Dr. Babasaheb Ambedkar Technological University

Lonere- Maharashtra

Energy Audit Report

December 2019

Sharad Institute of Technology College of Engineering, Yadrav.

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Report on

DETAILED ENERGY AUDIT

of

Dr. Babasaheb Ambedkar Technological University

Vidyavihar, Lonere, Dist. Raigad, Maharashtra.

Conducted by

Dr. Sanjay A. Khot, Certified Energy Auditor (7218)

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December 2019

I. Table of Contents

A. List of Tables

B. List of Figures

C. List of Abbreviations

DBATU	: Dr. Babasaheb Ambedkar Technological University
BEE	: Bureau of Energy Efficiency
MEDA	: Maharashtra Energy Development Agency
EB	: Electricity Board
DG	: Diesel Generator
ECM	: Energy Conservation Measures
GCV	: Gross Calorific Value
kWh	: kilo Watt hour
LT	: Low Tension
HT	: High Tension
MSEDCL	: Maharashtra State Electricity Distribution Co. Ltd.
MT	: Metric Ton
MTOE	: Metric Ton Oil Equivalent
kW	: Kilo Watt
TPA	: Tons Per Annum
SEC	: Specific Energy Consumption
SPC	: Specific Power Consumption
TPH	: Tons Per Hour
VFD	: Variable Frequency Drive
DOL	: Direct On Line
Yr	: Year
Kg	: Kilo Gram
W	: Watt
^{o}C	: Celsius

II. Acknowledgement

Energy Audit Team of SITCOE expresses our sincere gratitude to management of Dr. Babasaheb Ambedkar Technological University Lonere, for providing us an opportunity to conduct an Energy Audit of their Institute located in Lonere, Raigad Dist-402103. We are grateful to **Professor V. R. Sastry**, Hon. Vice Chancellor and **Dr. S. B. Deosarkar,** Institute Project Director, TEQIP-III, **Dr. Mudigonda Sadaiah**, Registrar **Dr. S. L. Nalbalwar**, Dean faculty of Engineering and Technology **Dr. R. S. Pawade**, Prof. Mechanical Engineering Department **Mr. V. S. Chavan**, University Engineer and other officials for showing keen interest in the study and for the help and co-operation extended to SITCOE Energy Audit Team during study.

We do hope that you will find the recommendations given in this report useful in helping you save energy. While we have made every attempt to adhere to high quality standards, in both data collection and analysis, as well as in presentation through the report, we should welcome any suggestions from your side as to how we can improve further.

In case of any suggestions or queries:

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III. Introduction

Project	Detailed Energy Audit
Client	Dr. Babasaheb Ambedkar Technological University, Lonere
Segment	Education
Contact	**Professor V. R. Sastry**
	Hon. Vice Chancellor
	Dr. R. S. Pawade
	Associate professor
	Mechanical Engineering Department
Site	Vidyavihar, Lonere, Dist. Raigad - 402 103, Maharashtra.
	India
Consultant	**Dr. Sanjay Khot (EA-7218)**
	Principal, SITCOE, Yadrav
Involved	Mr. P. G. Ganthade
	Mr. M. M. Khade
	Mr. D. L. Kamble
	Mr. Y. Y. Kamble
Involved from DBATU Lonere:	
	Mr. Rohit Wakade
	Mr. Nikhil Pandharpatte
Duration	November- December 2019
Project scope	Conducting energy audit at Dr. Babasaheb Ambedkar Technological University, Lonere to identify Measures for Energy Conservation.
Report	This document gives recommendations, details of findings and the way forward.
Notes	The suggestions/ alternatives in the audit report are based on the operating conditions of equipment/ systems during the field work and based on information and details collected from site and to the best of our knowledge. It is recommended to obtain vendor quotations before implementation.

IV. Executive Summary

❖ Highlights

Description	Units	Values
Total annual savings	**□. Lakhs**	**33.37**
Total investments	**□. Lakhs**	**83.65**
Payback period	**Years**	**2.51**
Electric energy drawn from MSEDCL	**Lakhs kWh**	**8.46**
Electricity generated by AC genset	**Lakhs kWh**	**0.037**
Annual electricity consumption	**Lakhs kWh**	**8.50**
Annual electricity cost	**□. Lakhs**	**94.16**
Annual diesel cost	**□. Lakhs**	**0.25**
Total annual energy cost	**□. Lakhs**	**94.41**

❖ Impact of Proposed Energy Conservation Measures

Description	Units	Values
Electricity	**Lakhs kWh/annum**	**3.81**
	%	**45%**
Estimated annual cost reduction	**□. Lakhs/annum**	**33.38**
Simple Payback period	**Years**	**2.51**

❖ Energy Cost

Electricity unit charges = □ 7.9/kWh

Fuel Cost (Diesel) = □ 68/lit

❖ Summary of Energy Conservation Measures

❖ Table 1: Summary of Energy Conservation Measures (DBATU Campus)

DBATU campus							
Sr. No.	Energy Conservation Measures	Annual Saving		Investment	Simple payback period	Reduction in CO2 emissions
		kWh	₹. Lakh	₹. Lakh	Years	MT/year
A- Short term						
1	Replacement of existing pump with EE pump (09 Nos)	87711	7.03	6.45	0.92	114.02
2	Improvement in PF by APFC made in operation		1.11	-	-	-
B- Medium term						
3	Replacement of FTL to LED tubes (1234 Nos)	48605	3.91	8.63	2.21	63.19
4	Replacement of old ceiling Fan to EE fan (1213 Nos)	151818	12.52	38.82	3.10	197.36
5	Replacement CFL at corridor with LED tube light (60 Nos)	4860	0.38	0.42	1.09	6.32
6	Replacement of existing AC (1 TR & 1.25 TR Split) with 5 star inverter AC (02 Nos)	2304	0.18	0.70	3.85	3.00
7	Replacement of existing AC (5.5 TR Fixed Speed Package) with 5 star inverter AC (05 Nos)	17846	2.04	8.00	3.92	23.20
8	Replacement of existing electric geyser with Heat Pump	68302	6.20	20.64	3.33	88.79
Total		**381446**	**33.37**	**83.65**	**2.51**	**495.88**

Table 2: Summary of Energy Conservation Measures (Main Building)

Main Building						
Sr. No.	**Energy Conservation Measures**	**Annual Saving**		**Investment**	**Simple payback period**	**Reduction in CO_2 emissions**
		kWh	**₹. Lakh**	**₹. Lakh**	**Years**	**MT/year**
A- Short term						
1	Improvement in PF by APFC made in operation		1.11	-	-	-
2	Replacement of existing pump with EE pump (01 Nos)	5583	0.44	0.41	0.93	7.26
B- Medium term						
3	Replacement of FTL to LED tubes (318 Nos)	13157	1.04	2.22	2.14	17.10
4	Replacement of old ceiling Fan to EE fan (266 Nos)	34409	2.72	8.51	3.13	44.73
5	Replacement CFL at corridor with LED tube light (60 Nos)	4860	0.38	0.42	1.09	6.32
6	Replacement of existing AC (1 TR & 1.25 TR Split) with 5 star inverter AC (02 Nos)	2304	0.18	0.70	3.85	3.00
7	Replacement of existing AC (5.5 TR Fixed Speed Package) with 5 star inverter AC (05 Nos)	17846	2.04	8.00	3.92	23.20
Total		**78159**	**7.91**	**20.26**	**2.56**	**101.61**

Table 3: Summary of Energy Conservation Measures (Hostel)

Hostel						
Sr. No.	Energy Conservation Measures	Annual Saving		Investment	Simple payback period	Reduction in CO_2 emissions
		kWh	₹. Lakh	₹. Lakh	Years	MT/year
A- Short term						
1	Replacement of existing pump with EE pump (03 Nos) (Gagangiri + Malaygiri)	23920	2.17	1.23	0.57	31.10
B- Medium term						
2	Replacement of FTL to LED tubes (706 Nos)	24834	2.25	4.93	2.19	32.28
3	Replacement of old ceiling Fan to EE fan (730 Nos)	91250	8.28	23.36	2.82	118.63
4	Replacement of existing electric geyser with Heat Pump	68302	6.20	20.64	3.17	88.79
Total		**208306**	**18.89**	**50.16**	**2.65**	**270.80**

Table 4: Summary of Energy Conservation Measures (Quarters)

Quarters						
Sr. No.	Energy Conservation Measures	Annual Saving		Investment	Simple payback period	Reduction in CO_2 emissions
		kWh	₹. Lakh	₹. Lakh	Years	MT/year
A- Short term						
1	Replacement of existing pump with EE pump (01 Nos)	8376	0.49	0.41	0.84	10.89
B- Medium term						
2	Replacement of FTL to LED tubes (211 Nos)	10614	0.62	1.47	2.38	13.80
3	Replacement of old ceiling Fan to EE fan (218 Nos)	26160	1.53	6.98	4.57	34.01
Total		**45150**	**2.63**	**8.86**	**3.37**	**58.70**

1. Energy and Utility System Description

Dr. Babasaheb Ambedkar Technological University is located in Lonere, Dist. – Raigad.

Major utilities in this university are

1. General
2. Electrical

1.1 Brief Description of each Facility

This study is being done under the indicative scope of work for conduct of Energy Audit specified by MEDA (Maharashtra Energy Development Agency) & BEE (Bureau of Energy Efficiency). This study is mainly carried out to identify saving areas in Dr. Babasaheb Ambedkar Technological University, Lonere with short term, medium term & long-term investments, yielding significant savings. The study can be mainly divided into following groups.

a. General

Energy Audit focuses on study of correlation of electricity consumption on production. Opportunities for load factor improvement, power factor improvements, etc.

b. Electrical

It includes motor load study of 5 HP & above by measuring input parameters (Voltage, Current, P.F., & kW), performance analysis of water pumps having capacities above 5 HP, performance analysis and identification of energy efficiency opportunities in motors, pumps, air compressors, lighting, etc

1.2 Instrument Used

Following instruments are used for the study:

a. Three phase power analyzer

b. Lux Meter

c. Measuring tape

d. Anemometer

e. Thermal imager

The site study was carried out from Nov-Dec 2019.

2. Description and Energy Consumption

2.1 About University

Dr. Babasaheb Ambedkar Technological University, with its headquarters situated at Lonere, is now a statutory State Technical University established by Government of Maharashtra through special Dr. Babasaheb Ambedkar Technological University Act. The university has been accorded the status of an ‘affiliating’ university of the entire State of Maharashtra from March 2, 2016, by the Maharashtra Act No. XXIX of 2014. Dr. Babasaheb Ambedkar Technological University is one and only one of its kinds in the State. The University is located at Lonere, the place in the ranges of Western Ghat, at the foot of Raigad fort. It is autonomous in nature and Unitary in its character. It is established in the year 1989 by the Government of Maharashtra. Although relatively young, the University is making its mark in the field of research and technological services through its dedicated faculty and disciplined students.

The University offered 20 B Tech programmes such as

- Automobile Engineering
- Second Year B. Tech program in MINING ENGINEERING
- Civil Engineering
- Chemical Engineering Second Year (Revised)
- Computer Engineering
- Information Technology
- Electronics Engineering
- Mechanical Engineering
- Mechanical Engineering (Sandwich)
- Instrumentation Engineering
- Production Engineering
- Electrical Engineering
- Chemical Engineering
- Electronics & Telecommunication Engineering
- B. Tech. in Electronics & Communication Engineering (Sandwich)
- Petrochemical Engineering Second Year
- Electrical & Instrumentation Engineering (Second Year)
- Instrumentation Engineering (Second Year)

- Mining Engineering
- Biomedical Engineering

The University introduced choice-based credit system from the academic year 2010-11.

Academic systems such as credit-based continuous assessment system, non-negotiable academic calendar, transparency in the evaluation, etc. have been put in place.

A two-fold increase in enrolment of M.Tech. programmes have been achieved due to the grant of assistantship to non-GATE M.Tech. students and 29 PhDs were given research assistantship in TEQIP-II which concluded in March 2017

Several research labs, library and learning resources have been augmented and strengthened with TEQIP-II support. 180 institutes are affiliated to DBATU for different streams.

2.2 Annual Energy Consumption

2.2.1 Electricity

DBATU, Lonere is receiving electricity from MSEDCL. A part of the plant electricity is met by open access. Contract demand with MSEDCL is 170 kVA with a minimum billing demand 50% contract demand or 75% highest billing demand during preceding 11 months.

2.2.2 Marginal Energy Cost

Marginal cost of electricity is calculated based on the energy cost of electricity from EB and DG. This marginal cost is considered for the cost benefit analysis of energy conservation measures.

Table 05: Marginal Energy Cost

Description	Units	Value	Value	Value
Name of building	-	Main building	Hostel	Quarters
Average monthly EB energy consumption	kWh	26672	26330	17504
Average basic cost of energy from EB	₹/kWh	7.9	9.07	5.83
% of electricity from EB	%	100	100	100
Marginal cost of electricity	₹/kWh	7.9	9.07	5.83
Actual cost of electricity	₹/kWh	13.52	10.11	9.06

2.2.3 Annual Energy Consumption Breakup

Table 06: Annual Energy Consumption

Month	Gangotri building bill in Lakhs	Chandrabhaga building bill in Lakhs	Main building bill in Lakhs	Total bill in Lakhs
2018 Aug	3.34	1.82	3.69	8.85
2018 Sep	2.31	1.37	3.08	6.76
2018 Oct	3.22	1.96	3.80	8.98
2018 Nov	2.45	1.49	2.55	6.48
2018 Dec	2.15	1.59	2.74	6.49
2019 Jan	2.21	1.61	2.82	6.64
2019 Feb	2.71	1.42	2.95	7.09
2019 Mar	3.30	1.74	3.50	8.54
2019 Apr	2.86	1.77	5.15	9.78
2019 May	2.44	1.60	4.96	9.00
2019 July	1.85	1.07	3.93	6.86
2019 Aug	3.14	1.53	4.03	8.70
Total	31.98	18.97	43.21	94.16

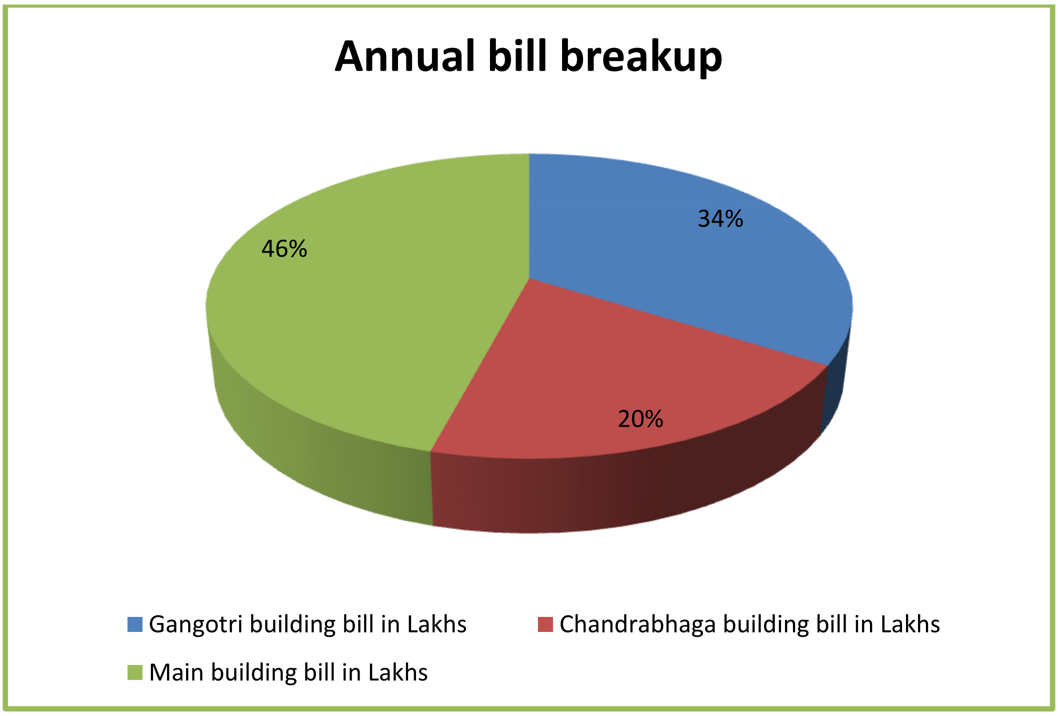


Figure 01: Annual Energy Consumption Breakup

3. Energy Scenario

3.1 Electrical Systems

3.1.1 Electrical bill analysis

DBATU, Lonere is getting electricity supply from Maharashtra State Electricity Distribution Co. Ltd. Major portion of the energy consumption is used for academics and hostel.

The observations made during the study are given in the following sections.

The Tariff Structure at the plant

Tariff structure of the facility is given below

- Tariff Code = 169 HT- IX A
- Supply voltage = 22 kV
- Contracted demand = 170 kVA
- Minimum billing demand = 85 kVA
- Demand charges = ₹. 391 per kVA
- TOD = Opted
- Unit charge = 7.9 ₹. /kWh

1. Billing Demand

The billing demand during unrestricted period shall be minimum billing demand 50% contract demand or 75% highest billing demand during preceding 11 months or actual Maximum Demand recorded in the month during 0600 hours to 2200 hours; whichever is higher.

2. Power factor (PF)

It shall be the responsibility of the HT Consumer to determine the capacity of PF correction apparatus and maintain an average PF of not less than 0.90.

3. Load Factor Incentive

Consumers having Load Factor above 75% and up to 85% will be entitled to an incentive in the form of a rebate of 0.75% on the Energy Charges for every percentage point increase in Load Factor from 75% to 85%. Consumers having a Load Factor above 85 % will be entitled to a rebate of 1% on the Energy Charges for every percentage point increase in Load Factor from

85%. The total rebate will be subject to a ceiling of 15% of the Energy Charges applicable to the consumer.

4. Time of Day Tariff

As per Maharashtra State Electricity Distribution Company Limited, HT consumers have an option to take Time of Day (TOD) tariff instead of the normal tariff. Under TOD tariff electricity consumption and maximum demand in respect of HT consumers for different periods of the day i.e. normal period, peak load period and off-peak load period could be recorded by installing TOD meter. The maximum demand and consumption recorded in different periods could be billed on the following rates of the tariff applicable.

Table 07: Time of Day Tariff (TOD)

S. No	Description	Energy Charge (/kWh)
1	**Energy Charges**	
(i)	22:00 Hrs-06:00 Hrs	-1.50
(ii)	06:00 Hrs-09:00 Hrs & 12:00 Hrs-18:00 Hrs	0.00
(iii)	09:00 Hrs-12:00 Hrs	0.80
(iv)	18:00 Hrs-22:00 Hrs	1.10
2	**Demand Charges**	Normal rate of Demand Charges

The analysis of plant electricity consumption from EB and Open Access is given below. For the electricity consumption analysis, electricity bill for the last twelve months (Aug-18 to Aug-19) is considered.

