KVQA CERTIFICATION SERVICES PVT.LTD
101, Vigyapan Lok, Mayur Vihar, Phase-1,
Delhi- 110091,
India Phone: +91-11-22711940.

To
BHILAI INSTITUTE OF TECHNOLOGY (BIT)
BHILAI HOUSE,
DURG, CHATTISGARH ,
INDIA

Date of audit: 16/08/2022

Dear Sir,

Sub: Certificate of continuity of ISO 9001:2015 & ISO 14001:2015

This is to confirm that Annual Surveillance Audit of Bhilai Institute of Technology (BIT,Durg) has been conducted successfully as per ISO 9001:2015 & ISO 14001:2015.The various procedures were audited and it was found that the requirements of ISO 9001:2015& ISO 14001:2015 have been fulfilled. Hence, we are pleased to recommend continuity of the Certificates for ISO 9001:2015 & ISO14001:2015.

ASMITA SENGUPTA
LEAD AUDITOR

KVQA CERTIFICATION SERVICES PVT.LTD
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Delhi- 110091,
India Phone: +91-11-22711940.

BHILLAI INSTITUTE OF TECHNOLOGY (BIT ,DURG)

Surveillance Audit Report of ISO 9001:2015 and ISO 14001:2015.

Date of audit : 16/08/2022.

Major Functional Areas of the Institute Audited	
1. Site Tour – departments and its facilities. 2. Periphery/maintenance /Utilities./ Solar Panel-operation 3. Central Library 4. IT Server Room 5. Training and Placement Cell. 6. Emergency Preparedness Plan 7. Legal and Statutory Compliances 8. Aspect-Impact, Operational Control Procedures, 9. Management System Function	

Classification of Non-Conformance	
Major Non Conformity (Major NC)	If there is a significant doubt that effective process control is not in place, or that products or services will not meet the specified requirements of the standard ;
Minor Non Conformity (Minor NC)	Non-Conformities could be classified as minor, if these do not affect the capability of the system to achieve the intended results with proper corrective actions.
Opportunities for Improvement (OFI)	Activities which would allow optimisation of the system in relation to the requirements of the relevant standard. It is recommended that the organisation implements these items.
Observations (Obs)	Special situation and information to be traced in next audit for conformation assessment

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Audit Report:

The opening meeting was held from 11.00 AM to 11.30 AM in the conference room. The **scope of the institute** "CONDUCTING COURSES AT BACHELORS ,MASTERS &RESEARCH LEVEL IN ENGINEERING TECHNOLOGY & MANAGEMENT". Prof. Dr. S.K. Jaiswal , was acting as Management Representative.

The top-management , Principal , is aware of the quality and environmental management system requirements in the context of current situation of business and strategy.

- ✓ The External-Internal issues and Need & Expectations are verified from Doc. no. EMS/BIT /1/00 and QMS/BIT/1/00
- ✓ The Quality & Environmental Policy have been defined and the Scope remains the same.
- ✓ The Quality and Environmental Objectives are defined in terms of base line, target and monitoring data at relevant functions
- ✓ The Risk, Opportunity and Mitigation plan have been verified from doc. no. BIT-Risk & Opportunity, Rev-01,
- ✓ The Aspect-Impact procedure has been verified with evaluation criterion of Significance available and all the activities are included and analysed.
- ✓ MRM and Internal Audit report for the month of July verified ,and all the records are maintained as per the standard requirements.

Legal Compliances:

- ✓ The organisation has maintained an updated registrar of Legal and statutory compliances under the responsibility of a competent person. MOU for E waste management verified.

TRAINING AND PLACEMENT CELL:

Verified all the records of training and placement and found ok and maintained in systematic manner. Final selection Batch -2022 verified –Total no of students :524 ,no of companies: 80 , No. of selection in Computer science and engineering: 139.- list maintained. BIT/TPO/2022.

CENTRAL LIBRARY /DIGITAL LIBRARY:

OPAC system available . Initiatives for usage of more digital books are emphasized, old question paper yearwise / branchwise , class test question papers are all accessible by the students. Maximum books and readout materials are in soft form. Several

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renowned eJournals – International and National – subscribed and available in the system.Students are also encouraged to use digit learning resources in the central library.. Server Room: All Back ups are maintained – UPS system available.

ADMISSION AND EXAM PROCESS:

Admission procedure –SOP verified including admission process flow chart organizational chart for admission cell 1st year intake: 100% - Toatal engineering: 720 inatke , MBA-120, Phd -160 and MCA-60 verified the intake. SOP for exam cell functioning (process flow) and order for conducting offline exam for even Semester/year.

IT DEPARTMENT:

Verified all the records and documents related to the department and maintained as per the standard requirements .Departmental objectives for the financial year are measured ,analysed and achieved .

Non-Conformance, Observation and OFI's during Visit:

- The Departmental objectives and achievements analysis may be displayed for encouragement and motivation of the faculty and students.-OFI
- Housekeeping of the Server room and IT and other departments may be enhanced.-OFI
- Segregation of waste Bins may be carried out.-OFI
- All electrical points may be reviewed further for its adequacy.-OFI
- In Chemical Lab, all the measuring cylinders and equipments may be segregated and identification and labelling for the items may be carried out for proper storing.-OFI
- All leakage of water points may be arrested to improve the environmental impact.-OFI.

ISO 9001:2015 and ISO 14001:2015 requirements were found to be in-conformance and in view of this the continuation of the certificates of ISO 9001: 2015 and ISO 14001:2015 are recommended .

Asmita Sengupta

ASMITA SENGUPTA
LEAD AUDITOR .

Energy Audit Report

Prepared by:

RAJ ENERGY SERVICES

ENERGY AUDIT OF BIT CAMPUS

Draft Final Report

Prepared by:

RAJ ENERGY SERVICES

भिलाई प्रौद्योगिकी संस्थान, दुर्ग
BHILAI INSTITUTE OF TECHNOLOGY, DURG
Bhilai House, Durg-491001 (Chhattisgarh) INDIA
Established in 1986, Accredited by NBA, Affiliated to AICTE, CSVTU, Institute Code: 01
ASPIRE TO EXCEL (Seth Balkrishan Memorial)

Energy Audit Report of

Bhilai Institute of Technology Durg (C.G)

SEPTEMBER, 2018

1. Location of the Building

The building is Located at: Durg Chhattisgarh. In latitude of 21.191 and longitude of 81.299 with sea level of 289 meter. location map is depicted below:

Aerial View of Bhilai Institute of Technology, Durg

2. Contents

3. List of Tables

3. List of figures

5. Acknowledgment

We express our sincere thanks to Shri Vijay Gupta Sir, Chairman, Board of Governors of Seth Balkrishna Memorial Institure, Durg and Shri I.P. Mishra Sir, Honorary Secretary of Trust for their kind support and giving us the assignment to contribute in their effort towards efficient energy management in Bhilai Institute of Technology, Durg.

We are highly indebted to Dr. Arun Arora Sir , Principal, Bhilai Institute of Technology, Durg. for their guidance, intellectual advice and constant supervision as well as for providing necessary information regarding the project & also for his kind support in completing the project.

We also thank Dr. S.P. Shukla , Assistant Professor, Bhilai Institute of Technology, Durg. for the cooperation extended during our Audit work.

Last but not the least; we are thankful to all employees of site office in this institute with whom we interacted during the field studies for their wholehearted support in undertaking measurements and eagerness to assess the system / equipment efficiencies and saving potential.

We trust that the findings of this study will help the BIT Durg in improving the performance with optimum energy consumption in the institute.

Raj Energy Services

Sanjay Kumar Mishra

Certified Energy Auditor

EA- 8696

6.Executive Summary

Energy Scenario

Following forms of Energy are being used in BIT and this energy is utilized from following sources:-

1) Electrical Distribution Company (CSPDCL) of Contract demand 250 KVA
2) Grid Connected Solar Power Plant of capacity 200 KW
3) Diesel Generator set of capacity 500 KVA
4) Liquid Petroleum Gas of 19 Kg cylinders.

The Average Annual consumption data of energy being consumed is based on the basis of last two year consumption, which are mentioned below :-

Sl. No.	Energy Utilization	Average Annual Consumption
01.	Electricity Consumption from CSPDCL	6,16,991 KWH
02.	Electricity Consumption from off grid solar power plant of capacity 100 KW	42,451 KWH
03.	Diesel Consumption in DG Set	530 Liter
04	LPG Consumption in Kitchen	12094 KG

Table 1: Average Annual Energy consumption

The loads are segregated based on the end use as lighting and fans, air conditioning, Computer/printers, water pumping, hostel mess cooking loads, washing machines and irons. Quantification, types and necessary measurements were carried out.

Installed Load

Nearly 41% of total load is air conditioner load, which is followed by nearly 21% load of fan, exhaust &coolers , 16% shared by room, class room & office lighting and then 13% load is shared by computers & Printers. Rest 09 % installed load is shared by campus lighting, pumping and other installation.

Particulars	Load in KW
Lighting	130
Fan/Exhaust/ Cooler	175
Computers	110
Air Conditioning	340
Campus Lighting	47
Others	20
Total	822

Table 02 : Installed Load- application wise

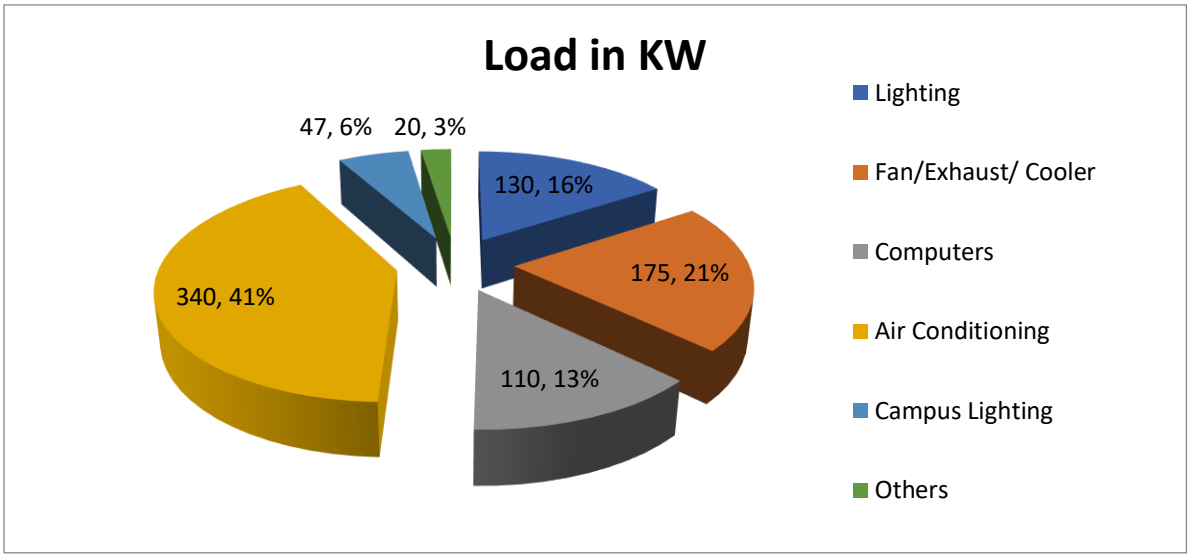

Figure 01 : Percentage Share of Installed Load in KW

We have drawn pie graph for above data of connected load. The air conditioners have the maximum contribution of electrical load followed by computers and fans & coolers.Air conditioner has 41% share of total connected load, while lighting has 16% share of total connected load.

Electricity Consumption

We have analyzed the electricity bills for two years during the period in between January 2016 to December 2017. On the basis of analysis of those monthly electricity bill we have concluded following average data.

Average Monthly Electricity Consumption figure based on last two year data.

Average maximum demand	226.7 KVA
Average Power Factor	0.97
Average KVAH Consumption	52203
Average KWH Consumption	51416
Average Monthly Bill	492127
Average Energy Cost	Rs. 9.24 per KVAH

Table 03 : Average monthly Electricity Consumption

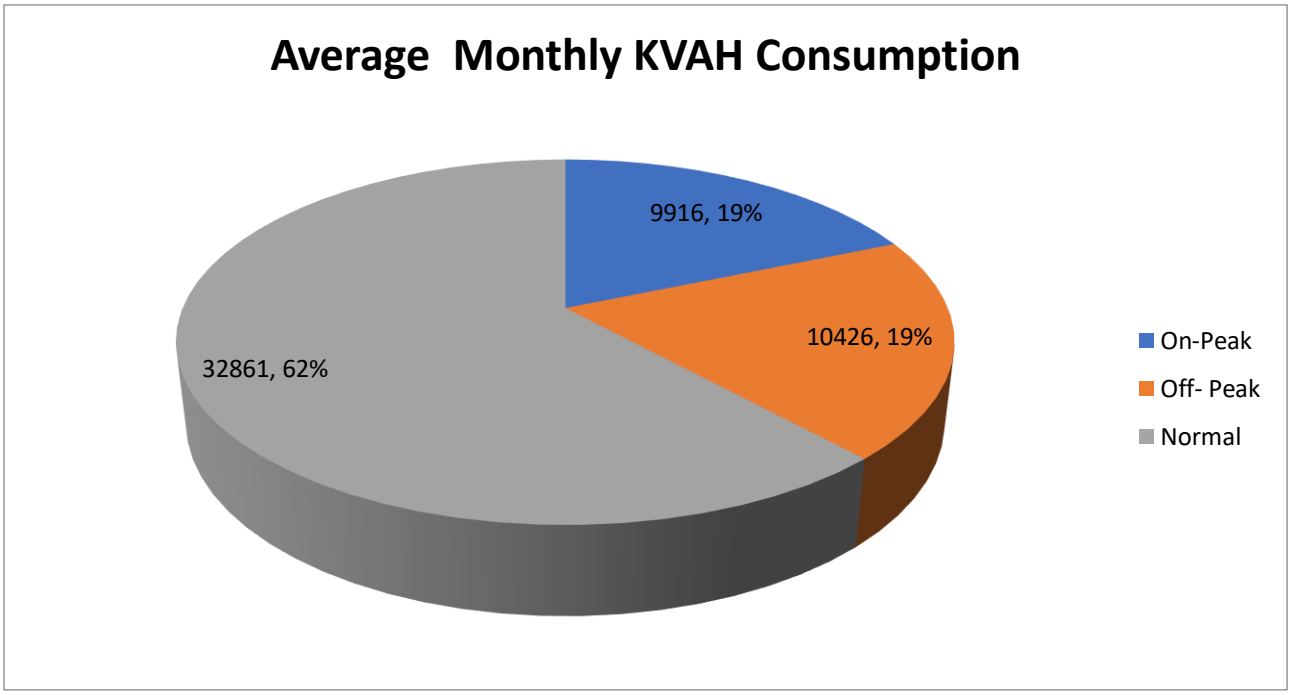

Figure 02 : Average monthly consumption and its percentage during on- Peak, Off- Peak and Normal period

The average monthly bill was around Rs. 4.92 Lacs which have average maximum demand around 227 KVA at monthly average power factor 0.97 and average KVAH consumption is 53203.

