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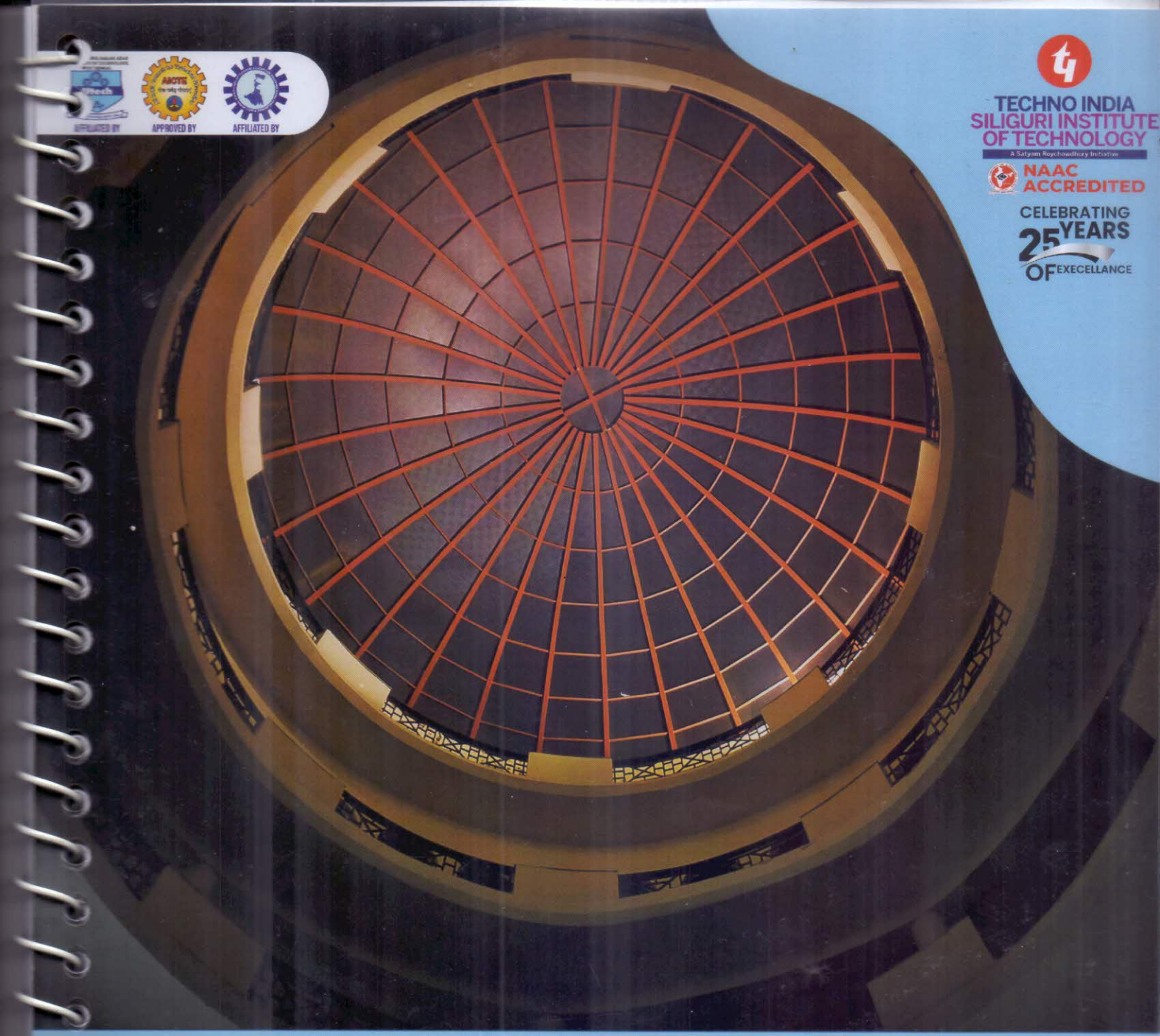

