# ENERGY AUDIT REPORT

## GOKHALE INSTITUTE OF POLITICS AND ECONOMICS
## PUNE

**AUGUST 18**

IGNISENSE ECOENERGY LLP

GOKHALE INSTITUTE OF POLITICS AND ECONOMICS DEEMED TO BE UNIVERSITY PUNE-4.

Acknowledgement

We would like to express **our** sincere thanks to **Pune International Centre, Prof. Amitava Mallik (Padma Shree), for the opportunity to perform Energy Audit of Gokhale Institute of Politics and Economics, (GIPE), Pune.**

**We also acknowledge with thanks the co-operation and the support extended by the GIPE team during the conduct of this audit.**

**We sincerely acknowledge the contribution of the following dignitaries, Admin and maintenance personnel because of whom the study could progress smoothly.**

**Col. Kapil Jodh**
**Mr. Deepak Ganbavale**
**Mr. Mahesh Deodhar**
**Mr. Santosh Jadhav**

**We are also thankful to the staff of GIPE, PIC and Ignisense team without whom the audit was not possible.**

## Audit Team Member

**The team deputed for the GIPE is well experienced and qualified personnel as follows.**

| Sr. No. | Name | Qualification, experience and Expertise |
|---|---|---|
| 1 | Mr. Aroha Kulkarni | Certified Energy Auditor – EA 13147, 16+ years of experience, Solar PV audit, Regulatory and policy, merger and acquisition of RE project & Energy Audit |
| 2 | Dr. Asmita Marathe | Certified Energy Auditor – EA 4621, 16+years of experience in Solar, Boilers, heat exchangers, power plant and manufacturing plant, Energy Audit, Training |
| 3 | Mr. Prasad Badakh | Electrical Expert, 14+ years of experience in Solar PV plant O&M, Solar PV plant audit and performance assessment. |
| 4 | Mrs. Shruti Kulkarni | MBA (Business Analytics), BE (E & TC) |
| 5 | Ms. Poonam Chaudhari | BE (Electrical Engineering) |

**The team deputed by PIC is as follows,**

| Sr. No. | Name | Organization |
|---|---|---|
| 1 | Mr. Mahesh Deodhar | PIC |
| 2 | Mr. Siddhartha Bhagwat | PIC |
| 3 | Ms. Shalwi Pawar | PIC |
| 4 | Mr. Vedant Page | GIPE |
| 5 | Ms. Mihika Asawa | GIPE |

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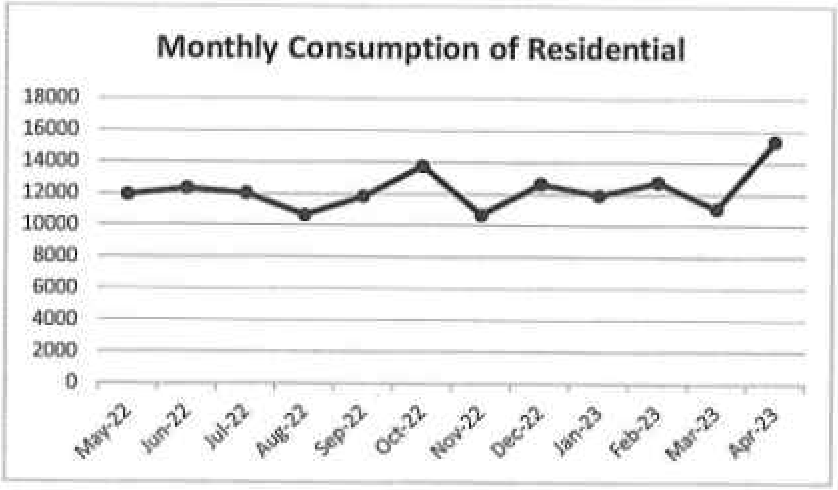
## Executive Summary & Critical Comments

**Executive Summary:**

| Location | | Units |
|---|---|---|
| **Main Campus** | Total Energy Consumption from MSEDCL | **48454 kWh** |
| | Annual Solar Energy Generation | **95487 kWh** |
| **Residential Campus** | **Total Energy Consumption from MSEDCL** | **147002 kWh** |

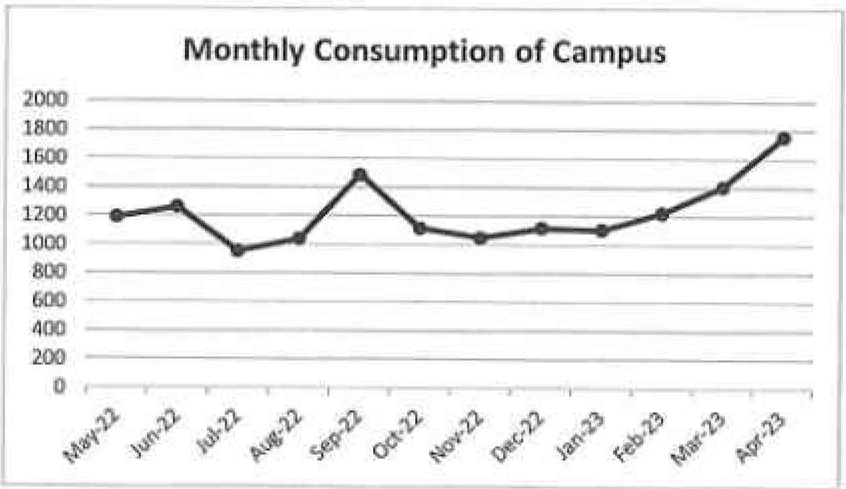
**Monthly Consumption pattern**

| Month | Consumption |
|---|---|
| Apr-23 | 15362 |
| Mar-23 | 11094 |
| Feb-23 | 12749 |
| Jan-23 | 11935 |
| Dec-22 | 12638 |
| Nov-22 | 10689 |
| Oct-22 | 13742 |
| Sep-22 | 11831 |
| Aug-22 | 10659 |
| Jul-22 | 12029 |
| Jun-22 | 12335 |
| May-22 | 11939 |




Above table and graph shows the monthly unit consumption for Residential Area of 'Gokhale Institute, Pune' from May-2022 to April-2023 having average monthly consumption of 12,250 units.

| Month | Consumption |
|---|---|
| Apr-23 | 1756 |
| Mar-23 | 1409 |
| Feb-23 | 1225 |
| Jan-23 | 1107 |
| Dec-22 | 1120 |
| Nov-22 | 1050 |
| Oct-22 | 1117 |
| Sep-22 | 1488 |
| Aug-22 | 1041 |
| Jul-22 | 955 |
| Jun-22 | 1262 |
| May-22 | 1190 |

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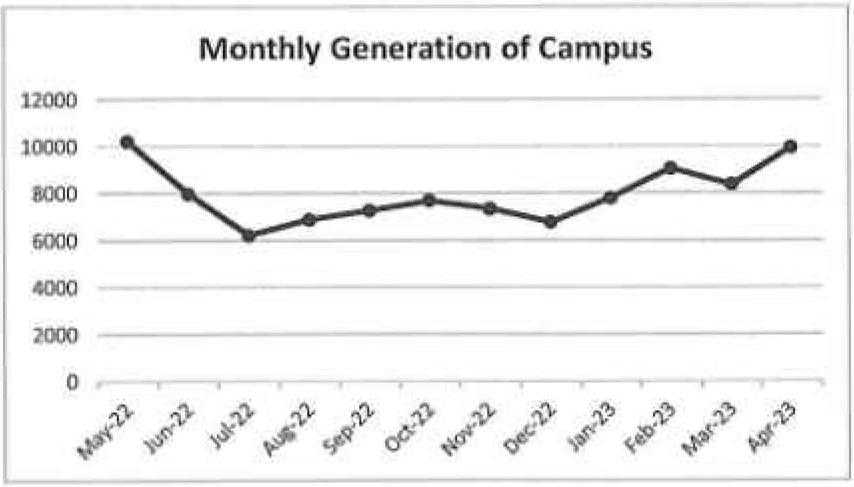
Above table and graph shows the monthly unit consumption for Campus Area of Gokhale Institute, Pune from May-2022 to April-2023 having average monthly consumption of 1,225 units.

**Monthly generation pattern**

| Month | Consumption |
|---|---|
| Apr-23 | 9941 |
| Mar-23 | 8372 |
| Feb-23 | 9050 |
| Jan-23 | 7800 |
| Dec-22 | 6759 |
| Nov-22 | 7336 |
| Oct-22 | 7683 |
| Sep-22 | 7264 |
| Aug-22 | 6883 |
| Jul-22 | 6211 |
| Jun-22 | 7973 |
| May-22 | 10215 |




Above table with graph shows that, monthly solar generation for Residential Area of 'Gokhale Institute, Pune' from May-2022 to April-2023 duration.

**Critical Comments**:

1. The solar PV plant is under performing.
2. Installed capacity of the solar power plant is higher than the total consumption of Campus leading to banking of solar generation with MSEDCL. The lapsation of units at the end of financial year is causing financial loss as the reimbursement received from MSEDCL for lapse units is at much lower tariff than Solar PPA rate.
3. There are hot spots and the burning of panel back sheet observed.
4. Inverter DCDB bypassed and one inverter display cover broken hampering its IP rating
5. Lift at the new building is recently installed, hence the load is not counted.
6. Pump data is unavailable and pumps are running on SIS meter.
7. All the utilities and electrical appliances are counted either visiting the premises and or interviewing the occupants.
8. Harmonics and Power factor fluctuation are seen in the power analyzer readings.
9. DG set is sparingly used, however the data for the usage is not traceable.
10. Potential electrical safety and fire hazards have been highlighted.
11. Good potential to effectively use day lightning so as to reduced lighting load.
12. Water consumption data available only for residential campus.
13. B Phase wire does not have proper insulation in boys hostel it may lead to fire hazards.

## INTRODUCTION OF GIPE

Sector: Educational Institute.
Name: Gokhale Institute of Politics and Economics.
Year of Establishment:
Address:
Contact details:

Gokhale Institute of Politics and Economics (GIPE), commonly known as Gokhale Institute, is one of the oldest research and training institutes for economics in India. The institute was founded on 6 June 1930 by R. R. Kale as a centre for research and higher learning in economics. The institute was set up with an objective of conducting research on the economic and political problems of India and to train researchers in these disciplines.

### Purpose of the Energy Audit

The primary objective of energy audit is to determine the ways to reduce the energy consumption so as to lower the operating cost and understanding the energy consumption trends as a prerequisite microgrid. We are sure energy audit will provide a "bench mark" for managing energy in the organization and also may provide the basis for effectively planning energy utilization throughout the organization. The Energy Audit has been carried out from 06 June 2023 to 30 June 2023.

## APPROACH SCOPE AND METHODOLOGY

### SCOPE OF WORK –

**1.1** Collect historical energy data and analysis the same to identify Key Result Area (KRA).
**1.2** Interact with relevant officials to understand present approach and practice followed to monitor energy use.
**1.3** Collect relevant equipment energy data to understand equipment selection level energy performance.
**1.4** Schedule and conduct physical measurement wherever necessary to confirm actual energy use.
**1.5** Measure and then evaluate energy performance and compare with manufacturer's data. This helps to establish actual plant demand vis-a-vis it's capacity. This includes measured kW, kVa, P.F. of operating motor, Air flow and its air handling capacity, etc.
**1.6** Analysis will evolve measures to reduce operating energy cost.
**1.7** Estimate broad base realistic cost benefit analysis for recommendations.
**1.8** Identify sources with possible vendor details to simplify implementation.
**1.9** Suggest energy consumption reporting system to create energy consumption records and ensure implementation, so as to provide sustained results. This will help management to establish control over energy cost.
**1.10** Electrical Distribution System & Transformer
**1.11** Illumination System
**1.12** DG Set, Water Pump
**1.13** Solar Photovoltaic system – performance assessment – Thermography, IV curve analysis on sample basis and actual vs. design performance checking.
**1.14** Detailed Power Quality Analysis (As per scope mentioned in RFQ)

**APPROACH AND METHODOLOGY**

1 Ignisense has appointed Energy auditors, two Senior Energy Engineers and a Thermography expert having adequate experience of similar assignments.

2 Ignisense has initiated communication with the CLIENT and discussed preliminary Checklist for the detailed information required during the first visit.

3 Ignisense with the GIPE team and PIC members has collected the data in different areas/disciplines like Electrical, Illumination and Mechanical Utilities like Air Conditioning System, Illumination, and Pumping system.

4 Detailed checklist is prepared for each of the Energy / Utility Systems involved in the study.

5 'On-going' Energy Conservation Projects already initiated by the Client, has been reviewed and specifically documented.