Share of Solar power plant in total consumption

Grid connected solar power plant has operated in the month of May 2018.We have analyzed the solar generation and electricity bill of last four months. The solar consumption was 36% in the month of May during sunny days in summer season and it was only 22% in the month of August having cloudy and rainy days. On average of last four months, solar power consumption has the share of 29%.

2018	**Month**	**Solar unit**	**CSPDCL Unit**	**Total**	**Solar %**
	May	22632	39867	62499	36
	June	13771	30080	43851	31
	July	13377	37984	51361	26
	August	11576	41286	52862	22
	Total	**61356**	**149217**	**210573**	**29**

Table 4: Share of Solar power plant in total consumption

Important Suggestions:-

We have given recommendation for energy saving. Beside this, we are strongly recommending following suggestions which are helpful to find out loading and consumption pattern of auditorium during program, fuel consumption with :-

1. A three phase Multi function meter, which displays KVA, KWH, Power factor, Voltages and current, should be installed at incomer of auditorium electric panel.

Why needed :

The auditorium contributes substantial amount of unit consumption in total electricity consumption during a program. At present, there is no metering of electricity consumption of auditorium. After installation of meter, we can get the demand (KVA)and unit consumption data (KWH) from installed meter and also.whenever auditorium is hired by other organization, we may charge some amount towards electricity consumption.

2. A three phase Multi function meter should be installed at incomer for computer labs**.**

Why needed :

The computer lab has the load of Air Conditioners and computers. It also contributes substantial amount of unit consumption in total electricity consumption during examination/ lab period. At present, there is no metering of electricity consumption of computer lab. After installation of meter, we can get the demand (KVA)and unit consumption data (KWH) from installed meter .

3. A Maximum demand controller should be installed at incomer of main panel to avoid penalty for excess demand.

Why needed

Maximum demand controller is a device which Prevents crossing over of set level of maximum demand at any point. It also has Unique Predictive Technique provides advance warning on likely cross over of maximum demand level and its Sliding Window Technique to automatically synchronize with the EB meter.

4. A KWH meter should be installed for diesel generator, presently we note only the quantity of fuel used and total operational hours of DG set.

Why needed

At present, there is no recording of units generated by DG set, which is output of DG set. They only record fuel consumption and operating hours of DG set, which is input of DG set. Thus we cannot know about the units generated per liter by DG set. BIT must have to monitor the fuel consumption. For this, they have to install a KWH meter for DG set, which will give unit generation of DG set.This unit generation should be recorded along with fuel consumption.

5. An "Energy Conservation Cell" should be formed in college which should be responsible for all types of energy use, promotion of renewable energy and enhancement of energy efficiency in college campus.

Why needed

Though BIT, Durg is sincere about his energy conservation activities, but We are recommending to establish " Energy Efficiency Cell " at Bhilai Institute of Technology Durg headed by the Principal. We have observed that there is a need to increase in awareness towards energy conservation. Bhilai Institute of Technology, Durg shall immediately nominate an Energy Manager, who shall be entrusted to handle the areas related to energy conservation. Energy manager occupies an important position and is a focal point of all the activities pertaining to energy management in the organization. He will also be responsible for promotion of renewable energy activity in the college.

Responsibilities:

- Initiate activities to improve monitoring and process control to reduce energy costs.
- Establishing benchmarks for each energy services by following the proper logging of energy consumption data & also ensuring proper implementation of the energy conservation options & verification of the savings achieved at a later stage.
- Arrangement for training of the employees on energy conservation issues Improve disaggregating of energy consumption data down to shop level or profit center of a firm.
- Co-ordinate implementation of energy audit/efficiency improvement projects through external agencies.
- Report to principal regarding all energy conservation issues.

Energy Saving Recommendations:

S.No	Energy Saving Measures	Investment in lakh Rs.	Annual Electricity Saving in KVAH	Annual Monitory savings in Rs.	Simple Payback Period
Low Cost					
1	Installation of MD controller	45,000		4,46,561	1
2	Replacement of 250 watt Mercury halide with 110 Watt LED Lights.	83,000	6868	44,642	23
3	Replacement of Mercury Vapor 125 Watt By LED street Light 55 Watt	98,700	7212	46,878	25
Medium Cost					
4	Replacing Conventional FTLs with 22 W T-5 LED	4,71,600	49,500	3,21,750	17.5
5	Installing Airtron Energy Savers for ACs with a higher duty cycle (> 6 hrs./day)	3,15,000	1,42,310	1,85,004	20.4
6	Replacing of CFL light fixtures with LED light in a phase manner of 1282 numbers	2,58,925	14,237	90,409	35
High Cost					
7	Replacement of conventional fans by Energy Efficient Fan	50,07,000	93,686	6,08,959	98.7

7. Introduction

Bhilai Institute of Technology (BIT) is a private engineering college located in Durg, Chhattisgarh, India. It is the first self-financed engineering college in Central India. Established in 1986, it is affiliated to Chhattisgarh Swami Vivekanand Technical University.
Commissioning of the Bhilai Steel Plant at Bhilai in 1959[1] necessitated having suitably trained and skilled personnel to perform specific technical tasks at the plant. Seeing this need, various organizations, industrialists, charitable institutions and philanthropic societies of the region took an initiative to establish an engineering institution, and to this end, a trust was formed and registered. The Government of Madhya Pradesh accorded the permission to open a self-supporting and self-financing engineering institute, and thus, in July 1986, the Bhilai Institute of Technology came into existence.

Seth Balkrishan was a philanthropist and a key founding member of BIT. His contribution in the fields of education, sports, social advancement, and the spiritual needs of the community are seen as legendary in Bhilai and the neighboring regions. The institute is therefore dedicated to him.

BIT-Durg was established in 1986, it was affiliated to Pandit Ravishankar Shukla University, Raipur and started offering Bachelor of Engineering in Civil Engineering, Electrical Engineering, Electronics and Telecommunication and Mechanical Engineering with an intake capacity of 180 students. Over the years it started offering Computer Science and Engineering and Master of Business Administration (1998), Master of Computer Applications (1999), Information Technology (2000) and Electrical and Electronics (2006).[2] In 2005, Institute get affiliated to newly formed Chhattisgarh Swami Vivekanand Technical University, Bhilai.

Leading the future of technocrats in India and proving its mettle once again, Bhilai Institute of Technology, Durg again has been ranked in the ranking band 150-200 under Engineering category for the second time consecutively.

General Information

Name and Address of Institute	Bhilai Institute of Technology (Seth Balkrishan Memorial) G.E. Road, Bhilai House, Durg- 491001 Phone : (0788) 2359297, 2359163,2359424, Email : bit@bitdurg.ac.in , durgbit@gmail.com
Contact Person	Mr. Arun Arora , Principal, Bhilai Institute of Technology
Coordinator of Audit	Mr. S.P. Shukla, Professor, Electrical Engg. Department
Name of Audit Agency	Raj Energy Services 62 & 81, Daya Nagar , Risali, Bhilai Nagar (M) 98261 79597, resbhilai@gmail.com
Annual Total Electricity Consumption of Last Year	6,45,269 KVAH
Annual Total Diesel Consumption of Last Year	375 Litre
Annual Total LPG Consumption of Last Year	13,053 KG (687 Cylinders)
Total Intake Capacity of Students	1027
Total capacity of Boys Hostel	400
Power Generation/ Distribution Facility	(a) CSPDCL contract Demand 250 KVA (b) Solar Power Plant, 200 KW Capacity (c) Diesel Generator 500 KVA
Audit Period	February 2018 – August 2018
Name of the persons in Audit Team	1. Sanjay Mishra – Certified Energy Auditor (EA- 8696) 2. Mr. N. Ponraja – Certified Energy Auditor (EA - 24097) 3. Mr. Rahul Agrawal – Certified Energy Auditor (EA- 20984) 4. Mr. Jayendra G. Mohabe - Energy Engineer

8. Building Description

The institute has 5 blocks:

- Administrative block, holding offices of various administrative departments and the central library
- ECOMIT block, holds three departments Electronics, Computer and Information Technology, as well as the central computer lab
- Mechanical Engineering Block
- Electrical Engineering |Electrical/Civil Engineering Block
- Engineering Sciences and Management Block, including facilities for research in basic sciences

There is also an auditorium and an open-air theater which host various cultural programmers and national and local seminars.

- **Open-Air Theater**

The Open-Air Theater of BIT is used for hosting several activities like skits, dramas, renditions, festivals, competitions, seminars, Annual function etc. It has a total build up area of 3,300 sq ft (310 m2), seating capacity of 3000 people, 30 ft (9.1 m) × 40 ft (12 m) stage size, 300 sq ft (28 m2) each of Gent's and Girl's green room, 400 sq ft (37 m2) of Store room and 26,000 sq ft (2,400 m2) of open area.

- **Auditorium**

The Auditorium of BIT was inaugurated in 2006. From then on it is responsible for hosting seminars, music shows and other activities. BITCON, the national conference is hosted in the Auditorium. The Auditorium has a build-up area of 10,000 sq ft (930 m2), seating capacity of 500 persons, Stage size of 40 ft (12 m) × 30 ft (9.1 m), Air-conditioned hall, Air cooled entrance foyer area of 2,000 sq ft (190 m2), Boy's and girl's green rooms each of area 200 sq ft (19 m2), Rest room, projector room, front area parking and electrical panel room.

- **Sports Complex**

The institute has an outdoor field area of 2000 m^2 comprising cricket, hockey and football fields and courts for volleyball, handball & basketball. The sports complex also has an athletics track of 400 meters. Supporting it are the Indoor Stadium and Gymnasium of 350 m^2 for indoor events like table tennis, badminton, chess and carrom.

9. Energy Scenario

Following forms of Energy are being used in BIT and this energy is utilized from following sources:-

5) Electrical Distribution Company (CSPDCL) of Contract demand 250 KVA
6) Grid Connected Solar Power Plant of capacity 200 KW
7) Diesel Generator set of capacity 500 KVA
8) Liquid Petroleum Gas of 19 Kg cylinders.

The Annual consumption data based on the basis of last two year consumption are mentioned below :-

Sl. No.	Energy Utilization	Average Annual Consumption
01.	Electricity Consumption from CSPDCL	6,16,991 KWH= **53.0517 TOE**
02.	Electricity Consumption from off grid solar power plant of capacity 100 KW	42,451 KWH = **3.650 TOE**
03.	Diesel Consumption in DG Set	530 Liter or **0.467 TOE**
04	LPG Consumption in Kitchen	12094 KG or **0.0487 TOE**

Table 5: Annual energy consumption in toe.

[Conversions: 1 toe = 10000000 kcal; 1 toe = 11630 kWh; 1 toe = 41868000 kJ; Density of LPG= 0.557 Kg/L and calorific value of LPG=s 94 KJ /L, Calorific Value of Diesel is 36.9 MJ/ liter]

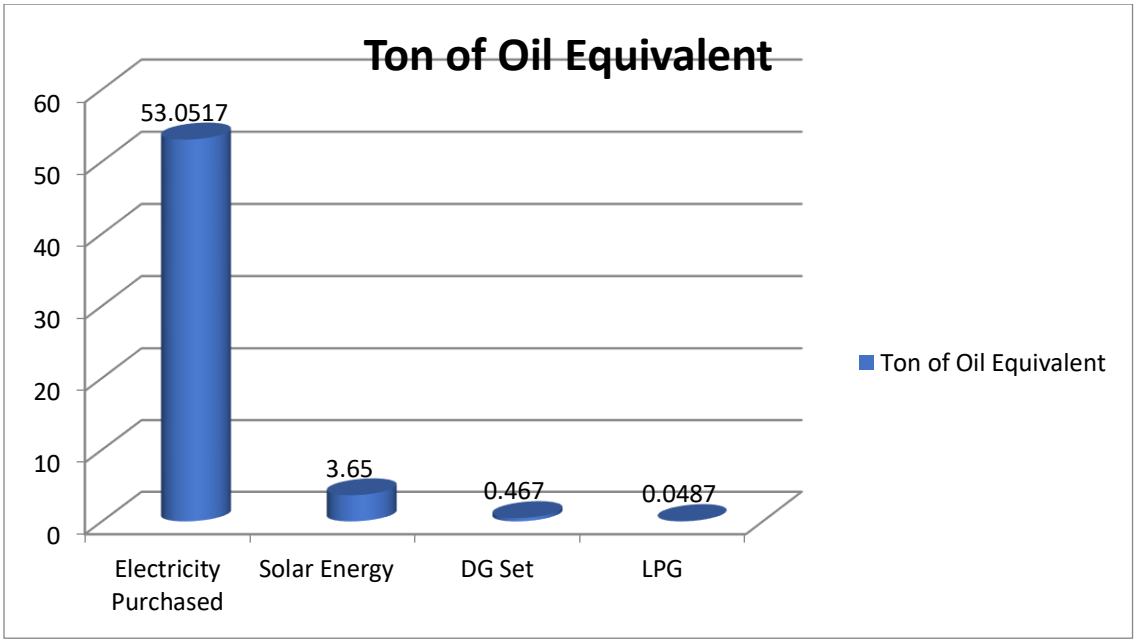

Figure 3: Annual energy consumption in toe

9.1 Electricity consumption from CSPDCL

The month wise electricity consumption from CSPDCL in the year 2016 and 2017 is tabulated below :-

Months	KWH Consumed from CSPDCL	
	Year 2016	Year 2017
January	31475	34218
February	46047	37350
March	58833	47718
April	67241	64073
May	65450	52056
June	57173	57317
July	53909	63542
August	58635	64334
September	62704	64104
October	47245	54661
November	36314	43577
December	30600	35406
Total	6,15,626	6,18,356
Average Annual consumption	**6,16,991**	

Table 6 : Electricity consumption from CSPDCL

9.2 Electricity Consumption from off grid solar power plant

The details of electricity consumption from off grid solar power plant is mentioned below :-

Months	Electricity Consumption	
	2016	2017
January	5501	5965.1
February	5596.7	5248.1
March	5495.4	7592.6
April	7010.1	7216
May	7926	6169.3
June	6565.6	3071
July	0	801.7
August	0	263.6
September	0	1863.1
October	0	712.8
November	1189.5	368.9
December	6345.7	0
Total	45630	39272.2
Average Annually	42,451	

Table 7 : Electricity consumption from off grid solar power plant

9.3 Diesel Consumption of DG Set

The details of diesel consumption in the year of 2016 and 2017 is mentioned below :-

2016		2017	
Operational Hour	**Fuel consumption in Litre**	**Operational Hour**	**Fuel Consumption**
42 Hours 55 Minutes	685	43 Hours 30 Minutes	375
Fuel consumption per Hour = 16.1 liter		Fuel consumption per Hour = 11.3 liter	
13.8 Liter Per Hour			

Table 8 : Diesel consumption of DG set.