Energy Audit Report
SIT Campus

JOINTLY CONDUCTED BY:
Civil Engineering Department, SIT
Electrical Engineering Department, SIT

www.sittechno.org

Energy Audit

CONTENTS

Abbreviations

AC	Alternate current
KVA	Kilo volt ampere
Kwh	Kilo watt hour
LED	Light emitting diodes
MELEC	Mitsubishi Electric Logic Controller (trade name)
PLC	Programmable logic controller
SIT	Siliguri Institute of Technology
SPV	Solar Photovoltaic
TPLC	Toshiba Programmable Logic Controller (trade name)
WBSEDCL	West Bengal State Electricity Distribution Company Limited

Introduction

Energy Audit & Energy Management system of Siliguri Institute of Technology (SIT) campus, Siliguri, Dist.-Darjeeling, West Bengal, has been conducted during January-February 2023.The study encompassed the examination of the existing pattern of energy use in the SIT campus and identification of areas where energy & monetary savings could be achieved by employing suitable techno-economic measures and good practices. An energy audit may identify energy-saving opportunities along with safety concerns with electrical systems, wiring and ventilation, thus making the campus safer.

Department of Civil Engineering & Electrical Engineering of SIT were entrusted with the task of conducting Energy Audit & Energy Management study for the Siliguri Institute Technology, (SIT). This report gives the details of the observations of the study along with appropriate recommendations. It is expected that the findings of this report will supplement the efforts of the management in bringing the energy consumption of the campus to the lowest possible level. It will also help to understand the energy usage and ways to use energy better.

EXECUTIVE SUMMARY

The summary of the observations and recommendations evolved out of the Energy Audit study of the SIT Camus is given below:-

1. The energy demand of the SIT campus varies from 109 kVA to 351 kVA and the average demand is 232 KVA, whereas the contract demand is 400 KVA. So, it is advisable to reduce the contract demand with WBSEDCL. This may reduce the monthly fixed energy cost. Exact value may be calculated after discussion with WBSEDCL. For precaution, a demand controller may be installed which would help in keeping the maximum running demand within the limit. Stand by electric generator(s) may be used during on-peak high load periods. However, while reduction of demand, future expansion plan may please be kept in mind.

2. The running maximum Demand depends on power factor. The average monthly power factor atSITcampusis0.899 which is quite satisfactory. However, if the power factor can be improved to 0.99 or unity, it will reduce some amount of fixed cost also. Installation of automatic power Fact or controller (APFC) may save some energy cost.

3. Replacement of fluorescent lights with LED lights in SIT campus may save substantial energy cost. Onetime investment of about Rs. 9.28 lakh, with a payback period of 8 months only, may save about Rs.1.24 lakh per month from the 9th. months, if all the fluorescent tube lights (40watt) of the buildings of the SIT campus are replaced by LED lights (18 watt).

4. It is estimated that installation of 300 KW roof top power plant in two phases (Phase I–100 KW& Phase II- 200 KW) in SIT campus may generate about 50400 kwh of energy (Phase I – 16800 Kwh & Phase II-33600 Kwh) per month when both the phases would be operational. Out of 50400kwh energy, 20350 kwh may be used for monthly captive consumption and the rest can be sold to grid. However, actual size of the plant will depend upon the local factors like solar radiation and weather conditions and net area of the roof surface, shadow analysis etc.

Detailed Report

1.0 Data Collection

Data collection of energy usage on energy consumption pattern has been gathered. Data include sources of drawings energy, electricity supply, metering, energy consumption and different gadgets and appliances. Some qualitative method such as questionnaires/ surveys has been conducted by the audit team.

Information Obtained from Electrical Wing of SIT

A description of the data collected from different sources are appended below:

TableNo.-1.Indoor(Buildings/ Canteens/Auditorium/Guest House/ Gym etc.)

