A REPORT ON

ENERGY AUDIT AT SILAPATHAR COLLEGE, DHEMAJI, ASSAM

SUBMITTED TO

THE PRINCIPAL,
SILAPATHAR COLLEGE,
DHEMAJI, ASSAM.
PIN: 787059

SUBMITTED BY:

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Contents

1. Background

With the fast pace of development throughout the world demand for resources like electricity, water have increased manifold. The urge of human being to raise the quality of life has increased demand for natural resources including electricity and water. The prevailing model of development has brought with it environmental issues like pollution of air and water, deforestation, degradation of land, melting glaciers and host of other issues. In order to sustain the pace of development it is imperative that electricity and water have to be used efficiently.

Since the advent of Industrial Revolution coal has been used extensively to produce steam for steam powered engines, to generate electricity and in transportation. Burning of coal and other fossil fuel for energy generation, industrial production, and transportation has resulted in emission and accumulation of CO_2 in the atmosphere. This deposition of CO_2 has led to the phenomenon of greenhouse effect leading to global warming. As a consequence of global warming phenomenon of Climate Change is facing the entire human race. There is only one earth for us to live and in order to survive this earth has to be brought back to a sustainable level.

India generates 70% of electricity from fossil fuel. India being a developing nation has to maintain this pace of development to uplift quality of life for its entire people. At the same time energy has to be used efficiently to sustain the pace of development. We belong to Silapathar. Silapathar is located within the state of Assam and Assam within India. It belongs to the only world. The fact that Silapathar College is taking up such a vital exercise of Energy Audit resonates with the phrase “Think Global and act Local”. This is the need of time.

2. Introduction to Energy Audit

Energy Audit is a better way to increase energy efficiency and reduce energy bills. An energy audit is an assessment of the energy consumed within a time frame in a given location to find out inefficiencies.

As per Energy Conservation Act, 2001, 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”.

In the provision of the Energy Conservation Act, 2001 the Bureau of Energy Efficiency has been set up under the ministry of power. The parliament of India passed the bill on conservation of energy bill in 2001 there by enlisting a set of rules to make efficient use of energy.

3. Scope of Works

3.1 Assessment of actual operating load and scope for optimizing load

- Review of existing electrical load in the campus
- Review of electrical load based on actual requirement

3.2 Study of individual units and means to conserve electrical power

- Study of existing use of power
- Review of unit wise electrical load based on requirement
- Recommendation for saving electricity

3.3 Energy conservation in Air-conditioning and water pumping system

- Observation in use of power and water
- Methods to save power and water

3.4 Diesel Generator (DG) set

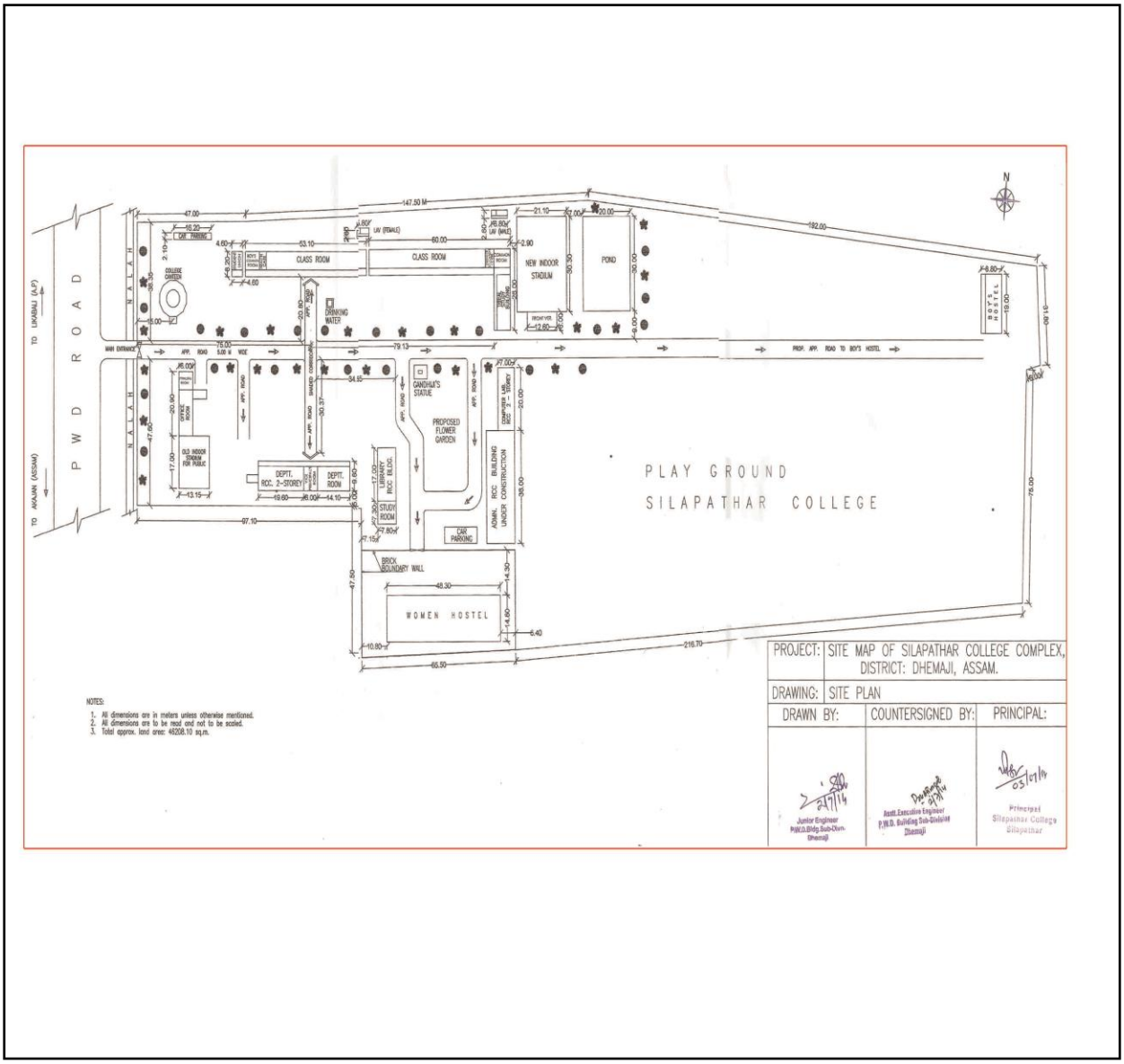
- Existing standard of operation
- Performance of DG set in terms of specific fuel consumption (SFC-Kwh/lit)
- Recommendation for optimum use of DG set

