2023

Detailed Energy Audit Report

Government Shivalik College
Naya Nangal, District Ropar
Punjab- 140126

Submitted to:

PEDA

Punjab Energy Development Agency
Solar passive complex, Plot No. 1&2,
Sector-33D, Chandigarh, 160020

Report Submitted by:

Indona Innovative Solutions
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Acknowledgement

Indona Innovative Solutions take the opportunity to express our profound gratitude to Punjab Energy Development Agency to giving us an opportunity to conduct detailed energy audit & Preparation for energy efficiency improvements at Government Shivalik College, Naya Nangal, District Ropar, Punjab- 140126. We would like to place on record our sincere thanks to:

- Chief Executive Officer– Sh. Sh. Ravi Bhagat, IAS
- Director - Sh. M.P Singh
- Joint Director – Sh. Kulbir Singh
- Project Engineer – Sh. Money Khanna
- Project Coordinator Govt Shivalik College – Sh. Nishant

We would also like to extend gratitude to the Smt. Seema Principal of Government Shivalik College Naya Nangal and the entire staff who have rendered their valuable assistance during the course of study. We do hope that you will find the recommendations given in this report useful in helping you to save energy.

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List of Abbreviations used in this report

APFC	Automatic Power Factor Correction Capacitor
DG	Diesel Generator
EL	Electronics
FTL	Fluorescent Tube Light
HSD	High speed diesel
HT	High Tension
HV	High Voltage
LT	Low Tension
LV	Low Voltage
MDI	Maximum Demand Index
PA	Power Analyzer
PBP	Payback Period
SFC	Specific fuel consumption
SPV	Solar Photovoltaic

Assumptions for calculation

Operating days per annum	250
Operating hours per day	8
Unit Cost, Rs./kVAh	6.75
Unit Cost(inclusive of Electricity Duty, Rs./kVAh	7.62
Average Power Factor	0.956

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1. Executive Summary

Government Shivalik College, Naya Nagal is located at district Ropar, Punjab. The College is spread over a period of 16.5 acres. The College was taken over by the Government of Punjab on May 12, 1997. The College complex comprises three Teaching, a Library-cum-Administrative Block, student's Centre, a Sports Complex etc. The connected load of the building is around 116.09kW. The annual energy consumption in the campus from Grid and DG Set is 57,804kWh (60241kVAh). An intensive energy audit was conducted during to identify the energy conservation potential in the campus. The details of the facility and saving potential identified in the campus are as below:

Description	Values
Name of the building	Government Shivalik College
Name and address of ownership	Naya Nangal, District Ropar, Punjab
Total Area, m^2	16 Acre (64,750m^2)
Conditioned Area, %	1.08%
Total conditioned area, m^2	700
Number of Floors	G+2
Climate Condition of the region	Composite
Connected Load, kW	116.09
Contract Demand as per Electricity Bill, kVA	97.7
Incoming Voltage	0.415
Existing Annual Energy consumption from all sources, kVAh	60,241
Unit Price, Rs/kVAh	Rs 7.62(Rs/kVAh 6.75+ Electricity Duty Rs 0.878@13%)
Proposed Annual Energy saving, kVAh	17,509
Proposed Energy saving potential, %	29.1%
Proposed Annual Monetary saving from reduction in energy consumption only, Rs.	1,33,420
Proposed total Investment, Rs	3,35,960
Simple Payback period, years	2.52
Proposed Annual Monetary saving from reduction in energy consumption and Demand Reduction, Rs.	161187.78
Simple Payback period based upon reduction in energy consumption and Demand Reduction, years	2.08
Annual Energy saving after installation of SPV, kVAh	44,500
Proposed Annual Monetary saving for solar, Rs.	3,39,090
Investment for installation of SPV	17,32,500
Payback period, year	5.11

An intensive energy audit was conducted during to identify the energy conservation potential in the building. The performance assessment of the utilities and the data analysis was carried out to identify the potential and found that there is huge electrical energy saving potential. The saving potential is based upon the recommendation and implementation of Energy conservation measures. The list of major energy conservation measures is as below:

S. No.	Description	Energy Consumption in Present scenario, kVAh	Energy consumption after implementation of measure, kVAh	Annual Energy Saving, kVAh	Annual Monetary saving, Rs.	Investment, Rs	Simple Payback period, Years
1	Reduction in contract demand from 97.7kVA to 65kVA to reduce fixed charges in electricity bill				27,768		Immediate
2	Improvement in annual average power factor from 0.956 to 0.99 by installing APFC at main incomer	59,387	57,525	1,862	14,187	26,500	1.87
3	Installation of Photo sensor in lift lobby and staircase area to maximum use of natural light in place of artificial light	6,408	5,631	777	5,921	12,460	2.10
4	Replacement of 35 number of FTL- 12 lights with new energy efficient 20W LED lights to reduce energy consumption	2,363	875	1,488	11,335	15,750	1.39
5	Replacement of 65 number of T- 8 and T- 5 lights with new energy efficient 20W LED lights to reduce energy consumption	4,631	2,950	1,681	12,805	29,250	2.28
6	Replacement of 40 number of old ceiling fans with Energy efficient star rated BLDC ceiling fans	7,040	2,464	4,576	34,869	96,000	2.75
7	Installation of Upgraded Energy monitoring	59,387	52,261	7,126	54,303	1,56,000	2.87

S. No.	Description	Energy Consumption in Present scenario, kVAh	Energy consumption after implementation of measure, kVAh	Annual Energy Saving, kVAh	Annual Monetary saving, Rs.	Investment, Rs	Simple Payback period, Years
	and management system in Energy distribution network to maximize the optimum energy utilization						
	Total Energy potential without RE			**17,509**	**1,33,420**	**3,35,960**	**2.52**
	RE Energy potential						
8	Installation of 45kWp SPV for energy	**59,387**	**14,887**	**44,500**	**3,00,375**	**17,32,500**	**5.8**

Table 1: List of Energy Conservation Measures

The measures have been categorized based upon payback period (as long terms and medium term measures). The measures with payback period less than 1 year are short term, 1 to 3 years are medium term and more than 3 years are long terms. The list of these measures is as below:

S. No.	Description	Simple Payback period, Years	Type of measures
1	Reduction in contract demand from 97.7kVA to 65kVA to reduce fixed charges in electricity bill	Immediate	Short Term
2	Replacement of 35 number of FTL- 12 lights with new energy efficient 20W LED lights to reduce energy consumption	1.4	Medium Term
3	Improvement in annual average power factor from 0.956 to 0.99 by installing APFC at main incomer	1.9	Medium Term
4	Installation of Photo sensor in lift lobby and staircase area to maximum use of natural light in place of artificial light	2.1	Medium Term
5	Replacement of 65 number of T- 8 and T- 5 lights with new energy efficient 20W LED lights to reduce energy consumption	2.3	Medium Term
6	Installation of Upgraded Energy monitoring and management system in Energy distribution network to	2.9	Long Term

S. No.	Description	Simple Payback period, Years	Type of measures
	maximize the optimum energy utilization		
7	Replacement of 40 number of old ceiling fans with Energy efficient star rated BLDC ceiling fans	2.8	Long Term
8	Installation of 45kWp SPV	5.1	Long Term

Table 2: Classification of Energy conservation measures on payback basis

- The annual energy saving from rest of the measure is 17,509kVAh (Rs 1.33Lkah).
- The annual monetary saving from reduction in energy consumption saving and demand is 1.62Lakh. Reduction in demand will not lead to any energy saving.
- The maximum saving achieved in the college after implementing energy conservation measures is 44,500kVAh which can be achieved after installation of the SPV only. Saving from after SPV installation can't be clubbed with the energy saving after technological advancement in the system.
- The lists of utilities that are considered for replacement or installation are:

Name of Equipment/Utility	Capacity of new installation	Number
Capacity of capacitor bank consider for installation	15kVAr	1
Load considered for PIR Sensor Installation and de-lamping	For 3.5kW (in 5 Rooms)	5
FTL- 12 lights for replacement	20W	35
T- 8 and T- 5 lights for replacement	20W	65
Old ceiling fans replacement	35W	40

2. Project Background and Introduction

2.1. About the Project

Punjab Energy Development Agency was formed in September 1991 as a state nodal agency for promotion and development of renewable energy programmes/projects and energy conservation programme in the state of Punjab. PEDA is registered as a Society under the Societies Act of 1860. The Punjab Energy Development Agency (PEDA) was established in 1991 by the Government of Punjab in order to provide a long term perspective of future energy scenario. The objectives of PEDA include:

- Promotion, development and implementation of alternative/non-conventional energy technologies programs and projects.
- Implementation of comprehensive energy conservation programme in the industrial, agricultural, commercial and household sector.
- Promotion and development of new and emerging technology areas (e.g. biomass co-generation).
- Collection of energy data to build a reliable database to provide required information to the State Government to form its energy policy and planning for future.

Government Shivalik College, Naya Nangal, District Ropar, Punjab- 140126 with a view to support and promote energy efficiency and conservation wishes has requested to PEDA for conducting Energy Audit at their college campus. In response of the request, the PEDA has deputed the team for Energy Audit.

The general description of the facility for which energy audit was conducted is given below:

Description	Details
Name of Building Organization	Government Shivalik College
Address	Naya Nangal, District Ropar, Punjab- 140126
Audit Date	18/07/2023
Approximate Area	16.5 acres
Climate	Composite

Table 3: General details about Facility

2.2. Government Shivalik College, Naya Nangal

Government Government Shivalik College, Naya Nangal is built in District Ropar, Punjab. The college came into existence in 1979. The College is situated at a site measuring about 16.5 acres in picturesque surroundings on the right bank of the Satluj, on the Nangal-Bhallan Road about 2.5 kms from Nangal Dam. The College was taken over by the Government of Punjab on May 12, 1997. The College complex comprises three Teaching Blocks, a Library-cum-Administrative Block, a student's Centre, a Sports Complex and a Cycle stand etc. The Arial view of the college is as below:

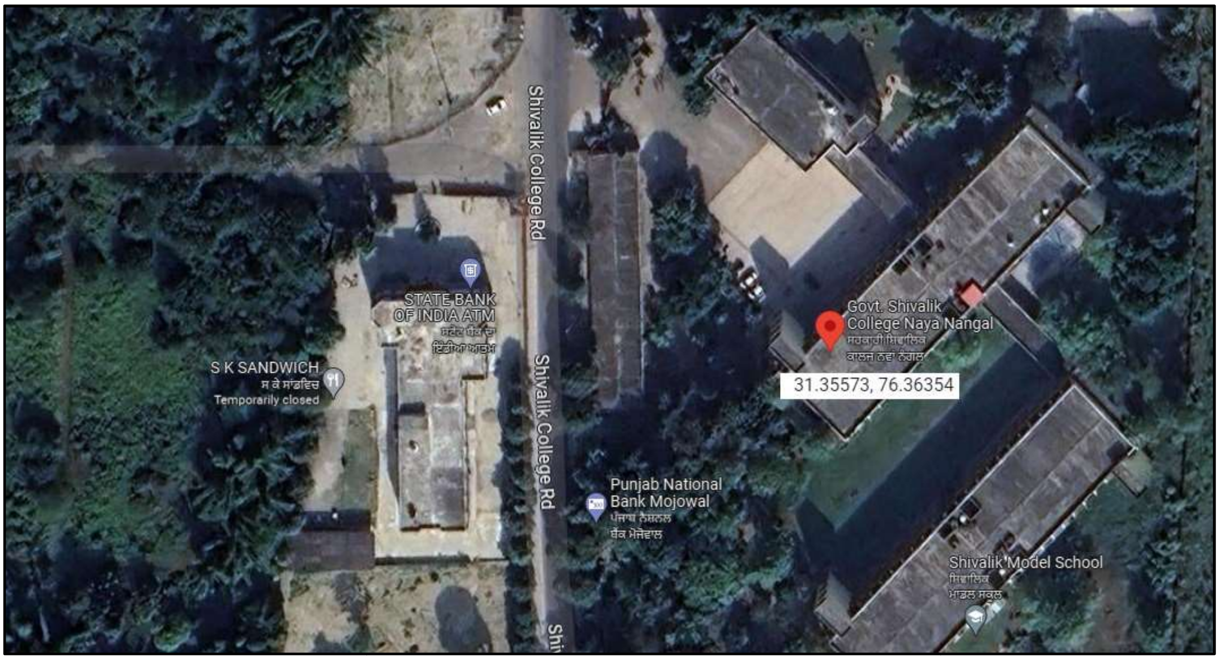


Figure 1: Arial view of the Government Shivalik College Naya Nangal

The college is affiliated to Punjabi University, Patiala. It has a spacious and beautiful campus with manicured lawns, fully equipped modern laboratories, a highly rated well-stocked Library. The college has sprawling playground, a gymnasium and a Canteen. The Computer labs consist of latest version of computers with broadband internet facility, LAN and software.

To run the day to day activities, the college has electricity supply from Punjab State Power Corporation Limited (PSPCL).

2.3. Initiative taken by college for Energy conservation

In this building already few energy conservation measures are implemented such as

- Installation of LED lights.
- Installation of BEE star rated appliances.
- Awareness program for the college staff and students

2.4. Objective of Energy Audit

1. The objective of the Energy Audit is to ensure optimum energy efficiency of the operations and to maintain awareness on optimum utilization of energy resources.
2. The other purpose is to identify potential for decrease in annual energy consumption.
3. Identifying the quality and cost of various energy inputs.
4. Assessing present pattern of energy consumption at different utility level.
5. Identifying potential areas of thermal and electrical energy conservation.
6. Providing most viable energy conservation measure based upon the cost benefit analysis.
7. Fixing of energy saving potential targets in individual sections.

3. Methodology adopted for Energy Audit

The general methodology followed is captured in the following figure:

Figure 2: Methodology

Step 1: Data Collection

1. The data required for preparation of detailed energy audit report is collected from various sources which electrical department, water supply department, PEDA office and Site In charge/operators etc.
2. The secondary data collected comprised of climate condition, electrical bill data, electrical distribution system, existing metering system, tariff order and subsidy details, electricity consumption pattern, seasonal energy and fuel consumption etc.

Step 2: Field Studies

1. The field level data collection includes detailed energy audit and physical measurements of various operating parameters for different utilities. The objective of detailed audit is to determine the energy performance of existing utilities, which mainly involves electrical energy consumption, performance parameters and comparison of both.
2. In addition, information like mode of energy distribution, back-up power source etc are also explored.