Table 08: Electrical Bill Analysis of Main Building

Month	Contract Demand KVA	Highest Recorded Demand KVA	Billed Demand KVA	Power Factor	Consumption kWh	Demand Charges	Wheeling Charges	Energy charges	TOD tariff EC	FAC	Electricity Duty	Tax on sale	P.F. incentive /penal charges	Charges for excess demand	Bill as per MERC in Lakhs
2018 Aug	144	170	170	0.884	28071	45900	23018.2	202111.2	1257.5	4210.65	60275.8	2245.68	19354.83	10530	3.69
2018 Sep	170	170	170	0.87	22359	59500	8496.42	172164.3	-153.2	9167.19	52326.7	1178.72	4983.46		3.08
2018 Oct	170	164	164	0.896	28619	57400	10875.2	220366.3	1186.5	22609.01	65611.8	2289.52	0		3.80
2018 Nov	170	116	123	0.83	19190	43050	7292.2	147763	-691.6	5181.3	42544.9	1535.2	8103.8		2.55
2018 Dec	170	109	123	0.751	19783	43050	7517.54	152329.1	-1208	9495.84	44348.7	1582.64	16894.76		2.74
2019 Jan	170	96	123	0.725	19812	43050	7528.56	152552.4	-1077.9	12085.32	44969.1	3566.16	19272.45		2.82
2019 Feb	170	136	136	0.784	21528	47600	8180.64	165765.6	-744.4	7534.8	47950.7	3875.04	14841.88		2.95
2019 Mar	170	145	145	0.862	26647	50750	10125.9	205181.9	-81.3	13856.44	58764.9	4796.46	6995.82		3.50
2019 Apr	170	200	200	0.918	36459	78200	13489.8	288026.1	2183	21146.22	88334.4	6562.62	-344.59	17595	5.15
2019 May	170	175	175	0.924	37382	68425	13831.3	295317.8	2039.1	22429.2	85044.7	6728.76	-344.59	2932	4.96
2019 July	170	146	150	0.854	29581	58650	10945	233689.9	150.4	9465.92	65709.3	5324.58	9387.04		3.93
2019 Aug	170	163	163	0.828	30632	63733	11333.8	241992.8	477.8	306.32	66747.2	5513.76	12713.75		4.03
Min	144	96	123	0.725	19190	43050	7292.2	147763	-1208	306.32	42544.9	1178.72	-344.59	2932	2.55
Max	170	200	200	0.924	37382	78200	23018.2	295317.8	2183	22609.01	88334.4	6728.76	19354.83	17595	5.15
Average	167.83	149.17	153.50	0.84	26671.92	54942.33	11052.8	206438.3	278.16	11457.35	60219.02	3766.60	9321.55	10352.3	3.60
Total					320063	659308	132635	2477260	3337.9	137488.2	722628	45199.1	111858.61	31057	43.21

Observation:

- The contract demand is 170 kVA and the minimum billing demand 50% contract demand or 75% highest billing demand during preceding 11 months whichever is higher.
- Max demand recorded for the month Apr 2019 is 200 kVA which is more than the contract demand
- The average demand recorded for twelve months; from Aug 2018 to Aug 2019 is 153.5 kVA which is more than the minimum billed demand i.e. 85 kVA.
- The lowest & highest recorded demand in the month of Nov 2018 and Apr 2019 is 123 kVA and 200 kVA.
- The average energy consumption is 26672 kWh.

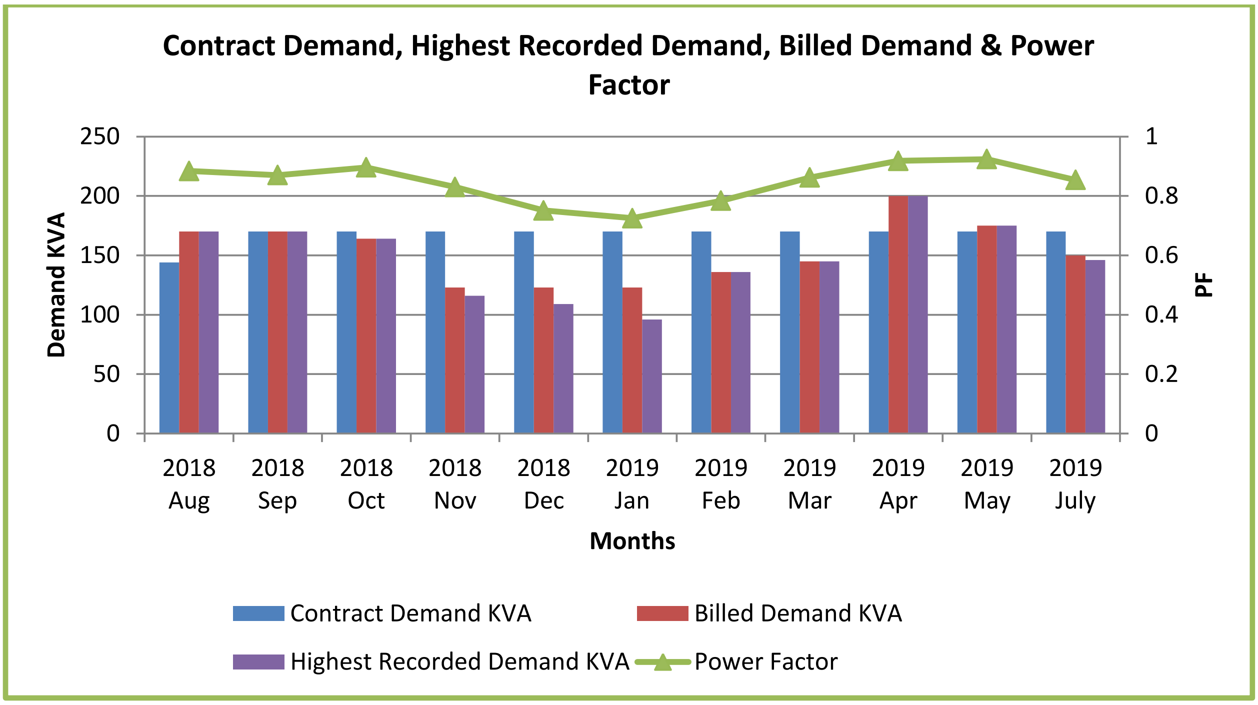


Figure 02: Contract Demand, Recorded Demand and PF Profile of Main Building

Observation:

- The maximum and minimum recorded demand was 123 kVA in Nov 2018 and 200 kVA in Apr 2019 respectively.
- The power factor is not maintained.

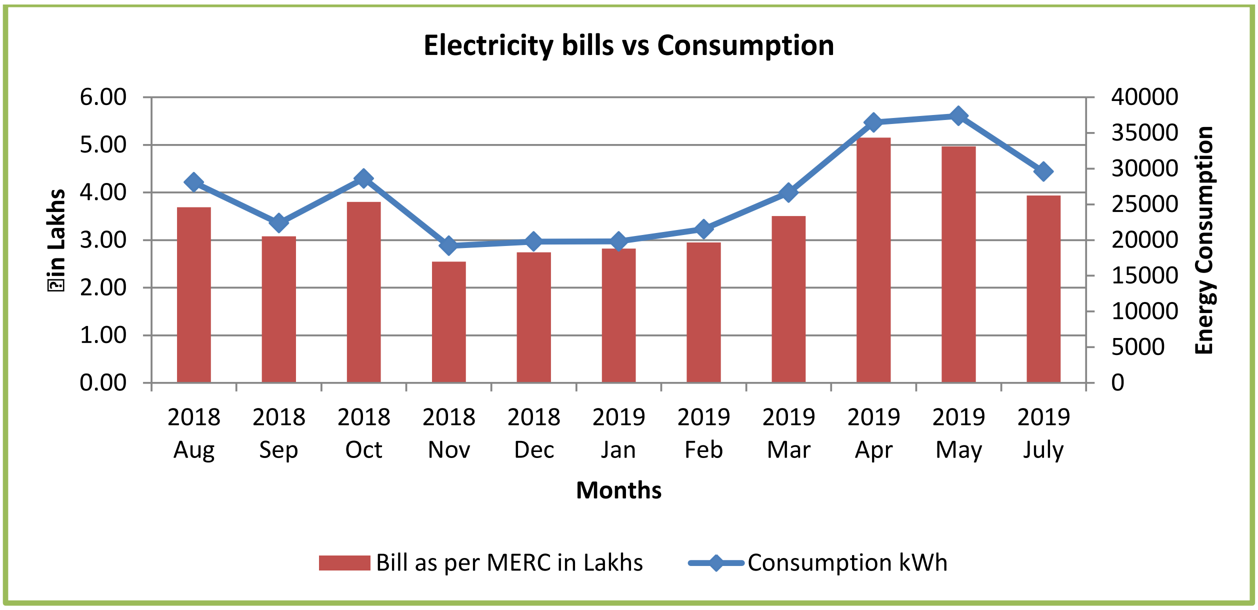


Figure 03: Annual Energy Consumption of Main Building

Observation:

- Energy consumption varies from 19190 to 37382 kWh from Nov 2018 to May 2019.
- The bill as per MERC for last twelve months is □43.21 in Lakhs.

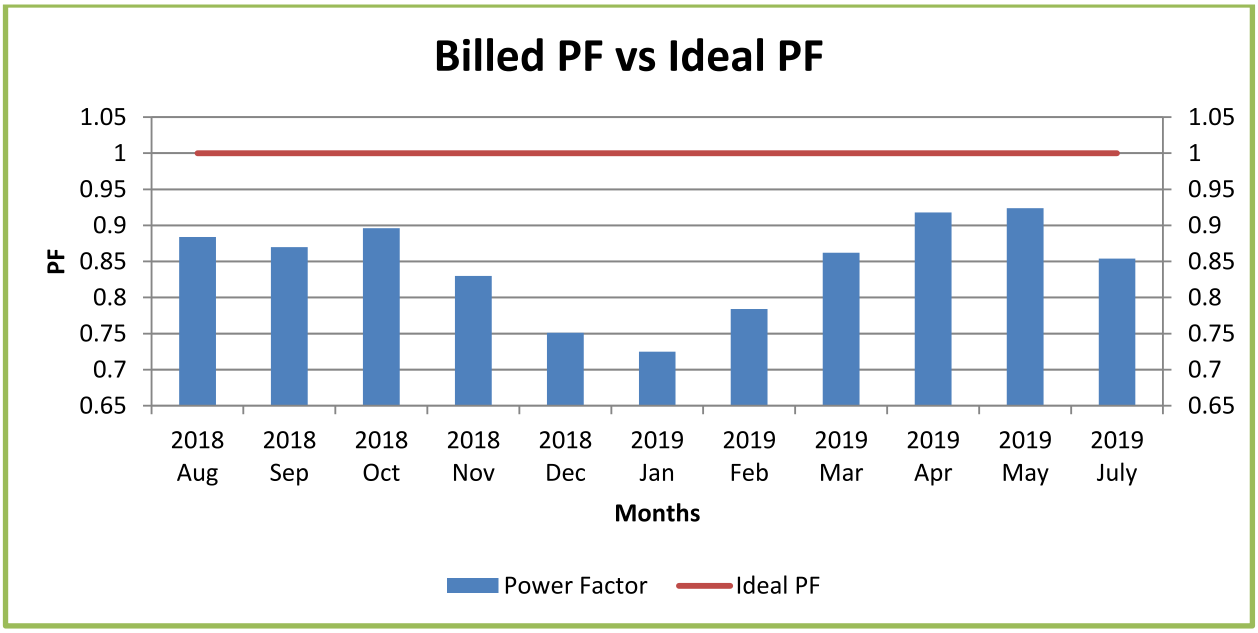


Figure 04: Billed PF Vs Ideal PF of Main Building

Observation:

- Billed PF varies from 0.725 to 0.924.
- Billed is less in the month of Jan 2019.

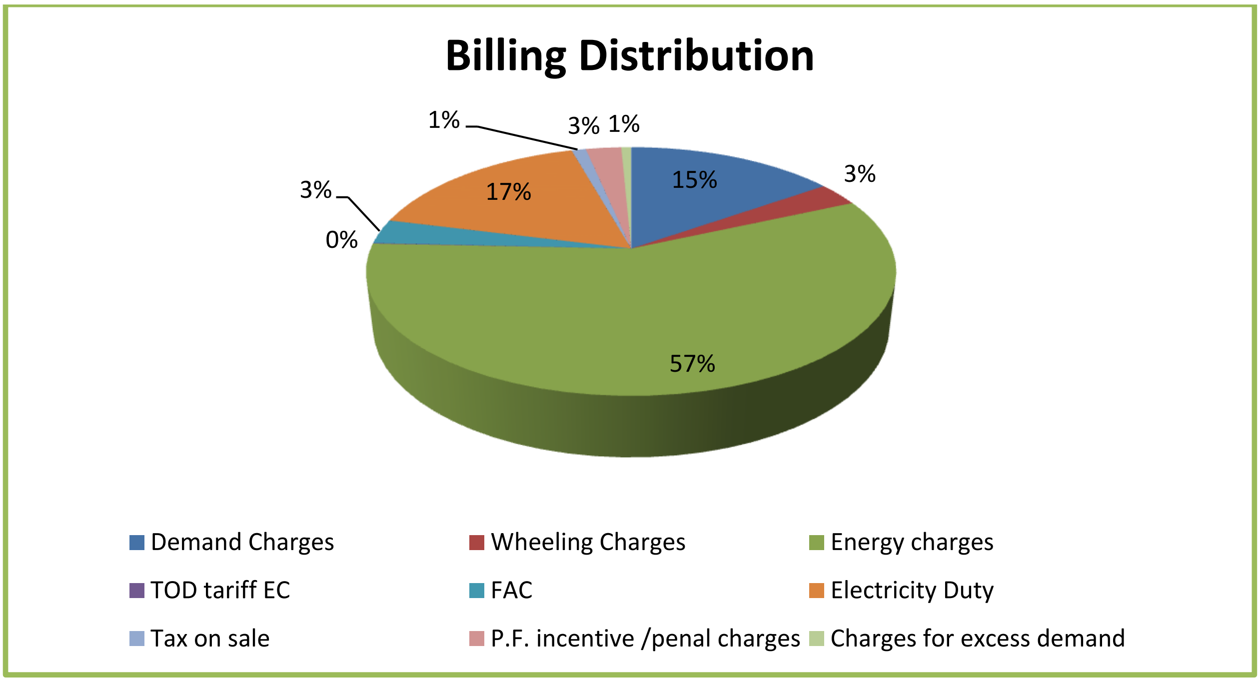


Figure 05: Billing Distribution of Main Building

Table 09: Electrical Bill Analysis of Chandrabhaga Building

Month	Contract Demand KVA	Highest Recorded Demand KVA	Billed Demand KVA	Power Factor	Consumption kWh	Demand Charges	Wheeling Charges	Energy charges	FAC	Electricity Duty	P.F. incentive /penal charges	Bill as per MERC in Lakhs
2018 Aug	100	69	71	0.98	21486	15620	17618.5	125048.5	2793.18	25772.8	-4832.41	1.82
2018 Sep	100	70	71	0.983	15148	21300	5756.24	86798.04	5604.76	19113.5	-1791.89	1.37
2018 Oct	100	77	77	0.986	21917	23100	8328.46	125584.4	15341.9	27576.8	-4308.87	1.96
2018 Nov	100	94	94	0.976	16036	28200	6093.68	91886.28	3848.64	20804.6	-1950.43	1.49
2018 Dec	100	98	94	0.979	17136	28200	6511.68	98189.28	6340.32	22278.6	-2088.62	1.59
2019 Jan	100	71	71	0.982	18157	21300	6899.66	104039.6	8553.79	22523.7	-2111.6	1.61
2019 Feb	100	94	94	0.983	15072	28200	5727.36	86362.56	4059.44	19897.5	-1865.39	1.42
2019 Mar	100	94	94	0.935	18729	28200	7117	107317	7678	24050	0	1.74
2019 Apr	100	94	94	0.993	19056	29422	7050	110905	8575.2	24952.6	-4220	1.77
2019 May	100	45	71	0.993	17845	22223	6602	103857	8208	22542	-3844	1.60
2019 July	100	67	71	0.985	11260	22223	4166	65533	2702	15139	-2687	1.07
2019 Aug	100	70	71	0.987	18206	22223	6736	105958	127	21607	-3698	1.53
Min	100	45	71	0.935	11260	15620	4166	65533	127	15139	-4832.41	1.07
Max	100	98	94	0.993	21917	29422	17618.5	125584.4	15341.9	27576.8	0	1.96
Average	100	79	81	0.98	17504	24184.25	7383.88	100956.56	6152.69	22188.17	-2783.18	1.58
Total					210048	290211	88606.6	1211479	73832.23	266258	-33398.21	18.97

Observation:

- The contract demand is 100 kVA and the minimum billing demand 50% contract demand or 75% highest billing demand during preceding 11 months whichever is higher.
- Max demand recorded for the month Dec 2018 is 98 kVA which is less than contract demand.
- The average demand recorded for twelve months; from Aug 2018 to Aug 2019 is 81 kVA which is more than the minimum billed demand i.e. 50 kVA.
- The lowest & highest recorded demand in the month of May 2019 and Dec 2018 is 45 kVA and 98 kVA respectively.
- The average energy consumption is 17504 kWh.

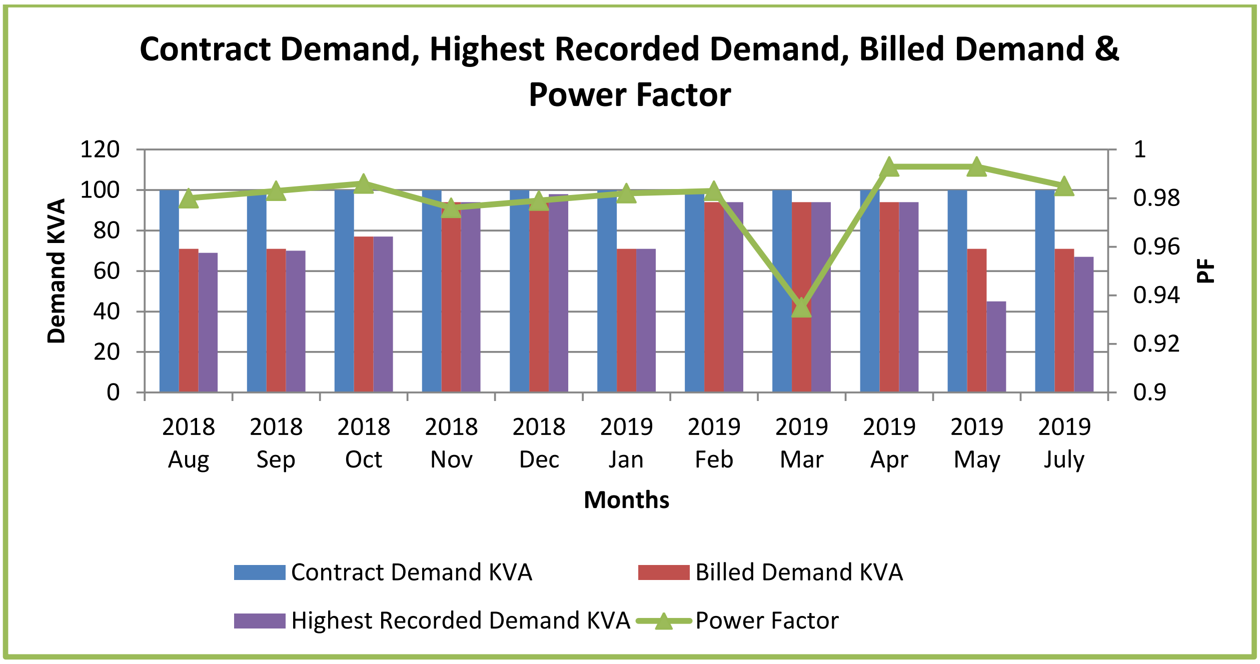


Figure 06: Contract Demand, Recorded Demand and PF Profile of Chandrabhaga Building

Observation:

- The maximum and minimum billed demand was 71 kVA in Oct 2018 and 94 kVA in Apr 2019 respectively.
- The power factor is maintained except Mar 2019.