6 Requisite copies of the final report are prepared and submitted to the CLIENT for record and subsequent implementation.

## SUMMARY OF GIPE

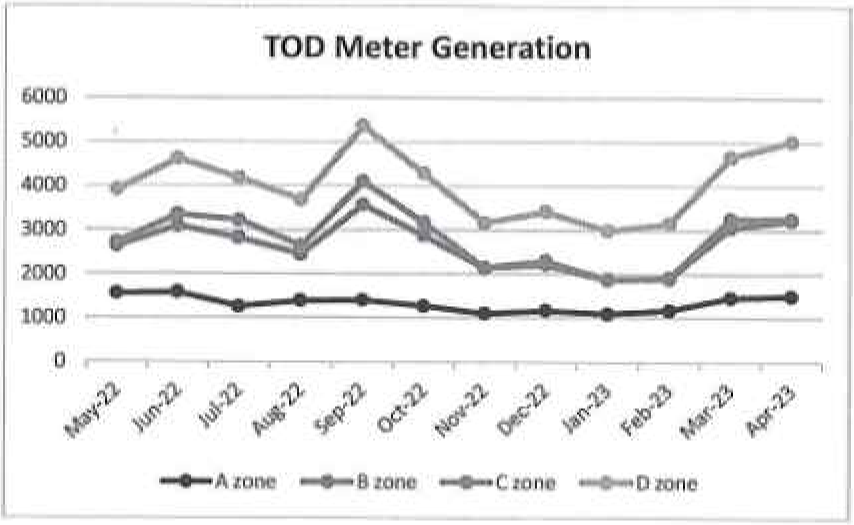
GIPE has two premises, educational institute and residential area. The meter details are as per the **Annexure A**

| Sr. No | Premises | Total consumption in last 12 months | | | | | |
|---|---|---|---|---|---|---|---|
| | | Electricity Units (kWh) | Amount in Rs. | Water Consumption | Amount in Rs. | Diesel Ltrs | Amount in Rs. |
| 1 | GIPE university premises | 48,454 | 5,19,487 | Data not available | | | |
| 2 | GIPE Residential Premises | 1,47,002 | 16,45,083 | Data not available | | | |
| 3 | SIS premises – GIPE payment | NA | | Data not available | | | |

**Energy Consumption of the institute**

TOD Zone wise energy consumption of institute for last 12 months is as follows

| | Units | | | |
|---|---|---|---|---|
| Month | A zone | B zone | C zone | D zone |
| Apr-23 | 1505 | 1727 | 31 | 1757 |
| Mar-23 | 1463 | 1594 | 201 | 1409 |
| Feb-23 | 1179 | 724 | 20 | 1225 |
| Jan-23 | 1101 | 776 | 7 | 1107 |
| Dec-22 | 1171 | 1050 | 79 | 1120 |
| Nov-22 | 1104 | 1045 | 2 | 1015 |
| Oct-22 | 1277 | 1595 | 300 | 1117 |
| Sep-22 | 1407 | 2168 | 524 | 1264 |
| Aug-22 | 1389 | 1058 | 195 | 1043 |
| Jul-22 | 1263 | 1555 | 404 | 960 |
| Jun-22 | 1579 | 1505 | 269 | 1262 |
| May-22 | 1553 | 1085 | 79 | 1191 |




Above table with graph shows that, zone wise consumption for Campus Area of Gokhale Institute, Pune from May-2022 to April-2023 duration.

**Single Line Diagram:**

**Electrical SLD**

GIPE University: Not Available.

GIPE residential: Not Available.

**Hot Water System**

GIPE University: Not Available.

GIPE residential: Two systems Available in dismantled condition.

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**Energy Conservation Projects**

| Energy Conservation Measure Number: 1 | | | | |
|---|---|---|---|---|
| 1 | Title of Recommendation | To replace old tube lights with the efficient luminaries under **public service tariff.** | | |
| 2 | Description of Existing System and its operation | Presently there are T12, T8 and T5 old tube lights. | | |
| 3 | Description of Proposed System | To install LED tube lights. | | |
| 4 | Existing System | Presently there are old tube lights which are power consuming. | | |
| 5 | Modified System | LED tube lights are energy efficient. | | |
| | | T5 | T8 | T12 |
| 6 | Energy Cost Savings (Rs/day): | Rs. 54.44 | Rs. 247.39 | Rs. 35.56 |
| | Savings in one year, (lakhs): | Rs.19870.16 | Rs. 90297.04 | Rs. 12979.70 |
| | Savings in Next 5 Years (Lakh.): | Rs. 99350.8 | Rs. 451485.2 | Rs. 64898.5 |
| 7 | Investment (Lakh.) (This cost is very approximate including pipeline modification) | Rs. 5850 | Rs. 47775 | Rs. 20150 |
| 8 | Simple Payback Period (Months) | 12.17 | 6.35 | 5.41 |
| 9 | Issues in implementation | | | |

| **Public Service (>50KWh)** | ED=16% | | | |
|---|---|---|---|---|
| **Tube Cost** | 325 | | | |
| **Present Case** | | | | |
| | | T8 | T12 | T5 |
| Tubelight | Nos | 147 | 18 | 62 |
| Wattage | Watt | 41 | 45 | 30 |
| Hours of operation/day | Hrs | 8 | 8 | 8 |
| Days of operation in a year | Nos | 260 | 260 | 260 |
| Total energy consumption in year | kWh | 12536.16 | 1684.8 | 3868.8 |
| Variable Tariff | Rs/kWh | 12.84 | 12.84 | 12.84 |
| Annual Running cost | Rs | 160964.2944 | 21632.83 | 49675.39 |

| Energy Efficient Scenario | | | | |
|---|---|---|---|---|
| Tubes which have to be replace | | T8 | T12 | T5 |
| LED Wattage | Watt | 18 | 18 | 18 |
| Hours of operation/day | Hrs | 8 | 8 | 8 |
| Days of operation in a year | Nos | 260 | 260 | 260 |
| Total energy consumption in year | kWh | 5503.68 | 673.92 | 2321.28 |
| Variable Tariff | Rs/kWh | 12.84 | 12.84 | 12.84 |
| Annual Running cost | Rs. | 70667.2512 | 8653.133 | 29805.24 |
| | | | | |
| Annual saving | Rs. | 90297.0432 | 12979.7 | 19870.16 |
| Capital investment | Rs. | 47775 | 5850 | 20150 |
| Payback Period | Years | 0.53 | 0.45 | 1.01 |
| Payback Period | Months | 6.35 | 5.41 | 12.17 |

| Energy Conservation Measure Number: 1 | | | | |
|---|---|---|---|---|
| 1 | Title of Recommendation | To replace old tube lights with the efficient luminaries under **commercial tariff.** | | |
| 2 | Description of Existing System and its operation | Presently there are T12, T8 and T5 old tube lights. | | |
| 3 | Description of Proposed System | To install LED tube lights | | |
| 4 | Existing System | Presently there are old tubes which are power consuming. | | |
| 5 | Modified System | LED tube lights are more efficient. | | |
| | | T5 | T8 | T12 |
| 6 | Energy Cost Savings (Rs/day): | Rs. 49.22 | Rs. 85.22 | Rs. 5.36 |
| | Savings in one year, (lakhs): | Rs.17966.71 | Rs.31103.65 | Rs.1956.05 |
| | Savings in Next 5 Years (Lakh.): | Rs. 89833.5 | Rs.155518.25 | Rs. 9780.25 |
| 7 | Investment (Lakh.) (This cost is very approximate including pipeline modification) | Rs. 20150 | Rs. 18200 | Rs. 975 |
| 8 | Simple Payback Period (Months) | 13.44 | 7.08 | 6.00 |
| 9 | Issues in implementation | | | |

| Commercial (0-20KWh) | ED=21% | | | |
|---|---|---|---|---|
| Tube Cost | 325 | | | |
| **Present Case** | | | | |
| | | T8 | T12 | T5 |
| Tubelight | Nos | 56 | 3 | 62 |
| Wattage | Watt | 41 | 45 | 30 |
| Hours of operation/day | Hrs | 8 | 8 | 8 |
| Days of operation in a year | Nos | 260 | 260 | 2360 |
| Total energy consumption in year | kWh | 4775.68 | 280.8 | 3868.8 |
| Variable Tariff | Rs/kWh | 11.61 | 11.61 | 11.61 |
| Annual Running cost | Rs | 55445.64 | 3260.088 | 44916.77 |

| Energy Efficient Scenario | | | | |
|---|---|---|---|---|
| Tubes which have to be replace | | **T8** | **T12** | **T5** |
| LED Wattage | Watt | 18 | 18 | 18 |
| Hours of operation/day | Hrs | 8 | 8 | 8 |
| Days of operation in a year | Nos | 260 | 260 | 260 |
| Total energy consumption in year | kWh | 2096.64 | 112.32 | 2321.28 |
| Variable Tariff | Rs/kWh | 11.61 | 11.61 | 11.61 |
| Annual Running cost | Rs. | 24341.99 | 1304.035 | 26950.06 |
| | | | | |
| Annual saving | Rs. | 31103.65 | 1956.053 | 17966.71 |
| Capital investment | Rs. | 18200 | 975 | 20150 |
| Payback Period | Years | **0.59** | **0.50** | **1.12** |
| Payback Period | Months | **7.08** | **6.00** | **13.44** |

| **Energy Conservation Measure Number: 1** | | | | |
|---|---|---|---|---|
| 1 | Title of Recommendation | To replace old tube lights with the efficient luminaries under **Residential tariff.** | | |
| 2 | Description of Existing System and its operation | Presently there are T5, T8 and T12 old tube lights. | | |
| 3 | Description of Proposed System | To install LED tube lights | | |
| 4 | Existing System | Presently there are old tubes which are power consuming. | | |
| 5 | Modified System | LED tubes are more energy efficient. | | |
| 6 | | T5 | T8 | T12 |
| | Energy Cost Savings (Rs/day): | Rs.13.93 | Rs.85.09 | Rs.21.55 |
| | Savings in one year, (lakhs): | Rs.5083.85 | Rs.31059.16 | Rs.7864.08 |
| | Savings in Next 5 Years (Lakh.): | Rs.25419.25 | Rs.155295.8 | Rs.39320.4 |
| 7 | Investment (Lakh.) (This cost is very approximate including pipeline modification) | Rs.5200 | Rs.16575 | Rs.3575 |
| 8 | Simple Payback Period (Months) | 12.24 | 6.36 | 5.40 |
| 9 | Issues in implementation | | | |

| | | | | |
|---|---|---|---|---|
| **Residential (100-300)** | ED=16% | | | |
| **Tube Cost** | 325 | | | |
| **Present Case** | | | | |
| | | T8 | T12 | T5 |
| Tubelight | Nos | 51 | 11 | 16 |
| Wattage | Watt | 41 | 45 | 30 |
| Hours of operation/day | Hrs | 8 | 8 | 8 |
| Days of operation in a year | Nos | 260 | 260 | 260 |
| Total energy consumption in year | kWh | 4349.28 | 1029.6 | 998.4 |
| Variable Tariff | Rs/kWh | 12.73 | 12.73 | 12.73 |
| Annual Running cost | Rs | 55366.33 | 13106.81 | 12709.63 |

| **Energy Efficient Scenario** | | | | |
|---|---|---|---|---|
| Tubes which have to be replace | | **T8** | **T12** | **T5** |
| LED Wattage | Watt | 18 | 18 | 18 |
| Hours of operation/day | Hrs | 8 | 8 | 8 |
| Days of operation in a year | Nos | 260 | 260 | 260 |
| Total energy consumption in year | kWh | 1909.44 | 411.84 | 599.04 |
| Variable Tariff | Rs/kWh | 12.73 | 12.73 | 12.73 |
| Annual Running cost | Rs. | 24307.17 | 5242.723 | 7625.779 |
| | | | | |
| Annual saving | Rs. | 31059.16 | 7864.085 | 5083.853 |
| Capital investment | Rs. | 16575 | 3575 | 5200 |
| Payback Period | Years | **0.53** | **0.45** | **1.02** |
| Payback Period | Months | **6.36** | **5.40** | **12.24** |

| Energy Conservation Measure Number: 2 | | |
|---|---|---|
| 1 | Title of Recommendation | To replace fans with the efficient BLDC fans under **Residential tariff.** |
| 2 | Description of Existing System and its operation | Presently there are old fans |
| 3 | Description of Proposed System | To install fans |
| 4 | Existing System | Presently there are old normal fans which consumes more power. |
| 5 | Modified System | BLDC fans are much more efficient than normal fans as they consume less power. |
| 6 | Energy Cost Savings (Rs/day): | Rs. 522.31 |
| | Savings in one year, (lakhs) | Rs. 190644.5 |
| | Savings in Next 5 Years (Lakh.) | Rs. 953222.5 |
| 7 | Investment (Lakh.) (This cost is very approximate including pipeline modification) | Rs. 504000 |
| 8 | Simple Payback Period (Months) | 31.72 |
| 9 | Issues in implementation | |