Step 3: Interactions with different Stakeholders

3. The energy performance analysis of the utilities was carried out and scouting was done to select the appropriate capacity energy efficiency measures.
4. Interactions with leading manufacturers / suppliers are also carried out for selection and understanding the operational behaviour. The study of pump curves carried out to check the impact on pump efficiencies with change in one or the other parameter. During the interaction, the efficiency range of different types of pumps (both star labelled and non- star labelled but higher efficiency) pumps along with technical details, budgetary quotes, suppliers of spare parts etc. is also discussed.

Step 4: Preparation of Best Practices Manual and Monitoring & Verification Protocol

5. The findings from the study of existing systems were thoroughly analyzed and factors attributing to lower system efficiencies were identified. Practices pertaining to existing operating and maintenance and factor for improvement these practices were also explored.
6. Best standard operating and maintenance practices are suggested with respect to the pumping stations. The measures pertaining to selection of pipelines, safety of electrical equipments are also suggested in the report.

7. In order to ensure the energy savings, appropriate monitoring and verification protocol need to be in place. Detailed monitoring and verification protocol is provided to capture the performance parameters and to accommodate the uncertainties in the savings.

Step 5: Cost Benefit Analysis

8. Carried out cost benefit analysis for investments made in different energy efficiency measures. Estimation of energy saving potential and associated monetary benefits with payback period was also done.

3.1 Instruments Used for Energy Audit

The following portable instruments were used for data measurement:

- 3 – phase Power Analyser
- Single phase Power Analyser
- Ultrasonic Water Flow Meter
- Anemometer
- Hygrometer
- Digital Thermometer
- Infrared Thermometer
- Pressure gauge
- Lux Meter
- Stroboscope

4. Present Energy Scenario of Government Shivalik College, Naya Nangal

In Government Shivalik College, Naya Nangal, This facility is receiving 0.415kV power supply from Punjab State Power Corporation Limited (PSPCL) as main source of power supply. The direct power supply is coming at main LT panel installed in the Electrical Room. There is one DG Set also to cater the energy supply during power failure in exam/emergency. The change over switch is provided in the LT panel to switch over the power supply based upon the requirement. The electrical energy is required to meet the daily operational activities. In annual energy bill, major contribution is due to Electrical Energy consumption from grid and least is from DG Set. The fuel (HSD) is also used in the facility but for electrical energy generation. The electrical energy from different sources on annual basis is as below:

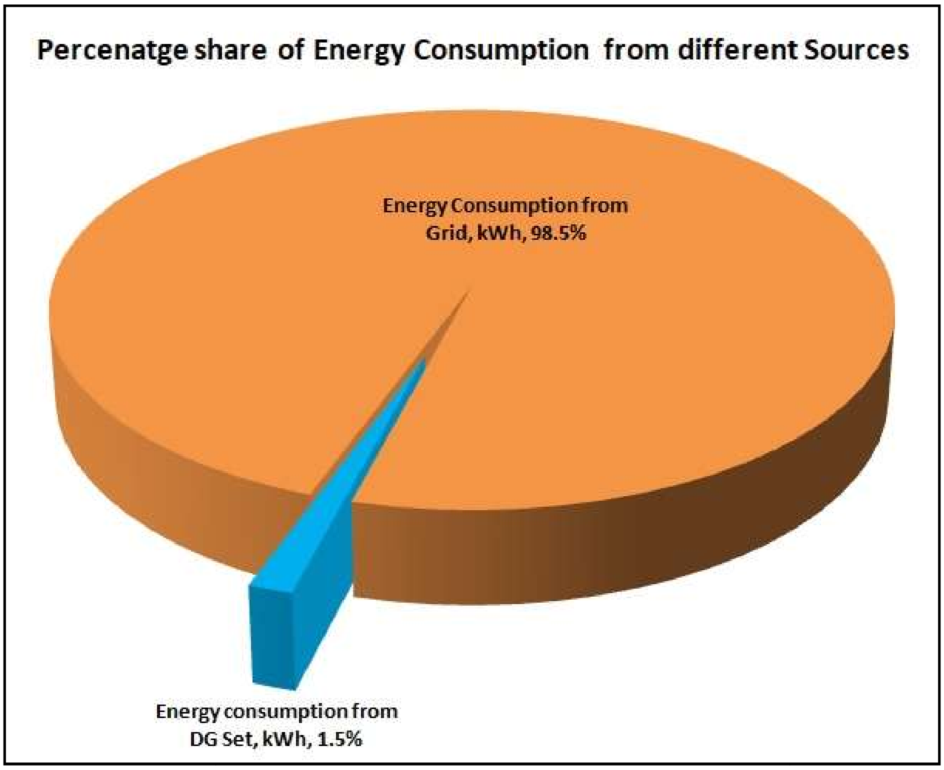


Figure 3: Percentage Share of Energy consumption from different sources

Month	Energy Consumption from Grid, kVAh	DG Set Energy Consumption, kVAh	Total Energy Consumption, kVAh
Jul-22	4,594	69	4,663
Aug-22	7,155	107	7,262
Sep-22	5,993	90	6,083
Oct-22	6,853	103	6,956
Nov-22	5,326	80	5,406
Dec-22	3,512	53	3,565
Jan-23	3,423	51	3,474
Feb-23	3,680	55	3,735
Mar-23	3,071	46	3,117

Month	Energy Consumption from Grid, kVAh	DG Set Energy Consumption, kVAh	Total Energy Consumption, kVAh
Apr-23	3,234	49	3,283
May-23	4,029	60	4,089
Jun-23	6,080	91	6,171
Total	**56,950**	**854**	**57,804**
Maximum	**7,155**	**107**	**7,262**
Average	**4,746**	**71**	**4,817**
Minimum	**3,071**	**46**	**3,117**

Table 4: Energy consumption from different sources

As per annual energy consumption data, this facility is mainly dependent on grid supply. The contribution the energy consumption from the grid is 98.5% of the total annual energy consumption.

In this facility HSD is also consumed for power generation in DG Sets. Since there are very few power cuts in this region, most of fuel consumption is during the DG Set testing. Based upon the fuel consumption during DG testing and generation from DG Set is only 1.5% (854kWh) of total annual energy consumption.

5. Electricity Distribution System

5.1 Main Incomer

As mentioned earlier the main source of electrical power supply is 0.415kV from grid which received at main electrical panel room. From main electrical panel room, the supply is brought to the change over installed near DG Set area. After that the power is distributed to different floors. The distribution along with position of power analyser is as below:

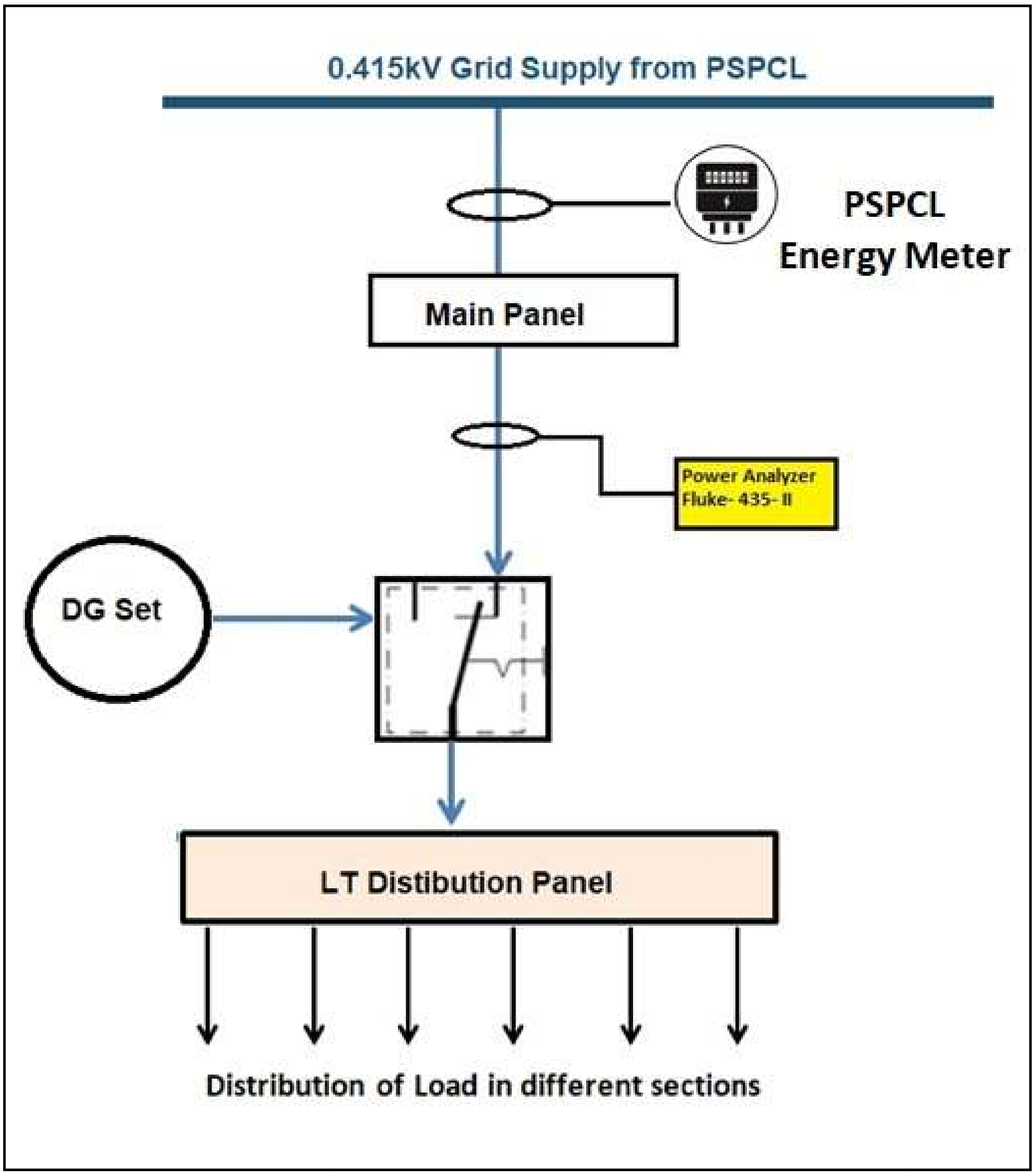
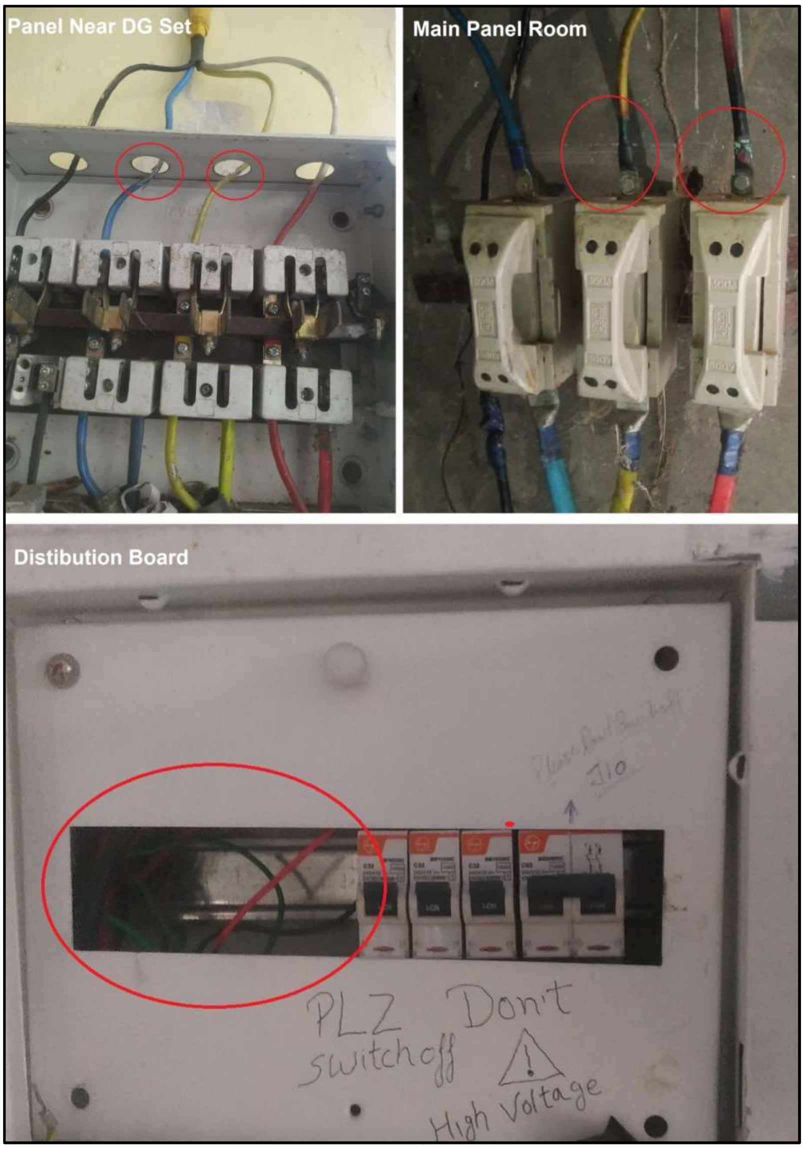


Figure 4: Power Distribution and Location of Power Analyzer

The visual inspection of electrical installation in the premises including Electrical room, Low tension switch gear panel, Distribution boards, lighting installations, earthing arrangements. During visual inspection all the observations, which are either dangerous or non compatible to the standard engineering practice are noted and potential corrective actions are made to improve the safety level of the electrical installation. The detailed testing and inspection results are tabulated as below:

<table>
<tr>
<td rowspan="2">
</td>
<td>Observations

Poor management of wires/cable and no mechanically protection provided.
Lugs and glands are not found.
Dressing/ terminations of wires not done properly.
Conditions of cabling carried out in the Premises are very poor and at many place, cable joints are found.
The number of cable with joints are lying on floor in Electrical Panel Room
</td>
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<tr>
<td>Recommendations

Use lugs and glands at end terminations to protect ingress of water, vermin and dust.
New Fuse units should be provided.
All final circuits should be provided with individual overload and short- circuit protection.
Cables/wires should have mechanical protection (means always to run inside the pipes) and should be adequately supported throughout their run.
Avoid lose wires and joints in the wiring system.
</td>
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Table 5: Critical point in Electrical distribution