Name of Building	Tube Lights		Ac Machine		Fans		Other Machine (Projector)		Computer		Others (Please Specify)		Total Wattage
Name of Building/Department	No. of Tube Lights(40watt)	Wattage(In Watt)	No. Ac Machine	Wattage	No. of Fans(60W)	Wattage	No. Machine(100	Wattage	No. 350watt)	Wattage	No. (printers)(600	Wattage	
Main Building	742	29680	73	214912	216	12960	12	12000	584	204400	32	19200	493152
Central Library	102	4080	16	47104	52	3120	4	4000	152	53200	5	3000	114504
DESH Building	282	11280	9	26496	157	9420	5	5000	65	22750	8	4800	79746
Nursing College	241	9680	9		164	9840			216	75600	4	2400	124016
Hotel Management	63	2520			32	1940	2	2000	24	8400	1	600	15440
GYM	12	480			12	720							1200
Other	62	2480			34	2040							4520
Other													
Other													
												Total	**832578**

Table No.-2.Outdoor/ Workshop /etc.

Location	Lights		AC Machines		Pump & Motors		Machines		Comp uter		Others		Total Wattage (Watt)
	No. (40 w)	Wattage	No. (60Watt)	Capacity	No.	Wattage	No.	Wattage	No.	Wattage	No.(Pleas eSpecify)	Wattage	
Workshop CE	31	1240	8	480	2	1500	26	22505					24225
Workshop EE	12						18	45870					47070
Workshop DESH	15						16	69980					71300
Security Light	LED (25w*25 nos.=2025 watt)						[Metal Light 10nos.*400watt= 800 watts].						6025
												Total	**148620**

Table No. 3 Laboratory Machines/Apparatus/Water Pumps etc.

Location	Pumps & Motors(Please Specify)			Machines (Please Specify)			Others (Please Specify)			Others (Please Specify)			Total Wattage
	No.	Wattage	No .of hour sr un /day	No.	Wattage	No. of hours	No.	Wattage	No. of hours r un /day	No. (Plase Specify)	Wattage (in Watt)	No. of hours run /day	
DESH Lab				15	4600								4600
EE Lab				29	22700								22700
ECE Lab				27	5000								5000
CE Lab				10	3000								3000
Water Pump													1500
						Total							**36800**

Total Load in the System=1018 KW

TableNo.-4. Auxiliary Power Sources and Supporting Installations

Sl No.	Particulars	Description	Capacity	No.	Remark
1.	Number of DG sets and capacity		125KVA	2	
2.	Transformer		630 KV	1	
3.	Switch Gear		11 KV	1	
4.	Any other if any				

Table No. 5 General Information

Sl. No.	Particulars	Please specify (Yes/No)	Remarks
1.	Connection is LT or HT or both; please specify	LT only	
2.	Installed Automatic Power Factor controller(APFC)	**No**	If yes, capacity-
3.	Installed maximum Demand Controller (DC) at the main LT panel to avoid the maximum demand penalty.	**No**	If yes, capacity-
4.	Three phase capacitor banks near the main distribution panel/box have been installed.	**No**	If yes, capacity-
5.	Transformers, Generators and UPS are protected with proper fencing so that common people do not have access.	**Yes**	
6.	Properawarenessboardsdisplaying"danger&warning"signsdisplayedatappropriateplaces. 	**Yes**	
7.	In every unit energy load is balanced	**Yes**	
8.	Age of electric wiring	22 years	
9.	Electrical wiring was done by aluminum or copper cable	Copper	
10.	Joining of wires or cables are maintained as per the IndianElectricityRules-1956	**Yes**	
11.	Leakages of current or flux is checked periodically.	**Yes**	
12.	All electrical appliances Grounding and Earthling are properly built and maintained	**Yes**	
13.	Installation of Solar power plants	Scheme has been drawn for roof top solar power system in two phases, phase -I &phase-I,100KW&200KW respectively and it is under consideration	