9.4 LPG Consumption in Kitchen

LPG consumption in kitchen in the year of 2016 and 2017 is shown below.

Month	LPG Consumption (kg)		Food Wastage (kg)
	2016	2017	Average
January	43	56	50
February	40	56	50
March	45	56	50
April	50	56	50
May	50	51	50
June	48	54	50
July	50	61	55
August	55	64	55
September	50	57	50
October	50	48	50
November	50	64	55
December	55	64	55
Total	**586**	**687**	**720**
Total KG	11134	13053	
Average Annual Consumption	12,094 KG		

Table9: LPG consumption and food wastage

10. Connected Load

On the basis of load survey, we have concluded that total connected load of the campus is 822 KW, in which air conditioner has load of 340KW.

Particulars	Load in KW
Lighting	130
Fan/Exhaust/ Cooler	175
Computers	110
Air Conditioning	340
Campus Lighting	47
Others	20
Total	822

Table 10 : Connected load- application wise

We have drawn pie graph for above data of connected load. The air conditioners have the maximum contribution of electrical load followed by computers and fans & coolers.Air conditioner has 41% share of total connected load, while lighting has 16% share of total connected load.

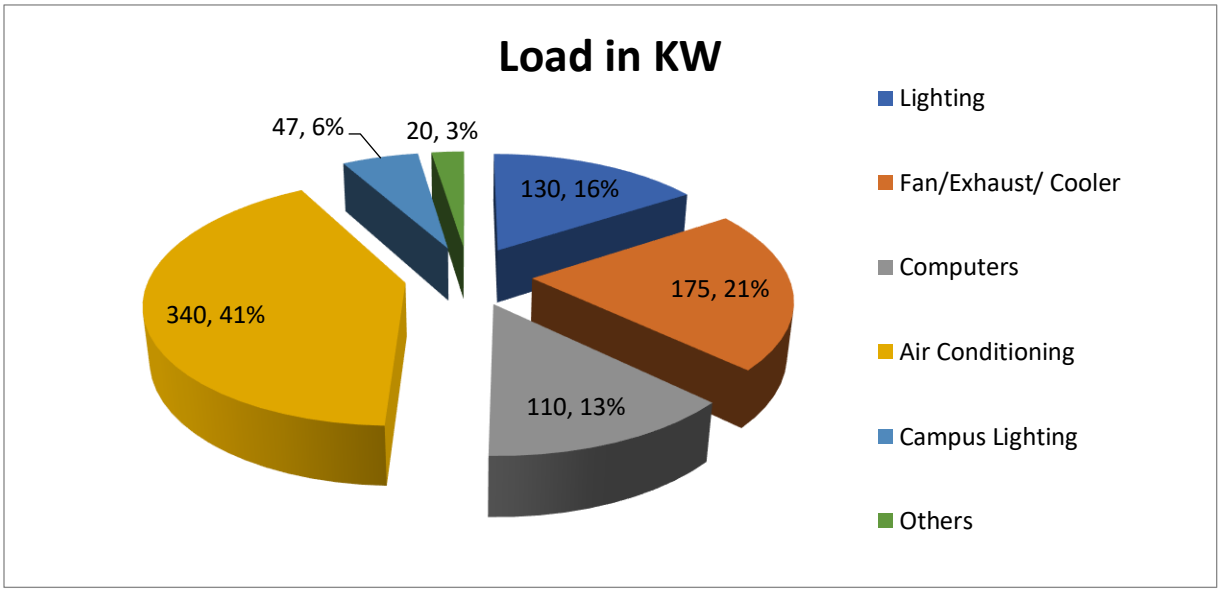

Figure 4:Distribution of connected load by end use in BIT

10.1 Lighting

The Institute has total about 1762 Fluorescent tube lights. out of which about 1 6 5 8 tube lights are of T-12 type and rest are with T - 8 t y p e t. The Institute is having 1,262 nos. CFL having different wattage rating. & 643 nos. LED lights in different departments and labs.

10.2 Fans and Coolers

The Institute is having 1,811 fans and 140 coolers in different departments and labs. Out of which about 200 fans are fitted with resistance type regulator and rest are with electronic regulator. The total lighting load from the above is 130 kW and the connected fan & Cooler load is about 175 kW.

10.3 Air Conditioners

On using the rated capacity details supplied by the manufacturers, the total room AC load is about 340 kW.

Particulate	Floor	Window AC	Audi-AC	Split AC .-3 Star (2-Ton)	Split AC-3 Star (1.5 Ton)	Split AC-3 Star (1 Ton)
Rating- Watt		2200	14200	2073	1550	1465
Science Block	Ground Floor	0	0	3	3	0
	1st Floor	0	0	1	0	0
Mechanical Dept.	Ground Floor	11	0	1	0	0
	1st Floor	0	0	0	0	0
Electrical Dept.	Ground Floor (ELG)	0	0	2	0	0
	1st Floor (ELF)	9	0	1	0	0
	2nd Floor (ELS)	0	0	1	0	0
Electronic Block	Ground Floor (EXG)	0	0	23	4	0
	1st Floor (EXF)	1	0	0	0	0
	2nd Floor (EXS)	0	0	0	0	0
ADM Block	Ground Floor	0	0	1	12	3
	1st Floor	1	0	0	5	0
	2nd Floor	0	0	0	0	0
Auditorium		0	12	0	0	0
Workshop		0	0	1	0	0
Boys Hostal		4	0	0	0	0
Total No.		26	12	34	24	3
Rated Power (kW)		57	170	70	37	4

Table 11: Population of air conditioner in different block.

10.4 Computers/printers

Computers and monitors account for 30%-40% of the energy used by office equipment. Their energy consumption is second only to office lighting. It is estimated that a power managed computer consumes less than half the energy of a computer without power management.

The total number of computers and printers in different departments in the campus is as shown below. The computers in hostels and residential area are not included here.

Table 1: Computer and auxiliary inventory

Computers/printers						
Particulate	**Floor**	**PC**	**Printer**	**Scanner**	**Projector**	**Xerox**
Rating- Watt		**250**	**200**	**20**	**60**	**500**
Science Block	**Ground Floor**	69	5	0	0	0
	1st Floor	98	4	0	0	0
Mechanical Dept.	**Ground Floor**	68	3	0	2	0
	1st Floor	6	2	0	2	0
Electrical Dept.	**Ground Floor (ELG)**	6	4	0	0	0
	1st Floor (ELF)	48	4	0	1	0
	2nd Floor (ELS)	63	3	0	0	0
Electronic Block	**Ground Floor (EXG)**	195	10	5	3	0
	1st Floor (EXF)	27	7	4	0	0
	2nd Floor (EXS)	10	3	0	0	0
ADM Block	**Ground Floor**	33	10	5	2	8
	1st Floor	38	8	0	0	0
	2nd Floor	31	10	0	0	1
Workshop		4	0	0	0	0
Mess, Warden off. canteen & Bank		8	8	0	0	0
Total No.		**704**	**81**	**14**	**10**	**9**
10% excess assumed for unaccounted areas		774	89	15	11	10
Total Watt (kW)		194	18	0.31	1	5

Table 12: Population of Computers & printers

Thus there are a total of about 774 computers and about 89-90 printers in the departments.

10.5 Campus Lighting

All street lights and garden lights in the campus, corridor lights, and lights on Basketball grounds were accounted. The quantification is as follows.

Campus Lighting				
No	**Fitting**	**Rating (W)**	**Number of Fittings**	**Total watt (kW)**
1	High Mast LED- 160W	160	20	3.2
2	High Mast LED- 200W	200	10	2
3	High Mast MH- 250W	250	10	2.5
4	MH- 400W for Sports ground	400	39	15.6
5	MH- 250W for Sports ground	250	68	17
6	MH- 150W	150	3	0.45
7	HPSV-250W	250	2	0.5
8	HPMV-125W	125	21	2.625
9	Flood Lights - 165W	165	8	1.32
10	LED Street Lights - 100W	100	5	0.5
11	LED Street Lights - 50 W	50	19	0.95
	Total		**205**	**47**

Table 13: Population of luminaries in Campus lighting

The total number of lighting fixtures in common area is **205**.

10.6 Water Pump

Water Pump Capacity	**Quantity**
7.5 HP	02 Nos.
3 HP	01 No.
1 HP	02 Nos.

Table 14: Population of water pump

10.7 Connected Load (Building wise)

The total connected load of BIT is 822 KW, in which Auditorium contributes maximum sharing around 180 KW. The BIT consisting of 5 Blocks, like Administrative block, Science block, Electronic block, Mechanical block, and Electrical Block. Admin block build up in three floors, Science block build up in two floors, Electronic block build up in three floors, Mechanical block build up in two floors and Electrical block build up in three floor, Additional building like, Auditorium building, Workshop building, boys hostel, Mess & canteen Building.

Name of Building	Connected Load in KW
Science Block	71
Mechanical Dept.	85
Electrical Dept.	112
Electronic Block	145
ADM Block	90
Auditorium	180
Workshop	16
Boys Hostel	58
Mess, Warden office, canteen & Bank	18
Campus Lighting	47
Total	**822**

Table 15: Connected load – building wise

The percentage share of connected load is shown below in pie graph. The percentage share of connected load of Auditorium is 22% however, 18% for electronic block.

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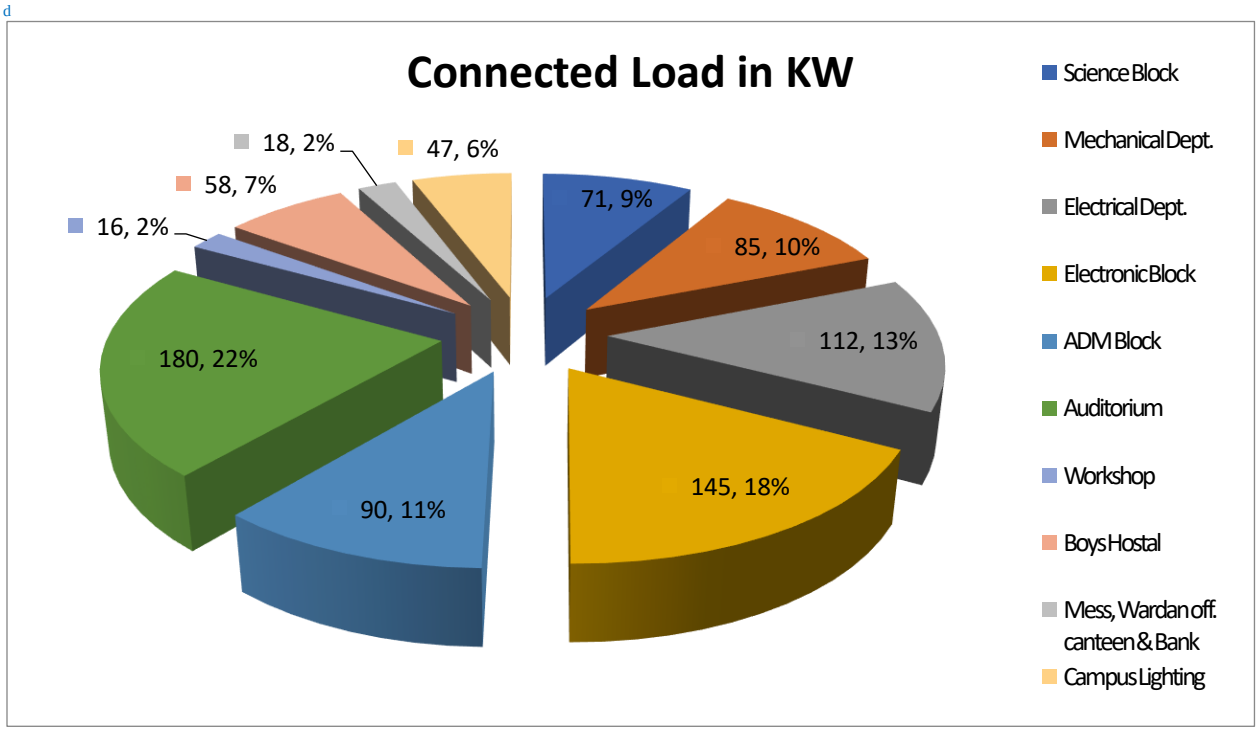


Figure 5 : Connected load- building wise

Total Connected load in Boys hostel feeder includes both canteen, mess, coffee corner, Astro club, TV room, both warden office, UCO bank & ATM.We have also noticed that some of the air conditioners were disconnected from supply. It is worthy to mention that Energy Conservation measures should not be compromised with comfort levels of occupants or vice versa.

11. Electrical System

Power source of 33 kV is feed to incomer is stepped down to 433 V for the further distribution. Total contract demand of the institute is 250 KVA. The power rating of Transformer is 500 kVA, and its Voltage rating is 33 kV/433V , current rating is 8.67 A/ 667.5 A.

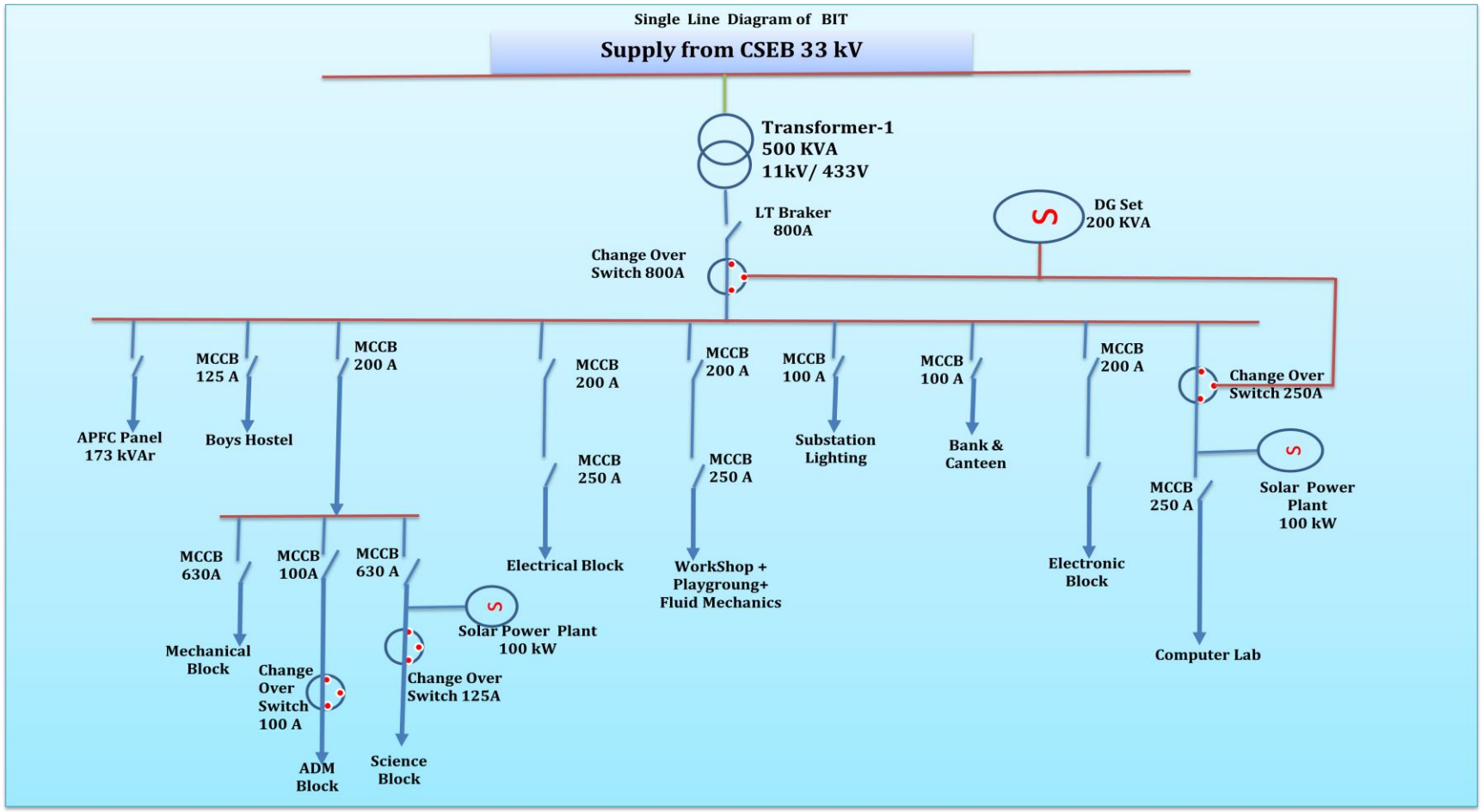


Figure 6 : Single line diagram of BIT

11.1 Electricity Bill Analysis

The power is utilized under tariff category HV3GEN3316: Other of CSPDCL which is We have analyzed the electricity bill of last two year. The campus has a connected electrical load of 822 kW as on April 2018 and a contract demand of 250 KVA. The monthly recorded peak demand for the year 2017 is given in Fig.1.

