DETAILED ENERGY AUDIT FINAL REPORT

Sant Gadge Baba Amravati University

Address:

Mardi, Near Tapovan Gate, Amravati, Maharashtra-444602

SGBAU

October 2016

Conducted By

PPS Energy Solutions Pvt. Ltd.

Engineering Consultants

Plot No-18, Girish Housing Society

Warje, Pune – 411058, Maharashtra, India

Table of Contents

Table of Figures

Acknowledgement

We express our sincere gratitude to the authorities of Sant Gadge Baba Amravati University for entrusting and offering the opportunity of energy performance assessment assignment.

- Mr. Shashikant Rode – Executive engineer
- Mr. Rajesh Edle – University Dy. Engineer (Electrical)
- Mr. Rameshwar Gheware- Wireman

We are thankful to Sant Gadge Baba Amravati University for their positive support in undertaking the task of system mapping and energy efficiency assessment of all electrical system, air-conditioners, utilities and other equipment. The field studies would not have been completed on time without their interaction and guidance. We are grateful to their cooperation during field studies and providing necessary data for the study.

We are also thankful to all field staff and agencies working with whom we interacted during the field studies for their wholehearted support in undertaking measurements and eagerness to assess the system / equipment performance and saving potential. Also thankful to all concerned staff interacted during the conduct of this exercise for completing official documentations.

Energy Audit Team

The team members of PPSES:

Name	Role	Field of expertise
Dr. Ravi G. Deshmukh	ECM verification, Report verification and presentation	Accredited Energy Auditor Ph.D, M tech, MBA (Power), Graduate E&TC Engineer with over 18 years of experience in Energy Management, Management of Power System, Power Exchange Operations, Power Trading and Analysis, Electrical Automation. Has worked as Expert in Iron & Steel sector and Energy
Mr. Ram G. Harne	Project management, ECM preparation, report preparation and presentation	Certified Energy Manager, ASQ CSSBB with 16 years of experience in Energy efficiency assessment, Industrial engineering sector
Mr. Prasad Bhosale	Verification of power distribution, renewable energy	Graduate Electrical Engineer with over 7 years of experience in project management, energy efficiency assessment, power distribution.
Mr. KedarPandit	Field study, data tabulation and analysis, report preparation, co odination with local team	Graduate E & TC, Sr. Engineer, experience in project management, energy efficiency assessment
Mr. Mahesh Khode	Field study, data tabulation and analysis, SLD preparation, report preparation,	Graduate in Electrical &Electronics Engineering, Sr. Engineer, experience in power projects, energy efficiency assessment
Mr. NileshS. Saraf	Field Study and study of Renewable energy	Graduate Engineer, Sr. Consultant, experience in Renewable Energy projects, energy efficiency assessment

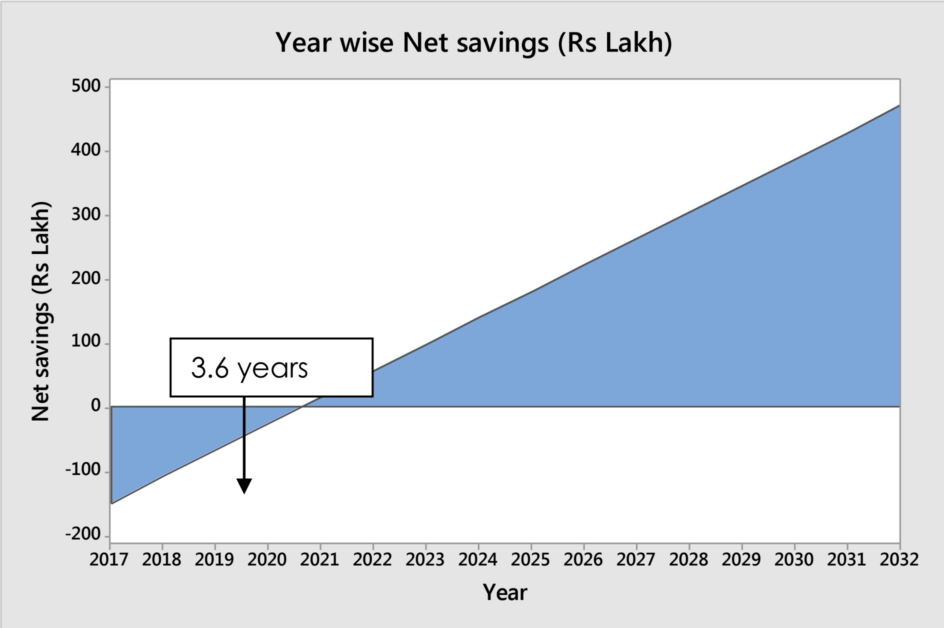
Executive Summary

Summary of recommended Energy Conservation Measures:

Sr. No.	Equipment Name	ECM Details	Investment (Rs. in Lakh)	Savings (kWh/year)	Carbon credit (Tons of CO_2)	Saving (Rs. in Lakh /Year)	Payback (Years)
1	Substation	Power factor improvement	7.8	0	0.00	5.48	1.4
2	Contract demand	Changing Contract demand	8.9	0	0.00	1.60	5.6
3	Tube Lights	Replacement of 40 Watt Tube lights with LED tube lights	28.0	77760	69.56	6.22	4.5
4	Electric Motors and Pumps	Maintenance of Monoblock pumps and electric motors - cleaning fan inlet, cooling fins, replacement of bearings and proper greasing	0.5	7648	6.84	0.61	0.8
5	Electric Motors and Pumps	Peak Load management- Running the water pumps during off peak hours	0.0	0	0.00	0.72	0.0
6	Ac's	Optimize the temperature setting to 25°C	0.0	6521	5.83	0.52	0.0
7	Ac's	Replacement of No star ACs (1.5 T and 2.0 T) with 5 stars Ac's.	44.1	167006	149.39	13.36	3.3

Sr. No.	Equipment Name	ECM Details	Investment (Rs. in Lakh)	Savings (kWh/year)	Carbon credit (Tons of CO_2)	Saving (Rs. in Lakh /Year)	Payback (Years)
8	Street Light	Replacement of existing street light with LEDs	10.3	54192	48.48	4.34	2.4
9	Fans	Replacement of existing old (without star rating) fans with 5 star rated energy efficient fans	50.0	105840	94.68	8.47	5.9
Total			**150**	**418967**	**375**	**41**	**3.6**

Year	Investment (Rs. in Lakh)	Saving (Rs. in Lakh /Year)	Cum Savings(Rs. Lakh)	Net savings (Rs. Lakh)
0	-150	0	0	-150
1	0	41	41	-108
2	0	41	83	-67
3	0	41	124	-26
4	0	41	165	16
5	0	41	207	57
6	0	41	248	98
7	0	41	289	140
8	0	41	330	181
9	0	41	372	222
10	0	41	413	264
11	0	41	454	305
12	0	41	496	346
13	0	41	537	387
14	0	41	578	429
15	0	41	620	470



Observations and Recommendations:

Sr. No.	Equipment Name	Observation	Recommendation	Skill requirement	Time frame for Execution
1	Substation	Power factor of the University is below 0.95 for one last year	Install Automatic power factor controller	High	3 months
2	Contract demand	In the last 4 months, Maximum demand exceeded the sanctioned demand. University is paying for the excess demand charges	Increase the contract demand up to 580 KVA	High	3 months
3	Tube Lights	University has installed 40 Watt Tube lights in the buildings	Replace the T12 (40W) tube lights with LED lights	Medium	6 months

Sr. No.	Equipment Name	Observation	Recommendation	Skill requirement	Time frame for Execution
4	Electric Motors and Pumps	Friction sound of the bearing was loud, motors needed the maintenance	Improve the preventive maintenance	Low	2 months
5	Electric Motors and Pumps	Running during daytime	Run the water pump as much as possible during night time (10.00 pm to 6.00 am)	Low	1 month
6	Ac's	Temperature settings are very low	Increase the AC temperature setting to 25 deg. C.	Low	1 month
7	Ac's	Few AC are without star rating (1.5 T)	Replace the no star Ac's (1.5 T and 2.0 T) with energy efficient 5 star Ac's	Medium	6 months
8	Street Light	Streetlights are CFL, Florescent, MH, and SV.	Replace the street lights with LED lights	Medium	4 months
9	Fans	Fans are 10+ year older and without star rating	Replace the old ceiling fans with energy efficient 5 star rated fans	Medium	6 months

1. Introduction

The university was established on 1st May 1983, the auspicious Maharashtra Day & Worker's Day. This University geographically covers the western Vidarbha belt (i.e., five districts – Amravati, Akola, Yavatmal, Buldhana and Washim) of Maharashtra State. The University, in its small span of two decades, has contributed in many ways for economic, social and cultural upliftment of the society by offering quality education.

The Motto of this University is *"Education for Salvation of Soul'.*

The University is recognised under Section 12(B) of UGC Act. The University is also an associate member of Association of Commonwealth Universities, London (U.K.). It has 10 faculties, which include Arts, Commerce, Sciences, Medicine, Ayurved, Education, Social Science, Law,Home Science, and Engineering& Technology. The University has facilities to offer post-graduate & advanced education in Computer, Biotechnology, Business Management, Law & degree courses in Chemical-Technology.

University values research as evidence that teaching programmes are underpinned by a solid base of latest knowledge and advanced techniques.

1.1 Objective of Audit

The overall objective of the assignment is to quantify energy saving in existing system and achieve reduction in energy consumption pattern.
Hence the detail objectives are as under,

- To carry out the energy consumption
- To evaluate the performance of the equipment
- To find out the energy saving opportunities
- To quantify the total energy savings
- To find out the ways to achieve energy efficiency

1.2 Scope of Work

Following is the scope of work envisaged for this assignment,

A. <u>Field Study</u>

The field study should incorporate technical data collection. Physical verification of connected load, preparation of single line diagram of building & campus electrical distribution system & analysis of readings obtained from site measurement with the standard consumption.

1) SantGadge Baba Amravati University is a H. T. consumer of MSEDCL & have a single meter. University had created energy meter at maximum buiiding points but it is to be checked for accuracy & faulty.
2) Visit and inspect the exisiting condition of all metering installation and submit the meter wise data with remarks and observations. (Table-1)
3) Carryout meter wise building wise department wise load survey of all existing Electrical installation in Building with details and submit the data with remarks and observation and with over all meter wise remarks and observations. (Table-2)
4) Submit the consolidated meter wise building wise department wise total existing load classifying as lighting/ power/ AC /load with remarks and observation. (Table-3)
5) Carry out the meter point wise Electrical para-meter measurements (Table-4)
6) Power parameter measurement data logging should be carried out building wise according to utilization pattern.

B. Report

1) Submit tabulated field study data as per formats (Table 1 to 4) with remarks & observations.
2) Draft Report :- The detail draft report giving the recommendation for energy saving shall be prepared. The report shall contain overview of existing conditions, parameters measured analysis methodology other details of equipments suggestions for improvement to operating and maintenance for the activities to be carried out without or with major investments. The payback period calculations shall be given for the activities to be completed with investment.
3) The draft report should be submitted in standard format as per the guide lines of Energy Efficiency. Also it should consist of saving potentials, skills requirements, time frame for execution, investment cost, payback period , observation and recommendation.
4) Recommendation should incorporate short term, medium term and long terms implementation system with and without investment. The contractor should highlight the metering point / buildings / department with larger saving potential in the draft report. Incorporate updated technology in energy saving in Building in the draft report. Also incorporate the possibilities of implementation of energy saving projects on DPR for MEDA for financial assistance from MEDA.

The scope of work given above is common for all the areas. The detail study as per the scope given shall be carried out in each area.

The draft report should be prepared as mentioned above and same shall be discussed with the deputed authority of the SantGadge Baba Amravati University.

1.3 Approach and Methodology

1. Understanding the Scope of Work and Resource Planning

2. Identification of Key Personnel for the assignment/ project

3. Structured Organization Matrix

4. Steps in preparing and implementing energy audit assignment.
    a) Discussions with key facility personnel
    b) Site visits and conducting "walk-through audit"
    c) Preliminary Data Collection through questionnaire before audit team's site visit
    d) Steps for conducting the detailed audit
        - Plan the activities of site data collection in coordination with the facility in-charge.
        - Study the existing operations involving energy consumption
        - Collect and collate the energy consumption data with respect to electricity consumption
        - Conduct performance tests to assess the efficiency of the system equipment/ electricity distribution, lighting, and identify energy losses.
        - Discuss with facility operation / maintenance personnel about identified energy losses.

5. List proposed efficiency measures
    - Develop a set of potential efficiency improvement proposals
    - Baseline parameters
    - Data presentation
    - System mapping
    - List of potential Energy Savings proposals with cost benefit analysis.
    - Review of current operation & maintenance practices

6. Preparation of the Draft Energy Audit Report

7. Preparation of final Energy Audit Report after discussion with concern persons

1.4 Work Schedule:

- Field study- The field study that includes technical data collection, physical verification of connected load, and measurement of various energy intensive equipments will be carried during office hrs.If it is required to extend the working hrs.beyond the above-specified timings, PPSES will take permission of the concerned authority prior to commencement of work on that particular day.SantGadge Baba Amravati University has authorized person or the person nominated by authority should accompany PPSES person while carrying out the field study.
- Working days: The activities to be carried out in Sant Gadge Baba Amravati University premises like field study, report presentation, energy conservation measures discussions will done during working days as per Sant Gadge Baba Amravati University rules.

- If it is required to work on non-working days, PPSES will take permission of the concerned authority prior to commencement of work on that particular day.
- Activities like data tabulation, energy conservation measures preparation, report preparation, single line diagram preparation will be done as per PPSES working hours and working days.
- Time Schedule:

Sr No	Activity	Start Date	End Date
1	Field study as mentioned in scope of work	04-Jul-2016	03-Sep-2016
2	Preparation and submission of draft report	04-Sep-2016	18-Sep-2016
3	Submission of final report		28-Sep-2016
Revised (Extended) dates of activities			
4	Preparation and submission of draft report		03-Oct-2016
5	Submission of final report		13-Oct-2016

1.5 Bar Chart:

Bar Chart			Week 27	Week 28	Week 29	Week 30	Week 31	Week 32	Week 33	Week 34	Week 35	Week 36	Week 37	Week 38	Week 39	Week 40	Week 41
Sr. No.	Task Name		04Jul - 10Jul	11Jul - 17Jul	18Jul - 24Jul	25Jul - 31Jul	01Aug - 07Aug	08Aug - 14Aug	15Aug - 21Aug	22Aug - 28Aug	28Aug - 03Sep	04Sep - 10Sep	11Sep - 17Sep	18Sep - 24Sep	25Sep - 28Nov	29Sep - 04Oct	05Oct - 13Oct
1	Walk through audit and informal meetings with energy manager	Plan															
		Actual															
2	Introductory meeting with all divisional heads and persons concerned with energy management (1-2) Hrs	Plan															
		Actual															
3	Preliminary data collection i.e. electricity bills, site map, load details	Plan															
		Actual															
4	Field Study- Load data survey, trials, measurement of buildings (Allotted building (1 to 10)	Plan															
		Actual															
5	SLD preparation of buildings 1 to 10	Plan															
		Actual															
6	Field Study- Load data survey, trails, measurement of buildings (Allotted building (11to 20)	Plan															
		Actual															
7	SLD preparation of buildings 11 to 20	Plan															
		Actual															
8	Field Study- Load data survey, trails, measurement of buildings (Allotted building (21 to 30)	Plan															
		Actual															
9	SLD preparation of buildings 21 to 30	Plan															
		Actual															
10	Field Study- Load data survey, trials, measurement of	Plan															

Bar Chart			Week 27	Week 28	Week 29	Week 30	Week 31	Week 32	Week 33	Week 34	Week 35	Week 36	Week 37	Week 38	Week 39	Week 40	Week 41
Sr. No.	Task Name		04Jul - 10Jul	11Jul - 17Jul	18Jul - 24Jul	25Jul - 31Jul	01Aug - 07Aug	08Aug - 14Aug	15Aug - 21Aug	22Aug - 28Aug	28Aug - 03Sep	04Sep - 10Sep	11Sep - 17Sep	18Sep - 24Sep	25Sep - 28Nov	29Sep - 04Oct	05Oct - 13Oct
	buildings (Allotted building (31 to 40)	Actual															
11	SLD preparation of buildings 41 to 50	Plan															
		Actual															
12	Field Study- Load data survey, trails, measurement of buildings (Allotted building (51 to 60)	Plan															
		Actual															
13	SLD preparation of buildings 51 to 60	Plan															
		Actual															
14	Field Study- Load data survey, trails, measurement of buildings (Allotted building (61 to 70)	Plan															
		Actual															
15	SLD preparation of buildings 61 to 70	Plan															
		Actual															
16	Analysis of energy use	Plan															
		Actual															
17	Identification and development of Energy Conservation (ENCON) opportunities	Plan															
		Actual															
18	Cost benefit analysis	Plan															
		Actual															
19	Preparation & submission of draft report and presentation	Plan															
		Actual															

Bar Chart			Week 27	Week 28	Week 29	Week 30	Week 31	Week 32	Week 33	Week 34	Week 35	Week 36	Week 37	Week 38	Week 39	Week 40	Week 41
Sr. No.	Task Name		04Jul - 10Jul	11Jul - 17Jul	18Jul - 24Jul	25Jul - 31Jul	01Aug - 07Aug	08Aug - 14Aug	15Aug - 21Aug	22Aug - 28Aug	28Aug - 03Sep	04Sep - 10Sep	11Sep - 17Sep	18Sep - 24Sep	25Sep - 28Nov	29Sep - 04Oct	05Oct - 13Oct
20	Submission of final report	Plan															
		Actual															
21	Implementation and follow up	Plan															
		Actual															

Note:

Sr. No.	Cell Color	Description
1		Initial Plan activities
2		Activity Status- planned
3		Activity Status- Actual
4		Week extended

Few of the activities were extended during the draft report preparation due to following reason:

1) Full load data of Teaching department building captured late as it were started late during the field study phase.
2) Got less working days (manpower and facility availability issue) for field data collection and draft report preparation during the month Aug-16 and Sep-16
3) Field study was affected due to rainy season
4) Due to above reasons data verification was delayed.

Hence, on the ground of above reasons we requested extension of 15 days for completionof energy audit work. The earlier project completion date was 28-Sep-16. We propose the revised date for completion of work as 13-Oct-16.

1.6 About PPSES

M/s. PPS Energy Solutions Pvt. Ltd (PPSES) is an ambitious company, established by enterprising engineering professionals in the year 2004. The company offers services pertaining to Energy and Engineering to clients across the globe. Our team is based in Pune, a city known for its Software and

Engineering talent in India. We are a rapidly growing company with a team of about 100 people which includes highly trained and experienced Techno-Managers, Analysts, and Engineers & Detailers.

We are presently working in India (Maharashtra, Madhya Pradesh, Gujarat, Andhra Pradesh, Delhi, Orissa, Chhattisgarh, Bihar, Andhra Pradesh, Telangana, Assam, Rajasthan and Jharkhand) and Abroad (Bahrain, Stanford, Laos)

We provide services for,

- Energy Audit, Management and System Evaluations
- Power Distribution System Design, Evaluations and Monitoring
- MEP Design and Project management
- Research and Training
- Services for Solar Installation

Followings are the certificates of empanelment and Accreditation & EM:

Accreditation certificate of Dr. Ravi G. Deshmukh:

ENERGY IS LIFE
BEE
CONSERVE IT

BUREAU OF ENERGY EFFICIENCY

Examination Registration No. : EA-4015

Accreditation Registration No.: AEA-0243

Certificate of Accreditation

This is to certify that Mr./Ms. Ravi Gunwantrao Deshmukh having its trade/registered office at Pune has been given accreditation as accredited energy auditor. The certificate shall be effective from 1st day of Feb 2016

The certificate is subject to the provisions of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010.