Table6:Usage of Devices/appliances

Sl. No.	Particulars	Please specify . (Yes/No)	Remarks
1.	Replacement of single/double fluorescent, FL, and tungsten lamps by single LED devices.		Scheme has been drawn. and it is under consideration
2.	AC machines filters are cleaned regularly	Yes	
3.	AC machines filters are replaced periodically.	Yes	
4.	Earthing of all buildings are made properly	Yes	
5.	Number of deskjet printers	32	
6.	Number of inkjet printers	18	
7.	Number of desktop computer Old (>5 years)New(<5years)	 915 126	
8.	Number of Air-conditioning units Old (>10 years)New(<10years)	 85 22	
9.	Number of Air-conditioning Units i)Having copper coil ii) Having Aluminum coil	 107 Nil	
10.	Sub-meters for energy monitoring in order to noted own energy consumption in each building exists.	No	
11.	Motion sensor in toilets and rooms exists.	No	
12.	Master switch outside each room exists	No	
13.	Master automatic switches with sensor outside each room exists.	No	

[Note: i) Kindly bring to our notice if any filled up data is not true.]

The information collected from different sources and analysis of those data enabled audit team to detect energy saving measures to reduce energy consumption. Energy and cost savings of these measures has been assessed, together with investment needed and payback.

3.0 Present situation

General

Siliguri Institute of Technology (SIT),a Techno India Group College, under Maulana Abul Kalam Azad University of Technology (MAKUT), West Bengal, is established in the year 1999, imparting higher education in the field of Engineering Technology, Science & Commerce. It is in the foothills of the Himalayan region near Siliguri, in the District of Darjeeling, West Bengal, India. Assignment was conducted and the following areas have been covered in the study.

1. Electricity Bill
2. Distribution Network
3. DG Sets
4. Lights &fans
5. Air Conditioning machines
6. Laboratory Equipment
7. Workshop Machines
8. Pumps and motors
9. Computers & printers etc.

A. Basic Information Obtained from Monthly Energy bills of SIT (Jan'2022toDec' 2022)

Table5. Basic Information

SL No.	Particulars	Value
1.	Connection is LT or HT or both; (please specify)	LT
2.	Contract Demand	400KVA
3.	Supply Voltage	11 KV
4.	Power Factor Max	0.9346
5.	Power Factor Min	0.8011
6.	Av. Power Factor	>0.85
7.	Running maximum Demand (KVA)	351KVA
8.	Lowest Demand	109KVA
9.	Average Demand	232KVA

TableNo.6:Monthly Power Consumption Status

Months	Sanction Demand (kVA)	Running Max. Demand (*)(KVA)	Monthly Power Factor	KVAh	Monthly Consumption (KWh)	Monthly Energy bill amount(Rs)
Jan'22	400	109.2	0.8929	18730	16309	316312
Feb'22	400	159.6	0.8011	17041	15004	309222
March'22	400	126.8	0.8465	22741	14425	301433
Apr'22	400	263.6	0.8938	23881	20326	358908
May'22	400	260	0.9103	26531	21738	365685
June'22	400	295	0.9209	27015	24433	387721
July'22	400	287	0.9346	26376	25247	398455
Aug'22	400	140	0.9224	28606	24329	387852
Sept'22	400	351	0.9325	32120	26676	411244
Oct'22	400	336	0.9352	21481	30038	440606
Nov'22	400	260	0.8935	21816	18924	343058
Dec'22	400	200	0.9154	17992	19970	351913
Average		**232**	**0.899**		21451	364367

[(*) Before multiplying by MF]

[Note: Obtained from Monthly Energy bill of SIT (Jan2021toDec'2022).]

Energy Sources

ElectricityisthemajorenergysourcesoftheSITcampusissuppliedbyWBSEDCL.Dieseloilisbeingusedin the DG sets for in-house generation of electricity during power cut.