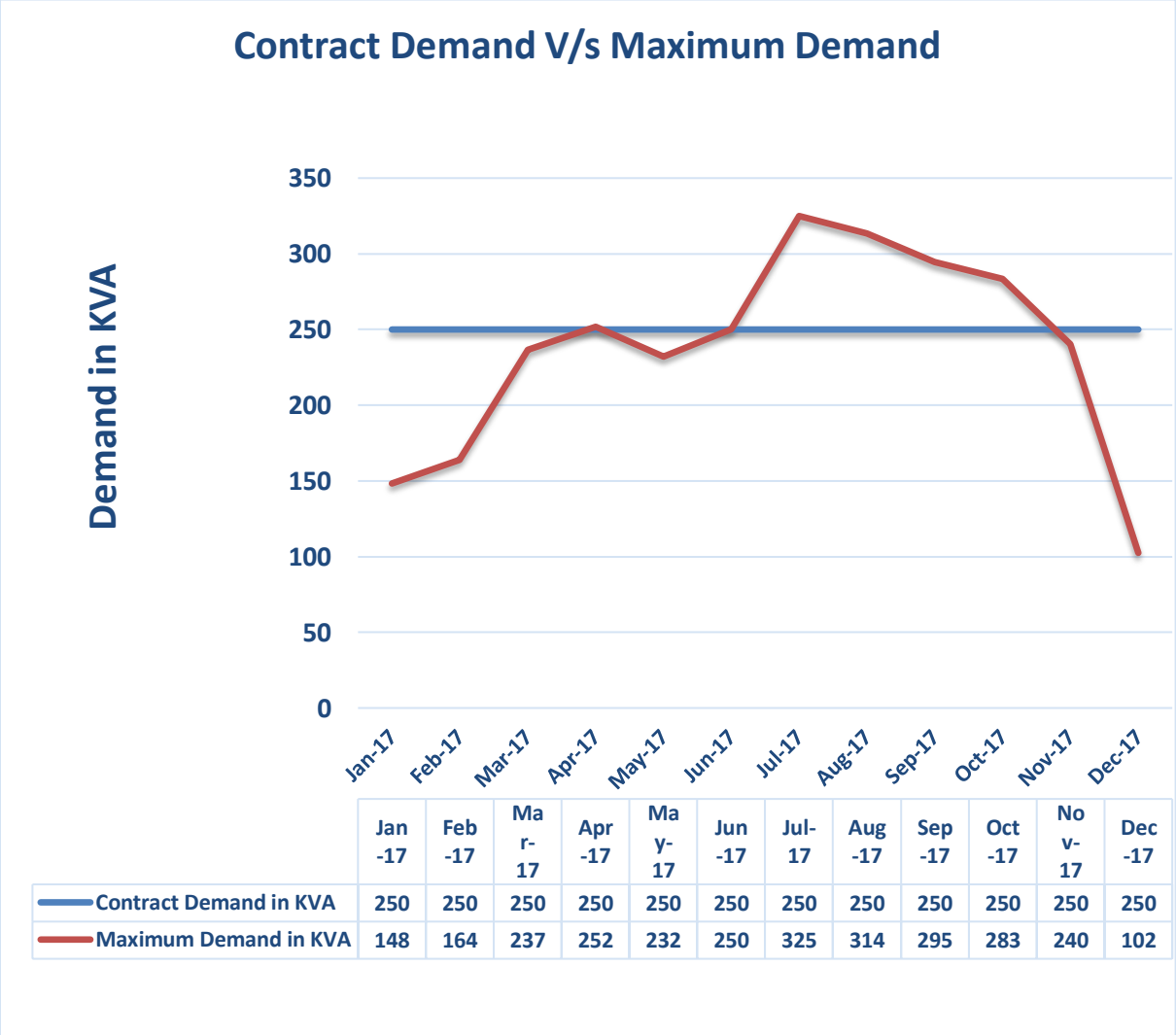
The energy bill for the year 2017 was Rs. 63.43 Lakhs. The electricity bill comprises two parts: one related to the energy consumed (per kWh or per unit energy consumed) and the other is the maximum demand charge (per kVHA of maximum demand during the month). Furthermore, the energy charge includes a component based on time of use. The Time of Day (TOD) tariff as per the CSPDCL (Chhattisgarh State Power Distribution Company Ltd.) for category te is Rs. 375/kVA for maximum demand and Rs. 6.35 /kVAH.

The maximum demand in July 2017 was 325 kVA and corresponding power factor was 0.92. The average power factor for the year 2017 was 0.96 which is slightly lower side because of non-operational of capacitance bank. We have analyzed the electricity bill of last two year.

Month	Contract Demand in KVA	Electricity Consumption (kWh)	Electricity Consumption (KVAH)	Power Factor	Maximum Demand (KVA)	Load Factor %
17-Jan	250	34218	35948	0.95	148	59.2
17-Feb	250	37350	38490	0.97	164	65.6
17-Mar	250	47718	48612	0.98	237	94.8
17-Apr	250	64073	64478	0.99	252	100.8
17-May	250	52056	52440	0.99	232	92.8
17-Jun	250	57317	57630	0.99	250	100
17-Jul	250	63542	69176	0.92	325	130
17-Aug	250	64334	69333	0.93	314	125.6
17-Sep	250	64104	69903	0.92	295	118
17-Oct	250	54661	59052	0.93	283	113.2
17-Nov	250	43577	44985	0.97	240	96
17-Dec	250	35406	36122	0.98	102	40.8
	Total	**618356**	**646169**			
	Min	**34218**	**35948**	**0.92**	**102**	**40.8**
	Max	**64334**	**69903**	**0.99**	**325**	**130**
	Average	**51530**	**53847**	**0.96**	**237**	**94.733**

Table 16: Contract demand Vs. maximum demand

Comments: From the above table, and analysis based on the 12 months of electricity bill, the maximum demand in the month of July-17 is 325 kVA which is higher than contract demand and minimum demand in the month of Dec-17 is 102 kVA.



	Jan -17	Feb -17	Mar- 17	Apr -17	May- 17	Jun -17	Jul- 17	Aug -17	Sep -17	Oct -17	Nov- 17	Dec -17
Contract Demand in KVA	250	250	250	250	250	250	250	250	250	250	250	250
Maximum Demand in KVA	148	164	237	252	232	250	325	314	295	283	240	102

Figure 7 : Contract demand Vs. maximum demand

Month	Actual Demand in KVA	Avg. Power Factor	KVAH Consumed				KWH	Excess Dem.	Excess Sup Dem. charge	Ex. Sup Energy	Ex. Sup Energy Charge	Monthly Bill	Energy Cost (Rs./ KVAH)
			On peak	off peak	Normal	Total							
Jan-16	133.92	0.95	7542	7482	17979	33003	31475	0	0	0	0	263592	7.98
Feb-16	205.92	0.97	10025	10106	27203	47333	46047	0	0	0	0	354184	7.48
Mar-06	244.8	0.98	12177	13652	33986	59814	58833	0	0	0	0	439906	7.35
Apr-16	264.8	0.99	12306	13505	38409	67939	67241	15	8438	3720	31806	589710	8.68
May-16	244.44	0.99	12270	13992	40046	66308	65450	0	0	0	0	554440	8.36
Jun-16	218.88	0.98	11474	13056	33569	58098	57173	0	0	0	0	487691	8.39
Jul-16	230.88	0.97	9378	10679	35258	55314	53909	0	0	0	0	472634	8.54
Aug-16	284.52	0.97	10778	11706	30718	60547	58635	35	19688	7346	62808	580300	9.58
Sep-16	262.08	0.98	11153	11966	38037	64110	62704	13	7313	2955	25265	586606	9.15
Oct-16	266.76	0.97	10026	9959	25557	48594	47245	17	9563	3053	26103	476153	9.8
Nov-16	149.76	0.96	8401	8258	21192	37851	36314	0	0	0	0	351833	9.3
Dec-16	91.56	0.94	8061	7907	16695	32663	30600	0	0	0	0	313459	9.6
Jan-17	148.32	0.95	8438	7991	19520	35948	34218	0	0	0	0	345307	9.6
Feb-17	163.92	0.97	8009	7835	22647	38490	37350	0	0	0	0	364214	9.46
Mar-17	236.64	0.98	9752	10032	28829	48612	47718	0	0	0	0	459449	9.45
Apr-17	251.88	0.99	11352	11433	41212	64478	64073	2	1125	481	4582	599881	9.3
May-17	232.2	0.99	9458	10268	32715	52440	52056	0	0	0	0	496340	9.46
Jun-17	250.08	0.99	9338	10419	37856	57630	57317	1	563	18	171	543165	9.42
Jul-17	324.96	0.92	10101	10365	32753	69176	63542	75	56250	15957	202654	793528	11.47
Aug-17	313.56	0.93	10632	11168	33480	69333	64334	64	48000	14054	178486	774986	11.17
Sep-17	294.6	0.92	11021	11310	36226	69003	64104	45	25313	10447	99508	652079	9.33
Oct-17	283.44	0.93	10134	10712	31240	59052	54661	34	19125	6967	66361	561825	9.51
Nov-17	240.12	0.97	8579	8813	27594	44985	43577	0	0	0	0	416797	9.26
Dec-17	102.48	0.98	7571	7601	20951	36122	35406	0	0	0	0	332977	9.22
Average	**226.7**	**0.97**	**9916**	**10426**	**30153**	**53203**	**51416**					**492127**	**9.24**

Table 17 : Electricity bill analysis

On the basis of analysis of electricity bill of last two years, we have concluded that the energy cost of BIT was Rs. 9.24 per KVAH.

Average maximum demand	226.7 KVA
Average Power Factor	0.97
Average KVAH Consumption	53203
Average KWH Consumption	51416
Average Monthly Bill	492127
Average Energy Cost	Rs. 9.24 per KVAH

CSPDCL charges different rates during on-peak hours, off-peak hours and normal hours.

Period	Time	Average Consumption
On-Peak	6 PM- 11 PM	9916
Off- Peak	11 PM - 5 AM	10426
Normal	5 AM-6PM	32861
Total KVAH Consumption		53203

Table 18: Average monthly consumption during on-peak, off-peak and normal hours

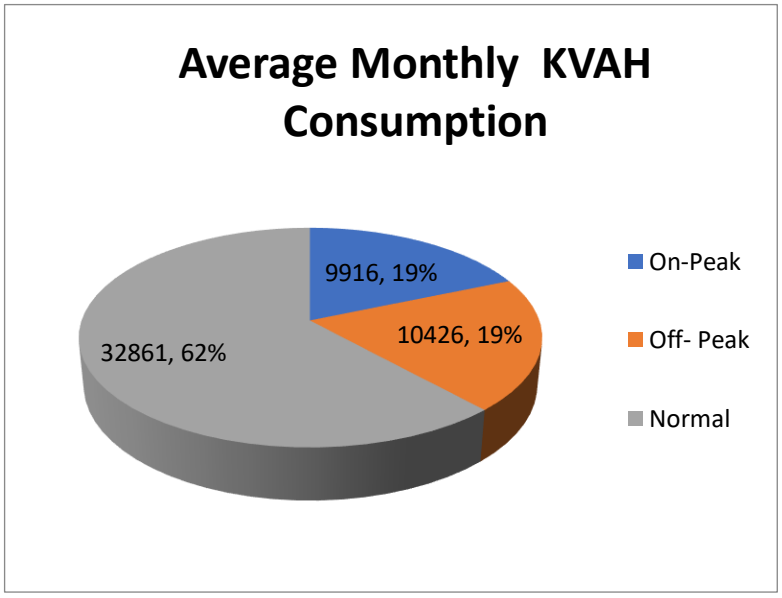


Figure 8 : Average monthly KVAH Consumption

The pie chart shows average monthly KVAH consumption of institute. Nearly 62% of KVAH consumption is in between 5 A.M. to 6 P.M. and average consumption in off-peak hours is slightly higher then

12. Measurement and Performance Evaluation

12.1. Transformer

As mentioned earlier 33 KV was voltage feed by CSPDCL. There are 1 no of transformer is installed in the campus.

Transformer: 500 kVA(33 kV/433V),(8.67A/667.5A)and 4.27 % of Voltage Impedance

The transformer is monitored for 24 hours for their performance and same depicted below:

1. 33 KV/433 V : 0.5 MVA

Winding resistance and No load losses data are collected from Client.

