study”) is to determine where, when, why and how energy is used in a facility, and to identify opportunities to improve efficiency. Energy auditing services are offered by energy services companies (ESCOs), energy consultants and engineering firms. The energy auditor leads the audit process but works closely with building owners, staff and other key participants throughout to ensure accuracy of data collection and appropriateness of energy efficiency recommendation. Simple energy audit provides building owner a list of no cost or low-cost recommendation which can be implemented by operations and maintenance staff. The audit typically begins with a review of historical and current utility data and benchmarking of your building’s energy use against similar buildings. The main outcome of an energy audit is a list of recommended energy efficiency measures (EEMs), their associated energy savings potential, and an assessment of whether EEM installation costs are a good financial investment [3]

In Bangladesh, the energy efficiency and conservation rules were passed in 22nd October 2012 from the Ministry of Power, Energy and Mineral Resources. The draft illustrates on energy audit and conservation on its section 4, clearly stating that all the commercial buildings must comply the rules and use efficient, and cost-effective life cycle appliances following Bangladesh National Building Code (BNBC) [4] . Although rules on energy audits were from 2012, comprehensive studies have not been published accordingly in Bangladesh.

2.3 Types of Energy audit

Energy audits typically take a whole building approach by examining the building envelope, building systems, operations and maintenance procedures, and building schedules. Whole building audits provide the most accurate picture of energy savings opportunities at your facility.

Alternately, energy audits can be targeted to specific systems (i.e., lighting or heating, ventilation and air conditioning). Targeted audits may miss significant bigger picture energy savings opportunities but may be a good route if you have specific energy efficiency retrofit projects in mind and limited funds to invest.

2.4 Levels of Energy audit

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) defines three levels of audits. Each audit level builds on the previous level. As audit complexity increases, so does thoroughness of the site assessment, the amount of data collected, and the detail provided in the final audit report. This effort can translate into higher energy savings.

Level 1: Preliminary or walkthrough audit

The preliminary audit is the simplest type of audit. It consists simple interviews with site operating personnel, review utility bills and other operating data briefly. Walkthrough audit is physical site inspection and become familiar with the building operation. Also finding the areas of energy waste and energy efficiency improvement. By these auditors find the areas where the energy is used properly and the areas where the saving opportunities can be applied. It’s not provided details analysis.

Level 2: Standard or General Energy Audit

Standard or general energy audit provide expansion of preliminary audit. Collecting more detailed information about operation, it includes depth analysis of energy cost, usage and analysis equipment, system and characteristics of the building. To evaluate the facilities energy demand rate structures and energy usages profile, auditor need to collect utility for a 12 to 36-month period. In depth interview conducted with operation personnel to understand of major energy consumption system, and knowing the variation in short-term and long-term energy consumption and demand like daily and annual. This type of audit covered detailed financial analysis for cost estimate, site specific operating cost saving, and investment criteria. Also provide sufficient detail to justify project implementation. This type of audit is helpful for energy and cost saving of the building by using energy engineering calculations based on the data collected from the site.

Level 3: Detailed or Investment-grade Energy Audit

Detailed Analysis of Capital-Intensive Modification Audits (sometimes referred to as an "investment grade" audit) provide solid recommendations and financial analysis for major capital investments. In addition to Level I and Level II activities, Level III audits include monitoring, data collection and engineering analysis.

From above discussion levels of energy audit can be summarized in table 2.1 –

Table 2.1: Audit phase

Auditing level	Activities
Level 1: Preliminary audit	1.site survey and collect and analyze utility data 2.visually inspect building and key system 3.analyze energy efficiency improvement potential
Level 2:Standard audit	1. Detailed building survey 2. In-depth interview with building staff 3. Analyze the energy and cost savings 4. Breakdown of energy use
Level 3: Detailed energy audit	1.develop simulation tool 2summarize finding 3.Calculating cost and saving with a high level of accuracy 4.Making professional report including recommendation

CHAPTER 3

METHODOLOGY

3.1 Introduction

The energy crisis in the present day world has led us to the design of new energy efficient buildings. However the existing buildings consume a lot of conventional energy and minimizing them will help us to conserve them for future. Moreover it would help us to meet the Energy Efficiency standards [5].

Energy audit in any commercial and household building is likelihood study. It’s not only serves to mark out energy use among the various electrical equipment or to link opportunities for energy conservation but also a crucial first steps for adopting a comprehensive energy management programme. The audit will outrun the data according to the programme is based on. The options available for reducing the energy waste, cost involved, and profit attainable from implementing those energy conserving opportunities and consciousness of their team need to maintain should be clear to the owner or management team by the study.

The energy audit is a systematic on-going technique for opposing a building's energy consumption pattern. Its design to reduce the waste of energy and money to the minimum permitted by the climate the building is located, occupancy schedules, its functions and other factors. It constitutes and sustains efficient balance between a building's annual functional energy requirements and its annual actual energy consumption.

3.2 Processes of energy assessment work

To perform this energy audit at first we have been trained by novelty Engineering Corporation around six months. After that we formed a group of six members and with permission of our department we have been visited CSE building of DIU.

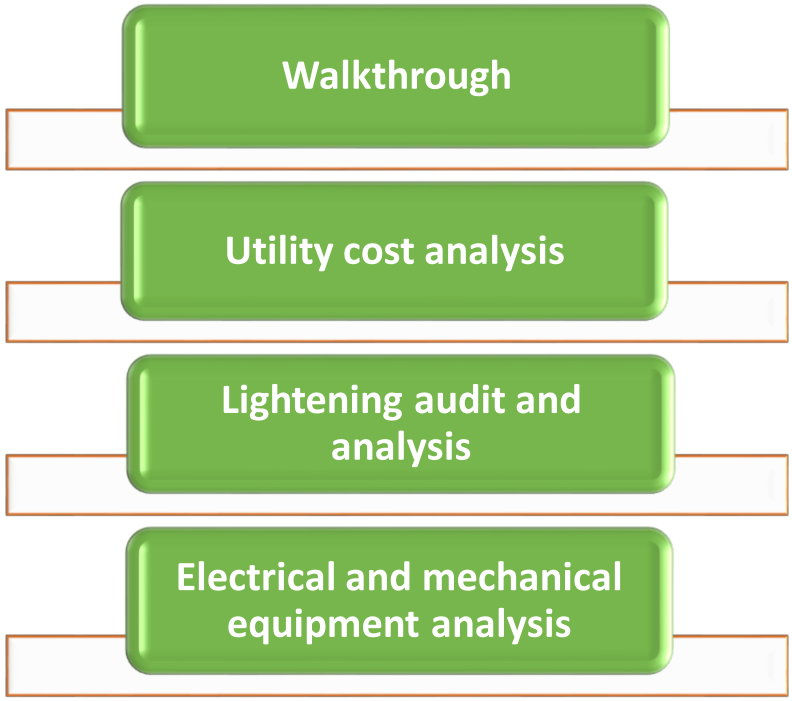

Figure 3.1: Processes of our assessment work

3.2.1 Walkthrough

At first we did a simple work through survey, followed by monitoring of energy use in building services and then computer simulation of building operation. We talked with the staff and coordinator of CSE building and gathered information as far as possible. We have collected few previous electricity bills and noted about the working days, working hours, shifts. After that with help of measuring tape we have taken the measurement of building per square fit in meter. Counted all electric appliance and model used in whole building like light, fan, AC, Computers, elevator, photocopy machine, printers, filters, card print machine, oven etc. even we checked climates and all rooms that are using in which purpose like lab, classroom or teachers room etc. Then calculated energy consumption in kWh and cost of it.

3.2.2 Utility cost analysis

In this stage we carefully analyze the operating cost of the facility. The data obtained over a long period of time energy bills, peak demands, energy use patterns, weather effects are identified. This helps us to establish a relation between cost and utility. Usually this stage contains-

- Checking utility charges and ensuring that no mistakes are made in calculating the monthly energy bills. This is important because the energy rate structures for the commercial facilities can be quite complex.
- Equipment loads and hours of operation were used to determine the breakdown of the total energy uses in the facilities
- Determination of the dominant charges in the energy bills is another part of this analysis. Peak demands take-up a major share of the power consumption cost. Thus for shaving off the peak demand supplemental energy measures can be recommended.
- Checking whether the facility can benefit from alternative fuels which are more cost effective than the prevailing ones. This will make significant reductions in energy bills. Moreover, the energy auditor can determine whether or not the facility is prime for energy retrofit projects by analyzing the utility data. Indeed, the energy use of the facility can be normalized and compared to indices (for instance, the energy use per unit of floor area for commercial buildings or per unit of a product for industrial facilities).

3.2.4 Lightening audit and analysis

The lighting study includes an audit of the facilities‟ lighting systems and controls, an analysis of available alternatives and a summary of recommendations. The audit includes a detailed review of the various sources of lighting installed. This information was obtained through a physical, onsite review of the lighting system on a room-by-room basis.

3.2.5 Electrical and air condition system analysis

The electrical and air condition analysis contain an audit of the facilities plug load, cooling and ventilation systems and controls analysis of retrofit alternatives and a summary of recommendations. . For this information we conducted a physical, on-site inventory and review of the mechanical equipment and equipment data.

3.2.6 Integration of renewable Energy

Renewable Energy Integration focuses on incorporating renewable energy generation and distribution. The goal of Renewable energy integration is to advance system design, planning, and operation of the electric grid to:

- Reduce carbon emissions and emissions of other air pollutants through increased use of renewable energy such as solar energy.
- Increasing asset use through integration of distributed systems and customer demand to reduce peak load and thus lower the costs of electricity.
- Enrich reliability, security, and resiliency from micro grid applications in critical infrastructure protection and highly constrained areas of the electric grid

CHAPTER 4

BUILDING ANALYSIS AND SAVINGS

4.1 Introduction

CSE building of daffodil international university is a 10 storied building with a basement and perking area allocated with two lift used for office work and computer laboratories. Later DIU authority made few changes of the plan inside the building for their own. Ground floor basically a lounge / canteen, level 1&2 classroom, level 3 to 5 made up for official work and level 6 and above made up for computer laboratories. This building is based on 100% electricity and water, No Gas is used in this building.