Particulars	Capacity/Unit
Contract Demand	400KVA
Supply Voltage	11.0 KV
Monthly Demand Charge	Rs. 13560
Average Monthly Consumption	21451 KWh
Maximum Monthly Consumption	30038 KWh
Minimum Monthly Consumption	14425 KWh
Multiplying Factor	0.5

Energy Consumption

Energy consumption charges of WBSEDCL consists of two parts i.e., a fixed cost (Demand Charges) and unit (kWh) rate. The average monthly unit consumption of the campus is 21451 KWh and the average monthly electricity bill amount is around Rs.364367/-.The average monthly unit cost would be around Rs.16.98 /-per kWh.

DG Sets

There are two DG sets of capacity 125 kVA installed in the college. There is hardly any power cut, so the running hour of DG set is very less.

Air Conditioning

In the campus, there are 85 nos. air conditioners which are more than 10 years old and 85 nos. air conditioners which are less than 10 years old.

Computers

In the campus, there are 915 nos. desktop computers which are more than 5 years old and 126 nos. desktop computers which are less than 5 years old.

4.0 Observations and Recommendations

Whole electrical system of SIT campus is being operated and maintained satisfactorily. Power factor is reasonably good. However there remain a scope of reduction of contract demand load. Apparently, nopowerleakageorlosscouldbenoticed.Howeverthereremainssomescopeoffurtherimprovementwhichar enoted below:

a. Demand Load

Demand Charge for the energy connection (400 KVA) is Rs. 130560/- per month. This fixed amount is levied on the sanctioned load for the connection, or the maximum power demand registered during the billing period, which must be paid irrespective of the actual power usage. Minimum demand 109 KVA Maximum demand is 351 KVA and the average demand is 232 KVA. So, reduction of contract demand (400 KVA) may reduce the monthly energy fixed cost. For precaution, a maximum Demand (MD) Controller (DC) can be installed at the main LT panel to avoid the maximum demand penalty.

The demand controller willcontrolthemajorelectricappliancestolimitthepeakenergyuseinyoursystem.The demand controller will monitor the electricity use and begin shutting off major appliances on a prioritized basis as demand reaches your preset kilowatt limit.

In case the running maximum demand increases, the demand controller will switch off some non-essential load like Air-conditioning load etc. and simultaneously it will also give alarm for further action.Numberofdemandcontrollermaybedecidedasperthedistributionsystem.Standbyelectricgenerator maybeusedduringon-peakhigh load periods.

Note: *Price of MD controller is around ₹ 15000/- (Schneider), ii) L&T 6000 Series Cl 0.5S with LCD Maximum Demand Controller Meter, Price- ₹31124/-;iii)L&T6000SeriesCl 1withRS485Maximum Demand Controller LED Meter, price -Rs.23245/-.*

[*Heavy discount is available in the market]

b. Power Factor

Automatic Power Factor controller (APFC) has not been installed in the campus. Presently the power factor is reasonably good (>0.85). However, benefits of installation of power factor correction includes avoidance of power factor penalties, reduced demand charges, increased load carrying capabilities in existing circuits ,improved voltage, reduced power system losses. Annual saving in Fixed cost may be possible by maintaining recommended powerfactor0.99.

A high power factor is generally desirable in a transmission system to reduce transmission losses and improve voltage regulation at the load. As the line current increases, the voltage drop in the conduct or increases, resulting in a lower voltage at the equipment. Ideally the power factor is required to be unity. However, the power factor is leading if the load is predominantly capacitive and lagging if the load is predominantly inductive. PF incentives are given onelectricitybillifthePowerFactorisbetween0.95 to 1.0. On other hand, penalties are levied if the Power Factor is below 0.9. It is therefore required that consumer should maintain higher power factorabove0.95 through proper compensation.

With an improved power factor, the voltage drop in the conductor is reduced, improving the voltage of the equipment.

The most practical and economic power factor improvement device is the capacitor. Capacitors produce capacitive reactive power, which is the opposite of inductive reactive power that is the primary driver behind low power factor values. Synchronous condensers use an automatic excitation controller to measure the power factor of the system and operate at the required state.