This certificate shall be valid until it is cancelled under regulation 9 of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010

On cancellation, the certificate of accreditation shall be surrendered to the Bureau within fifteen days from the date of receipt of order of cancellation.

Your name has been entered at AEA No. 0243 in the register of list of accredited energy auditors. Your name shall be liable to be struck out on the grounds specified in regulation 8 of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010.

Given under the seal of the Bureau of Energy Efficiency, Ministry of Power, this 1st day of April 2016

Secretary,
Bureau of Energy Efficiency
New Delhi

MEDA empanelment certificate:

Speed Post

MAHARASHTRA ENERGY DEVELOPMENT AGENCY (MEDA)

(A Government of Maharashtra Institution)

ECN/2014-15/CR-25/5016 8th August, 2014

To,
PPS Energy Solutions Pvt. Ltd
B-403, Bharat Vihar,
S.No-78, Bharti Vidyapith, Campus,
Katraj, Pune-411046

Sub: Empanelment Certificate – "Save Energy Programme"

Dear Sir,

This is in reference to your application for empanelment under Save Energy Programme. We are pleased to inform you that your firm has been granted empanelment. Kindly find the enclosed Empanelment Certificate.

Thanking you,

Yours faithfully,

(Rohit Dumate)
Project Executive (EC)

Encl: As above.

MAHARASHTRA ENERGY DEVELOPMENT AGENCY
An ISO 9001 : 2000 Reg. no. : RQ 91 / 2482

Maharashtra Energy Development Agency
(A Government of Maharashtra Institution)
2nd Floor, MHADA Commercial Complex, Opp. Tridal Nagar, Yerwada, Pune 411 006
Ph No: 020-26614393/266144403, Fax No: 020-26615031
Email: econ@mahaurja.com , Web: www.mahaurja.com

ECN/2014-15/CR-25/5016 — 8th August, 2014

Certificate of Registration
For Class 'A'

We hereby certify that, the firm having following particulars is registered with ***MAHARASHTRA ENERGY DEVELOPMENT AGENCY (MEDA)*** under given category as "Energy Planner & Energy Auditor" in Maharashtra under Save Energy Programme of MEDA.

Name and Address of the firm :	PPS Energy Solutions Pvt. Ltd B-403, Bharat Vihar, S.No-78, Bharti Vidyapith, Campus, Katraj, Pune-411046
Registration Category	*Empanelled Consultant for Save Energy Programme.*
Registration Number	***MEDA/ECN/CR-25/2014-15/ EA-43***

The Save Energy Programme intends to identify areas where wasteful use of energy occurs and to evaluate the scope for Energy Conservation and take concrete steps to achieve the evaluated energy savings.

- MEDA reserves the right to visit the firm at any time without giving any prior information and canceling the registration, if the information is found incorrect.
- This empanelment is valid upto **3 years** from the date of registration, to carry out energy audits under the Save Energy Programme of MEDA.
- The Director General, MEDA reserves the right to cancel the registration at any time without assigning any reasons thereof.

Harshvardhan L. Patil

Manager (EC)

MAHARASHTRA ENERGY DEVELOPMENT AGENCY
Unique Registration No:ECN/ Govt. EA/2016-17/05

Maharashtra Energy Development Agency

(A Government of Maharashtra Institution)
2nd Floor, MHADA Commercial Complex, Opp. Tridal Nagar, Yerwada, Pune 411 006
Ph No: 020-26614393/266144403, Fax No: 020-26615031
Web: www.mahaurja.com

MEDA/2016-17/CR-34 12th July, 2016

CERTIFICATE OF EMPANELMENT

We hereby certify that, the firm having following particulars is Empanelled with ***MAHARASHTRA ENERGY DEVELOPMENT AGENCY (MEDA)*** under given Sector as per the Criteria for Empanelment given at Annexure I

Name and Address of the firm	:	PPS Energy Solutions Pvt. Ltd. 3rd Floor, Ashirvad, 18-Girish Society, Warje, Pune-410058
Sector For Empanelment	:	Government /Semi-Government/ Local Government.
Sector Code	:	**11**
Unique Registration Number	:	**ECN/ Government /2016-17/05**

Purview of Empanelment:

- Preparation of detailed project report
- Preparation of drafts and assisting in finalizing and signing of various contractual documents / agreements required for the projects
- Monitoring & supervision of project execution and commissioning activities to ensure quality & project time frame
- To ensure and evaluate that the project designs and drawings are in line with the project requirement
- Capacity building for successful management and operation of the project
- To assist in successful commissioning
- This empanelment is valid for the period of 2 years from the date of empanelment.
- The Director General, MEDA reserves the right to cancel the registration at any time without assigning any reasons thereof.

(Hemant H. Patil)
Manager (Energy Conservation)

ENERGY IS LIFE
BEE
CONSERVE IT

ऊर्जा दक्षता ब्यूरो

परीक्षा रजिस्ट्रीकरण सं. : EM-6257 क्रम सं. 11633

प्रमाणपत्र रजिस्ट्रीकरण सं. : 11633

प्रमाणित ऊर्जा प्रबंधक के लिए प्रमाणपत्र

यह प्रमाणित किया जाता है कि श्री / श्रीमती / सुश्री रामेश्वर गजाननराव हरने जो श्री / श्रीमती गजाननराव के पुत्र / पुत्री हैं जिन्होंने वर्ष 2014 मास August में आयोजित ऊर्जा प्रबंधक प्रमाणन के लिए राष्ट्रीय परीक्षा उत्तीर्ण की है, ऊर्जा दक्षता ब्यूरो (ऊर्जा प्रबंधकों के लिए प्रमाणन प्रक्रिया) विनियम 2010 के उपबंधों के अध्यधीन रहते हुए प्रमाणित ऊर्जा प्रबंधक के रूप में अर्हक हैं।

यह प्रमाणपत्र, प्रदान किए जाने की तारीख से पांच वर्ष के लिए विधिमान्य होगा और प्रत्येक पांच वर्ष में एक बार विहित पुनश्चर्या प्रशिक्षण पाठ्यक्रम में उपस्थित रहने के अध्यधीन रहते हुए पुनः नवीकरण किया जाएगा।

उनके नाम को पूर्वोक्त विनियमों के अधीन ऊर्जा दक्षता ब्यूरो द्वारा अनुरक्षित क्रम संख्या 11633 पर प्रमाणित ऊर्जा प्रबंधक के रजिस्टर में प्रविष्ट कर दिया गया है।

श्री / श्रीमती / सुश्री रामेश्वर गजाननराव हरने ऊर्जा संरक्षण अधिनियम 2001 (2001 का अधिनियम संख्यांक 52) की धारा 14 के खंड (ट) के अधीन ऊर्जा प्रबंधक के रूप में नियुक्ति या पदनाम के लिए अर्हित समझे गए हैं।

2015 मास October दिन 30 को ऊर्जा दक्षता ब्यूरो के अधीन दिया गया है।

सचिव
ऊर्जा दक्षता ब्यूरो
नई दिल्ली

पुनश्चर्या पाठ्यक्रम में उपस्थित रहने की तारीखें	सचिव के हस्ताक्षर	पुनश्चर्या पाठ्यक्रम में उपस्थित रहने की तारीखें	सचिव के हस्ताक्षर

MEDA Solar emepanelment:

Unique Registration No: Off-grid/SPV/Micro-grid*Code-5/004

Maharashtra Energy Development Agency

(A Government of Maharashtra Institution)
2nd Floor, MHADA Commercial Complex, Opp. Tridal Nagar, Yerwada, Pune 411 006
Ph No: 020-26614393/266144403, Fax No: 020-26615031
Web: www.mahaurja.com

Date: 19/07/2016

CERTIFICATE OF EMPANELMENT

We hereby certify that, the firm having following particulars is Empanelled with ***MAHARASHTRA ENERGY DEVELOPMENT AGENCY (MEDA)*** under given Sector as per the Criteria for Empanelment given at Annexure I

Name and Address of the firm	:	PPS Energy Solutions Pvt. Ltd., Third Floor, Ashirwad, 18-Girish Society, Warje, Pune - 410058.
Sector for Empanelment	:	Sector Name: **SPV/Micro-grid** Sector Code - **5**
Unique Registration Number	:	**Off-grid/SPV/Micro-grid*Code-5/004**

Purview of Empanelment:

- Preparation of detailed project report
- Preparation of drafts and assisting in finalizing and signing of various contractual documents / agreements required for the projects
- Monitoring & supervision of project execution and commissioning activities to ensure quality & project time frame
- To ensure and evaluate that the project designs and drawings are in line with the project requirement
- Capacity building for successful management and operation of the project
- To assist in successful commissioning.
- This empanelment is valid for the period of 2 years from the date of empanelment.
- The Director General, MEDA reserves the right to cancel the registration at any time without assigning any reasons thereof.

Place: - Pune.

MAHARASHTRA ENERGY DEVELOPMENT AGENCY PUNE

Authorized Signatory

2. Energy details

2.1. Energy details

The electricity supply for Sant Gadge Baba Amravati University is provided by Maharashtra State Electricity Distribution Company Limited. The energy consumed by SGBAU falls under HT IX-E Category. The facility also has 3 DG sets of 125 KVA 2 nos. and 62.5 KVA 1 no. The DGs are mainly used for in case of power failure from MSEDCL. The annual diesel consumption is around 1350 liters. The DGs are connected to the following buildings.

Sr. No	DG details	Name of the building
1	DG no. 1- 125 KVA	Valuation Building
2	DG no. 2- 125 KVA	Administration Building
3	DG no. 3- 62.5 KVA	Guest House , Hon'ble VC Bungalow, IQAC, Teachers Quarters

The energy efficiency assessment was conducted for the load connected to the mains supply. Power analyser was connected to the mains supply in order to study the energy demand profile, Power factor, Harmonics etc. for the period of 24 hours.

Consumer details:

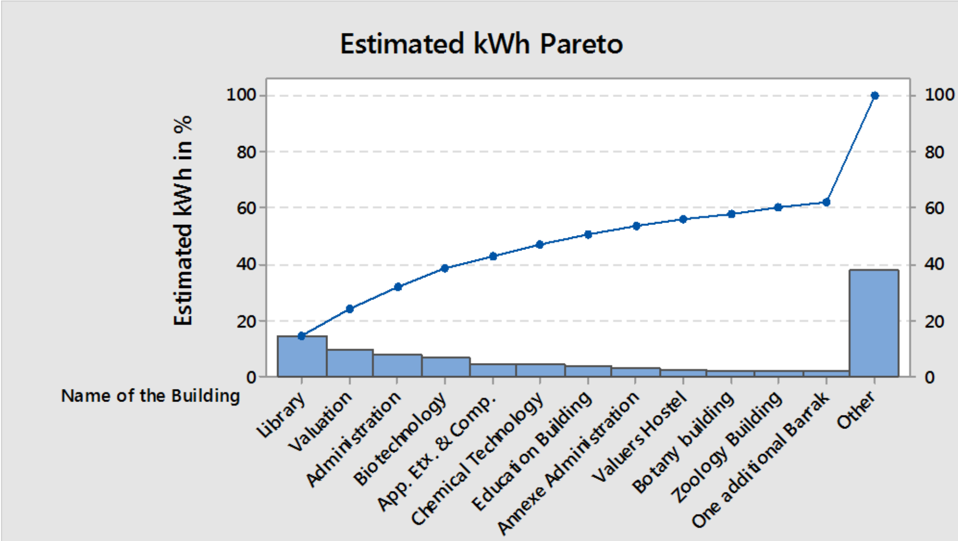
Name of Consumer	Tariff Category	Consumer No.
Register , SGBAU	HT IX-E	359019001669

Mainly energy is used on this facility for the following purposes:

1) Lightings load
2) Air conditioners
3) Pumps
4) Computers
5) Ceiling fans
6) Laboratory machinaries / Equipments

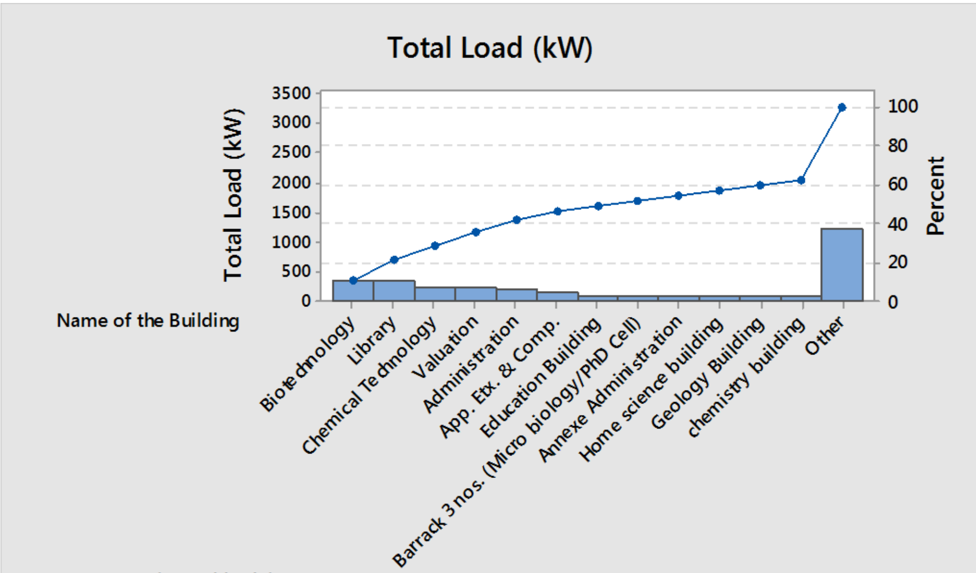
2.2. Major Energy use and areas

Pareto based on estimated monthly kWh consumption:



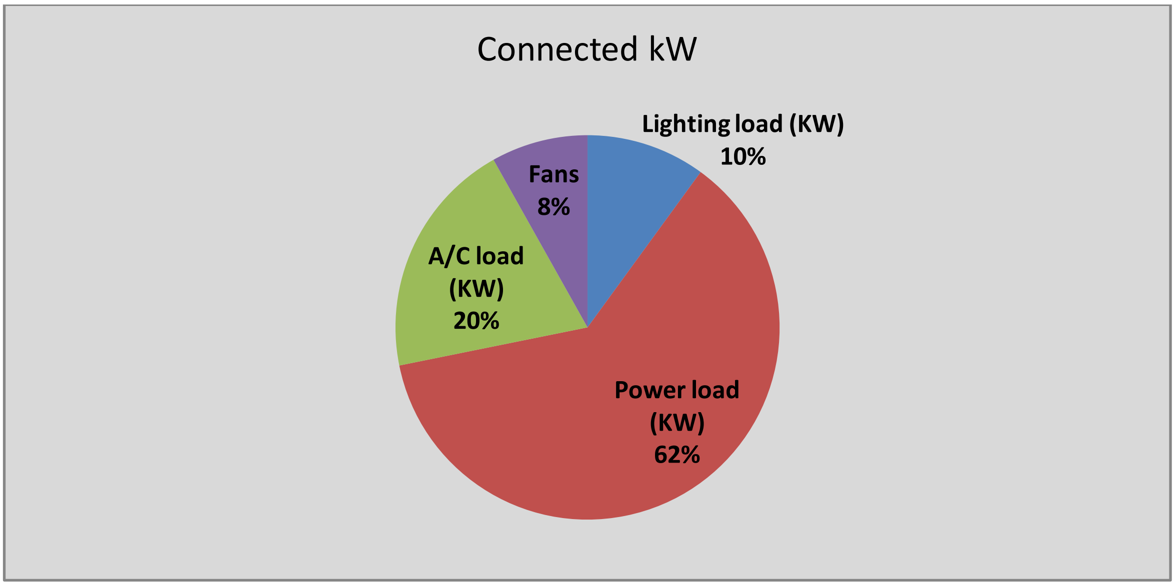
Estimated kWh in %	14.73	9.61	7.75	6.41	4.31	3.96	3.67	3.25	2.47	1.95	1.87	1.79	38.22
Percent	15	10	8	6	4	4	4	3	2	2	2	2	38
Cum %	15	24	32	39	43	47	50	54	56	58	60	62	100

Pareto based on estimated connected load kW:



Estimated kWh in %	351	342	246	231	216	135	91	90	90	87	79	78	1240
Percent	11	10	7	7	7	4	3	3	3	3	2	2	38
Cum %	11	21	29	36	42	46	49	52	55	57	60	62	100

Pie chart based on appliances category wise connected load:



Based on above it is clear that followings buildings has highest potential for energy savings.

Name of the Building
Consolidated Library
Valuation building
Administration Building
Biotechnology
Applied electronics and Computer Building
Chemical Technology
Education Building
Annexe Administration Building
Valuers Hostel
Botany building
Zoology Building
One additional Barrak (Mathematics/ Statistics/Migration dept)

2.3. Monthly energy consumption

Monthly energy consumption of SGBAU ranges from 81715 kWh to 145595 kWh.

Note: Control chart is plotted using individual/moving-range chart and 2 sigma limits.

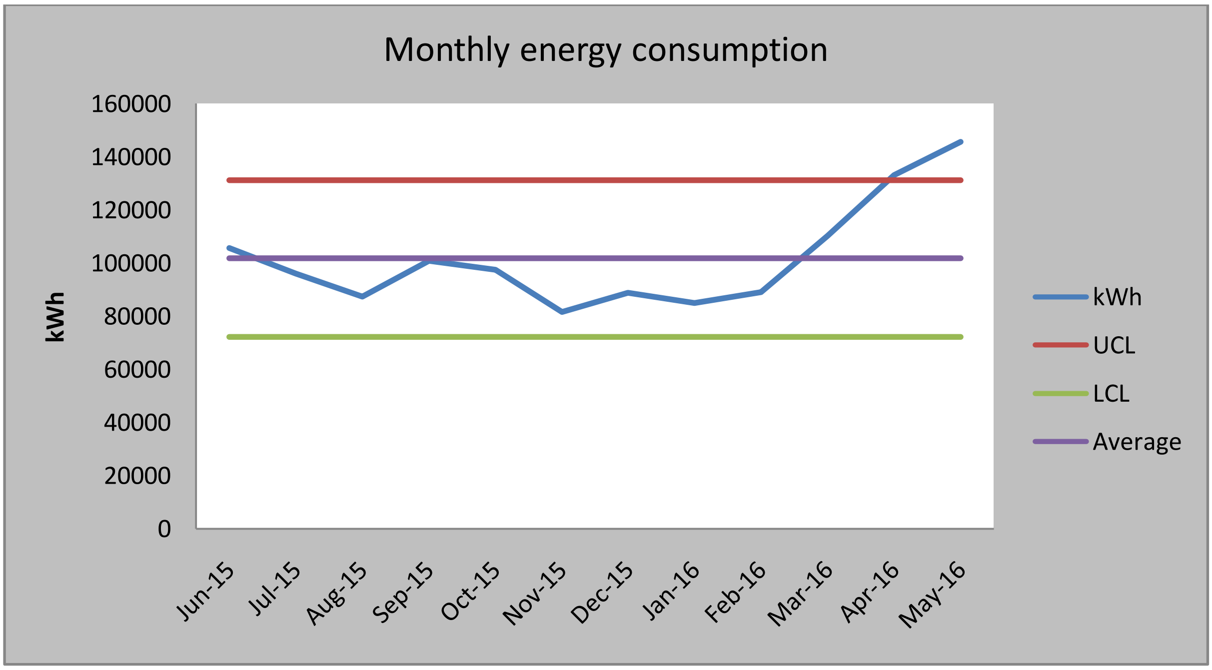


Figure 1–Monthly energy consumption

Monthly energy consumption in the month of May-16 has gone beyond the upper control limit. It was observed that the AC load was high during the May-16.