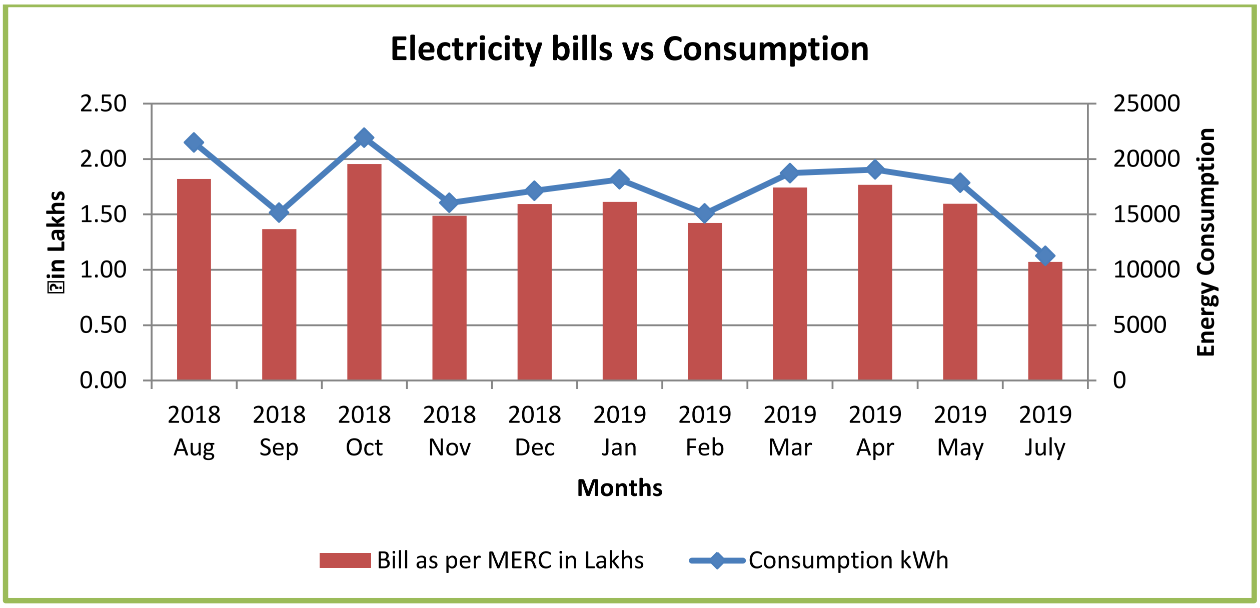


Figure 07: Annual Energy Consumption of Chandrabhaga Building

Observation:

- Energy consumption varies from 11260 to 21917 kWh from Jul 2019 to Oct 2018.
- The bill as per MERC for last twelve months is ₹18.97 in Lakhs.

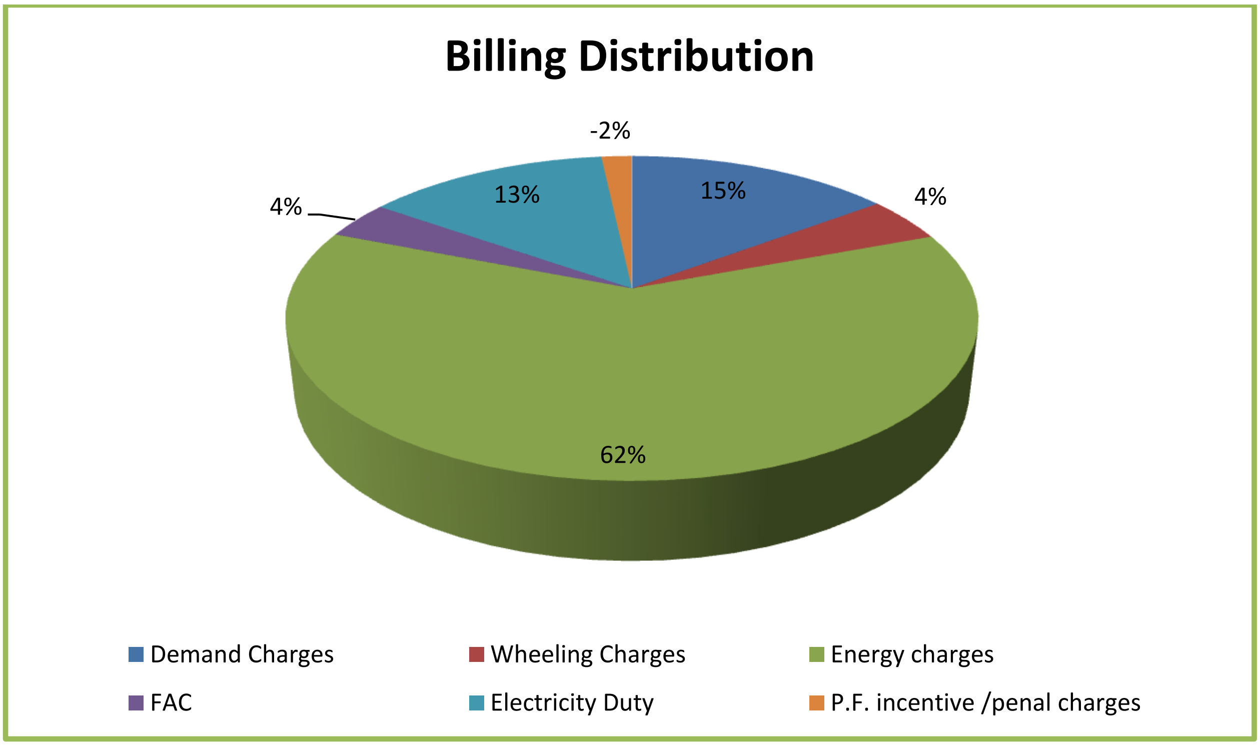


Figure 08: Billing Distribution of Chandrabhaga Building

Table 10: Electrical Bill Analysis of Gangotri Building

Month	Contract Demand KVA	Highest Recorded Demand KVA	Billed Demand KVA	Power Factor	Consumption kWh	Demand Charges	Wheeling Charges	Energy charges	TOD tariff EC	FAC	Electricity Duty	Tax on sale	P.F. incentive /penal charges	Bill as per MERC in Lakhs
2018 Aug	120	87	87	0.925	31746	23490	26031	217560	9336	5714	51062	807	0	3.34
2018 Sep	120	84	84	0.927	24198	19400	9195	148458	6998	12340	34842	200	0	2.31
2018 Oct	120	85	85	0.962	31566	29750	11995	194961	9172	30303	46792	287	-1380	3.22
2018 Nov	120	80	80	0.988	25402	28000	9652	159920	7211	8382	36567	293	-5329	2.45
2018 Dec	120	80	80	0.985	21010	28000	7983	133280	6023	12185	32260	263	-4686	2.15
2019 Jan	120	82	82	0.987	21856	28700	8305	132776	6500	16392	32316	346	-4816	2.21
2019 Feb	120	88	88	0.991	27304	30800	10375	174636	7983	11740	40772	835	-5888	2.71
2019 Mar	120	82	82	0.993	30794	28700	11701	214387	9069	19708	51438	1742	-7089	3.30
2019 Apr	120	72	72	0.993	27866	28152	10310	182131	8335	19784	43242	925	-6890	2.86
2019 May	120	55	66	0.991	24584	25806	9096	153081	7405	17946	36031	464	-6006	2.44
2019 July	120	62	66	0.982	18088	25806	6692	115523	5593	6873	27526	475	-3080	1.85
2019 Aug	120	95	95	0.995	31540	37145	11669	215720	9205	346	48979	1491	-10265	3.14
Min	120	55	66	0.925	18088	19400	6692	115523	5593	346	27526	200	0	1.85
Max	120	95	95	0.995	31746	37145	26031	217560	9336	30303	51438	1742	0	3.34
Average	120	79	81	0.977	26330	27812	11084	170203	7736	13476	40152	677	-4619	2.67
Total	-	-	-	-	315954	333749	133004	2042433	92830	161713	481827	8128	-55429	31.98

Observation:

- The contract demand is 120 kVA and the minimum billing demand 50% contract demand or 75% highest billing demand during preceding 11 months whichever is higher.
- Max demand recorded for the month Aug 2019 is 95 kVA which is less than contract demand.
- The average demand recorded for twelve months; from Aug 2018 to Aug 2019 is 79 kVA which is more than the minimum billed demand i.e. 60 kVA.
- The lowest & highest recorded demand in the month of May 2019 and Aug 2019 is 55 kVA and 95 kVA respectively.
- The average energy consumption is 26330 kWh.

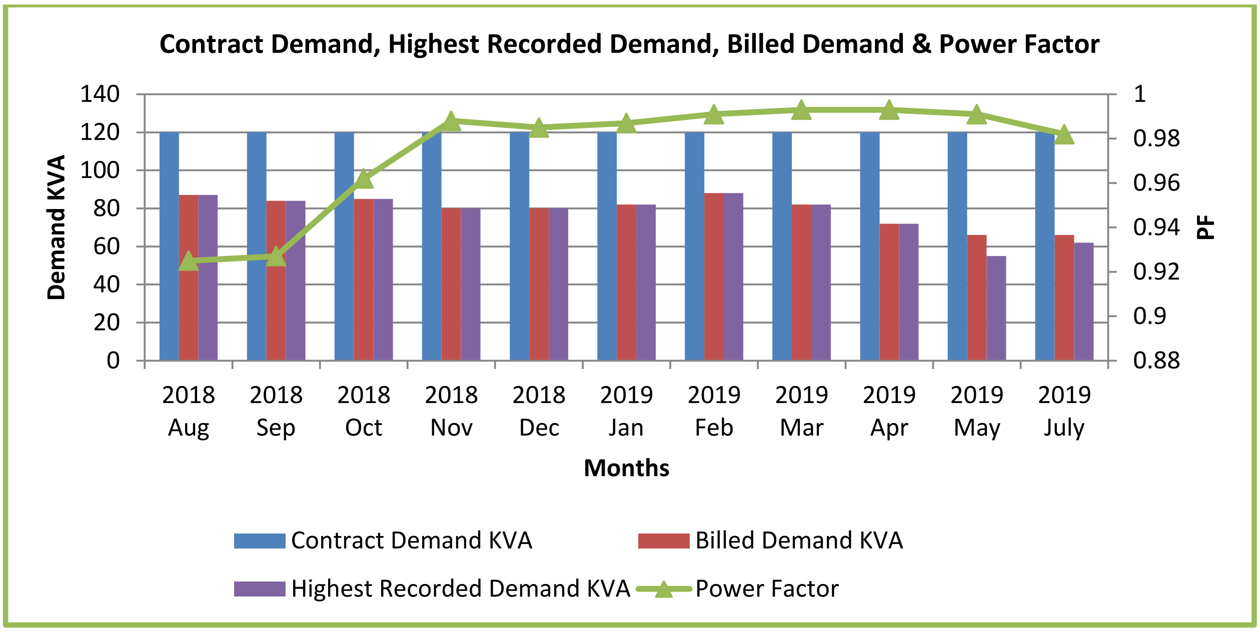


Figure 09: Contract Demand, Recorded Demand and PF Profile of Gangotri Building

Observation:

- The maximum and minimum billed demand was 66 kVA in May 2019 and 95 kVA in Aug 2019 respectively.
- The power factor is maintained except Aug, Sep 2018.

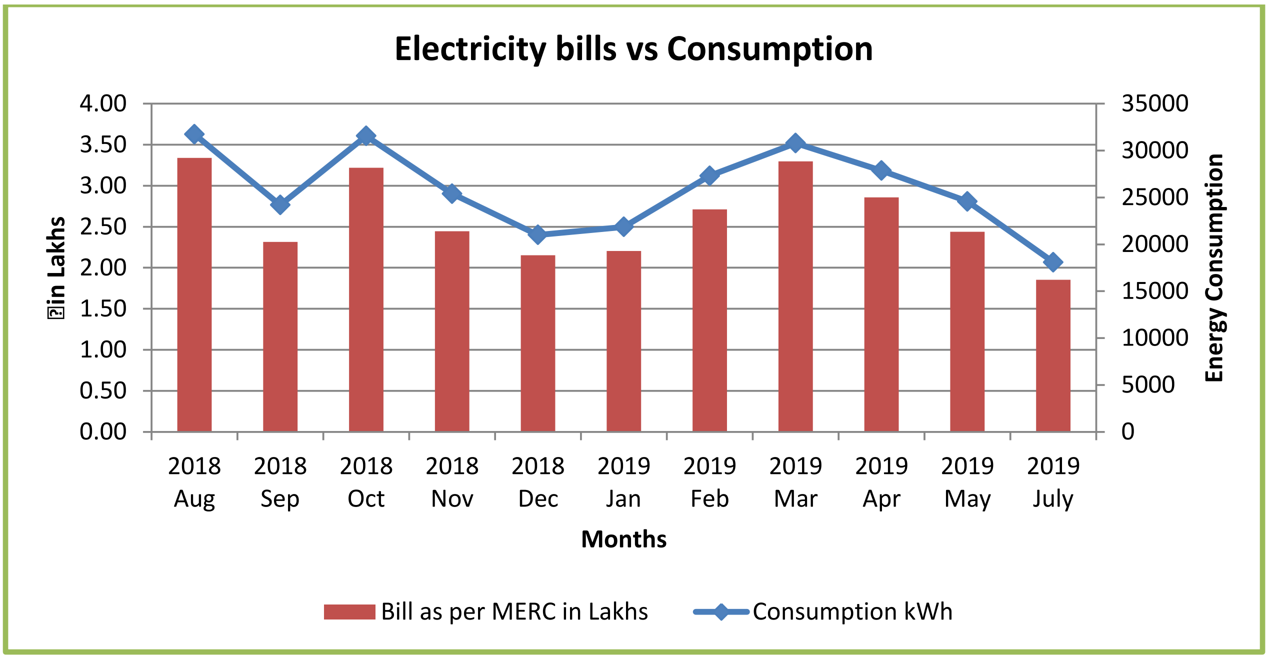


Figure 10: Annual Energy Consumption of Gangotri Building

Observation:

- Energy consumption varies from 18088 to 31746 kWh for Jul 2019 to Aug 2018.
- The bill as per MERC for last twelve months is □31.98 in Lakhs.

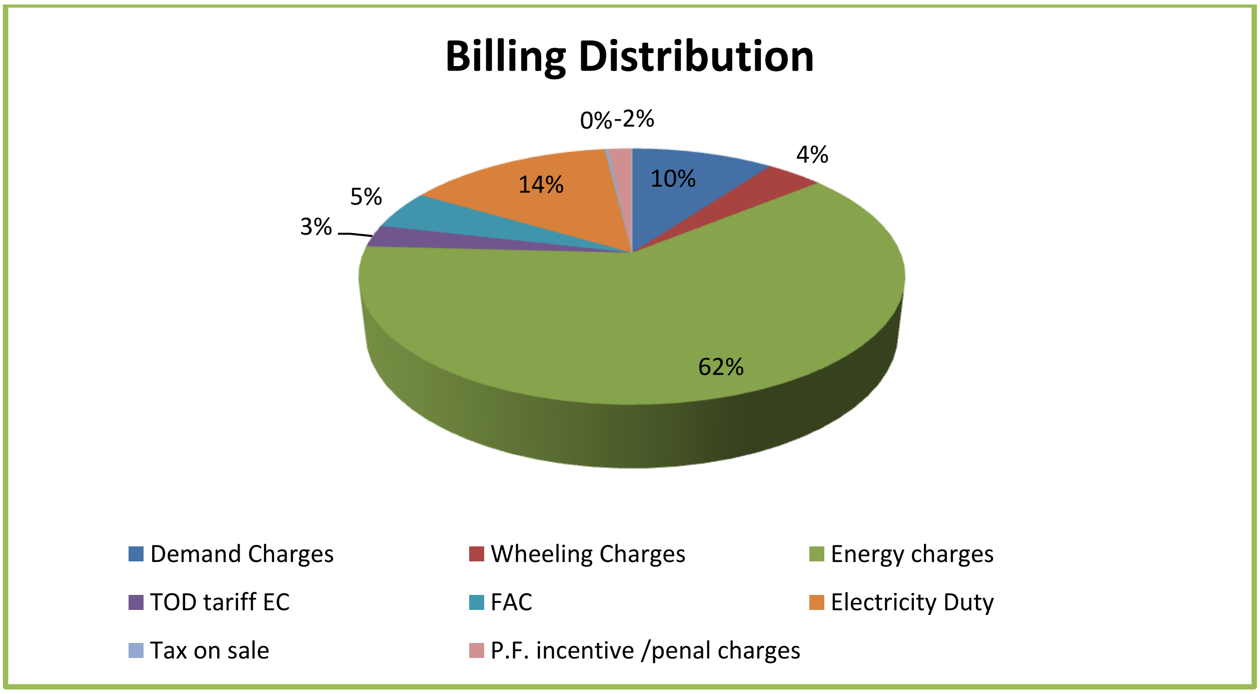


Figure 11: Billing Distribution of Gangotri Building

3.1.2 Transformer Details

In DBATU there are 3 transformers. These transformers receive power from MSEDCL. Supply voltage to transformer is 22 kV. Following table shows the details of transformer

Table 11: Transformer details

Sr. No.	Name of transformer	Capacity in kVA
1	Main degree building	500
2	Gangotri	200
3	Malaygiri & Dhawalgiri	200

Figure 12: Supply Voltage from MSEDCL

Figure 13: Transformer images

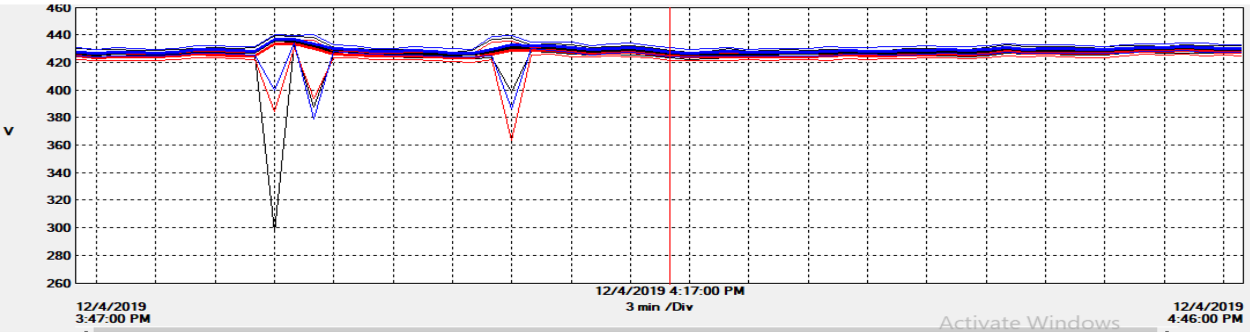


Figure 14: Voltage Profile of Transformer (Main Building)