Note:

i) L&T Automatic Power Factor Controller, Model Name/Number: L8, 1a/ 5a may be available at Rs175000; ii) L&T andL&T3phasepowerfactorcontroller, 440V,price -₹ 5,000/-.

[***Heavy discount is available in the market]**

c. DG Set

There are two DG sets available in the campus, capacity of each set is 125 kVA for in house generation of electricity. As the power supply is very good in the area so the running hour of DG set is very less.

ItisadvisabletoputanenergymeteroneachDGsetthenitwouldbeeasytoconducttheefficiencyofDGset.This way, the operator could also note down the unit generation and oil consumed. The operator may record the operating parameters of the sets in the following manner in future.

Start Time	Off Time	Diesel consumption	Unit Generated	Voltage	KVAh/l it.

It may be noted that the efficiency of the DG set depends largely on the operating load factor. The maximum efficiency of the DG set is available atabout80-85% load factor.

d. Lighting

In the management of any workplace, energy consumption is a major area of revenue. Since electricityconsumptionformsthebulkoftherunningcostoflightfixtures,an energy efficient option like LED lights can help to save a good amount of money in the long run.

With an estimated energy efficiency of 80-90% compared to conventional light bulbs, LED lights significantly reduce energy consumption, and thus help save money by lowering electricity bills. LED lights are much more eco-friendly and have good illuminating power. LEDs may cost 30-40% more than traditional lighting options, depending on the brand chosen, but they last four to five times longer. The return on investment for installing LEDs is also much quicker because of their longevity and light emission per wattage.

The total lighting (luminary) load of the campus is about 61.44 kW which includes fluorescent tubes of40watt. Replacement of fluorescent light with LED light may save substantial of energy cost. It is calculated that one time investment required for the replacement of all the fluorescence tube lights with LED lights (indoor only) will be about Rs. 9.28 lakh; however, the Payback period of the said investment will be 8 months only.

After 8 months onwards net savings in energy bill may be about Rs. 1.24 lakh per month, if all the fluorescent tube lights(40watt) of the buildings of the SIT campus are replaced by LED lights (18watt).

Moreover, LED Tube lights will not only save them an intendance cost of replacing them often, but also make them environmentally sustainable by avoiding greenhouse gas emission and conservation of natural resources.

e. Air Conditioning

In the campus there are 107 nos. AC units of total load 288.5 KW. The age of 85 no. AC units are more than10 years thus require phase wise replacement.

It was observed that some split ACs fitted in the office carries 5 Star, which is good from energy efficiency point of view. It is recommended that whenever new split/ window ACs are being installed, it should be Five Star rated.

Filters of AC units are cleaned periodically. Proper cleaning of ACs is very important for its output performance. At least, once in two months cleaning of ACs filter is recommended during the season.

f. Solar Power Generation

Presently there is no roof top Solar Photo voltaic (SPV) unit for Power Generation in the campus. Total roof area available in the campus is 4175 m^2. So, about 370 to 450 kw solar power capacity may be installed on the roof top of buildings of SIT campus. Actual size, however, depends on local factors of solar radiation and weather conditions and shape of the roof etc. However, maximum 400KW can be generated. Present demand load of SIT Campus is 340KW. Approx. 300 KW Power plant may be viable, which can be finalized after detailed study only with shadow analysis and assessing other site conditions. Initially 100 KW Installation in Phase-I is suggested and after seeing the performance further enhancement of 200 KW can be carried out in Phase-II. Rough estimate shows that total energy generation potential per month from Phase – I& Phase II may be 16800 Kwh and 33600 Kwh respectively i.e., in total 50400 kwh per month when both the Phases will be completed. Out of which monthly captive consumption may be 20350 kwh and the rest can be sold to grid.