5.2 Connected Load

Electrical Load contributes towards the total possible energy consumed by a system, circuit, component, device or equipment that is connected to a source of electric power. Electrical load is further broken down into connected Load and demand load. The connected load is defined as the sum of continuous ratings of all the equipment connected to the electrical power station. It is the maximum load of all the equipment and appliances at a particular time over a particular time span. In this building, connected load is around 116.09kW. The break-up of the connected load is as below:

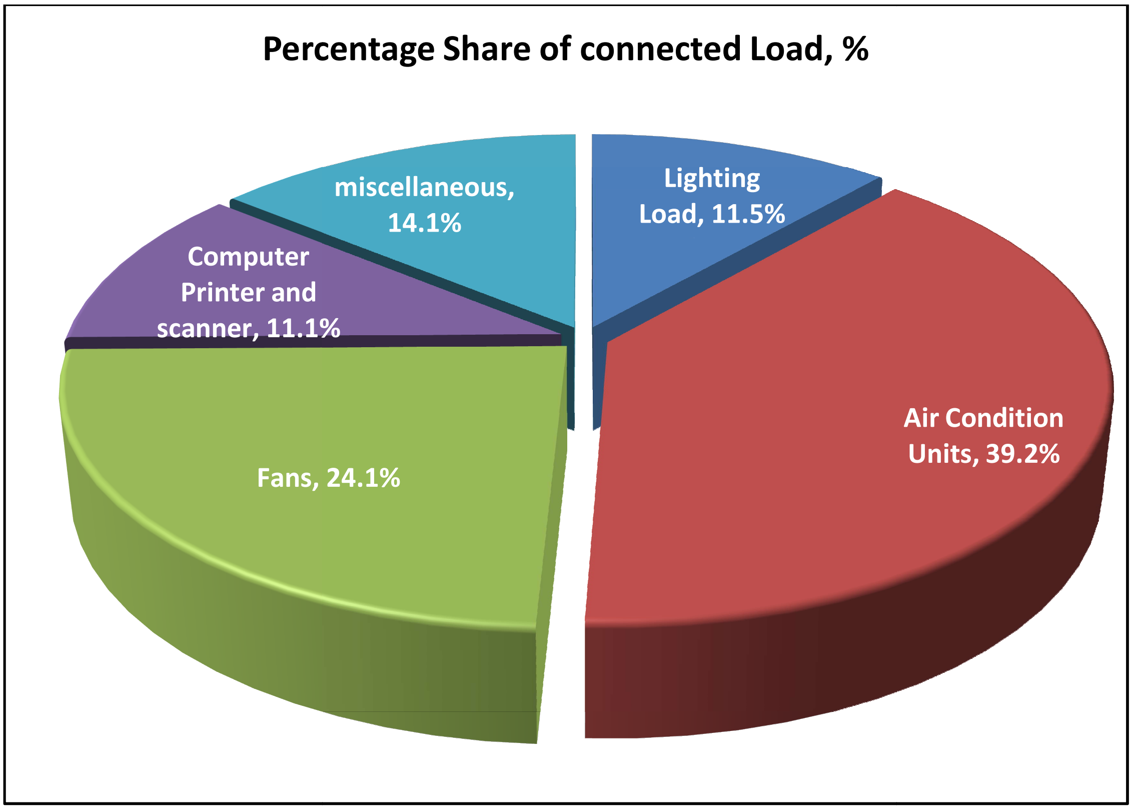

Figure 5: Connected Load Share

Description	Percentage Share, %	Connected Load, kW
Lighting Load	11.5%	13.34
Air Condition Units	39.2%	45.55
Fans	24.1%	27.95
Computer Printer and Scanner	11.1%	12.9
Miscellaneous	14.1%	16.35
Total		**116.09**

Table 6: Connected Load

6. Bill Analysis

The bill analysis is done for the facility and compared with the tariff orders of the respective years to check if there any additional charge, penalty, or any excess charges. The major highlights from the bill analysis are:

Description	UoM	Values
Account Number		3000152821
Meter Number		918056
Category		GC/SAP-NONSBM-/DS RATE CATEGORY FOR DS>50 KW FOR DPC
Energy Charges	Rs/kVAh	6.75
Fixed Charges	Rs/kW	130
Sanctioned Load	kW	87.95
Contract Demand	kVA	97.7

Table 7: Components of electricity bill

The annual bill data as per electricity bill is as below:

Month	Electricity Consumption, kWh	Electricity Consumption, kVAh	Power Factor	Billing demand, kVA	Energy Charges, Rs	Demand Charges, Rs	Monthly electricity bill, Rs
Jul-22	4,594	4,726	0.972	46.9	30,388	8,867	1,60,680
Aug-22	7,155	7,339	0.975	45.8	47,190	9,163	68,510
Sep-22	5,993	6,147	0.975	47.8	39,525	9,163	59,920
Oct-22	6,853	7,106	0.964	47.0	45,692	8,867	65,510
Nov-22	5,326	5,572	0.956	38.0	35,828	9,163	1,21,930
Dec-22	3,512	3,742	0.939	37.9	24,061	8,867	1,33,070
Jan-23	3,423	3,593	0.953	22.0	23,103	9163.0	1,74,720
Feb-23	3,680	3,852	0.955	21.2	24,768	9,163	40,780
Mar-23	3,071	3,242	0.947	13.9	20,846	8,276	1,07,630
Apr-23	3,234	3,492	0.926	11.8	22,454	9,163	37,430
May-23	4,029	4,243	0.950	27.5	27,282	8,867	43,460
Jun-23	6,080	6,333	0.960	33.4	40,721	10,166	63,170
Total	**56,950**	**59,387**			**3,81,858**	**1,08,888**	**10,76,810**
Maximum	**7,155**	**7,339**	**0.975**		**47,190**	**10,166**	**1,74,720**
Average	**4,746**	**4,949**	**0.956**		**31,822**	**9,074**	**89,734**
Minimum	**3,071**	**3,242**	**0.926**		**20,846**	**8,276**	**37,430**

Table 8: Components of Electricity Bill

The major highlights from the bill analysis are:

6.1 Maximum Demand Index

The contract demand for this facility is 97.7kVA and the minimum billable demand is 85% of the contract demand. The period, for which bill analysis has been done, the demand is charged for Rs 110/kVA (which is now revised to Rs 130/kVA). The month wise MDI demand for this facility is as below:

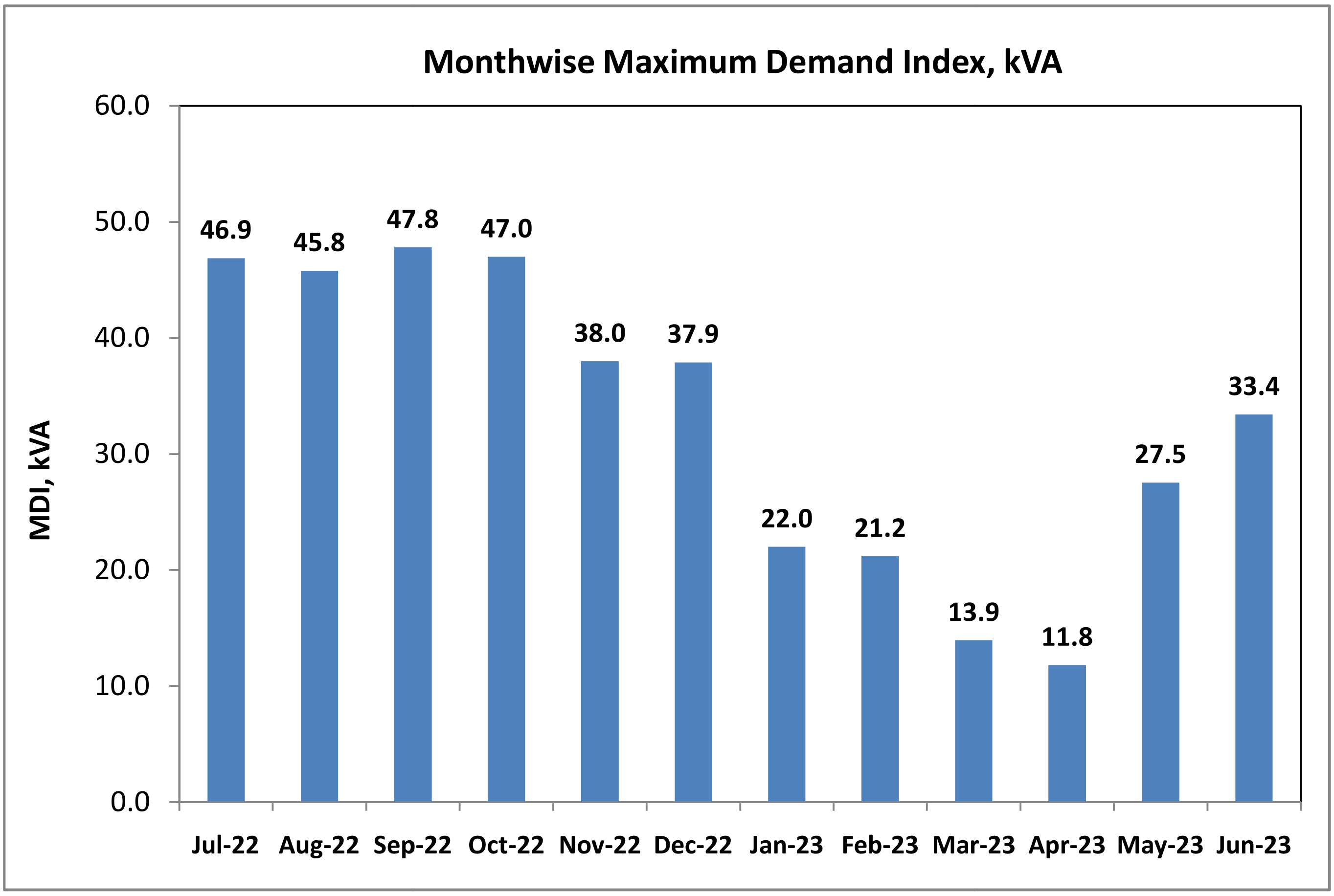

Figure 6: Month wise Maximum Demand Index

Forms the bill analysis, it is clear that month wise demand (MDI) has never reached close to the contract demand. In energy bill, fixed charges are on 85% of the contract demand. The maximum demand recorded in one year is September- 22 (47.8kVA) and minimum during Apr- 23 (11.8kVA).

6.2 Energy Consumption Pattern (kVAh)

The month wise energy consumption for the facility is as below:

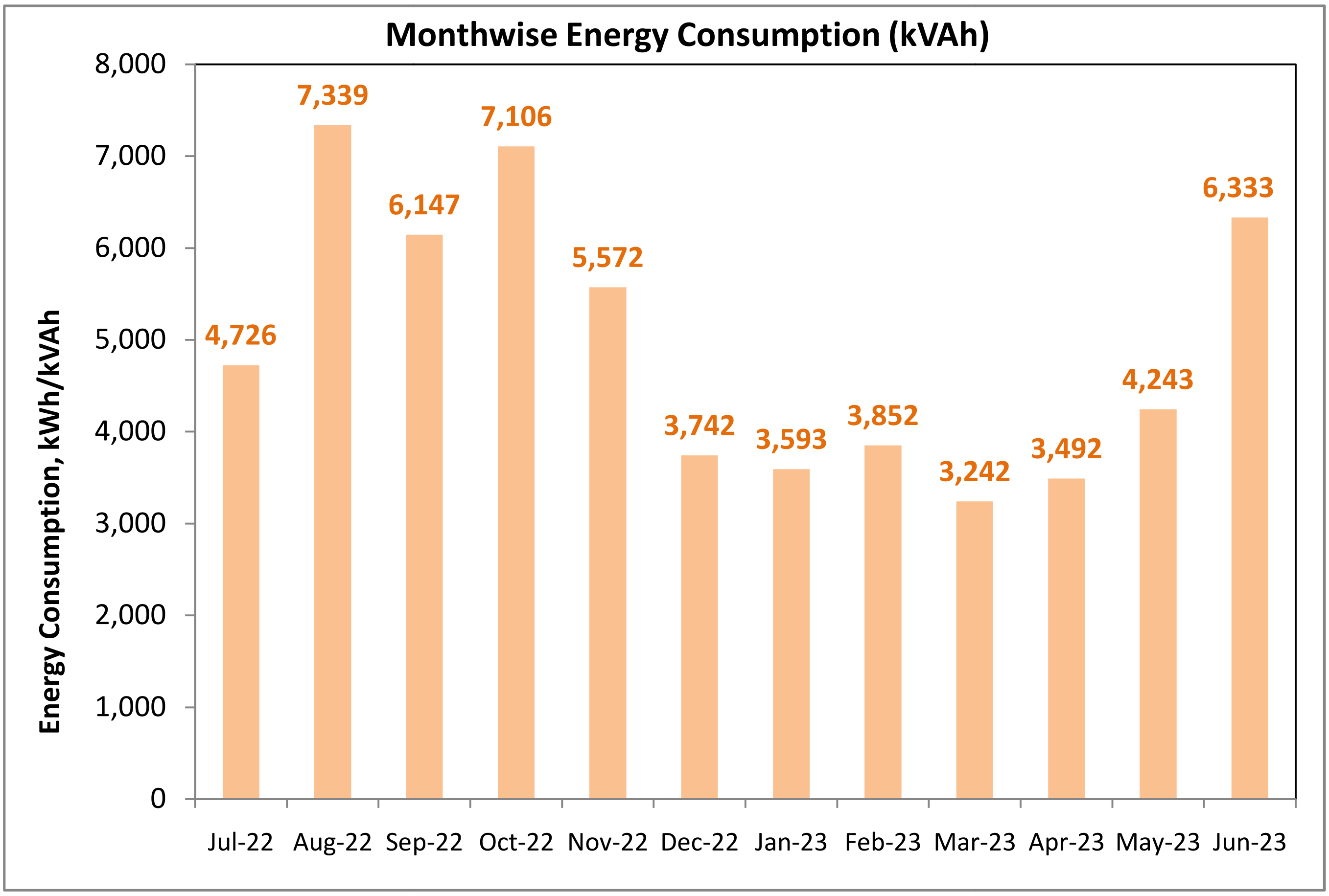

Figure 7: Month wise Energy Consumption

Forms the bill analysis, the annual energy consumption is 59,387kVAh. The maximum energy consumption in one month is 7,339kVAh during August- 22 and minimum energy consumption is 3,242kVAh during Mar-23. The energy consumption is in line with the maximum demand index.