As part of the Building Master Plan our team conducted an ASHRAE Level I & II Energy Audit to identify several energy conservation opportunities at the building. Upon completion of the inspection, we are confident that the Daffodil International University (CSE Building) has several no cost/low cost energy conservation opportunities it can pursue. These opportunities will support the Building's economic benefit to the region and are summarized in this report.

The purpose of this ASHRAE Level I and level II Energy Audit is to evaluate utility usage and billing, observe how the energy using systems are operated and maintained, and to develop no cost/low cost recommendations to improve efficiency and reduce utility consumption at the CSE building of Daffodil International University. However, due to numerous limitations of instruments we had to confine our comprehensive study to some major areas which will be discussed in the following chapters.

4.2 Building Profile

4.2.1 General Description

The Construction of CSE Building was originally completed in 2013.It is a commercial building and owner rented it to Daffodil International University. The CSE building's weekly operating hours are listed in Table 4.1-

Table 4.1 CSE building weekly operating hours

DAY	SAT	SUN	MON	TUE	WED	THU	TOTAL HOUR
DAY SHIFT	8:30	8:30	8:30	8:30	8:30	8:30	51
	5:00	5:00	5:00	5:00	5:00	5:00	
EVE SHIFT	6:00	6:00	6:00	6:00	6:00	6:00	18
	9:00	9:00	9:00	9:00	9:00	9:00	
FRIDAY	9:00 – 3:00						6
Total weekly operating hours							**75**

4.2.2 CSE building floor area details

The gross square footage is approximately 1973.8 square feet (SF). The buildings and there Respective areas are shown in Table 4.2-

Table 4.2 CSE building area details

Room area	Square feet
Lab room	829
Lab room	865
Cori door	79.8
Lift	80
Stairs	40
IT office	80
Total	**1973.8**

4.2.2.1 CSE Building Floor Layout

During observation, we noted how many appliances connected in a single room and actual measurement of the room in square feet. Here is the schematic diagram of few floor as follows -

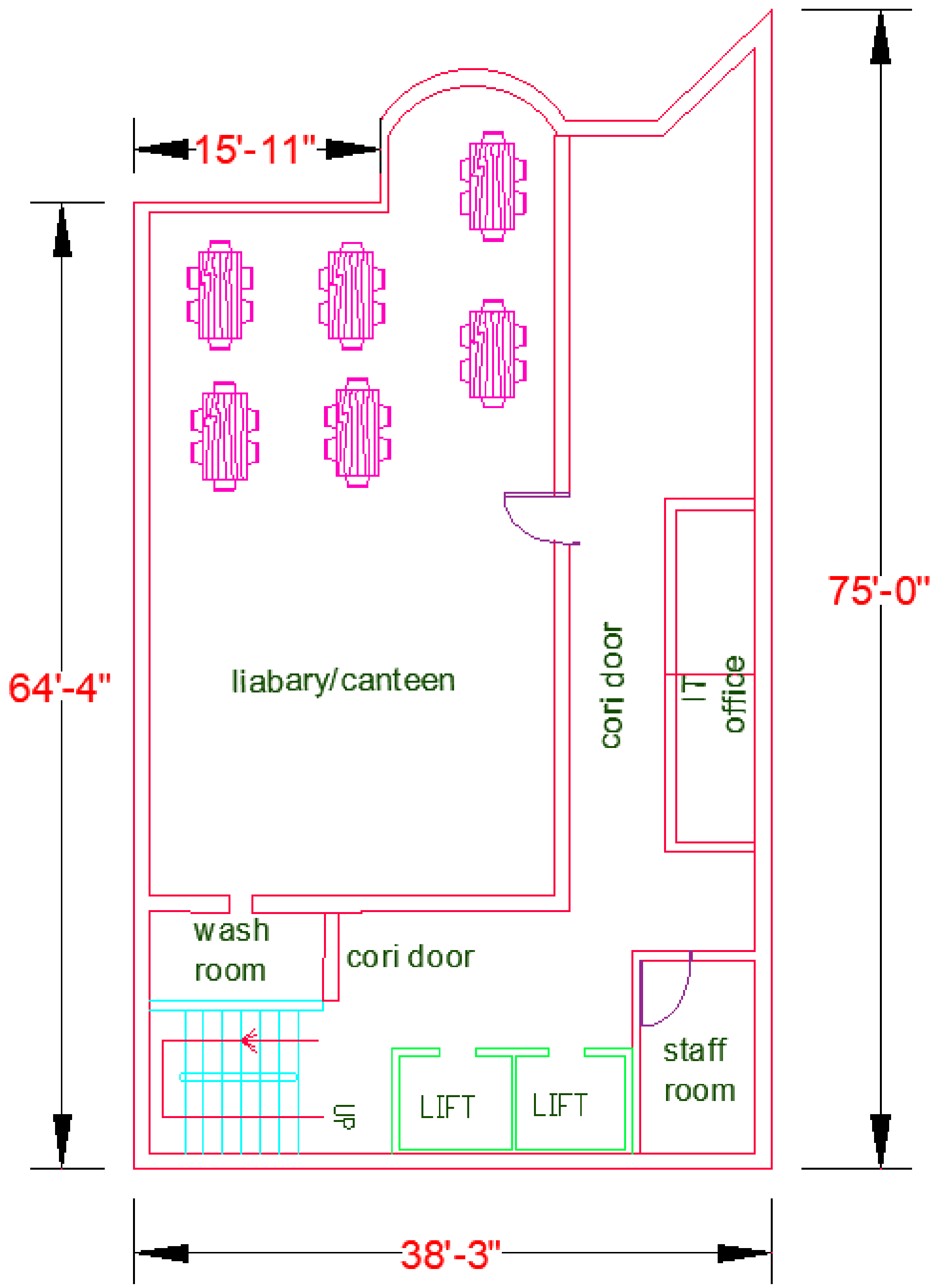

Figure 4.1 schematic diagram of ground floor

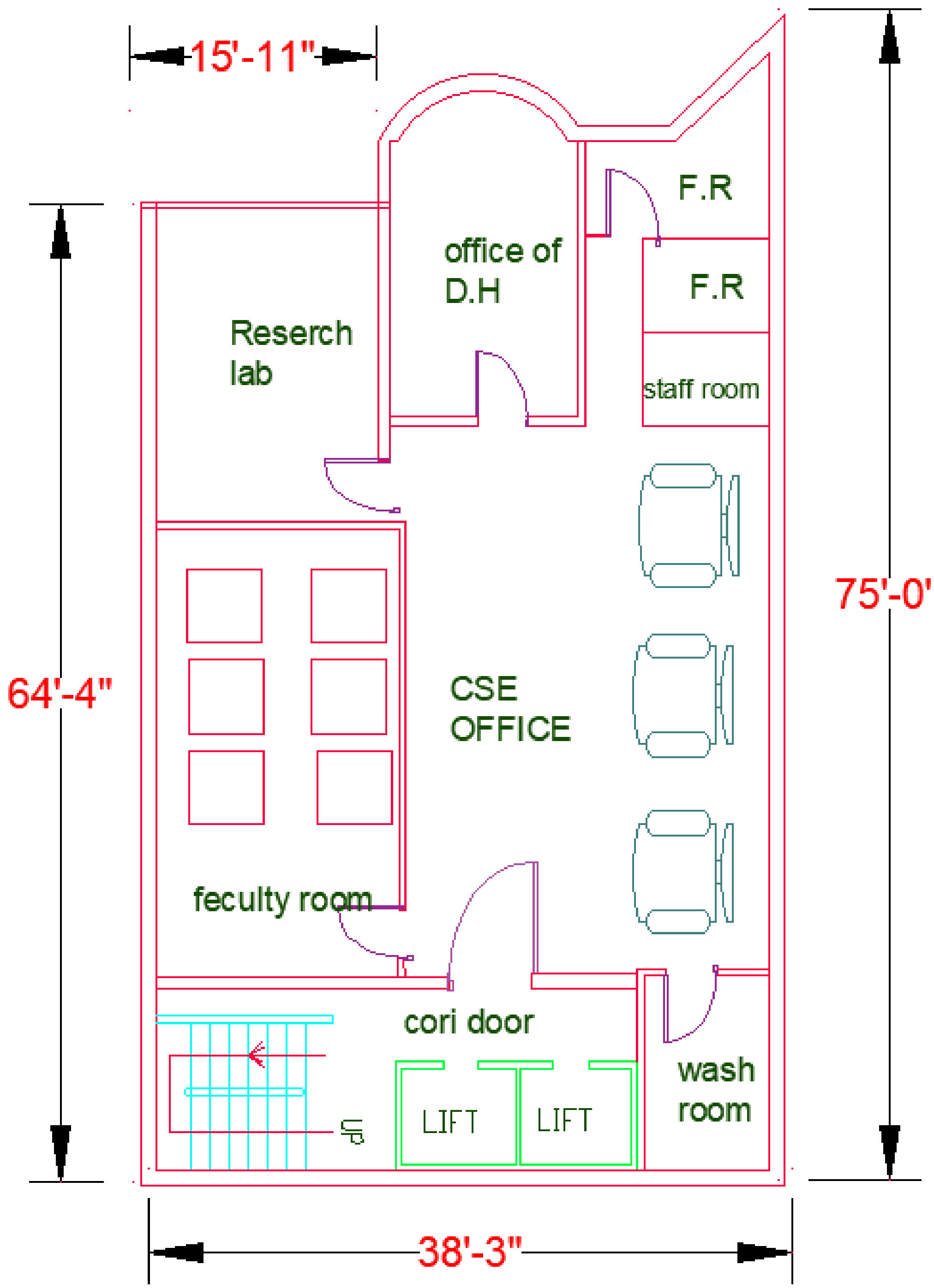

Figure 4.2: schematic diagram of 3rd floor (CSE Office)