Table: Estimated Revenue Generation Potential from Roof Top Solar Power Plant

Solar Power Generation		Revenue Earning per Month(*)						Remark
		Captive Use			Sale			
Phase	Generation (Kwh/ month)	Captive	Unit Rate (Rs. /kWh)	Savings from Energy bill(Rs. /month)	To gride	Unit Rate (Rs. /kWh)	Revenue generation from Sale of Solar Power on Grid (Rs./month)	Total Revenue Generation(Rs. /month)
Phase-I	16800	16800	17.5	294000	0	0	0	294000
Phase-II	33600	3530	17.5	61775	30070	10	300700	362475
Total	**50400**	**20330**		**355775**	**30070**		**300700**	**656475**

[Note: *After completion of Phase – II, a net of 30070 units of power can be sold through grid*]

However, exact figure can be arrived at after detailed investigation of net area available, shadow analysis and radiation factor etc. of the project.

4.1 Some Suggested Actions for further Improvement:

1. Electrical infrastructure:

- Minimize maximum demand by tripping loads through a demand controller.
- Installationof3phasecapacitorbanknearthemaindistributionpanel/box.
- Use standby electric generation equipment for on-peak high load periods. Correct power factor to at least0.99 under rated load conditions.
- Set transformer taps to optimum settings.
- Balance the three-phase power supply.
- Renewal/replacement of old Distribution panel by programmable logic controller(PLC).TPLC or MELEC etc. make may be used
- Transformers, Generators and UPS are to be protected property with fencing and awareness boards are kept displaying "danger &warning" signs so that common people do not have access.
- Load balancing at every unit should be maintained.
- Joining of wires or cables should be maintained as per the IS 13573.
- Indian Electricity Act, 2003, The Indian Electricity Rules, 1956 should be followed.
- Leakages of current or flux should be maintained as minimum as possible.
- So far protection is concerned of electrical appliances Grounding and Earthing should be kept in considerations.

2. Use of Devices/appliances:

- Use of motion sensor in toilets and rooms.
- Replacement of single/double fluorescent, and tungsten lamps by single LED devices.
- AC machines filters to replace periodically.
- Remove and replace old AC units after 8 to 10 years for split and after12 to15 years for Window. However, old Air-conditioning units having copper coil may be replaced after 15 years and non-copper coil to be replaced within 10 years (reduces 20% consumption)
- Ceiling or portable fans may be used for circulating cold air.
- Installation of Brushless Direct Current (BLDC) fan in place of conventional fans (both ceiling and others) (65% savings).
- Installation of master switch outside each room/installation of automatic switches with sensor.
- Use of 4 to 5 star rated devices/appliances/accessories for minimum consumption.
- Use of sub-meters for energy monitoring to noted own energy consumption in each building.
- Solar power plants to use in roof top along with LED and Solar Streetlights.
- Latest models of AC units should be used.
- More laptop instead of desktop will reduce energy consumption. Replacement of old computers is required to reduce energy consumption.
- More inject printers should be used in place of laser printers.
- Devices to be used to increase power factor.
- One switch for multiple lights is to bed is couraged. Use more switches as far as practicable.
- Unnecessary lights in a single room should be avoided.
- Earthing of all buildings should be made compulsory.

3. Changing behavior for using the devices:

- Switching of electrical devices from the main supply rather than leaving it on standby supply.
- Turning off switch while leaving the room. It is advisable to install room censor and at toilets.
- Sleep mode operation to be used for AC to reduce consumption(40%savings)
- AC should be operated within a temperature of25^{0}C.
- Windows and doors of the AC rooms should be made airtight.
- Servicing of Air conditioners should be done quarterly.
- All electronic appliances should be unplugged on being turned off and removed from the socket after the office hours.
- Try to avoid putting appliances on standby mode.
- Remove faulty lights.
- No one should leave the room door open while entering or exiting AC rooms.

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Prepared by :
Dr. Asit Aich, HOD, CIVIL Engineering
Dr. Arup Das, HOD, Electrical Engineering

Dr. Mithun Chakraborty
Principal
Siliguri Institute of Technology