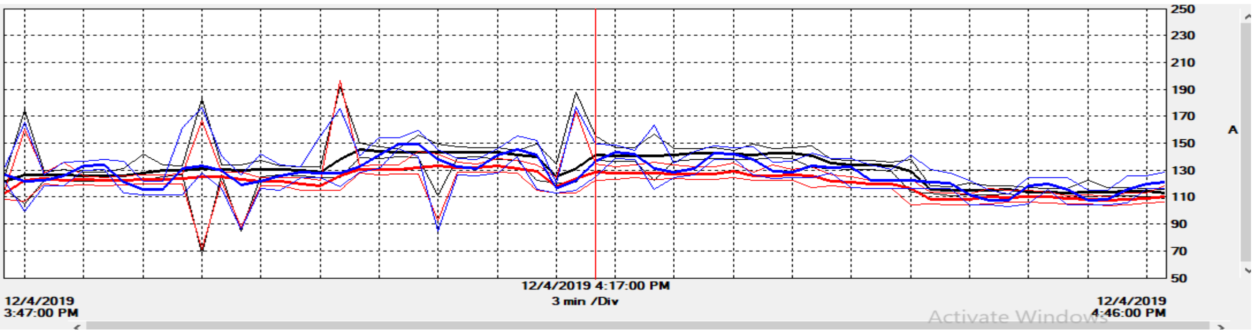


Figure 15: Current Profile of Transformer

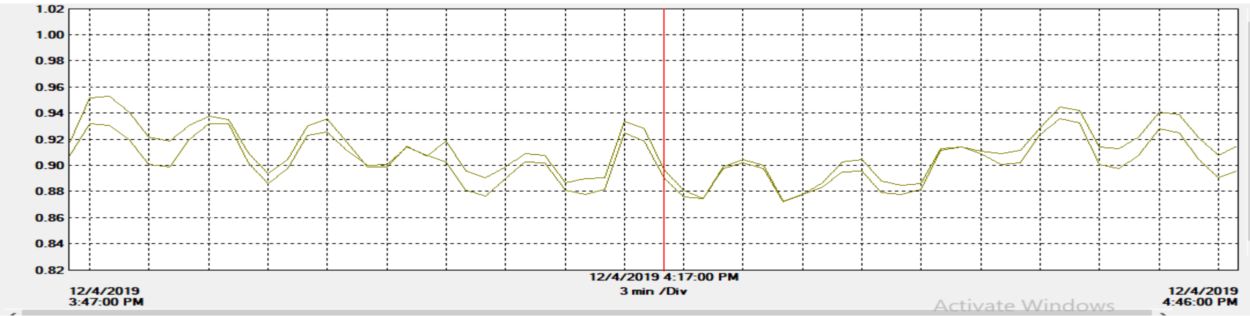
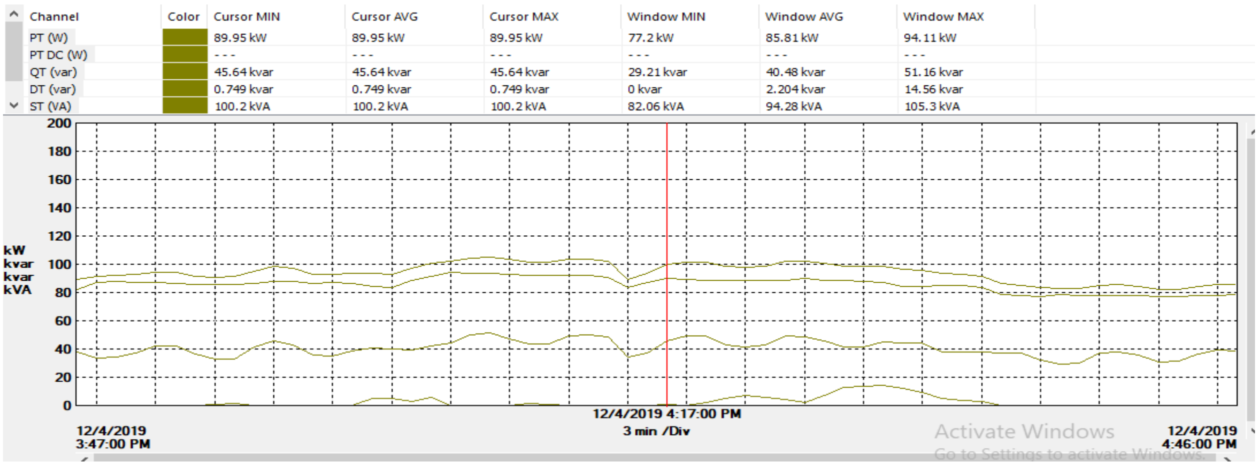


Figure 16: Power Factor Profile Transformer



Channel	Color	Cursor MIN	Cursor AVG	Cursor MAX	Window MIN	Window AVG	Window MAX
PT (W)		89.95 kW	89.95 kW	89.95 kW	77.2 kW	85.81 kW	94.11 kW
PT DC (W)		---	---	---	---	---	---
QT (var)		45.64 kvar	45.64 kvar	45.64 kvar	29.21 kvar	40.48 kvar	51.16 kvar
DT (var)		0.749 kvar	0.749 kvar	0.749 kvar	0 kvar	2.204 kvar	14.56 kvar
ST (VA)		100.2 kVA	100.2 kVA	100.2 kVA	82.06 kVA	94.28 kVA	105.3 kVA

Figure 17: Power Profile of Transformer

3.1.3 Harmonics

Harmonic of a wave is the wave which has frequency as the positive integer multiple of the frequency of the original wave, known as the fundamental frequency.

Electrical loads can be classified as linear and non-linear loads. A linear load is one, which draws a sinusoidal current when subjected to sinusoidal voltage. The current wave may or may not have a phase difference with respect to the voltage. A pure resistance, inductance or capacitance or any combination of these forms a linear load. On the contrary, a non-linear load is one, which draws non-sinusoidal or pulsating current when subjected to sinusoidal voltage.

Any non-sinusoidal current can be mathematically resolved into a series of sinusoidal components (Fourier series). The first component is called as fundamental and the remaining components whose frequencies are integral multiples of the fundamental frequency are known as harmonics. If the fundamental frequency is 50 Hz, then 2nd harmonic will have a frequency of 100Hz and the 3rd will have 150Hz and so on.

Non-linear loads that draw current in abrupt pulses rather than a smooth sinusoidal manner create harmonics. The pulses of current cause distorted current wave shape, which in turn cause harmonic currents to flow back into other parts of the power system.

3.1.3.1 Current Harmonics

In a normal alternating current power system, the current drawn by a linear load will be sinusoidal at the specified frequency. The current wave may or may not have a phase difference with respect to the voltage. Current harmonics are caused by non-linear loads which draw current that is not necessarily sinusoidal. The current wave form can be distorted and complex depending on the load and the interaction between other components of the system. Using Fourier series, the complex wave form can be resolved into simple sinusoidal waves of multiple frequency for analysis purpose.

Any non-sinusoidal current can be mathematically resolved into a series of sinusoidal components (Fourier series). The first component is called as fundamental and the remaining components whose frequencies are integral multiples of the fundamental frequency are known as harmonics. If the fundamental frequency is 50 Hz, then 2nd harmonic will have a frequency of 100Hz and the 3rd will have 150Hz and so on.

3.1.3.2 Voltage Harmonics

Main reason for voltage harmonics is current harmonics. The voltage wave form from voltage source is distorted by the current harmonics due to source impedance. Larger the source impedance, higher will be the voltage harmonics caused by current harmonics. It is typically the case that voltage harmonics are indeed small compared to current harmonics.

Thus, harmonic voltage can be defined as the product of harmonic current and source impedance at the harmonic frequency.

The source impedance includes the Impedance of the power source (Transformer, Generator, and Grid etc.), Impedance of the Bus bars, Cables, Switchgears and other loads in the network.

Harmonics table

Table 12: Details of Harmonics

Name of the lab	R			Remarks
	Volts	Amps	Harmonics	
Computer center	230.4	2.66	30%	More than standard
Computer Lab	230.3	2.46	16%	More than standard
Computer Lab	230.5	1.73	28%	More than standard
Computer Lab	230	4.13	15%	More than standard

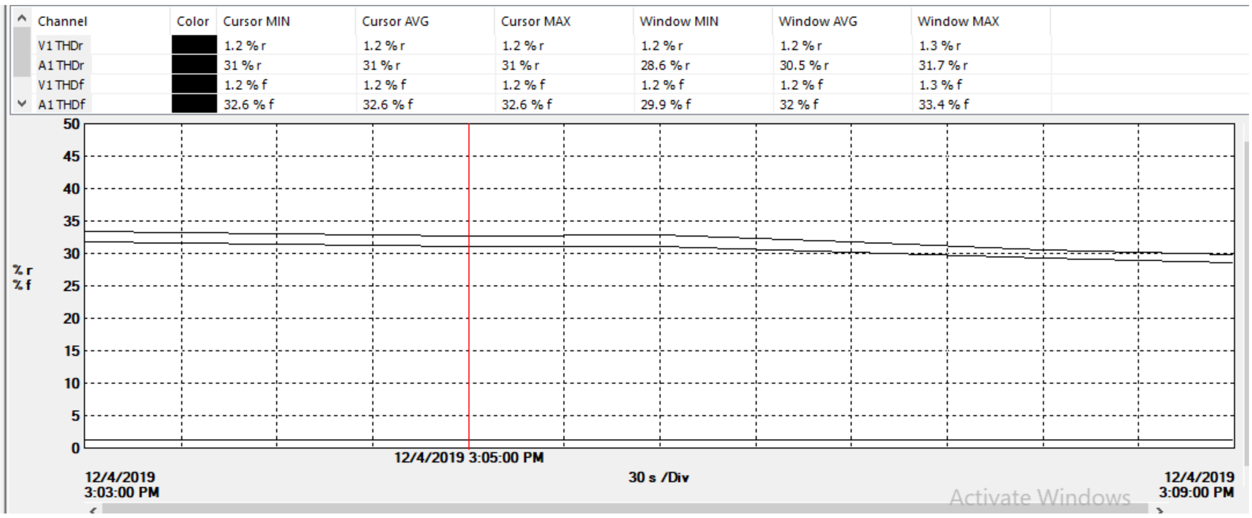


Figure 18: Harmonic Profile of Computer Center

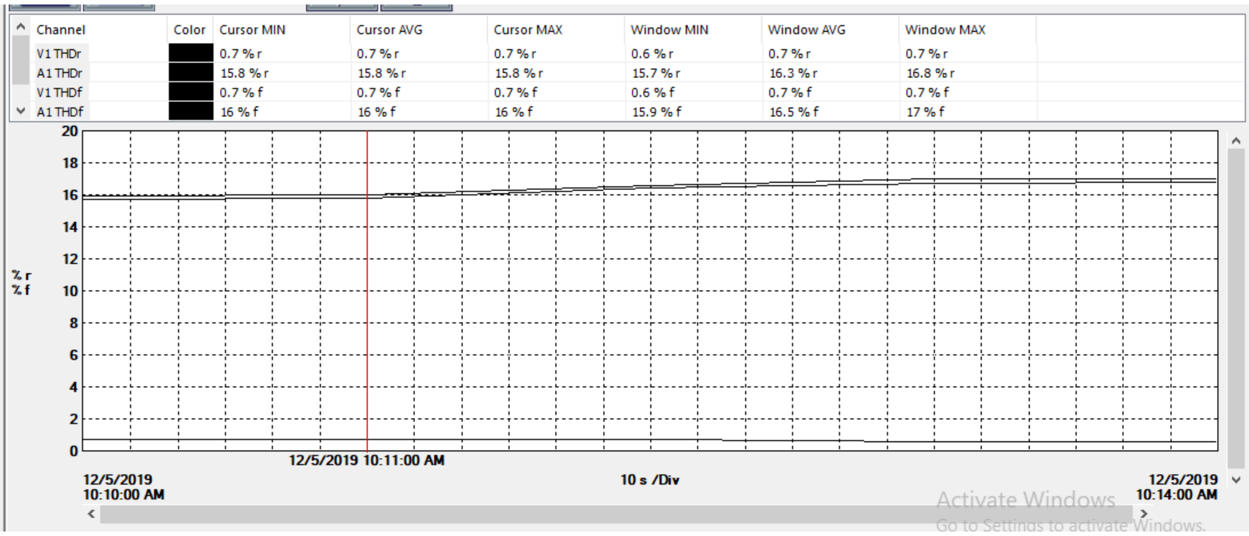


Figure 19: Harmonic Profile of Computer Lab

3.1.4 Diesel Generator

In DBATU there are 3 DG sets. Following table shows the details of transformer

Table 13: DG sets details

Sr. No.	Name of DG set	Capacity in kVA	Usage (Lit)
1	Main degree building DG set	63	291
2	Class room	30	90
Total		**93**	**381**

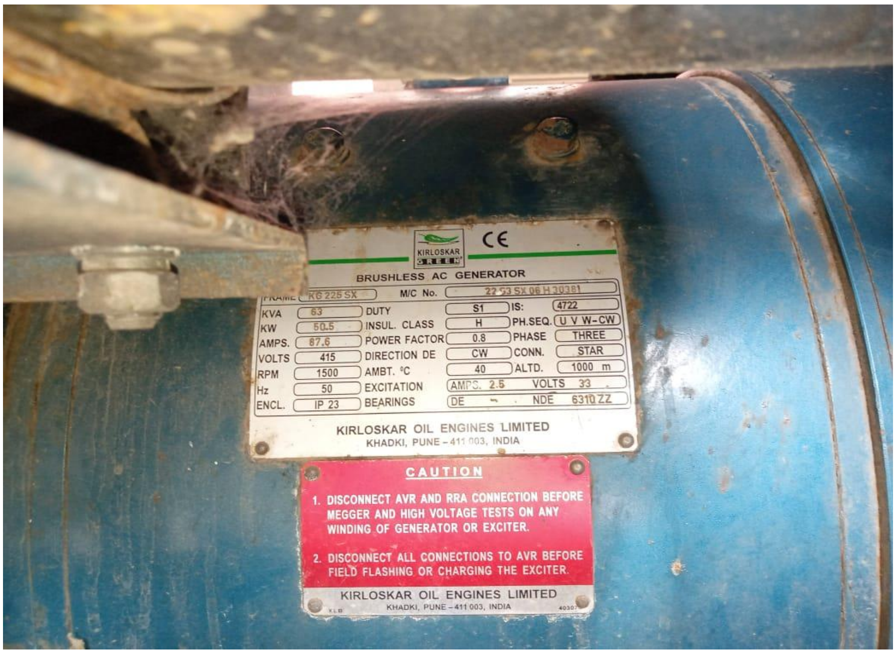


Figure 20: DG set

Figure 21: Glimpse of while taking reading

3.2 Water Pump

The performance analysis of the pumps used for water required for the institute is done based on the present operating parameters like water flow, head and power. Pumps of different capacities are installed based on the water flow requirement at different sections of the plant. The water supply of the institute is met by open well. There are number of pumps are running mainly in the institute campus.

Daily consumption of DBATU campus is around 6.5 to 7 lakhs of lit. The water from the Goregaon dam is supplied to the campus. There are 2 pumps in Goregaon with a capacity of 10 kW and 7.5 kW used to supply water to campus. Then this water gets filtered in and then supplied to the various areas in the university campus.

Figure 22: Snapshot of power analyzer reading of Water pump

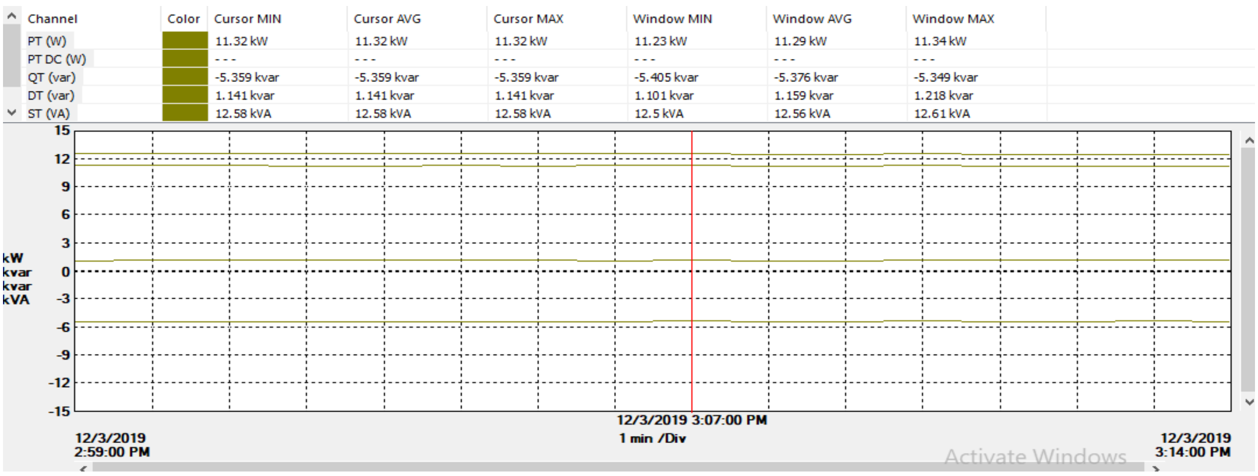


Figure 23: Power profile of Goregaon water pump (10 kW)

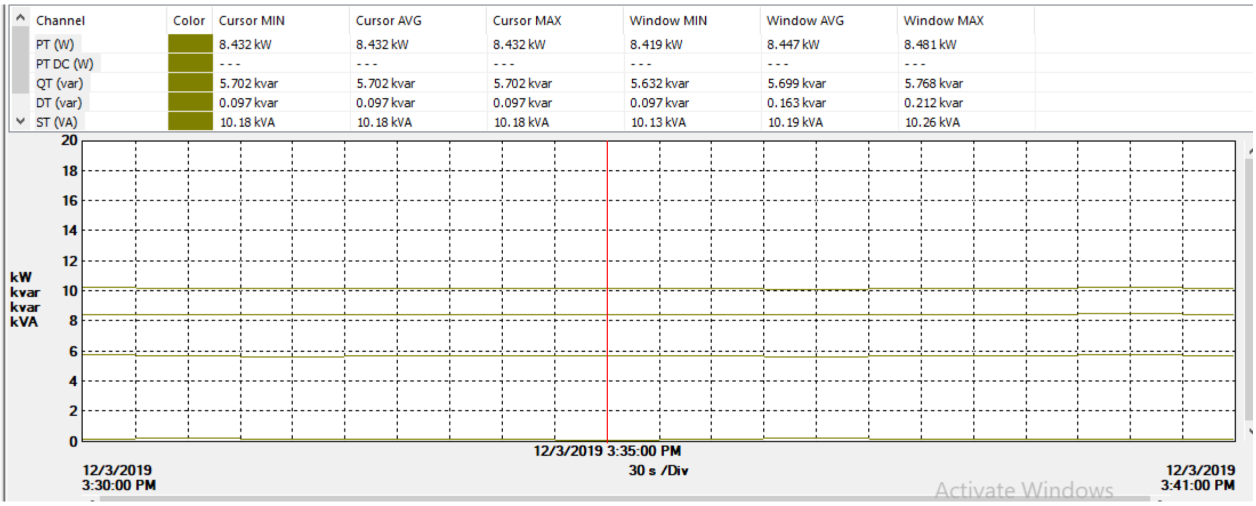


Figure 24: Power profile of Goregaon water pump (7.5 kW)