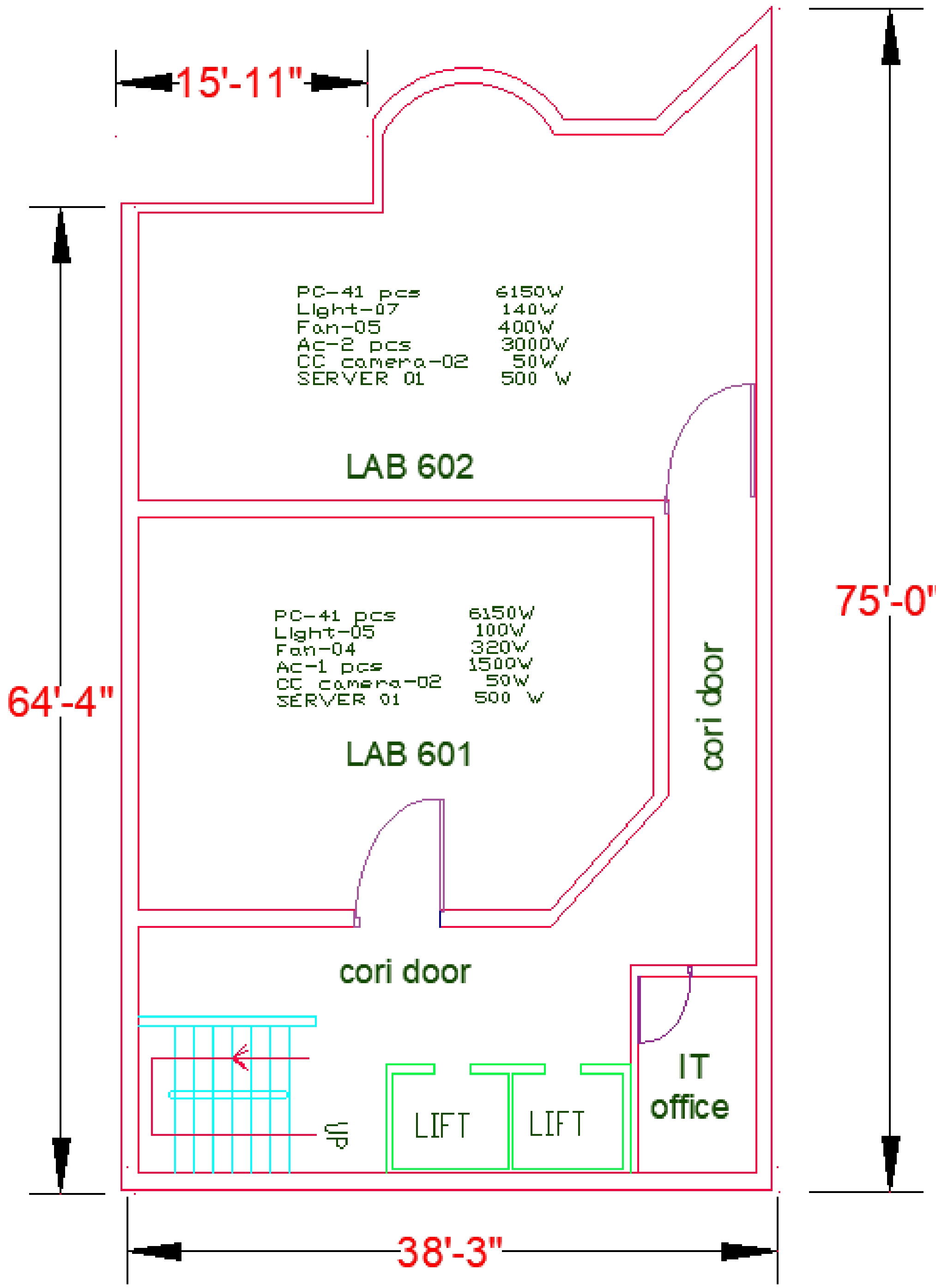

Figure 4.3: schematic diagram of level 6 (computer lab)

4.2.3 Single line diagram of DIU CSE building

Our energy audit team physically visited the mentioned building and collected all the data and readings from the transformer and other electrical appliances. Dhaka power Distribution Company limited (DPDC) medium voltage (MT) 11 KV line is connected as a power source of the building. There are two backup generator is installed in the facilities, one is 220 KV and another is 110 KV. Details single line diagram of DIU CSE building is given down below in figure -4.4

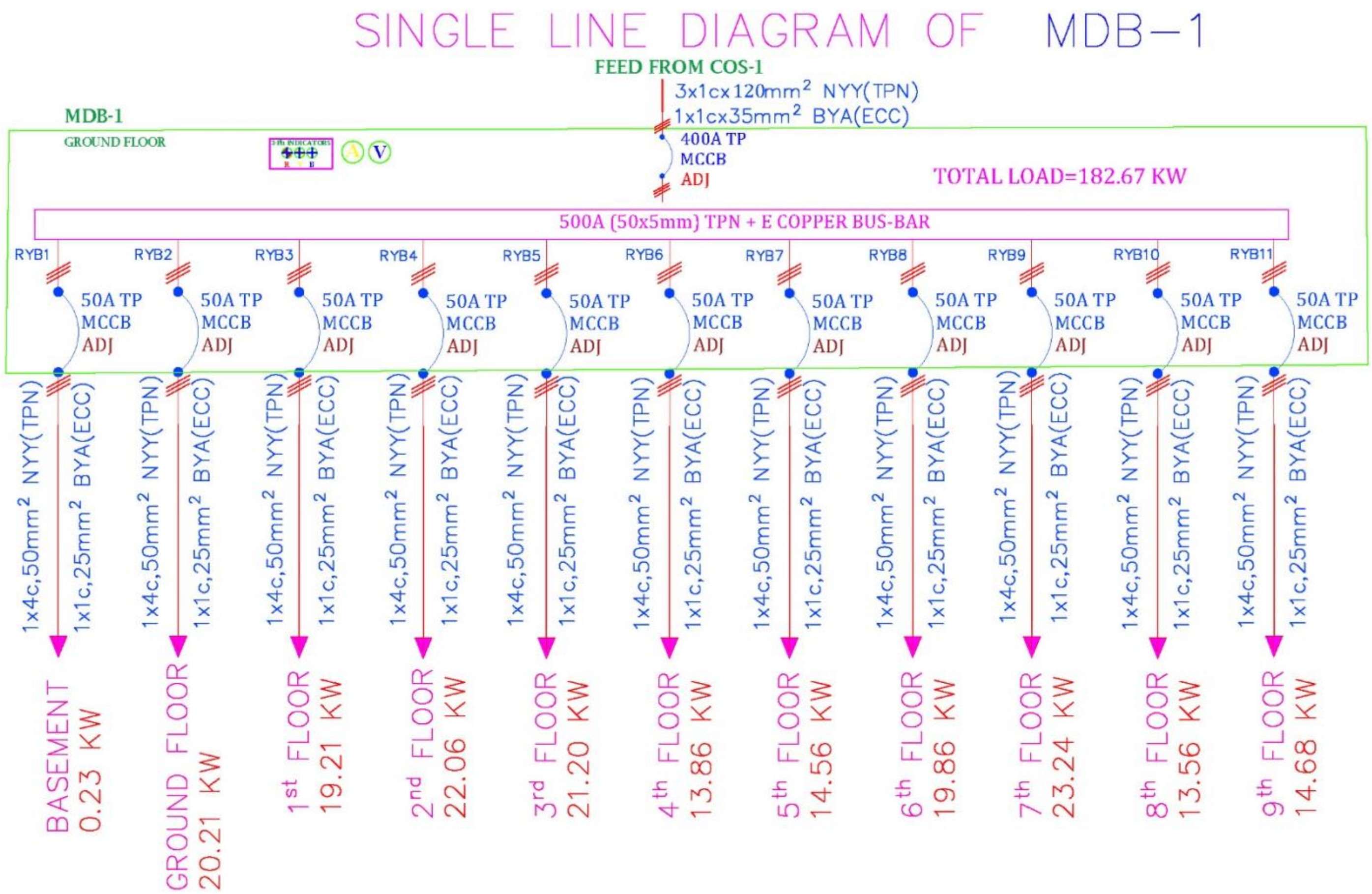

Figure 4.4 –single line diagram of DIU CSE building

4.3 CSE building utility Information

4.3.1 Historical utility consumption/energy use & cost (EUI & ECI)

Table 4.3 energy use & cost history

YEAR	Electric		Water		
	Use(kWh)	Cost (TK)	Use (Litters)	Cost (Tk)	Total Cost (TK)
Jan 18-Dec 18	317947.0303	**2623063**	5452171.43	**190826**	**3027381**

4.3.2 Electricity information

Electricity is metered and billed based on the existing electric meter, #310168463 there are also several sub-meters. The current demand charges of 8.25 taka/Kwh are high consequently, it would be beneficial to look for ways to reduce the peak demand in the terminal. This analysis is beyond the scope of this report, however there appears to be an opportunity to save additional energy.