4. Energy Scenario of Silapathar College

Silapathar College is located in a sprawling campus of 41 bighas of land dotted with administrative block, Academic blocks with library, language laboratory, various departments with science and art streams, indoor and outdoor stadium, gymnasium block, auditorium and canteen with power supplied by A.P.D.C.L.

Sl. No.	Data on power supply	Values
1	Rating of Distribution Transformer	63 kva
1	Connected Load	50kw
2	Contract Demand	58.82 Kva
3	Billed Electricity Consumption in kwh ((April'2020-Mar'21)	10647.99 kwh
4	Annual cost of Electricity Consumption@Rs.7.36/unit	Rs.78369.28
5	Annual bill for Maximum Demand @Rs.180/kva	Rs.127552.94
6	Annual cost of electricity charges	Rs.229783.29
7	Working hours (Administrative and Academic)	8 Hrs
8	Sub-metering of individual units	Nil
9	Average annual cost of operating DG set	Rs.1000

5. Layout of Silapathar College



6. Methodology for Energy Audit

The methodology for energy audit consists of preliminary audit, audit and post audit stages.

Step 1- Building a team for Energy conservation (ECC).

During preliminary audit an Energy Conservation Committee (ECC) is formed with Principal as the team leader. The idea of Energy Audit is a collective effort. It is essential that an energy conservation team is formed to carry forward the objective of energy audit. A meeting is scheduled between the auditor and the team to start with the process. The agenda of the meeting focuses on objectives, scope of works, rules and regulations, roles and responsibilities of team members and description of scheduled project activities. During the meeting the team is enlightened about power system within the campus, energy system specifications, standard operating practices, importance of saving electricity and safety measures to be adopted during operation of various electrical equipment.

Step-2. Walk in Audit

After formation of ECC members of the team with energy auditor goes round the entire college campus to take stock of various electrical power consuming devices including lighting system, fan, and various laboratory equipment in science blocks.

Step-3. Documents verification

In this phase various documents like energy bills, agreements with utility are verified, log sheets of DG set are looked into to ascertain if the pattern of energy consumption are tallying.

Step-4. Identification of energy consuming devices

After a study of the facilities energy consuming devices are identified and where appropriate field measurements are collected to substantiate findings.

Step-5. Bills by utility for analysis

This is one of the steps where bills served by utilities have to be verified to ascertain if cost incurred on electricity charges are reasonable. It also seeks to verify balance between energy actually required and energy consumed.

Step-6. Evaluation and feasibility of Energy Conservation Measures.

After walk in audit, scrutiny of relevant data, information based on available documents, measurements where required feasibility of conservation measures is studied with pay back method. This may be segregated to short-, medium- and long-term period.

Step-7. Preparation of Audit finding report

The findings and recommendations of audit are documented in the audit report. This report includes description of the existing power network within the campus and focuses on areas of major energy consuming locations. A discussion with the Energy conservation Committee highlights the need for saving energy. This will lead to save cost on electricity consumption and recommends the short, medium and long-term measures. These Energy saving measures try to rationalize the use of electricity and estimates payback period after implementation of the recommendations.

Step -8. Post audit period

The energy conservation measures will bring benefits of energy and costs saving only after the recommendations are implemented. The onus is on the user and stake holders of the institution to implement the ECM. The energy auditor has to highlight the importance of implementing ECM so as to achieve broader goal of efficient use of energy as stated in the Energy Conservation Act 2001.

7. Energy conservation committee, Walk-in-audit, observation and evaluation

7.1 Energy Conservation Committee (ECC)

As a part of energy audit exercise energy auditor visited Silapathar College on 30th December, 2021. The purpose was to have first hand information of electrical loads of Silapathar College, consumption pattern and prospect of saving energy. Conserving energy is always a collective work and a collaborative action. The management of Silapathar College was committed to exercise of energy audit. At the suggestion of forming an energy conservation committee by energy auditor college authorities lost no time to form ECC to ensure full participation of stake holders including teachers, staff and students. The energy conservation committee formed with principal of Silapathar College as the team leader included following members.