**Residential (100-300 unit)**

**Fan Cost-2800**

| Present Case | | |
|---|---|---|
| Fan | Nos | 180 |
| Wattage | Watt | 70 |
| Hours of operation/day | Hrs | 8 |
| Days of operation in a year | Nos | 260 |
| Total energy consumption in year | kWh | 26208 |
| Variable Tariff | Rs/kWh | 12.73 |
| Annual Running cost | Rs | 333627.8 |

| Energy Efficient Scenario | | |
|---|---|---|
| Fan | | 180 |
| Wattage | Watt | 30 |
| Hours of operation/day | Hrs | 8 |
| Days of operation in a year | Nos | 260 |
| Total energy consumption in year | kWh | 11232 |
| Variable Tariff | Rs/kWh | 12.73 |
| Annual Running cost | Rs. | 142983.4 |

| | | |
|---|---|---|
| Annual saving | Rs. | 190644.5 |
| Capital investment | Rs. | 504000 |
| Payback Period | Years | **2.64** |
| Payback Period | Months | 31.72397 |

| Energy Conservation Measure Number: 2 | | |
|---|---|---|
| 1 | Title of Recommendation | To replace fans with the efficient BLDC fans under **commercial tariff.** |
| 2 | Description of Existing System and its operation | Presently there are old fans |
| 3 | Description of Proposed System | To install fans |
| 4 | Existing System | Presently there are old normal fans which consumes more power. |
| 5 | Modified System | BLDC fans are much more efficient than normal fans as they consume less power. |
| 6 | Energy Cost Savings (Rs/day): | Rs. 727.77 |
| | Savings in one year, (lakhs) | Rs. 265636.8 |
| | Savings in Next 5 Years (Lakh.) | Rs. 1328184 |
| 7 | Investment (Lakh.) (This cost is very approximate including pipeline modification) | Rs. 770000 |
| 8 | Simple Payback Period (Months) | 34.78 |
| 9 | Issues in implementation | |

| Commercial (0-20 unit) | | |
|---|---|---|
| Fan Cost-2800 | | |
| **Present Case** | | |
| Fan | Nos | 275 |
| Wattage | Watt | 70 |
| Hours of operation/day | Hrs | 8 |
| Days of operation in a year | Nos | 260 |
| Total energy consumption in year | kWh | 40040 |
| Variable Tariff | Rs/kWh | 11.61 |
| Annual Running cost | Rs | 464864.4 |

| Energy Efficient Scenario | | |
|---|---|---|
| BLDC Fan | | 275 |
| Wattage | Watt | 30 |
| Hours of operation/day | Hrs | 8 |
| Days of operation in a year | Nos | 260 |
| Total energy consumption in year | kWh | 17160 |
| Variable Tariff | Rs/kWh | 11.61 |
| Annual Running cost | Rs. | 199227.6 |

| | | |
|---|---|---|
| Annual saving | Rs. | 265636.8 |
| Capital investment | Rs. | 770000 |
| Payback Period | Years | 2.90 |
| Payback Period | Months | 34.78434 |

| Energy Conservation Measure Number: 2 | | |
|---|---|---|
| 1 | Title of Recommendation | To replace fans with the efficient BLDC fans under **Public Service tariff.** |
| 2 | Description of Existing System and its operation | Presently there are old fans |
| 3 | Description of Proposed System | To install fans |
| 4 | Existing System | Presently there are old normal fans which consumes more power. |
| 5 | Modified System | BLDC fans are much more efficient than normal fans as they consume less power. |
| 6 | Energy Cost Savings (Rs/day): | Rs. 679.02 |
| | Savings in one year, (lakhs) | Rs. 247842.8 |
| | Savings in Next 5 Years (Lakh.) | Rs. 1239214 |
| 7 | Investment (Lakh.) (This cost is very approximate including pipeline modification) | Rs. 649600 |
| 8 | Simple Payback Period (Months) | 31.45 |
| 9 | Issues in implementation | |

| **Public Service (>50 KWh)** | | |
|---|---|---|
| **Fan Cost-2800** | | |
| **Present Case** | | |
| Fan | Nos | 232 |
| Wattage | Watt | 70 |
| Hours of operation/day | Hrs | 8 |
| Days of operation in a year | Nos | 260 |
| Total energy consumption in year | kWh | 33779.2 |
| Variable Tariff | Rs/kWh | 12.84 |
| Annual Running cost | Rs | 433724.9 |

| **Energy Efficient Scenario** | | |
|---|---|---|
| BLDC Fan | | 232 |
| Wattage | Watt | 30 |
| Hours of operation/day | Hrs | 8 |
| Days of operation in a year | Nos | 260 |
| Total energy consumption in year | kWh | 14476.8 |
| Variable Tariff | Rs/kWh | 12.84 |
| Annual Running cost | Rs. | 185882.1 |

| | | |
|---|---|---|
| Annual saving | Rs. | 247842.8 |
| Capital investment | Rs. | 649600 |
| Payback Period | Years | **2.62** |
| Payback Period | Months | 31.45219 |

| Energy Conservation Measure Number: 3 | | |
|---|---|---|
| 1 | Title of Recommendation | Installation of heat pump water heating system |
| 2 | Description of Existing System and its operation | Presently there are Geyser. |
| 3 | Description of Proposed System | To install heat pumps |
| 4 | Existing System | Presently there are geyser in residential area |
| 5 | Modified System | Heat pumps are more energy efficient |
| 6 | Energy Cost Savings (Rs/day): | Rs. 7116.593 |
| | Savings in one year, (lakhs) | Rs. 2597557 |
| | Savings in Next 5 Years (Lakh.) | Rs. 12987785 |
| 7 | Investment (Lakh) (This cost is very approximate including pipeline modification) | Rs. 5000000 |
| 8 | Simple Payback Period (Months) | 23.09 |
| 9 | Issues in implementation | |

| Residential (100-300) | ED=16% | |
|---|---|---|
| Heat pump cost | 500000 | |
| No of Heat pump | 10 | |
| Present Case | | |
| Geyser | Nos | 56 |
| Wattage | Watt | 3000 |
| Hours of operation/day | Hrs | 5 |
| Days of operation in a year | Nos | 275 |
| Total energy consumption in year | kWh | 231000 |
| Variable Tariff | Rs/kWh | 12.73 |
| Annual Running cost | Rs | 2940630 |

| Energy Efficient Scenario | | |
|---|---|---|
| Heat Pump | | 10 |
| Wattage | Watt | 19600 |
| Hours of operation/day | Hrs | 5 |
| Days of operation in a year | Nos | 275 |
| Total energy consumption in year | kWh | 26950 |
| Variable Tariff | Rs/kWh | 12.73 |
| Annual Running cost | Rs. | 343073.5 |

| | | |
|---|---|---|
| Annual saving | Rs. | 2597557 |
| Capital investment | Rs. | 5000000 |
| Payback Period | Years | **1.92** |
| Payback Period | Months | 23.09863 |

| Energy Conservation Measure Number: | | |
|---|---|---|
| 1 | Title of Recommendation | Automation of lighting system in library area |
| 2 | Description of Existing System and its operation | Most of the lights are kept on continuously in book shelf area. |
| 3 | Description of Proposed System | Proximity sensor-based automation of lighting to be implemented in the entire book shelf area which will switch on the lights in particular area if there is occupancy in that area. |
| 4 | Existing System | Manual switching of lights |
| 5 | Modified System | Automatic on-off system |
| 6 | Energy Cost Savings (Rs/day):<br>Savings in one year, (lakhs)<br>Savings in Next 5 Years (Lakh.) | |
| 7 | Investment (Lakh.) (This cost is very approximate including pipeline modification) | |
| 8 | Simple Payback Period (Months) | |
| 9 | Issues in implementation | |

| Energy Conservation Measure Number: 7 | | |
|---|---|---|
| 1 | Title of Recommendation | Installation of biogas plant |
| 2 | Description of Existing System and its operation | Presently LPG cylinders are used in canteen for cooking and the wet waste is disposed in the waste disposal trucks of PMC |
| 3 | Description of Proposed System | Wet kitchen and garden waste to be fed to bio digester for converting it to biogas and manure |
| 4 | Existing System | LPG cylinders used for cooking |
| 5 | Modified System | To install biogas plant which will partly replace LPG cylinders. |
| 6 | Energy Cost Savings (Rs/day): | Rs. 246.57 |
| | Savings in one year, (lakhs) | Rs. 90000 |
| | Savings in Next 5 Years (Lakh.) | Rs. 450000 |
| 7 | Investment (Lakh.) (This cost is very approximate including pipeline modification) | Rs. 110000 |
| 8 | Simple Payback Period (Months) | 66 |
| 9 | Issues in implementation | |

| Present Case | | |
|---|---|---|
| Cylinders | Nos | 10 |
| Cost | Rs | 2000 |
| Running Cost | Rs | 20000 |

| Energy Efficient Scenario | | |
|---|---|---|
| Biogas Plants | | 1 |
| Cost | Rs. | 110000 |
| Capital investment | Rs. | 110000 |
| Payback Period | Years | 5.50 |
| Payback Period | Months | 66 |

## Solar PV plant performance assessment

### Plant performance:

The Solar power plant is set-up under OPEX route by M/s Fourth Partner Energy Pvt. Ltd. and was installed and commissioned on ____2016. Capacity of a plant as per PPA is 100 kWp and is connected to GIPE's main LT panel at 440V along with the Net Metering arrangement with MSEDCL.

Following is annual generation as per MSEDCL generation meter readings for year 2022

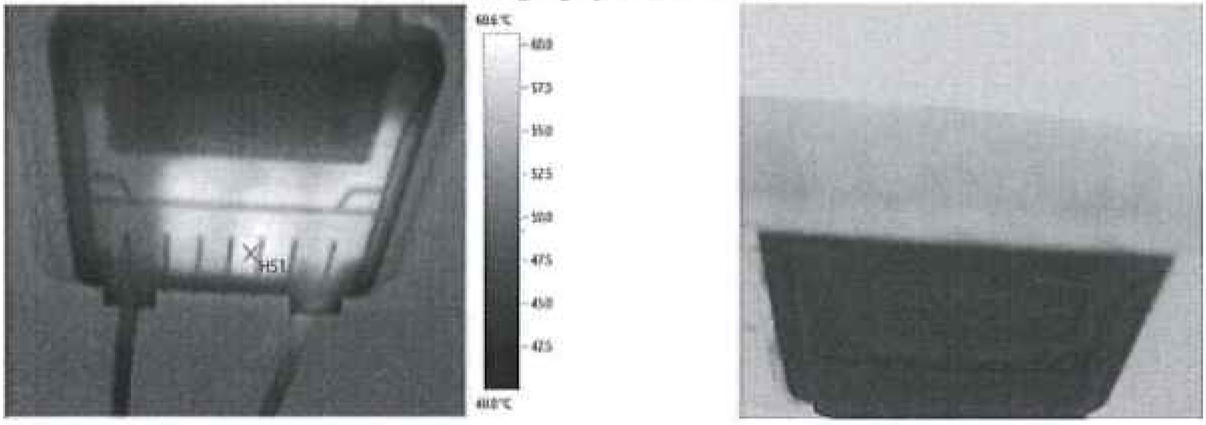
| Month | Solar Generation (kWh) |
|---|---|
| Jan | 9,008 |
| Feb | 9,677 |
| Mar | 9,901 |
| Apr | 9,777 |
| May | 10,215 |
| Jun | 7,973 |
| Jul | 6,211 |
| Aug | 6,883 |
| Sep | 7,264 |
| Oct | 7,683 |
| Nov | 7,336 |
| Dec | 6,759 |
| Total | **98,687** |

| | | |
|---|---|---|
| Plant Capacity as per PPA | kWp | 100 |
| Annual specific generation for 2022 | kWh/kWp/year | 986.87 |
| Estimated Sp generation for Pune | kWh/kWp/year | 1387 |
| System performance | % | 71% |

Actual performance of the system is almost 37% lower as compared to estimated generation. Even with this under performance of the system, the solar generation is in excess of the actual consumption of the campus indicating the system is oversized for the campus. M/s GIPE is suffering financial losses on account of adjusted units as the MSEDCL tariff for unadjusted units will be much lower than the PPA tariff. As of 31 March 2023, there were ______ units of solar electricity were banked with MSEDCL that have lapsed leading to loss of approx. _________Rs.