4.3.2.1 Monthly electricity bill for the year (2017-18)

Table 4.4 monthly electricity bill

Months	Bills in BDT
Dec	188356
Jan	142823
Feb	203564
Mar	274566
Apr	205891
May	254429
Jun	258954
Jul	156525
Aug	200645
Sep	448209
Oct	293273
Nov	209320

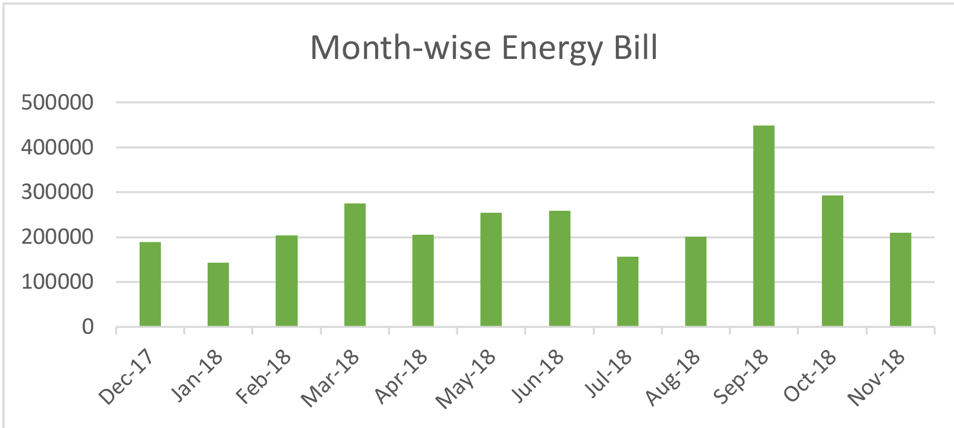

Figure 4.5: bar chart of month wise electricity bill

4.3.2.2 Total Load Consumption

Here is the total load consumption in terms of four major electricity consumption units in the facilities are shown below-

Table 4.5 total load consumption

Lighting Load	4903.8
Air Conditioning	177000
Desktop and Laptop	64520
Utilities	54362

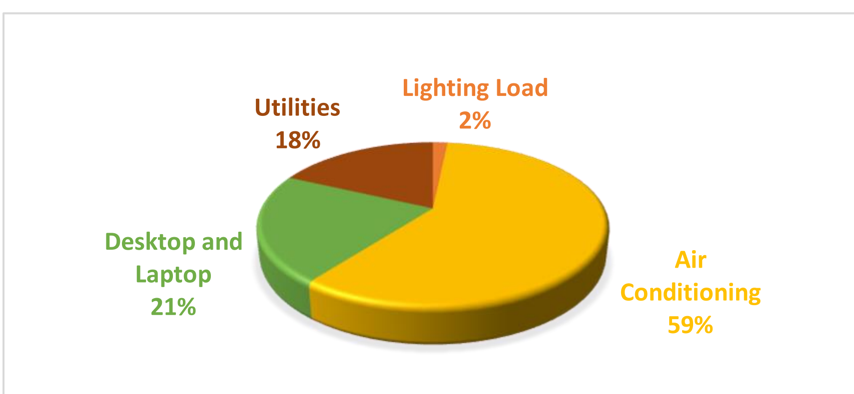

Figure 4.6: pie chart of total load consumption

4.3.2.3 Load wise electricity consumption

Here is the total load wise electricity consumption are shown below

Table 4.6 load wise electricity consumption

Connected Load			
Name of the appliances	Number	Watts	Total Watts
T5	118	28	3304
T8	21	32	672
Fluorescent Bulb	15	36	540
LED Spot Light	162	15	2430
LED	7	23	161
Fan	107	80	8560
Stand Fan	3	90	270
projector	12	200	2400
desktop	380	150	57000
Laptop	94	80	7520
cc camera	39	25	975
air condition (Ton)	118	1500	177000
water purifier	10	100	1000
printer	4	100	400
photocopier	4	1300	5200
scanner	5	18	90
Server	15	500	7500
Sound Box	12	11	132
LCD Monitor	4	40	160
router	15	7	105
Coffee Machine	1	800	800
Oven	3	1000	3000
Display Cooler	2	120	240
Ice Cream Freezer	1	130	130
Elevator	2	11700	23400
TOTAL			**263105.2**

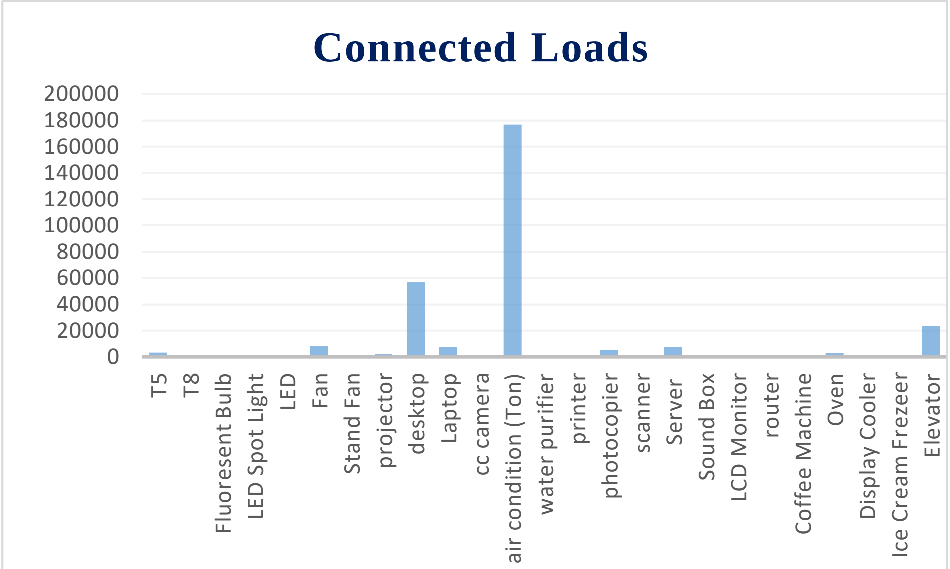

Figure 4.7: bar chart of connected appliances load

4.3.4 Water consumption information

There are several water meters however the Main Terminal Meter #0303239653 indicated a usage of approximately 5452171.43 liters per year. Water consumption can be reduced approximately 25% by installing 0.5 GPM aerators on the faucets and using low flow water closets and urinals.

Table 4.7 water and sewerage bill

Month	Water & Sewerage Bill
Dec-17	17002
Nov-17	15456
Oct-17	17774
Sep-17	18400
Aug-17	8390
Jul-17	18032
Jun-17	17370
May-17	14058

Apr-17	11408
Jan-18	19706
Feb-18	17774
Mar-18	15456

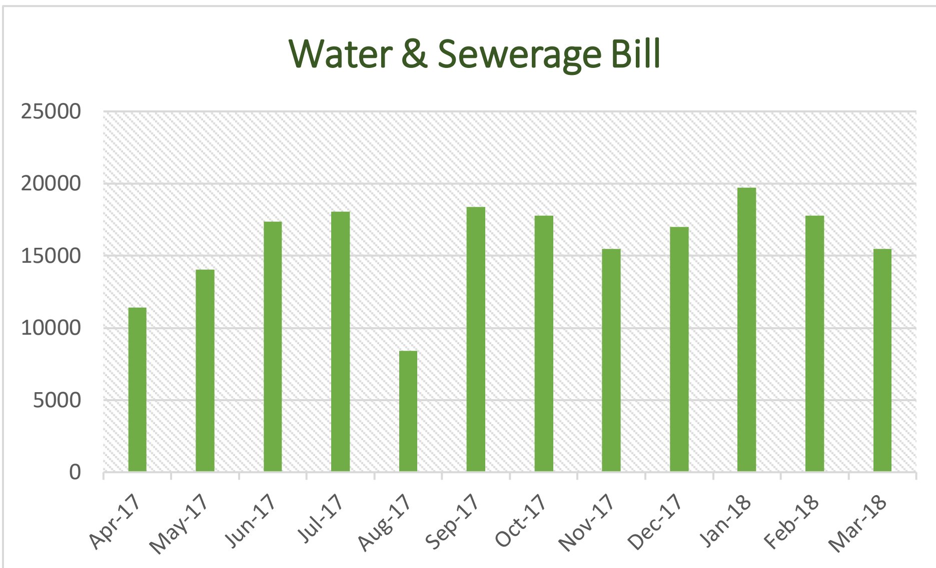

Figure 4.8: Bar chart of water and sewerage bill

4.3.5 Ventilation and Air Conditioning Systems

There is no heating facilities are used in the building only air conditioning system is installed and used in the building. The following table shows us the comparison between the measured temperature and relative humidity (RH) to the ASHRAE standard 55.