1. Dr. L.N.Pegu, Principal,Silapathar College – Chairman.
2. Mr. Raju Pegu, IQAC Coordinator – Member.
3. Dr. Dilip Saikia , Asst. Professor, Dept. of Physics – Member.
4. Dr. Upen Deka , Asst. Professor, Dept of Botany – Member.
5. Dr. Happy Borgohain, Asst. Professor, Dept of Physics – Member.
6. Mr. Utpal Saikia, Asst. Professor, Dept. of Mathematics – Member.
7. Mr. Pabitra Konwar, Junior Assistant – Member.
8. Mr. Polo Pegu, President, Students Union, Silapathar College.

7.2 Walk in audit and observation:

Walk in audit forms a part of preliminary audit. In this exercise energy auditor along with Energy Conservation Team (ECC) takes a round of the college campus to have objective assessment and observe use of electrical energy at different blocks and departments of the college. The purpose of walk-in - audit is to have an insight into electrical network and power consuming devices and explore if there was any possibility of saving power. The devices included lights both LED & CFL, Fans, plug points (both 6 and 16 amps), computers, projectors, audio visual systems, incinerators, diesel generator, water pumps, air conditioners and so on. The team went round different blocks of the college including office of principal, administrative block, library, virtual class room, language Laboratory, Computer Laboratory, Indoor stadium, Class rooms of Zoology, Botany, Physics, Mathematics, Chemistry and related laboratories of science departments. The team visited class rooms of History, Economics, Political Science, Education, English, Assamese, Sociology, Philosophy and other infrastructure like gymnasium hall, indoor stadium, hostels for boys & girls, canteen toilets etc. This was a learning experience for members and energy auditor to observe and evaluate the need for electricity at locations in an objective manner. This walk-in audit helped the team to judge whether there can be saving of power by its optimum use.

Some observations during walk in audit

- There were a number of plug points (6 and 16 amps) in the science laboratories which were rarely used.
- CFL lamps used for illumination needed to be replaced by LED lamps to save power.
- Halide lamps used in the indoor stadium could be replaced with energy saving LED lamps.
- The DG set was used occasionally and had no logbook for record.
- The 63kva transformer had rusted in some portions of body. The terminal joints of conductors needed to be checked for any loose connections to avoid energy loss due to spark.
- Solar panels with street lights in the campus needed to be cleaned regularly to ensure optimum performance of solar lamps.
- There was a scope to install roof top solar system on roof facing south direction.
- Water taps in toilets needed to be leak proof to prevent wastage of water.
- Air filters of air conditioners needed to be cleaned as a part of annual maintenance exercise to save power.
- All class rooms should have a MCB (miniature circuit breaker) to put off electrical appliances after the classes are over.
- There could be some hoarding in prominent places in the campus to highlight about need to save power.
- There was substantial use of day light in the class rooms which could serve to save grid power.
- The illumination level of the class rooms and toilets need to be optimized.

7.3 Data Collection

Walk in audit is followed by data collection, information related to bills served by the utility (Assam Power Distribution Company Limited), log book of DG Set, and other relevant documents related to use of electricity.

Relevant data have been tabulated in various tables for scrutiny and analysis.

- Table 1 shows list and quantities of electrical devices in use and power consumption on the basis of 6 hours of daily use for 30 days.

- Table 2 illustrates monthly power consumption of the college on the basis of electricity bills served by the utility.

- Table 3 informs about number of students in classes and total population.

- The pie chart highlights components of electrical loads like light, fan, pump, AC load and others on percentage basis.

- A pie chart illustrates the component of maximum demand as percentage of total electricity bills served by the utility for a year.

Table-1.Energy Consumption of equipment for 6 hours /day for 30 days						
Sl.No.	**Equipment**	**Quantity**	**watt/unit**	**watts**	**Kw**	**Kwh*6 * 30**
1	LED Tube light	20	20	400	0.4	72
2	LED Light	70	15	1050	1.05	189
3	LED Light	180	10	1800	1.8	324
4	CFL Light	68	23	1564	1.564	281.52
5	Ceiling Fan	292	65	18980	18.98	3416.4
6	Exhaust Fan	20	60	1200	1.2	216
7	Exhaust Fan	6	100	600	0.6	108
8	Computer	48	35	1680	1.68	302.4
9	Printer	6	360	2160	2.16	388.8
10	Photostat	1	1600	1600	1.6	288
11	Inverter	3	750	2250	2.25	405
12	Incinerator	2	1500	3000	3	540
13	AC 1.5 tons	2	1500	3000	3	540
14	AC 2 tons	3	2000	6000	6	1080
15	LCD Projector	2	420	840	0.84	151.2
16	Water pump	1	373	373	0.373	67.14
17	Water pump	4	560	2240	2.24	403.2
18	Water pump	1	746	746	0.746	134.28
19	Aqua guard	3	60	180	0.18	32.4
20	UPS online	2	5000	10000	10	1800
21	LED	7	50	350	0.35	63
22	Halide Lamps	3	400	1200	1.2	216
23	Monitor	1	630	630	0.63	113.4
24	Stabilizer	1	5000	5000	5	900
25	Refrigerator	1	215	215	0.215	38.7
26	UV Spectro photometer	1	750	750	0.75	135
27	Hot Air oven	2	1750	3500	3.5	630
28	Incubator	2	1500	3000	3	540
29	Water bath	2	200	400	0.4	72
30	Laminar Air Flow	1	1000	1000	1	180
31	Heater	1	800	800	0.8	144
32	Shaker	2	1500	3000	3	540
33	UV Cabinets	1	300	300	0.3	54
34	Speaker	5	25	125	0.125	22.5
35			**Power**	**79933**	**Energy**	**14387.94**