HIOKI

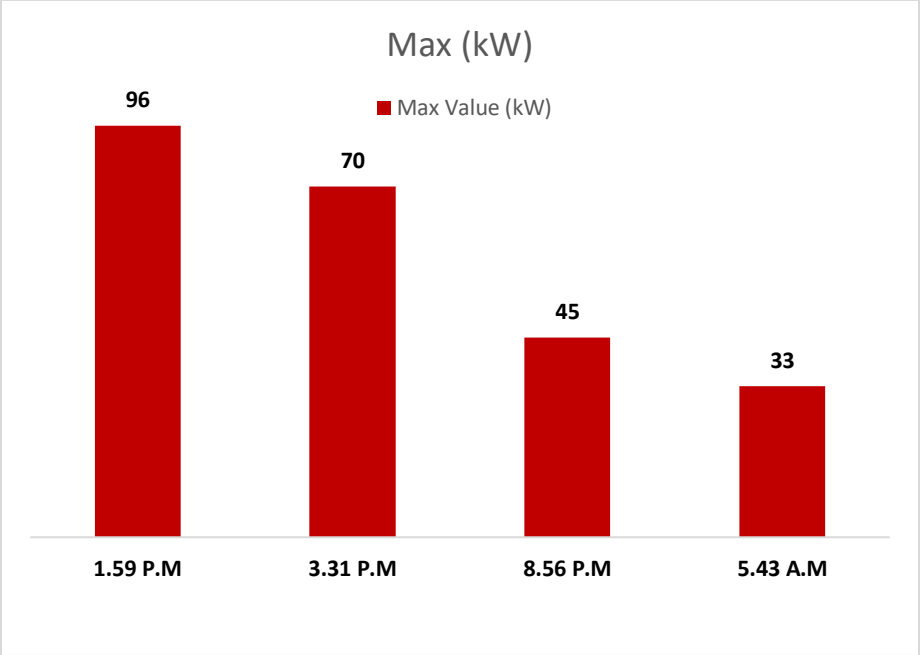
Time series data

Title	021300##.csv		
Measurement period	2/13/2018 12:05:36 - 2/14/2018 10:16:48		
Display period	2/13/2018 12:05:36 - 2/14/2018 10:15:36		
Measurement interval	2 Second	Data interval	5 Minute
Comment	Model number : PW3360 S/N.170710464		

Date	Time	U1[V]Average value,021300#	U2[V]Average value,021300#	U3[V]Average value,021300#	I1[A]Average value,021300#	I2[A]Average value,021300#	I3[A]Average value,021300#	P[kW]Average value,021300#	PFAverage value,021300#
Average value in the period		440.22	440.68	440.97	64.14	71.62	60.19	48.22	-0.4785
Maximum value in the period		453.10	452.95	453.66	139.29	138.45	124.97	95.36	0.9864
Time of maximum value		2/14/2018 04:35:36	2/14/2018 04:35:36	2/14/2018 04:05:36	2/13/2018 12:15:36	2/13/2018 12:55:36	2/13/2018 12:20:36	2/13/2018 12:15:36	2/14/2018 08:15:36
Minimum value in the period		429.53	430.35	429.80	27.69	31.37	25.62	21.36	-0.9873
Time of minimum value		2/13/2018 12:15:36	2/13/2018 12:20:36	2/13/2018 12:20:36	2/14/2018 06:30:36	2/14/2018 07:00:36	2/14/2018 07:00:36	2/14/2018 07:00:36	2/14/2018 09:30:36

Table 19: Measurement by Power analyzer

The transformer load is monitored for 24 hours a part of result shown above and Power factor is T @ 0.98.



The graph depicts max demand during recording. From the graph, the peak load of day is @ 12.15 P.M when ambient temperature is maximum. The street light, Hostel and other miscellaneous load is 45 kW during night time.

Figure 9:Maximum and Average value of load during measurement

The graph is the comparison of P.F during the peak load.

Observation: The power factor is maintained between 0.98 to 0.92 during peak demand the P.F is 0.98. but on monthly average its 0.96.

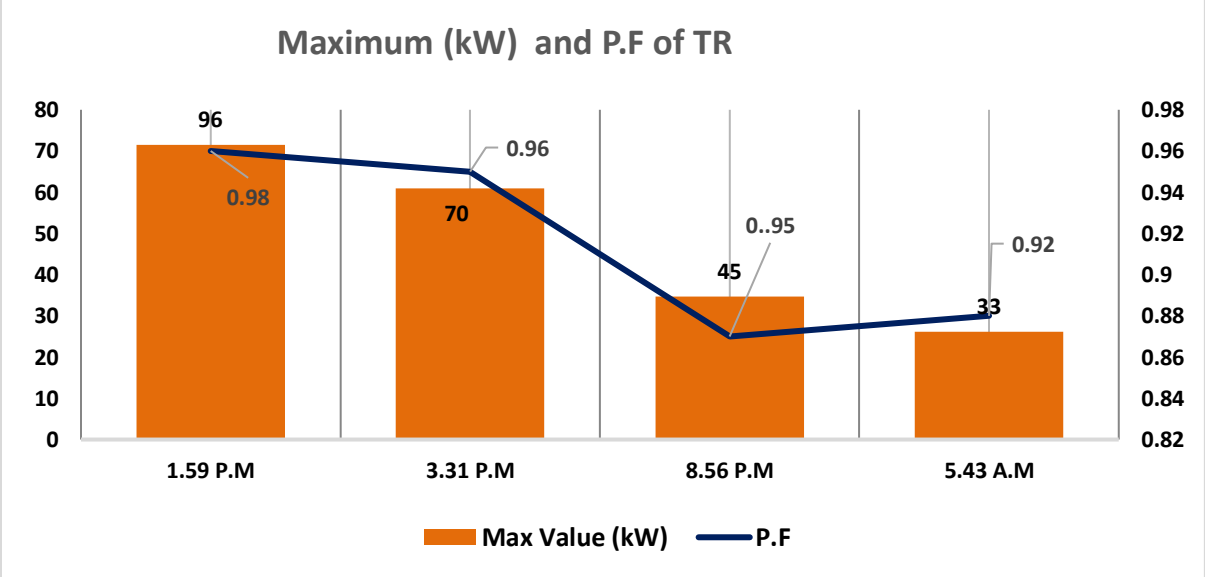


Figure 10:Maximum load with power factor of Transformer.

Connected Load for Boys hostel only

Particulars	Load in KW
Lighting	9
Fan, Exhaust & Cooler	37
AC	8.4
Others	2.8
Total	57.2 KW

Table 20: Connected load of boys hostel

We can say that during night load only street light and hostel loads are in operation and it is evident from measurement taken by power analyzer during night , the operating load is 45 KW and gradually decreased up to 33 KW till 5 AM.

12.1.1 All day Efficiency of the Transformer

Transformer Loading				
Sno	Parameters	Unit	Design	Actual
1	Capacity	KVA	500	109
2	No-Load loss	KW	1.2	1.20
3	Load Loss (Primary and secondary side)	KW	5.76	0.22
4	Voltage	V	433	453
5	Current	Amps	667.5	139
6	Power	KW		107
7	Power Factor			0.99
8	VTHD max.	%		2.82
9	ITHD max.	%		22.03
10	Impedance	%		4.27
11	Loading @ operating pf	%		21.8
12	Efficiency	%		98.53

Table 21 : All day efficiency of transformer

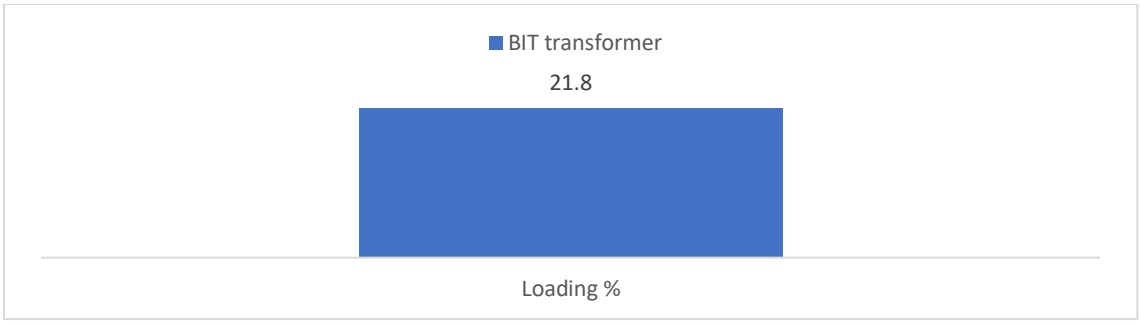


Figure 11 : Percentage loading of transformer during measurement

Optimal efficiency of transformer is where core loss (No load loss) equal to copper loss (Load loss). So for distrubution transformer optimal loading will their optimum efficiency.

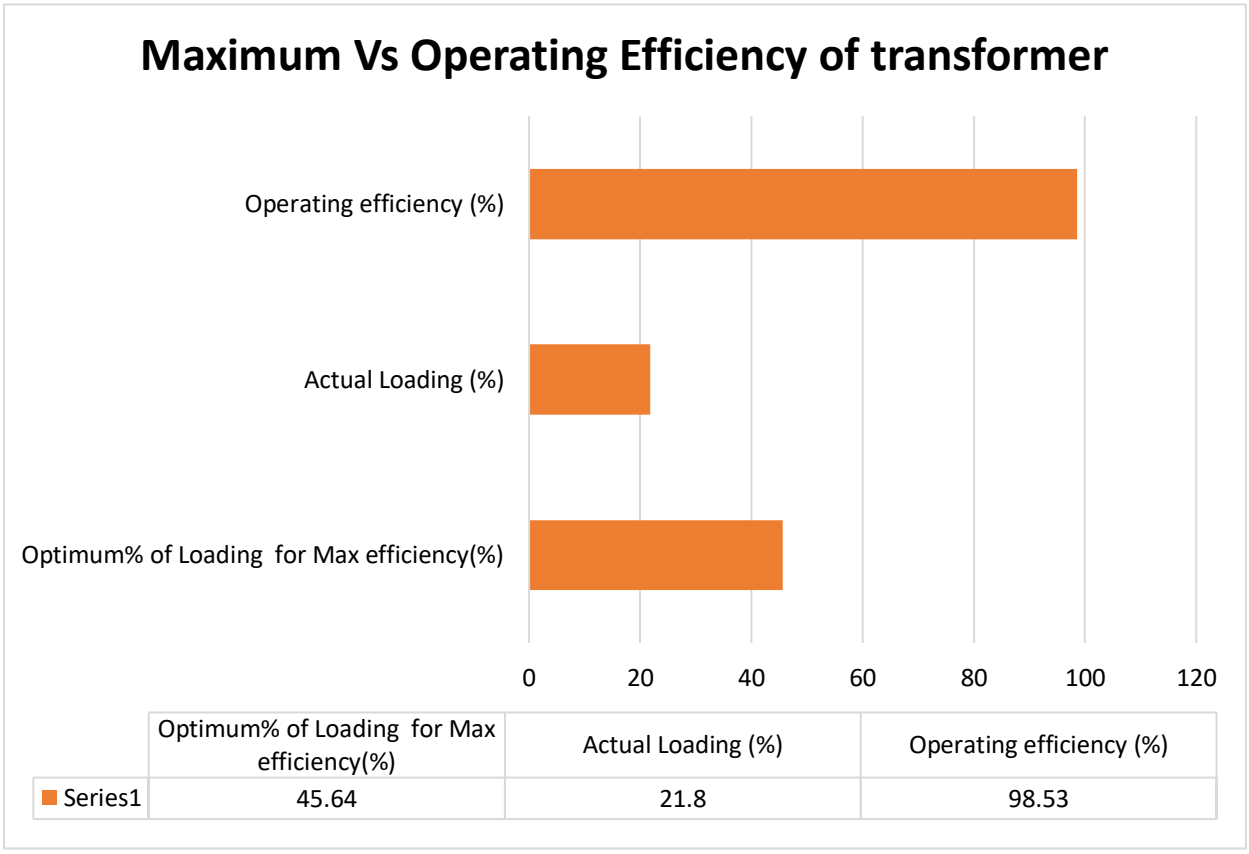


Figure 12:Maximum Vs Operating efficiency of transformer

12.2 Power Quality

Study of Power Quality Parameters i.e. Total Harmonics Distortion, Voltage unbalance, Current imbalance voltage profile and losses between PCC and MCC are measured with sophisticated "Hioki" 3-phase power quality analyzer.

The instrument is capable of measuring all electrical parameters of interest at the set measurement interval and can be downloaded to a PC for further analysis. We measured the parameters like voltage, current, power factor variation, phase voltage- unbalance, CF, total harmonics distortion i.e. voltage (V-thd) and current (-Ithd) in the different phase.

Parameters which is used to gauge power quality are listed below:

- Voltage imbalance
- Current imbalance
- Voltage THD%

Current Harmonics% or TDD
IEE 519-2014 standards are used for comparison of harmonics level and for voltage and current imbalance no such standards.

S no	Particulars of Power Quality	Values
1	Average Observed Frequency	50 HZ
2	Average Voltage Level	415 V
3	Voltage % Imbalance	<1%
4	Current % Imbalance	3-4%

Table 22:Power quality standard

Sr	Name	LT side													V-THD %	I-THD %	TAP Position
		Voltage					Current					Power Factor	kW	kVA			
		RY	YB	BR	Ave rage	% imbalance	RY	YB	BR	Ave rage	% Imbalanc						
1	TR-(500KVA)	440	441	441	441	0.08	139	138	125	134	3.73	0.98	95	97	2.73	18.55	3

Table 23 : performance of PCC

Observations:

1. Reading of the above table is record from power analyzer in LT side.
2. Current & voltage unbalance is also noted to be within permissible limit.
3. The frequency variation is noted as 49.88 Hz to 50.00 Hz.
4. Power factor maintained at 0.99 at grid level.

Comments:

1. The transformer secondary is connected with servo voltage stabilizer, so voltage fluctuation can be controlled more over the voltage is maintained at 399 V in order to avoid any voltage surge.
2. The voltage imbalance is within the limit. It shows there are equal distribution of loads between phases so imbalance between phases are due switching between loads.
3. Based on the harmonic at PCC table showing below, Voltage Harmonic Distortion is 2.73 % and current harmonics is 18.55% at LT side of transformers. The current harmonics is high compared to Standard.

Harmonics

The harmonics present in system is verified through IEEE 519-2014 regulation. Which is mentioned below table for both voltage and current need to maintain at PCC level.

IEEE 519 Harmonic Voltage Level		
Bus Voltage	Maximum Individual Harmonic Component (%)	Maximum THD%
69 KV and Below	3.00%	5%
115 KV to 161 KV	1.50%	2.50%
Above 161 KV	1%	1.50%

Table 24:IEEE 519 Harmonic voltage level

IEEE 519 Harmonic Current Level						
SCR= Isc/IL	<11	11<h<17	17<h<23	23<h<35	35<h	TDD
<20	4	2	1.5	0.6	0.3	5
20-50	7	3.5	2.5	1	0.5	8
50-100	10	4.5	4	1.5	0.7	12
100-1000	12	5.5	5	2	1	15
>1000	15	7	6	2.5	1.4	20

Table 25:IEEE 519 Harmonic Current level

12.3 Reactive Power Compensation Panel

Plant team has opted for both centralized and load end capacitor installation to optimize PF and for better voltage regulation. The plant has installed with 173 kVAr Capacitors both at PCC end to improve the system power factor through APFC in the centralized and distributed units.