Table 4.8 facilities environmental condition measured (5-1-19)

Season	Area	Operation Mode	Audit			ASHREE Standard 55		
			Temperature			Temperature		
SUMMER	Classes & Lab	Cooling	F	C	RH%	F	C	RH%
	Outside		68	20	80	73-79	23-26	50
			102.2	44	80	73-80	23-27	50
WINTER	Classes & Lab	Cooling	71.6	22	65	73-81	23-28	50
	Outside		78.8	26	65	73-82	23-29	50

4.3.6 Lightning system in the facilities

Floor No.	Room Type	Room area (ft.)^2	Type of Light	Wattage (Watt)	Quantity of Light (Pcs)	Effective Lumen/ Watt (Lm)	Hours on during day	Hours on per week	Hours on during a year	Energy Use/Yr. (KWh)
11th Floor	Lift Room		T5	28	2	90	11.5	69	3312	185472
10th Floor	Computer Lab (903)	829.5	T5	28	6	90	11.5	69	3312	556416
	Computer Lab(904)	865.92	Under Construction							
	Cori door	40	T5	28	1	90	11.5	69	3312	92736
		79.8	T5	28	1	90	11.5	69	3312	92736
	Stair		LED Spot Light	15	2	65	11.5	69	3312	99360
	IT office	80	T5	28	2	90	11.5	69	3312	185472
9th Floor	Computer Lab(901)	829.5	T5	28	6	90	11.5	69	3312	556416
	Computer Lab(902)	865.92	T5	28	6	90	11.5	69	3312	556416
	Cori door	79.8	T5	28	1	90	11.5	69	3312	92736
		40	LED Spot Light	15	4	65	11.5	69	3312	198720
	Stair		LED Spot Light	15	2	65	11.5	69	3312	99360
	Washroom	80	T5	28	1	90	11.5	69	3312	92736
8th Floor	Computer Lab(801)	829.5	T5	28	6	90	11.5	69	3312	556416
	Computer Lab(802)	865.92	T5	28	5	90	11.5	69	3312	463680
	Washroom	80	T5	28	2	90	11.5	69	3312	185472
			LED Spot Light	15	1	65	11.5	69	3312	49680
	Stair		LED Spot Light	15	2	65	11.5	69	3312	99360
	Cori door	79.8	T5	28	2	90	11.5	69	3312	185472
		40	LED Spot Light	15	4	65	11.5	69	3312	198720
7th Floor	Computer Lab(701)	829.5	T5	28	6	90	11.5	69	3312	556416
	Computer Lab(702)	865.92	T5	28	5	90	11.5	69	3312	463680
			Fluorescent	36	2	75	11.5	69	3312	238464
	Stair		LED Spot Light	15	2	65	11.5	69	3312	99360
	Cori door	79.8	T5	23	1	90	11.5	69	3312	76176
		40	LED Spot Light	15	4	65	11.5	69	3312	198720
	Washroom	80	LED Spot Light	15	3	65	11.5	69	3312	149040
			LED	23	1	150	11.5	69	3312	76176
6th Floor	Computer Lab	829.5	T5	28	8	90	11.5	69	3312	741888
	Computer Lab	865.92	T5	28	2	90	11.5	69	3312	185472
			Fluorescent	36	4	75	11.5	69	3312	476928
	Stair		LED Spot Light	15	2	65	11.5	69	3312	99360
	Cori door	79.8	T8	36	2	90	11.5	69	3312	238464
		40	LED Spot Light	15	4	65	11.5	69	3312	198720
	IT office	80	T5	28	1	90	11.5	69	3312	92736
			T8	32	1	90	11.5	69	3312	105984
			LED Spot Light	15	2	65	11.5	69	3312	99360
5th Floor	Faculty Room	1400	T5	28	13	90	11.5	69	3312	1205568
			T8	32	1	90	11.5	69	3312	105984
	IT office	80	T5	28	1	90	11.5	69	3312	92736

	Washroom	80	T5	28	2	90	11.5	69	3312	185472
			LED Spot Light	15	3	65	11.5	69	3312	149040
	Stair		LED Spot Light	15	2	65	11.5	69	3312	99360
	Cori door	79.8	LED Spot Light	15	4	65	11.5	69	3312	198720
4th Floor	Faculty Room	1400	T5	28	7	90	11.5	69	3312	649152
			T8	32	8	90	11.5	69	3312	847872
	Washroom	80	LED Spot Light	15	5	65	11.5	69	3312	248400
	Stair		LED Spot Light	15	2	65	11.5	69	3312	99360
	Cori door	79.8	Led Spot Light	15	4	65	11.5	69	3312	198720
3rh Floor	Faculty Room	35	LED Spot Light	15	2	65	11.5	69	3312	99360
	Faculty Room	35	LED Spot Light	15	4	65	11.5	69	3312	198720
	Research Room	35	LED Spot Light	15	2	65	11.5	69	3312	99360
	Office	40	LED Spot Light	15	8	65	11.5	69	3312	397440
	Cori door	40	Led Spot Light	15	4	65	11.5	69	3312	198720
			T5	28	1	90	11.5	69	3312	92736
	Stair		LED Spot Light	15	2	65	11.5	69	3312	99360
	Staff Room	30	LED Spot Light	1.4	7	65	11.5	69	3312	32457.6
	Wash Room	80	T5	28	3	90	11.5	69	3312	278208
2nd Floor	Faculty Room	865.98	T5	28	4	90	11.5	69	3312	370944
			T8	32	1	90	11.5	69	3312	105984
	Classroom	829.5	T5	28	5	90	11.5	69	3312	463680
	Office room	80	LED Spot Light	15	2	65	11.5	69	3312	99360
	Cori door	79.8	T5	23	4	90	11.5	69	3312	304704
		40	LED Spot Light	15	3	65	11.5	69	3312	149040
1st Floor	Classroom(101)	829.5	T5	28	4	90	11.5	69	3312	370944
			T8	32	3	90	11.5	69	3312	317952
	Classroom(102)	865.92	T5	28	3	90	11.5	69	3312	278208
			T8	32	3	75	11.5	69	3312	317952
	Washroom	80	T5	28	4	90	11.5	69	3312	370944
	Cori door	79.8	T5	28	1	90	11.5	69	3312	92736
		40	LED Spot Light	15	4	65	11.5	69	3312	198720
Ground Floor	Washroom	30	T8	32	1	90	11.5	69	3312	105984
	Office	40	LED	23	1	150	11.5	69	3312	76176
			LED Spot Light	15	4	65	11.5	69	3312	198720
	Canteen	1596	LED Spot Light	1.4	14	65	11.5	69	3312	64915.2
			T8	32	1	90	11.5	69	3312	105984
			LED Light	23	1	150	11.5	69	3312	76176
	Lounge	441	LED Spot Light	15	47	65	11.5	69	3312	2334960
	Security Room	30	T5	28	2	90	11.5	69	3312	185472
Basemen t	Parking	2466.52	Fluorescent	36	9	75	11.5	69	3312	1073088
	Canteen		LED Light	23	4	65	11.5	69	3312	304704
	Kitchen		LED Spot Light	15	7	65	11.5	69	3312	347760
	Prayer Hall		T5	28	2	90	11.5	69	3312	185472

Consumption of lightening system are given below where a pie chart shows us that T5 consumed 21%, T8 consumed 24%, Fluorescent light consumed 27% and LED Spot Light consumed 17%

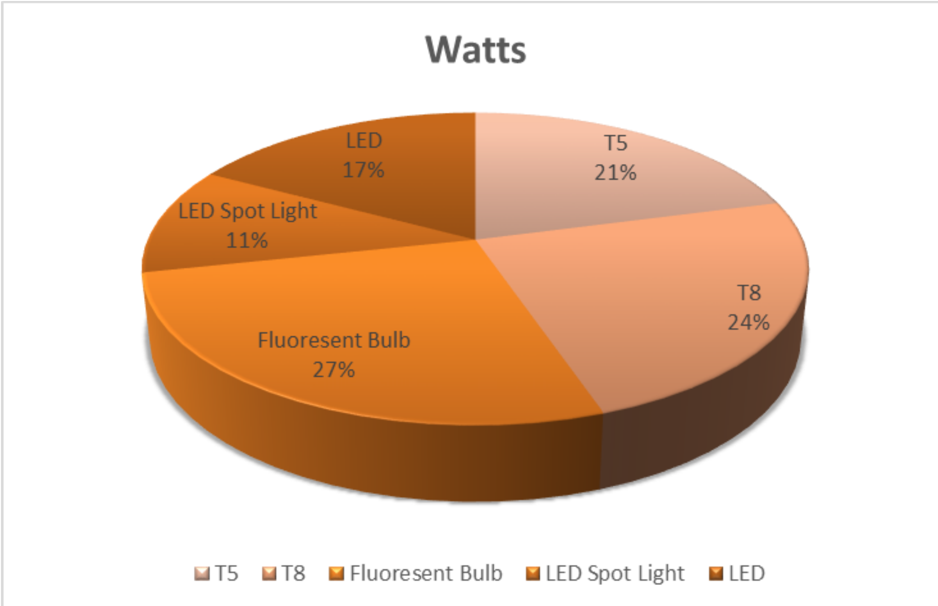

Figure 4.9: Pie chart of connected lightning loads

4.4 Various energy savings opportunities in the building

4.4.1 Energy savings on air condition

Here all the Term we used for the calculation of saving from Air Condition

Q_a= Quantity of air conditioner

WH_d = Working hours per day

WD_y = Working days per year

U_c = Unit cost of electricity for commercial building

P_{exist} = Power rating of existing appliance

P_{star} = Power rating of ENERGY STAR* rated appliance

P^{exist} =Power consumption of existing appliance

P^* = Power consumption of ENERGY STAR* rated appliance

P = saving in power consumption

Saving calculation for DIU CSE Building for electrical appliances -

Saving from the replacement of conventional air conditioner by ENERGY STAR* rated air conditioner-

Q_a = 112, WH_d = 11.5 hour, WD_y = 300 day, P_{exist} = 1500 W, P_{star} = 1350W

Power demand for proposed AC = $Qa \times P_{star}$

= 112× 1350w

= 151.2 kW

Power demand for existing AC =$Q \times P_{exist}$

= 112× 1500

= 168 kW

U_c = 8.25 BDT

Power demand saving = P_{exist} consumption- P_{Star} consumption

= 168- 151.2 = 16.8 kW

Saving in BDT/Yearly

= $P \times WH_d \times WD_y \times U_c$

= 16.8 × 11.5 × 300 × 8.25

= **4, 78,170** BDT

So, we can save BDT 4, 78,170 per year from air conditioning only. As the replacement of the air conditioning system is costly but it also has an excellent service life.