2.4. Power factor trend

Power factor is in the range of 0.917 to 0.953. Regular monitoring of PF and installation of the automatic power factor capacitor banks will help to maintain the PF to unity.

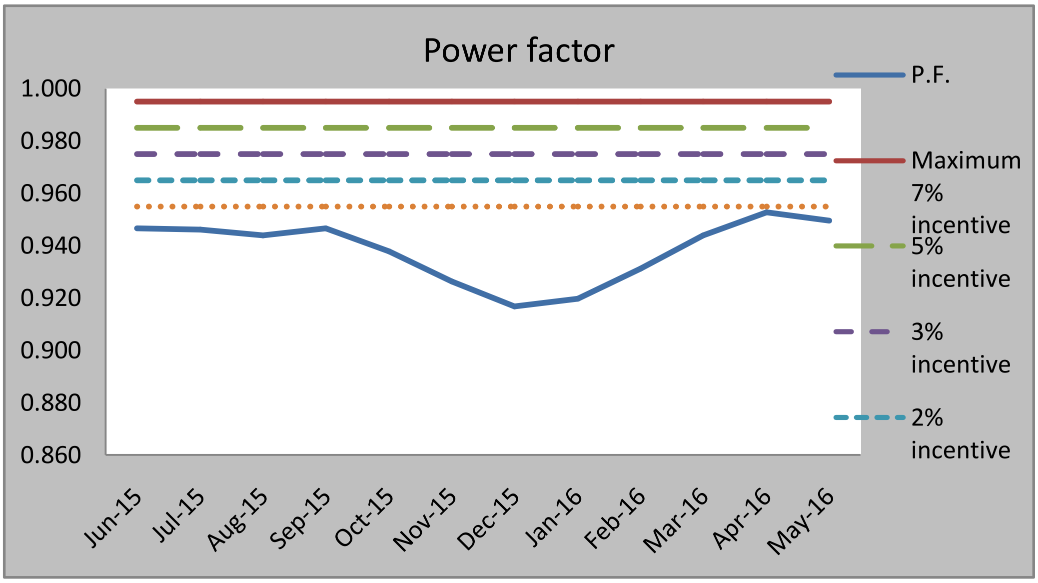


Figure 2 – Power factor

2.5. Zone-wise kWh consumption

Time of Day (or TOD) tariff is a tariff structure in which different rates are applicable for use of electricity at different time of the day. It means that cost of using 1 unit of electricity will be different in mornings, noon, evenings and nights. This means that using appliances during certain time of the day will be cheaper than using them during other times.

Zone	ToD (Time of Day interval)	Unit rate difference (Rs/kWh)
A	22.00 hrs to 06.00 hrs	-1.50
B	06.00 hrs to 09.00 hrs and 12.00 hrs to 18.00 hrs	0.00
C	09.00 hrs to 12.00 hrs	0.80
D	18.00 hrs to 22.00 hrs	1.10

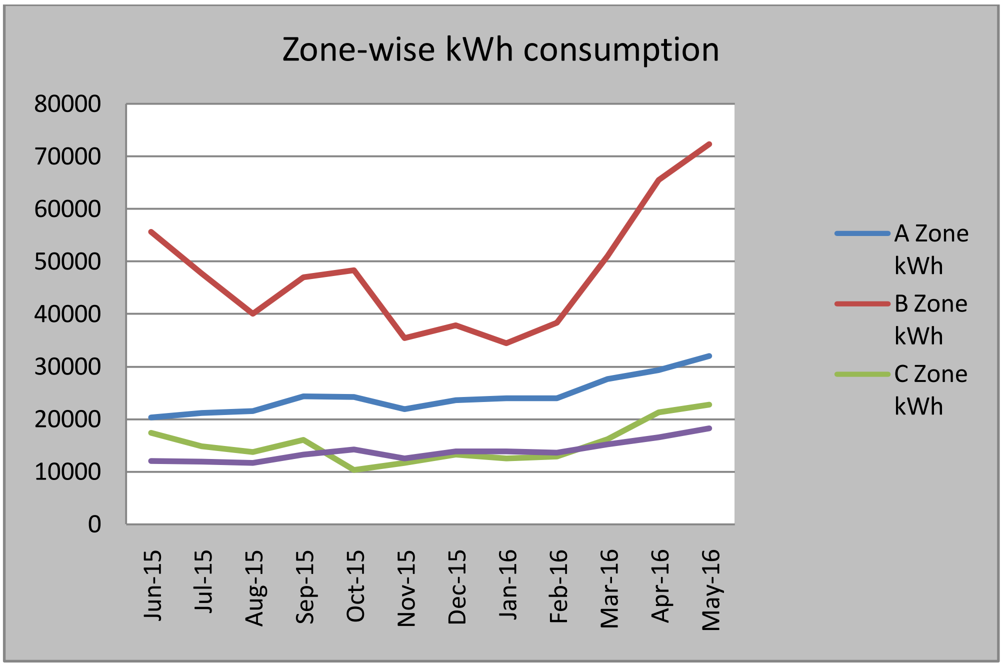
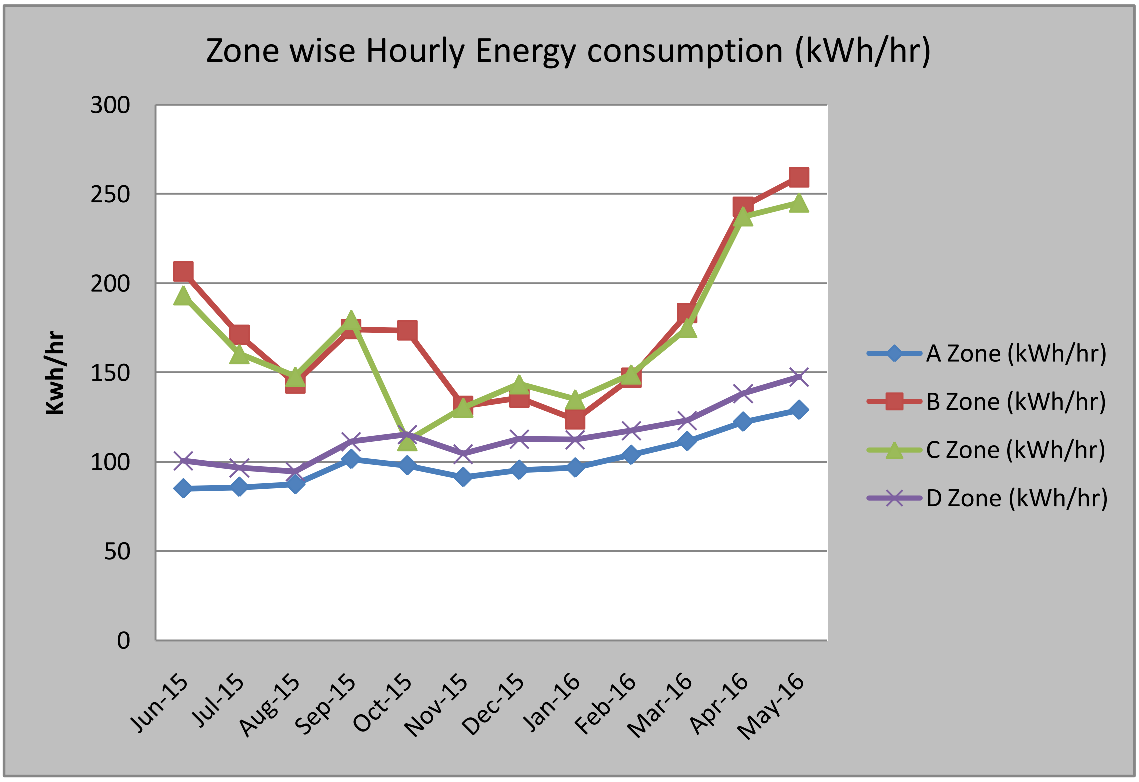


Figure 3 – Zone-wise kWh consumption

2.6. Zone wise hourly energy consumption:



Base load i.e. kWh/hr in B zone (0600 Hrs-0900 Hrs& 1200 Hrs-1800 Hrs) and C zone (0900 Hrs-1200 Hrs) is more as compare to A zone and D zone.

2.7. Maximum demand

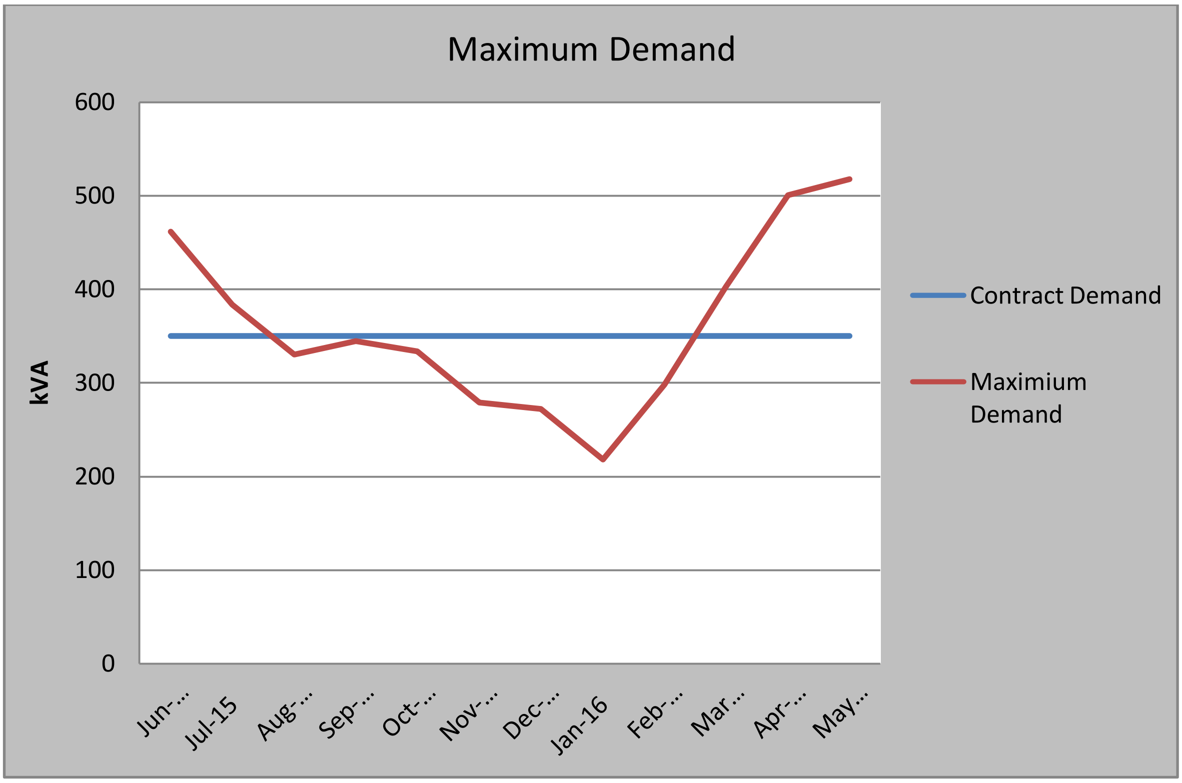


Figure 4 – Maximum demand

From the chart, it is clear that the maximum demand had exceeded contract demand 5 times during last year. The facility had paid Rs. 1,70,940/- as excess demand charges for exceeding demand. It is prudent to increase contract demand to avoid excess demand charges.

Note: The SGBAU has already initiated the action to increase the contract demand from MSEDCL.

2.8. Electricity bill details

Month	kWh	Contract Demand (kVA)	Maximum Demand (kVA)	Excess demand charges (Rs.)	PF	PF incentive / penalty	Energy Charges (Rs.)	ToD (Rs.)	Demand Charges (Rs.)	Total Bill (Rs.)
Jun-15	105695	350	462	36960	0.947	0	761004	-3415.9	101640	976083
Jul-15	96019	350	384	11220	0.946	0	648	-6820.1	84480	852790
Aug-15	87394	350	330	0	0.944	0	629230	-8612	72600	774927
Sep-15	101034	350	345	0	0.947	0	727445	-8930.5	75900	879706
Oct-15	97511	350	334	0	0.938	0	745272	-12423	73480	847492
Nov-15	81715	350	279	0	0.926	0	588485	-9729.2	61380	681689
Dec-15	89031	350	272	0	0.917	0	641002	-9461.5	59840	736787
Jan-16	85096	350	218	0	0.920	0	612684	-10591.6	47960	748658
Feb-16	89129	350	298	0	0.931	0	641729	-10785.5	65560	780806
Mar-16	110401	350	403	17490	0.944	0	794887	-11692.6	88660	979597
Apr-16	133050	350	501	49830	0.953	0	957953	-8758.1	110220	1312866
May-16	145595	350	518	55440	0.950	0	1048284	-9687.6	113960	1359997

3. Energy and Utility system descriptions

3.1. List of utilities:

SGBAU has following energy and utility systems.

1) Electrical substation – The facility has two transformers of 315 KVA, 11kV/415V each.
2) Water Pumps across the facility at different locations.
3) Street lights
4) Electrical distribution network
5) DG sets- 125 KVA 2 no's, 62.5 KVA 1no.
6) Lifts – 3 Nos.
7) Solar Water Heaters / Solar Streetlights / Solar garden Lights

3.2. Electrical substation:

SGBAU has two transformers of 315 KVA 11kV/415V each. Transformer loading is 30% to 40% in winter and rainy season and it goes up to 85 % in summer season.

3.2.1. List of water pump:

Sr. No.	Location	Connected Load (hp)	kW	Remark	1ph/3ph
1	Nursery Well - 1	5	3.75	Submersible	3ph
2	Nursery Well - 2	5	3.75	Submersible	3ph
3	Well Near Computer Science Building	5	3.75	Submersible	3ph
4	Well Near Computer Science Building -2	5	3.75	Submersible	3ph
5	Well Near Zoology Department	5	3.75	Submersible	3ph
6	Well Near Zoology Department -2	5	3.75	Submersible	3ph
7	Well Near Athletic track	5	3.75	Submersible	3ph
8	Well Near Athletic track - 2	5	3.75	Submersible	3ph
9	Well Near Zoology Department	3	2.25	Submersible	3ph
10	Well Near SantraBaug	7.5	5.625	Submersible	3ph
11	Boys Hostel no. 2	5	3.75	Submersible	3ph
12	Garden section	5	3.75	Submersible	3ph
13	Behind sub station	5	3.75	Submersible	3ph
14	Garden Section Pump	5	3.75	Submersible	3ph
15	KulguruNiwasBandhara Pump	5	3.75	Submersible	3ph
16	Physical Education department pump	5	3.75	Submersible	3ph
17	Home Sciences department pump	3	2.25	Submersible	3ph
18	Valuers Hostel	3	2.25	monoblock	3ph
19	Boys Hostel no. 2	3	2.25	monoblock	3ph
20	Girls Hostel no. 2	3	2.25	monoblock	3ph

Sr. No.	Location	Connected Load (hp)	kW	Remark	1ph/3ph
21	Main Building	3	2.25	monoblock	3ph
22	Guest House	3	2.25	monoblock	3ph
23	Biotechnology department	3	2.25	monoblock	3ph
24	Main Building (Garden)	3	2.25	Submersible	3ph
25	Main Building (Garden)	1	0.75	Submersible	3ph
26	Jichkar building	2	1.5	Submersible	3ph
27	Girls Hostel no. 1	1.5	1.125	Submersible	1ph
28	Girls Hostel no. 3	1.5	1.125	Submersible	1ph
29	Teachers quarters	5	3.75	Submersible	3ph
30	Swimming pool	25	18.75	monoblock	3ph
31	City bus stand	2	1.5	Submersible	3ph
32	Botany garden	1	3.75	monoblock	3ph
33	SantraBaug (Garden)	1	0.75	monoblock	1ph
34	SantraBaug (Garden)	3	2.25	Submersible	3ph
35	KulguruNiwas Garden	3	2.25	monoblock	3ph
36	K G Deshmukh hall	15	11.25	monoblock	3ph
Stand by pumps					
37	Nursery Well	5	3.75	Submersible	3ph
38	Computer Sciences	5	3.75	Submersible	3ph
39	Zoology department	5	3.75	Submersible	3ph
40	Swimming pool	25	18.75	monoblock	3ph
41	Valuers Hostel	3	2.25	monoblock	3ph
42	Girls Hostel Nr. 2	3	2.25	monoblock	3ph
43	Girls Hostel Nr. 2	3	2.25	monoblock	3ph
44	SantraBaug (Garden)	3	2.25	Submersible	3ph
45	SantraBaug (Garden)	5	3.75	Submersible	3ph
46	SantraBaug (Garden)	5	3.75	Submersible	3ph
47	Biotechnology department	1	0.75	monoblock	1ph
48	Biotechnology department	0.5	0.375	monoblock	1ph
49	Garden section	1	0.75	monoblock	1ph
50	Garden section	1	0.75	monoblock	1ph
51	Main entrance	0.5	0.375	monoblock	3ph

3.2.2.Street Lights:

SGBAU has total 13 nos. Of lighting metering point and lighting poles are spread across the university area.

1. Street Light Main Gate

2. Street Light Library
3. Street Light Sport Sector (Research lab -Phy Education)
4. street Light Valuer's Hostel
5. Street Light SC Girls Hostel
6. Street Light Chemical Technology
7. Street Light Athletic track Tower
8. Boys Hostel Street Light
9. Street light DL road
10. Street Light Electric Sub station
11. Street Light ShikshakBhavan
12. Street Light near math building Gate NO-1
13. Street Light Addl. Barracks-1

Following lamps are used for the lighting system as follows:

- Compact Fluorescent Lamps (CFL)
- Mercury Vapour Lamps
- Metal Halide Lamps
- LEDs

SGBAU has also installed the solar streetlights at some its places (181 no’s at various street and 16 no’s at garden area).However, at many of the places solar cell are not getting the shadow free area because of the trees and due to that batteries are not getting charged even during daytime. It is suggested to trim the tree branches as much possible, so that solar cells will be free from shadow.


3.2.3. Electrical distribution network:

SGBAU has total 82 nos. of buildings. Electrical supply from substation is given to the seven nos. of feeder pillar where from it is distributed across the facility.

3.2.4. Lifts:

SGBAU has total three nos. of lifts installed. Lifts maintenance should be done on regular basis.