**From above it is clear that plant is underperforming as the generation of about 70% of estimated generation based on solar irradiation for location in Pune**

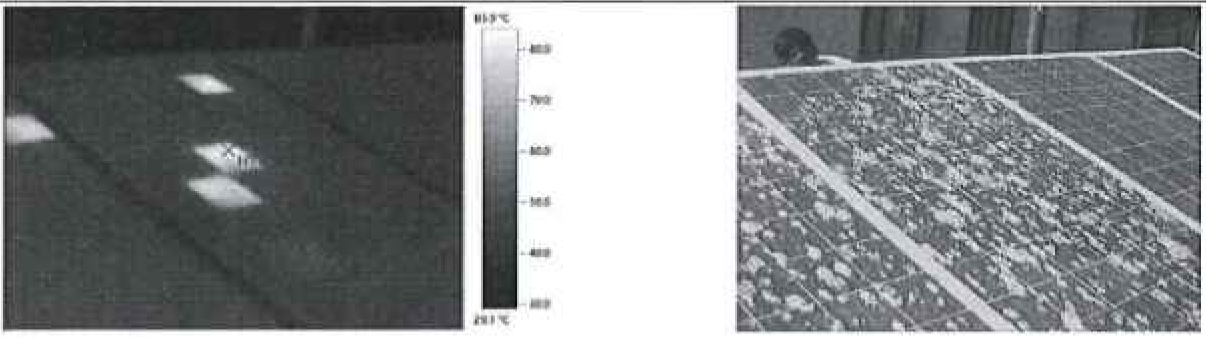
## Thermography of Solar Plant



**Picture markings:**

| Measurement Objects | Temp. [°C] | Emiss. | Refl. temp. [°C] | Remarks |
|---|---|---|---|---|
| Hot spot 1 | 60.6 | 0.90 | 20.0 | - |

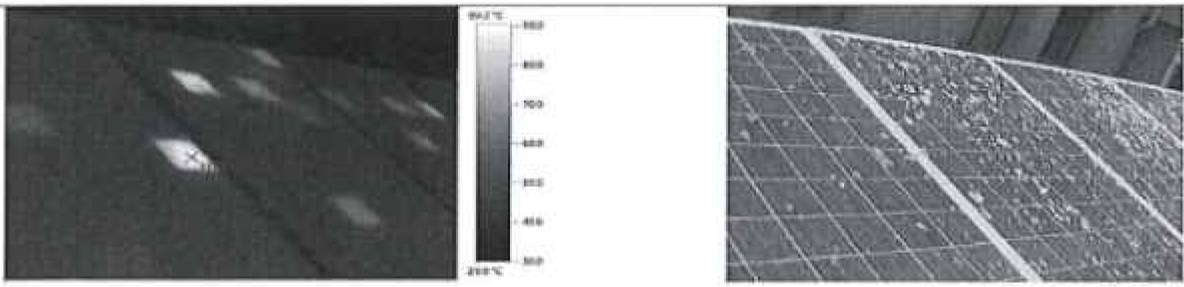
*Figure 1Heating of junction box due to shadow on modules*



**Picture markings:**

| Measurement Objects | Temp. [°C] | Emiss. | Refl. temp. [°C] | Remarks |
|---|---|---|---|---|
| Hot spot 1 | 83.9 | 0.90 | 20.0 | - |

*Figure 2 Hotspot due to soiling on module*



**Picture markings:**

| Measurement Objects | Temp. [°C] | Emiss. | Refl. temp. [°C] | Remarks |
|---|---|---|---|---|
| Hot spot 1 | 90.2 | 0.90 | 20.0 | - |

*Figure 3Hotspot due to soiling on module*

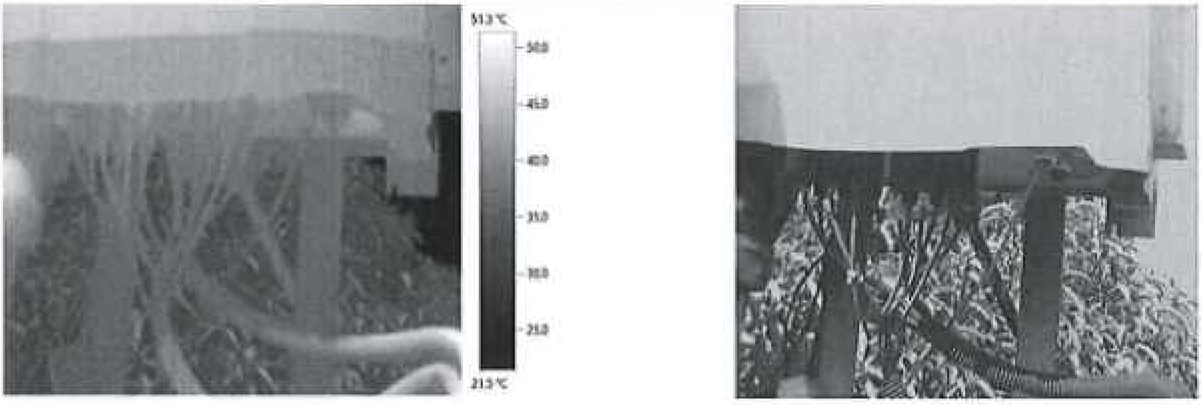


*Figure 4No Excess Heating in Inverter*

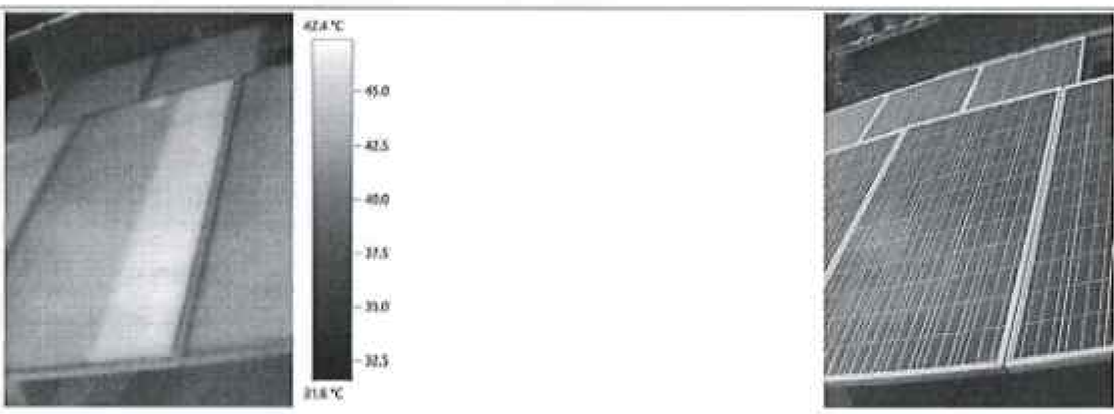
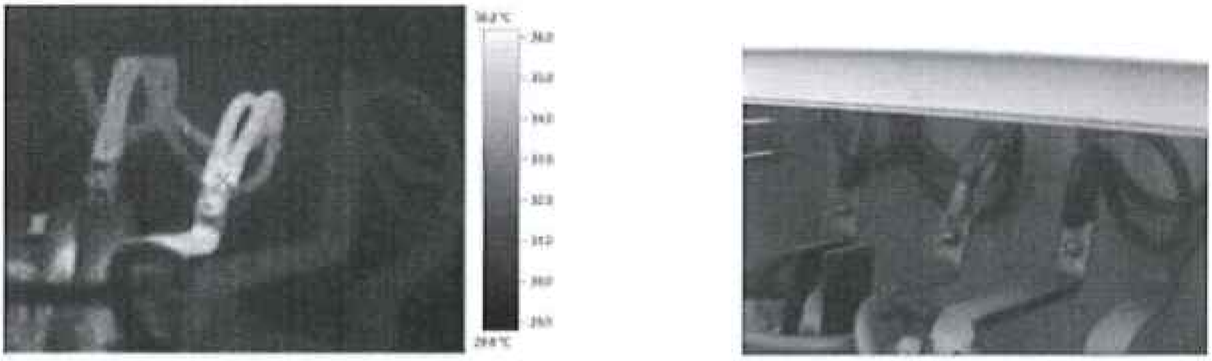


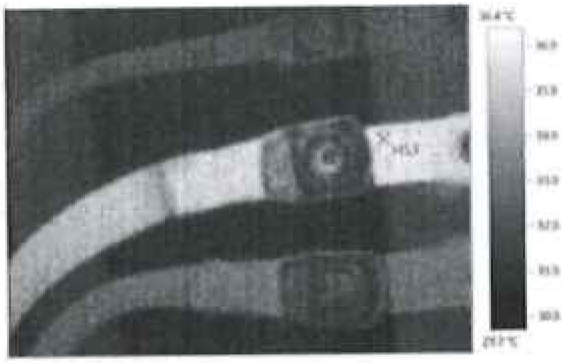
*Figure 5Partial over heating of module*

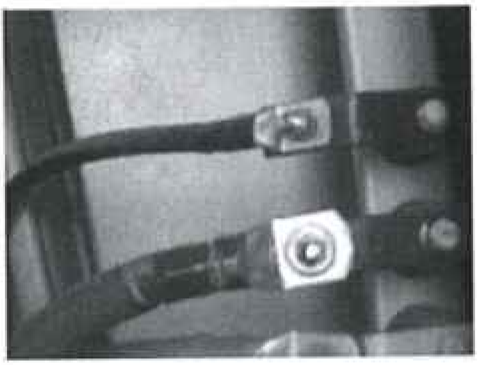


**Picture markings:**

| Measurement Objects | Temp. [°C] | Emiss. | Refl. temp. [°C] | Remarks |
|---|---|---|---|---|
| Hot spot 1 | 36.2 | 0.90 | 20.0 | - |

*Figure 6 Overheating of Busbar*

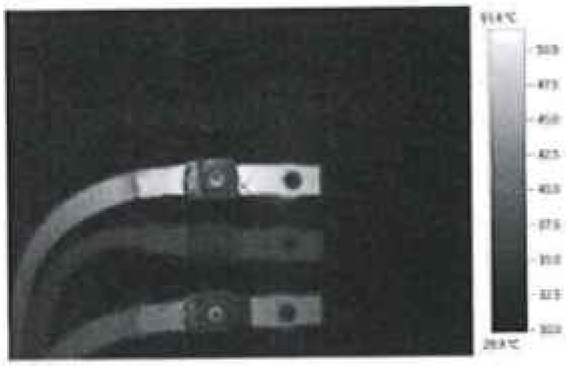


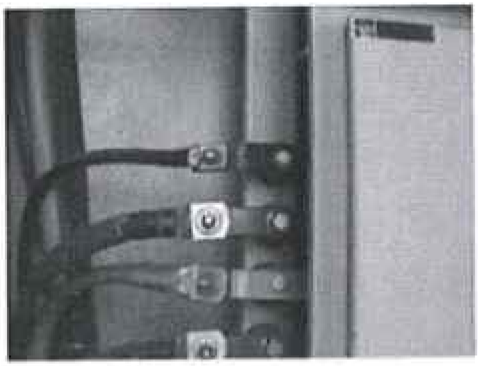


**Picture markings:**

| Measurement Objects | Temp. [°C] | Emiss. | Refl. temp. [°C] | Remarks |
|---|---|---|---|---|
| Hot spot 1 | 36.4 | 0.90 | 20.0 | - |

*Figure 7Overheating of Busbar*

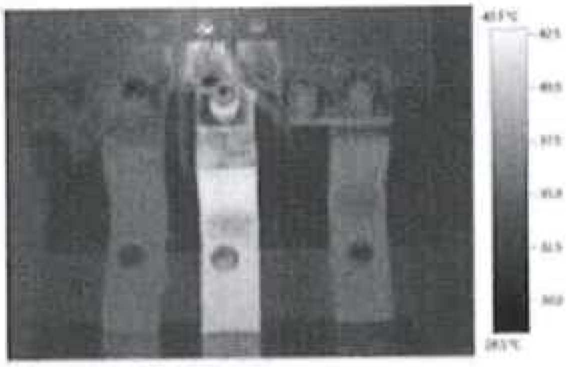


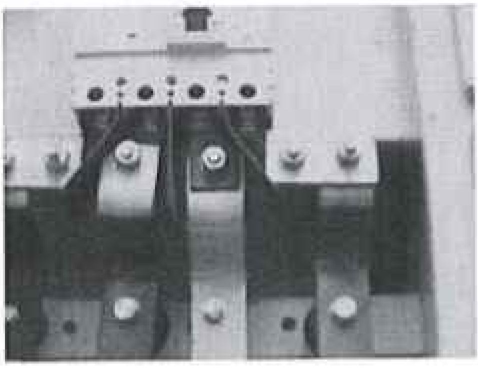


**Picture markings:**

| Measurement Objects | Temp. [°C] | Emiss. | Refl. temp. [°C] | Remarks |
|---|---|---|---|---|
| Hot spot 1 | 51.4 | 0.90 | 20.0 | - |