- Existing capacity of the air condition in the facilities =112 ton
- Replacing them with 3 star rated “whirlpool” 1 ton split air condition
- Market value for recommended air condition per ton = **39,200**
- Total replacing cost of recommended AC = 112 x 39200 = **4,39,0400** BDT

- Annual savings in BDT =**4,78,170**
- Saving from reselling the existing AC = 112 x 12000 =**1,34,4000** BDT
- Actual investment required in BDT =4,39,0400 – 1,34,4000 =**3,04,6400** BDT

Simple payback year = 3,04,6400 / 4, 78,170 =**6.4 year**

Table 4.9 summary of replacement of air condition

Investment required	**BDT 36,46,400**
Annual saving	**BDT 4,78,179**
Simple payback year	**6.4 year**

4.4.2 Savings from installing right size of air conditioner

As we mention in the previous topic we can save 4, 78,170 BDT annually from air conditioner by replacing them. Before installing an AC it is key to select the proper size and it does not refer to the physical size of the air conditioner. Rather it means the cooling capacity of the AC as measured in British thermal unit (BTU). 12000 BTU are measured as 1 ton. To calculate the exact size of the air conditioner, we need to measure the room area in square foot and simply multiply that with 25 BTU. This allows a constant cooling weather it's a rainy, moist, hot, sunny or humid day.by choosing the air conditioner in right size we also can save unwanted energy consumption as per as energy conservation is concerned.

In this facilities class room, faculty room and office rooms are mostly used for where the authority do not select the proper size for air conditioner. For selecting the right size air conditioner they can also conserve energy.

Table 4.10 required capacity for air condition

Room type	Area (square feet)	BTU/ square feet	Required BTU	Required capacity (Ton)	Existing capacity (Ton)
Class room	**829.5**	**25**	**20737.4**	**2**	**4**
Classroom	**865.92**	**25**	**21648**	**2**	**8**
Faculty room	**1400**	**25**	**35000**	**3**	**12**

4.4.2 Energy savings on lightning system

Existing lightning system

118 T5 Lights of 28 watts, 21 T8 Lights of 32 watts, 15 Fluorescent Lights, 162 LED Spot Lights of 15 watts and 7 LED single panel Lights of 23 watts are currently used in the Building. The lights are being used for 11.5 hours in a day for 300 days.

Proposed lightning System

Replace all the T5 28 watts, T8 32 watts and Fluorescent 36 watts lights by energy efficient WLED-DTDL2F-18 watts lights.

- Wattage of recommended Light = 18 W
- Total number of existing T5, T8 and Fluorescent light = 118+21+15 = 154
- Total consumption of existing lights = (118*28)+(21*32)+(15*36) = 4516 W
- Total consumption of recommended light = 154*18 = 2772 W
- Wattage difference = 4516-2772 = 1744 W = 1.744 kW
- Working hours = 11.5
- Total number of days light active=300 days
- Savings in Unit=300*11.5*1.744 = 6016.8 kW
- Annual costs savings = 6016.8*8.25 = **49638.6** Taka

- The total annual energy cost for T5, T8 and Fluorescent lighting = **128536.65 BDT**
- Therefore, after replacements with LED we can annually save= $\frac{49638.6}{128536.65} * 100$ =38.62%
- Investment = 650*154

  =**1, 00100 BDT**

Table 4.11 energy saving from lightning and payback year

Investment Required	**BDT 1,00100**
Annual Saving	**BDT 49,638.6**
Simple Payback Period	**2.1 years**

4.5 Benchmarking of similar kinds of building

Benchmarking of the commercial building Like Daffodil International University for energy efficiency is a challenging and debatable issue due to wide variations in the working environment. The variation can be due to geography, climate, manpower, working conditions etc. Therefore, first benchmarks the consultants propose are the minimum SEC already achieved by the building. This level of intensities cannot be disputed as the company has already achieved these under the existing conditions. It is important for the building authority to analyze the activities and practices of that month and drive the staff to replicate them going forward. By benchmarking system, it shows that either building using more energy from other similar buildings or not.

Table 4.12 benchmark of similar kind of commercial building

Serial	Commercial Building type	Built –up area (m^2)	Annual energy Consumption (KWh)	Energy User Index(EUI) (KWh/m^2/year)
1	One shift building	16,716	20,92,364	149
2	Three shifts building	31,226	88,82,824	349
3	Public sector building	15,799	18,38,331	115
4	Private sector building	28,335	44,98,942	258
5	CSE building	1,834	3,17,947	173

Above table shows us the comparison between similar types building energy consumption. From that we can say that, EUI of DIU, CSE building is reliable.

CHAPTER 5

ENERGY SAVING BY INSTALLING SOLAR PLANT

5.1 Introduction

Every day, we are surrounded by one of the most importance innovations of all time, electricity. Starting with house, electricity is important for operating all appliances, entertainment, lighting and of course all technology. All energy fact has some bad impact on our environment. Fossil fuels—coal, oil, and natural gas—do substantially more harm than renewable energy sources by most measures, including air and water pollution, damage to public health, wildlife and habitat loss, water use, land use, and global warming emissions. [6]

The world is running for renewable and reliable energy sources where solar power has evidently become the trend in renewable energy. The most commonly known fact about solar energy is that it represents a clean, green source of energy. Solar energy is a great way to reduce your carbon footprint. Solar power doesn't release any greenhouse gasses, its safe and environment friendly. So hence we can install a harmless solar power system in the rooftop of CSE building of DIU for small appliances like light and fans which will diminish the electricity bill and pressure on grid.

Figure 5.1: Solar Panels

Here we can install a 3kWp solar PV system on Rooftop of CSE building where required area is 36 meter square.

For this purpose will use 320Wp SPV module

Table 5.1 electrical & mechanical characteristics of 320Wp module

Length	1.9 m2
Width	.99m2
Thickness	44mm
Weight	22.50
Solar cell type	Multi crystalline Silicon
Cable cross section	4mm2
Solar cell per module	72 / (12*6)
Module efficiency	16.50
Power tolerance	0/+5
Nominal maximum power	320W

Module quantity: 10

Latitude of Dhaka Bangladesh: 23 degree N

Longitude of Dhaka Bangladesh: 90 degree E

Tilt Angle in summer: 38 degree

Tilt angle in winter: 8 degree

Inverter Size: 3kwP

5.2 Solar path at CSE Building, DIU

Photovoltaic (PV) panels collect solar radiation directly from the sun, from the sky, and from sunlight reflected off the ground or area surrounding the PV panel. Orienting the PV panel in a direction and tilt to maximize its exposure to direct sunlight will optimize the collection efficiency. The panel will collect solar radiation most efficiently when the sun's rays are perpendicular to the panel's surface. The angle of the sun varies throughout the year. Therefore, the optimal tilt angle for a PV panel in the winter will differ from the optimal tilt angle for the summer. This angle will also vary by latitude. [7]

The relative position of the Sun is a major factor in the heat gain of buildings and in the performance of solar energy systems. Accurate location-specific knowledge of sun path and climatic conditions is essential for economic decisions about solar collector area, orientation, landscaping, summer shading, and the cost-effective use of solar trackers.

5.3 3D design of CSE Building in Helioscope Software

On solar energy often give the advice that the tilt should be equal to your latitude, plus 15 degrees in winter, or minus 15 degrees in summer. It turns out that you can do better than this - about 4% better. [8]

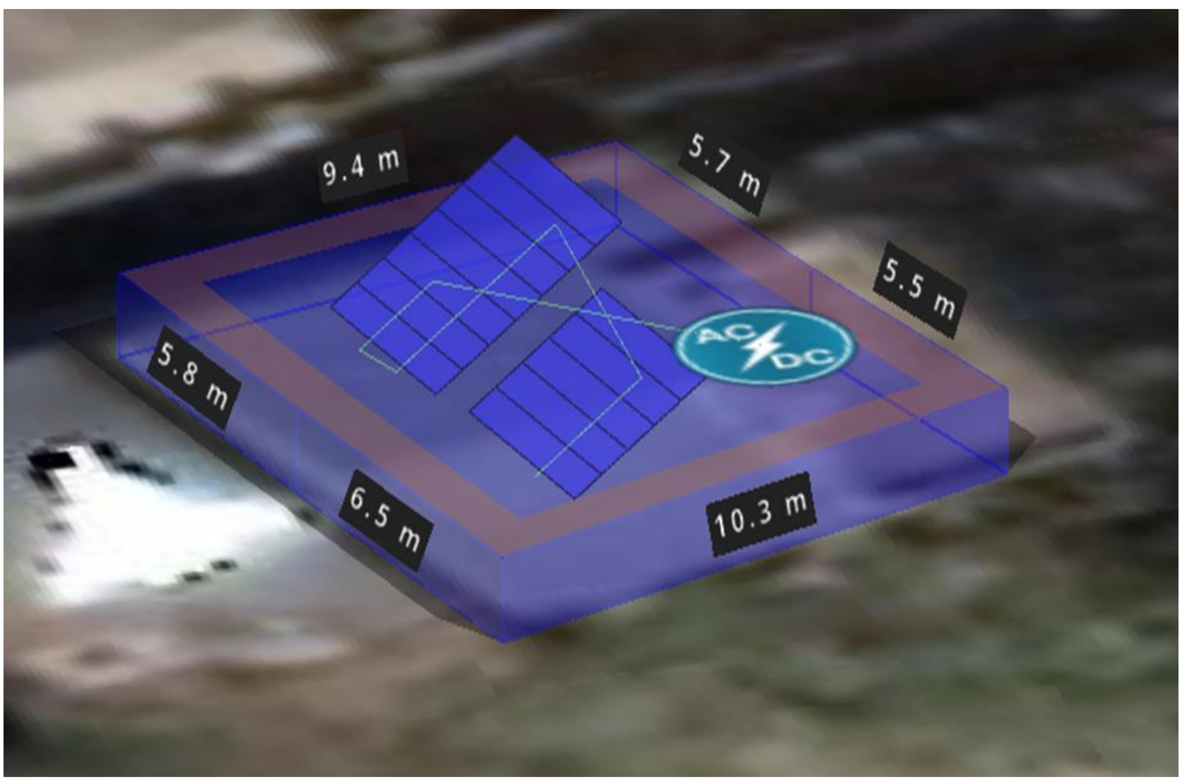

Figure 5.2: 3D design of 4kWp solar plant

By Analysis we must determine tilt angle and Azimuth angle of Project site.