Sr. No.	Location of the lift	Make of the lift	Motor HP	Carrying capacity- KG	Speed of the lift-meter/sec	Remark
1	Administration building Gr. Fl.	Marconi	5	272 (4 persons)	0.66	Constant speed
2	Valuation building Gr Fl	ThyssenKrupp	5	1000 (10 persons)	0.35	Variable speed
3	Administration building Gr. Fl.	Power link (Hydraulic)	7.5	544 (8 persons)	0.50	Variable speed

Location of the lift	Motor HP	Rated Current	Motor current while downward movement	Motor current while upward movement	Remark
Administration building Gr. Fl.	5	7.2 Amp	4.9 Amp	5.2 Amp	Operating current found within limit

3.2.5.Solar water heaters:

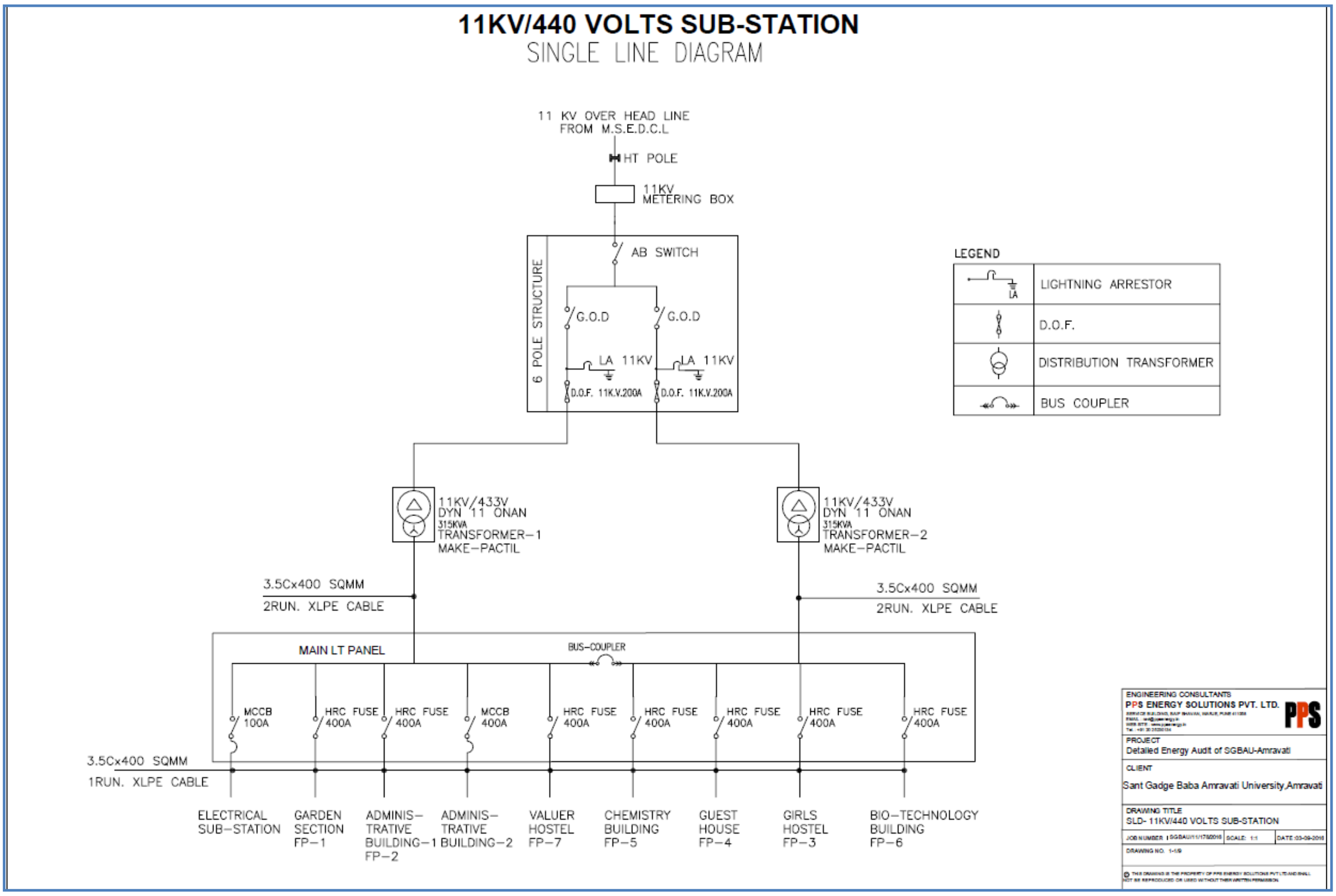
SGBAU has total 12 nos. of solar water heater system. All systems are in operating condition and are maintained regularly.

Sr. No.	Name of the Building	Installation year	Solar capacity	Make	Cell dimension	Type
1	Boys Hostel - 2	2003	1250	Jain	2.5' x 4' x 10 nos	Plate Type
2	Boys Hostel - 2	2003	1250	Jain	2.5' x 4' x 10 nos	Plate Type
3	Boys Hostel - 1	2003	750	Jain	2.5' x 4' x 6 nos	Plate Type
4	Valuer's Hostel	2003	1250	Jain	2.5' x 4' x 12 nos	Plate Type
5	Valuer's Hostel	2003	1250	Jain	2.5' x 4' x 12 nos	Plate Type
6	Hon'ble VC Bungalow	2003	250	Jain	2.5' x 4' x 2 nos	Plate Type
7	Girl's Hostel - 2	2003	1250	Jain	2.5' x 4' x 10 nos	Plate Type
8	Girl's Hostel - 2	2003	1250	Jain	2.5' x 4' x 10 nos	Plate Type
9	Girl's Hostel - 3	2015	750	Jain	2.5' x 4' x 6 nos	Plate Type
10	Girl's Hostel - 3	2016	1000	Jain	25 tubes x 4 Nos	Tube Type
11	Girl's Hostel - 1	2003	1250	Jain	2.5' x 4' x 10 nos	Plate Type
12	Girl's Hostel - 1	2003	750	Jain	2.5' x 4' x 6 nos	Plate Type
13	Guest House	2003	1250	Jain	2.5' x 4' x 10 nos	Plate Type

4. Single Line Diagram

Annexure 1: SLD

11KV/440 VOLTS SUB-STATION



5. Energy Efficiency Assessment

5.1. DG set performance assessment:

DG sets are used mainly in case of power failure and shutdown maintenance incidents. DG set performance assessment was carried out at 125 KVA and 62.5 KVA DG sets. The test results are as follows:

Parameter	Unit	Value	
DG No.	each	1	3
DG Capacity	KVA	125	62.5
Start Time		05:00 pm	12:14 pm
End Time		06:00 pm	01:54 pm
Run hrs	Hrs	1.00	1.67
Start meter reading	Nos	15.20	163.35
End meter reading	Nos	15.6	164.1
CT Ratio	Nos	40	20
KWH generated	kWh	16	15
Tank area	m^3	0.28224	0.91875
Initial Height	meter	0.54	0.166
Final Height	meter	0.52	0.158
Diesel consumed	Litre	5.64	7.35
Average Voltage	Volts	416.00	418.00
Average current	Amp	24.10	15.47
Average Power Factor	Nos	0.8	0.8
Specific Energy Consumption	(KWH/Litre)	2.83	2.04
Running load KVA	KVA	17.36	11.2

During energy efficiency study, it was also observed that during summer season the DG set load goes beyond its rated capacity. This may result in failure of DG operation. Hence, it is suggested to run the DG at the optimum level i.e. 80-85% of its rated capacity. This will ensure the breakdown free operation of DG sets.

5.2. Electric motor load analysis:

Water pump motor load analysis was done for some of the pumps at the facility:

Sr. No.	Location	Connected Load (hp)	Operating hrs	kW	Running kW	% Loading	1ph/3ph	Running Current			Running Voltage		
1	Well Near Zoology Department	5	4	3.75	3.77	100%	3ph	6.78	7.2	7.6	380	382	372
2	Well Near Zoology Department -2	5	5	3.75	4.13	110%	3ph	7.6	8.2	8	390	358	380
3	Well Near Athletic track	5	6	3.75	5.23	139%	3ph	10.5	10.8	10.2	368	348	362
4	Well Near Athletic track – 2	5	4	3.75	5.23	139%	3ph	10.5	10.8	10.2	368	348	362
5	Well Near Zoology Department	3	2	2.25	3.41	152%	3ph	6.2	6.5	6.35	382	390	392
6	Well Near SantraBaug	7.5	1	5.625	2.96	53%	3ph	5.8	6.2	5.6	358	364	370
7	KulguruNiwasBandhara Pump	5	5	3.75	3.09	83%	3ph	5.7	5.2	6.02	402	395	391
8	Home Sciences department pump	3	1	2.25	1.87	83%	3ph	3.6	3.52	3.46	372	385	394
9	Valuers Hostel	3	2	2.25	1.85	82%	3ph	3.6	3.52	3.85	360	355	380
10	Boys Hostel no. 2	3	3	2.25	3.31	147%	3ph	6.2	6.12	5.95	385	392	398
11	Girls Hostel no. 2	3	3	2.25	3.18	141%	3ph	5.75	6.03	5.58	392	396	402
12	Main Building	3	2.5	2.25	1.73	77%	3ph	3.2	3.25	3.28	380	384	392
13	Main Building (Garden)	3	2	2.25	1.66	74%	3ph	3.2	3.4	2.8	372	382	392
14	Jichkar building	2	3	1.5	1.67	111%	3ph	3	3.2	3.05	402	390	382
15	Girls Hostel no. 1	1.5	4	1.125	1.62	144%	1ph	3.17	6.47	5.62	230	385	381
16	Girls Hostel no. 3	1.5	3	1.125	0.78	69%	1ph	2.1	2.17	3.05	230	392	386
17	Botany garden	1	2	3.75	3.25	87%	3ph	5.8	6.1	5.84	403	392	395
18	SantraBaug (Garden)	1	6	0.75	0.82	109%	1ph	2.1	2.7	3.1	225	391	395
19	SantraBaug (Garden)	3	3	2.25	3.05	135%	3ph	5.2	6.03	5.58	394	385	398
20	KulguruNiwas Garden	3	4	2.25	3.11	138%	3ph	5.6	6.2	5.8	384	371	393
21	K G Deshmukh hall	15	0	11.25	6.23	55%	3ph	11.5	12	11.8	382	390	374
39	Zoology department	5		3.75	3.84	102%	3ph	7.2	7.45	7.6	378	384	358
40	Swimming pool	25		18.75	13.13	70%	3ph	24.2	25	24.5	382	385	390
41	Valuers Hostel	3		2.25	2.05	91%	3ph	3.85	3.9	3.92	380	372	390
42	Girls Hostel Nr. 2	3		2.25	3.26	145%	3ph	5.5	6.2	5.95	401	394	406
44	SantraBaug (Garden)	3		2.25	2.95	131%	3ph	5.8	5.9	5.4	362	385	372
45	SantraBaug (Garden)	5		3.75	2.99	80%	3ph	5.5	5.8	5.6	367	392	390
46	SantraBaug (Garden)	5		3.75	2.93	78%	3ph	5.6	5.2	6.2	378	382	358

Performance assessment of Split AC:

Cooling equipment systems used in small commercial buildings often express cooling system efficiency in terms of the Energy Efficiency Ratio - EER - For room air conditioners the commonly used efficiency ratio is the –

EER - Energy Efficiency Ratio:

EER is a measure of how efficient a cooling system operates in steady state (over time) when the outdoor temperature is at a specific level (outdoor conditions commonly used are 95°F). The higher EER, the more energy efficient system is.

$$EERinWatt = \frac{\text{Refigeration effect in watts}}{\text{Input power in watts}}$$

$$EER\ in\ Watt = \frac{\text{mass flow rate} * (\text{Enthalpy in} - \text{Enthalpy out}) * 1000/(4.18 * 860)}{\text{Input power in watts}}$$

<u>1.5 TR non star rated AC’s</u>

Parameter	Value	Unit
Air flow in (m/s)	4	m/s
Area	0.1	m2
Air density	1.17	kg/m3
Dry Bulb temperature at Inlet	26	^{o}C
Wet bulb temperature at Inlet	21	^{o}C
Dry Bulb temperature at Outlet	21	^{o}C
Wet bulb temperature at Outlet	18	^{o}C
Enthalpy In	60.7	kJ/kg
Enthalpy out	50.8	kJ/kg
Measured current of the compressor	8	A
Energy demand of the compressor	1.656	kW
Watt refrigeration effect	4.64	kW
Energy Efficiency Ratio	2.8	-

<u>1.5 TR 5 star rated AC’s</u>

Parameter	Value	Unit
Air flow in (m/s)	4	m/s
Area	0.1	m2
Air density	1.17	kg/m3
Dry Bulb temperature at Inlet	26	^{o}C

Wet bulb temperature at Inlet	21	°C
Dry Bulb temperature at Outlet	21	°C
Wet bulb temperature at Outlet	18	°C
Enthalpy In	60.7	kJ/kg
Enthalpy out	50.8	kJ/kg
Measured current of the compressor	6	A
Energy demand of the compressor	1.242	kW
Watt refrigeration effect	4.64	kW
Energy Efficiency Ratio	3.7	-

2 TR non rated AC's

Parameter	Value	Unit
Air flow in (m/s)	4	m/s
Area	0.14	m2
Air density	1.17	kg/m3
Dry Bulb temperature at Inlet	26	°C
Wet bulb temperature at Inlet	21	°C
Dry Bulb temperature at Outlet	21	°C
Wet bulb temperature at Outlet	18	°C
Enthalpy In	60.7	kJ/kg
Enthalpy out	50.8	kJ/kg
Measured current of the compressor	11	A
Energy demand of the compressor	2.277	kW
Watt refrigeration effect	6.495863	kW
Energy Efficiency Ratio	2.85282	-

2 TR 5 star rated AC's

Parameter	Value	Unit
Air flow in (m/s)	4	m/s
Area	0.14	m2
Air density	1.17	kg/m3
Dry Bulb temperature at Inlet	26	°C
Wet bulb temperature at Inlet	21	°C
Dry Bulb temperature at Outlet	21	°C
Wet bulb temperature at Outlet	18	°C
Enthalpy In	60.7	kJ/kg
Enthalpy out	50.8	kJ/kg

Measured current of the compressor	9	A
Energy demand of the compressor	1.863	kW
Watt refrigeration effect	6.495863	kW
Energy Efficiency Ratio	3.48678	-

5.3. Lighting system:

Lux level was assessed at different location and it is mentioned below:

In most of the buildings, electrical supply for lighting load is given separately. Lighting load includes lights, fans and coolers. Voltage at lighting DB is observed in the range of 220V to 230V. Administrative and teaching buildings are operating mostly during daytime where day light availability is supporting the lux level.

Sr. No.	Location	Measured lux level range	Lighting Device	Rating in watts	No. of working hours
1	Street lights	5-20	MV 250	250	12 (Night)
2	Office cabins	550-750	T-12 x 2	102	10 (Day)
3	Hostel rooms	150-300	T-12 x 2	102	12 (Day)
4	Hostel passage	75-100	PL 11x2	22	12 (Night)
5	Building passage	150-300	PL 11x 2	22	10 (Day)
6	Sub station	25 - 40	HPSV 250	250	12 (Night)
7	Library Chowk	30-40	MH 400 x4	1600	12 (Night)

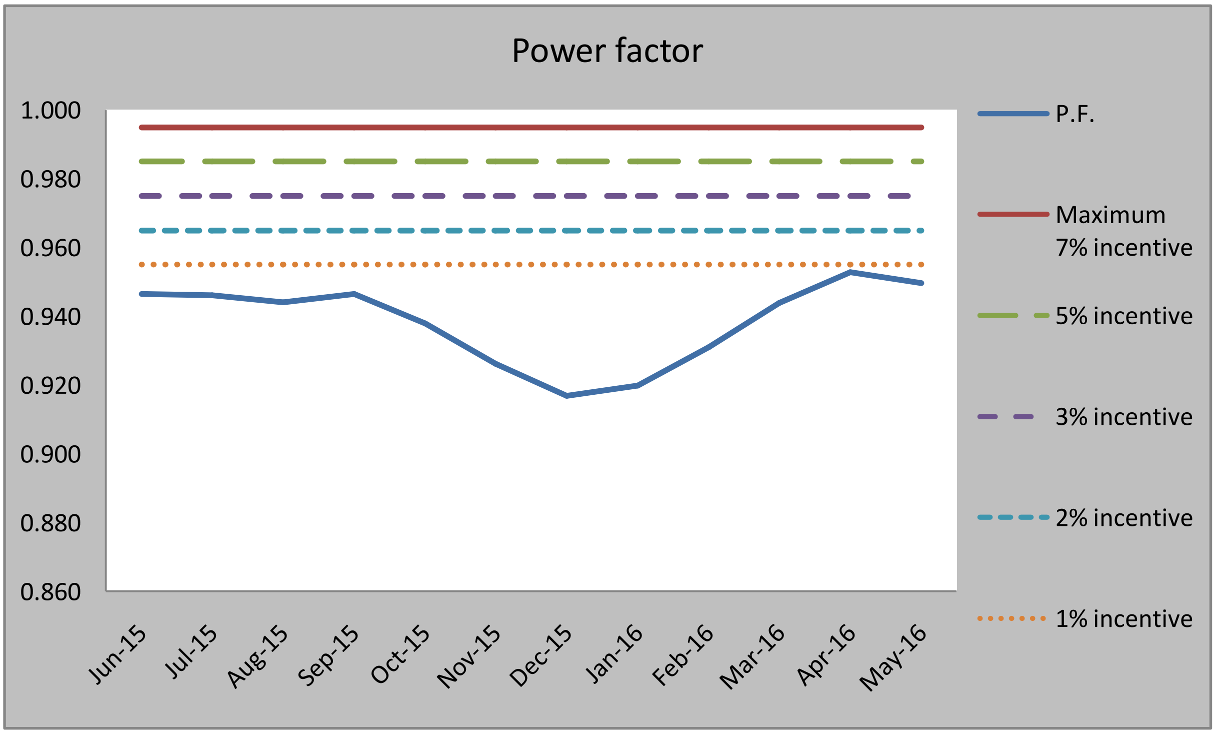
6. Energy Conservation Options & Recommendations

ECM 1:

Name	Power factor improvement
Location	Sub station
Estimated Annual Savings	5.48Lakhs INR/year
Estimated investment Cost	7.8Lakhs INR/Year
Estimated Payback	1.4 Years
Environmental Benefits.	NA
Next Steps	Installfixed type capacitor banks at high energy consuming buildings and install APFC panel at substation.

Observations:

The power factor trend for last year is shown below.



During energy efficiency assessment study, it was observed that the power factor is below 0.950 and SGBAU not getting any power factor incentive (to maintain PF above 0.955).

Why maintain power factor?

In all industrial/commercial buildings electrical distribution systems, the major loads are resistive and inductive. Resistive loads are incandescent lighting and resistance heating. In case of pure resistive loads, the voltage (V), current (I), resistance (R) relations are linearly related.

Typical inductive loads are A.C. Motors, induction furnaces, transformers and ballast-type lighting. Inductive loads require two kinds of power: a) active (or working) power to perform the work and b) reactive power to create and maintain electro-magnetic fields. Active power is measured in kW (Kilo Watts). Reactive power is measured in kVAr (Kilo Volt-Amperes Reactive).

The vector sum of the active power and reactive power make up the total (or apparent) power used. This is the power generated by the SEBs for the user to perform a given amount of work. Total Power is measured in kVA (Kilo Volts-Amperes)

The active power (shaft power required or true power required) in kW and the reactive power required (kVAr) are 900 apart vectorically in a pure inductive circuit i.e., reactive power kVAr lagging the active kW. The vector sum of the two is called the apparent power or kVA, and the kVA reflects the actual electrical load on distribution system.

The ratio of kW to kVA is called the power factor, which is always less than or equal to unity. Theoretically, when electric utilities supply power, if all loads have unity power factor, maximum power can be transferred for the same distribution system capacity. However, as the loads are inductive in nature, with the power factor ranging from 0.2 to 0.9, the electrical distribution network is stressed for capacity at low power factors.

Recommendations:

The solution to improve the power factor is to add power factor correction capacitors to the plant power distribution system. They act as reactive power generators, and provide the needed reactive power to accomplish kW of work. This reduces the amount of reactive power, and thus total power, generated by the utilities.

The advantages of PF improvement by capacitor addition:

a) Reactive component of the network is reduced and so also the total current in the systemfrom the source end.
b) I2R power losses are reduced in the system because of reduction in current.
c) Voltage level at the load end is increased.

Cost benefits of PF improvement:

While costs of PF improvement are in terms of investment needs for capacitor addition, the benefits to be quantified for feasibility analysis are:

- Reduced kVA (Maximum demand) charges in utility bill
- Reduced distribution losses (kWh) within the plant network
- Better voltage at motor terminals and improved performance of motors
- A high power factor eliminates excess demand charges imposed when operating with a low power factor
- Investment on system facilities such as transformers, cables, switchgears etc for delivering load is reduced.