TABLE-2. ENERGY CONSUMPTION DATA OF SILAPATHAR COLLEGE FOR 2020-21						
Connected Load- 50kw: Contract Demand- 58.82 KVA					63 KVA DTR	
Sl no	**Months**	**Billed kwh**	**Max. Demand**	**Total Bill**	**Bill for Max. Demand**	**MD as % of total bill**
1	**2**	**3**	**3**	**4**	**5**	**6**
1	April,2020	442.16	3.9	33447.00	10474.39	31.32
2	May,2020	951.7	4.2	18710.00	10823.67	57.85
3	June,2020	724.9	3	16780.00	10474.52	62.42
4	July,2020	623.5	3	16177.00	10823.67	66.91
5	August,2020	652	7.8	16396.00	10823.67	66.01
6	Sept,2020	782.3	16.5	17036.00	10823.67	63.53
7	Oct,2020	965.1	16.5	18813.00	10823.67	57.53
8	November,2020	856.5	11.7	17609.00	10474.52	59.48
9	December,2020	1388.83	4.8	22083.00	10823.67	49.01
10	January,2021	917.73	3.9	18447.00	10823.67	58.67
11	February,2021	972.79	4.5	12814.00	9776.22	76.29
12	March,2021	1370.48	7.5	21471.29	10587.6	49.31
13	**Year 2020-21**	**10647.99**		**229783.29**	**127552.94**	55.51

TABLE-3. NUMBER OF TEACHERS, STUDENTS AND STAFF				
Sl.No.	Description (20-21)	Male	Female	Total
1	Students	602	804	1406
2	Teachers	21	18	39
3	Non-teaching Staff	8	1	9
Total				**1444**

Overall energy Consumption per year/person= 14388 /1444= 9.96 kwh per year. To the extent possible there should be attempt to reduce energy consumption per person per year.

7.3 Analysis and Evaluation:

During walk in audit, it was mentioned that there were number of CFL lamps which if replaced by LED light will save power. As per table-1 there are 68 numbers of CFL lamps.

1. **Cost analysis and Payback period of Replacing 68 nos. CFLs with LEDs**

- Total number of CFL in College-68
- Average power of CFL – 23w
- Average power of LED – 9w
- Power saved per LED= (23-9) =14w
- Total power saving = 68*14=952 w=0 .952 kw
- Average use of CFL per year= 270*6hour=1620 hrs
- Total energy saved per year=0 .952*1620=1542.24 kwh
- Saving in Rupees per year = 1542.24* Rs. 7.35/unit = Rs. 11335.46
- Average cost of replacing each CFL = Rs.90.08
- Total cost of replacing all CFLs = 68* 90 .08= Rs.6125.44
- Payback time of Capital cost = 6125.44/ 11335.46= .54 years = 6.48 months

2. Cost analysis and payback period of replacing Halide lamps with LED lamps

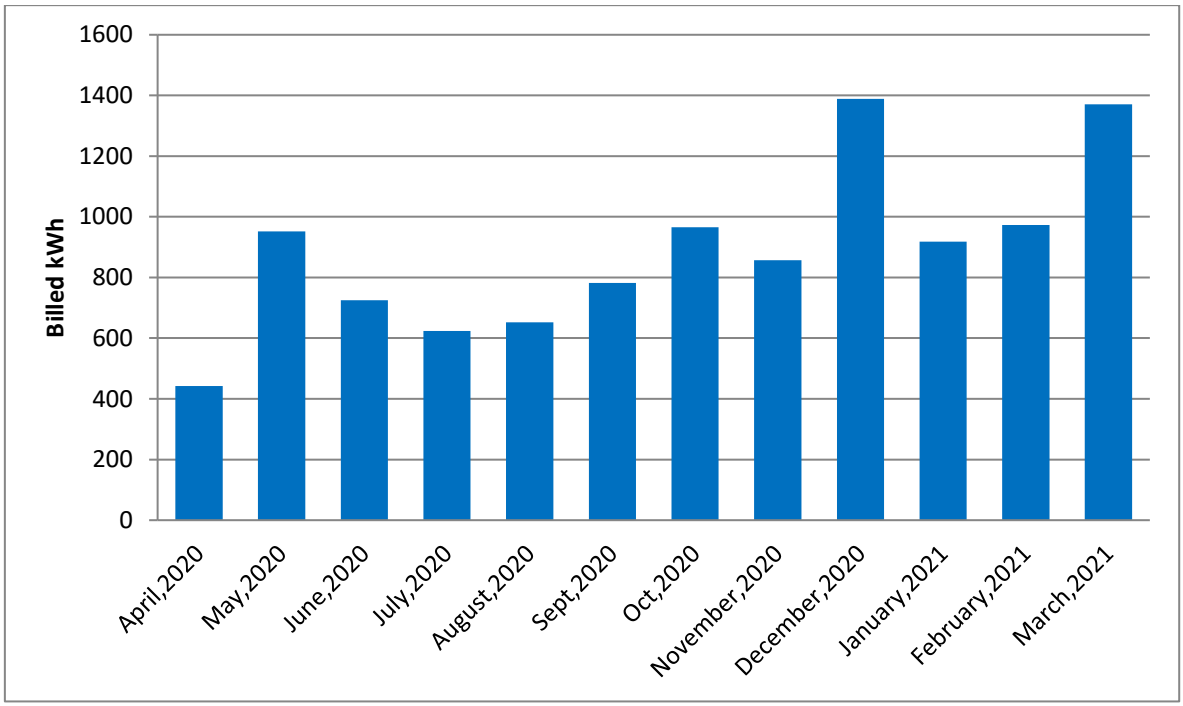
As per serial 21 and 22 of table-1 consumption of LED and halide lamps are 50w and 400w respectively.