5.4 Material required for the project

- Solar Module- 320Wp SPV
- Inverter-3kWp
- Fittings
- Cable
- Circuit Breaker

5.5 Weather and climate of Dhaka, Bangladesh [9]

Table 5.2 weather and climate of Dhaka, Bangladesh

Month	Min Temperature (Celsius)	Max Temperature (Celsius)	Chance of Rain (%)	Rainy days	Sunshine hours
January	12	25	6.7	2	273
February	15	27	10	3	224
March	20	32	16.7	5	229
April	23	33	30	9	192
May	24	32	50	15	155
June	25	31	70	21	81
July	26	31	86.7	26	59
August	26	31	83.3	25	56
September	26	31	63.3	19	90
October	23	31	26.7	8	198
November	18	28	6.7	2	252
December	13	26	3.3	1	267

5.6 Energy generation per month in kWh

Calculation solar panel output = solar panel watt*average hour of sunlight*PR

Where,

PR= Performance ratio, co-efficient for losses (range between0.5 to 0.9, default value is .75) [10]

If, Average daylight per day is 7 hours then the average peak sun hour maybe closer to 3 to 4 hours.

The climate in Bangladesh is tropical with a mild winter (October - March), a hot humid summer (March - June) and a humid warm rainy monsoon season. (June - October). The average bright sunshine duration in Bangladesh in the dry season is about 7.6 hours a day, and in the monsoon season is about 4.7 hours.

Table 5.3 power generation per month

Month	Generation (kWh)
January	438.96
February	420
March	457.56
April	460.8
May	372
June	194.4
July	141.36
August	133.92
September	216.66
October	404.55
November	545.4
December	302.25
Total energy generation	**4,087.86**

5.7 Financial Data Analysis

Financial data analysis includes project life time, capacity, plant efficiency, annual generation, and profit.

Tariff rate: Flat rate 7.66tk [11]

Table 5.4: financial data analysis of the project

Year	capacity (kW)	Annual sunlight (Hour)	Expected Tariff (BDT)	Annual Panel efficiency	Plant efficiency	Annual Generation (kWh)	Annual Revenue (BDT)	Operation and maintenance cost (BDT)
1st	3	2020	7.66	100.00%	80.00%	4087.86	31,313	0.00
2nd			7.66	99%		4046.88	30,992	0.00
3rd			7.66	98%		4006.52	30,689	0.00
4th			7.66	97%		3966.46	30,383	0.00
5th			7.66	96%		3926.8	30,079	0.00
6th			8.04	95%		3887.54	31,255	0.00
7th			8.04	94%		3848.67	30,943	0.00
8th			8.04	93%		3810.19	30,633	0.00
9th			8.04	92%		3772.09	30,327	0.00
10th			8.04	91%		3734.37	30,024	0.00
11th			8.42	90%		3697.03	31,128	0.00
12th			8.42	89%		3660.06	30,817	0.00
13th			8.42	88%		3623.46	30,509	0.00
14th			8.42	87%		3587.23	30,204	0.00
15th			8.42	96%		3551.36	29,899	0.00
16th			8.80	85%		3515.85	30,939	0.00
17th			8.80	84%		3480.7	30,630	0.00
18th			8.80	83%		3445.9	30,323	0.00
19th			8.80	82%		3411.45	30,020	0.00
20th			8.80	81%		3377.34	29,720	0.00
Total 20 Years						**74437.76**	**6,10,826**	

5.7.1 Break-even point analysis

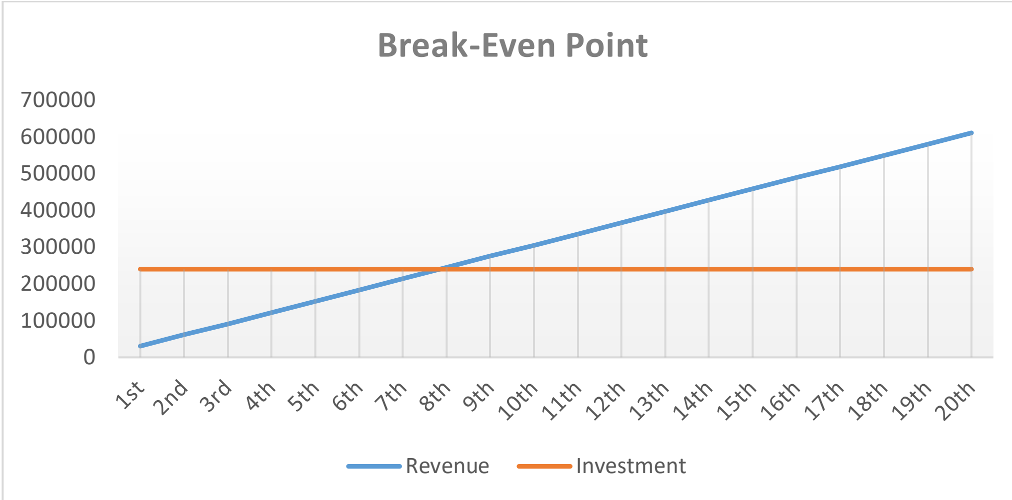

Figure 5.3 chart of break-even point

Payback period for this 3kWp is only 8 years. So this project could be very profitable in terms of financial investment.

5.8 Summary of this 3kWp Project

Table 5.5: summary of this 3kWp solar project

Projection	Unit	Amount
Generation Capacity	kW	3.00
Required Space (approx.)	Square feet	387.501
Project Life (extendable)	Years	20
Initial investment	BDT	2,40,000
Total Investment for 20 years	BDT	2,40,000
Project life total revenue	BDT	6,10,826
Net profit after 20 years (Project timeline)	BDT	3,70,826
Payback Period	Years	8

So, we can install mini off grid Solar PV System for LED spotlight, LED and Stand fan Load. It will save energy from grid as well as will reduce CO_2 generation from National grid because it doesn't consume fuel or require other resources, such as water or wind.

3kWp solar system is okay for starting but according to the needs it can be extended further as still there is enough space in the rooftop.

CHAPTER 6

CONCLUTION

In this contemporary world the uses of electrical energy is increasing rapidly because of extreme urbanization. Especially in least developed and developing country like Bangladesh, energy demand in industrial sector are very high. Country like Bangladesh where limited natural resource is the main source for energy need to think the alternative energy resource to meet the high demand in the future. Therefore, energy conservation is the new global issue we need to take very utterly.

Energy audit is one of the unconventional way to save limited resource of energy by implement the efficient uses of energy through audit. In this thesis paper we conducted an energy audit in the CSE building of daffodil international university, to find out the various energy conservation opportunities that can be adopted by the authority. After completion of our energy assessment work we found few energy savings opportunities such as saving on air conditioning system by replacing the old AC into a new one with proper size required for the certain room, the existing one is not the right size for the room. We can also save from lightning system by replacing all the existing light into 18W WLED-DTDL2F-18 lights.

- **Annual energy savings from air condition system is 4,78,170 BDT at Uc of 8.25 BDT**
- **Annual energy savings from lightning system is 49,638.6 BDT at Uc of 8.25 BDT**
- **Annual revenue from installing solar system is 31,313 BDT at Uc of 7.66 BDT**

Thus, for a sustainable environment and to contribute towards carbon neutrality, it is very much crucial to introduce energy audit in every sector with few changes in existing system to cut the growing energy demand in Bangladesh. Among all the benefits of solar plant, the most important thing is that solar energy is a truly renewable energy source, which reduce electricity bill, diverse appliance, and low maintenance.

REFERENCES

[1] bangladesh power developement board, "annual report 2017-18," bangladesh power developement board, dhaka, 2018.

[2] weikipedia, "weikipedia," weikipedia, 15 deccember 2019. [Online]. Available: https://en.wikipedia.org/wiki/Electricity_sector_in_Bangladesh. [Accessed 10 january 2020].

[3] pnnl, pnnl report 2019, usa: pacefic northwest national labratory, 2019.

[4] E. E. a. C. r. G. o. P. R. Bangladesh, Vols. pp.4-11, 2012.

[5] the constructer, "the constructor," civil engineering company, 2019. [Online]. Available: https://theconstructor.org/building/energy-audit-for-buildings/1258/?fbclid=IwAR1AlIK5oljfMYoWi21YqOfG5o8Hyrofn5kYKkJnhszlovZDe33oaMOGWzc. [Accessed 12 january 2020].

[6] union of concerned scientist, "union of concerned scientiat," [Online]. Available: https://www.ucsusa.org/resources/environmental-impacts-renewable-energy-technologies. [Accessed 13 01 2020].

[7] NLPIP, "lightning answer," *photovoltaic lightning,* vol. 9, no. 3, 2006.

[8] c. R.Landau, "solarpaneltilt.com," 18 march 2017. [Online]. Available: https://www.solarpaneltilt.com/. [Accessed 13 01 2020].

[9] weather and climate, "www.weather-and-climate.com," [Online]. Available: https://weather-and-climate.com/average-monthly-Rainfall-Temperature-Sunshine,Dhaka,Bangladesh. [Accessed 18 january 20201].

[10] vivint solar, "www.vivintsolar.com," 2019. [Online]. Available: https://www.vivintsolar.com/blog/how-calculate-solar-panel-output. [Accessed 18 january 2020].