Towards monitoring health of capacitors, operating voltage and current of each phase of the capacitors have been measured. A detail of the current measurement is tabulated below. It can be observed that the capacitors is delivering desired output.

Capacitance Performance														
Particulates	Rated	Rated	Actual	Actual Current			Calculated	Delivered	% age Current			% Derating Current		
	Kvar	Voltage	Voltage	R-Phase	Y-Phase	B-Phase	rated Current	Kvar	R-Phase	Y-Phase	B-Phase	R	Y	B
Capacitor-1	10	440	430	13	13	13	13.1	9.5	99	99	99	0.9	0.9	0.9
Capacitor-2	25	440	433	OFF										
Capacitor-3	10	440	429	9.42	9.54	0	13.1	9.5	72	73	0	28.2	27.3	100.0
Capacitor-4	25	440	431	0	19	19	32.8	24.0	0	58	58	100.0	42.1	42.1
Capacitor-5	25	440	428	OFF										
Capacitor-6	25	440	428	33	19	19	32.8	23.7	101	58	58	-0.6	42.1	42.1
Capacitor-7	3	440		OFF										
Capacitor-8	5	440	430	5.6	5.85	0	6.6	4.8	85	89	0	14.6	10.8	100.0
Capacitor-9	5	440		OFF										
Capacitor-10	5	440	431	3.77	3.72	6.65	6.6	4.8	57	57	101	42.5	43.3	-1.4
Capacitor-11	10	440	428	13.5	13.6	13.5	13.1	9.5	103	104	103	-2.9	-3.6	-2.9
Capacitor-12	25	440	432	13.5	13.3	13.7	32.8	24.1	41	41	42	58.8	59.5	58.2

Table 26:Capacitor performance

For a healthy LT capacitor, the charging current should be 1.3 to 1.45 times the kVAr rating at the rated voltage. Hence, a 10 kVAr capacitor should deliver 13.12 A in all the three phases at 440 volts. If the output falls below 75% of the rated capacity or there is a considerable current unbalance between the phases; such capacitors may be replaced with new capacitors.

Comments: It is suggested to purchase and install the following capacitors:-

(a) Capacitor -3 : 10 KVAR
(b) Capacitor-4 : 25 KVAR
(c) Capacitor-6 : 25 KVAR
(d) Capacitor- 8 : 5 KVAR
(e) Capacitor-10 : 5 KVAR

the de-rated capacitor can act as a burden due to increased internal losses rather than delivering the desired output. It would also increase the voltage unbalance in the distribution system and hence further increase the system losses, from the above table it should be highlighted.

To Maintain Power factor @ 0.98, The installed 173 kVAr is sufficient to maintain desired power factor. But operation of the capacitor need to be in auto mode. So, capacitor ON/OFF status can be controlled based on load condition.

12.4 Air Conditioners

We have measured load in some of the air conditioner . The system has a rating of 142 ton (2 X 7200 watt, 2 X 666000 Btu/hr) refrigeration capacity and mostly operates at part load. It has been discussed in below Appendix I. The savings could not be quantified due to difficulties in taking measurements. However, considerable potential for energy savings may exist as the efficiency of the system will be lower at part loads.

Better Practices for AC

The institute has in total 26 window type ACs and 73 split type ACs which make a very large part of total energy consumption of the campus. But, at many places it was found that AC is not used with best recommended practices. Even simple things, such as insulation, are not taken care of. Window panes were found broken at many places. Also, at certain places ACs were found to be used without keeping curtains. These poor practices account for increase in AC load and thus consumption.

Summarized below are some guidelines for most efficient use of ACs:

- **Proper Insulation –** Good quality insulation must be maintained in the air-conditioned rooms by keeping all doors and windows closed properly so as to prevent cool air go out and hot air come in.

- **Curtains –** Always keep curtains on windows to prevent direct sunlight inside the room to avoid heating of cooled air. This reduces AC load significantly.

- **Maintenance –** Proper maintenance and cleaning of ACs is required at regular intervals to make it work at highest efficiency. Any dirt in filter may reduce efficiency of ACs very significantly.

- **Operating –** The ACs should be switched on 15 minutes before actual use and should be switched off before leaving the room, set point for AC's in between 23 deg to 25deg.

Performance of AC

	Description	Unit	Electronic Block (TPO)		EXG-13	ADM-Student section	Principal Sir Room		
			Voltas	Diakin	Voltas	Voltas	Diakin	Diakin	Blue Star
Design Parameters	AC Type		Split	Split	Split	Split	Split	Split	Split
	Make		Voltas	Dikin	Voltas	Voltas	Dikin	Dikin	Blue Star
	Ton of Refrigeration	TR	2	2	2	2	2	2	1.5
	Power Consumption	W	2073	2200	1970	1970	1720	1773	1773
	Refrigerant		R-22	R-22	R-32	R-22	R-22	R-22	R-22
	Star Ratings		3 *	3 *	3*	3 *	3*	3*	3*
	Rated EER	W/W	2.72	2.7	2.7	2.7	2.72	2.72	2.7
Measured Parameters	Velocity	m/s	3.4	3.6	4.5	4.7	1.4	1.25	1.28
	Area	m2	0.17	0.17	0.17	0.17	0.17	0.17	0.17
	Density	kg/Nm3	1.293	1.293	1.293	1.293	1.293	1.293	1.293
	Mean Sea Level	m	213	213	213	213	213	213	213
	Measured Height	m	2	2	2	2	2	2	2
	DBT (Cold Air)	℃	16	23.1	20	22	20.5	18.5	21
	WBT (Cold Air)	°C	13	15.1	13	16.5	16	15	16.5
	Rh- (Cold Air)	%	57	55	52	47	50	48	51
	DBT (Hot Air)	°C	26	25	29	28	24.5	26	25
	WBT (Hot Air)	°C	21	20	21	20	19.5	21	20
	Rh- (Hot Air)	%	62	61	59	61	61	62	61
	Power Consumption	kW	1.84	2.09	1.74	1.80	1.54	1.57	1.26
Calculations	Barometric Pressure	mmWG	10060.73	10060.73	10060.73	10060.73	10060.73	10060.73	10060.73
	Density Correction	kg/m3	1.15	1.15	1.14	1.14	1.15	1.15	1.15
	Flow	m3/hr	2033.14	2152.73	2690.92	2810.51	837.17	747.48	765.42
	Enthalpy of Hot Air	kCal/kg	16.00	17.00	14.10	13.50	16.80	16.90	17.10
	Enthalpy of Cold air	kCal/kg	13.62	14.40	12.43	11.80	11.95	11.47	12.19
	Measured Cooling Capacity	TR	1.84	2.13	1.69	1.80	1.55	1.54	1.43
	Cooling Capacity	kW	6.46	7.51	5.95	6.34	5.45	5.42	5.04
	Measured EER	W/W	3.51	3.59	3.42	3.52	3.53	3.45	3.99

Table 27:Performance of Air Conditioner

12.5 Water Pump

BIT				
	Description	Units	Pump-1	Pump-2
Design Parameters				
	Rated Motor Power	kW	7.50	7.50
	Motor Efficiency	%	95.00	93.50
	Rated Flow	m3/hr		
	Rated Head	m		
	Rated RPM	rpm		
Measured Parameters				
	Power Measured	kW	4.18	4.80
	Flow	m3/hr	5.00	4.50
	Flow	m3/sec	0.00	0.00
	Suction head (h1):	m	-160.00	-160.00
	Delivery head (h2):	m	6.00	6.00
	Totel Head (h2-h1):	m	166.00	166.00
	Density of Water	kg/m3	996.00	996.00
	Acce. Due to gravity	m/sec2	9.81	9.81
	STARTER		SD	SD
Calculations				
	Hydraulic Power	kW	2.25	2.03
	Pump shaft Power	kW	3.9710	4.49
	Efficiency of the pump	%	**57**	**45**
	Disc. Valve	%	100	100

Table 28: Performance of water pump

Comments: Both pump running hour is 7Hr. in a day.

12.6 Diesel Generator

There is one numbers of Diesel generator of 200 KVA is installed in the premises. Operation of these DGs are limited to only during emergency which has able to handle 80% loading or when there is no power supply from grid. Performance can be assessed through running of generator for a limited period.

Particulars	Unit	DG
Capacity	kVA	200
Test Period	**Minute**	**65**
Fuel Consumed during the test period	Liters	55
Power Generated during the test period.	KWh	88
Load variations on the DG Set	KVA	113-66
DG Loading (%)	%	57-33
Power Factor	----	0.88
Specific Power Generation	KWh/ ltr.	**1.60**
Fuel Rate	Rs/ Ltr.	58
Basic Power Generation Cost	Rs per Kwh	36.25
Fuel Consumption Per Unit Generation	ltr/KWh	0.63
Required Fuel Consumption per Unit Generation	ltrs/KWh	0.18
Excess Fuel Consumption per Unit Generation	Ltr. /KWh	0.445
Heat Rate	kCal/kWh	5603

Table 29: Performance of DG set

The heat rate of the DG is in higher side due to age factor. The standard heat rate of DG is between 4000 to 4500 Kcal/kWh.

12.7 Solar Power Plant

The 100Kwp Roof top solar plant is installed in the premises. Which is installed in 2010 but due to technical glitches its not in operation.

Mono SiN solar PV modules are used	175 Wp
Total number of modules	580
Solar Cell material	Mono SiN solar PV module
Number solar panels in series	10 panels in series
Number of such strings in parallel	58 strings/array
Supplier	Tata BP solar
Inclination of Modules	22 degrees
PCU rating	100 kW MPPT, 100 KVA inverter, 415 VAC

Table 30: Description of Solar module

Since the plant is not in operation, CUF cant be calculated.

There is hybrid system installed which has small wind turbine and solar panel with capacity of 2 kW.

Time series data

Title			
Measurement period	5/29/2018 14:39:54 - 5/29/2018 15:00:51		
Display period	5/29/2018 14:39:54 - 5/29/2018 15:00:49		
Measurement interval	5 Second	Data interval	5 Second
Comment			

Date	Time	U1[V]	I1[A]	P1[kW]	Q1[kvar]	S1[kVA]	PF1	WP+1[kWh]
Average value in the period		221.59	4.295	0.918	0.251	0.952	0.9646	
Maximum value in the period		221.83	4.309	0.922	0.254	0.955	0.9655	
Time of maximum value		5/29/2018 14:40:29	5/29/2018 14:52:49	5/29/2018 14:52:39	5/29/2018 14:41:19	5/29/2018 14:51:24	5/29/2018 15:00:49	
Minimum value in the period		221.37	4.281	0.914	0.248	0.948	0.9638	
Time of minimum value		5/29/2018 14:59:54	5/29/2018 14:46:49	5/29/2018 14:45:59	5/29/2018 15:00:09	5/29/2018 14:45:39	5/29/2018 14:41:19	
5/29/2018	14:39:54							
	14:39:59	221.72	4.287	0.916	0.252	0.951	0.9641	0.0013
	14:40:04	221.80	4.292	0.918	0.252	0.952	0.9643	0.0025
	14:40:09	221.75	4.289	0.917	0.252	0.951	0.9643	0.0038
	14:40:14	221.79	4.289	0.917	0.252	0.951	0.9643	0.0051
	14:40:19	221.78	4.288	0.917	0.252	0.951	0.9643	0.0064
	14:40:24	221.80	4.287	0.917	0.252	0.951	0.9641	0.0076
	14:40:29	221.83	4.289	0.917	0.252	0.951	0.9642	0.0089
	14:40:34	221.82	4.290	0.917	0.253	0.952	0.9641	0.0102
	14:40:39	221.80	4.290	0.917	0.253	0.952	0.9641	0.0115
	14:40:44	221.80	4.289	0.917	0.253	0.951	0.9640	0.0127
	14:40:49	221.80	4.288	0.917	0.253	0.951	0.9639	0.0140
	14:40:54	221.81	4.292	0.918	0.253	0.952	0.9641	0.0153

Figure 13: Hybrid system data recording

13. Impact Assessment of New Solar Plant

In recent years, however, the number of solar powered homes connected to the local electricity grid has increased dramatically. These **Grid Connected PV Systems** have solar panels that provide some or even most of their power needs during the day time, while still being connected to the local electrical grid network during the night time.

Solar powered PV systems can sometimes produce more electricity than is actually needed or consumed, especially during the long hot summer months. This extra or surplus electricity is either stored in batteries or as in most grid connected PV systems, fed directly back into the electrical grid network.

We have analyzed electricity bills of BIT, Durg before and after the installation of New grid connected solar plants.

13.1 Analysis of Electricity bills before and after installation of Solar Power Plant

Month	Actual Demand in KVA	Avg. Power Factor	KVAH Consumed					KWH Consumed	Monthly Bill	Energy Cost (Rs. Per KVAH)
			On peak	off peak	Normal		Total in Bill			
Feb-18	157.92	0.99	7577	7818	24246		39640	39226	368130	9.29
Mar-18	218.04	0.99	9407	10718	33359		53482.5	53118	483450	9.04
Apr-18	237.72	0.99	10155	11562	38528		60244.5	59961	528100	8.76
Solar Power Plant of total 200 KW started power generation in May 2018										
May-18	172.68	0.99	10112	11649	18345		40105	39867	364950	9.10
Jun-18	133.92	0.99	8555	10178	11594		30325.5	30079.5	292230	9.63
Jul-18	208.68	0.99	7488	9033	21765		38286	37984	366330	9.57
Aug-18	228.84	0.99	8,694	9,939	23,138		41,770.50	41,286	400550	9.59

Table 31: Analysis of Electricity bills before and after installation of Solar Power Plant

BIT has implemented grid connected solar power plant of 200 KW capacity in the month of April 2018. We have analyzed the electricity bill of the same month but last two years i.e. 2016 & 2017. After analyzing the data, it is crystal clear that maximum demand and unit consumption, both decreased after installation of new system.