Location of Capacitors:

The primary purpose of capacitors is to reduce the maximum demand. Additional benefits are derived by capacitor location. Maximum benefit of capacitors is derived by locating them as close as possible to the load. At this location, its kVAr are confined to the smallest possible segment, decreasing the load current. This, in turn, will reduce power losses of the system substantially. Power losses are proportional to the square of the current. When power losses are reduced, voltage at the motor increases; thus, motor performance also increases.

Hence, it is recommended to install the fixed type capacitor banks at high-energy consuming buildings and APFC at substation to correct the PF to unity level.

Energy Saving Calculations:

Particular	Unit	Value
Existing PF incentive	Rs/year	0
Achievable PF incentive @7%	Rs/year	521707
Existing Billed demand charges	-	1037960
Estimated demand charges after APFC	Rs/year	1012052
Savings	Rs/year	547615
Diversity factor	%	70%
KVA Existing		518
Existing PF	nos	0.938
Proposed PF	nos	1
Req KVAr	kVAr	179
Proposed KVAr		200

Month	P.F.	Demand Charges	Energy Charges	FAC	TOD charges	Amount	P.F. Incentives / Charges	P.F. incentive (%) Received	P.F. incentive (7 %) Savings (Projected)	Total Amount Of the Bill	Recorded demand	Billed demand	Proposed PF	estimated Demand	Estimated demand charges as recorded demand	estimated Billed demand charges	Savings (demand reduction)	PF incentive @ 7%
Jun-15	0.947	101640	761004	71439	-3416	930667	0	0	65147	852789	462	462	1	437	96207	96207	5433	65147
Jul-15	0.946	84480	691329	64891	-6820	833879	0	0	58372	774927	384	384	1	363	79924	79924	4556	58372
Aug-15	0.944	77000	629230	64924	-8612	762542	0	0	53378	879705	330	350	1	330	72691	77000	0	53378
Sep-15	0.947	77000	727445	75058	-8931	870572	0	0	60940	847492	345	350	1	331	72887	77000	0	60940
Oct-15	0.938	77000	745272	23486	-7623	838135	0	0	58669	681689	334	350	1	328	72216	77000	0	58669
Nov-15	0.926	77000	588485	18545	-9729	674301	0	0	47201	736787	279	350	1	324	71321	77000	0	47201
Dec-15	0.917	77000	641002	20200	-9462	728741	0	0	51012	748657	272	350	1	321	70598	77000	0	51012
Jan-16	0.920	77000	612684	61872	-10592	740964	0	0	51868	780806	218	350	1	322	70823	77000	0	51868
Feb-16	0.931	77000	641729	64805	-10786	772748	0	0	54092	979597	298	350	1	326	71697	77000	0	54092
Mar-16	0.944	88660	794887	80273	-11693	952127	0	0	66649	1312862	403	403	1	380	83681	83681	4979	66649
Apr-16	0.953	110220	957953	191590	-8758	1251005	0	0	87570	1359997	501	501	1	477	105013	105013	5207	87570
May-16	0.950	113960	1048284	138839	-9688	1291396	0	0	90398	1173513	518	518	1	492	108227	108227	5733	90398

ECM 2:

Name	Changing (Increase) Contract demand
Location	Sub station
Estimated Annual Savings	1.60Lakhs INR/year
Estimated investment Cost	8.93 Lakhs
Estimated Payback	5.6 Years
Environmental Benefits.	NA
Next Steps	Increase contract demand from 350 kVA to 580 kVA.

Observations

Contract demand is the amount of electric power that a customer demands from utility in a specified interval. Unit used is kVA or kW. It is the amount of electric power that the consumer agreed upon with the utility. This would mean that utility has to plan for the specified capacity.

Maximum demand is the highest average kVA recorded during any one-demand interval within the month. The demand interval is normally 30 minutes.

The contract demand for SGBAUis 350 kVA. However, during last year the maximum demand had crossed the contract demand on four occasions. The facility has to pay billed demand charges and excess demand charges (150% demand charges on exceeded demand).

The facility had paid excess demand charges on four occasions during last year.

Recommendations

Billed demand is 50% of contract demand (it will be 275 kVA if we increase contract demand to 580 KVA) or recorded maximum demand (in current situation it is between 218 kVA to 518 kVA) whichever is more.

The maximum-recorded demand for last year was in the range of 218 kVA to 518 kVA. If facility increases contract demand from 350 kVA to 580 kVA, it will not overshoot contract demand and will not have to pay excess demand charges as well.

Note: SGBAU has already applied for increasing the contract demand.

Energy Saving Calculations:

Month	Contract Demand	Recorded Demand (Max)	50 % of the Contract Demand	Billed kVA (MD)	Billed kVA Demand @	Demand Charges	Charges for the excess demand	Excess Demand	Excess demand rate	Proposed Contract Demand
Jun-15	350	462	175	462	220	101640	36960	112	330	580
Jul-15	350	384	175	384	220	84480	0	34	330	580
Aug-15	350	330	175	350	220	77000	0	-20	330	580
Sep-15	350	345	175	350	220	77000	0	-5	330	580
Oct-15	350	334	175	350	220	77000	0	-16	330	580
Nov-15	350	279	175	350	220	77000	0	-71	330	580
Dec-15	350	272	175	350	220	77000	0	-78	330	580
Jan-16	350	218	175	350	220	77000	0	-132	330	580
Feb-16	350	298	175	350	220	77000	0	-52	330	580
Mar-16	350	403	175	403	220	88660	17490	53	330	580
Apr-16	350	501	175	501	220	110220	49830	151	330	580
May-16	350	518	175	518	220	113960	55440	168	330	580
Estimated annual savings (Rs. Lakh)					1.60					

ECM 3:

Name	Replacement of 40 Watt Tube lights with LED tube lights
Location	All the buidlings
Estimated Annual Savings	77760 kWh/year, 6.22Lakhs INR/year
Estimated investment Cost	28.00 Lakh
Estimated Payback	4.5 Years
Environmental Benefits.	Reduced CO_2 emissions from less electricity used @ 69.6 tCO_2e per year
Next Steps	Replace T12 tube lights with energy efficient LED lights in a phased manner.

Observations:

The tubular fluorescent lights (T12/T8) are used for lighting purpose.

Recommendations:

The 40-Watt Fluorescent tubular lights could be replaced with 22 Watt LEDs. LEDs have better efficacy per watt as well as they have much larger lifespan than TFLs.

Energy Efficiency & Energy Costs	Light Emitting Diodes (LEDs)	Incandescent Light Bulbs	Fluorescent light
Life Span (average)	50,000 hours	1,200 hours	10000 hours
Watts of electricity used (equivalent to 60-watt bulb). LEDs use less power (watts) per unit of light generated (lumens). LEDs help reduce greenhouse gas emissions from power plants and lower electric bills	6 - 8 watts	60 watts	13-15 watts
Kilo-watts of Electricity used	329 KWh/yr.	3285 KWh/yr.	767 KWh/yr.
Annual Operating Cost	INR 3454 /year	INR 34492/year	INR 8053/year

Note: In above table calculation are done considering 16 nos. of lamps with 10 hrs/day, 300 days/year as operating hrs. and unit rate as 10.5 Rs/kWh

Energy Saving Calculations:Calculations for 1stphase:

Parameter	Unit	Value
Existing No. of tube lights (T12)	No.	6004
No. of tube lights to be replaced (1st phase)	No.	2000
Power consumption by each tube light fitting with ballast	W	40
Power consumption by new LED tube lights	W	22
Energy savings by replacement	W	18
Operating hrs/year	Hrs/year	2160
Yearly savings	kWh	77760
Unit Rate	Rs./kWh	8
Annual Saving	Rs Lakh/year	6.22
Investment	Rs Lakh	28.00
Payback	Years	4.5

Also considering the remaining tube lights replacement, following are the estimates of savings and investment:

Calculations for 2nd phase:

It is suggested to replace the remaining tube lights with T5 tube lights

Sr. No.	Parameter	Value
No. of tube lights to be replaced (2nd phase)	No.	2000
Power consumption by each tube light fitting with ballast	W	40
Power consumption by T5 tube lights	W	28
Energy savings by replacement	W	12
Operating hrs/year	Hrs/year	1080

Sr. No.	Parameter	Value
Yearly savings	kWh	25920
Unit Rate	Rs./kWh	8
Annual Saving	Rs Lakh/year	2.07
Investment	Rs Lakh	7.00
Payback	Years	3.38

Calculations for 3rd phase:

It is suggested to replace the remaining tube lights with T5 tube lights

Sr. No.	Parameter	Value
Existing No. of tube lights (T12)	No.	6004
No. of tube lights to be replaced (3rd phase)	No.	2000
Power consumption by each tube light fitting with ballast	W	40
Power consumption by new T5 tube lights	W	28
Energy savings by replacement	W	12
Operating hrs/year	Hrs/year	540
Yearly savings	kWh	12960
Unit Rate	Rs./kWh	8
Annual Saving	Rs Lakh/year	1.04
Investment	Rs Lakh	7.00
Payback	Years	6.75

ECM 4:

Name	Maintenance of Monoblock pumps and electric motors - cleaning fan inlet, cooling fins, replacement of bearings and proper greasing
Location	Monoblock pumps locations
Estimated Annual Savings	7648 kWh/year, 0.61Lakhs INR/year
Estimated investment Cost	0.50 Lakh
Estimated Payback	0.8 Years
Environmental Benefits.	Reduced CO_2 emissions from less electricity used @ 6.8 tCO_2e per year
Next Steps	Regular maintenance and preventive maintenance schedule

Observations:

During energy efficiency assessment study, it was observed that pump motors are not in healthy condition. Friction sound of the bearing was loud, motors needed the maintenance

Recommendations:

Preventive maintenance of pump motor will reduce the energy consumption and improve the motor performance. Preventive maintenance in case of pump motor includes cleaning of motor fan and cooling fins, proper greasing of motor bearings, tightening of foundation bolts etc.

Energy Saving Calculations:

Sr.No.	Parameter	Value
1	Total energy consumption of Pumps	120285
2	Yearly energy consumption of monoblock pumps	38239
3	Estimated savings through maintenance	20%
4	Savings in kWh	7647.75
5	Unit rate in Rs.	8.00
6	Savings in Rs.	61182
7	Maintenance cost Rs.	50000

ECM 5:

Name	Peak Load management- Running the water pumps during off peak hours
Location	Water pumps across the facility
Estimated Annual Savings	0.72Lakhs INR/year
Estimated investment Cost	Nil
Estimated Payback	Nil
Environmental Benefits.	NA
Next Steps	Run the water pumps during night period (A zone)

Observations:

Water pumps are running during daytime (B and C zone).

Recommendations:

Rescheduling of large electric loads and equipment operations, in different shifts can be planned and implemented to minimize the simultaneous maximum demand. Reschedule the operations and running equipment in such a way as to improve the load factor, which in turn reduces the maximum demand.

Better load management helps to minimize peak demands. The utilities (State Electricity Boards) charges different power tariff structure to influence better load management through measures like time of use tariffs, penalties on exceeding allowed maximum demand, night tariff concessions etc. Load management is a powerful means of efficiency improvement for both end user as well as utility.

As the demand charges constitute a considerable portion of the electricity bill, there is a need for integrated load management to effectively control the maximum demand.

Hence, it is recommended to run the water pumps during night period (A zone).

Note: SGBAU has already initiated the action to make overhead tank (1 no. of 4.0 Lakh Liter capacity.) wherefrom water will be supplied to the whole facility. SGBAU has decided to run the water pump to fill up the overhead tanks during night period (A zone)

Energy Saving Calculations:

Sr.No.	Parameter	Value
1	Total energy consumption of Pumps	120285
2	Average Tariff Difference	1.50
3	Diversity factor	40%
4	Savings in Lakh Rs.	0.72

ECM 6:

Name	Optimize the tempreture setting to 25 C
Location	All ACs
Estimated Annual Savings	6521kWh/year, 0.52Lakh INR/year
Estimated investment Cost	Nil
Estimated Payback	Nil
Environmental Benefits.	Reduced CO_2 emissions from less electricity used @ 5.8tCO_2e per year
Next Steps	Set the AC temperature between 24-26 deg. C.

Observations:

Temperature settings are very low

Recommendations:

During EEA study at facility it was observed that temperature settings of AC in office & meeting rooms were in the range of 17^0 C to 22^0 C.
It is known that a 1°C raise in AC temperature can help to save almost 3 % on power consumption (this can also be verified in BEE guideline: Chapter 4.HVAC and Refrigeration System).
The TR capacity of the same AC systems will also increase with the increase in evaporator temperature (AC set points), as given in Table below:

Effect of variation in Evaporator Temperature on Compressor Power Consumption			
Evaporator temperature(^{0} C)	Refrigeration Capacity* (tons)	Specific Power Consumption	Increase in kW/ton (%)
5.0	67.58	0.81	-
0.0	56.07	0.94	16.0
-5.0	45.98	1.08	33.0
-10.0	37.20	1.25	54.0
-20.0	23.12	1.67	106.0

** Condenser temperature 40°C*

Hence it was recommended that temperature setting of outlet will be changed from present 22 ^{0}C to 25 ^{0} C and keeping inlet temperature unaltered.

SGBAU will further study the overall effect on the facility and may further tune the temperature settings.

Based on the recommended change of AC temperature settings, calculation for energy saving was completed and this has been elaborated in ECM calculation sheet (Annexure).

Energy Saving Calculations:

Particular	Unit	Value
Estimated consumption of Acs	kWh/hr	326037
Estimated Saving	%	2%
Operating Hrs per day	hrs/day	8
Operating days per year	Days/year	138
Estimated Saving	kWh/year	6521
Unit Rate	Rs/kWh	8
Annual Saving	Rs Lakh/year	0.5

ECM 7:

Name	Replacement of No star ACs (1.5 T and 2.0 T) with 5 starAcs.
Location	All offices
Estimated Annual Savings	167006 kWh/year, 13.36 Lakh INR/year
Estimated investment Cost	44.135 Lakh INR
Estimated Payback	3.3 Years
Environmental Benefits.	Reduced CO_2 emissions from less electricity used @ 149.4 tCO_2e per year
Next Steps	Replacement ofnon star rated 1.5T and 2.0T air conditioners in phased manner

Observations:

It has been found that at many of the places no star AC's are there

Recommendations:

The non-star rated air conditioners could be replaced with new Bureau of Energy efficiency five stars rated air conditioners. The energy consumption of the five star rated air conditioners is much less, than the energy consumption of the old non-star rated air conditioners. The payback period of the replacement is quite less and further maintenance cost could also be avoided.

Star Ratings	Max. Cooling capacity (Watts)	Input power (Watts)	Units consumption Day (kWh)
1*	5200	1926	15.4
2**	5200	1793	14.34
3***	5200	1677	13.42
4****	5200	1575	12.6
5*****	5200	1486	11.89

Energy saving Calculations:

Particular	Unit	Value
Windows A/C (1.5 Ton) - No star	Nos	32
Windows A/C (2 Ton) - No star	Nos	6

Air Conditioner (SS) (1.5 Ton) - No star	Nos	40
Air Conditioner (SS) (2.0 Ton) - No star	Nos	19
Estimated consumption of No star Acs	kWh/hr	283375
Estimated consumption of 5 star Acs		116368
Diversity factor	%	70%
Operating Hrs per day	hrs/day	8
Operating days per year	Days/year	138
Estimated Saving	kWh/year	167006
Unit Rate	Rs/kWh	8
Annual Saving	Rs Lakh/year	13.4

ECM 8:

Name	Replacement of existing street light with LEDs
Location	All Street Lights except 400Watt
Estimated Annual Savings	54192 kWh/year, 4.34 Lakh INR/year
Estimated investment Cost	10.3 Lakhs
Estimated Payback	2.4 Years
Environmental Benefits.	Reduced CO_2 emissions from less electricity used @ 48.5 tCO_2e per year
Next Steps	Replace existing all Street Lights except 400W with 45W LED's

Observations:

Lux level for existing streetlights& 45W LED's are almost same.

Recommendations:

An energy efficient street lighting system brings very strong positive externalities for society as indicated below:

1. Reduction in energy consumption and costs: Modern LED based energy efficient lighting systems consume about 45%- 55% less energy than older and inefficient systems that are installed in almost the entire country. The lower running cost is a significant benefit.
2. Optimizing Operational Performance: LED technology enables optimization of light sources at minimum intensity. It also can be integrated with centralized monitoring and control that turns off lights using a timer or sensor. Being directional light sources, LED also help in designs that enhance the quality of light output.
3. Social benefits: LEDs not only improves safety conditions for vehicular traffic and pedestrians but also improve the safety and security
4. Reduced operation and maintenance cost: The life of such lighting systems is longer and requires less maintenance, thus reducing O&M costs

Hence, it is recommended to replace existing all Street Lights except 400W with 45W LED's, so that saving in energy and at the same time no change in Lux level.

Energy Saving Calculations:

Particular	Unit	Value
125 watts street lights	Nos	137
250 watts street lights	Nos	50
Estimated LED wattage	Watts	45
Operating Hrs per day	hrs/day	10
Operating days per year	Days/year	365
Diversity factor	%	70%
Estimated Saving	kWh/year	54192
Unit Rate	Rs/kWh	8
Annual Saving	Rs Lakh/year	4.3

ECM 9:

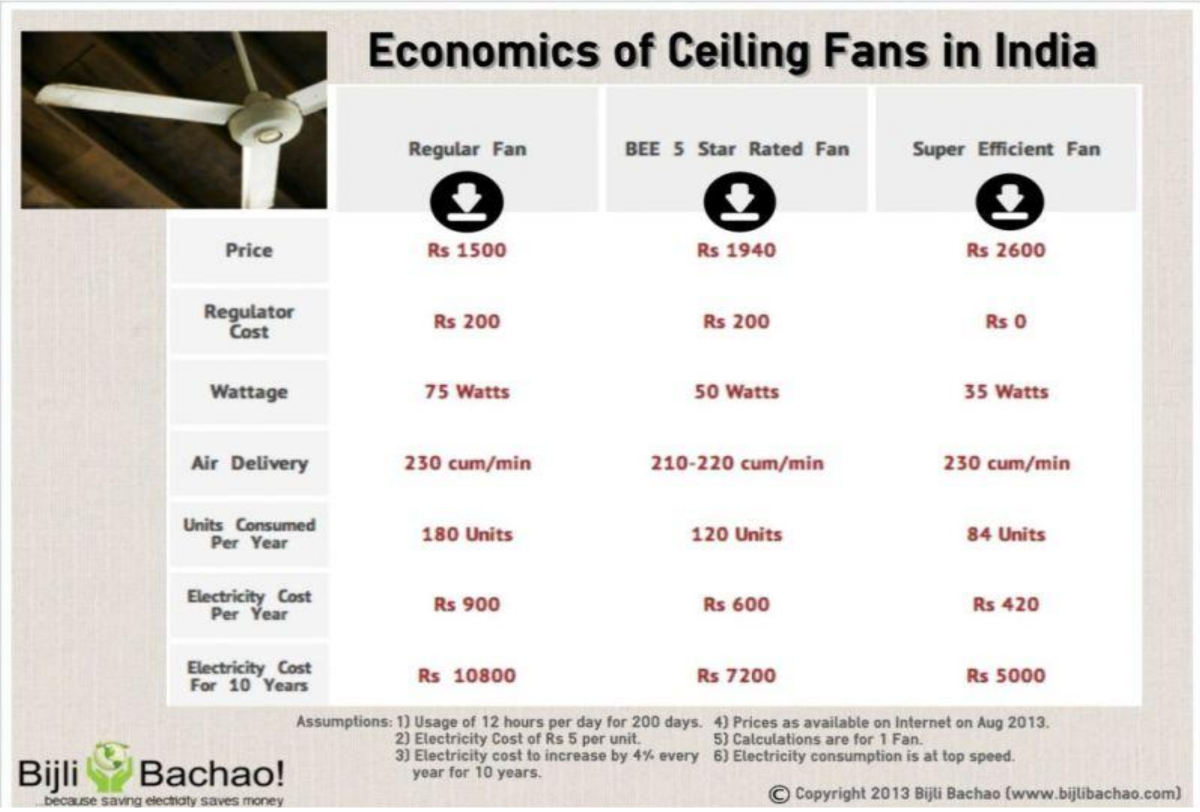
Name	Replacement of existing old (without star rating) fans with 5 star rated energy efficient fans
Location	Almost all locations where old fans exist
Estimated Annual Savings	75600 kWh/year, 6.05 Lakh INR/year
Estimated investment Cost	40.0 Lakhs
Estimated Payback	7.0 Years
Environmental Benefits.	Reduced CO_2 emissions from less electricity used @ 67.6 tCO_2e per year
Next Steps	Replace existing old fans (without star rating) with 5 star rated energy efficient fans

Observations:

Maximum fans are of old type without star rated.