6.3 Power Factor Variation

The power factor of an AC power system is defined as the ratio of the real power absorbed by the load to the apparent power flowing in the circuit. Power factor can be an important aspect to consider in an AC circuit because of any power factor less than one means that the circuit's wiring has to carry more current than what would be necessary with zero reactance in the circuit to deliver the same amount of (true) power to the resistive load. The month wise power factor variation for the college campus is as below:

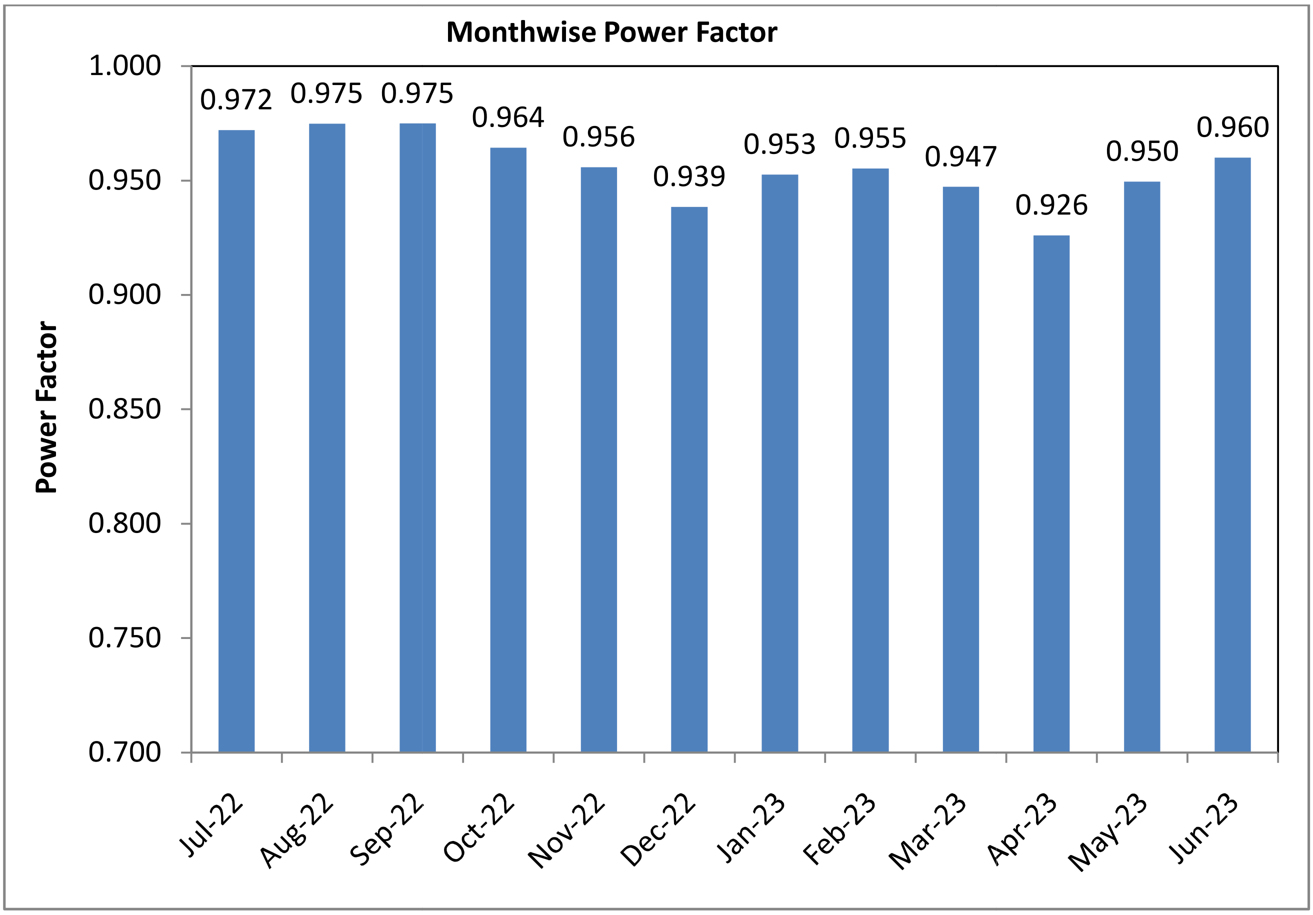

Figure 8: Month wise Power Factor

The power factor is close to unity is always preferable for more whenever the billing is in Rs/kVAh. The annual average power factor for the college campus is only 0.956 which indicates there is potential for improvement in power factor.

7. Power Quality

Power quality determines the fitness of electrical 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. It is used to describe electric power that drives an electrical load and the load's ability to function properly. Without the proper power, an electrical device (or load) may malfunction, fail prematurely or not operate at all. There are many ways in which electric power can be of poor quality such as voltage unbalance, harmonics etc. **Fluke make Power Analyser** to check power quality of the system. Under Power Quality, the various parameters measured and calculated are as below:

1. Load Variation
2. Voltage Variation
3. Power factor variation
4. Voltage Unbalance
5. Harmonics level

As per design, this is 8hr running facility so the maximum energy consumption is during day time. At night only minimum supporting load runs. The power analyser is used to record the parameters at main incomer. The power analyzer is used to record the power parameter at main incomer. The recorded value at main incomer is as below:

Description	Power, kW	Power, kVA	Total Power Factor
Maximum Power, kW	30.2	33.0	0.93
Average Power, kW	21.6	23.6	0.92
Minimum Power, kW	18.3	20.0	0.89

Table 9: Details of the recorded Parameters at main incomer

Based upon the recorded data by power analyser, the various descriptions are as below:

7.1 Load Variation

Since this is basically a 08hrs running facility, maximum energy consumption is observed during day time. The variation of total load at main incomer is as below:

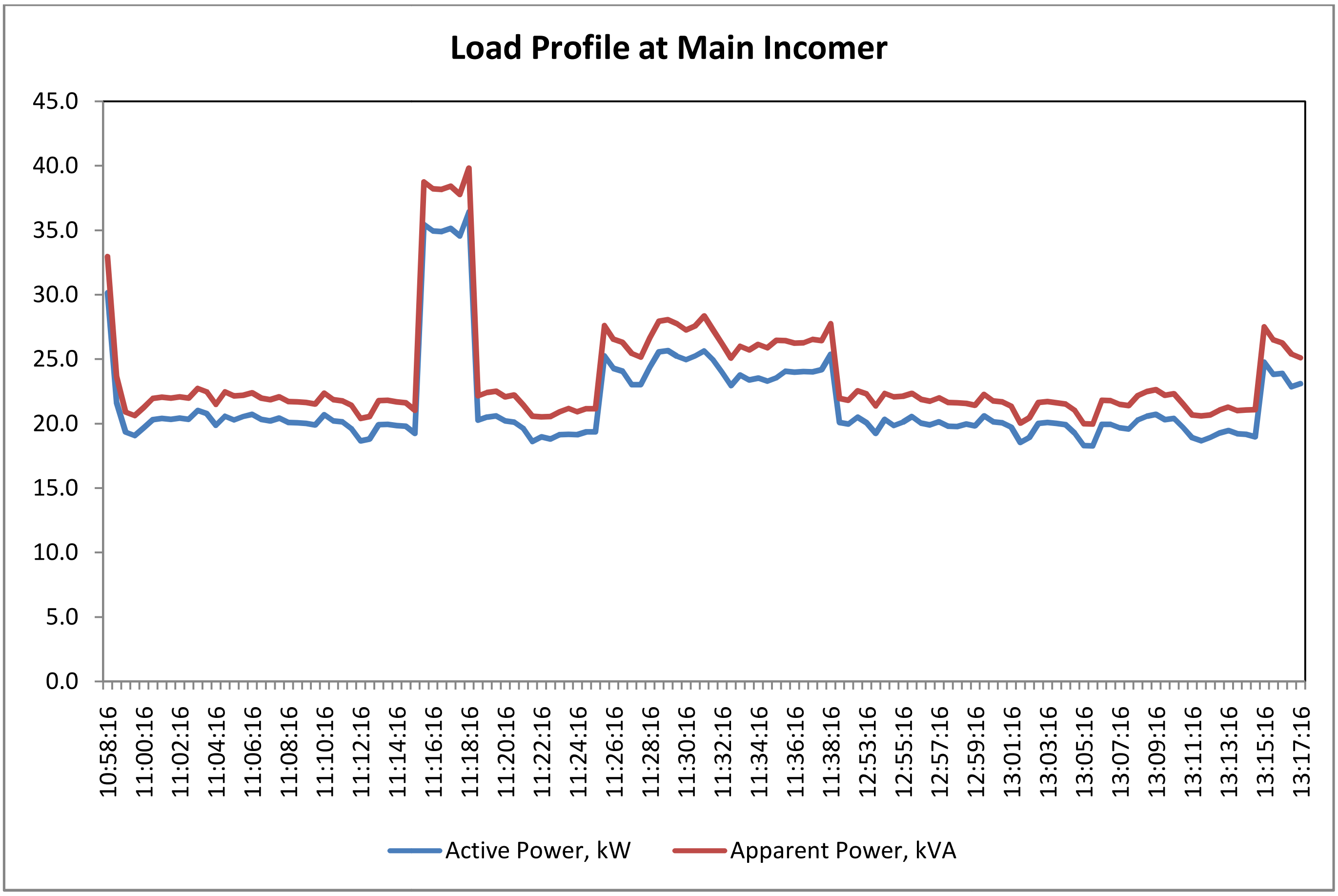

Figure 9: Trend of load variation

It was mentioned that the maximum load is 30.2kW and minimum is 18.3kW.

7.2 Voltage Variation

The voltage level at each phase of 0.415kV supply is measured and is as below:

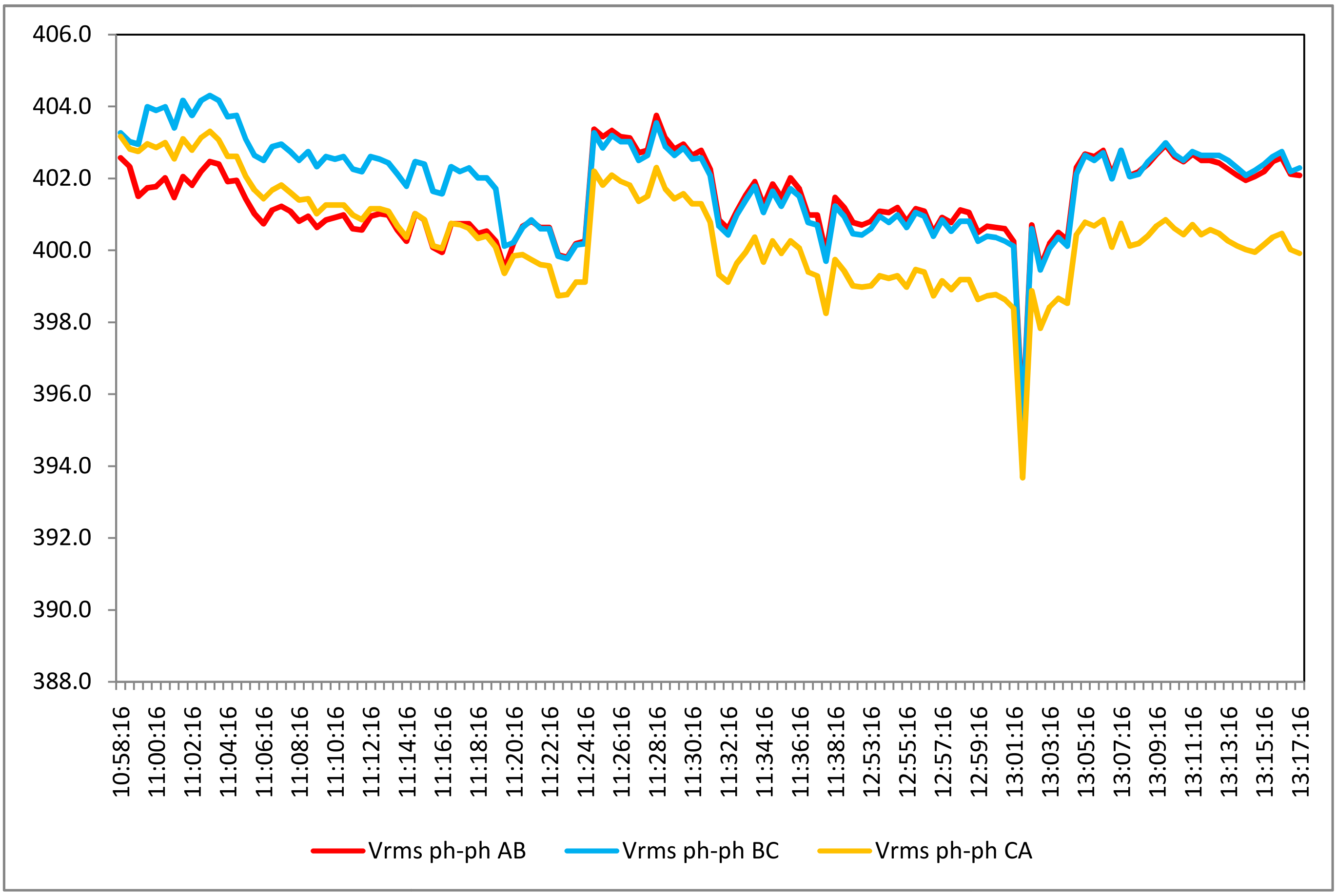

Figure 10: Trend of Voltage Variation

The voltage level was varying from 404.3V to 393.7V.

7.3 Power Factor

In an electric power system, a load with a low power factor draws more current than a load with high power factor for the same amount of useful power transferred.

The billing for this facility from main power supply is in Rs/kVAh so if there is low power factor, energy consumption will be higher.

It is observed that the average power factor is coming 0.92 at running load. There are no capacitor panels installed at load end in the premises to maintain the power factor.