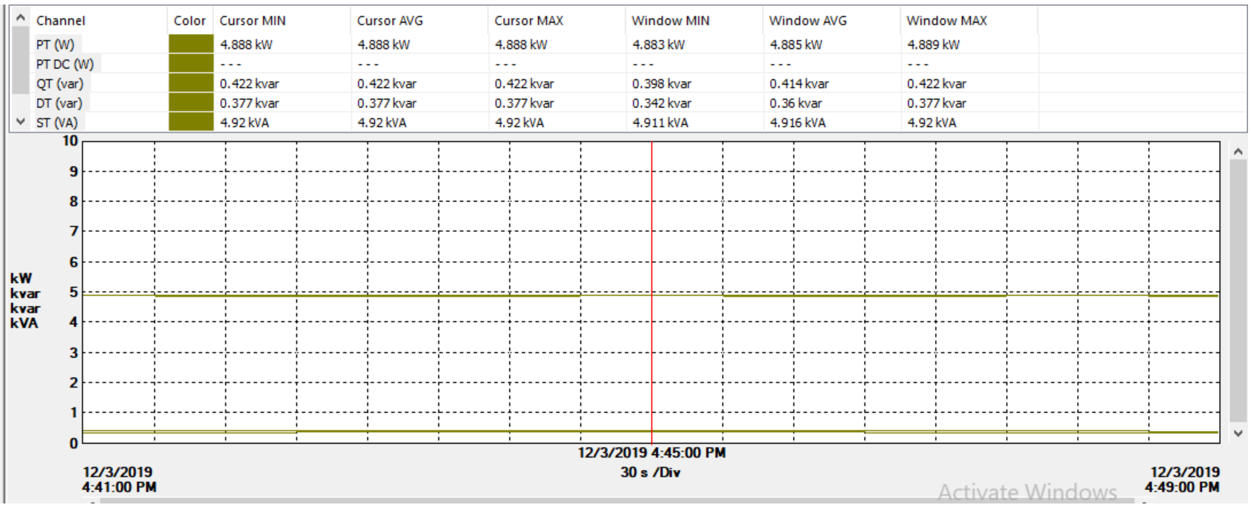


Figure 25: Power profile of Filter water pump 1

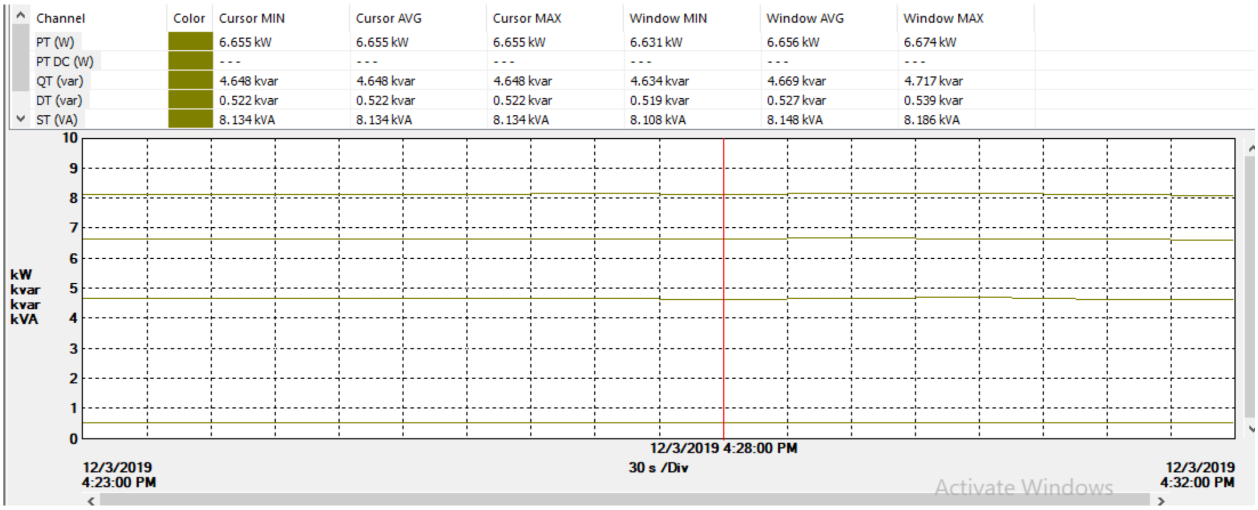


Figure 26: Power profile of Filter water pump 2

Channel	Color	Cursor MIN	Cursor AVG	Cursor MAX	Window MIN	Window AVG	Window MAX
PT (W)		8.36 kW	8.36 kW	8.36 kW	8.36 kW	8.394 kW	8.44 kW
PT DC (W)		---	---	---	---	---	---
QT (var)		5.326 kvar	5.326 kvar	5.326 kvar	5.25 kvar	5.308 kvar	5.378 kvar
DT (var)		0.034 kvar	0.034 kvar	0.034 kvar	0 kvar	0.059 kvar	0.159 kvar
ST (VA)		9.912 kVA	9.912 kVA	9.912 kVA	9.912 kVA	9.931 kVA	9.966 kVA

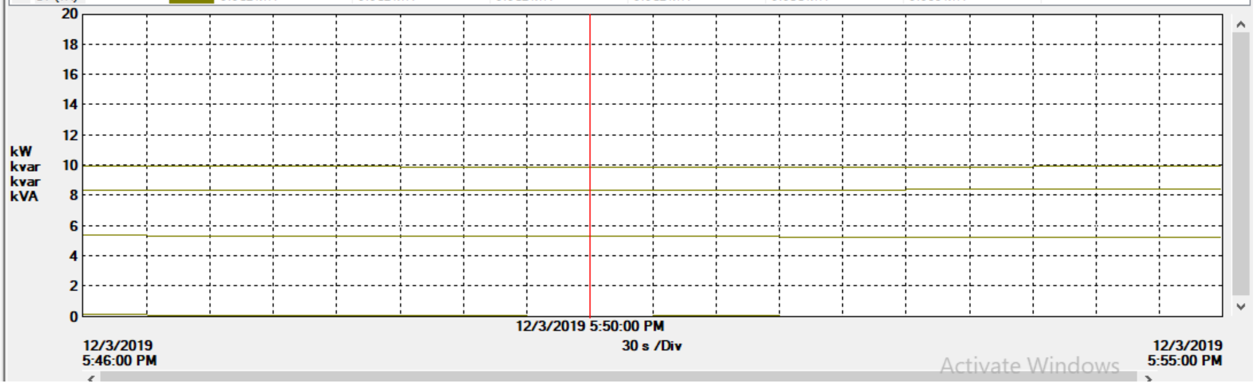


Figure 27: Power profile of Gagangiri well water pump

Channel	Color	Cursor MIN	Cursor AVG	Cursor MAX	Window MIN	Window AVG	Window MAX
PT (W)		3.619 kW	3.619 kW	3.619 kW	3.618 kW	3.621 kW	3.627 kW
PT DC (W)		---	---	---	---	---	---
QT (var)		2.528 kvar	2.528 kvar	2.528 kvar	2.517 kvar	2.533 kvar	2.555 kvar
DT (var)		0 kvar	0 kvar	0 kvar	0 kvar	0 kvar	0 kvar
ST (VA)		4.393 kVA	4.393 kVA	4.393 kVA	4.386 kVA	4.397 kVA	4.415 kVA

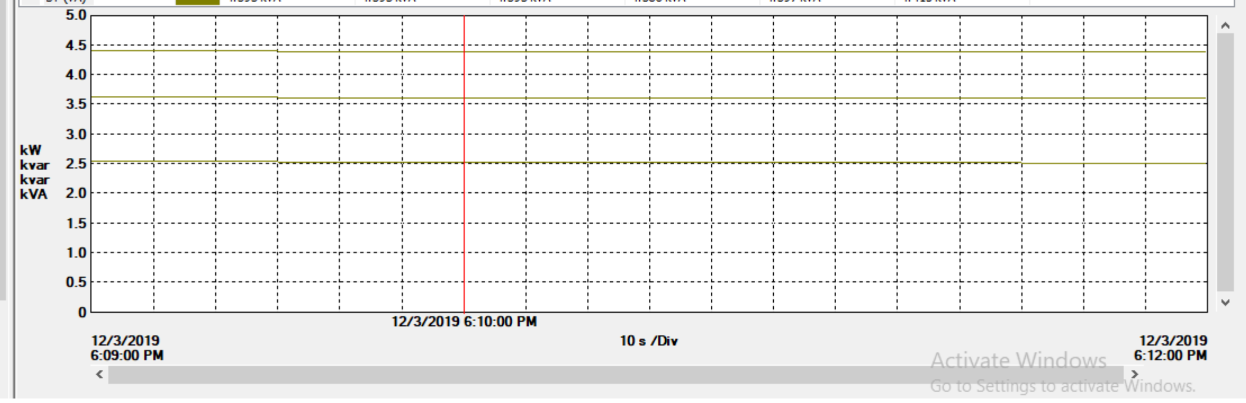


Figure 28: Power profile of Gagangiri tank

Channel	Color	Cursor MIN	Cursor AVG	Cursor MAX	Window MIN	Window AVG	Window MAX
PT (W)		3.955 kW	3.955 kW	3.955 kW	3.895 kW	3.936 kW	3.972 kW
PT DC (W)		---	---	---	---	---	---
QT (var)		-1.672 kvar	-1.672 kvar	-1.672 kvar	-1.678 kvar	-1.671 kvar	-1.667 kvar
DT (var)		0.038 kvar	0.038 kvar	0.038 kvar	0 kvar	0.01 kvar	0.038 kvar
ST (VA)		4.294 kVA	4.294 kVA	4.294 kVA	4.236 kVA	4.274 kVA	4.308 kVA

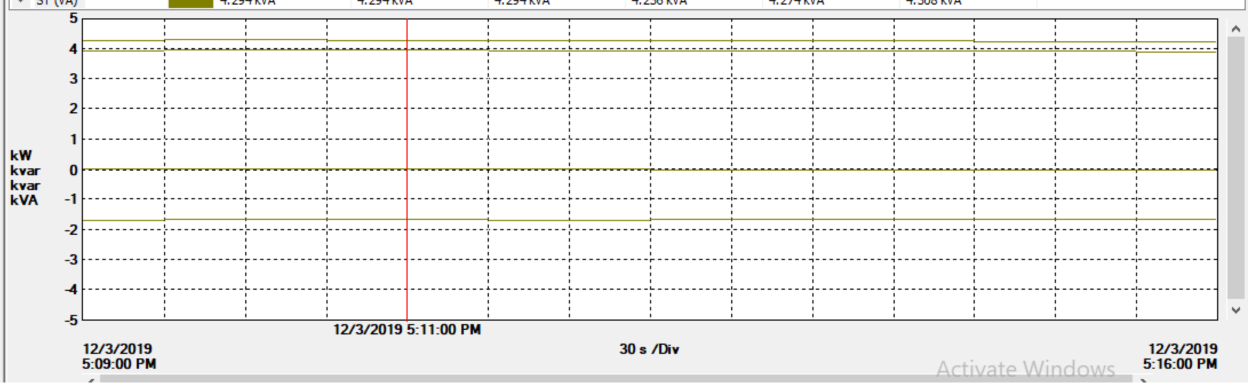


Figure 29: Power profile of Malaygiri tank

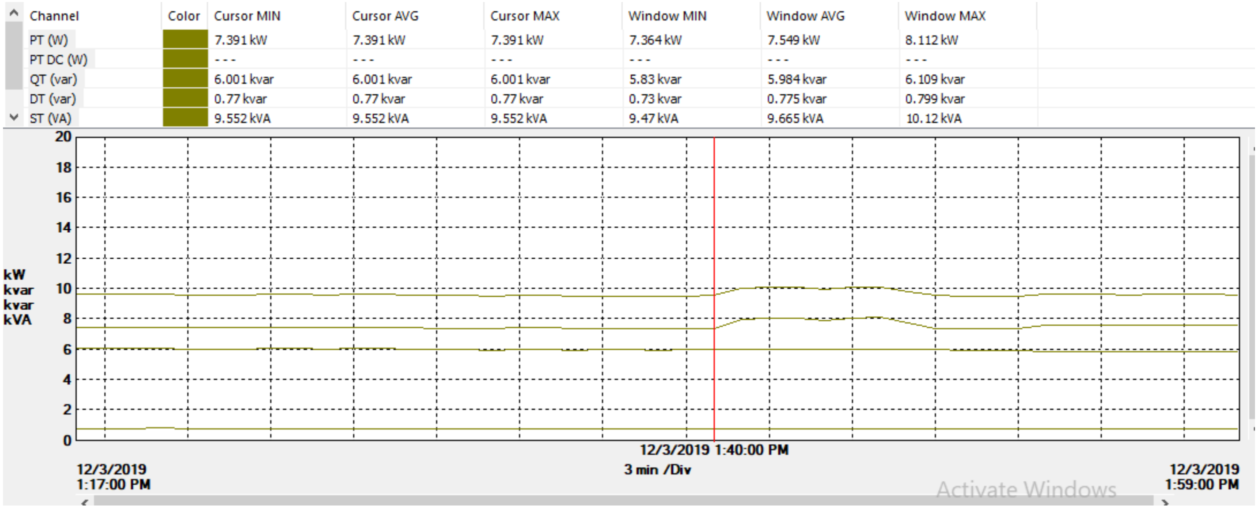


Figure 30: Power profile of main building water pump

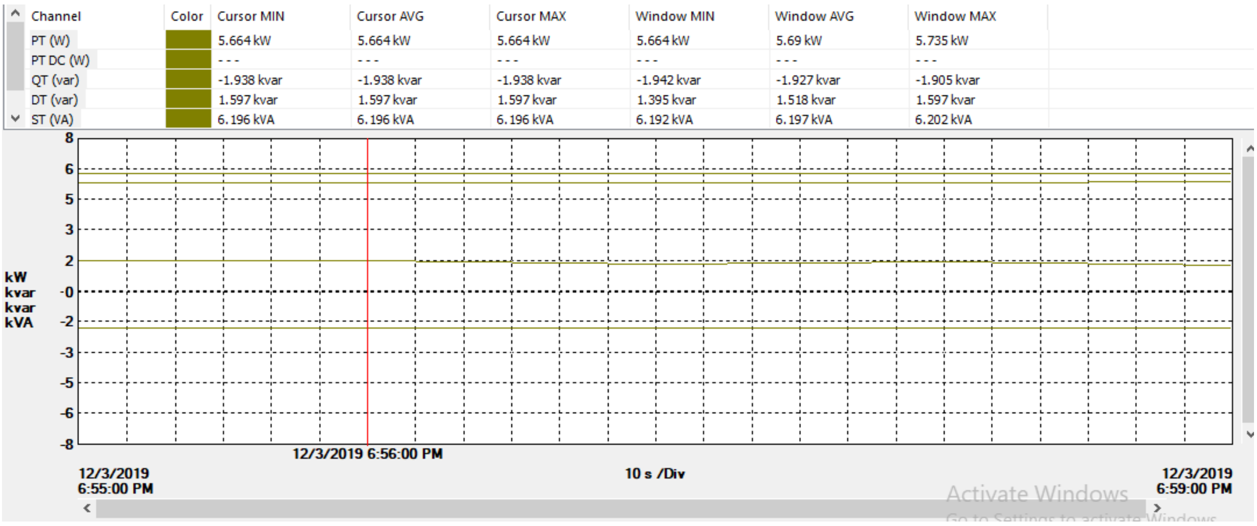


Figure 31: Power profile of quarters tank water pump

Following are the water tank capacity details in DBATU Campus.

- Hexagonal tank -1.25 lakh liters
- Main building back side tank 60000 liters
- Malaygiri Hostel tank 65000 liters
- Gagangiri Hostel tank 75000 liters
- Dhawalgiri Hostel tank 65000 liters
- IOPE tank 45000 liters
- Quarters tank 25000 liters

The Performance Analysis of the Pumps is given below.

Table 14: Water Pump Performance Analysis

Description	Units	Main building backside	Goregaon pump		Filter pump		Malaygiri hostel	Gagangiri well	Gagangiri/ Sahyagiri tank	Satff Quarter
Design parameter										
Rated output	kW	7.5	10	7.5	5.5	7.45	3.7	5.5	3.7	5.5
No. of pumps	Nos	2	1	1	1	1	1	1	1	1
Type		Open well submersible	Bore well submersible	Bore well submersible	Open well submersible	Open well submersible	Mono-block	Open well submersible	Mono-block	Mono-block
Make		Kirloskar	Kirloskar	Kirloskar	Kirloskar	Kirloskar	Kirloskar	Kirloskar	Kirloskar	Kirloskar
Measured parameter										
Voltage V1	Volts	428.8	406.5	407.5	413.4	413.8	399.2	398	392.5	383.9
Voltage V2	Volts	425.5	401	402.2	412.3	412.8	398.5	396.2	388.9	371.9
Voltage V3	Volts	426.5	400.8	401.6	411.5	411.9	395	393.5	391.6	382.9
Average Voltage V	Volts	426.93	402.77	403.77	412.40	412.83	397.57	395.90	391.00	379.57
Voltage unbalance	%	0.44	0.93	0.92	0.24	0.23	0.41	0.53	0.38	1.14
Current A1	Amps	13.44	16.82	13.51	11.72	6.79	6.46	14.08	6.26	7.64
Current A2	Amps	12.24	19.04	15.3	11.14	6.82	6	14.18	6.48	9.44
Current A3	Amps	13.48	18.06	14.82	11.33	7	6.15	15.15	6.7	10.89
Average Current A	Amps	13.05	17.97	14.54	11.40	6.87	6.20	14.47	6.48	9.32
Power factor		0.78	0.89	0.828	0.817	0.993	0.92	0.845	0.823	0.918
Power	kW	7.55	11.29	8.447	6.656	4.885	3.936	8.394	3.621	5.69
Method of starting	DOL/VFD	DOL	Star delta	DOL	Star delta	Star delta	DOL	Star delta	DOL	Star delta

Observations:

- The pumps which are used are more than 15 years old.
- The motor input power is varying from 3.9 kW to 11.29 kW.

The replacement options for the pumps with poor operating performance is given in the ECM section of the report.

3.3 Air Conditioning

In WCE split AC are used for server room, computer lab & faculty cabin. The list AC in WCE is as follows.

Table 15: AC Details with Location

Sr. No.	Name	AC 1 ton	AC 1.5 ton	AC 5.5 ton
1	Registrar Office	1		1
2	Establishment and account section		1	
3	VC office	2	5	2
4	Conference Hall			2
5	Edusat and Analytical			2
6	Student section		3	1
7	CNC Lab		2	
8	Computer center			7
11	Petrochemical Department			1
14	Exam Department		1	
18	Electronic		2	
21	Computer Department		4	
22	IT Department			1
23	Anandvan Guest House		9	
24	Raigad Darshan		6	
25	Indrayani		5	
26	Savitri		5	
27	Godavari		5	
28	Vainganga		5	
29	Panchganga		5	
30	Krishna		5	
31	Kaveri		5	
Total		**3**	**68**	**17**

The performances of AC of different companies are shown below.

Table 16: Split AC performances

Title	Units	Value	Value	Value
Designed Parameters				
Make	-	Godrej	Carrier	Voltas
Type	-	Split	Split	Split
Cooling Capacity	Ton	1	1.25	1
Inverter	-	-	-	-
Star rating	Nos	-	-	2
Energy Consumption	kW	-	-	1.099
Operating Parameters				
Voltage	Volts	241.8	249.3	240.4
Current	Amps	7.74	8.7	5.6
Power Factor	-	0.746	0.75	0.86
Output Power	kW	1.35	1.51	1.095

Observation:

- Godrej (old) and Carrier AC is not star labelled.