Recommendations:

SuperFan is one of the latest Super Efficient Ceiling fan in the market. This fan has a Brushless DC electronic motor that is super-efficient. The fan does not need a regulator and works with a remote control without remote as well. It can also work by toggling the switch on switchboard the same number of times as the desired speed. There is a LED at the center of the fan that blinks and shows the fan speed when it is changed. Although this fan is a little different from other fans, the installation was quite easy and straightforward.



Economics of Ceiling Fans in India

	Regular Fan	BEE 5 Star Rated Fan	Super Efficient Fan
Price	Rs 1500	Rs 1940	Rs 2600
Regulator Cost	Rs 200	Rs 200	Rs 0
Wattage	75 Watts	50 Watts	35 Watts
Air Delivery	230 cum/min	210-220 cum/min	230 cum/min
Units Consumed Per Year	180 Units	120 Units	84 Units
Electricity Cost Per Year	Rs 900	Rs 600	Rs 420
Electricity Cost For 10 Years	Rs 10800	Rs 7200	Rs 5000

Assumptions: 1) Usage of 12 hours per day for 200 days. 2) Electricity Cost of Rs 5 per unit. 3) Electricity cost to increase by 4% every year for 10 years. 4) Prices as available on Internet on Aug 2013. 5) Calculations are for 1 Fan. 6) Electricity consumption is at top speed.

Bijli Bachao! ...because saving electricity saves money

© Copyright 2013 Bijli Bachao (www.bijlibachao.com)

Hence, it is recommended to replace existing all without star rated fans with new 5 star rated energy efficient fans(Super fans)

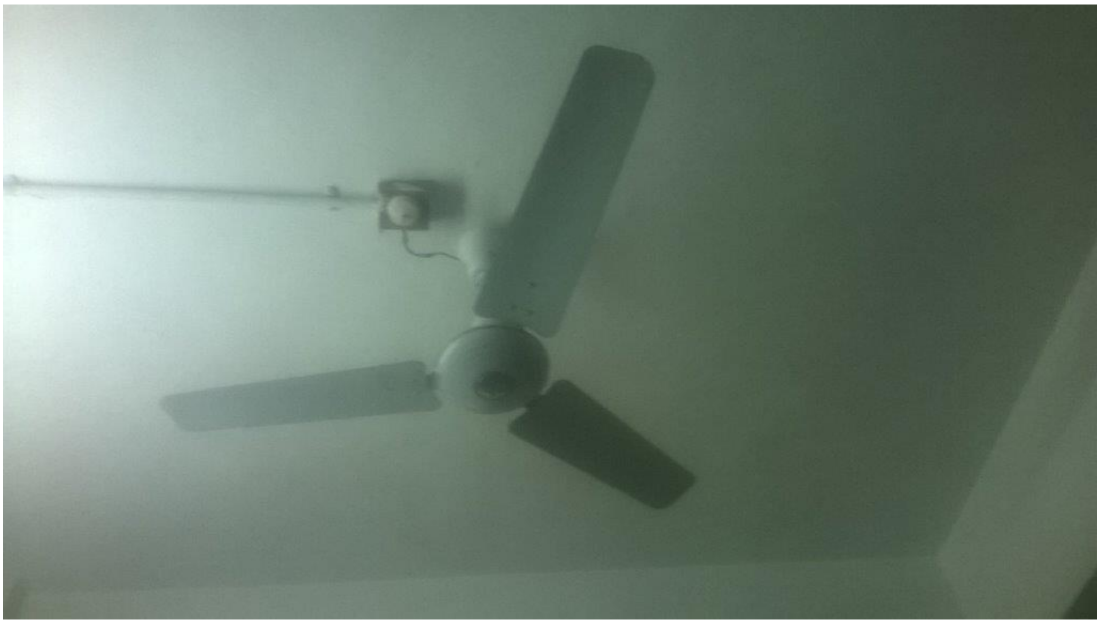
<u>Energy Saving Calculations:</u>

Particular	Unit	Value
No. of fans without star rating	Nos	3590
No of fans to be replaced (1st phase)	Nos	2000
Estimated Wattage of existing fans	Watts	60
Estimated wattage of energy efficient fan	Watts	35
Operating Hrs per day	hrs/day	8
Operating days per year	Days/year	270
Diversity factor	%	70%
Estimated Saving	kWh/year	75600
Unit Rate	Rs/kWh	8
Annual Saving	Rs Lakh/year	6.0

Also considering the remaining tube lights replacement, following are the estimates of savings and investment:

Calculations for 2nd Phase:

Particular	Unit	Value
No. of fans without star rating	Nos	3938
No of fans to be replaced (2nd phase)	Nos	1938
Estimated Wattage of existing fans	Watts	70
Estimated wattage of energy efficient fan	Watts	35
Operating Hrs per day	hrs/day	4
Operating days per year	Days/year	270
Diversity factor	%	70%
Estimated Saving	kWh/year	51279
Unit Rate	Rs/kWh	8
Annual Saving	Rs Lakh/year	4.1
Investment	Rs Lakh	48
payback	Years	11.8



7. Detail Study of Solar Grid Connected System:

Introduction

Solar is the fastest growing, affordable energy source in the world, offering an unlimited supply of clean, safe and renewable assets for heat and power. With solar costs rapidly declining, solar has become a very inexpensive and practical option. Since solar energy provides a healthy return financially for companies, it is quickly moving mainstream and growing worldwide at 40-50% annually.

a. Power from the sun is clean, silent, limitless and free.
b. Photovoltaic process releases no CO2, SO2, or NO2 gases, which are normally associated with burning finite fossil fuel reserves, and do not contribute to global warming.
c. Photovoltaic are now a proven technology which is inherently safe as opposed to other fossil fuel based electricity generating technologies.
d. Solar power shall augment the needs of peak power needs.
e. provides a potential revenue source in a diverse energy portfolio
f. Assists in meeting renewable portfolio standards goals.

More and more businesses are concluding that photovoltaic installations make sense financially – from low maintenance costs, lower energy bills and a short payback period, solar energy is becoming a popular option to incorporate into business plans. Businesses also are able to obtain added benefits as part of the photovoltaic installations. These benefits could range from shaded parking to outdoor shaded work and education areas. The sun generates 8,000 times the earth's annual energy usage, dominating all other non-renewable resource options. When this energy is capitalized through photovoltaic installations, there are minimal costs for upkeep and power is generated for multiple years.

Executive Summary

The proposed Grid Connected Ground mounted 600KWp Solar Photovoltaic (SPV) Power Plant would utilize shadow free vacant area of about 6970 sq. meters. The SPV power plant with proposed capacity of 600KWp would be connected to the main electrical distribution panel. The system would meet partial load requirement of the connected load during the day. Advance control mechanism in the Power Conditioning Unit will ensure that the maximum power generated by PV modules will be utilized first and the balance requirement of power will be met by either grid or DG set.
The 600KWp SPV Power Plant is estimated to afford annual energy feed of 6,75,000 KWh/year (After considering all losses) considering efficiency of the solar module as 15.16%, Power Conditioning Unit (PCU) efficiency as 98.3% and losses in the DC and AC system as 3%.

This proposal is prepared for design, engineering, procurement / manufacture and installation of solar power generating system. The grid-tie solar photovoltaic power generation system is mainly composed of PV array, String Inverter, Transformer (for 100KW & above capacity) and PV mounting structure. It also consists of supporting devices like AC / DC switchgears, Lighting Arrestor, Earth

Electrodes, AC / DC cables. As there is no any battery, its maintenance cost is negligible and initial investment per KW is very low.

Solar Power Plant comprises of the main equipment and components listedBelow:

1. Solar PV Modules
2. String Inverter with MPPT
3. Module mounting system
4. Transformer
5. Monitoring system
6. Cables & connectors

Objectives:

- Provide reliable, clean, regulated, un-interrupted power on demand to the pre-identified critical loads
- System to provide low life cycle cost and maximize savings to the beneficiaries.
- To save diesel in institutions and other commercial establishments including industry facing huge power cuts especially during daytime.

Important Points:

1. As SGBAU is having own requirement of 905KWp and ample shadow free space available for Solar plant installation, it is suggested to go for minimum600 KWp Solar Plant considering MD as 580 KVA.

2. Captive Solar Plant is generally used to fulfill in-house requirement & it can be install to any capacity without using net meter.

3. In case of Net meter we can install Solar Plant, which is at the most same as your maximum demand (In SGBAU case it is of 580 KWp)

Calculation for Required Solar Capacity plant to fulfill In-house Requirement:

Calculation to Fulfill In-house Requirement			
Sr.No.	Details	Value	Unit
1	Average electrical consumption per year	1221660	KWH
2	Shadow free area available at SGBAU	As Required	SQ.M
3	Units generated per day per kWp	4.5	kWh/kWp/day
4	Units generated per month per kWp (25 Days)	112.5	kWh/kWp/month
5	Units generated per year per kWp (300 Days)	1350	kWh/kWp/year
6	Solar KW capacity For 1221660 kwh consumption / year	905	KWp

Solar Payback Period Calculations are attached below:

Option 1:

Micro-Grid Connected 50 KWp Solar Roof Top Plant for SGBAU			
Sr.No.	Details	Value	Unit
1	Shadow free space required for approx 1 KWp Solar Plant	150	Sq.Ft
2	Shadow free space required for approx 1 KWp Solar Plant	13.940	Sq.m
3	Solar Plant capacity to be Installed	50	KWp
4	Shadow free space required for 50 KWp Solar Plant	697.03	Sq.m
5	Installation Cost Per KWp for below 100 KWp Plant	1.00	Rs. In Lakh
6	Gross Estimated System cost (For 50 KWp Roof Top Solar Plant)	50	Rs. In Lakh
7	Considered Subsidy as 30%	15.00	Rs. In Lakh
8	Net Estimated System cost (For 50 KWp Roof Top Solar Plant)	35	Rs. In Lakh
9	Unit generated per day per kWp	4.5	KWh
10	Electricity generation per day for 50 KWp Roof Top Solar Plant	225	KWh/day
11	Electricity generation per year for 50 KWp Roof Top Solar Plant	67500	KWh/year
12	Electricity unit cost as per electricity bill	8	Rs./KWh
13	Electricity cost saved per year	5.4	Rs. In Lakh
14	Simple payback period	6.48	Years

Option 2:

Micro-Grid Connected 100 KWp Solar Roof Top Plant for SGBAU			
Sr.No.	Details	Value	Unit
1	Shadow free space required for approx 1 KWp Solar Plant	150	Sq.Ft
2	Shadow free space required for approx 1 KWp Solar Plant	13.94052	Sq.m
3	Solar Plant capacity to be Installed	100	KWp
4	Shadow free space required for 100 KWp Grid Connected Solar Plant	1394.05	Sq.m
5	Installation Cost Per KW for 100 & above KWp Solar Plant	0.90	Rs. In Lakh
6	Gross Estimated System cost (For 100 KWp Grid Connected Solar Plant)	90	Rs. In Lakh
7	Considered Subsidy as 30%	27.00	Rs. In Lakh
8	Net Estimated System cost (For 100 KWp Grid Connected Solar Plant)	63	Rs. In Lakh
9	Unit generated per day per kWp	4.5	KWh
10	Electricity generation per day for 100 KWp Grid Connected Solar Plant	450	KWh/day
11	Electricity generation per year for 100 KWp Grid Connected Solar Plant	135000	KWh/year

12	Electricity unit cost as per electricity bill	8	Rs./KWh
13	Electricity cost saved per year	10.8	Rs. In Lakh
14	Simple payback period	5.83	Years

Option 3:

Ground Mounted Grid Connected 600 KWp Solar Plant for SGBAU			
Sr. No.	Details	Value	Unit
1	Shadow free space required for approx 1 KWp Solar Plant	150	Sq.Ft
2	Shadow free space required for approx 1 KWp Solar Plant	13.94	Sq.m
3	Solar Plant capacity to be Installed	600	KWp
4	Shadow free space required for 600 KWp Grid Connected Solar Plant	8364	Sq.m
5	Installation Cost Per KW for500 & above KWp Solar Plant	0.85	Rs. In Lakh
6	Gross Estimated System cost (For 600 KWp Grid Connected Solar Plant)	510	Rs. In Lakh
7	Considered Subsidy as 30%	165	Rs. In Lakh
8	Net Estimated System cost (For 600 KWp Grid Connected Solar Plant)	345	Rs. In Lakh
9	Unit generated per day per kWp	4.5	KWh
10	Electricity generation per day for 600 KWp Grid Connected Solar Plant	2700	KWh/day
11	Electricity generation per year for 600 KWp Grid Connected Solar Plant	810000	KWh/year
12	Electricity unit cost as per electricity bill	8	Rs./KWh
13	Electricity cost saved per year	64.8	Rs. In Lakh
14	Simple payback period	**5.32**	Years

Option 4 :

Ground Mounted Grid Connected 1MWp Solar Plant for SGBAU			
Sr.No.	Details	Value	Unit
1	Shadow free space required for approx 1 KWp Solar Plant	150	Sq.Ft
2	Shadow free space required for approx 1 KWp Solar Plant	13.94052	Sq.m
3	Solar Plant capacity to be Installed	1000	KWp
4	Shadow free space required for 1MWp Grid Connected Solar Plant	13940.52	Sq.m
5	Installation Cost Per KW for 1000 & above KWp Solar Plant	0.80	Lakh Rs.
6	Gross Estimated System cost (For 1MWp Grid Connected Solar Plant)	800	Lakh Rs.
7	Considered Subsidy as **30%**	240.00	Lakh Rs.
8	Net Estimated System cost (For 1MWp Grid Connected Solar Plant)	560	Lakh Rs.
9	Unit generated per day per kWp	4.5	KWh

10	Electricity generation per day for 1MWp Grid Connected Solar Plant	4500	KWh/day
11	Electricity generation per year for 1MWp Grid Connected Solar Plant	1350000	KWh/year
12	Electricity unit cost as per electricity bill	8	Rs./KWh
13	Electricity cost saved per year	108	Lakh Rs.
14	Simple payback period	**5.19**	Years

8. General Audit Review

The PPSES team gathered yearly energy data of utility departments (which is elaborated below), and from this energy consumption data it was clearly understood that facility should keep more focus on controlling the power factor, usage of Air conditioners, also the replacement of old appliances like tube lights, fans, ACs without star ratings and hence overall energy consumption will be reduced.

This means SGBAU shall work to find out various ways to control of energy usage and though they have initiated different ways for regular monitoring of energy usage, special focus need to be given for analyzing energy consumption for all major utility areas.

Still there is additional potential for energy cost reduction in optimizing energy usages by reducing the hidden losses (idle operations) as well as with improvements in operating efficiencies (like making small change in process or control parameters) which will help to bridge the gap between maximum and minimum values of monthly energy consumption.

The ECMs identified can provide some means for reduction of the energy consumption and this can provide an upper limit as to what is feasible in the way of electric energy use reduction, regardless of what equipment or systems are affected through new ECMs.

It is not likely that such savings will be achievable in full, but it is a means of identifying the maximum potential in each area in full.

Recommended Short-Term Plan for Energy Management Action (Next 12 Months)

To start energy efficiency activities at SGBAU, a number of suggestions for the following 12 months are recommended:

Begin the implementation of some of the faster payback energy conservation measures (ECMs) which have already been considered and for which the ECMs are fully developed.

- Other than the ECMs explained, following initiatives can improve energy efficiency and provide a good amount of savings in energy bill:
- The peak load power utility charges are higher to that of daytime charges. During energy assessment, it was observed that the various loads are used intermittently and can be shed during evening peak time. Detailed evaluation of each load and scheduling of the same in off peak period is recommended.
- Determination of building-wise energy consumption and monitoring the same periodically is recommended.
- Energy conservation awareness programs can be conducted once a year. Increasing energy awareness of employees and motivating them to work as a team can lead to reductions in energy consumption and save the money. Savings estimates range in the order of 5 to 10%. When implemented effectively these savings can be realized quickly and cost effectively.

- Try to arrange at least one training programme every year on awareness of Energy Saving Programme at SGBAU

  Depute Energy Manager or else depute Energy consultant considering such a vast area of SGBAU.

PPSES believes that with the current approach and organisation of energy management, energy can be reduced in a systematic, cost effective manner. PPSES hopes that this report will help SGBAU to implement these changes and provide direction to the Energy Management Team.

We would be delighted to review the findings and recommendations in this report further with SGBAU if requested.

9. Prioritization of Energy Conservation Measures

Sr.No.	Equipment Name	ECM Details	Investment (Rs. In Lacs)	Savings (kWh/year)	Saving (Rs.InLacs /Year)	Payback (Years)
5	Electic Motors and Pumps	Peak Load management- Running the water pumps during off peak hours	0.0	0	0.72	0.0
6	Acs	Optimize the tempreture setting to 25 C	0.0	6521	0.52	0.0
4	Electic Motors and Pumps	Maintenance of Monoblock pumps and electric motors - cleaning fan inlet, cooling fins, replacement of bearings and proper greasing	0.5	7648	0.61	0.8
1	Substation	Power factor improvement	7.8	0	5.48	1.4
7	Acs	Replacement of No star ACs (1.5 T and 2.0 T) with 5 starAcs.	44.1	167006	13.36	3.3
8	Street Light	Replacement of existing street light with LEDs	10.3	54192	4.34	2.4
3	Tube Lights	Replacement of 40 Watt Tube lights with LED tube lights	28.0	77760	6.22	4.5
2	Contract demand	Changing Contract demand	8.9	0	1.60	5.6

Sr.No.	Equipment Name	ECM Details	Investment (Rs. In Lacs)	Savings (kWh/year)	Saving (Rs.InLacs /Year)	Payback (Years)
9	Fans	Replacement of existing old (without star rating) fans with 5 star rated energy efficient fans	50.0	105840	8.47	5.9

10. Power Quality Analysis

Power quality definition:

Power quality determines the fitness of electric power to consumer devices. Synchronization of the voltage frequency and phase allows electrical systems to function in their intended manner without significant loss of performance or life.

Power quality is basically quality of voltage rather than power or electric current.

Electric power industry comprises:

Electricity generation (AC power) → Electric power transmission → Electric power distribution → Electric meter → Load

The complexity of the system to move electric energy from the point of production to the point of consumption combined with variations in weather, generation, demand and other factors compromise the quality of supply.