*Figure 8 Overheating of Busbar*

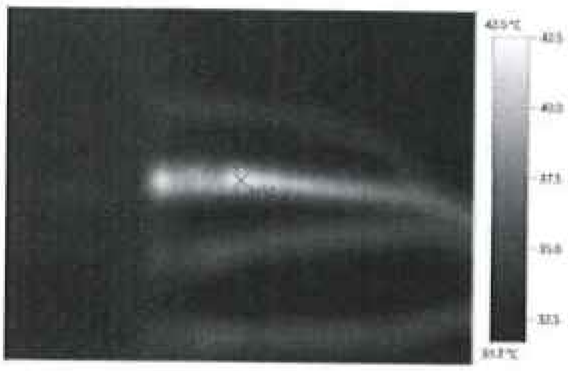


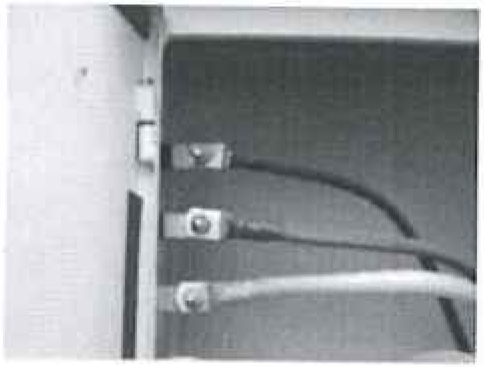


**Picture markings:**

| Measurement Objects | Temp. [°C] | Emiss. | Refl. temp. [°C] | Remarks |
|---|---|---|---|---|
| Hot spot 1 | 42.7 | 0.90 | 20.0 | - |

*Figure 9 overheating of MCCB Main Busbar*



**Picture markings:**

| Measurement Objects | Temp. [°C] | Emiss. | Refl. temp. [°C] | Remarks |
|---|---|---|---|---|
| Hot spot 1 | 42.5 | 0.90 | 20.0 | - |

*Figure 10 Overheating of Busbar*

**Power consumption Patterns:**

i. **During Peak Solar Generation Hours**

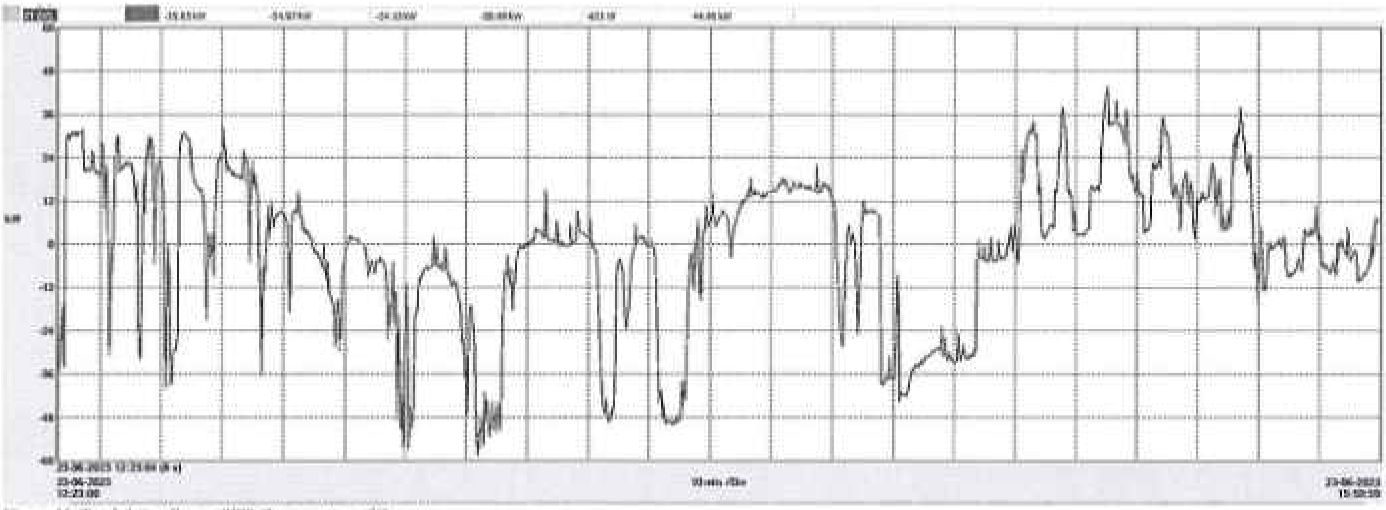


*Figure 11: Total Active Power (KW) Consumption of Campus*

At the time of taking these measurements weather was intermittently cloudy so the direction of power is alternating between import and export. Also, it is observed that the load curve is not stable and having frequent variations. Refer ANNEXURE – D for detailed data of One second interval.

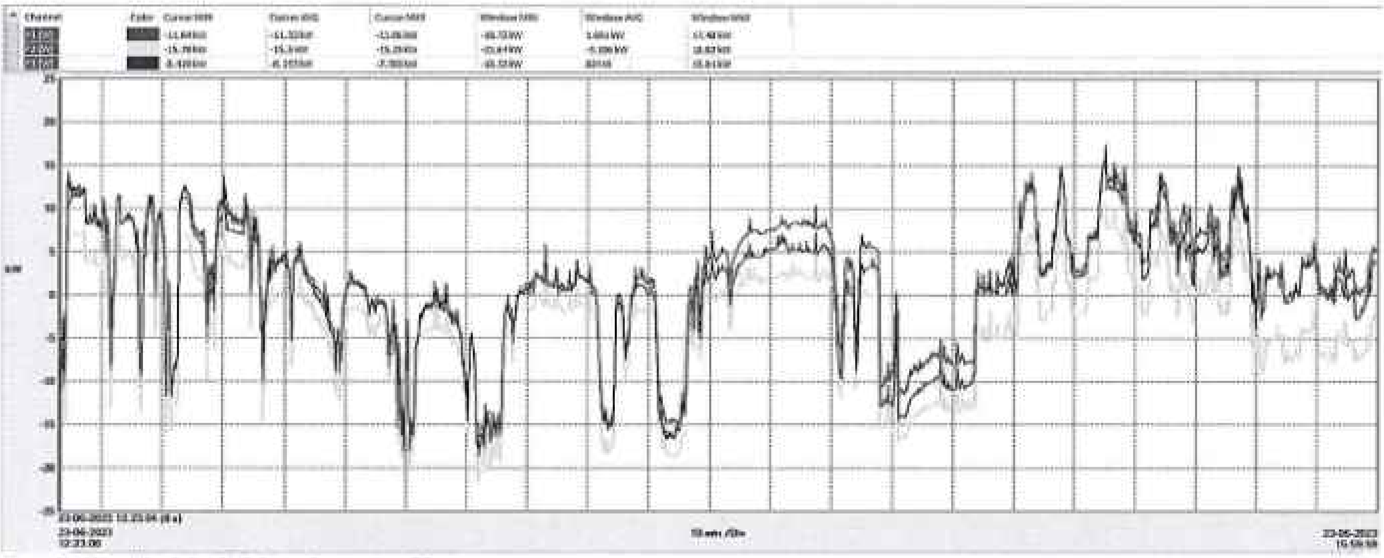


*Figure 12: Phase-Wise Active (KW) Power Consumption of Campus*

During the time of taking these measurements weather was intermittently cloudy so the direction of power is alternating between import and export. From above graph, it can be seen that the load is not balanced between the three phases and is varying constantly. Refer ANNEXURE – D for detailed data of One second interval.

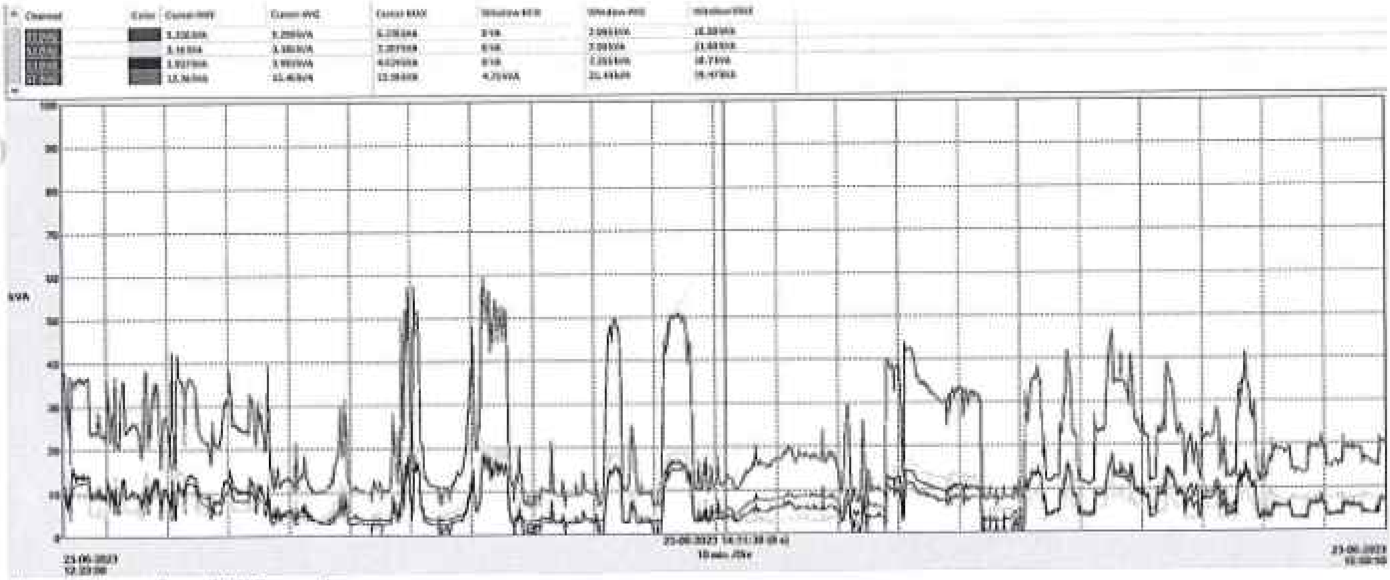



*Figure 11: Apparent Power (KVA) Consumption*

The direction of power is alternating between import and export. From above graph, it can be seen that the load is not balanced between the three phases and is varying constantly. Refer ANNEXURE – D for detailed data

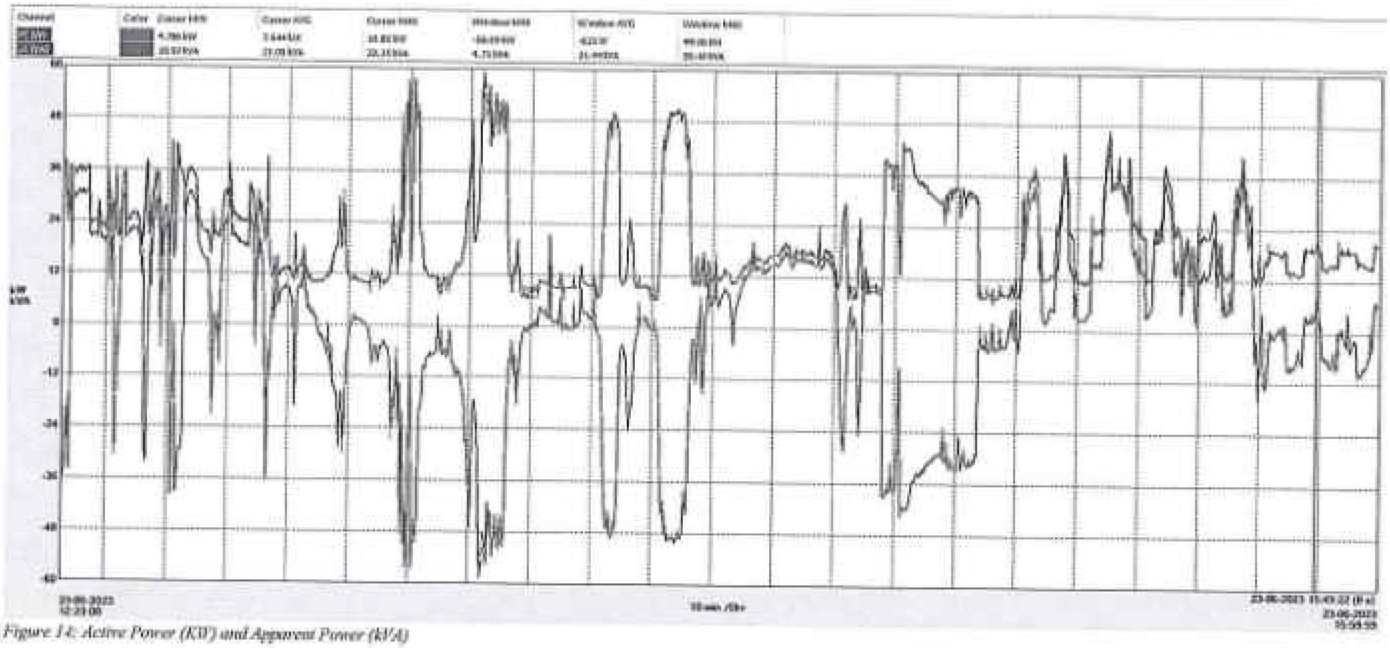


*Figure 14: Active Power (KW) and Apparent Power (kVA)*

The huge difference is seen between active and apparent power is on account of improper Power Factor (PF). Refer ANNEXURE – D for detailed data.