13.2 Comparison of consumption in particular month before and after installation of Solar Power Plant

Months	Years	Actual Demand in KVA	Avg. Power Factor	KVAH Consumed				Total KVAH	Total KWH
				On peak	off peak	Normal	Excess supply		
May	2016	244.44	0.99	12270	13992	40046	0	66308	65450
	2017	232.2	0.99	9458	10268	32715	0	52441	52056
	2018	172.68	0.99	10112	11649	18345	0	40105	39867
Maximum Demand decreased to 60 KVA & decrease in KVAH is 12,336 unit as compared from 2017 data									
June	2016	218.88	0.98	11474	13056	33569	0	58099	57173
	2017	250.08	0.99	9338	10419	37856	17	57630	57317
	2018	133.92	0.99	8555	10178	11594	0	30325.5	30080
Maximum Demand decreased to 116.16 KVA & decrease in KVAH is 27,305 unit as compared from 2017 data									
July	2016	230.88	0.97	9378	10679	35258	0	55315	53909
	2017	**324.96**	0.92	10101	10365	32753	15957	69176	63542
	2018	208.68	0.99	7488	9033	21765	0	38286	37984
Maximum Demand decreased to 116.28 KVA & decrease in KVAH is 30,890 unit as compared from 2017 data									
August	2016	**284.52**	0.97	10778	11706	30718	7345	60547	58635
	2017	**313.56**	0.93	10632	11168	33480	14054	69334	64334
	2018	228.84	0.99	8694	9939	23138		41771	41286
Maximum Demand decreased to 84.72 KVA & decrease in KVAH is 27,563 unit as compared from 2017 data									

Table 32: Comparison of consumption before and after installation of Solar Power Plant

13.3 Benefit of decrease in KVA & KVAH in Four Months

Months	Decrease in KVA	Decrease in KVAH
May	60	12336
June	116.16	27305
July	116.28	30890
August	84.72	27563
	377.16	98094

Table 33: Benefit of decrease in KVA & KVAH in Four Months

Total monitory benefit due to decrease in KVA (Rs. 375 per KVA)	141435
Total monitory benefit due to decrease in KVAH (Rs. 6.35 per KVAH)	617992.2
Total monitory benefit in four month	759427.2
Estimated Annual monitory benefit	2278282

It is estimated that the total monitory benefit of solar plant is 22.78 Lacs

13.4 Simple Pay Back Period of modified and new grid connected Solar Power Plant

Total Investment on modification and installation of new Solar Power Plant	63 Lacs
Total saving in Bill	22.78 Lacs
Simple Pay back period	34 Months

Table 34 : Simple payback period of new solar power plant

The Simple payback period is 34 months.

13.5 Comparison in unit generation performance of old solar plant and new solar plant.

We have also compared the data of solar generation of past two years. In 2017, solar power plant has the capacity of 100 KW and was off grid. But in 2018, BIT has started generation from 200 KW solar panels and it is grid connected.

	Month	**Solar Generation in KWH**	**KWH/KW**
2017	May	9593.4	95.934
	June	6948	69.48
	July	4326.1	43.261
	August	1251.5	12.515
	Total	22119	221.19
	Monthly Average	**5529.75**	**55.2975**

	Month	Solar Generation in KWH	KWH/KW
2018	May	22632	113.16
	June	13771	68.855
	July	13377	66.885
	August	11576	57.88
	Total	61356	306.78
	Monthly Average	**15339**	**76.695**

Table 35: Comparison in performance of old solar plant and new solar plant.

From above solar generation data of 2017 and 2018, we can conclude that solar generation increased 277%, while capacity is increased only 200%. Efficiency of new grid connected system is higher, as there is no system of power storage is involved. The unit generation per KW in grid connected system is higher around 21.4 KWH per KW compared to off grid solar power plant.

13.6 Share of Solar power plant in total consumption

We have analyzed the solar generation and electricity bill of last four months. The solar consumption was 36% in the month of May during sunny days in summer season and it was only 22% in the month of August having cloudy and rainy days. On average of last four months, solar power consumption has the share of 29%.

2018	Month	Solar unit	CSPDCL Unit	Total	Solar %
	May	22632	39867	62499	36
	June	13771	30080	43851	31
	July	13377	37984	51361	26
	August	11576	41286	52862	22
	Total	**61356**	**149217**	**210573**	**29**

Table 36: percentage Share of Solar power plant in total consumption

14. Recommendations

Based on the analysis of the power consumption data, certain steps have been recommended for improving energy efficiency of the campus. Complete cost analysis of implementation of recommended measures has been performed wherever necessary. Also, a number of general measures for energy efficiency have been listed.

DETAILS OF ENERGY SAVING MEASURES RECOMMENDATION

S.No	Energy Saving Measures	Investment in lakh Rs.	Annual Electricity Saving in KVAH	Annual Monitory savings in Rs.	Simple Payback Period
Low Cost					
1	Installation of MD controller	45,000		4,46,561	1
2	Replacement of 250 watt Mercury halide with 110 Watt LED Lights.	83,000	6868	44,642	23
3	Replacement of Mercury Vapor 125 Watt By LED street Light 55 Watt	98,700	7212	46,878	25
Medium Cost					
4	Replacing Conventional FTLs with 22 W T-5 LED	4,71,600	49,500	3,21,750	17.5
5	Installing Airtron Energy Savers for ACs with a higher duty cycle (> 6 hrs./day)	3,15,000	1,42,310	1,85,004	20.4
6	Replacing of CFL light fixtures with LED light in a phase manner of 1282 numbers	2,58,925	14,237	90,409	35
High Cost					
7	Replacement of conventional fans by Energy Efficient Fan	50,07,000	93,686	6,08,959	98.7

Table 372: Energy saving recommendation

14.1 Installation of Maximum Demand Controller

High-tension (HT) consumers have to pay a maximum demand charge in addition to the usual charge for the number of units consumed. This charge is usually based on the highest amount of power used during some period (say 30 minutes) during the metering month. The maximum demand charge often represents a large proportion of the total bill and may be based on only one isolated 30 minute episode of high power use. Considerable savings can be realised by monitoring power use and turning off or reducing non-essential loads during such periods of high power use.

CSPDCL charges penalty against the use of maximum demand more than contract demand. These charges in electricity bill reflects as Excess Supply demand charges and Excess Supply Energy Charges. BIT has paid a total extra amount Rs. 8,93,122 towards excess supply demand charge and excess supply energy charge during the year 2016 & 2017.

Excess Demand in KVA	Excess Sup Demand Charge in Rs.	Ex. Sup Energy in KVAH	Excess Sup Energy Charge in Rs.
301	1,95,378	64,998	6,97,744

Table 38: Total Penal charges in electricity bills

The total excess supply demand charge and energy charge in last two years was 8,93.122 . These charges can be controlled by installation of Maximum Demand Controller in the main incomer panel.

Presently some of the air conditioner loads are disconnected from mains supply. All air conditioner loads should be connected and maximum demand should be controlled by MD controller.

Total Penalty paid during last two years	Rs.8,93,122
Average penalty paid in a year	Rs. 4,46,561
Installation and Commissioning of Schneider make Maximum Demand Controller	Rs. 45,000
Simple Pay Back Period	Approx. One Month

14.1.1 Technical Description of Maximum Demand Controller.

Schneider make EM72xx series of Multi Function meters are very sophisticated, state-of-the-art instruments with multi function capabilities.

- Versatile and fully user programmable
- 1-Phase, 2-Phase, Delta, Open Delta & Star wiring configuration
- For installation on HT or LT lines with any PT or CT

Monitors

- Voltage: Line to Line & Average, Line to Neutral & Average, Neutral to Earth,
- Current: Phase Wise & Average, Neutral Current,
- Phase Angles of Vr, Vy, Vb, Ir, Iy, Ib and Frequency of Supply.

- All Power Parameters Phase wise and Total (kVA, kW, kVAR, PF)
- All Energy Parameters (kVAh, kWh, kVARh, Avg PF, Avg V, Amp Hours, Avg Hz). Also, Run Hrs, and No. of power Interruptions,
- Demand (kVA, kW, kVAR, Amps) - Present Demand, Max Demand, Day, Date and Time at which Max Demand occurred with 4 hi's and 4 lo's

Unique Features

- High accuracy over a wide dynamic operating range
- Available in Accuracy Class 1.0 and 0.5
- Utility meter cross check
- Two sets of Integrator registers, one for current and other one for last cleared values. The latter facilitates cross check of electricity bills with data recorded for the corresponding billing period, comparison between previous month and current month, etc.
- Measures Total Harmonic Distortion & Individual Harmonic up to the order of 15th for both current and voltage, per phase – a useful aid to check the power quality.
- Two Digital Inputs for status monitoring
- Whetting voltage with nominal range of 22 to 26V with allowable load of 8mA
- Import / Export option enables monitoring of bi-directional power flow – useful when in-house generation is run in parallel with the Grid.
- User programmable security codes ensure total security of operations.
- RS 485 Serial Port with galvanically isolated output for data transfer to a remote location.
- Optional – TOU for time enabled tariff users and Auto Resetting of Energy Parameters

Benefits

- Minimum disruption in production- It not only reduces frequency of load shedding but also the amount of load to be shed
- Improved load factor- the ratio of average kVA to kVA MD
- Reduced Energy losses
- No Maximum Demand Penalty

  - Prevents crossing over of set level of maximum demand at any point
  - Its 'Unique Predective Technique' provides advance warning on likely cross over of maximum demand level
  - Sliding Window Technique to automatically synchronize with the EB meter.

- Increase Production and Revenue
- Penalty savings lead to quick payback

- Condition/ Event/ Status monitoring
- Energy accounting & balancing
- EB meter cross check
- Electrical network healthiness

14.2 Replacement of 250 watt Mercury Halide with 110 Watt LED Lights.

A 250 watt metal halide can be replaced with a 110 watt LED. Implementing an LED replacement program should result in a 50% reduction in annual energy use (kWh) costs. It may also lower electric demand (kW) charges. The impact of this savings depends on the number of lamps being replaced, the time of operation and the electric rates.

Operational Comparison between LED and Metal Halide

LED technology has other potential benefits than long life and lower energy use. It also overcomes specific drawbacks of metal halide.

At initial start up, metal halide requires a 2 to 5 minute warm up time for cold lamps before full light output is achieved. Also, if power is interrupted, even momentarily, traditional "probe start" metal halide systems require a 5 to 10 minute cool down before the lamps can be restarted and then an additional warm up period of 10 to 15 minutes before full brightness is achieved. For "pulse start" systems the hot restart time is reduced to 3 to 4 minutes. Nevertheless, any lighting down time puts a stop to normal activities.

LED is an instant ON technology — no matter what the temperature in the space, when the switch is flipped, the lights come on at full light output.

Total wattage of 250 Watt Metal Halide including control gear	280 Watt
Total Wattage of LED light	110 Watt
Total wattage saving	170 watt
Total Number of Metal Halide 250 watt used as street light	10
Total wattage saving after replacement with LED	1.70 KW
Total operational Hours in a year	4000 Hours
Total annual saving in electricity consumption (KWH)	6800 Unit
Total annual saving in KVAH considering poer factor 0.99	6868 KVAH
Anticipated Annual Monitory Saving in Rs.(Considering unit charge @ Rs. 6.50 per KVAH	Rs. 44,642
Total Cost of 125 watt LED @ Rs.8,300	Rs.83,000

Simple Pay Back Period in years	1.86 Years
Simple Pay Back Period in months	23 Months

14.3 Replacement of Mercury Vapor 125 Watt By LED street Light 55 Watt

It is recommended to replace all Mercury Vapor Lamp of 125 watt by LED street light of 55 watt.

Total wattage of 125 Watt Mercury Vapor Lamps including control gear	140 Watt
Total Wattage of LED light	55 Watt
Total wattage saving	85 watt
Total Number of 125 Watt Mercury Vapor	21
Total wattage saving after replacement with 65 watt LED	1.785 KW
Total operational Hours in a year	4000 Hours
Total annual saving in electricity consumption (KWH)	7140 Unit
Total annual saving in KVAH assuming power factor 0.99	7212 Unit
Anticipated Annual Monitory Saving in Rs(assuming unit charge @ Rs. 6.50	Rs. 46,878
Total Cost of 55 watt LED (@ Rs.4,700)	Rs.98,700
Simple Pay Back Period in years	2.10 Years
Simple Pay Back Period in months	25 Months

Thus, by replacing Mercury vapour lamp by LED light will save 7212 KVAH unit and anticipated annual monitory saving will be Rs. 46,878. The simple payback of this recommendation is 25 months.

14.4 Replacing Conventional FTLs with 22 W T-5 LED lights:

Dominant light source at most places in the campus is traditional 40W FTLs with conventional Ballast [Choke] which consumes 12 W in addition to the 40W. As per our data collection, the campus has 1468 conventional Ballast[Choke] excluding 190 numbers of FTLs installed in boys hostel, Mess, canteen, bank. These florescent tube light conventional Ballast[Choke] should be replaced by 20 watt T-5 LED Tube light. Also, 104 numbers of T-8 FTL which has 36 Watt consumption, are installed in campus. These lights also should be replaced by 20 watt LED Tube light.

Sr. No.	Parameter		Remarks
A	Total No. of T-12,FTL (Total Consumption = 52 Watt)	1468	76,336 W
B	Total No. of T-8 FTL(Total Consumption = 40 Watt)	104 Nos.	4,160 W
C	Total Connected Load	80.50 KW	Say 80 KW
D	Total annual unit consumption (Assuming half of the total lights are operating and considering 2000 hrs operation in a year)	80,000 unit	
E	Total Load of 1572 numbers of 20 Watt LED T-5 Tube lights	31.44 KW	Say 31 KW
F	Total KWH Consumption per annum of all LED T-5 Tube lights after replacement (Assuming half of the total lights are operating and considering 2000 hrs operation in a year)	31,000 KWH	
G	Total Saving Per Annum(D - F) in KWH	49,000 KWH	
H	Total Saving in KWH assuming power factor 0.99	49,500 KVAH	
I	Reduction in Connected Load (C-E)	49 KW	
J	Monitory saving in Rs. Per Annum considering Rs. 6.50 per KVAH	Rs. 3,21,750	

PAYBACK

Sr.No.	Parameter	
A	Total no. of T-5 LED Tube Light required	1572
B	Total Investment @ 300.00 per lamp	Rs. 4,71,600
C	Total Saving per Annum	3,21,750
D	Simple Payback Period	17.5 Months

14.4.1 Technical Comparison between LED and Fluorescent Tube light

Factors	LED	Fluorescent Tube light
Efficacies lum/W	60-92	96.7
Heat Dissipation	3.5 btu/hour	37.565 btu/hr
Voltage	220v t0 360v	220v t0 360v
Color Rending Index	70	85
Life time	50,000 hrs*	10,000 hrs**

Table 39: Technical Comparison between LED and Fluorescent Tube light

14.5 Installing Airtron Energy Savers for ACs with a higher duty cycle (> 6 hrs./day)

AC's are only controlled by a Mechanical Relay & Timer. The AC manufacturer pre-sets the AC for the hottest geographical locations. Conventional Ac's do not have a Room temp. sensor or a Coil temp. sensor – and operate only on the Return Air temp. which shows error up to +/- 4C

The Airtron is an 'intelligent' microprocessor which operates on multiple algorithms in a 'closed – loop' circuit based on feedback from its 2 additional sensors, for Room Temperature & Coil Temperature. This also enables the Airtron to adapt to changes in ambient conditions automatically & save electricity. The Airtron allows you to program the AC to your climate & geographical locations & automatically adjusts itself to change the ambient conditions to save electricity. The Airtron has two additional sensors one for the Room & one for the Coil – and its multiple algorithms ensure the Room Temp is maintained while compressor run time is substantially reduced to guarantee savings irrespective of geographical location, climate, change of seasons, day or night and yet maintain the Set Room Temperature

To save energy in A.C's & maintain the Set temp. under changing climates, requires multiple algorithms and controls. Thus, simple 'plug-n-play' timers, currently available in the market are not viable, as they lead to increase in Room Temperature.