- Total number of Halide lamps-3
- Power of each of halide lamps- 400 watts
- Average power of replaced LED- 50 watts
- Total power saving =3*(400-50) =1050 watts=1.050 kw
- Average use of halide lamps per year=180 days *6=1080hrs
- Energy saved per year = 1.05*1080 hrs=1134 kwh
- Cost of power saved/year @Rs.7.35/unit*1134kwhr=8334.9 per year
- Average cost of LED lights = 3*Rs.1750 per unit =Rs.5250.00
- Payback period for capital investment- 5250/8334.9=0.629 yrs=7.55 months.

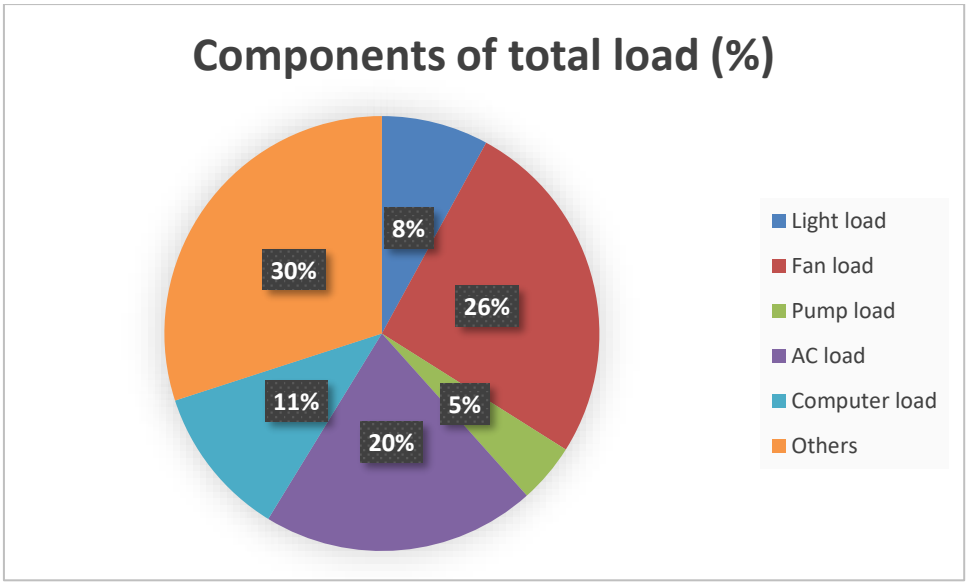
3. Cost analysis of reducing Contract Demand in Energy Bills.