To compare the actual power factor, the variation of power factor is recorded with the help of power analyzer. The power factor varies with load variation. The extreme value of power factor at different phases of main incomer is as below:

Description	Total Power Factor
Maximum	0.93
Average	0.92
Minimum	0.89

Table 10: Measured power factor at each phase of main incomer

The variation of Power Factor at main incomer is as below:

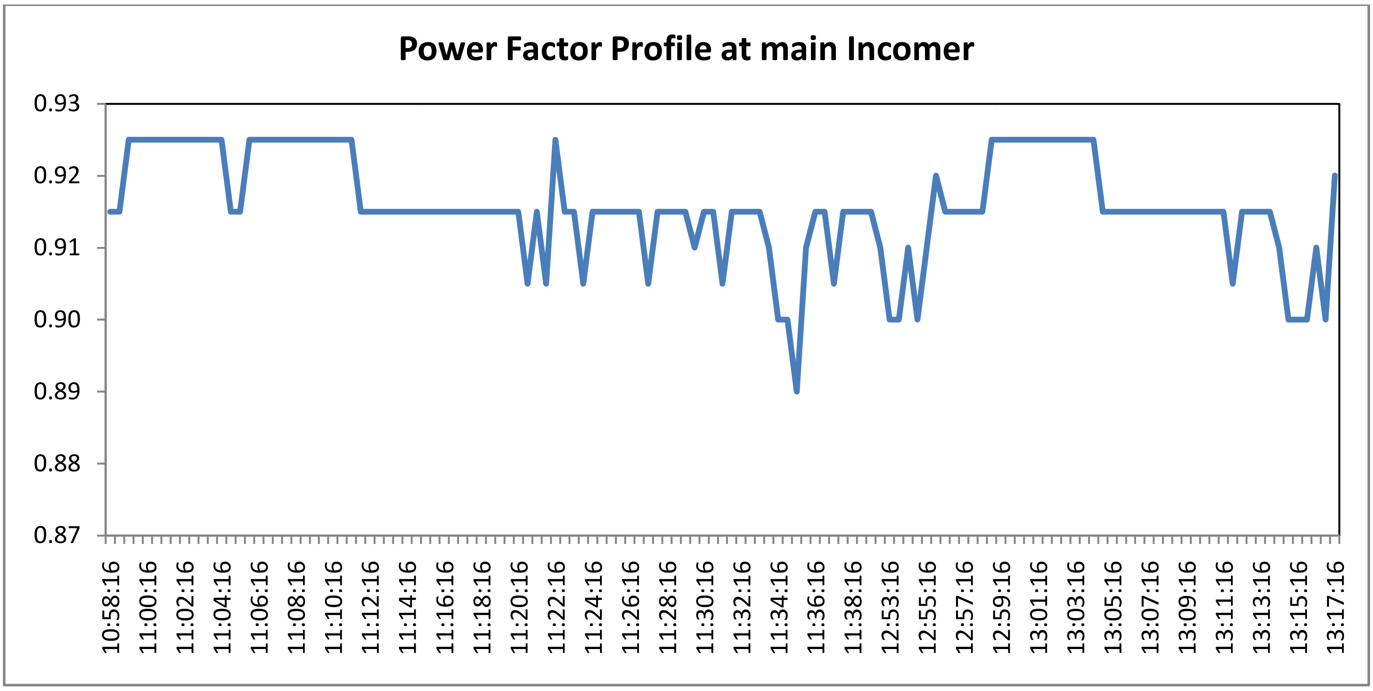

Figure 11: Trend of Power Factor

The average operating power factor is varying from 0.93 to 0.89 which can be improved if APFC with necessary modifications.

7.4 Voltage Unbalance

Voltage unbalance occurs when the RMS line voltages on a poly-phase system are unequal. Voltages are seldom perfectly balanced between phases, but when this unbalance becomes excessive, it can create problems for poly-phase motors. The main effect of voltage unbalance is motor damage from excessive heat. Voltage unbalance can create a current unbalance 6 to 10 times the magnitude of voltage unbalance. Consequently, this current unbalance creates heat in the motor windings that breaks down motor insulation causing cumulative and permanent damage to the motor. Since most of the load in the building is single phase load, voltage unbalance level is measured with power analyzer. The trend of voltage unbalance is as below:

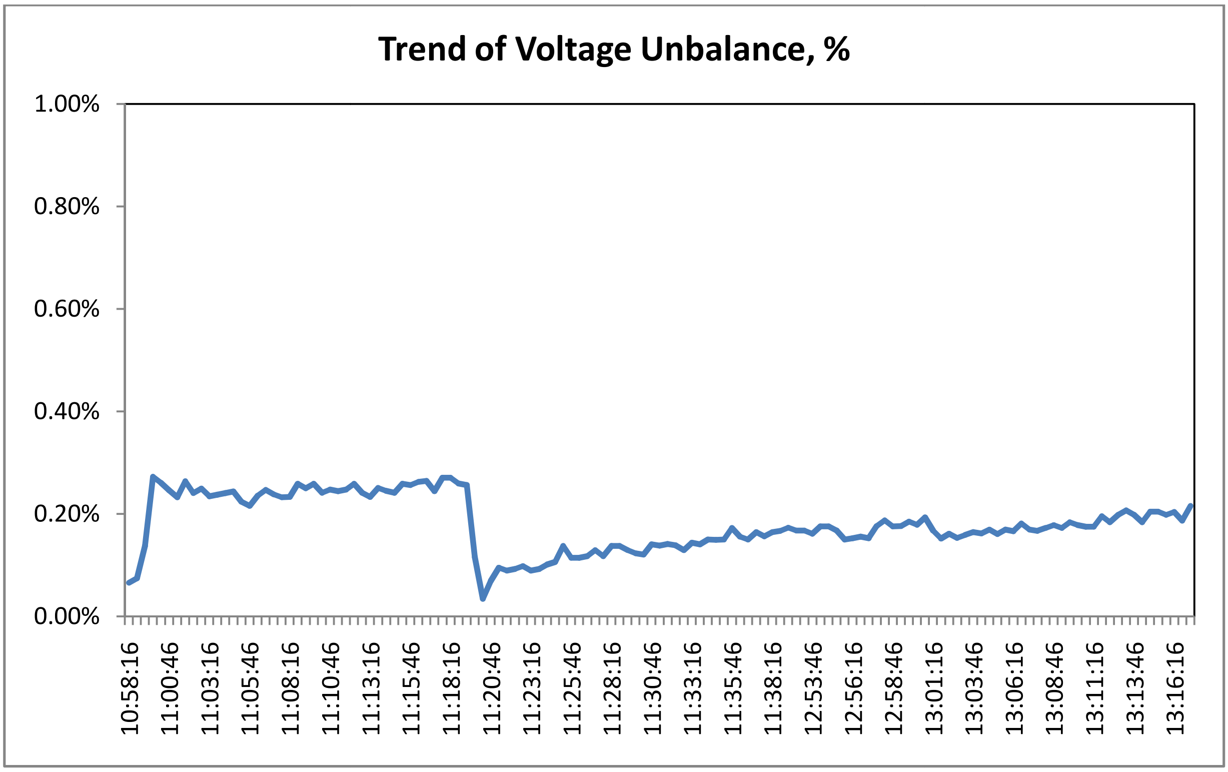

Figure 12: Trend of Voltage Unbalance

The maximum voltage unbalance measured in only 0.27%. It is clear that the voltage unbalance is under the prescribed limit of 1.0% as per IEEE standards.

7.5 Harmonics

Ideally, voltage and current waveforms are perfect sinusoids. However, due to the increased popularity of electronic and other non-linear loads, these waveforms get distorted. This deviation from a perfect sine wave can be represented by harmonics—sinusoidal components having a frequency that is an integral multiple of the fundamental frequency. Thus, a pure voltage or current sine wave has no distortion and no harmonics, and a non-sinusoidal wave has distortion and harmonics. To quantify the distortion, the term total harmonic distortion (THD) is used. The term expresses the distortion as a percentage of the fundamental (pure sine) of voltage and current waveforms.

IEEE Std 519-1992 Harmonic Voltage Limits

Bus Voltage at PCC	Individual Voltage Distortion (%)	Total Voltage Distortion THD (%)
69 kV and below	3.0	5.0
69.001 kV through 161 kV	1.5	2.5
161.001 kV and above	1.0	1.5

NOTE: High-voltage systems can have up to 2.0% THD where the cause is an HVDC terminal that will attenuate by the time it is tapped for a user.

Current Distortion Limits for General Distribution Systems (120 V Through 69000 V)

Maximum Harmonic Current Distortion in Percent of I_L						
Individual Harmonic Order (Odd Harmonics)						
I_{SC}/I_L	<11	$11 \leq h < 17$	$17 \leq h < 23$	$23 \leq h < 35$	$35 \leq h$	TDD
<20*	4.0	2.0	1.5	0.6	0.3	5.0
20<50	7.0	3.5	2.5	1.0	0.5	8.0
50<100	10.0	4.5	4.0	1.5	0.7	12.0
100<1000	12.0	5.5	5.0	2.0	1.0	15.0
>1000	15.0	7.0	6.0	2.5	1.4	20.0

Even harmonics are limited to 25% of the odd harmonic limits above.

Current distortions that result in a dc offset, e.g. half-wave converters, are not allowed.

* All power generation equipment is limited to these values of current distortion, regardless of actual I_{sc}/I_L.

Where

- I_{sc} = maximum short-circuit current at PCC.
- I_L = maximum demand load current (fundamental frequency component) at PCC.
- TDD = Total demand distortion (RSS), harmonic current distortion in % of maximum demand load current (15 or 30 min demand).
- PCC = Point of common coupling.

Harmonics are created from equipment's containing electronics that control other apparatus, e.g. variable speed drives, soft starters, static compensators, rectifiers and heating furnaces, etc.

Problems due to Harmonics

- Malfunctioning of control systems since electronic meters, relays, etc. are matched to the fundamental frequency
- Overloading of capacitors, leading to malfunctioning and premature ageing
- Miss-operation or failure of electronic equipment
- Interference with telecommunications and computers
- Increased losses, e.g. machines will operate at increased temperature and can be overheated
- Resonance problems between the inductive and capacitive parts of the power network
- Disturbances in ripple control systems
- High currents in neutral conductors.

The harmonic analysis based upon the data recorded in power analyser is carried out and it is observed that both Voltage and Current THD% is within the limit values in main incomer. As per IEEE-519, 1992, total harmonics distortion is tabulated as per below table:

Parameters	Voltage THD (%)			Current THD (%)		
	R-Phase	Y-Phase	B-Phase	R-Phase	Y-Phase	B-Phase
Maximum	2.4	1.9	2.5	3.7	3.6	3.7
Average	2.2	1.8	2.1	3.4	3.3	3.5
Minimum	1.5	1.1	1.4	3.0	2.8	3.1

Table 11: Details of harmonics level at main incomer

It is clear that there is no higher level of harmonics at main incomer. All the values are less than permissible limit which is good for health of electrical distribution network.

8. Electrical Utilities

There is manufacturing facility can be divided as following sections:

8.1 Diesel Generator Set

Introduction

There is one DG sets which cater to the running load corresponding to load from PSPCL in case of power failure. The contribution of energy generation from DG Set is only 1.5 %(inclusive of testing). The energy generation data is calculated based upon the fuel consumption and the Specific fuel consumption 3.5kWh/lit. The month wise energy consumption from DG Set is as below:

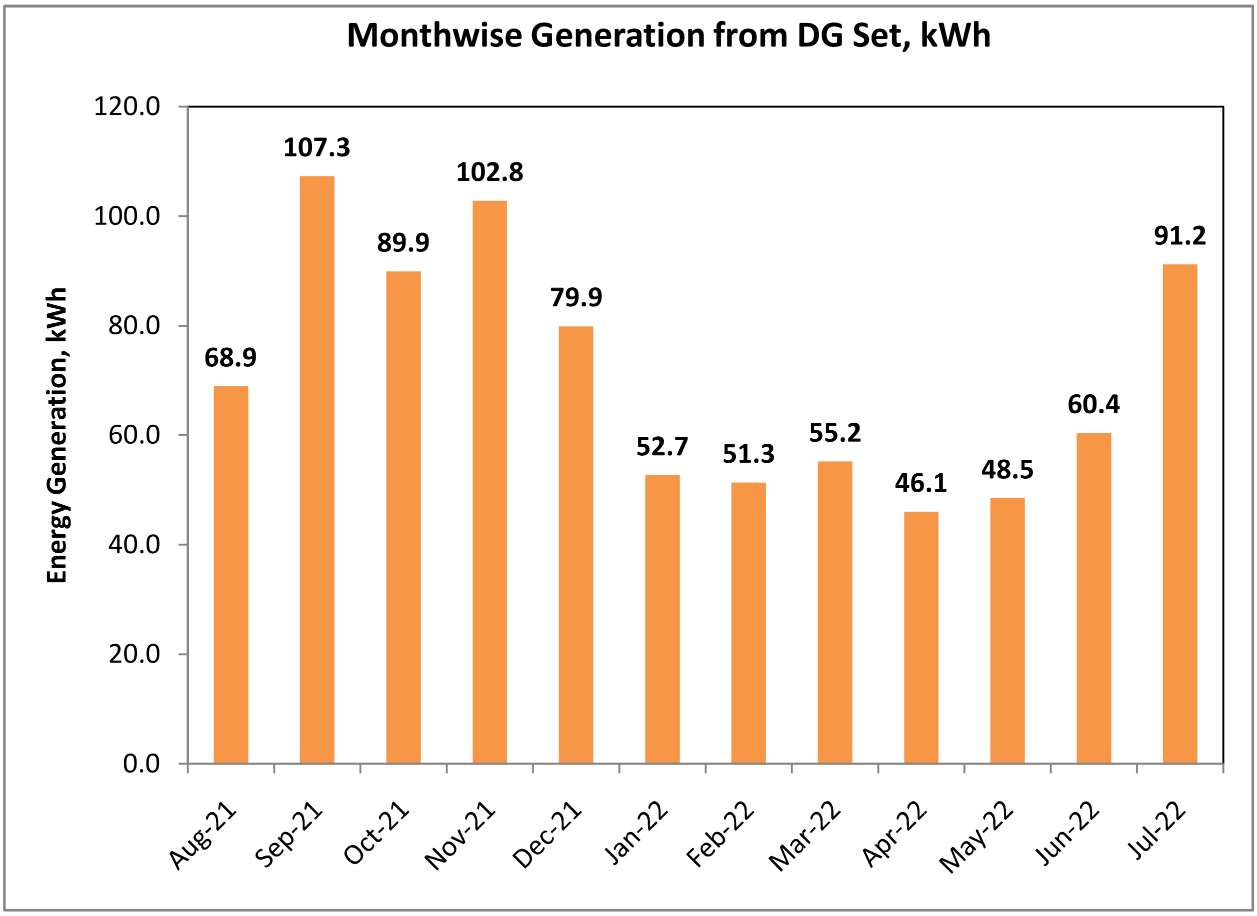

Figure 13: Month wise generation from DG sets

There are few general recommendations for DG Set as below:

- Specific Fuel Consumption (SFC) expressed in litre/hour or gm/kWh is an indication of performance of a DG Set. This parameter is of direct relevance to end users as it relates to the operating costs of generating electricity from diesel generator sets. The quantity of diesel consumption is recorded on regular basis however there is no provision for recording of energy generation from DG Set. It is recommended to install the energy meter for each DG set to keep record of the performance of evaluation of DG sets.