Table 17: Package AC performance

Description	Units	Value	Value	Value
Design parameter				
Make	-	Carrier	Blue star	Blue star
Cooling Capacity	Ton	5.5	5.5	5.5
Rated output	kW	7.5	3.7	5.5
No. of pumps	Nos	7	1	1
Type	-	Packaged	Packaged	Packaged
Measured parameter				
Voltage V1	Volts	380.9	426.9	423.7
Voltage V2	Volts	378.8	426.2	423.1
Voltage V3	Volts	383	424.3	421.2
Average Voltage V	Volts	380.90	425.80	422.67
Voltage unbalance	%	0.55	0.26	0.24
Current A1	Amps	9.79	9.75	9.84
Current A2	Amps	9.56	7.37	7.46
Current A3	Amps	7.52	6.99	7.1
Average Current A	Amps	8.96	8.04	8.13
Power factor	-	0.704	0.88	0.878
Power	kW	5.14	5.333	5.292

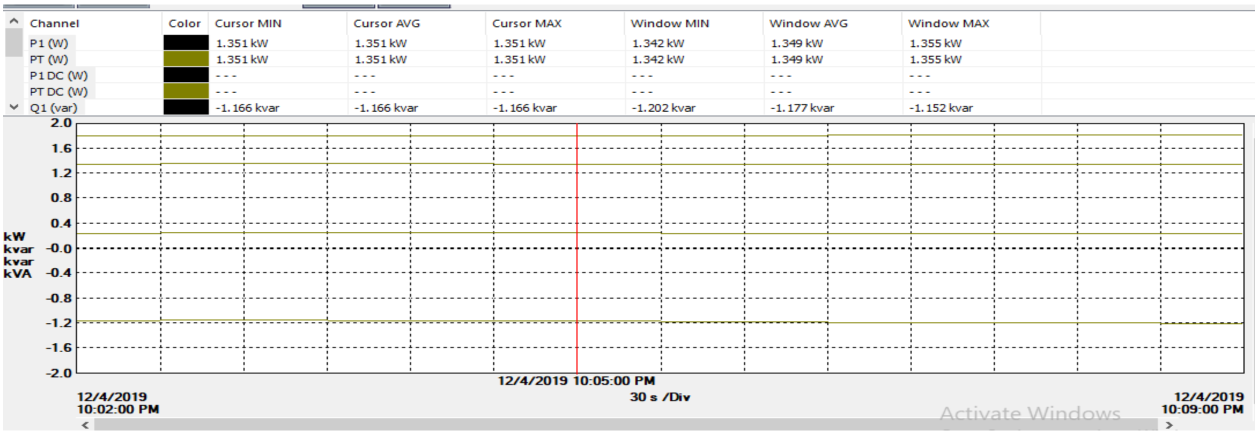


Figure 32: Power consumption of split AC 1 Ton

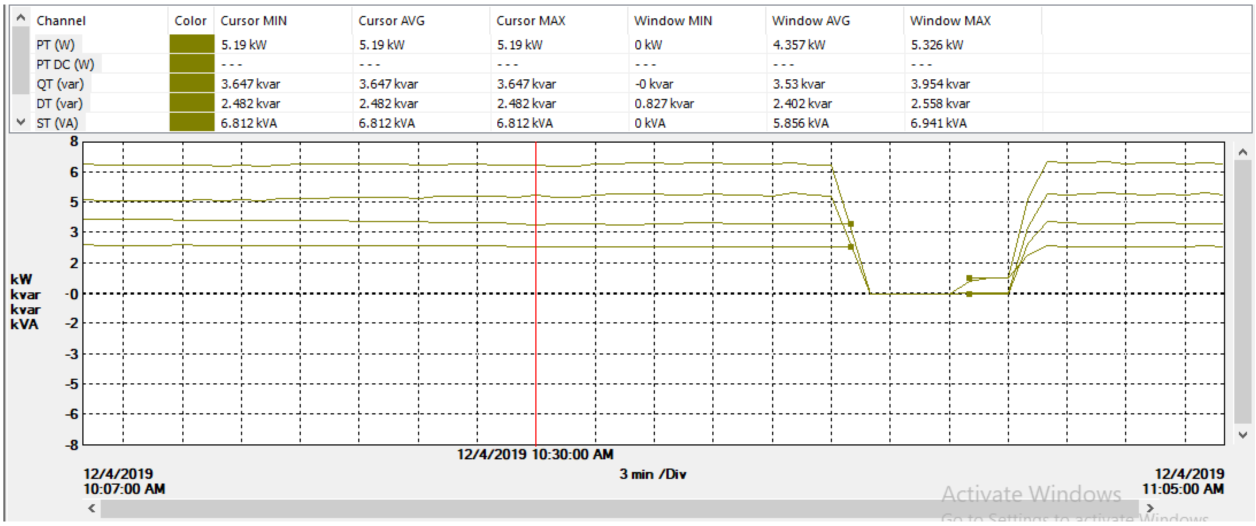


Figure 33: Power consumption of 5.5 Ton carrier AC (Package)

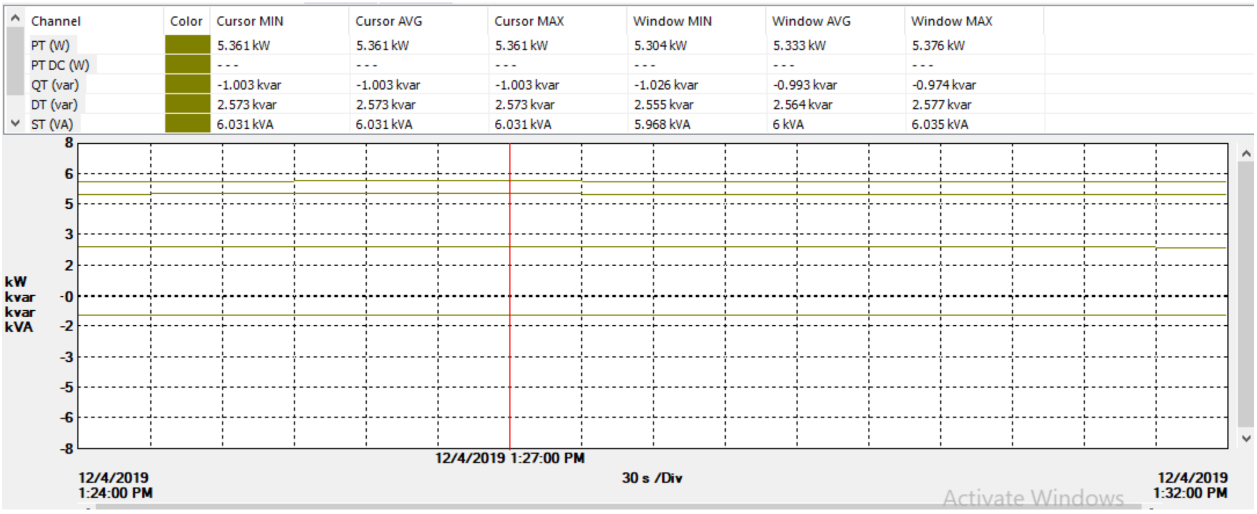


Figure 34: Power consumption of 5.5 Ton Blue Star AC (Package)

3.4 Lighting System

Lighting is provided in commercial buildings, indoor and outdoor for providing comfortable working environment. The primary objective is to provide the required lighting effect for the lowest installed load i.e. highest lighting at lowest power consumption. There are number of buildings in DBATU Campus. The details of inventories are shown in the table.

Table 18: Main building lighting inventory

Sr. No.	Name	PC	CFL 11 W	CFL 18 W	LED 45 W	Tube Light	Fan	Wall fan
1	Registrar Office	3		10		12	7	
2	Establishment and account section	18		0		40	20	
3	VC office	12		10		60	10	
4	Conference Hall			20		12	6	
5	Edusat and Analytical	10		10		36	18	
6	Student section	6				18	8	
7	CNC Lab	4				12	6	
8	Computer centre	60		40		20	4	
9	T&P	4		10				4
10	Class room complex					220	180	
11	Petrochemical Department	5				8	6	
12	Library	32				100	80	
13	Canteen							
14	Exam Department	10				40	18	
15	Mechanical	35				16	12	
16	Chemical and Petrochemical	10		24		20		
17	Electrical	30				40	30	
18	Electronic	20				24	18	
19	Physics	6				10	8	
20	Passage		500			120		
21	Computer Department	70				50	50	
22	IT Department	70				50	50	
23	Street Light				150			
Total		**405**	**500**	**124**	**150**	**908**	**531**	**4**

Table 19: Hostel inventory

Sr. No.	Name	PC	Tube Light	Fan	Exhaust fan
1	Sahyagiri	2	170	150	6
2	Gagangiri	2	210	190	6
3	Dhavalgiri	2	170	150	6
4	Malaygiri	2	170	150	6
5	Alaknanda	2	110	90	6
Total		**10**	**830**	**730**	**30**

Table 20: Guest House inventory

Sr. No.	Name	PC	Tube Light	Fan
1	Anandvan Guest House	2	100	80
2	Raigad Darshan	2	28	14
Total		**4**	**128**	**94**

Table 21: Quarters inventory

Sr. No.	Name	CFL 18 W	Tube Light	Fan	Exhaust fan
1	Indrayani	24	48	48	12
2	Savitri	24	48	48	12
3	Godavari	24	48	48	12
4	Vainganga	16	48	40	8
5	Panchganga	16	48	40	8
6	Krishna	16	48	40	8
7	Kaveri	16	48	40	8
8	Gomati	15	36	36	6
9	Saraswati	15	36	36	6
10	Sabarmati	15	36	36	6
11	Chandrabhaga	12	24	24	
Total		**193**	**468**	**436**	**86**

3.4.1 Purpose of the Performance Test

Most interior lighting requirements are for meeting average illuminance on a horizontal plane, either throughout the interior, or in specific areas within the interior combined with general lighting of lower value. The purpose of performance test is to calculate the installed efficacy in terms of lux/watt/m² (existing or design) for general lighting installation. The calculated value can be compared with the norms for specific types of interior installations for assessing Improvement options. The installed load efficacy of an existing (or design) lighting installation can be as follows

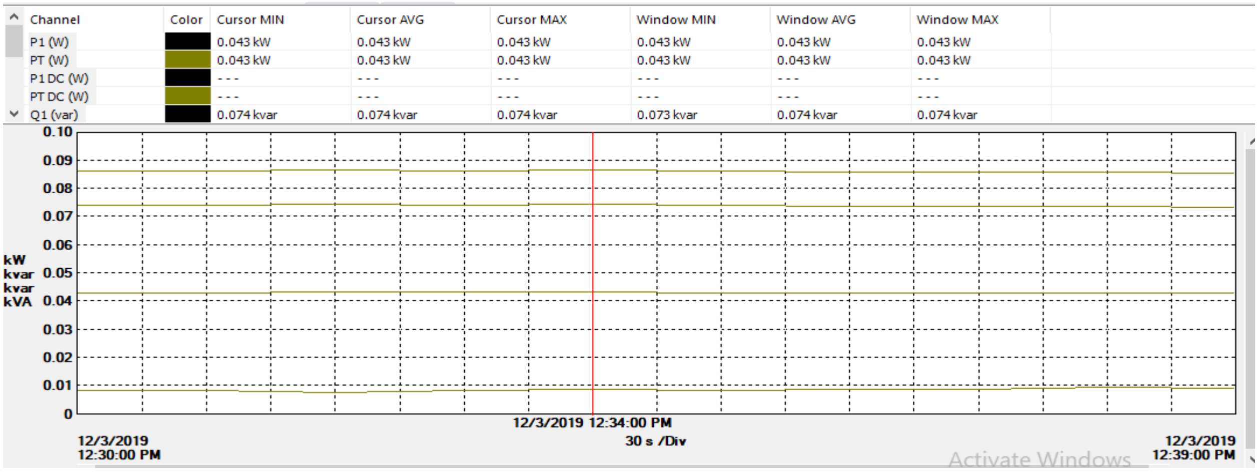


Figure 35: Power consumption of tube light

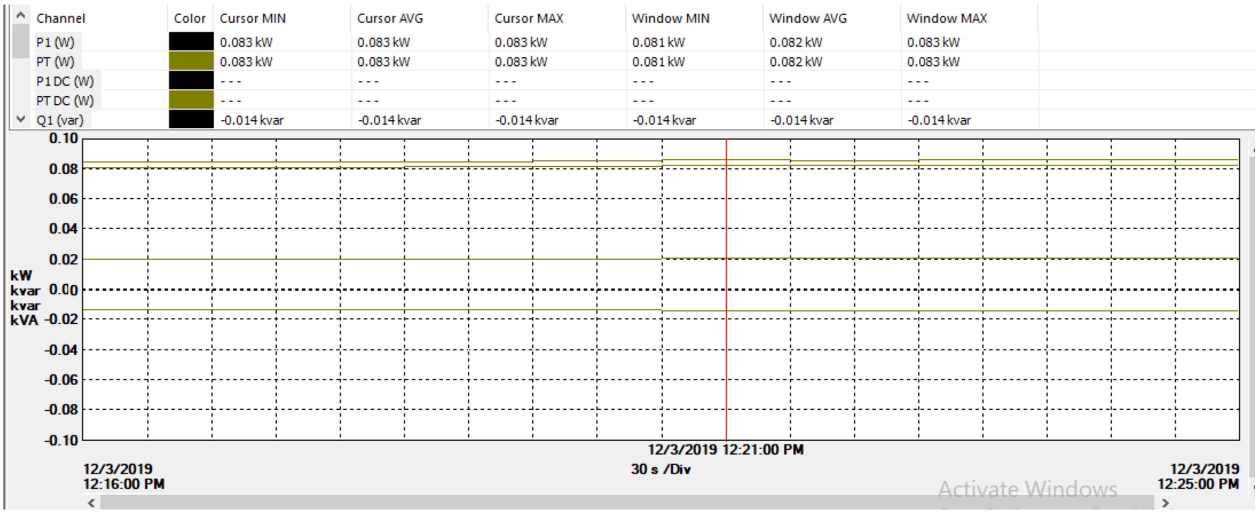


Figure 36: Power consumption of fan

Table 22: Main building: Calculation of ILER

Existing System

Title	Units	TPO office	CAMT	Pawade Sir Cabin	Edusat	RAC Lab	CAD CAM
Length of interior	Meter	9.93	13.7	8	6	13.7	15
Width of interior	Meter	6.6	6	7	12	7	15
Mounting height	Meter	1.85	3.04	3.04	3.04	3.04	3.04
Floor area of interior	$Meter^2$	65.538	82.2	56	72	95.9	225
Room Index	No	2.14	1.37	1.23	1.32	1.52	2.47
CFL18 W	No	25			10		
Tube 45 W			11	2	18	13	5
Total circuit watts	Watt	450	495	90	990	585	225
Watts per square meter	W/m^2	6.9	6	1.6	13.8	6.1	1
Average maintained illuminance	Lux	94.82	94.5	60	113.67	47.73	86.47
Actual lux per watt per meter square	$Lux/W/m^2$	13.81	15.69	37.33	8.27	7.82	86.47
Target $lux/W/m^2$ lux for type of the type of interior	$Lux/W/m^2$	48	43	40	43	46	48
Installed load efficiency ratio	ILER	0.29	0.36	0.93	0.19	0.17	1.8

Proposed System

Title	Units	Value	Value	Value	Value	Value	Value
LED 07 W	No	25					
LED TUBE 20 W			11	2	15	8	5
Total circuit watts		175	220	40	300	160	100
Watts per square meter	W/m^2	2.67	2.68	0.71	4.17	1.67	0.44
Average maintained illuminance	Lux	94.82	94.5	60	113.67	47.73	86.47
Actual lux per watt per meter square	$Lux/W/m^2$	35.51	35.31	84	27.28	28.61	194.55
Target $lux/W/m^2$ lux for type of the type of interior	$Lux/W/m^2$	48	43	40	43	46	48
Installed load efficiency ratio	ILER	0.74	0.82	2.1	0.63	0.62	4.05

Existing System

Title	Units	Power Engineering	Drawing Hall	IC Engine Lab	Computer department B-1 Lab	Computer department B-2 Lab	Computer department B-3 Lab
Length of interior	Meter	15	14	14	6.5	6.5	6.5
Width of interior	Meter	15	14	7	7	7	7
Mounting height	Meter	3.04	1.83	3.04	3.04	3.04	3.04
Floor area of interior	Meter²	225	196	98	45.5	45.5	45.5
Room Index	No	2.47	3.83	1.54	1.11	1.11	1.11
CFL18 W	No						
Tube 45 W		5	20	13	5	5	5
Total circuit watts	Watt	225	900	585	225	225	225
Watts per square meter	W/m²	1	4.6	6	4.9	4.9	4.9
Average maintained illuminance	Lux	190.17	198.18	82.3	77	80.8	87
Actual lux per watt per meter square	Lux/W/m²	190.17	43.16	13.79	15.57	16.34	17.59
Target lux/W/m² lux for type of the type of interior	Lux/W/m²	48	52	46	40	40	40
Installed load efficiency ratio	ILER	3.96	0.83	0.3	0.39	0.41	0.44

Proposed System

Title	Units	Value	Value	Value	Value	Value	Value
LED 07 W	No						
LED TUBE 20 W		5	20	13	5	5	5
Total circuit watts		100	400	260	100	100	100
Watts per square meter	W/m²	0.44	2.04	2.65	2.2	2.2	2.2
Average maintained illuminance	Lux	190.17	198.18	82.3	77	80.8	87
Actual lux per watt per meter square	Lux/W/m²	427.88	97.11	31.02	35.04	36.76	39.59
Target lux/W/m² lux for type of the type of interior	Lux/W/m²	48	52	46	40	40	40
Installed load efficiency ratio	ILER	8.91	1.87	0.67	0.88	0.92	0.99

Existing System

Title	Units	M2 Lab	Comp Seminar Room	F1 faculty cabin	F2 faculty cabin	F3 faculty cabin	Petrochemical Comp Lab
Length of interior	Meter	8	7.5	3.05	3.05	3.05	8
Width of interior	Meter	8	4.9	2.44	2.44	2.44	5
Mounting height	Meter	3.04	3.04	1.83	1.83	1.83	2.43
Floor area of interior	Meter²	64	36.75	7.442	7.442	7.442	40
Room Index	No	1.32	0.97	0.74	0.74	0.74	1.27
CFL18 W	No						
Tube 45 W		5	5	1	1	1	24
Total circuit watts	Watt	225	225	45	45	45	1080
Watts per square meter	W/m²	3.5	6.1	6.0	6.0	6.0	27.0
Average maintained illuminance	Lux	60.64	62.82	74.25	73.25	75.50	135.00
Actual lux per watt per meter square	Lux/W/m²	17.25	10.26	12.28	12.11	12.49	5.00
Target lux/W/m² lux for type of the type of interior	Lux/W/m²	43	36	36	36	36	43
Installed load efficiency ratio	ILER	0.40	0.29	0.34	0.34	0.35	0.12

Proposed System

Title	Units	M2 Lab	Computer Seminar Room	F1 faculty cabin	F2 faculty cabin	F3 faculty cabin	Petrochemical Comp Lab
LED 07 W	No						
LED TUBE 20 W		5	5	1	1	1	12
Total circuit watts		100	100	20	20	20	240
Watts per square meter	W/m²	1.56	2.72	2.69	2.69	2.69	6.00
Average maintained illuminance	Lux	60.64	62.82	74.25	73.25	75.50	135.00
Actual lux per watt per meter square	Lux/W/m²	38.81	23.09	27.63	27.26	28.09	22.50
Target lux/W/m² lux for type of the type of interior	Lux/W/m²	43	36	36	36	36	43
Installed load efficiency ratio	ILER	0.90	0.64	0.77	0.76	0.78	0.52

Existing System

Title	Units	IT Department L1 Lab	IT Department L2 Lab	IT Department L3 Lab	IT Department L4 Lab	IT Department L5 Lab (Seminar Hall)	IT Department L6 Lab (TV Room)
Length of interior	Meter	9	9	7.5	7.5	7.5	7.5
Width of interior	Meter	7.5	7.5	6	7.5	7.5	7.5
Mounting height	Meter	3.04	3.04	3.04	3.04	3.04	3.04
Floor area of interior	$Meter^2$	67.5	67.5	45	56.25	56.25	56.25
Room Index	No	1.35	1.35	1.10	1.23	1.23	1.23
Tube 45 W		5	5	5	5	5	5
Total circuit watts	Watt	225	225	225	225	225	225
Watts per square meter	W/m^2	3.3	3.3	5.0	4.0	4.0	4.0
Average maintained illuminance	Lux	82.40	92.60	84.20	89.45	102.75	96.30
Actual lux per watt per meter square	$Lux/W/m^2$	24.72	27.78	16.84	22.36	25.69	24.08
Target $lux/W/m^2$ lux for type of the type of interior	$Lux/W/m^2$	43	43	40	40	40	40
Installed load efficiency ratio	ILER	0.57	0.65	0.42	0.56	0.64	0.60