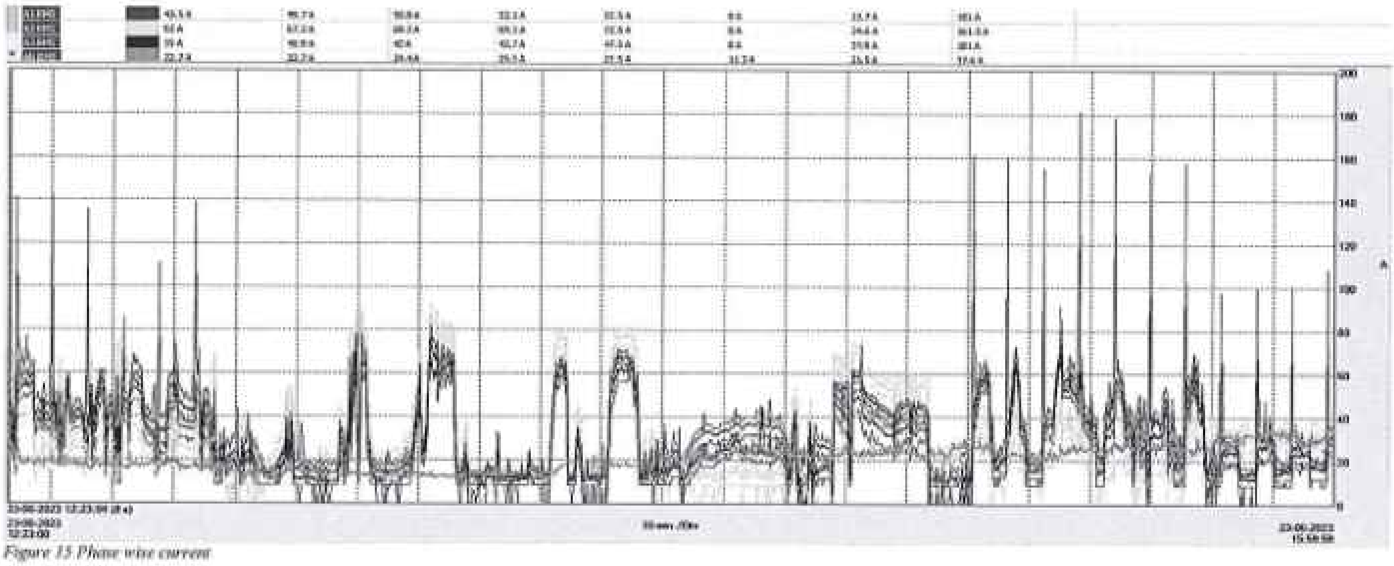


*Figure 15 Phase wise current*

As seen in above graph, load imbalance is observed in R-Phase, Y-Phase and B-Phase and there is significant current variation in current measured in each phase. Refer ANNEXURE – D for detailed data

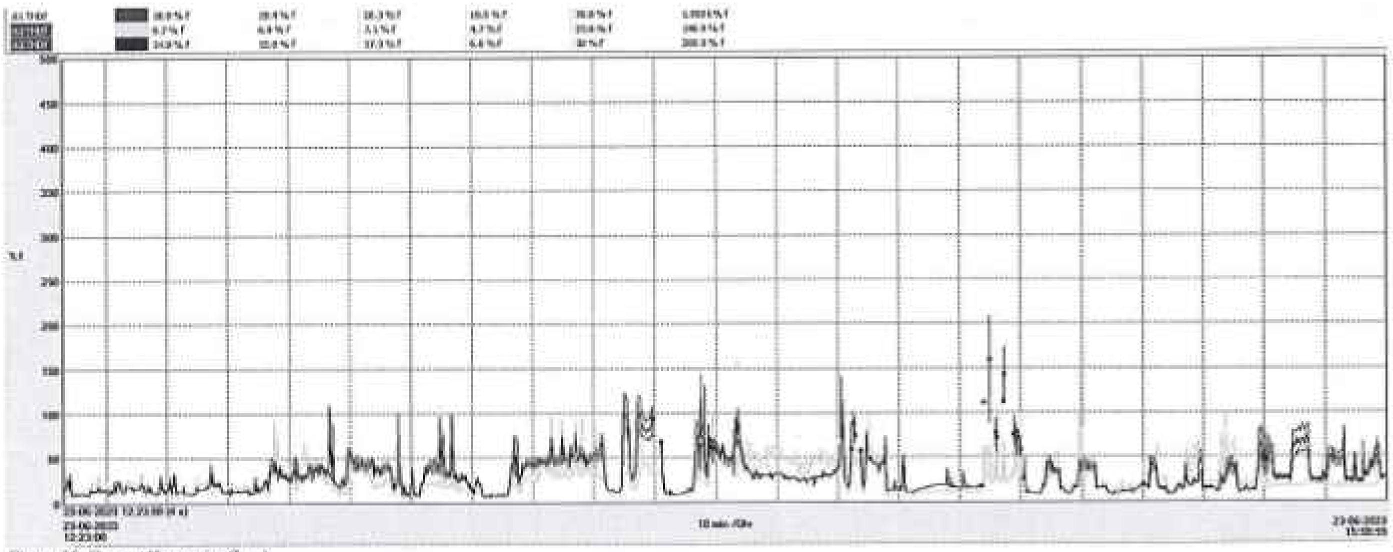


*Figure 16: Current Harmonics (Ithd)*

The voltage harmonics is within range as per IEEE standards but current harmonics is very high especially in R-Phase with average value of 79%. This is on account of harmonics induced by non-linear loads like VFDs, LEDs IT related loads and UPS. Refer ANNEXURE – D for detailed data

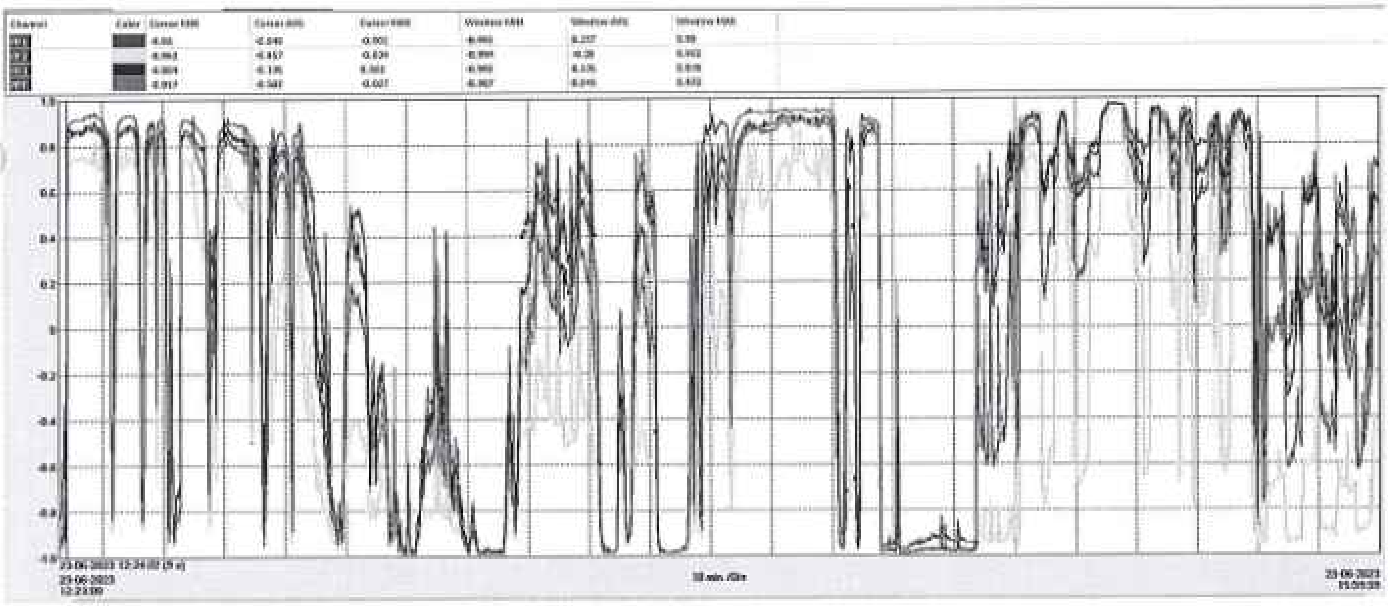


*Figure 17: Power Factor*

The current APFC is not able to maintain the Power Factor and the PF is not same in all three phases because of load imbalance. Refer ANNEXURE – D for detailed data

i. **During Night Hours**

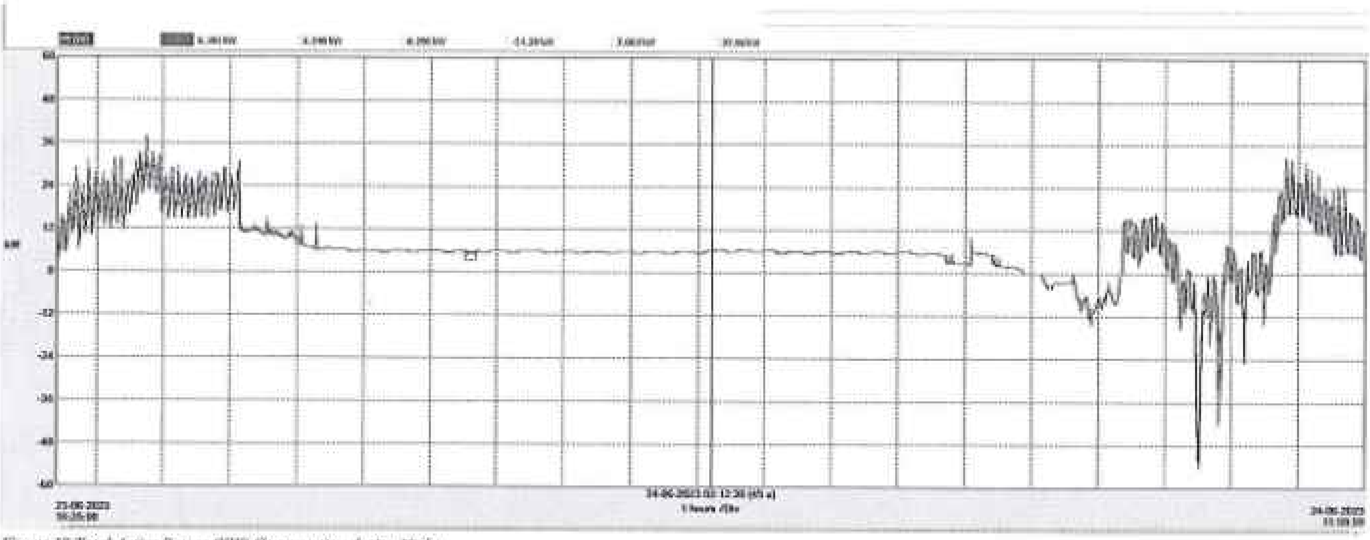


*Figure 18 Total Active Power (KW) Consumption during Night*

Also, it is observed that the load curve is not stable and having frequent variations all through out the day. At night time i.e. 9.30 PM to 6.30 AM the load is almost constant.