- Since the DG Set is used as backup power source, its availability and reliability is very important. To enhance both, it is recommended schedule Preventive maintenance of DG sets on half yearly basis. It will keep system healthy, better and uninterrupted power output at lesser fuel consumption.
- Calibrate fuel injection pumps frequently and Improve air filtration.
- Consider fuel oil additives in case they benefit fuel oil properties for DG set usage.
- Ensure fuel oil storage, handling and preparation as per manufacturers. Ensure compliance with maintenance checklist.
- The maximum permissible percentage unbalance in phase loads on DG sets is 10%.
- The permissible percentage overload on DG sets for 1 hour in every 12 hours of operation is 10%. Lower power factor of a DG set demands higher excitation currents.
- The sample data sheet which can be used for DG Set Performance on monthly basis and for each DG Set is as below:

Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Generation, kWh												
Fuel Consumption in Generation, lit												
SFC, lit/kWh												
Generation, kWh/lit												

Figure 14: Sample Performance Assessment Sheet for DG Set

8.2 Air condition Units

Introduction

There are 22 number of AC units installed in the campus and the connected load is around 45.55kW. The running load was also instantaneous only because these areas were not occupied. The computer lab new is not in operation so the AC load is not contributing towards the running load. The connected load of AC units is as below:

Location	Type	Number	Connected Load, kW	Running Load, kW
Office College (Light Location)	Split AC (inverter AC)	2	3.6	2.95
Staff Room	Split AC (inverter AC)	2	3.6	
Seminar Room	Split AC	2	3.6	
Seminar Room	Split AC	2	3.6	2.60
NCC Office	Split AC	1	1.8	1.55
PI Staff	Split AC	1	1.8	1.55
Clothing	Split AC	1	1.8	1.55
CR-16	Split AC	1	1.8	
Bank	Split AC	2	3.6	
Registrar Room	Window AC	1	1.85	
LAB-02	Window AC	3	5.55	4.00
LAB-01	Window AC	2	3.7	3.00
RUSA Lab. Computer	Window AC	2	3.7	2.95
Botany Seminar Room	Window AC	2	3.7	3.00
Language LAB.	Window AC	1	1.85	1.45
Total			**45.55**	**24.6**

Table 12: Details of AC units

The energy consumption of the AC units is 24.6 however in actual, there are only few AC units which run continuously. The continuous running load is only 8.22kW. There are few tips to Use Air Conditioner effectively all around the season:

1. Check and Change the Air Filter.
2. Use Smart Thermostat or AC Controllers.
3. Don’t Let Your Thermostat Take the Heat.
4. Try to fix the AC unit in air sealed room to the extent possible.
5. Avoid Steep Temperature Changes and try to run AC unit at 25°C.

8.3 Lighting

Introduction

The total connected lighting load in the building is around 13.34 kW. Total lighting load is sum of connected rated power of each luminary. The Mix of FTL- 12, T- 8, T-5 and different types of LED lights. The Percentage share of different types of lightings is given below:

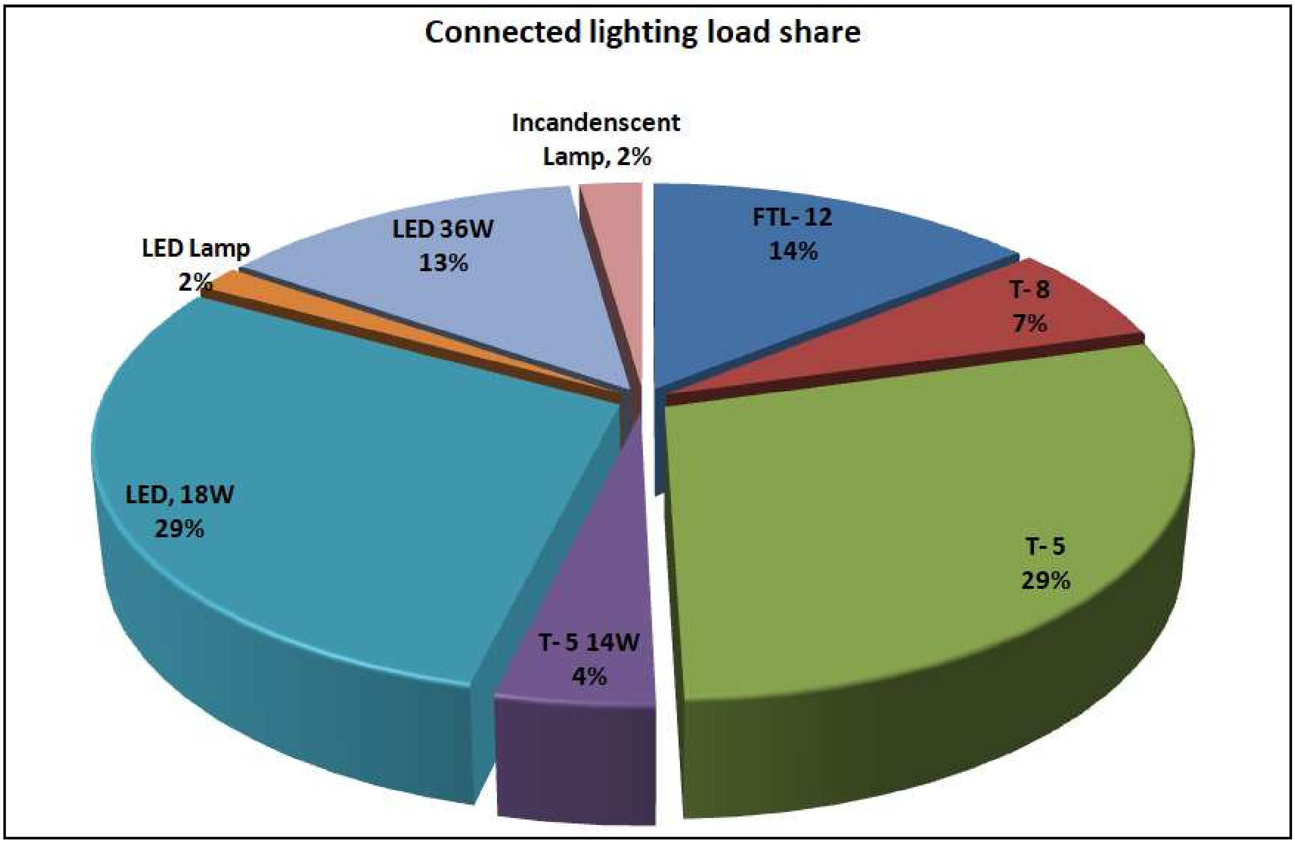

Figure 15: Percentage share of lighting Load

Performance Assessment

In the different areas of building, interior lighting requirements are for meeting average luminance on a horizontal plane, either throughout the interior, or in specific areas within the interior combined with general lighting of lower value. For assessing energy efficiency of lighting system, Inventory of the Lighting System is noted and the lux levels measurement at working level has been done with help of lux meter. In most of the areas, the measured lux level is found satisfactory.

8.4 Fans

Introduction

The ceiling fans are more affordable than air conditioners and the right size can make a difference. The summers are very hot in the region so the energy consumption by the fans adds into the energy consumption in summer. Apart from ceiling fans, exhaust fans and wall fans are installed to maintain the required ambient temperature. The connected load of the fans is 27.95 and is tabulated as below:

Description	Number	Average Rated Power, W	Connected Load, kW
Ceiling Fans	360	70	25.2
Wall Fans, 50W	31	50	1.55
Exhaust	8	150	1.2
Total	**397**		**27.95**

Table 13: Connected load of fans

It is to be mentioned that the number of fans connected is far more than the actual number of fans running at anytime. So the running load of the fans is only 10-15% of the connected load of the fans.

8.5 Computers and multi-function devices

Introduction

These devices are installed in the staff room, computer labs and the office areas for the supporting and main stream activities. The connected load of these devices is around 28.9kW.

Description	Number	Connected load, kW
Computers	113	16.95
Printer	13	8.45
Projector	6	2.4
Scanner	2	0.4
Total	**67**	**28.2**

Table 14: Connected load of Computers and multi-function devices

8.6 Miscellaneous Load

These devices are installed in the staff room, labs and the office areas for the supporting and main stream activities. The connected load of miscellaneous load is 16.35kW.

Description	Number	Connected load, kW
Microwave	4	4.00
Oven	3	7.50
Water Cooler	7	3.25
CCTV Setup		0.30
Refrigerator	1	0.30
Induction	1	1.00
Total		**16.35**

Table 15: Details of miscellaneous load

This is also not continuous running load. The contribution of this load in annual energy is bill is very less.

9. Energy Conservation Measures and recommendations

9.1 Reduction in contract demand from 97.7kVA to 65kVA to reduce fixed charges in electricity bill

Observation

From the trend of maximum demand index in the energy bill, it is clear that the recorded maximum demand for the facility is only 48.9 %(47.8kVA) while the minimum chargeable demand is 85% of the contract demand kVA.

Recommendation

It is recommended to reduce the contract demand from 97.7kVA to 65kVA. The reduction in demand will lead to direct reduction in energy bill irrespective of the energy consumption. The recommended demand is almost 35% higher than the maximum demand.

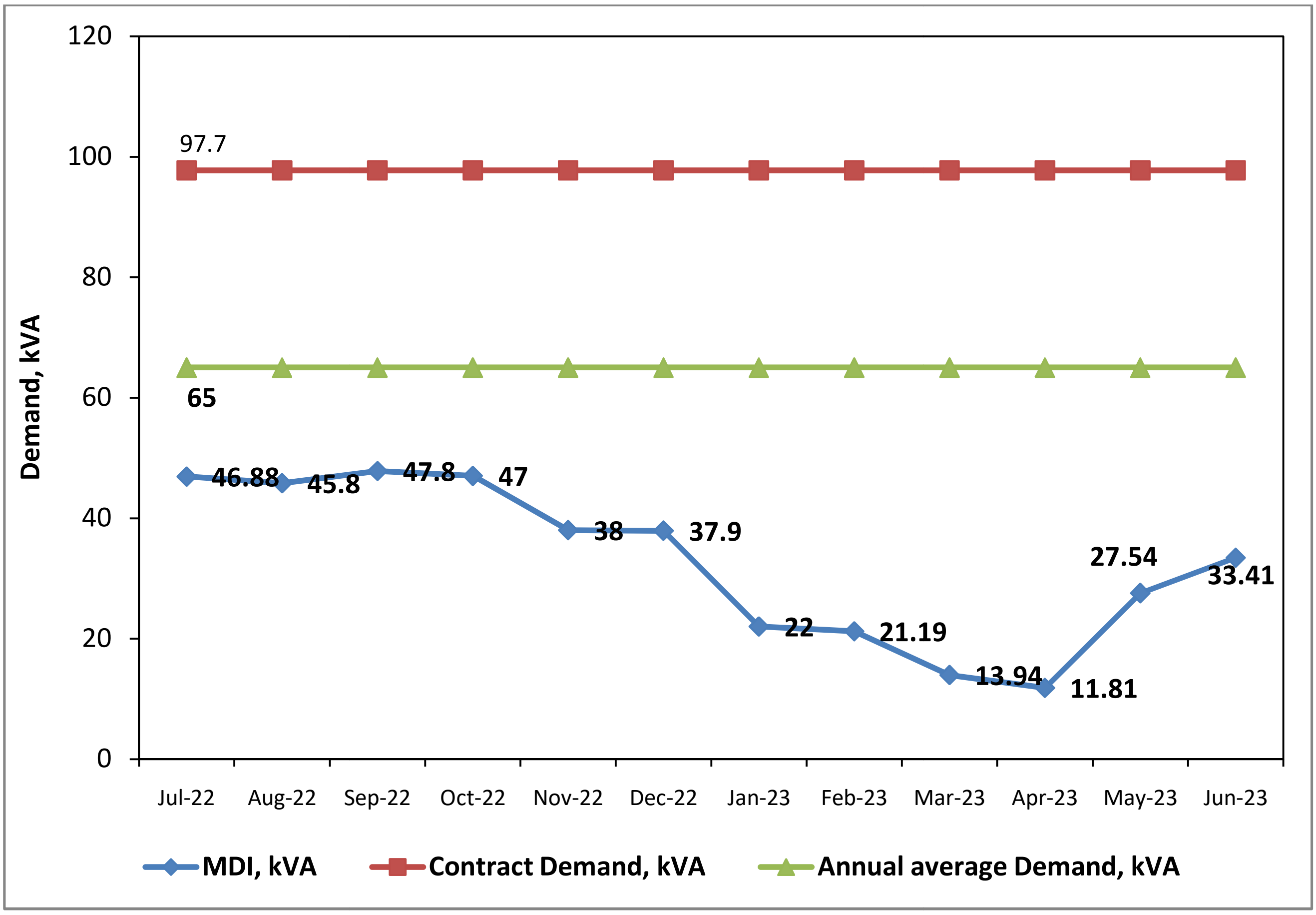

Figure 16: Current and recommended demand trend

The reduction in demand will lead to direct reduction in the energy bill. The calculated saving in energy bill is as below:

Description	UoM	Values
Present Contract Demand	kVA	97.7
Minimum Chargeable demand	kVA	78.2
Maximum Recorded demand	kVA	47.8
Annual average recorded demand	kVA	32.8
Recommended demand	kVA	65
Annual demand charges at present demand	Rs./annum	1,08,888
Annual demand charges at proposed demand	Rs./annum	81,120
Saving in fixed charges demand at recommended demand @INR 130/kVA	Rs	27,768
Investment	Rs	Nil
Payback period	Year	Immediate

9.2 *Improvement in annual average power factor from 0.956 to 0.99 by installing APFC at main incomer*

Observation

The annual average power factor as per electricity bill is 0.956. At present there is no provision for improvement in power factor for the facility at load end.