Power quality parameters:

- Frequency - The utility frequency is the frequency of the oscillations of alternating current (AC) in an electric power grid transmitted from a power plant to the end-user. The primary reason for accurate frequency control is to allow the flow of alternating current power from multiple generators through the network to be controlled. The trend in system frequency is a measure of mismatch between demand and generation, and so is a necessary parameter for load control in interconnected systems.
- Variation in voltage magnitude
  - Flicker - Random or repetitive variations in the RMS voltage between 90 and 110% of nominal voltage
  - Spikes - Abrupt, very brief increases in voltage, generally caused by large inductive loads being turned off, or more severely by lightning
  - Under voltage – it occurs when the nominal voltage drops below 90% for more than 1 minute
  - Overvoltage – it occurs when the nominal voltage rises above 110% for more than 1 minute.
- Harmonic content in the waveforms for AC power

  Harmonic voltages and currents in an electric power system are a result of non-linear electric loads. Harmonic frequencies in the power grid are a frequent cause of power quality problems.

Current harmonics: Current harmonics are caused by non-linear loads. When a non-linear load, such as a rectifier, is connected to the system, it draws a current that is not necessarily sinusoidal.

Voltage harmonics: Voltage harmonics are mostly caused by current harmonics. The voltage provided by the voltage source will be distorted by current harmonics due to source impedance.

Total harmonic distortion: THD is a common measurement of the level of harmonic distortion present in power systems. THD is defined as the ratio of total harmonics to the value at fundamental frequency.

- Power factor

the power factor of an AC electrical power system is defined as the ratio of the real power flowing to the load to the apparent power in the circuit, and is a dimensionless number in the closed interval of -1 to 1

In an electric power system, a load with a low power factor draws more current than a load with a high power factor for the same amount of useful power transferred. The higher currents increase the energy lost in the distribution system, and require larger wires and other equipment. Because of the costs of larger equipment and wasted energy, electrical utilities will usually charge a higher cost to industrial or commercial customers where there is a low power factor.

10.1. Power Quality Monitoring Results (Transformer 1)

During this period system parameters were recorded and were presented in form of graphs. The major findings are addressed below:

Main distribution panel:

Measured parameters at main feeder panel:

	V	A	PF	kW	kVA
Max	415	171.61	1.000	114	121
Min	398	35.54	0.867	25	25
Average	409	79.45	0.963	54	56

Measured voltage during peak hours :

	Vrms ph-n AN	Vrms ph-n BN	Vrms ph-n CN	Vrms ph-ph AB	Vrms ph-ph BC	Vrms ph-ph CA
Max	241	238	237	415	409	417
Min	232	228	228	398	392	401
Avg	237	234	233	408	402	410

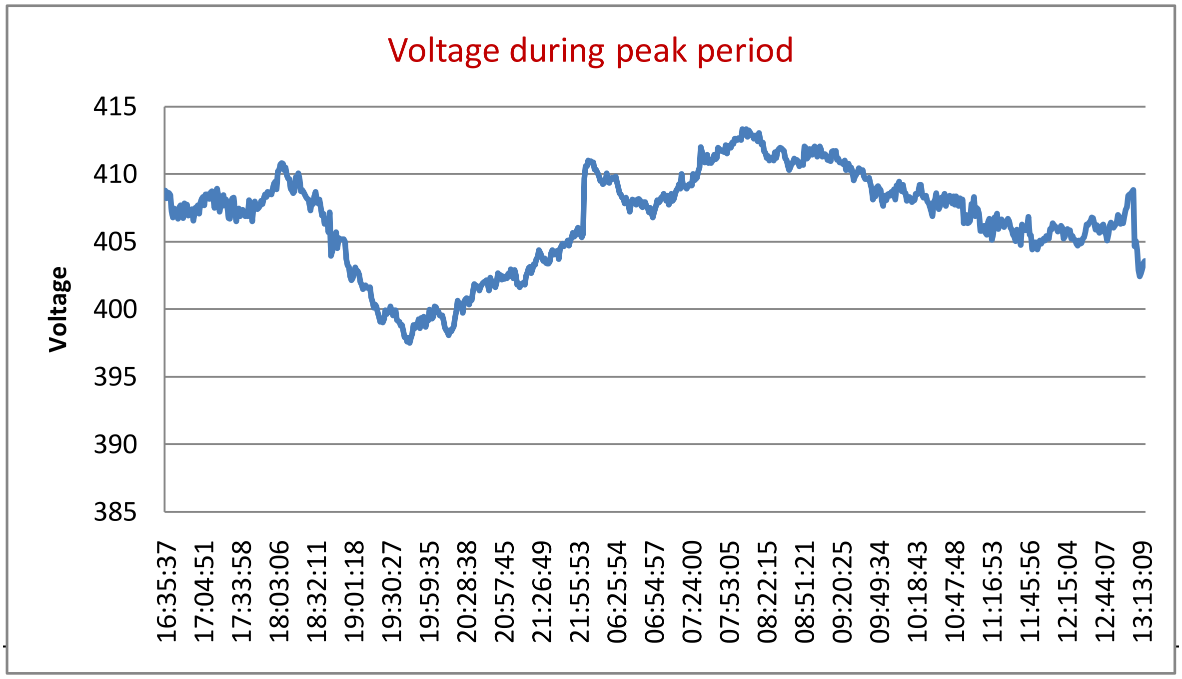


Figure 5 – Peak period voltage (transformer 1)

<u>Measured voltage during off peak hours:</u>

	Vrms ph-n AN	Vrms ph-n BN	Vrms ph-n CN	Vrms ph-ph AB	Vrms ph-ph BC	Vrms ph-ph CA
Max	242	238	238	416	410	419
Min	236	233	232	406	400	408
Avg	240	237	236	413	407	415

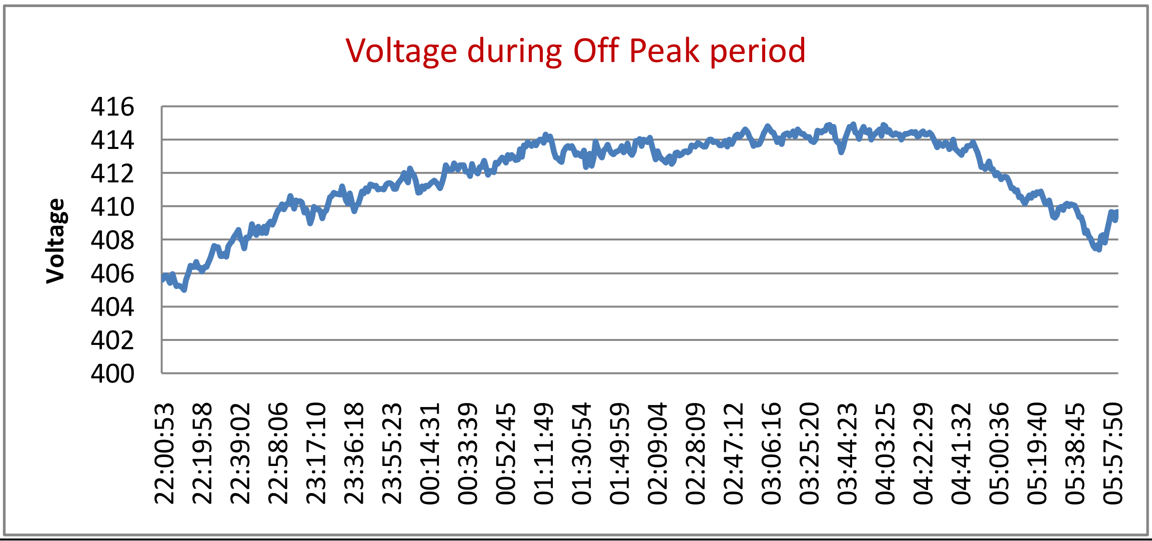


Figure 6 – Off peak period voltage (transformer 1)

Measured harmonics level:

	THD V AN	THD V BN	THD V CN	THD AA	THD AB	THD AC
Max	1.84	2.40	2.18	14.74	28.34	22.66
Min	0.81	1.14	1.00	3.46	5.80	6.04
Avg	1.31	1.67	1.52	9.81	12.74	11.24

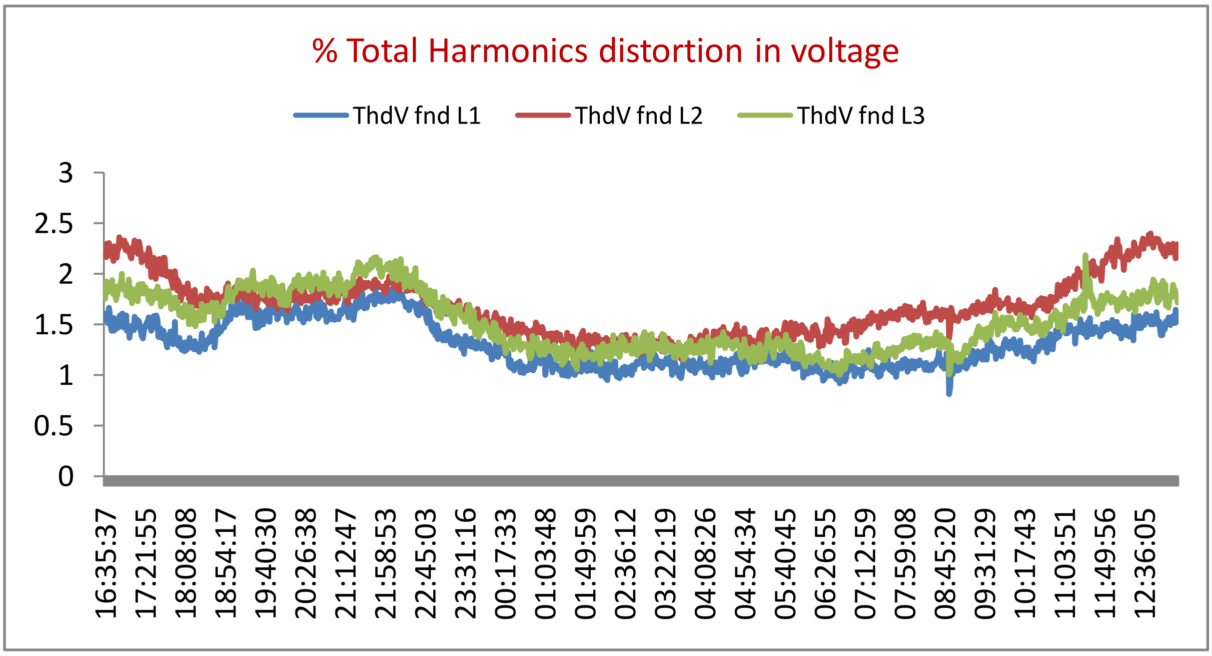


Figure 7 - %THD Voltage (transformer 1)

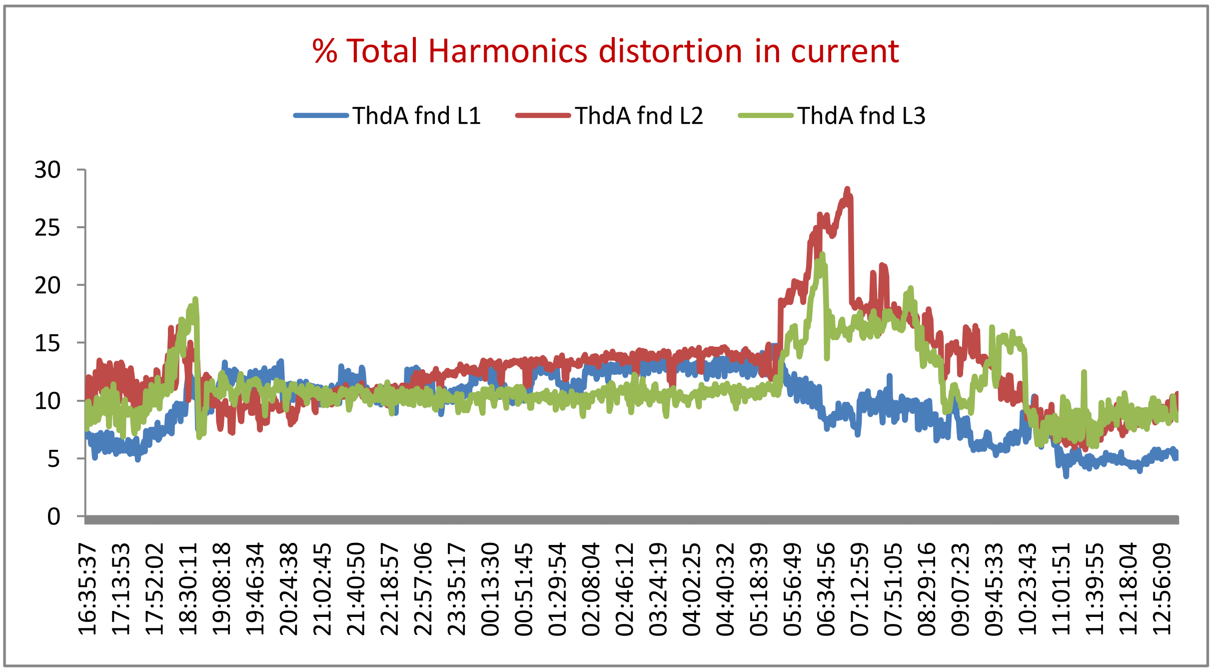


Figure 8 - %THD Current (transformer 1)

Frequency analysis:

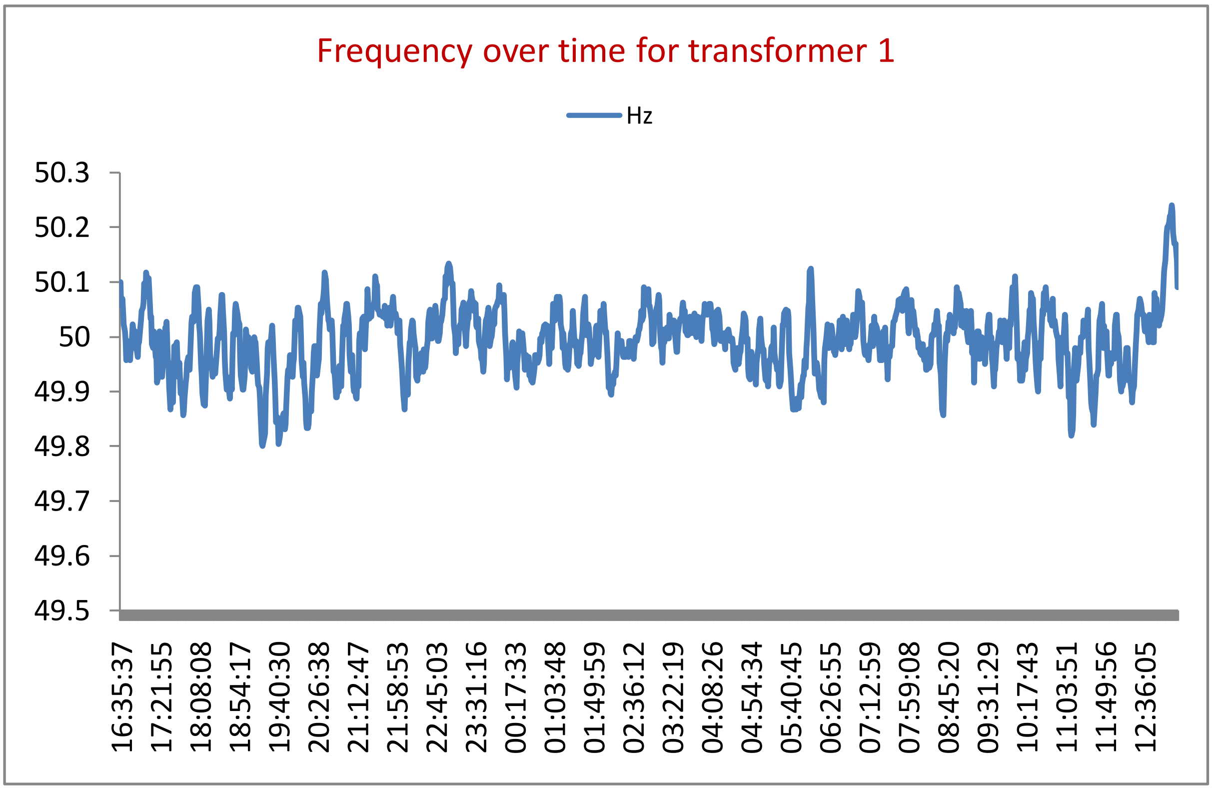


Figure 9 – Frequency (transformer 1)

Power analysis:

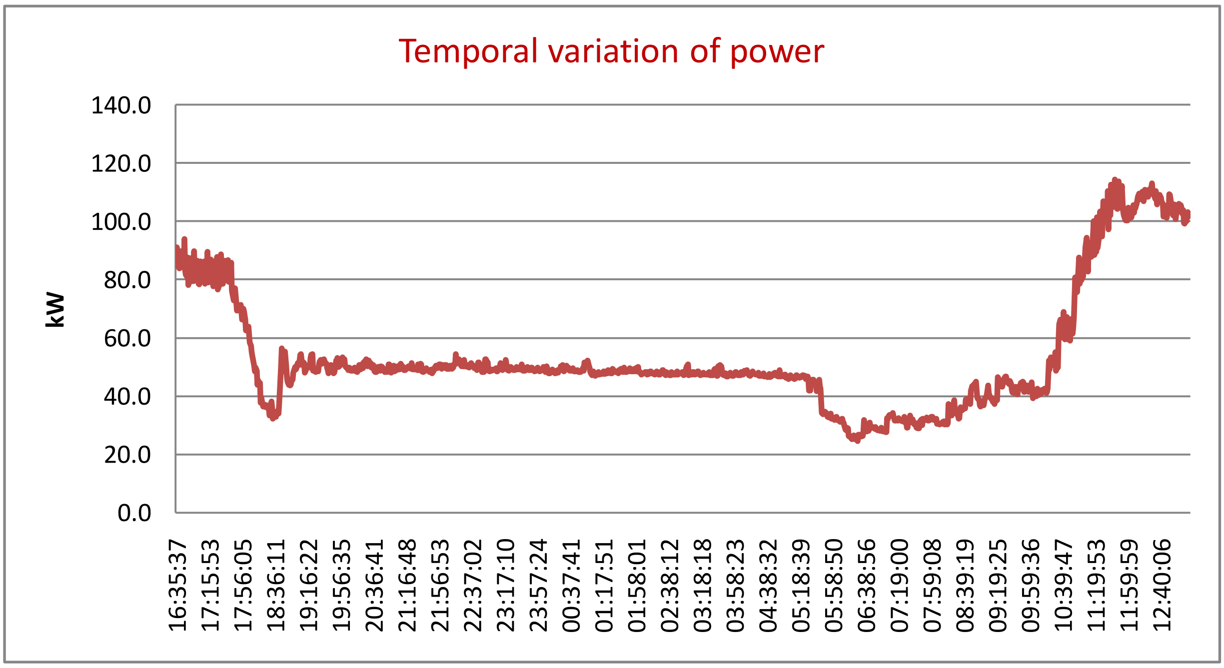


Figure 10 – Power (transformer 1)

10.2. Power Quality Monitoring Results (Transformer 2)

During this period system parameters were recorded and were presented in form of graphs. The major findings are addressed below:

Main distribution panel:

Measured parameters at main feeder panel:

	V	A	PF	kW	kVA
Max	413	246	1	161	169266
Min	395	66	0.917	45	46547
Average	405	125	0.940	82	87400

Measured voltage during peak hours:

	Vrms ph-n AN	Vrms ph-n BN	Vrms ph-n CN	Vrms ph-ph AB	Vrms ph-ph BC	Vrms ph-ph CA
Max	240	236	235	412	405	413
Min	230	227	226	397	390	397
Avg	235	231	231	404	398	406