Proposed System

Title	Units	IT Department L1 Lab	IT Department L2 Lab	IT Department L3 Lab	IT Department L4 Lab	IT Department L5 Lab (Seminar Hall)	IT Department L6 Lab (TV Room)
LED TUBE 20 W		5	5	5	5	5	5
Total circuit watts		100	100	100	100	100	100
Watts per square meter	W/m^2	1.48	1.48	2.22	1.78	1.78	1.78
Average maintained illuminance	Lux	82.40	92.60	84.20	89.45	102.75	96.30
Actual lux per watt per meter square	$Lux/W/m^2$	55.62	62.51	37.89	50.32	57.80	54.17
Target $lux/W/m^2$ lux for type of the type of interior	$Lux/W/m^2$	43	43	40	40	40	40
Installed load efficiency ratio	ILER	1.29	1.45	0.95	1.26	1.44	1.35

Existing System

Title	Units	Affiliation Center	VC Visitor Area	Conference hall	Canteen one part	Canteen second part
Length of interior	Meter	13	15	13.2	6.4	4.27
Width of interior	Meter	6	10	13.2	2.44	6.7
Mounting height	Meter	3.04	3.04	3.04	3.66	3.66
Floor area of interior	Meter²	78	150	174.24	15.616	28.609
Room Index	No	1.35	1.97	2.17	0.48	0.71
CFL18 W	No			50		
Tube 45 W		10	10	24	28	8
Total circuit watts	Watt	450	450	1980	1260	360
Watts per square meter	W/m²	5.8	3.0	11.4	80.7	12.6
Average maintained illuminance	Lux	157.88	133.92	162.56	110.00	78.00
Actual lux per watt per meter square	Lux/W/m²	27.37	44.64	14.31	1.36	6.20
Target lux/W/m² lux for type of the type of interior	Lux/W/m²	43	46	48	36	36
Installed load efficiency ratio	ILER	0.64	0.97	0.30	0.04	0.17

Proposed System

Title	Units	Affiliation Center	VC Visitor Area	Conference hall	Canteen one part	Canteen second part
LED 07 W	No			20		
LED TUBE 20 W		10	10	24	10	6
Total circuit watts		200	200	620	200	120
Watts per square meter	W/m²	2.56	1.33	3.56	12.81	4.19
Average maintained illuminance	Lux	157.88	133.92	162.56	110.00	78.00
Actual lux per watt per meter square	Lux/W/m²	61.57	100.44	45.69	8.59	18.60
Target lux/W/m² lux for type of the type of interior	Lux/W/m²	43	46	48	36	36
Installed load efficiency ratio	ILER	1.43	2.18	0.95	0.24	0.52

Existing System

Title	Units	Civil Computational Lab	Civil Department Lab	Geo Lab	Physics Lab	Basic Electrical Lab HOD cabin
Length of interior	Meter	6.5	25	7	30	25
Width of interior	Meter	6.5	15	7	22	25
Mounting height	Meter	3.04	2.43	2.43	2.43	2.43
Floor area of interior	Meter²	42.25	375	49	660	625
Room Index	No	1.07	3.86	1.44	5.22	5.14
Tube 45 W		8	20	5	13	7
Total circuit watts	Watt	360	900	225	585	315
Watts per square meter	W/m²	8.5	2.4	4.6	0.9	0.5
Average maintained illuminance	Lux	164.6	105.32	149.91	184.64	97.63
Actual lux per watt per meter square	Lux/W/m²	19.32	43.88	32.65	208.31	193.7
Target lux/W/m² lux for type of the type of interior	Lux/W/m²	40	52	43	53	53
Installed load efficiency ratio	ILER	0.48	0.84	0.76	3.93	3.65

Proposed System

Title	Units	Civil Computational Lab	Civil Department Lab	Geo Lab	Physics Lab	Basic Electrical Lab HOD cabin
LED 07 W	No					
LED TUBE 20 W		8	20	5	13	7
Total circuit watts		160	400	100	260	140
Watts per square meter	W/m²	3.79	1.07	2.04	0.39	0.22
Average maintained illuminance	Lux	164.6	105.32	149.91	184.64	97.63
Actual lux per watt per meter square	Lux/W/m²	43.46	98.74	73.46	468.69	435.83
Target lux/W/m² lux for type of the type of interior	Lux/W/m²	40	52	43	53	53
Installed load efficiency ratio	ILER	1.09	1.9	1.71	8.84	8.22

Existing System

Title	Units	Examination Department	E & TC Department	Computer Simulation and VLSI Lab	Lab Technician Room
Length of interior	Meter	13	13	15	3.66
Width of interior	Meter	7	7	10	2.43
Mounting height	Meter	2.43	2.43	2.43	2.43
Floor area of interior	$Meter^2$	91	91	150	8.8938
Room Index	No	1.87	1.87	2.47	0.6
Tube 45 W		40	2	5	1
Total circuit watts	Watt	1800	90	225	45
Watts per square meter	W/m^2	19.8	1	1.5	5.1
Average maintained illuminance	Lux	83.2	52.67	63.83	51
Actual lux per watt per meter square	$Lux/W/m^2$	4.21	53.25	42.56	10.08
Target $lux/W/m^2$ lux for type of the type of interior	$Lux/W/m^2$	46	46	48	36
Installed load efficiency ratio	ILER	0.09	1.16	0.89	0.28

Proposed System

Title	Units	Examination Department	E & TC Department	Computer Simulation and VLSI Lab	Lab Technician Room
LED TUBE 20 W		16	2	5	1
Total circuit watts		320	40	100	20
Watts per square meter	W/m^2	3.52	0.44	0.67	2.25
Average maintained illuminance	Lux	83.2	52.67	63.83	51
Actual lux per watt per meter square	$Lux/W/m^2$	23.66	119.82	95.75	22.68
Target $lux/W/m^2$ lux for type of the type of interior	$Lux/W/m^2$	46	46	48	36
Installed load efficiency ratio	ILER	0.51	2.6	1.99	0.63

Existing System

Title	Units	Registrar Cabin	Finance Section	Student Section	Estate Section	Store	Chemical	Petrochemical Lab
Length of interior	Meter	25	25	13	25	25	25	25
Width of interior	Meter	25	8	8	25	25	25	25
Mounting height	Meter	2.43	2.43	2.43	2.43	2.43	2.43	2.43
Floor area of interior	$Meter^2$	625	200	104	625	625	625	625
Room Index	No	5.14	2.49	2.04	5.14	5.14	5.14	5.14
CFL18 W	No	10						
Tube 45 W		12	40	18	8	16	24	20
Total circuit watts	Watt	720	1800	810	360	720	1080	900
Watts per square meter	W/m^2	1.2	9.0	7.8	0.6	1.2	1.7	1.4
Average maintained illuminance	Lux	90.80	187.33	97.33	111.31	110.29	80.91	53.33
Actual lux per watt per meter square	$Lux/W/m^2$	78.82	20.81	12.50	193.24	95.73	46.82	37.04
Target $lux/W/m^2$ lux for type of the type of interior	$Lux/W/m^2$	53	48	48	53	53	53	53
Installed load efficiency ratio	ILER	1.49	0.43	0.26	3.65	1.81	0.88	0.70

Proposed System

Title	Units	Registrar Cabin	Finance Section	Student Section	Estate Section	Store	Chemical	Petrochemical Lab
LED 07 W	No	10						
LED TUBE 20 W		12	40	18	8	16	24	20
Total circuit watts		310	800	360	160	320	480	400
Watts per square meter	W/m^2	0.50	4.00	3.46	0.26	0.51	0.77	0.64
Average maintained illuminance	Lux	90.80	187.33	97.33	111.31	110.29	80.91	53.33
Actual lux per watt per meter square	$Lux/W/m^2$	183.06	46.83	28.12	434.80	215.40	105.35	83.33
Target $lux/W/m^2$ lux for type of the type of interior	$Lux/W/m^2$	53	48	48	53	53	53	53
Installed load efficiency ratio	ILER	3.45	0.98	0.59	8.20	4.06	1.99	1.57

Table 23: Calculation of ILER: Library

Existing System

Title	Units	Librarian cabin	Reading section	Reference section	Periodicals	e-Reference/ comp lab
Length of interior	Meter	8	54	17	12	29.8
Width of interior	Meter	7	27	11.8	7	13.95
Mounting height	Meter	8	8	8	8	8
Floor area of interior	$Meter^2$	56	1458	200.6	84	415.71
Room Index	No	0.47	2.25	0.87	0.55	1.19
Number of Fitting	No	5.00	70.00	30.00	10.00	20.00
Total circuit watts	Watt	225	3150	1350	450	900
Watts per square meter	W/m^2	4.0	2.2	6.7	5.4	2.2
Average maintained illuminance	Lux	76	168	146	74	110
Actual lux per watt per meter square	$Lux/W/m^2$	18.87	77.73	21.75	13.74	50.62
Target $lux/W/m^2$ lux for type of the type of interior	$Lux/W/m^2$	36	48	36	36	40
Installed load efficiency ratio	ILER	0.52	1.62	0.60	0.38	1.27

Proposed System

Title	Units	Librarian cabin	Reading section	Reference section	Periodicals	e-Reference/comp lab
Number of Fitting	No	5	70	30	10	20
Total circuit watts	Watt	100	1400	600	200	400
Watts per square meter	W/m^2	1.8	1.0	3.0	2.4	1.0
Average maintained illuminance	Lux	76	168	146	74	110
Actual lux per watt per meter square	$Lux/W/m^2$	42.47	174.89	48.94	30.91	113.90
Target $lux/W/m^2$ lux for type of the type of interior	$Lux/W/m^2$	36	48	36	36	40
Installed load efficiency ratio	ILER	1.18	3.64	1.36	0.86	2.85

Table 24: Calculation of ILER: Class room

Existing System

Title	Units	CR1	CR6	CR103	CR204
Length of interior	Meter	11	11	11	11
Width of interior	Meter	7.5	7.5	6.5	6.5
Mounting height	Meter	2.43	2.43	2.43	2.43
Floor area of interior	Meter²	82.5	82.5	71.5	71.5
Room Index	No	1.84	1.84	1.68	1.68
Tube 45 W	No	9	9	12	12
Total circuit watts	Watt	405	405	540	540
Watts per square meter	W/m²	4.9	4.9	7.6	7.6
Average maintained illuminance	Lux	145.80	158.10	187.90	171.60
Actual lux per watt per meter square	Lux/W/m²	29.70	32.21	24.88	22.72
Target lux/W/m² lux for type of the type of interior	Lux/W/m²	46	46	46	46
Installed load efficiency ratio	ILER	0.65	0.70	0.54	0.49

Proposed System

Title	Units	CR1	CR6	CR103	CR204
LED TUBE 20 W		9	9	12	12
Total circuit watts		180	180	240	240
Watts per square meter	W/m²	2.18	2.18	3.36	3.36
Average maintained illuminance	Lux	145.80	158.10	187.90	171.60
Actual lux per watt per meter square	Lux/W/m²	66.83	72.46	55.98	51.12
Target lux/W/m² lux for type of the type of interior	Lux/W/m²	46	46	46	46
Installed load efficiency ratio	ILER	1.45	1.58	1.22	1.11

4 Energy Conservation Measures

4.1 Water Pumping System

Findings:

The submersible pump is use to supply the water for institute are more than 10 to 15 years old & power consumption of the pump is more than rated.

Recommendations:

Replace the existing pump with Energy Efficient water pump.

Benefits:

The cost benefit analysis is given below.

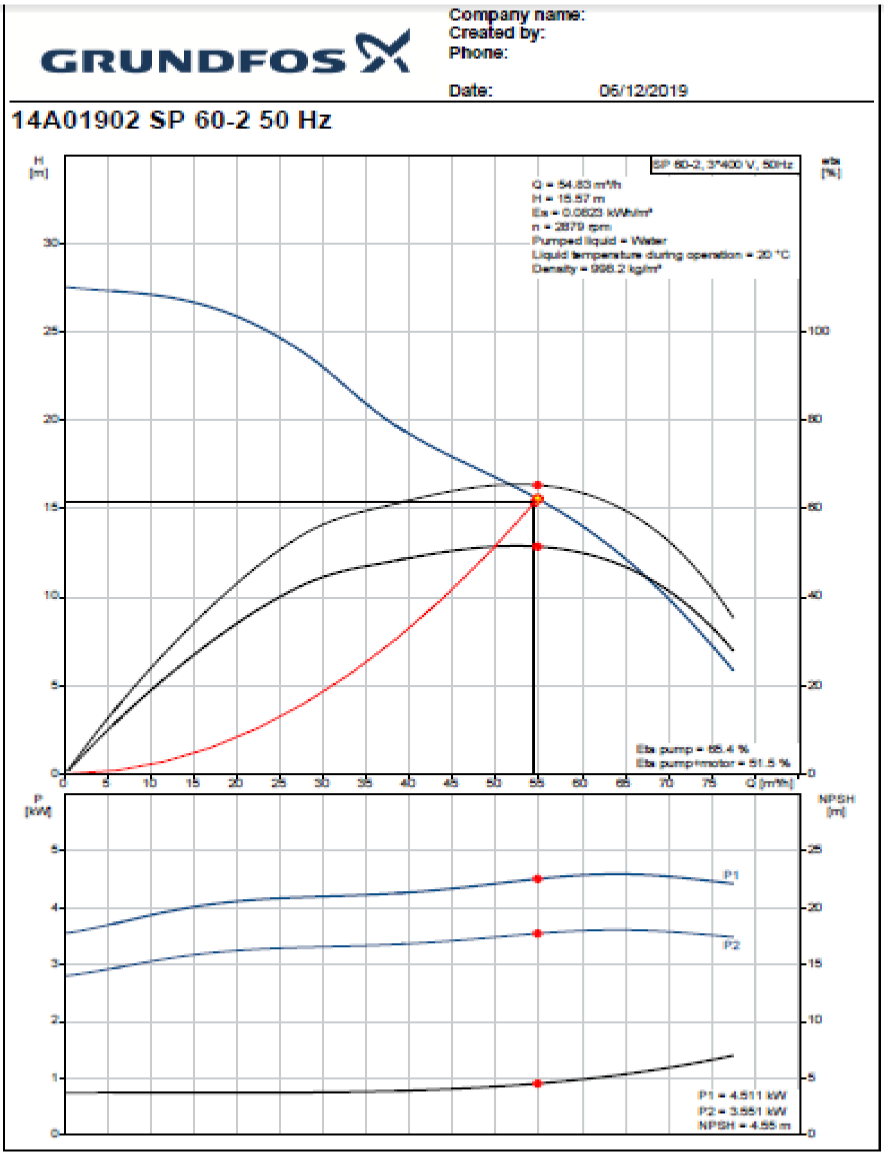


Figure 37: Pump selection for Goregaon water pump

Table 25: Cost benefit analysis of replacing EE water pump

Description	Units	Main building backside	Goregaon pump		Filter pump		Malaygiri hostel	Gagangiri well	Gagangiri/ Sahyagiri tank	Satff Quarter
Design parameter										
Rated output	kW	7.5	10	7.5	5.5	5.5	3.7	5.5	3.7	5.5
Type		Open well submersible	Bore well submersible	Bore well submersible	Open well submersible	Open well submersible	Mono-block	Open well submersible	Mono-block	Mono-block
Operating parameter										
Power	kW	7.55	11.29	8.447	6.656	4.885	3.936	8.394	3.621	5.69
Head	m	22	15	15	24	24	26	10	21	21
Proposed System										
Make		Grundfos	Grundfos	Grundfos	Grundfos	Grundfos	Grundfos	Grundfos	Grundfos	Grundfos
Type		Open well submersible	Bore well submersible	Bore well submersible	Open well submersible	Open well submersible	Open well submersible	Open well submersible	Open well submersible	Open well submersible
Proposed power	kW	3.7	4	4	3.7	3.7	2.2	3.7	2.2	2.2
Head	m	22	15	15	24	24	26	10	21	21
Flow	LPH	22440	45000	45000	22440	22440	15600	32160	17580	17580
Estimated power saving	kWh	3.85	7.29	4.447	2.956	1.185	1.736	4.694	1.421	3.49
Annual Working hours	Hrs/yr	1450	3500	3500	1450	3770	1450	3500	3500	2400
Annual power saving	kWh	5583	25515	15565	4286	4467	2517	16429	4974	8376
Energy Tariff	□/kWh	7.9	7.9	7.9	7.9	7.9	9.07	9.07	9.07	5.83
Estimated monetory saving	□	44102	201569	122960	33861	35293	22831	149011	45110	48832
Pump cost	□	36624	173600	173600	36960	36960	36624	36960	36624	36960
Installation cost	□	4500	4500	4500	4500	4500	4500	4500	4500	4500
Total investment	□	41124	178100	178100	41460	41460	41124	41460	41124	41460
Simple payback period	Years	0.93	0.88	1.45	1.22	1.17	1.80	0.28	0.91	0.85

4.2 Replacing the Conventional AC with 5 star AC

Findings:

The ACs are used in server room are not star labelled.

Recommendations:

Replace the conventional AC with 5 stars AC which consume less energy.

Benefits:

The cost benefit analysis of replacing 5 stars AC is given below.

Table 26: Cost benefit analysis of replacing the 5 star packages AC

Description	Units	Value	Value
Present system			
Make	-	Carrier	Blue star
Cooling Capacity	Ton	5.5	5.5
No. of AC	Nos	3	2
Type	-	Packaged	Packaged
Measured Power	kW	5.14	5.292
Proposed System			
Make	-	Carrier	Carrier
Cooling Capacity	Ton	5.5	5.5
Rated Power	kW	5.5	5.5
Type	-	Packaged	Packaged
Inverter	-	Yes	Yes
Star rating	-	5	5
Estimated power	kW	2.97	2.97
Saving in power	kW	2.17	2.322
Daily working hours	Hrs	8	8
Annual working days	Nos	200	200
Annual power saving	kWh	10416	7430
Energy tariff	□/kWh	7.9	7.9
Maintenance cost	□	37950	25300
Monitory saving	□	120236	84000
Investment/AC	□	160000	160000
Total investment	□	480000	320000
Simple Payback Period	**Years**	**3.99**	**3.81**

Table 27: Cost benefit analysis of replacing the 5 star split AC

Description	**Units**	**Value**
Present system		
Number of existing AC	Nos	2
Cooling capacity	Tonnes	1
Power	kW	1.27
Annual working hours (200*8)	Hrs	1600
Annual Energy consumption	kWh	4064
Proposed system		
Make	-	Voltas
Estimated power saving by 5 star AC	kW	0.72
Estimated annual energy saving	kWh	2304
Energy cost	□/kWh	7.9
Estimated annual energy saving	□	18201.6
Investment/AC	□	35000
Total investment	□	70000
Simple payback period	**Years**	**3.85**

4.3 Replacing the Conventional fan with energy efficient gorilla fan

Findings:

The conventional fan consumes average 80W energy.

Recommendations:

Replace the conventional fan with energy efficient fan which consume less energy.

Benefits:

The cost benefit analysis of replacing energy efficient fan is given below.

Table 28: Cost benefit analysis of replacing the energy efficient fan

Description	Units	Value	Value	Value
Name of Block		**Main Building**	**Hostel**	**Staff Quarter**
Present system				
Number of existing fans	Nos	531	730	436
wattage /fan	Watt	82	78	78
Usage of fan per day	Hrs	8	10	8
Working days per annum	Days	300	250	300
Annual Energy consumption	kWh	104501	142350	81619
Proposed system				
Recommended for replacement	%	50%	100%	50%
Recommended of EE fan	Nos	266	730	218
Wattage of EE fan	Watt	28	28	28
Annual Energy consumption	kWh	17842	51100	14650
Annual Power saving	kWh	34409	91250	26160
Energy tariff	□	7.9	9.07	5.83
Monitory saving	□. Lakh	2.72	8.28	1.53
Investment/fan	□	3200	3200	3200
Total investment	□. Lakh	8.50	23.36	6.98
Simple Payback period	**Years**	**3.13**	**2.82**	**4.57**

4.4 Replacing the florescent tube light with LED tube light

Findings:

The florescent tube light with LED tube light.