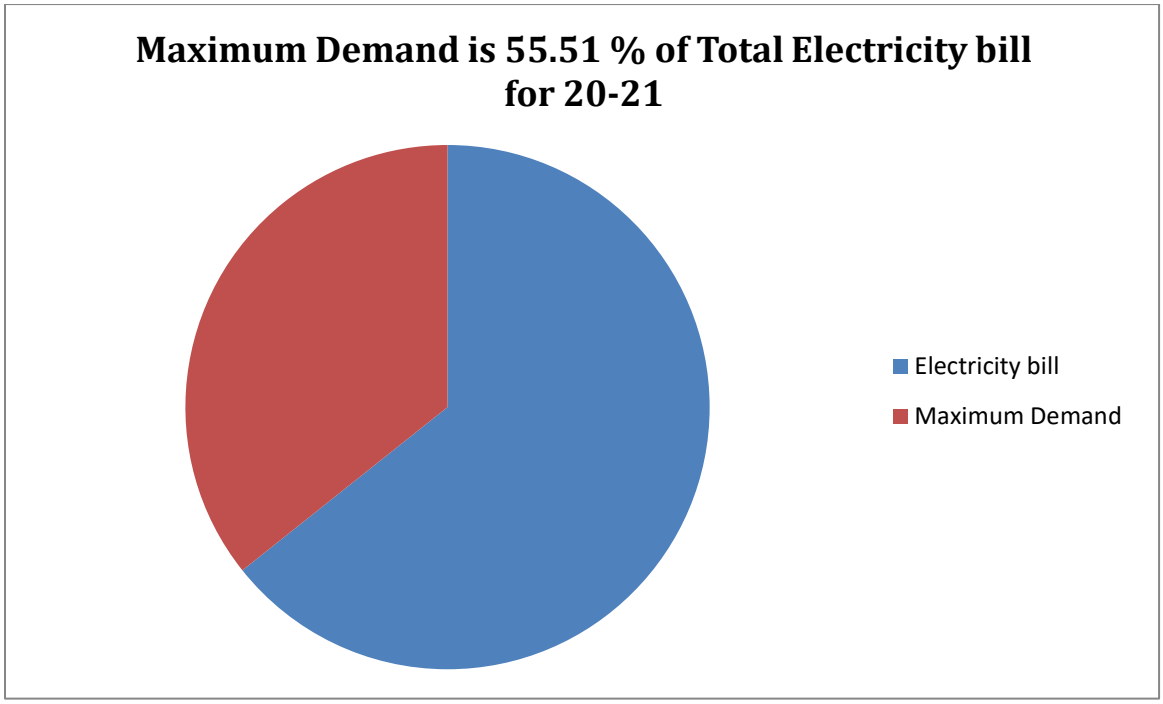
GRAPHICAL REPRESENTATION OF ENERGY CONSUMPTION FOR 2020-21

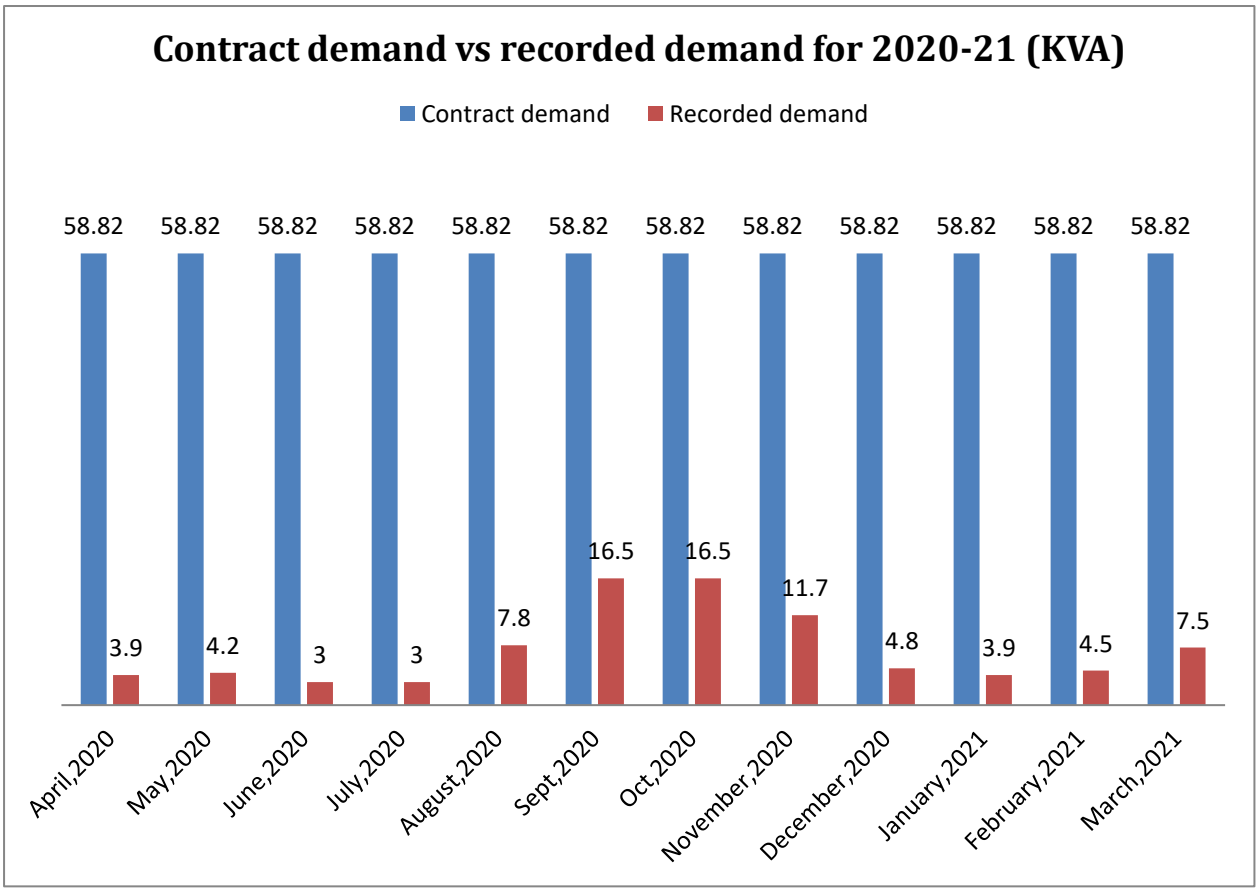
Monthly energy consumption for 2020-2021