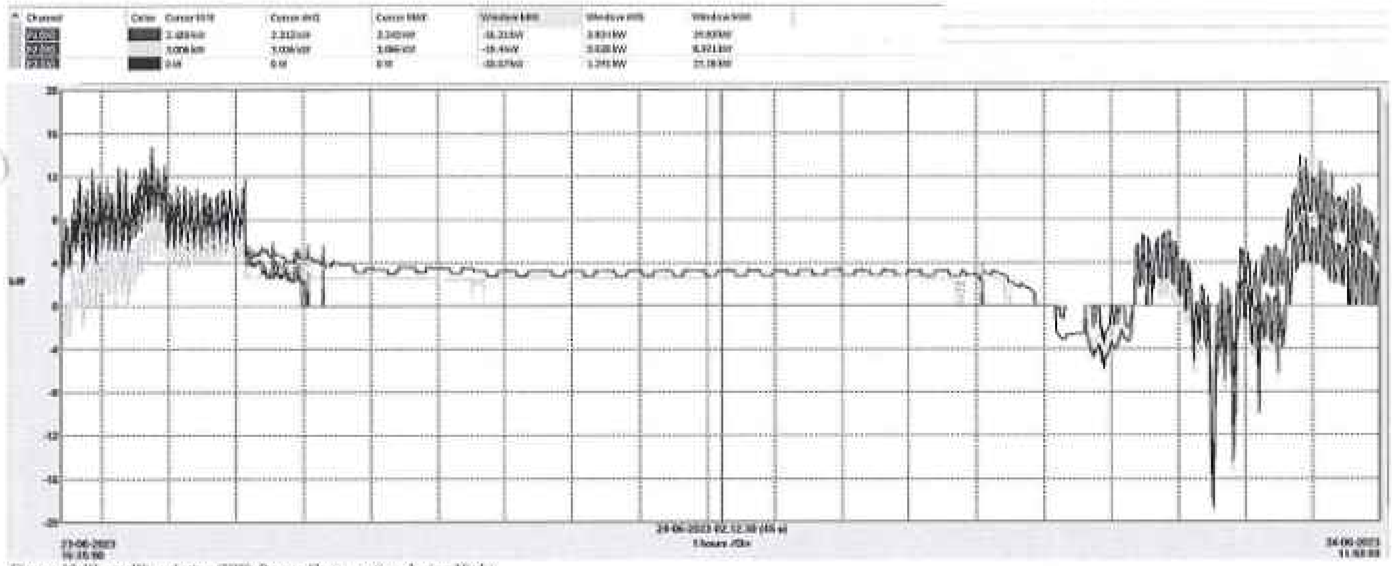


*Figure 19 Phase-Wise Active (KW) Power Consumption during Night*

From above graph, it can be seen that the load is not balanced between the three phases and is varying constantly. Night time load is almost constant in Y-phase and slightly varying in R-Phase on account of air conditioning load in B-Phase there is no load at night time. Refer ANNEXURE – D for detailed data of One second interval.

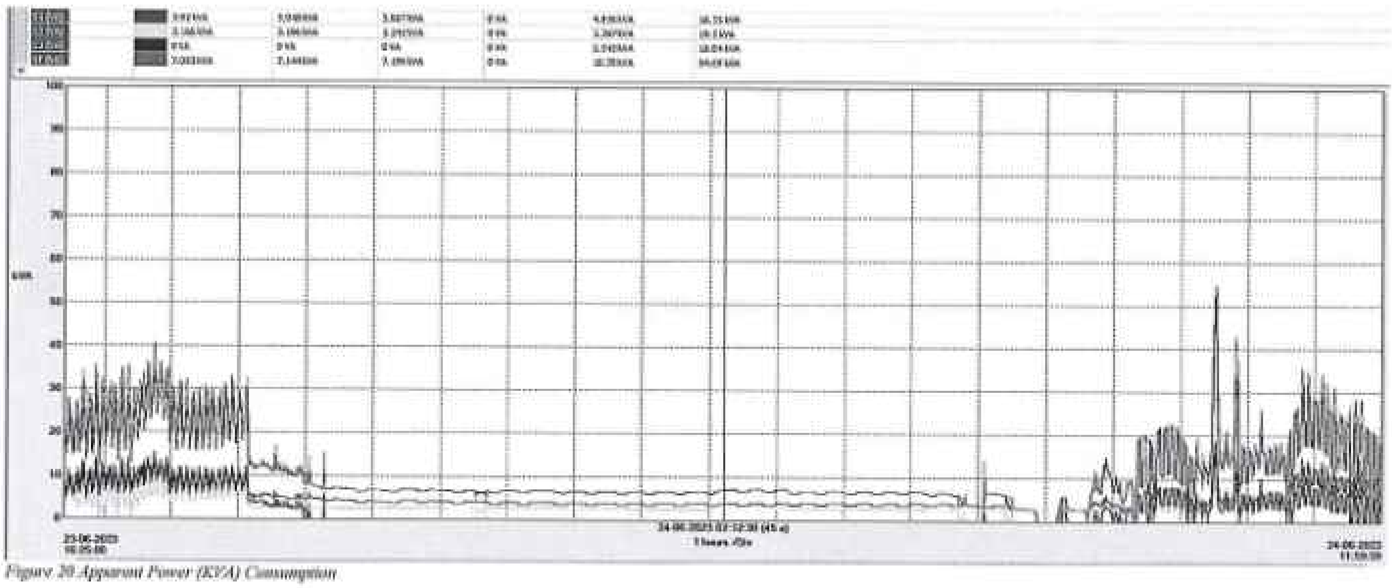


*Figure 20 Apparent Power (KVA) Consumption*

From above graph, it can be seen that the load is not balanced between the three phases and is varying constantly. Refer ANNEXURE – D for detailed data

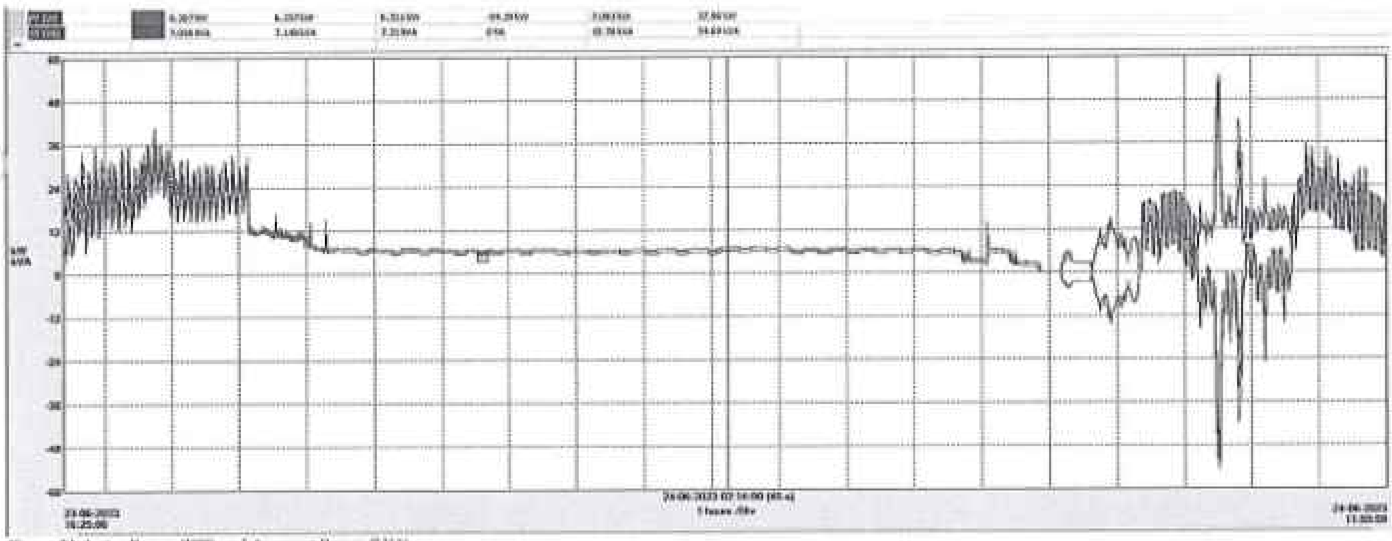


*Figure 21 Active Power (KW) and Apparent Power (KVA)*

The huge difference is seen between active and apparent power is on account of improper Power Factor (PF). Refer ANNEXURE – D for detailed data.

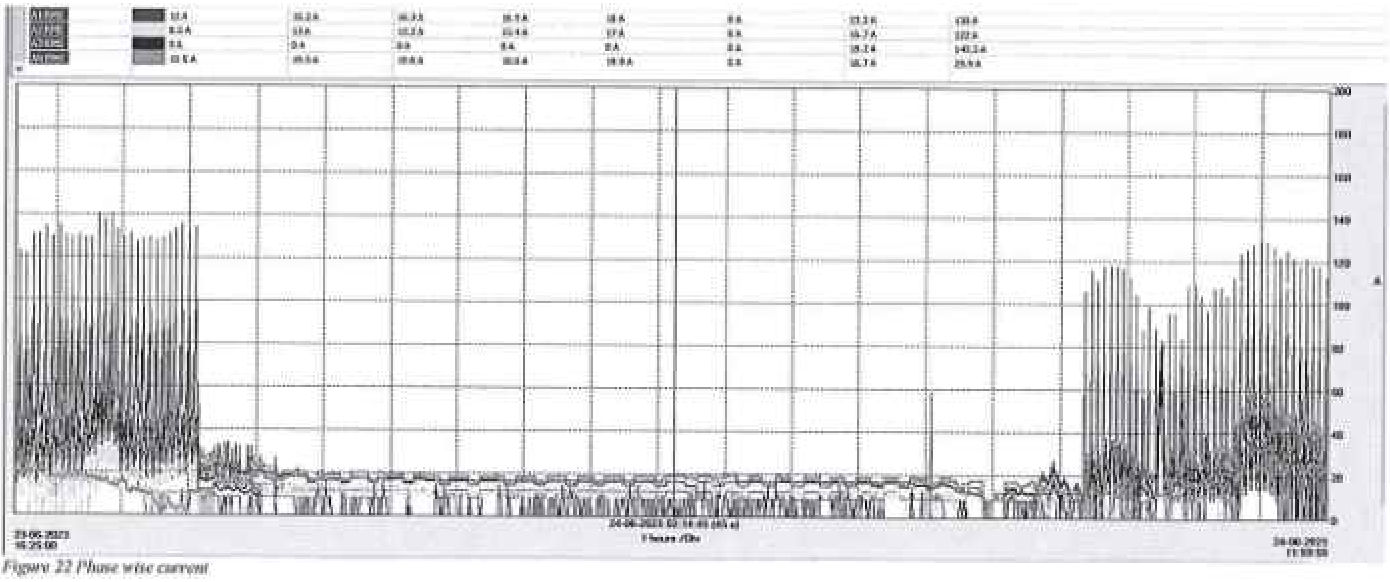


*Figure 22 Phase wise current*

As seen in above graph, load imbalance is observed in R-Phase, Y-Phase and B-Phase and there is significant current variation in current measured in each phase. Refer ANNEXURE – D for detailed data

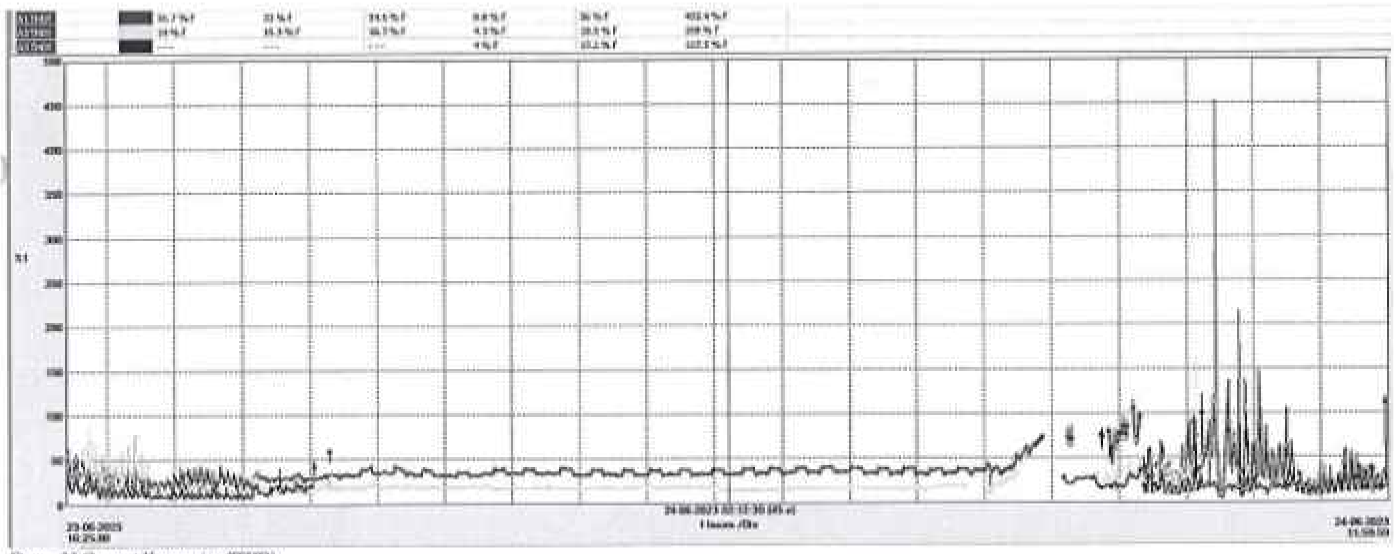


*Figure 23 Current Harmonics (ITHD)*

The voltage harmonics is within range as per IEEE standards but current harmonics is too high especially in R-Phase with average value of 453%. This is on account of drastic reduction in active power at night time but the harmonic current remaining constant. Refer ANNEXURE – D for detailed data