Recommendations:

Replace the florescent tube light with LED tube light which consume less energy.

Benefits:

The cost benefit analysis of replacing LED tube lights is given below.

Table 29: Cost benefit analysis of replacing fluorescent tubes the LED tube lights

Description	Units	Value	Value	Value
Name of Block		**Main Building**	**Hostel**	**Staff Quarter**
Present system				
Number of existing tube lights(T12/T8)	Nos	908	830	468
wattage /tube	Watt	43	43	43
Total wattage	Watt	39044	35690	20124
Annual working hours	Hrs	1800	1600	2400
Annual Energy consumption	kWh	70279	57104	48298
Proposed system				
Recommended for replacement	%	35%	85%	45%
Recommended of LED tube light	Nos	318	706	211
Wattage of LED tube light	Watt	20	21	22
Annual Energy consumption	kWh	11441	23705	11120
Annual Power saving	kWh	13157	24834	10614
Energy tariff	□	7.9	9.07	5.83
Monitory saving	□. Lakh	1.04	2.25	0.62
Investment/LED tube light	□	699	699	699
Total investment	□. Lakh	2.22	4.93	1.47
Simple Payback period	**Years**	**2.14**	**2.19**	**2.38**

4.5 Replacing the CFL (corridor) with LED tube light

Findings:

The CFL consume 24 W which is more than the LED tube light.

Recommendations:

Replace the CFL with LED tube light which consume less energy.

Benefits:

The cost benefit analysis of replacing LED tube lights is given below.

Table 30: Cost benefit analysis of replacing the CFL bulbs by LED tube lights

Description	Units	Main Building
Present system		
Number of existing CFL(11W*2)	Nos	250
wattage /CFL	Watt	24
Usage of CFL per day	Hrs	9
Working days per annum	Days	300
Annual Energy consumption	kWh	16200
Proposed system		
Recommended for replacement of CFL	Nos	125
2 sets of CFL would be replaced by 1 LED tube light		
Recommended of LED tube	Nos	60
Wattage of LED	Watt	20
Annual Energy consumption	kWh	3240
Annual Power saving	kWh	4860
Energy tariff	□	7.9
Monitory saving	□. Lakh	0.38
Investment/LED	□	699
Total investment	□. Lakh	0.42
Simple Payback period	**Years**	**1.09**

4.6 Replacing electric geyser with heat pump

Findings:

The electric geyser consumes more than the heat pump.

Recommendations:

Replace the electric water heater with heat pump with following capacity.

Benefits:

The cost benefit analysis of replacing heat pump.

Table 31: Cost benefit analysis of replacing heat pump

		Th	Pr	Th	Th	Th
Particulars	**Units**	**Value**	**Value**	**Value**	**Value**	**Value**
Name of hostel	-	Boys			Girls	
		Gagangiri	Gagangiri	Sahyagiri	Dhawalgiri	Malaygiri
Brand	-	Bajaj	Bajaj	Bajaj	Bajaj	Bajaj
Rated power/geyser	Watt	2000	2000	2000	2000	2000
Rated capacity/ geyser	Lit	15	15	15	15	15
No of geysers	Nos	12	12	9	8	20
Present system						
No of students	Nos	320	320	240	208	208
Daily water requirement/ student	Lit	20	15	20	20	20
Daily water required	Lit	6400	4800	4800	4160	4160
Ambient temperature	°C	25	25	25	25	25
Heated water temperature	°C	50	50	50	50	50
Specific heat of water	kJ/kg K	4.187	4.187	4.187	4.187	4.187
Electric energy required	kJ	669920	502440	502440	435448	435448
Daily working hours	Hrs	4	4	4	4	4
Annual working days		200	200	200	200	200
Measured power	kW	46.52	32.69	34.89	30.24	30.24
Annual energy consumption	kWh	37218	26152	27913	24192	24192
Proposed system						
Estimated power of heat pump	kW	45	45	33	30	30
Annual electric consumption	kWh	12405	8716	9304	8063	8063
Estimated saving	kWh	24813	17436	18610	16129	16129
Energy tariff	□/kWh	9.07	9.07	9.07	9.07	9.07
Monitory saving	□	225055	158140	168791	146286	146286
Heat pump cost	□	575000	575000	421000	384000	384000
Storage tank cost	□	75000	75000	75000	75000	75000
Total investment	□	650000	650000	496000	459000	459000
Simple payback period	**Years**	**2.89**	**4.11**	**2.94**	**3.14**	**3.14**

4.7 Improvement in PF by APFC made in operation

Findings:

The APFC is not in operation.

Recommendations:

Repair the APFC for improving Power Factor.

Benefits:

The cost benefit analysis of improvement in PF

Table 32: Cost benefit analysis of improvement in PF

Description	Units	Value
Bill demand	kVA	170
Present PF		0.84
kW drawn	kW	142.8
Improved PF		0.99
Monthly energy cost of the bill in □	□ Lakh	3.6
Percentage reduction in energy charge from 0.82 to 0.99	%	5%
Reduction in energy charge/month in □	□ Lakh	0.18
Saving in electricity bill in □	□ Lakh	2.16
Annual PF penal charges paid during last year	□ Lakh	1.11
Monitory Saving	□ Lakh	3.27
Investment in □	□ Lakh	-
Simple payback period in years	Years	0.00

4.8 Solar PV system

New Recommendations:

Install solar PV rooftop for main building and hostel building.

Table 33: Cost benefit analysis of Solar PV system

Title	Unit	Value	Value
Name of Building	**-**	**Main Building**	**Hostel**
Proposed solar PV	kW	100	150
Area required	m²	1200	1800
Proposed Output	kWh/day	350	525
Energy Tariff	□	7.9	9.07
Annual working days	days	300	300
Proposed Output	Lakh kWh/annum	1.05	1.575
Monetary Saving	□. Lakh	8.30	14.29
Investment	□. Lakh	30	45
Simple Payback Period	**Years**	**3.62**	**3.15**

4.9 Install MD controller

Findings:

MD controller need to be installed

Working:

A value is preset in the maximum demand controller when it is connected to the power line. When the demand approaches this value an alarm is sounded. The alarm is a signal to take corrective action. If the necessary action is not taken then the controller switches off less important loads in a sequence. In some factories loads such as compressors, air conditioners, pumps, fans and extractors, packaging machinery and shredders can be disconnected. The order in which the non-essential loads are disconnected can be decided by the user and accordingly programmed into the device. The necessary equipment's are then restarted at the appropriate time.

Benefits :

- Excess maximum demand on the entire supply grid can be avoided.
- During peak power usage the load factor can be improved by controlling and flattening the load curve.

4.10 Load scheduling need to be done in order to get TOD

Time of Day (TOD) tariff measure which is used as a means of incentivizing consumers to shift a portion of their loads from peak times to off-peak times, thereby improving the system load factor by reducing the demand on the system during peak period.

The TOD tariffs send price signals to consumers that reflect the underlying cost of generating, transmitting and supplying electricity, and enables resources to be allocated more judiciously and efficiently. Further price-based demand response can reduce or shape consumer demand particularly to reduce load at peak hours on the electricity system. Hence, TOD tariff assumes importance in the context of propagating and implementing DSM and achieving energy efficiency in the country.

4.11 Occupancy sensor should be fitted to every lab room

An occupancy sensor is an indoor motion detecting device used to detect the presence of a person to automatically control lights or temperature or ventilation systems. The sensors use infrared, ultrasonic, microwave, or other technology. The term encompasses devices as different as PIR sensors, hotel room keycard locks and smart meters. Occupancy sensors are typically used to save energy, provide automatic control, and comply with building codes.

4.12 Tube light and fan height need to be adjusted as per requirements

The most common method used to find the right down rod length is to take the ceiling height, subtract the height of the ceiling fan (most fans are between 12 and 18 inches in height depending on the fan), and then subtract the desired hanging height (usually eight feet).

Figure 38: Down rod length chart

4.13 Other long-term Opportunities

4.13.1 Energy Management System

Findings:

Plant is having multiple energy meters installed at various levels and meter readings is taken manually and consolidated and analyzed. Manual readings and consolidation typically causes error and uses and wastes man hours.

Recommendations:

Install a latest Energy Management System which will help the plant for better monitoring control of energy. Details of energy management system and benefits are given below.

Energy Management System:

EMS has dedicated Edge Control platform purpose-built to be the operational interface for Energy, Utility & Power Management System (EUPMS) whose primary purpose is to support Safe, Reliable & Efficient power within facilities & buildings. EMS has specialized data acquisition, visualization, analysis and reporting tools specifically designed for Power Management applications. The advantages of EMS are described below.

Real Time Monitoring:

EMS supports Auto Network Diagram Creation whereby a comprehensive set of linked hierarchical graphical diagrams are automatically created for all directly connected devices. It supports advanced power quality meters with on-board High-speed Power Analysis with Disturbance Direction Detection (DDD) capabilities and equipped with a built-in set of real-time graphical indicators for use in electrical single-line diagrams.

Alarm and Event Analysis and Notification:

EMS can acquire specialized, high speed power disturbance data directly from on-board advanced power quality meters for the purpose of Power Events Analysis, including -> Timestamped Power Events with Disturbance Direction Detection (DDD), Timestamped high speed (1/2 cycle sample rate) pre/post event RMS data, Pre/post event waveform captures (Voltage and Current all phases).

Data Analytics, Reports and Visualization:

EMS includes an interactive, web-based Dashboard application that provides auto-updating dashboard views that may contain not only energy and power data but also *Water, Air, Gas, Electric & Steam (WAGES),* historical data trends, power quality performance data, images and content from any accessible URL address. Also supports kiosk slideshow displays to run in unattended mode, scrolling through designated dashboards at a configurable time interval

The reporting tool supports automatic distribution (via email or shared folder) on a schedule basis or based on event or manual export using the following output formats: .csv, .xlsx, .pdf, .tiff, .html, .xml.

Benchmarking Energy Consumption: Understanding the patterns of all forms of energy use and other utilities is the first step in assessing the potential for energy savings. Your plant manager can organize and visualize key energy and other parameters in real time, thus identifying and solving energy problems and finding opportunities for cost savings.

Eliminating Inefficient Equipment Operation: This is highly useful in quickly spotting wasteful energy use. By reviewing daily load profiles and comparing to bench mark levels, plant manager can identify the instance when equipment is not performing properly or unused equipment is left running. Our services have helped customer in saving of 5% or more just from eliminating gross wastage.

Reduction in Distribution Loss: The electricity bought from Electricity board is being fed through various transformers to various load centers like MCC, PCC Pumps, Blowers, Compressors, Fan, Chillers, Lighting loads and so on. With energy management system it is easy for plant manager to identify energy consumed by each machinery. It is very important to know whether power received from source is being utilized effectively by all machines and level of the losses incurred due to distribution. By understanding the measured value, various steps can be taken to reduce losses. Ideally this loss should be less than 3%.

Energy Resource Planning: Monitors the energy balance at various nodes and computes system losses to formulate and implement loss elimination schemes as any electrical distribution network has inherent losses. Does overall energy accounting by monitoring energy usage pattern of every feeders, any variation in power consumption pattern at any process or sub section is exposed immediately for immediate control.

Reducing Demand charges: The system monitors complete operation of plant equipment usages and capture peak loading. The demand charges are based on maximum demand occurred in the plant due to wrong operation of any one particular equipment. The close monitoring of the demand curves helps to bring down demand charges.

Reduction of Idle running operation: Using energy management system idle running of machines can be identified. This will help to optimize dust collection system and blower operation during idle running.

Predictive Maintenance: Plan your shut down based on run hours and efficiency of your equipment. This reduces down time and helps plan predictive maintenance. The pattern of power consumption could be used as a diagnostic tool to assess the performance of the major motors and take decision on the maintenance schedule.

Root Cause Analysis: Analyze incidents like Excess energy consumption, overloading, excess T&D loss, Machine breakdown, breaker tripping, damages to capacitors etc. for which Root Cause Analysis is necessary. Corrects problem in production rate and product quality by analyzing the trends of energy consumption in relation to production

Measurement and Verification: Measure and records energy consumption trends. Verifies results of energy savings measures taken.

Improving Energy Equipment Performance: Malfunctioning or degraded equipment often has an associated "energy fingerprint". Such finger prints can be detected by regularly viewing data generated by the system over the time. EMS will work as your plant manager in this regular review process and will help in the "fingerprinting process"

Measuring and Verifying Energy Efficiency Improvements. This system provides a full capability for measuring baseline energy consumption and then comparing energy consumption following installation of energy saving devices.

Remote Monitoring of critical parameters for multiple sites: For multiple sites located in various geographies Energy Management System can be a vital tool for top management. This tool can help top management of any organization to monitor vital energy & production parameters of all the plants sitting in one place.

The screens, charts, trends, report and alarms of a typical EMS is given below.

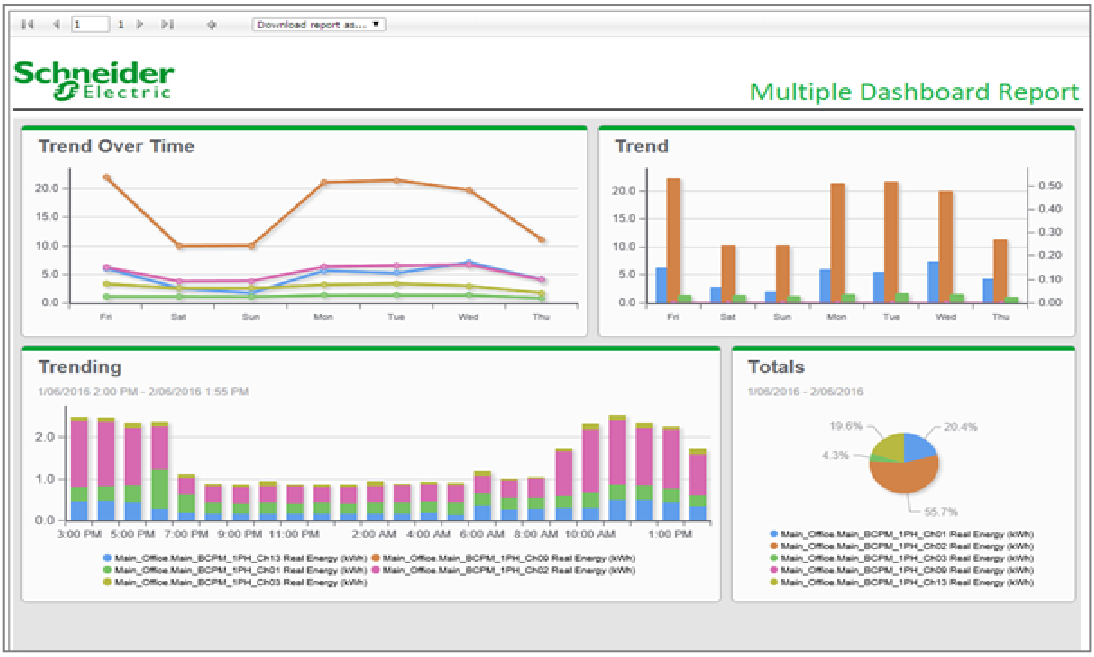


Figure 39: EMS- Screens

Figure 40: EMS- Dashboards

Figure 41: EMS- Charts

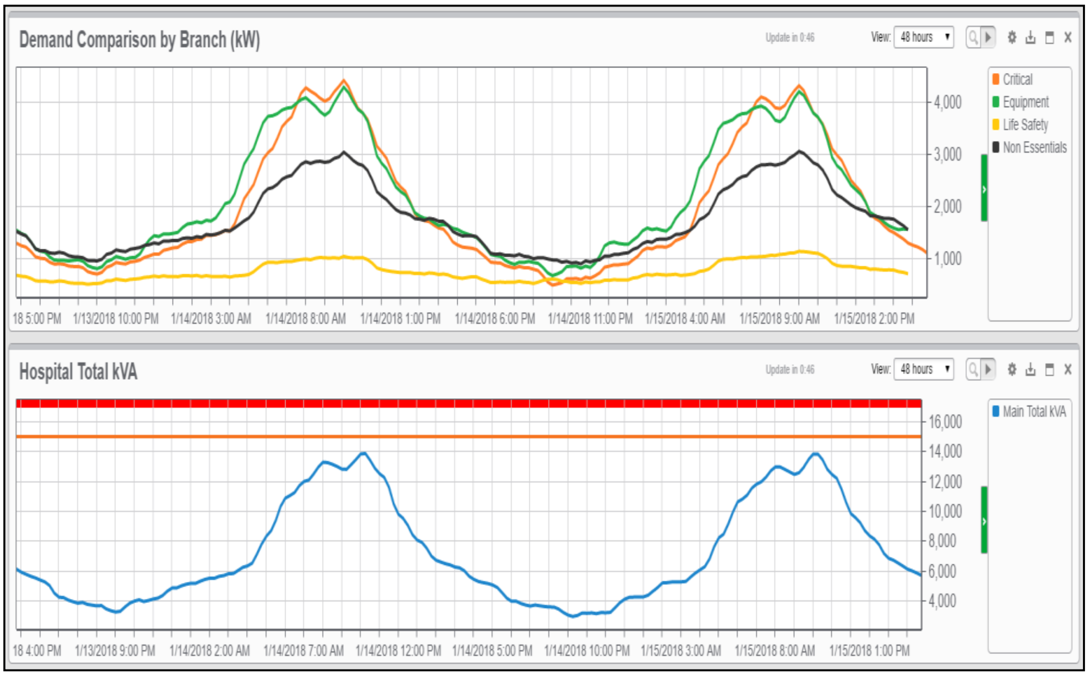


Figure 42: EMS- Trends

Table 34: Suppliers of Energy Efficient Appliances/Renewable Energy Product

Sr. No.	Product name	Vendor details
1	LED tube light	**Syska LED**
		Syska House
		Plot No. 89-91, Lane No. 4 Sr. No. 232, 1/2, Airport Road,
		Sakore Nagar, Lohegaon, Pune, Maharashtra 411014
		Email : support@syska.co.in
		Website : https://syska.co.in/
2	Energy Efficient Fan	**ATOMBERG TECHNOLOGIES**
		Plot No. 130 B, TTC industrial area,
		Shirawane, Navi-Mumbai, Maharashtra - 400706
		Email : sandeepencon@gmail.com
		Website : https://atomberg.com/
3	Water Pump	**GRUNDFUS**
		Vakratund Enterprises
		P-12, Shop No. 3/4 SAMK Building,
		Shiroli, Kolhapur, Maharashtra - 416122
		Email: kishor.u@vakratundent.com
		Mobile : +91 9922959080
4	Solar Water Heater/ Solar PV system	**Photon Energy Systems Limited**
		Plot 26, Rd Number 10, Krishnapuram Colony
		Singada Kunta, Banjara Hills, Hyderabad, Telangana - 500034
		Email : pradeep@photon solar.in
		Website : https://photonsolar.in/
		Jain Irrigation Systems Limited
		Jain Plastic Park, N.H.No. 6 Bambhori
		Jalgaon, Maharashtra - 425001
		Email : sandeepencon@gmail.com
		Website : https://www.jains.com/
5	Air-conditioning	**Neptune Engineers**
		Ram prasad complex, Miraj road
		Near Chandani Chowk, Sangli, Maharashtra - 416416
		Email : cak@hvacneptune.com
		Mobile : +91 8308000299
6	Heat Pump	**AO Smith**
		Vakratund Enterprises
		P-12, Shop No. 3/4 SAMK Building,
		Shiroli, Kolhapur, Maharashtra - 416122
		Email: kishor.u@vakratundent.com
		Mobile : +91 9922959080