Recommendation

The recommended to install 15kVA APFC to maintain power factor for the facility close to unity. APFC is an automatic power factor control panel which is used to improve the power factor, whenever required, by switching ON and OFF the required capacitor bank units automatically. It becomes very much important to reduce on electrical consumption for reducing expenditure and economizing the utility expenses by harnessing electrical utility by operation at desired power factor to curtail unwanted electricity penalty rising because of power factor drop. It also helps us to keep reactive power consumption low from the system and thus keeping MDI low. The trend of running and recommended power factor is as below:

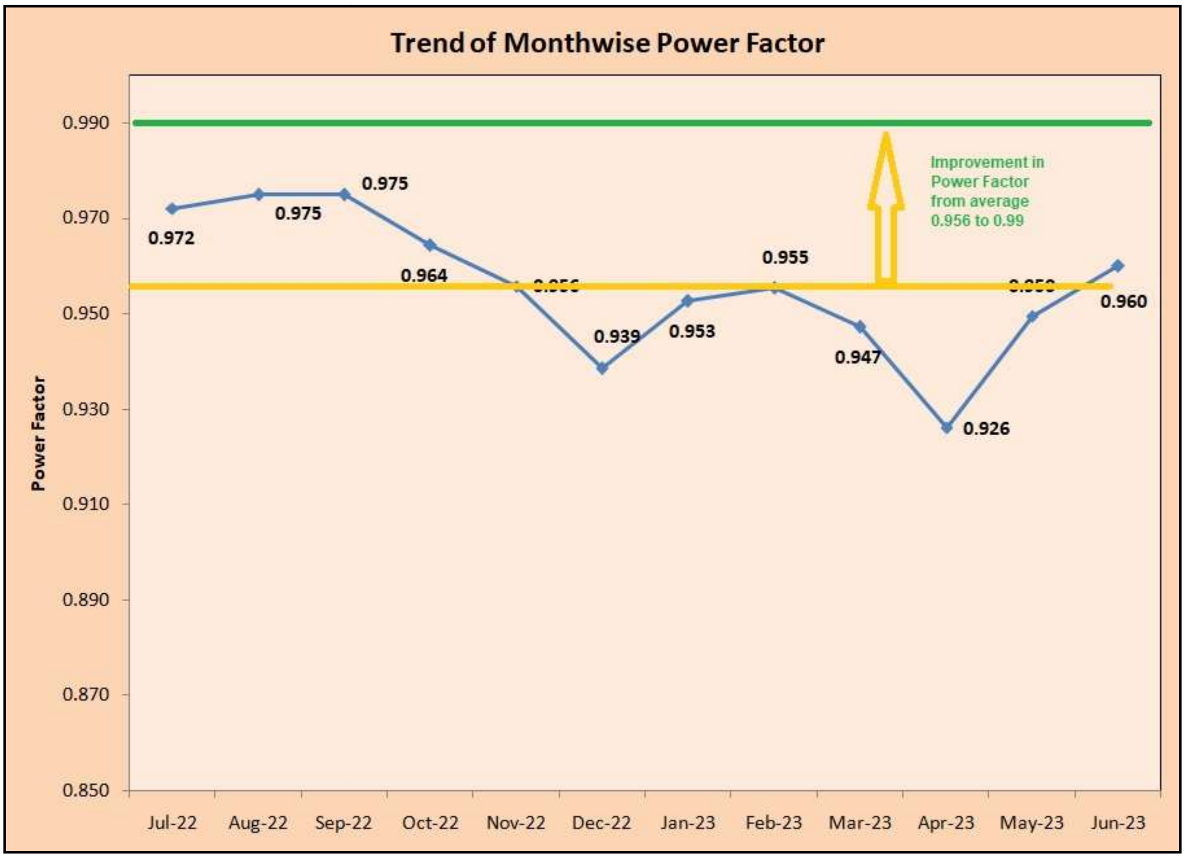

Figure 17: Trend for improvement in power factor

The details of saving calculations are as below:

Description	UoM	Values
Average monthly Power Factor at Main supply		0.956
Recommended Minimum Power Factor		0.990
Annual Energy consumption from Main supply	kVAh	59,387
Annual Energy consumption as per average power factor	kWh	56,950
Actual Energy consumption at improved power factor	kVAh	57,525
Energy saving as excess reactive power drawn	kVAh	1,862
Proposed capacity of capacitor bank	kVAr	15
Annual monetary saving @Rs7.62/kVAh	Rs	14,187
Investment, Rs	Rs	26,500
Payback period	Year	1.9

9.3 Installation of PIR (Passive Infrared) type occupancy sensor for individual rooms computer lab and common room area to reduce the energy consumption

Observation

It is observed that in many room the light, fans and AC units were running even when no occupant in the room which lead to energy consumption irrespective of useful output. In few areas, the lights are installed in such a way that the in spite of the installation, area was not getting lux level due to which effectiveness of the lights reduces.

Recommendation

It is recommended to install the occupancy sensor for individual rooms, computer lab and common room area to switch off running load when there is no occupant. Occupancy sensors are one kind of devices used for detecting occupancy in space automatically deactivates the light so that the energy can be conserved. This sensor may also activate the lights. This device can also activate the lights routinely by detecting the occurrence of people and provides security and convenience help. The strategies based on occupancy can generate 24% of normal savings of lighting energy. Based upon the running load, the calculated energy saving is as below:

Description	UoM	Value
Connected lighting load	kW	3.56
Load reduction after de-lamping and re-orientation	%	10
Connected load after de-lamping and re-orientation@7.5%	kW	3.20
Expected reduction in energy consumption after installation of Photo sensors	%	7.5%
Operating Hours	Hrs.	8
Operating Days	Days	250
Annual Energy Consumption at present scenario	kVAh	6,408
Annual Energy Consumption after installation of photo sensors and de-lamping	kVAh	5,631
Annual Energy Saving	kVAh	777
Annual monetary saving @Rs7.62/kVAh	Rs.	5,921
Investment for installation of photo sensors, de-lamping and re-orientation	Rs.	12,460
Payback Period, months	Years	2.1

9.4 Replacement of 35 number FTL- 12 (Fluorescent tube lights) with new energy efficient 20 LED lights to reduce energy consumption

Observation

The connected load of the FTL- 12 fluorescent tube lights is around 1.89kW. These lights require the installation of ballast to stabilize the internal current that produces light. The ballast also leads to the additional power consumption in the energy consumption of the fitting.

Recommendation

FTL- 12 can be replaced with LED tube in the exiting fixture. It will give better lux level reduces energy consumption by more than 50%. The calculated saving after replacement is as below:

Description	UoM	Values
Number of fitting		35
Rated power of FTL- 12 fittings with Ballast	W	54
Average Operating Hours	hours	5
Number of operating days	days/annum	250
Proposed Wattage of LED	W	20
Annual Energy Consumption at present scenario	kVAh	2,363
Annual Energy Consumption after implementation	kVAh	875
Annual Energy Saving	kVAh	1,488
Estimated monetary saving @INR7.62/kVAh	Rs.	11,335
Investment, Rs.450/Watt	Rs.	15,750
Payback Period, months	Years	1.4

9.5 Replacement of 65 number of T- 8 and T- 5 (Fluorescent tube lights) with new energy efficient 20W LED lights to reduce energy consumption

Observation

The connected load of the T- 8 and T- 5 tube lights is around 4.75kW. These lights require the use of a ballast to stabilize the internal current that produces light. The ballast also leads to the additional power consumption in the energy consumption of the fitting.

Recommendation

Both T- 8 and T- 5 tube lights can be replaced with 20W LED tube light. It will give better lux level reduces energy consumption by more than 50%. In this all the T- 8 lights (18number) and 47number of T- 5 lights are considered for replacement. The calculated saving after replacement is as below:

Description	UoM	Values
Number of fitting		65
Connected Load consider for replacement	kWh	3.1
Average Operating Hours	hours	6
Number of operating days	days/annum	250
Proposed Wattage of LED	W	20
Annual Energy Consumption at present scenario	kVAh	4,631
Annual Energy Consumption after implementation	kVAh	2,950
Annual Energy Saving	kVAh	1,681
Estimated monetary saving @INR7.62/kVAh	Rs.	12,805
Investment, Rs.450/Watt	Rs.	29,250
Payback Period, months	Years	2.3

9.6 Replacement of 40 number of old ceiling fans with Energy efficient star rated BLDC ceiling fans

Observation

The connected load of the fans installed in the building considered for replacement based upon number of running hours is 4.0kW. These fans are old/conventional and having low energy efficiency. The conventional ceiling fans built with an AC Induction Motor (ACIM). Typically, old fans may consume up to 100W.

Recommendation

Super Energy Efficient ceiling fans use enhanced semiconductor technology consume 35W or lesser power with no compromise in air delivery. These fans have a BLDC motor (Brushless DC Motor) with micro-controllers and save over 50% of the power consumed by regular fans. Energy-efficient fans or power-saving ceiling fans are another product in this category which uses a minimum level of electronic technology to reduce power consumption. They are BEE (Bureau of Energy Efficiency) 5 star rated fans and consume only 35W. They have an electronic step or an electronic fine-tuning regulator. The saving calculations are as follows:

Description	UoM	Value
Average running load of existing Fans	W	100
No. of fans	Qty	40
Total Load	kW	4.0
Average running load of Proposed Fans	W	35
Total Load after replacement	kW	1.4
Operating Hours	Hrs.	8
Operating Days	Days	220
Annual Energy Consumption	kVAh	7040
Annual Energy Consumption after implementation	kVAh	2464
Energy Saving	kVAh	4,576
Estimated monetary saving @INR 7.62/kVAh	INR	34,869
Investment @Rs 2400/fan	INR	96,000
Simple Payback period	Years	2.75

9.7 Installation of Upgraded Energy monitoring and management system in Energy distribution network to maximize the optimum energy utilization

The Measurement and Verification (M&V) Plan is a document that defines project-specific M&V methods and techniques that will be used to determine and verify the Nominated Energy Efficiency Value (i.e., the demand reduction) resulting from an Energy Efficiency Resource. In addition to providing accurate and conservative methods to calculate the Nominated EE Value, a good M&V Plan is clear, consistent, and repeatable. All the assumptions, procedures, and data for the M&V Plan should be recorded properly so that they may be easily referenced and verified by others. The data included should be sufficient for a third party to audit the M&V procedures and verify the Nominated EE Value of an EE Resource. M&V activities include, but are not limited to, site surveys, demand and energy measurements, metering of key variables, data analyses, calculations, and quality assurance procedures. All of these key components need to be adequately detailed in the M&V Plan.

Observation

After discussion with the officials on observation during the site visit, following observations are concluded on energy consumption for batch size:

1. During energy audit period after discussion with the different officials, it came to notice that the monitoring of energy consumption is done on monthly basis only.
2. There is no record of energy consumption section/electrical panel was as no energy meters are installed. Section wise there are many factors which will lead to variation in energy consumption. Clearly
3. College has installed PSPCL energy meters at main incomer only.
4. There is no provision for reordering energy consumption on daily basis. The track of load variation is not possible without these energy meters.

Recommendation

Considering all above facts we recommend the installation of Energy Monitoring System. Energy Monitoring System come with different software and parameters (regular and tailor made both) to best capture the process behaviour. It has all the standard reports that one would expect from an EMS with following parameters:

- Real-time views & trends
- Historical views & trends
- Energy Reports
- Alarm Reports

The detail presentations of the parameters at standard screens and features make system understanding very easy. Once data is recorded, next time directly parameter will be captured for same quantity and material. This will lead to minimum variation of energy consumption with better control of parameter without human intervention. The one snapshot of report prepared is as below:

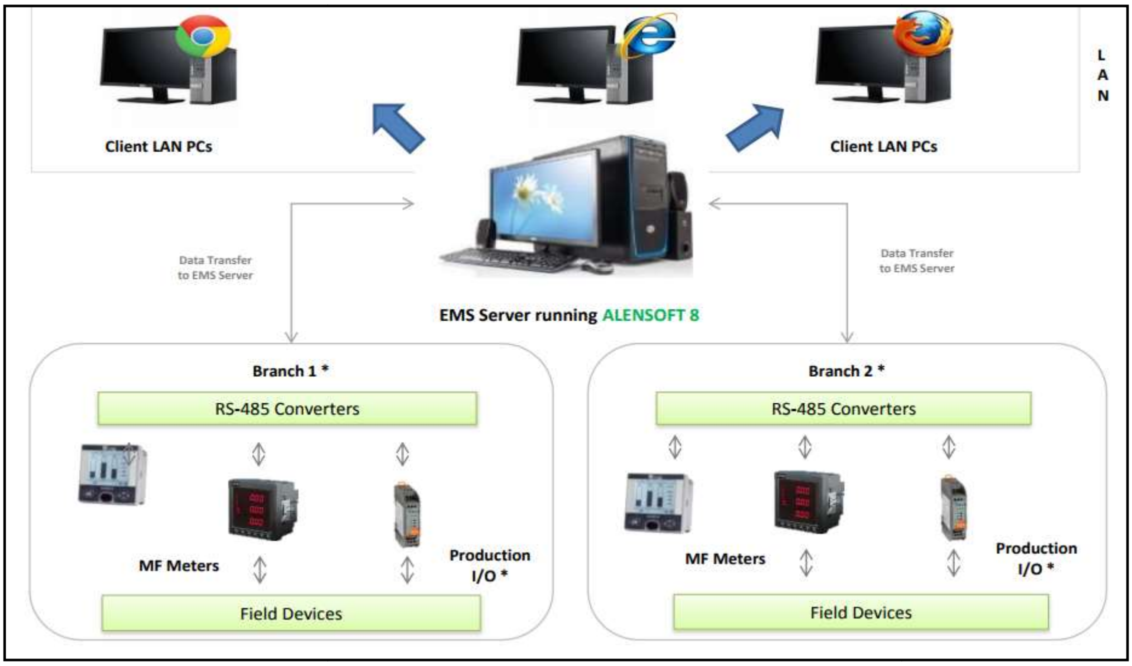

Figure 18: EnMS Report Snapshot

The calculated saving from installation of energy monitoring system is as below:

Description	UoM	Value
Annual energy consumption in the building	kVAh	59,387
Expected reduction in energy consumption after implementation of Energy Monitoring system	%	12%
Annual Energy Consumption after implementation of measure	kVAh	52,261
Annual Energy Saving	kVAh	7,126
Estimated monetary saving @INR7.62/kWh	Rs.	54,303
Investment for Implementation of Energy monitoring and Controlling system	Rs.	1,56,000
Payback Period	Years	2.87

9.8 Installation of 45.0kWp capacity Grid connected Solar PV System for lighting load and other load

Observation

The contract demand for the college campus as per electricity bill is 97.7kVA. This region of Punjab has immense potential for quality solar irradiation, harnessing of this resource can be best suited to meet the energy requirements. Punjab is endowed with vast potential of solar energy with over 300 days of sunshine in a year. The data source derived from website of Punjab Energy Development Agency and from a PVGIS satellite station indicates that insolation level varying between 4- 7 kWh/m^2. There is enough space on roof top in facility where SPV can be installed. The SDA in this region has notification for promoting Renewable energy sources.