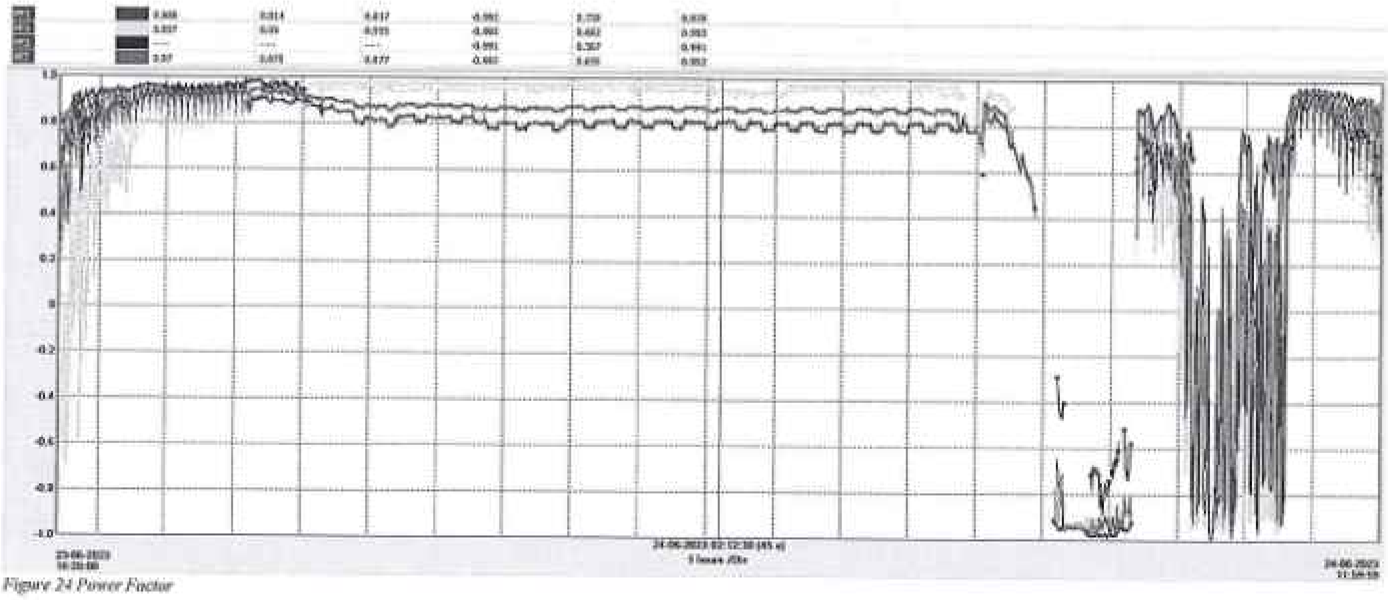



*Figure 24 Power Factor*

The current APFC is not able to maintain the Power Factor and the PF is not same in all three phases because of load imbalance. Refer ANNEXURE – D for detailed data

**Energy Audit instruments**

Please note all equipment are calibrated by a NABL accredited lab and hold valid calibration certificate.

| Sr. No. | Name of the Instrument | Number |
|---|---|---|
| 1 | Solar PV Module Testor | Metrel MI3108 |
| 2 | Thermal Imager | Testo 880 |
| 3 | Clamp Meter | Metrel MD 9231 |



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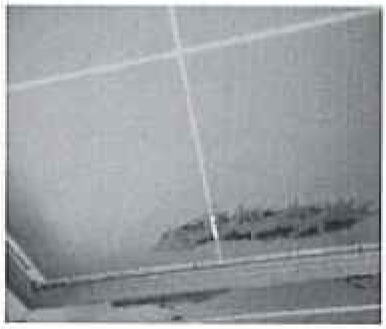
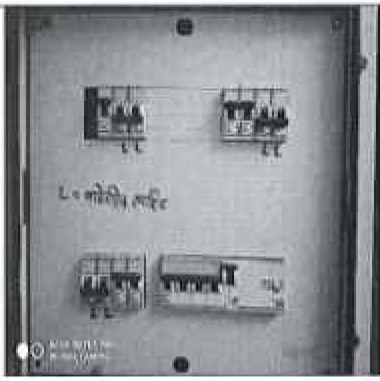
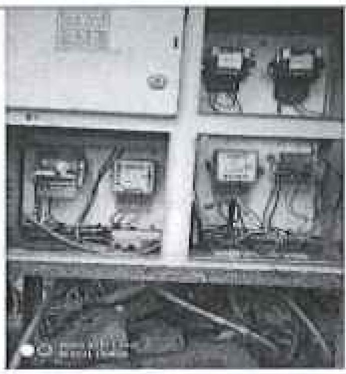
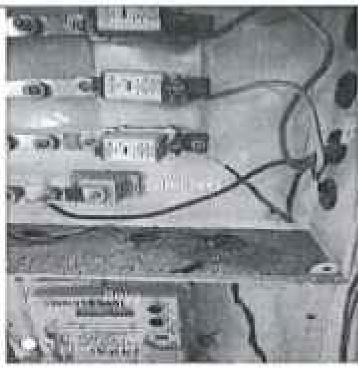
**Solar plant photos**

| | | |
|---|---|---|
|  |  |  |
|  |  | |

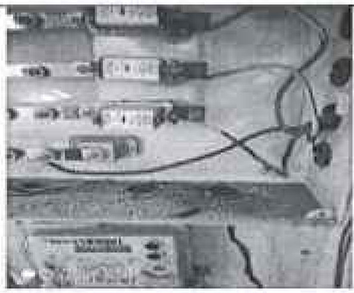
**Meter & Distribution Panel Photos**











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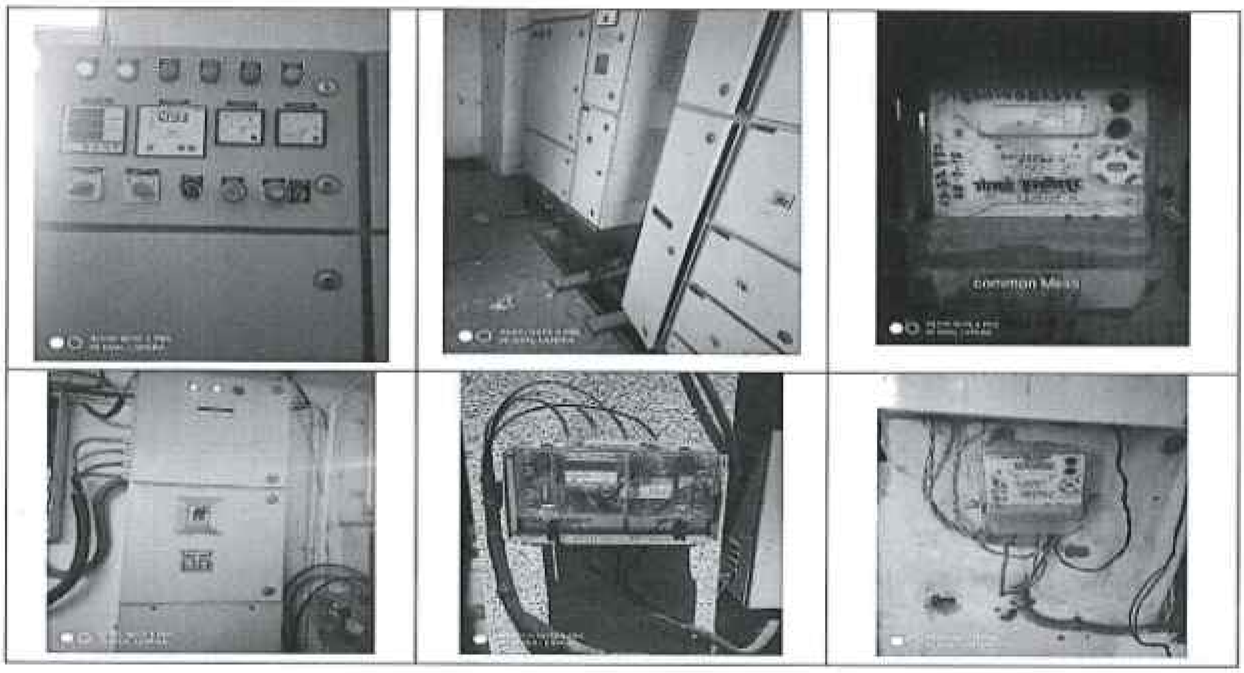


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## Annexure A

### GIPE meter data

| Sr. No. | Building Name | Consumer Number | Contract Demand (kVA) |
|---|---|---|---|
| 1 | GIPE university | [redacted] | [redacted] |
| 1 | Staff Quarters : A1 | 170010981622 | 0.5 |
| 2 | A2 | 170010981606 | 0.5 |
| 3 | A3 | 170010981550 | 0.5 |
| 4 | A4 | [redacted] | [redacted] |
| 5 | A5 | 170010981592 | 0.5 |
| 6 | A6 | 170010981614 | 0.5 |
| 7 | A7 | 170010981568 | 0.5 |
| 8 | A8 | 170010981584 | 0.5 |
| 9 | B1 | 170010981436 | 0.5 |
| 10 | B3 | 170010981452 | 0.5 |
| 11 | C1 | 170010980634 | 0.5 |
| 12 | C2 | 170010981517 | 0.5 |
| 13 | C3 | 170010981495 | 0.5 |
| 14 | C5 | 170010980642 | 0.5 |
| 15 | C6 | 170010981525 | 0.5 |
| 16 | C7 | 170010981509 | 0.5 |
| 17 | C8 | 170010980561 | 0.5 |
| 18 | D1 | 170010983447 | 0.5 |
| 19 | D2 | 170010983439 | 0.5 |
| 20 | D3 | 170010983455 | 0.5 |
| 21 | D4 | 170010983421 | 0.5 |
| 22 | E1 | 160260577902 | 3 |
| 23 | E2 | 160260577911 | 3 |
| 24 | E3 | 160260577929 | 3 |
| 25 | E4 | 160260577937 | 3 |
| 26 | E5 | 160260577945 | 3 |
| 27 | E6 | 160260577953 | 3 |
| 28 | E7 | 160260577961 | 3 |
| 29 | E8 | 160260577970 | 3 |
| 30 | F1 | 160260577996 | 4 |
| 31 | F2 | 160260578003 | 4 |
| 32 | F3 | 160260578011 | 4 |
| 33 | F4 | 160260578020 | 4 |
| 34 | F5 | 160260578038 | 4 |
| 35 | F6 | 160260578046 | 4 |
| 36 | F7 | 160260578054 | 4 |

| | | | |
|---|---|---|---|
| **37** | F8 | 160260578062 | 4 |
| **38** | G1 | 160260600289 | 5 |
| **39** | G2 | 160260600297 | 5 |
| **40** | G4 | 160260600319 | 5 |
| **41** | G7 | 160260600378 | 1 |
| **42** | G8 | 160260600343 | 1 |
| **43** | Quarter 8 | 170017720000 | 0.5 |
| **44** | Quarter 9 | 170017720018 | 0.5 |
| **45** | Quarter 10 | 170017720026 | 0.5 |
| **46** | Quarter 11 | 170017720034 | 0.5 |

**Annexure B**

**GIPE load data**

**Annexure C – Thermal imaging data**
**Annexure D – Power analyzer raw data**