For Energy Savers to be successful in such a wide range of climates & geographical variations, an intelligent program device is required. The AIRTRON delivers, with an impressive 10-point programmable menu and dual intelligent sensors to save electricity while maintaining the Set Room temperature.

Additionally, this has a user-friendly interface with easy programmability so that the instrument can be operated even by a lay person

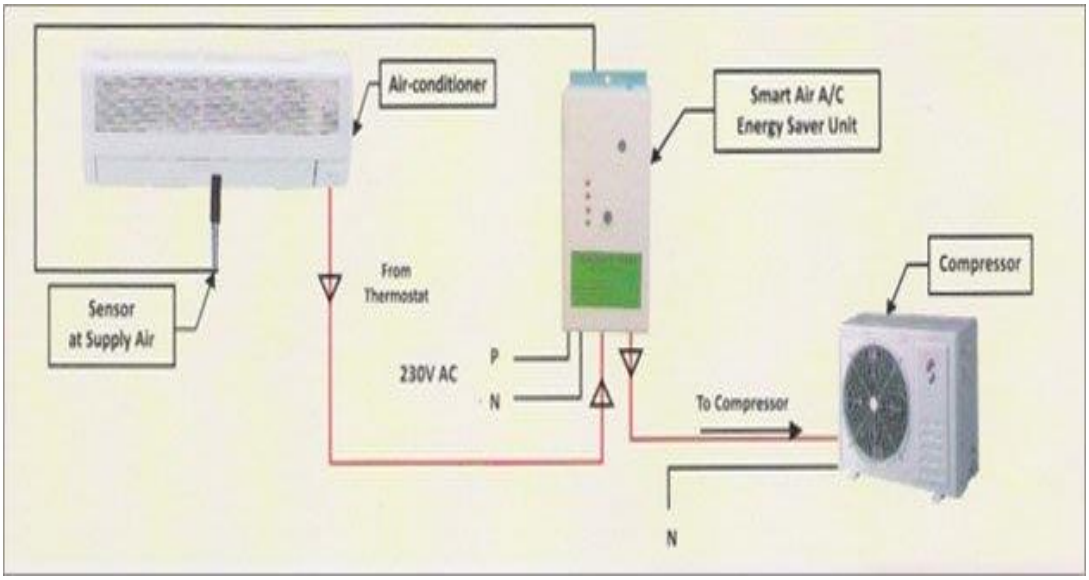


Figure 14 : Connection of energy Saver

Name of Particulars	wattage	Quantity	Annual Operational Hours	Total Unit Consumption
Auditorium AC Load	14200	12	270	46008
All Split AC 2 Ton	2100	34	900	64260
All Split AC 1.5 Ton	1550	24	900	33480
Total Annual KWH Consumption				143748
Total Annual KVAH Consumption considering PF @0.99				142310
Saving due to installation of Airtron Energy Saver@ 20%				28462
Total Monitory Saving considering Rs. @ 6.50 per KVAH				185004
Total Investment of installing 70 energy saver @ 4500				315000
Simple Payback period in Months				20.4

14.6 Replacement of All CFL light fixtures with LED light

It is recommended to replace all compact fluorescent lamp with LED lights.

Existing fitting	No of Fitting	Proposed Fitting
CFL- 11 W	331	LED -5 W
CFL- 18 W	722	LED- 9 W
CFL- 32 W	125	LED -18 W
CFL- 36 W	84	LED – 18 W

Table 40: Retrofit details for CFLs

Saving Calculation:

Existing fitting CFL in watt	No of Fitting	Proposed LED Fitting	Total Saving in watt
11	331	5	1986
18	722	9	6498
32	125	18	1750
36	84	18	1512
Total Saving in KW			11.746
Utilization coefficient for Total number of lights in operation			0.5
Total annual operating hours			2400
Total annual saving in KWH			14095.2
Total annual saving in KVAH (Considering PF=0.99)			14237.57
Total monitory saving in Rs.			90409

Proposed LED Fitting	No of Fitting	price	Investment in Rs.
5	331	125	41375
9	722	200	144400
18	125	350	43750
18	84	350	29400
Total Investment			2,58,925

Total Investment	2.59 Lacs
Total annual saving	0.9 Lacs
Simple payback period	35 Months

14.6.1 Technical Comparison between LED and Compact Fluorescent Lamp

Factors	LED	CFL
Efficacies lum/W	60-92	61
Heat Dissipation	3.5 btu/hour	30 btu/hour
Voltage	220v to 360v	220v to 360v
Color Rending Index	70	NA
Life time	50,000 hrs	8000 hrs

Table 41 : Technical Comparison between LED and Compact Fluorescent Lamp

14.7 Replacement of Conventional Fans of 70 Watt by Energy Efficient Fans of 40 watt :

A BLDC fan takes in AC voltage and internally converts it into DC using SMPS.

The main difference between BLDC and ordinary DC fans is the commutation method. A commutation is basically the technique of changing the direction of current in the motor for the rotational movement. In a BLDC motor, as there are no brushes so the commutation is done by the driving algorithm in the Electronics. The main advantage is that over a period of time, due to mechanical contact in a brushed motor the commutators can undergo wear and tear, this thing is eliminated in BLDC Motor making the motor more rugged for long-term use.

Figure 15: BLDC motor of Energy Efficient fan

To explain, BLDC technology in simpler terms, BLDC uses a combination of Permanent Magnets and Electronics to achieve the kind of efficiency and performance it delivers. A BLDC fan composes of 3 main components:

1.Stator

2.Rotor

3. Electronics.

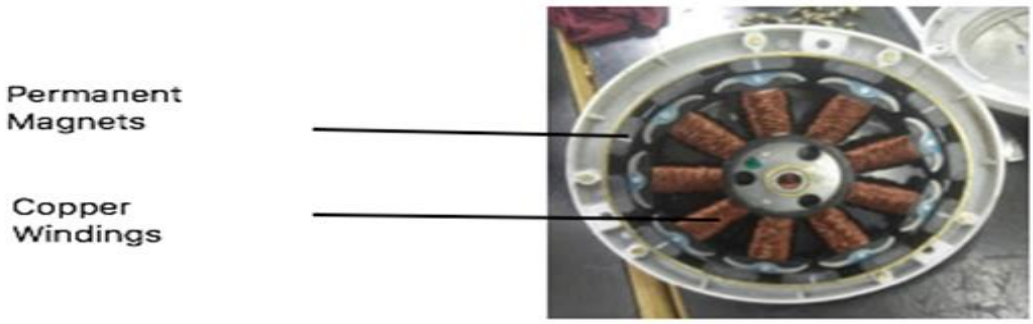


Figure 16: Inside view of BLDC motor

The electronics contains a driving algorithm which drives the BLDC motor. As discussed earlier in a BLDC motor the position of magnets in the fan is sensed by electronics that either uses a Hall effect sensor or back EMF. Modern BLDC motors use Back EMF for commutation due to proven disadvantages of hall effect sensor over period of time.

To explain it in easier terms, we can take an example of a donkey who has a carrot fixed over his head as per shown in the picture below:

Consider the Stator to be the Carrot and the donkey to be the Magnets. The polarity of the stator will keep changing, due to attraction the magnets will create rotational moment, just like how the donkey tries hard to reach the carrot in the picture.

Permanent magnets used in rotor are responsible for mass reduction in power consumption compared to windings used in the stator in an ordinary induction fan. One added advantage in a BLDC fans due to use of an electronic circuit is that you can add several additional features to increase convenience, few example of the same are sleep mode, timer mode also it is compatible with Home automation systems. Most of the BLDC Ceiling fans are operated by remote unlike traditional regulator reducing the purchase cost of regulator.

Compared to regular induction fan, a BLDC fan can save upto Rs 1000-1500/ Year/fan. And because there is no heating of the motor, the life of a BLDC fan is also expected to be much higher than ordinary fans.

Total Numbers of conventional fans	1669
Total wattage	70
Wattage of Energy Efficient Fans	35
Saving in wattage	35
Total Saving in wattage in connected load	58415
Total Saving in unit considering coefficient of utilization 0.6 and operating 2700 Hours	94632
Total saving in KVAH @PF0.99	93686
Total Annual Monitory Saving	608959
Total investment considering cost of fan @3000	5007000
Simple Payback Period in months	98.7

Note : Installation of Energy Efficient Fans 1669 conventional Fans, these existing Fans can be replaced in a phase manner.

15. General Recommendation for Energy Saving in Office Equipment

Equipment	Wattage	Comments
CRT Monitor	100 - 120W (during operating condition)	CRT monitors consume a lot of power, much of which is wasted as heat, and represent the largest power consumption component in a typical desktop computer. Emit potentially harmful radiation. Fortunately, most CRT monitors these days are legacy equipment as new computers are generally supplied with LCD monitors. Unfortunately, most CRT monitors end up in
Desktop Computer	150W (during operating condition)	Power consumption will differ significantly depending on whether a CRT or LCD monitor is used. In home and office situations where it is necessary to run multiple desktop computers, it may be possible to make significant power savings by running a single terminal server computer with several LCD monitors and keyboards attached. Terminal server computers can also greatly simplify network management, software upgrades, etc
Photo copier	7-30W (Sl. Mode) 40-300W (Standby) 200-1300W (op. cond)	Most of the energy used in a photocopier is consumed by the hot rollers, which are usually kept hot on stand-bay, consuming from 40-300W. Significant energy savings (40% to 60%) can be made by ensuring that photocopiers are switched off at night and on weekends.Some photocopiers consume up to 30 watts even when switched off, so photo copiers should be switched off at the power outlet to ensure they are really "off".
LCD Monitor	30-50W (during operating condition)	LCD monitors typically require about 30% of the power required for a CRT monitor with the same screen area. In addition, the amount of heat generated by an LCD monitor is considerably less than a CRT monitor, resulting in a lower load on ACs. Building cooling needs may be decreased
Inkjet Printer	120W (during operating condition)	Inkjet printers use relatively little power in comparison to laser printers. From an energy consumption point of view, inkjets are preferable to lasers. Unfortunately, they typically cost more to un on a cost -Per -print basis and sometimes produce less than optimum results
Laser Printer	25-80W (Standby) 150-1100W (during operating condition)	Laser printers consume significant amounts of power even when in standby mode. Over the course of an 8 -10 hr working day, a laser printer could consume around 1kWh of energy. On the other hand, laser printers are cheaper to run on a cost-per page basis and generally produce better results. Both the number of laser printers used, and the number of hours the are operated for, should be minimized. As with printing of any kind, office procedures should be developed which minimize the need for printing to paper
Laptop Computer	15-40 W (during operating condition)	Laptop computer power consumption is typically 10% to 25% of that of a desktop computer. In situations such as an office or home office, where computers may operate for 8 to 10 hours a day, this difference is significant and could represent an energy saving of up to 1kWh per day.

Table 42 : General Recommendation for Energy Saving in Office Equipment

16. Earth Pit Details

Building	S.No.	Name of Earth Pit	Value in Ohm (Ω)	Location
Electrical Engineering Block	1	G-01	2.9	Inside Electrical Engineering Block Towards Machine lab
	2	G-02	3.0	Inside EE Block Towards Workshop lab
	3	G-03	0.3	Inside EE Block Towards EEE Lab
	4	G-04	2.4	Inside EE Block Towards ELG-7
	5	P-01	0.4	INSIDE HIGH VOLTAGE LAB
	6	P-02	0.5	
	7	P-03	0.5	
	8	P-04	0.4	
	9	P-05	0.4	
	10	P -06	0.3	
	11	P -07	0.5	
Mechanical Engineering Block	1	M-01	2.7	Inside towards Conference hall
	2	M-02	2.4	Outside towards Conference hall
	3	M-03	***OPEN***	Inside Towards Science Lab
Main Auditorium	1	HM-01	0.5	High Mast
	2	HM-02	0.5	
	3	AP-01	0.3	Outside Control Panel of Auditorium
	4	AP-02	0.6	
Science Block	1	SG-01	0.6	In front of Physics Lab
	2	SG-02	0.9	In front of Physics Lab
	3	SG-03	0.9	In front of Physics Lab
	4	SG-04	0.9	In front of Chemistry Lab
	5	SG-05	0.1	Outside Chemistry lab
	6	SG -06	0.1	Backside of Science dept[Motor room]
	7	SG -07	0.1	Towards Play ground
	8	SG-08	1.2	
	9	HMS-01	1.2	High Mast
	10	HMS-02	< 3	
Electronics Block	1	ELEX-01	0.1	Towards computer lab left hand side
	2	ELEX -02	0.1	
	3	ELEX -03	***Open No wire***	
	4	ELEX -04	< 3	MCA computer lab left hand side
	5	ELEX -05	***Open No wire***	Towards Classroom
	6	ELEX -06		
	7	ELEX -07	0.9	Backside(Out) Electronics Library
	8	ELEX -08	0.9	
	9	ELEX -09	1.5	Backside(Out) HOD(IT) Room
	10	ELEX -10	0.9	
	11	ELEX -11	***Open No wire***	In front of Electronics Deptt.
	12	ELEX -12	0.3	

Building	S.No.	Name of Earth Pit	Value in Ohm (Ω)	Location
Substation	1	SST-01	1.8	Transformer
	2	SST -02	2.1	
	3	SST -03	0.9	
	4	SST -04	2.4	
	5	SST -05	0.6	
	6	SST -06	0.1	
	7	SST -07	0.1	
	8	SST -08	0.1	
	9	SST -09	< 3	
	10	SST -10	0.3	
Junior Boys Hostel	1	A-01	1.8	HIGH MAST (Outside the boundary)
	2	B -02	1.8	
	3	A-03	ONLY PIPE IS THERE	SITE OFFICE(51-60)
	4	B -04		
	5	A-05	0.4	PG-04
	6	B-06	0.3	
UCO Bank	1	A-01	0.3	N.S.S OFFICE
Astro Club	1	A-01	0.3	ASTRO CLUB
M- Wing	1	A-01	0.12	PIT IS NOT IN USE OF ROOM NO. 13 &14
	2	B-02	0.9	HIGH MASK
	3	C-03	-	PIT IS THERE BUT NO WIRE
	4	D-04	1.8	R/91, Senior wing
	5	E-05		R/90, PIT IS THERE BUT NO WIRE, Senior wing
Cricket Ground	1	A-01	0.1	SOUTH SIDE
	2	B-02	1.8	EAST SIDE
	3	C-03	0.3	WEST SIDE
	4	D-04	0.6	NORTH SIDE
Civil Block	1	A-01	NO WIRE 3 Ω	LEFT SIDE
	2	B-02	NO WIRE 6 Ω	BACK SIDE
Substation-Meter	1	SSM-01	0.2	Energy Meter Side
	2	SSM-02	0.2	

Table 43 : Earth pit details

The above details are provided by Electrical Department, BIT.