[11] bangladesh power developement board, "www.dpdc.gov.bd," dpdc, 2017. [Online]. Available: https://dpdc.org.bd/page/view/18. [Accessed 18 january 2020].

APENDIX

Head, EEE

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07.01.19

The Registrar
Daffodil International University
102, Mirpur Road, Dhaka

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07-01-19.
(Head. EEE)

Sub: Permission for Energy Audit in CSE building

Sir,

This is to inform you that we are the student of your institution; Level-4, Term-3; BSc in EEE.

We want to audit the CSE building and for this purpose we need some data and regarding information about the building.

May We therefore, pray and hope that you would be kind enough to grant my application and give us the permission for energy audit

We
remain
Sir
Students of Dpt. of EEE
152-33-2686
152-33-2681
152-33-2619
152-33-2649
151-33-2324
152-33-2707

Forwarded
R Ahsan
07/01/19

Dr. Md. Rezwanul Ahsan
Assistant Professor
Department of EEE
Daffodil International University
Dhaka, Bangladesh

Forwarded to Mr. Nazim, Dept. Director planning and development
[illegible signature]
10.01.2019

CUSTOMER COPY

HT CUSTOMER
DHAKA POWER DISTRIBUTION COMPANY LTD (DPDC).
Network Operation & Customer Service
Website Address: www.dpdc.org.bd
ELECTRICITY BILL

3005081148

SHERE

POLE :

RASEL SQURE

SHAMIM AHMED

.MOFIZ UDDIN
ANBAG MIRPUR

MONTH	BILL NO	CD	ISSUE DATE
Apr-17	4408153	37	11/05/17
LOCATION	BILL GROUP	BOOK	WALK ORDER
D5 / 35	22	RSH	1130
PRV. A/C NO	CUSTOMER NO.		LAST PAY DATE
SBN-9872	27607751		31/05/17

BS. TYPE	STATUS	CONN.ST	VALUE & RULE	SANC. LOAD (KW)	CONN. LOAD (KW)
56	98715	00		400	400

METER NO.	COND	OMF	CUST. DETAILS	SIN. REG./OFF PEAK	PEAK
612030138	00	900.00	X-FORMER LOSS	0	
12030138VAR	00	900.00	PFC UNIT	2184	728
	00	900.00	OLD METER	0	0

ADING DATE	KWH SIN. REG./OFF PEAK	KWH PEAK	KVARH SIN.REG./OFF. PEAK	KVARH PEAK
T 30/04/17	544.00	168.00	430.00	
S 31/03/17	508.00	156.00	405.00	
0	32400.00	10800.00	22500.00	

DEMAND METER READING DETAILS

CUMULATIVE NO	CUMULATIVE /KW RDG.		
T	0.32	POWER FACTOR	0.89
S		POWER FACTOR COR.	0.0674
D	288.00	ARREAR FROM / ARREAR UPTO	

IT CHARGES	TAKA	ADJUSTMENT/ARREAR	TAKA
. ELEC. CHARGE	0.00	ADJ. PRINCIPAL	0.18
ELEC. CHARGE	222912.00	ADJ. L.P.S.	0.00
. ELEC. CHARGE	103356.00	ADJ. VAT	0.00
EMAND CHARGE	12960.00	ADV. / ARR. PRINCIPAL	0.03
NIMUM CHARGE	0.00	CURR. & ARR. L.P.S.	0.00
ERVICE CHARGE	400.00	ADV. / ARR. VAT	-0.13
X-FORMER LOSS	0.00		
X-FORMER RENT			
PFC.CHARGE	21992.88		
METER RENT			
CIPAL AMOUNT	361620.88		
00%) VAT	18081.04	VAT TOTAL	18080.91
MONTH TOTAL	379701.92	AMOUNT TO BE PAID	379702.00
FTER LAST PAY DATE	397783.00	TOTAL TO BE PAID AFTER LAST PAY DATE	397784.00

Paisa element will be carried to the next bill

THS	PRINCIPAL	L. P. S.	VAT	TOTAL
	0.03	0.00	0.00	0.03

BRAC Bank Limited
21 MAY 2017

/04/17 225978.00

GREEN ROAD
BRAC BANK LTD. -
Any branch of NCC
and Other Online

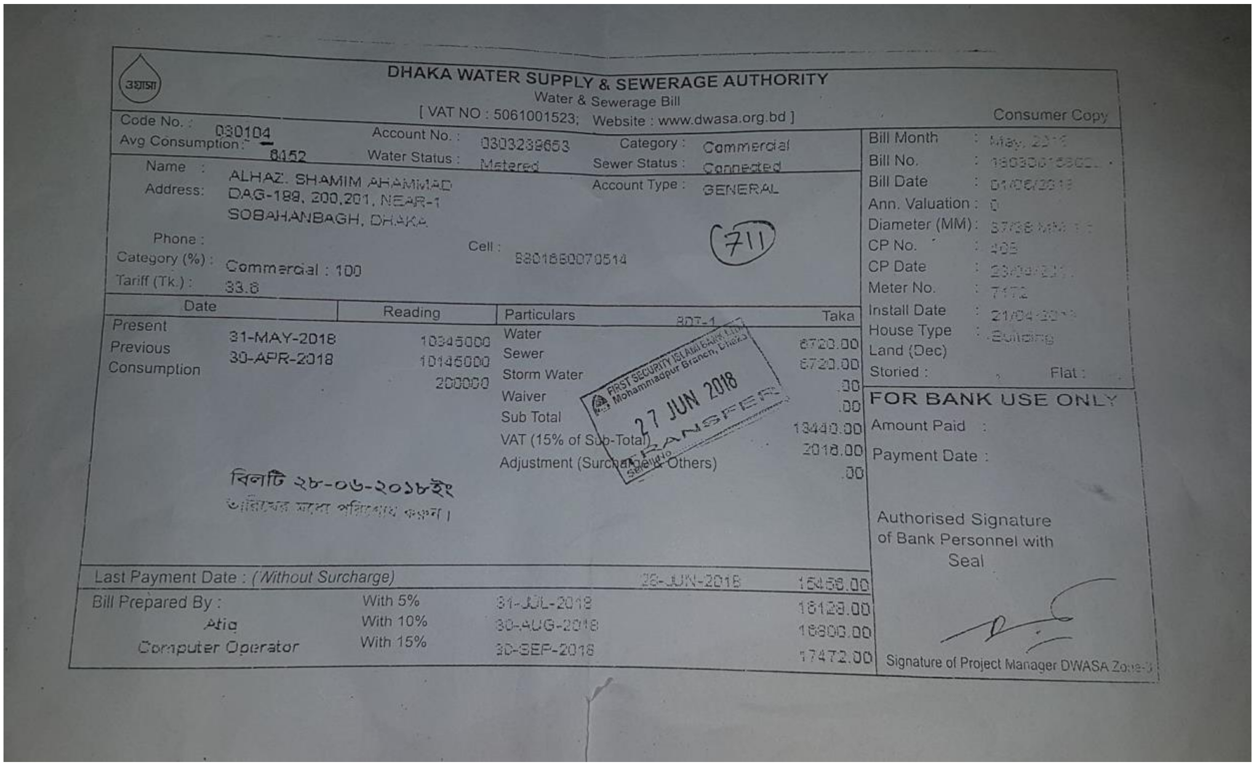
ICE BOOTH
SIBL,FSIB,EXIM,IFIC
ntioned below

EXECUTIVE ENGINEER
NETWORK OPERATION &
CUSTOMER SERVICE
SHERE B.NAGAR
145

সদা আপনার সেবায় নিয়োজিত

অপর পৃষ্ঠায় বর্ণিত নির্দেশাবলী দেখুন

VAT ID NO: 9021023849 AREA CODE : 90102



DHAKA WATER SUPPLY & SEWERAGE AUTHORITY
Water & Sewerage Bill
[VAT NO : 5061001523; Website : www.dwasa.org.bd]
Consumer Copy

Code No. : 030104
Avg Consumption : 8452
Account No. : 0303239653
Water Status : Metered
Category : Commercial
Sewer Status : Connected
Account Type : GENERAL
Name : ALHAZ. SHAMIM AHAMMAD
Address: DAG-189, 200,201, NEAR-1 SOBAHANBAGH, DHAKA
Phone :
Cell : 8801680070514
Category (%) : Commercial : 100
Tariff (Tk.) : 33.6

Bill Month : May, 2018
Bill No. : [illegible]
Bill Date : 01/06/2018
Ann. Valuation : 0
Diameter (MM) : [illegible]
CP No. : 408
CP Date : [illegible]
Meter No. : 7172
Install Date : [illegible]
House Type : Building
Land (Dec)
Storied : Flat :

	Date	Reading
Present	31-MAY-2018	10345000
Previous	30-APR-2018	10145000
Consumption		200000

Particulars	Taka
Water	6720.00
Sewer	6720.00
Storm Water	.00
Waiver	.00
Sub Total	13440.00
VAT (15% of Sub-Total)	2016.00
Adjustment (Surcharge & Others)	.00

বিলটি ২৮-০৬-২০১৮ইং
তারিখের মধ্যে পরিশোধ করুন।

FIRST SECURITY ISLAMI BANK LTD. Mohammadpur Branch, Dhaka
27 JUN 2018
TRANSFER

FOR BANK USE ONLY
Amount Paid :
Payment Date :

Authorised Signature of Bank Personnel with Seal

Last Payment Date : (Without Surcharge)		28-JUN-2018	15456.00
Bill Prepared By :	With 5%	31-JUL-2018	16128.00
Atiq	With 10%	30-AUG-2018	16800.00
Computer Operator	With 15%	30-SEP-2018	17472.00

Signature of Project Manager DWASA Zone-3