Recommendation

It is recommended to put Grid connected Solar PV System. The recommended rated power for the SPV system is 45.0kWp. In Grid connected Solar Rooftop PV system the DC power generated from SPV panel is converted to AC power using power conditioning unit. Generated Power by this system during the day time is utilized fully for powering captive loads and excess power is fed to the Grid. Grid connected Solar Rooftop system is operational so long as grid is available. In case, where solar power is not sufficient due to cloud cover etc., the captive loads are served by drawing power from the grid. The Advantages of Grid-Connected Rooftop Solar System is as below:

1. Electricity generation at the consumption point therefore Savings in transmission and distribution losses.
2. Low gestation time.
3. No requirement of additional land.
4. Improvement of tail-end grid voltages and reduction in system congestion with higher self-consumption of solar electricity.
5. Local employment generation.

The facility can also plan for system with battery back-up to shift lighting load from main power supply to solar power during day time. It will be a Hybrid system in which the battery bank could be charged both from Main, DG Set and SPV. The diagram for Hybrid System is as below:

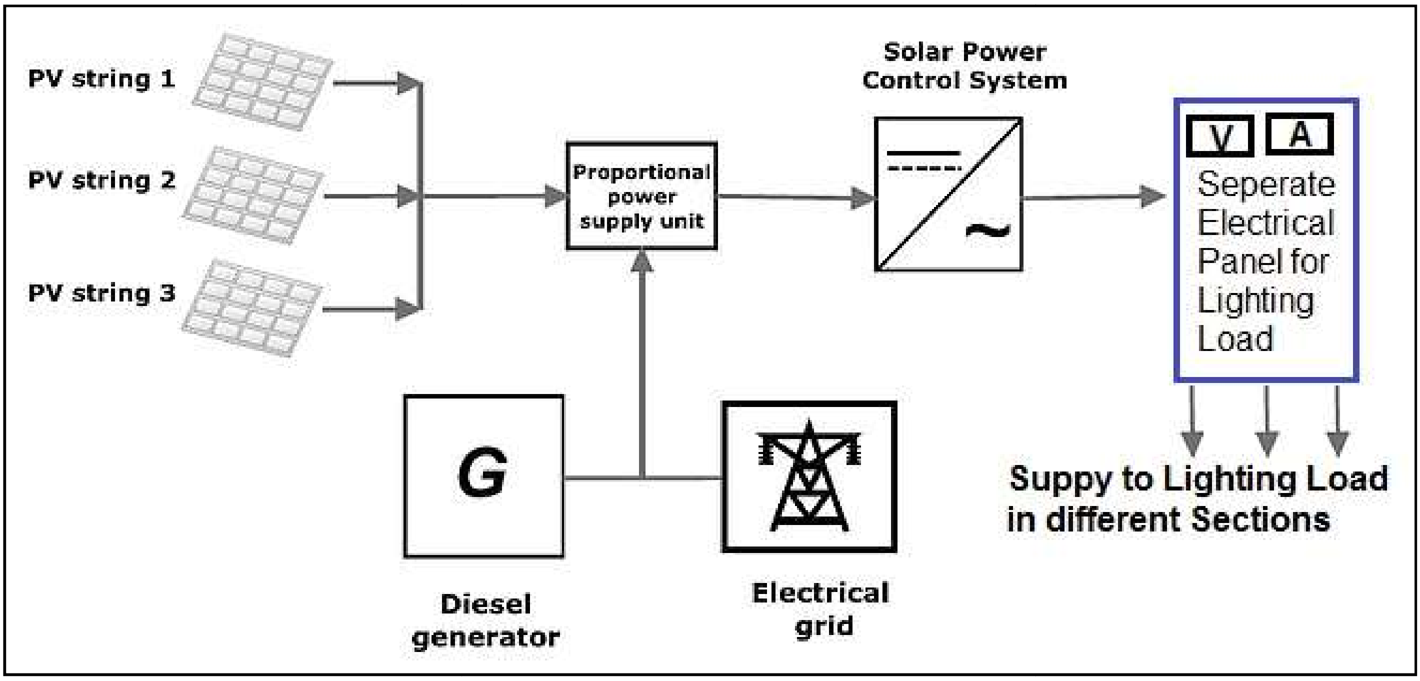

Figure 19: Grid Connected Hybrid SPV System

The saving calculation is done based upon grid connected system and cost is taken as per MNRE website. The detailed calculations are as below:

Description	Units	Value
Sanctioned load of Unit	kVA	97.7
Recommended capacity of SPV considering load reduction	kWp	45
Expected annual generation from SPV	kVAh	44,500
Annual energy consumption at present scenario	kVAh	59,387
Annual energy consumption after installation of SPV based upon energy bill	kVAh	14,887
Annual energy saving based upon the present energy consumption scenario	kVAh	44,500
Estimated monetary saving @INR7.62/kWh	Rs.	3,39,090
Investment @Rs. 38,500/kWp	Rs.	17,32,500
Payback period	months	5.1

Annexure I. Copy of Electricity Bill

PUNJAB STATE POWER CORPORATION LIMITED (Regd. Office P.S.E.B. Head Office, The Mall Patiala-147001,Ph. 1912), **CIN: U40109PB2010SGC033813** E-mail: 1912@pspcl.in, Website: www.pspcl.in, **GSTIN NO: 03AAFCP5120Q1ZC**	Billing Category: **GC/SAP-NONSBM-/DS RATE CATEGORY FOR DS>50 KW FOR DPC**

Sub Division	Division	Circle	Bill Cycle	Bill Date	Bill No.
NANGAL SUB-DIVISION	ANANDPUR SAHIB DIVIS	ROPAR	04-2023	14-JUL-2023	51412795983

A/C No.: 3000152821
Consumer Name: MR. PRINCIPAL SHIVALI
Address: COLLEGE MOZOWAL MOJOWAL NANGAL-140126-INDIA
GST No.:
Connection Date: 09-09-1983
Mobile No.: 98XXXXX931

Load	Contract Demand	Tariff Type	Bill Status	Due Date Cash/Online	Due Date DD/Cheque	Bill Amount
87.95		DS RATE CATEGORY FOR DS>50 KW FOR DPC	O	24-Jul-2023	24-Jul-2023	Rs.75670/-

Voltage Supply	Meter Number	Make	Capacity	Digit	Meter Status	CT Make	CT No.
0.415	918056	L&T	10-40	6	O	123	

Feeder Code	Date of New Reading	Date of Old Reading	Bill Period	Meter Security	Securit Cons	Security cons/Meter Security Interest
FDC0000000212	10-JUL-2023	10-JUN-2023	30	0	55850	

Meter Reading

Type	Old Reading	New Reading	Current Units	Meter Multiplier	Line CT Ratio	Meter CT Ratio	Overall Multiplier	MMTS Correction	Old Meter Cons	Unit Consumed
KWH	851663.00	859220.00		1.00	200/5	200/5	1.00			7557
KVAH	950212.00	958060.00		1.00	200/5	200/5	1.00			7848
MDI	33.41	50.00		1.00	200/5	200/5	1.00			50.00

(A) Fixed Charges

Contract Load / Contract Demand (L) KWH/KVA	Actual Load/Demand KWH/KVA (A)	80% of (L) KWH/KVA (B)	A or B whichever greater KWH/KVA (C)	Rate per KWH/KVA per month (R)	Billing Days (D)	A: Fixed Charges Amount =CxRxDx12/365
	50.00	78.18	78.18	130.00	30	10024.00

(B) Energy Charges			(C) Fuel Cost Adjustment Charges			*Additional Surcharge			
KVAH	Tariff Rate	B: Amount	KVAH Consumption	Rate of FCS/KVAH	C: Amount	Units	Tariff Rate	Amount	Total Energy Charges(Rs.) + FCA + Addl. Surcharge
7848	6.75	52974			0.00			0.00	52974

(D) Rental Charges				GST				
Meter Rent for PSPCL Meter	MCB, CT/PT Unit Rental	Rent for any other equipment	Total Rent	HSN Code	SGST	CGST	Total GST	D: Total Rent with Tax
83	64		147		13.23	13.23	26.46	173.46

(E) Surcharges

Voltage Surcharge				Demand Surcharge			ToD Surcharge			
Supply Voltage	Catered Voltage	Surcharge Rate	Voltage Surcharge Amount	Demand in excess	Rate of Demand Surcharge	Amount of Demand Surcharge	Peak Hours KVAH	Rate	Amount	E: Total Surcharge (Rs.)
0.415	0.415			0.00	0.00	0.00	0.00		0.00	0.00

(F) Rebates

Voltage Rebates			ToD Rebates			
Units	HT/EHT Rebate	Amount	Non-Peak Hours KVAH	Rate	Amount	F: Total Rebates (Rs.)
7848	0.00	0.00	0.00		0.00	0.00

(G) Previous Adjustment Amount Notice No.: and Date:

Units	Fixed Charges	Energy Charges	FCA	Rentals	Surcharges(+)	Rebates(-)	Taxes	Subsidy	Total	G: Net Previous Adjustment (Rs.)
		/		/			/0		0/-100	0/-100

(H) Sundry Charges/Allowances Notice No.: - and Date: -

Late Payment Interest	Units	Fixed Charges	Energy Charges	FCA	Rentals	Surcharges(+)	Rebates(-)	Taxes	Subsidy	Total	H: Net Sundry Charges/Allowances (Rs.)
	/	/	/ 0	/ 0	/ 0	/	/ 0	/ 0	/	/ 0	/ 0

(I) Subsidy

Subsidised KVAH	Rate for Subsidy	Amount	I: Net Subsidy (Rs.)
7848	0.00	0.00	0.00

(J) Taxation								
Electricity Duty	Municipal Tax	IDF	Cow Cess	Total Tax (J)	Net Energy Charges	TCS/TDS	Curr/Prev Rounding Amount	NET BILL AMOUNT Rs.75670/-
9450.00	0.00	3150.00	0.00	12600		0.00		*Seventy Five Thousand Six Hundred Seventy Rupees Only*

Annexure II. ISO Certificate

CERTIFICATE

This is to Certify that the Management System of

INDONA INNOVATIVE SOLUTIONS

8/W-11, RAILWAY ROAD, OPPOSITE ONKAR FEED STORE,
DINANAGAR, GURDASPUR-143531, PUNJAB, INDIA

has been found to conform to the Quality Management System standard:

ISO 9001:2015

This certificate is valid for the following scope of operations:

PROVIDING ENERGY AUDIT, SAFETY AUDIT, INFRARED THERMOGRAPHY, POWER QUALITY AND HARMONICS STUDY, AIR AND WATER AUDIT, DESIGNING, PROJECT EXECUTION, TRAINING AND SKILL DEVELOPMENT.

IAF Code: 34, 37

NACE Code: 74.90, 85.59

:: Certificate No :: IN121298A

Date of initial registration	*Date of this Certificate*	*Surv. audit on or before / Certificate expiry*	*Recertification Due*
08 December 2022	*08 December 2022*	*07 December 2023*	*07 December 2025*

This Certificate remains valid subject to satisfactory surveillance audits.

Director

QMS

For verification and updated information concerning the present certificate visit to www.lmsassessments.com

This Certificate is the property of LMS Certifications Private Limited and shall be returned immediately when demanded.

IAF

eiaci

CB-QMS-006

LMS Certifications Private Limited
1, Ananddham, Rainbow City, Fareedi Nagar,
Lucknow - 226015, U.P. (INDIA).
Phone : +91-9554645464
Visit :- www.lmsassessments.com
E-mail :- info@lmsassessments.com

LMS/FM/001/QMS/REV06

Annexure III. BEE Certificate

ऊर्जा दक्षता ब्यूरो
(भारत सरकार, विद्युत मंत्रालय)
BUREAU OF ENERGY EFFICIENCY
(Government of India, Ministry of Power)

YEARS OF CELEBRATING THE MAHATMA

17/05/ESCO/22-23/ 4341 – 420 15th September,2022

Shri Hardeep Kaur
Partner
Indona Innovative Solutions
8/W-11, Railway Road,
Opposite Onkar Feed Store Dinanagar,
District Gurdaspur, Punjab- 143531

Sub: Empanelment of Energy Service Company (ESCO)

Dear Sir,

This has reference to your application for empanelment/ re-empanelment as an Energy Service Company with BEE in response to our advertisement for re-empanelment and fresh empanelment of ESCOs in the month of May, 2022.

Consequent to scrutiny and evaluation of your documents by SEBI accredited Grading Agencies CRISIL /CARE Advisory/ICRA Analytics/SMERA/ IRR Advisory in terms of the approved parameters for evaluation, BEE is pleased to inform that your company **Indona Innovative Solutions** has qualified for empanelment with BEE as a **Grade 3** Energy Service Company (ESCO). This empanelment would be effective from 16th August, 2022 and will be valid till 15th August, 2024.

Further, the list of all the empanelled ESCOs along with grade assigned is uploaded on its website (www.beeindia.gov.in) for use by State/Central government/Public Sector agencies as well as by any other agency interested in implementing energy efficiency projects on ESCO mode. Please acknowledge your acceptance to this letter.

Yours faithfully,

(Arijit Sengupta)
Director

स्वहित एवं राष्ट्रहित में ऊर्जा बचाएँ Save Energy for Benefit of Self and Nation

चौथा तल, सेवा भवन, आर० के० पुरम, नई दिल्ली–110 066, वेबसाईट/Website : www.beeindia.gov.in
4th Floor, Sewa Bhawan, R.K. Puram, New Delhi-110 066 टेली/Tel.: 91 (11) 26766700, फैक्स/Fax: 91 (11) 26178352

Annexure IV. Onsite Measurements




Annexure V. Vendor List

For APFC

- Indona Innovative Solutions
- VSM Solutions
- Ensure Tech Solutions

For Interlocking and Automation

- Indona Innovative Solutions
- AKS Techno
- Delta Cooling Tower Pvt. Limited
- ENCON India Pvt. Limited

For Occupancy and Photo Sensor

- KAYER Engineers
- VSM Solutions
- Ensure Tech Solutions
- A R C Ventures

For Star Rated Appliances

- RL Consumer Products
- Philips India Limited
- Avni Energy Solutions Pvt Ltd

---End of Report---