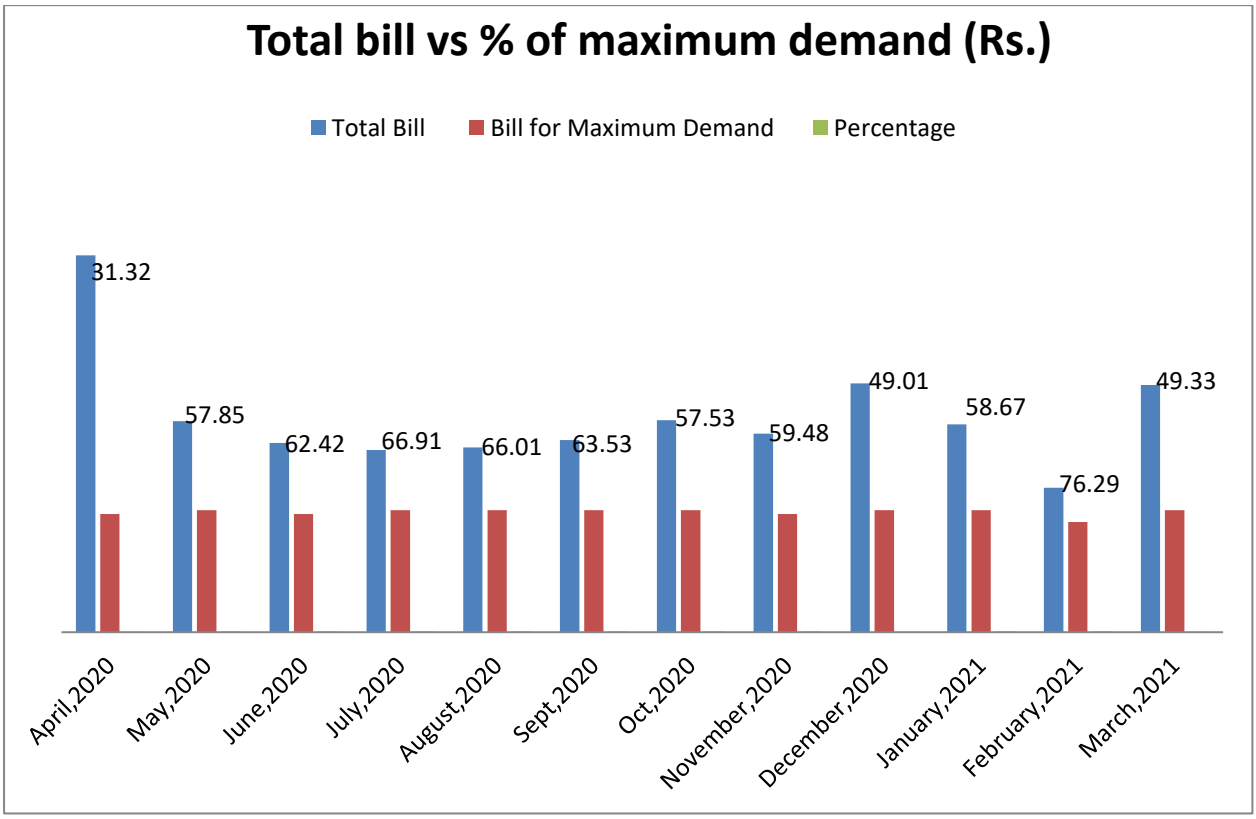
Electricity bill is composed of three cost components. Energy charge billed in Kwh, Contract demand in Kva and electricity duty in Rs.




Maximum Demand is 55.51 % of Total Electricity bill for 20-21
Electricity bill
Maximum Demand


Contract demand vs recorded demand for 2020-21 (KVA)
Contract demand
Recorded demand
58.82
58.82
58.82
58.82
58.82
58.82
58.82
58.82
58.82
58.82
58.82
58.82
3.9
4.2
3
3
7.8
16.5
16.5
11.7
4.8
3.9
4.5
7.5
April,2020
May,2020
June,2020
July,2020
August,2020
Sept,2020
Oct,2020
November,2020
December,2020
January,2021
February,2021
March,2021

- The graphic on page 14 shows that contract demand with APDCL was 58.82 kva.
- However, against contract demand of 58.82 Kva Silapathar College used only 16.5 kva for the months of September and October of 2020 as highest recorded demand in 2020-21.
- The college can reduce contract demand from 58.82 Kva to the extent of 30kva in the first go.
- Silapathar College will save a substantial amount on electricity bill without any capital investment.
- The amount of saving at contract demand of 30kva is expected to be around Rs.60, 000.00 annually.
- The pie chart shows maximum contract demand 55.51% as component of electricity bill for 20-21.



- The above chart shows percentage of maximum demand (kva) as a component of total bill.
- As referred already the contract demand need to be reduced to a desired level to save on electricity cost.
- It is felt that a fresh agreement with revised contract agreement has to be concluded with APDCL.