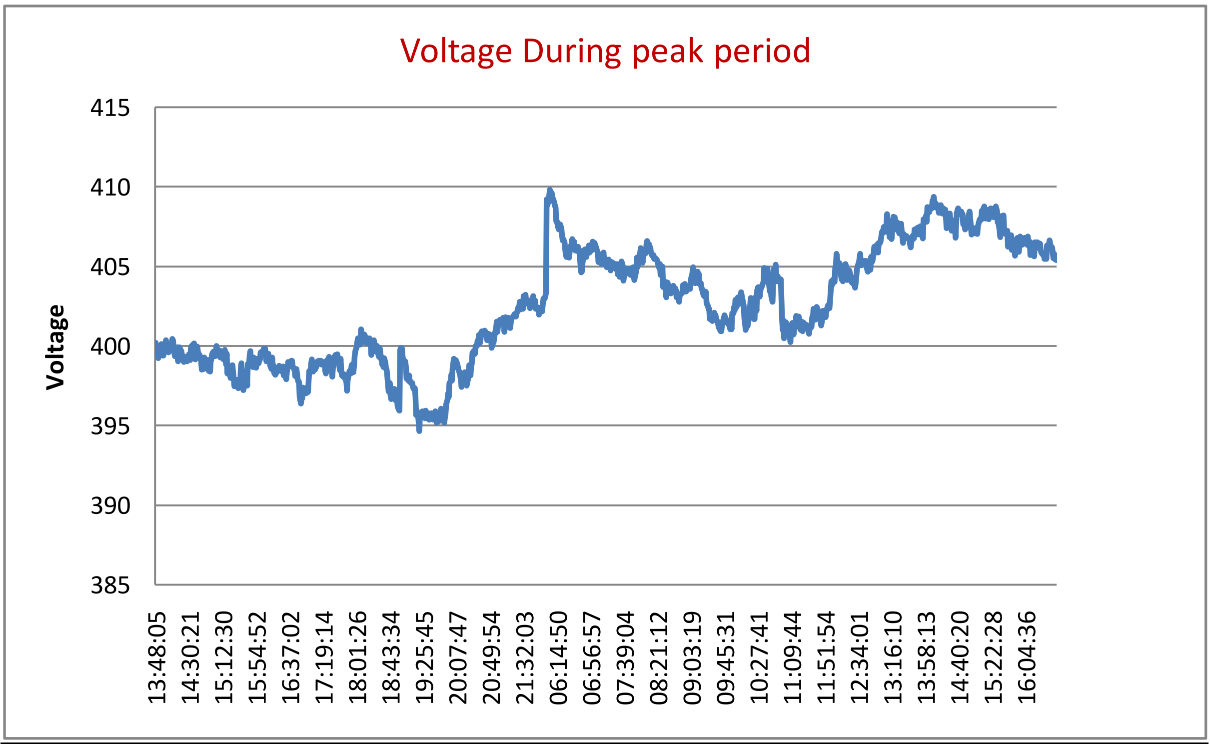


Figure 11 – Peak period voltage (transformer 2)

Measured voltage during off peak hours:

	Vrms ph-n AN	Vrms ph-n BN	Vrms ph-n CN	Vrms ph-ph AB	Vrms ph-ph BC	Vrms ph-ph CA
Max	241	237	236	415	408	416
Min	236	232	231	405	398	406
Avg	239	235	235	411	405	413

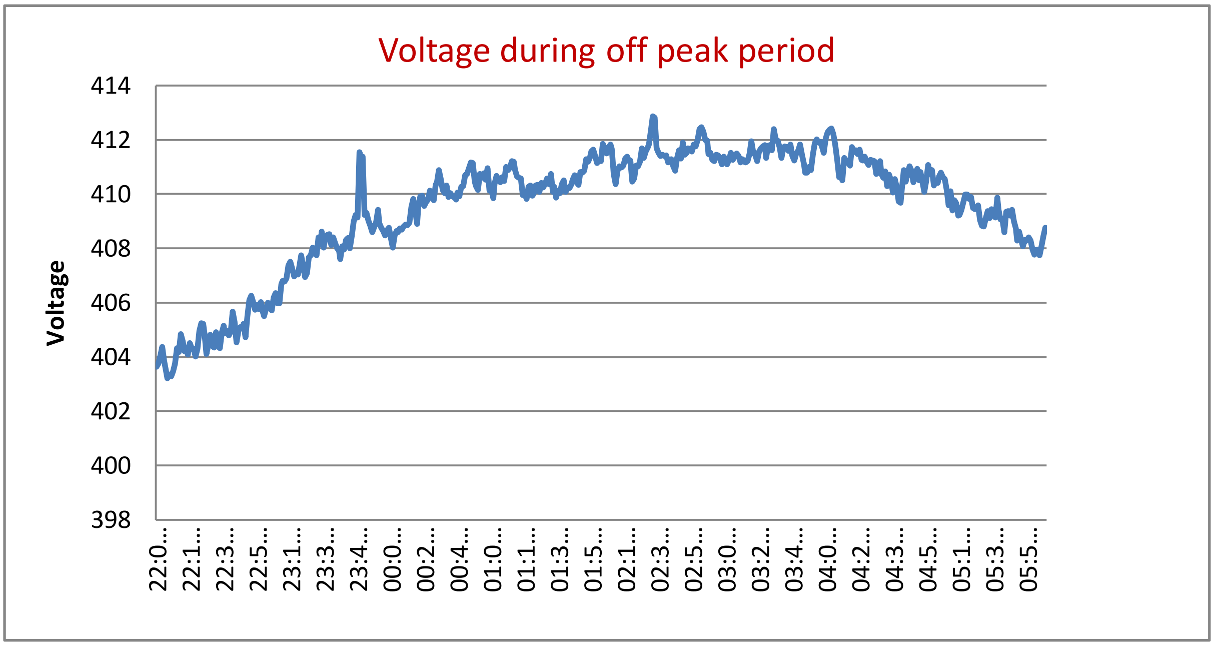


Figure 12 – Off peak period voltage (transformer 2)

Measured harmonics level:

	THD V AN Avg	THD V BN Avg	THD V CN Avg	THD AA Avg	THD AB Avg	THD AC Avg
Max	2.12	1.89	2.13	16.12	14.20	12.84
Min	1.13	0.99	1.00	3.75	0.00	0.00
Avg	1.56	1.42	1.47	7.93	6.89	8.37

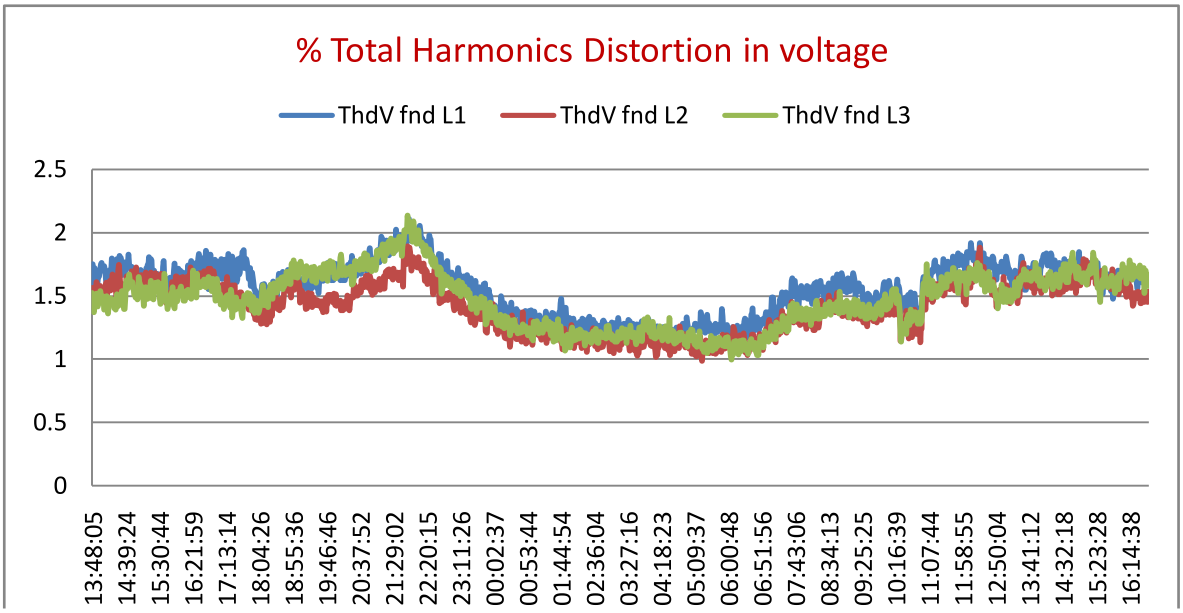


Figure 13 - %THD Voltage (transformer 2)

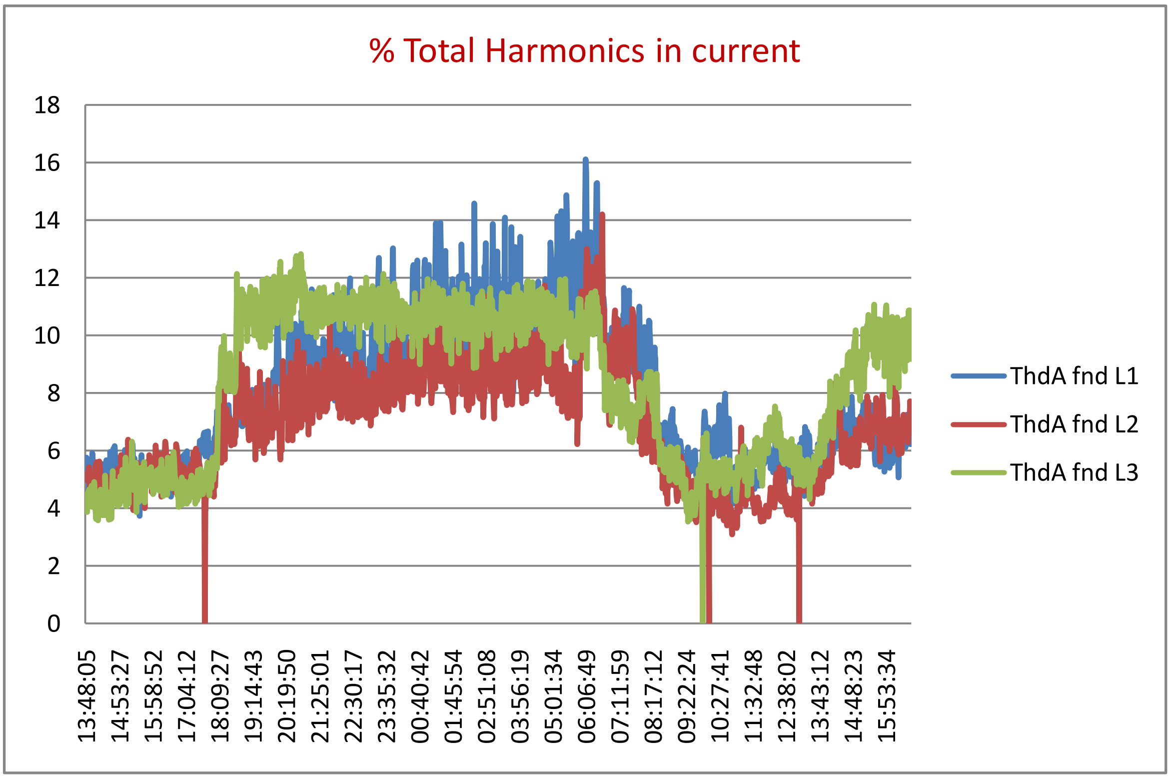


Figure 14 - %THD Current (transformer 2)

Frequency analysis:

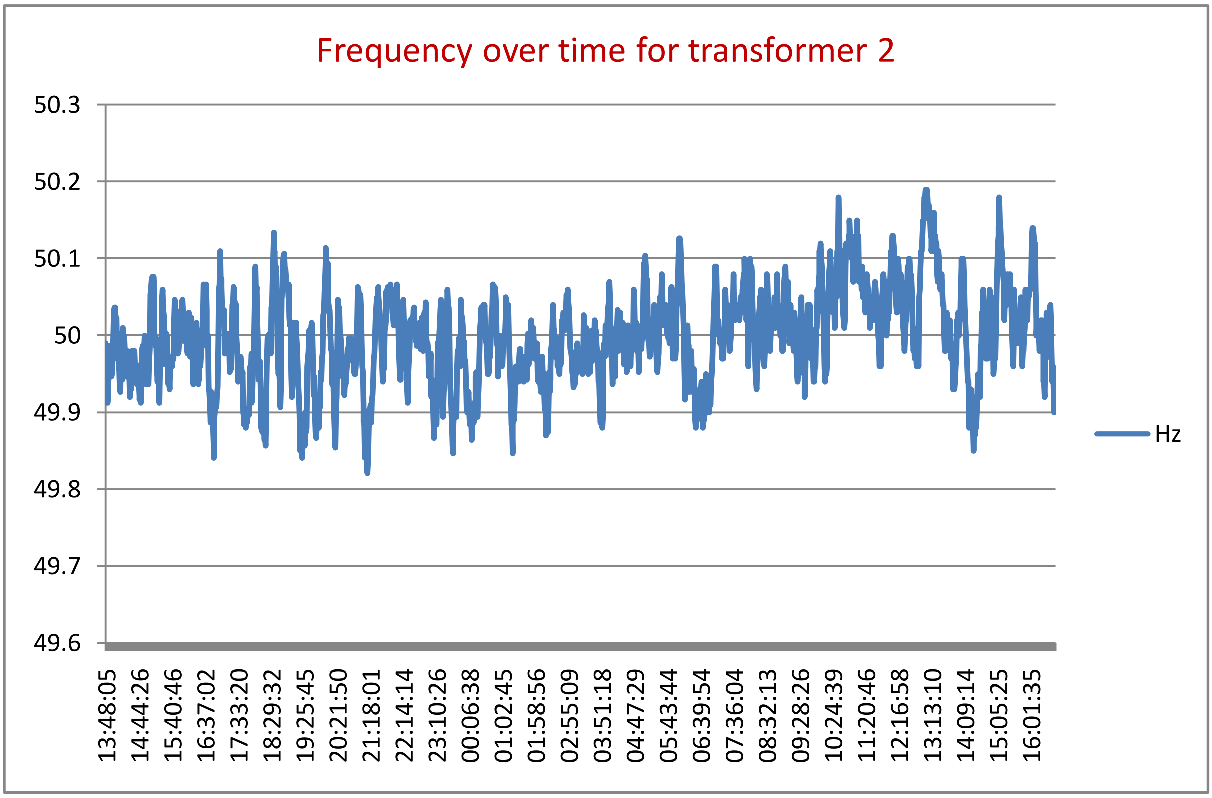


Figure 15 – Frequency (transformer 2)

Power analysis:

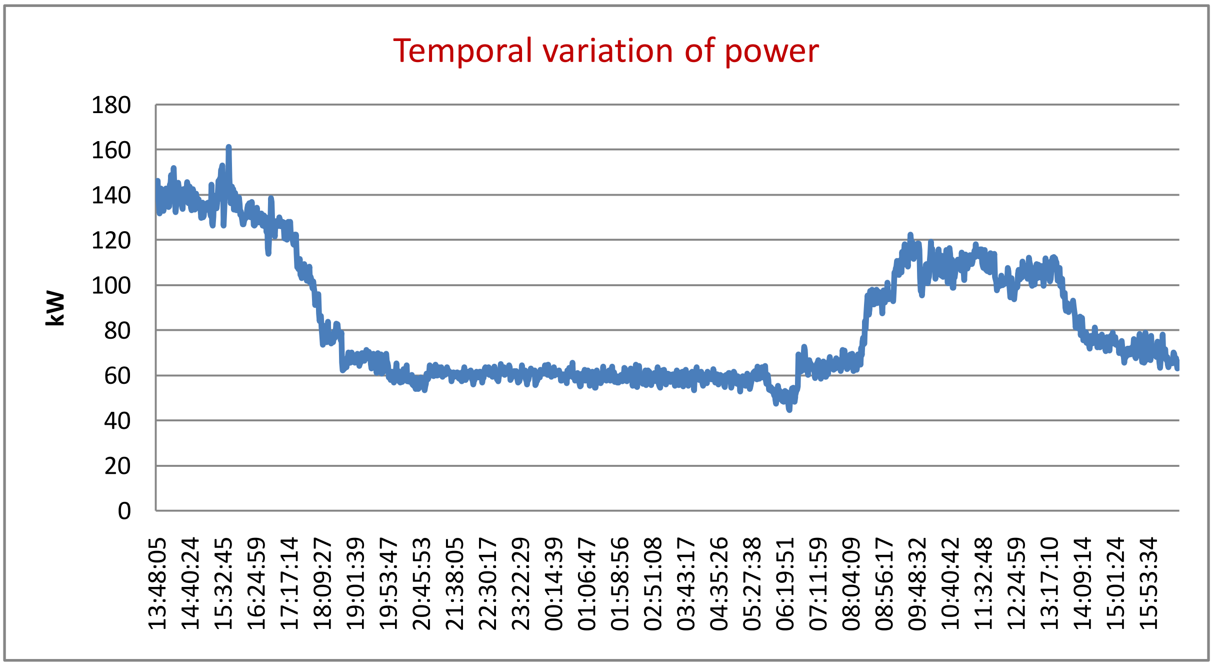


Figure 16- Power (transformer 2)

11. List of instruments

Power analyser

Picture 1 Fluke Power analyzer

Specification of the 434 Fluke power analyzer:

Electrical	
Single Phase	YES
Three Phase	YES
USER INTERFACE	
LCD-Type	Graphic LCD
LCD-Dimension	127 x 88 mm
Traditional energy analysis	V, I, P, Q, S, F, PF, cos φ, peak, minimum, maximum, demand etc.
Voltage	1V to 1000 V phase to neutral
Current	Up to 6000 A
Frequency	42.50 to 57.50 Hz
Precision Voltage, Current, Power	±0.1 %

Luxmeter

Picture 2 Luxmeter

Indi 6171 Luxmeter was used to measure the lux levels.

Digital Clamp Meter

Picture 3 Mastech M266 clamp meter

Mastech M266C Digital AC Clamp Meter is used to measure the instantaneous current. The temporary measurements were recorded for the Main feeder, Lightings panel, ducted air conditioners. Following are the specification for this clamp meter:

Specification	**Range**	**Accuracy**
DC Voltage	200mV	-1.005
	2V/20V/200V	-3.005
	1000V	-3.008
AC Voltage	200V	-5.01
	750V	-5.012
AC Current	20A	-5.04
	200A	-5.025
	1000A	-10.03
Resistance	200Ω	-5.01
	2KΩ/20KΩ/200KΩ/2MΩ	-8.01
Temperature	0°C~400°C(32°F~752°F)	-3.01
	401°C~750°C(752°F~1382°F)	-3.02
Insulation Test	20MΩ	-2.02
	2000MΩ(Note<500Ω)	-2.04
	2000MΩ(Note>500Ω)	-2.05

Infrared thermometer

Picture 4 HTC IRX 64 Infrared thermometer

HTC IRX 64 infrared thermometer was used in order to record the temperature of the insulations. The following are the specifications:

Specification	Range
IR	-50°C~1050 °C
Contact	-50°C~1370 °C
IR Temp. Resolution	0.1°C
Basic Accuracy	+/- 1.5% of reading
Emissivity	Adjustable 0.10 ~ 1.0
Optical resolution	30 : 1

Annexure

1. Single line diagrams
2. Table 1 to 4 (All buildings)
3. Reference information