8 Diesel Generator Set:

There is one Diesel Generator set of 20 Kva capacity to take care of standby power in the event of failure of power supply by APDCL. The technical specifications of the DG set are as follows:

Make	Kirloskar Oil Engines Limited
Rated Kva	20 KVA
Machine No	KG20WS2
Voltage	230
Rated KW	16KW
Current	87 Amps
Frequency	50hz
Phase	Single phase
Cooling medium	Air cooling
Excitation	Volts 33- 3.3 amps

Performance assessment of the Diesel Generator set:

In order to assess performance of DG set it is essential to know Specific Fuel Consumption. Specific Fuel Consumption expressed in litres per hour or gram per Kwh is an indication of quantity of diesel required to generate one unit of electricity. The parameter is of direct relevance to end users as it relates to operating cost of generating electricity from DG sets. However, for that to happen we need to have a monthly fuel consumption and monthly energy generation data 12 months.

As monthly energy generation data was not available it was not possible to assess specific fuel consumption of the DG set. There was no log book to keep records of consumables and electricity generated by the DG set. It appears that the DG set was used rarely as power supply to the college had a steady power supply.

The standard value of fuel consumption/hr of 20 KVA DG set are as follows:

	Load %	Fuel Consumption	Unit
Fuel Consumption	At 100 % load	5.8	Lit per hour
	At 75 % load	4.4	Lit per hour
	At 50 % load	2.9	Lit per hour

Follow up measures after walk-in-audit:

- As informed by authorities a log book is maintained from January'2022 to record month wise consumption of fuel and energy generated to evaluate performance of DG set.
- An agreement has been concluded under BANDHAN scheme with supplier of DG set to carry out maintenance four times a year. This is a right move in the sense that DG set will be ready to supply essential power in standby mode every time the grid power fails.

9. Water pumping system:

There were six numbers of water pumps to cater to need of the users. As water is essential for our day-to-day activities the pumps, lines, valves, taps and joints need to be maintained without any leak so as to prevent wastage of water.

10. Air conditioning System:

Air conditioners are energy consuming devices and need maintenance on regular basis. Although geographical location of Silapathar presents a mild climate there is a need to run air conditioners occasionally. To that extent it is appropriate to maintain air conditioners so that excess energy is not consumed.

- The filters of the air conditioners need to be cleaned on a regular basis.
- Clogged filters increase consumption of excess energy due to overloading of compressor.

11. Recommendations:

Short term measures

i. All CFL lamps should be replaced by energy efficient LED lamps.

ii. Halide lamps should to be replaced by LED lamps.

iii. A fresh agreement for revised contract demand should be signed with APDCL.

iv. Unused plugs (6 and 16amps) should be removed from circuit.

Midterm measures

v. A roof top solar system should be installed to reduce use of grid power.

vi. Conventional ceiling fans (65kw) may be replaced by energy efficient 35w BLDC fans.

12. Implementation of Audit recommendations:

i. It is confirmed by the management that all CFL (23w) lamps have been replaced by energy efficient 9w LED lamps.
ii. All 400w halide lamps have been replaced with 50w LED lamps.
iii. A fresh agreement has been signed with APDCL to reduce contracted maximum demand from 58.82 Kva to 30 Kva.
iv. Unused plugs (6& 16 amps) have been removed from the system.

13. Standard operating practices:

13.1 Illumination:

Lux level is a measurement of illumination. For class rooms lux level is standardized at 300 lux. Natural light is the best and most important light to incorporate in the classrooms. Natural sun light provides physical and physiological benefits to both students and teachers. However LED lights are best man-made lights for illumination of class rooms. Higher illumination if needed should be evaluated for the specific needs of class rooms.

13.2 Air- Conditioning system:

As mentioned, air conditioners should have regular cleaning of air filter. Depending on efficiency rating by BEE it is always a better bench mark. The air conditioners with higher star rating (4-to-5-star rating) are energy efficient.

13.3 Earthing system, preventive maintenance and safety:

Safe handling of electricity is one of the most important aspects of dealing with electricity. It needs to be underlined that all electrical devices including laboratory power points need to be earthed to avoid any short circuit and to prevent possibility of fire hazard.

Every electrical system should be earthed to ensure safety of the equipment and safety of person handling equipment. There should be scheduled inspection of electrical networks to take up preventive maintenance and ensure safety.

13.4 Awareness on Energy conservation:

The need to save energy has to be understood by all stake holders as source of generating electricity by fossil fuel has become incompatible with the global warming. Awareness on need for energy conservation has to percolate to every level of society by means of hoarding in prominent places, organizing discussion and popular talks, quiz and so on.

13.5 Formats for monitoring energy consumption:

It is expected that after implementation of short-term recommendations in energy audit there will be reduction in energy bill of Silapathar College. To keep a track of consumption of energy following formats may be used.

Format-1

Monthly energy consumption for year 2021-22						
Month of Year	**Units billed (Kwh)**	**Recorded demand (Kva)**	**Electricity duty (Rs)**	**Cost of billed units (Rs)**	**Bill for recorded demand (Rs)**	**Total bill (Rs)**

14. Acknowledgement:

We express our thanks and gratitude to the management of Silapathar College for giving us the opportunity to conduct energy audit in Silapathar College.

We are also grateful to Dr. Lakhi Nath Pegu, Principal, Silapathar College, and Silapathar, Assam for his valuable comments/feedback and for support with which we could prepare this audit report.

We express our sincere thanks to all other concerned official for their support and guidance during the exercise of energy audit.

Khanindra Talukdar.

B.E.E Certified Energy Auditor

(EA-5846)

Dated- 21st Feb, 2022.

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