Energy Wastage Identification at SRM University -AP

SRM University–AP has undergone a detailed energy review to find where energy waste is highest. The review was an Energy, Environment and Green Audit carried out by RAM-KALAM Centre for Energy Consultancy and Training, an ISO 9001:2015 certified firm led by a BEE certified energy auditor. The audit team made field measurements on 30 June and 1 to 3 July 2025 and analysed the energy data for April 2024 to March 2025. The detailed energy audit report is attached with this report as Annexure A.

- **Energy review done:** a detailed audit of the campus, with measurements on transformers, chillers, air handling units (AHUs), pumps and electrical panels, and an infra-red thermography survey.
- **Energy waste identified:** 16,50,964 kWh a year, which is 9 percent of the 1,82,86,800 kWh of electricity used in 2024–25, worth Rs. 170.0 lakh a year.
- **Highest waste:** the air-conditioning (HVAC) system, which accounts for 13,96,800 kWh or 84.6 percent of the waste identified.
- **Action plan:** 13 energy conservation proposals, with a total investment of Rs. 230.9 lakh and a simple payback of 1.36 years.

1. The Energy Review

The audit looked at where, when, why and how energy is used on the campus. The team followed two approaches: measurements on the equipment themselves, and data collected from the maintenance department. The measurements covered the two utility transformers over 24 hours, the voltage, current, power factor and harmonics at the main load points, the chiller, AHU and pump loads, and the temperature of electrical panels using a thermal imager.

The outcome is a list of energy conservation proposals, each with the energy saved, the money saved, the investment and the payback period. Each proposal marks a place where energy is being wasted today.

2. Energy Use Before the Review

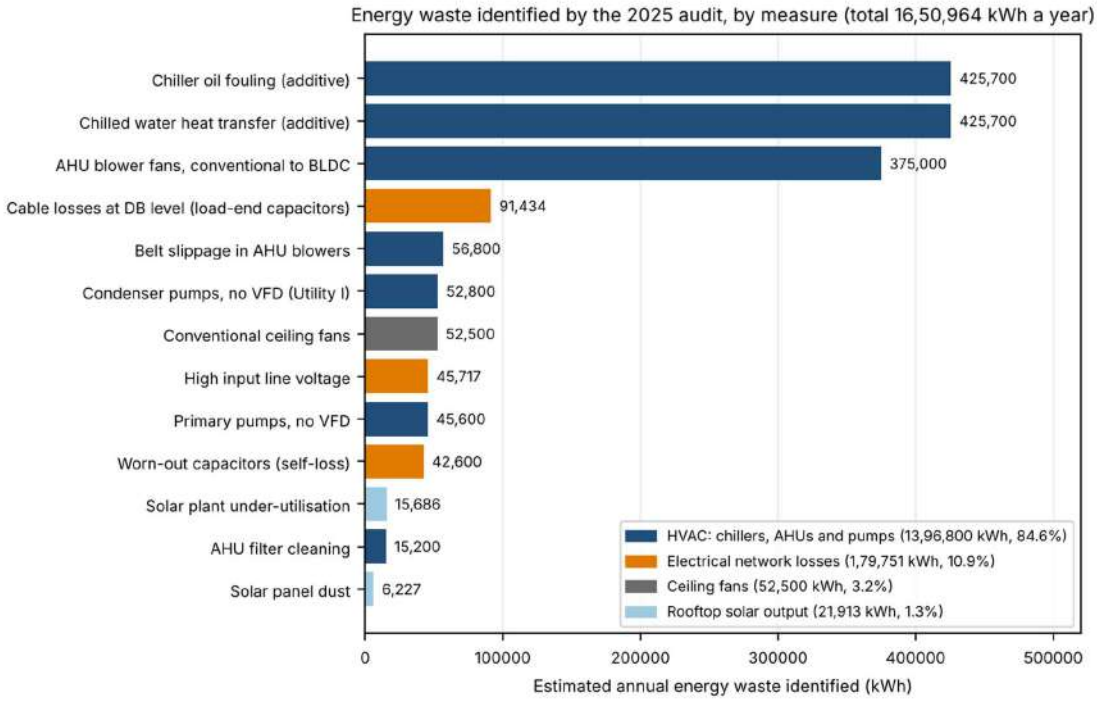
The campus used 1,91,69,459 kWh of energy in 2024–25. Almost all of it came from the grid. Table 1 gives the figures. The average cost of electricity was Rs. 10.28 per kWh.

Table 1: Energy use on the campus, April 2024 to March 2025

Energy source	Quantity	Share of total
Grid electricity (APCPDCL)	1,82,86,800 kWh	95.4 %
Rooftop solar PV (532 kW)	6,22,714 kWh	3.2 %
Diesel generator sets	2,59,945 kWh	1.4 %
Total electrical energy	**1,91,69,459 kWh**	**100 %**
LPG for cooking	1,43,070 kg	--
Diesel for transport and generators	3,35,502 litres	--

3. Where Energy Waste Is Highest

The audit measured the running power of each major system and worked out how much of it is waste. Figure 1 and Table 2 rank the 13 areas by the energy that can be saved every year. The air-conditioning system is the clear first. The two chiller measures alone account for 8,51,400 kWh, and the AHU blowers and pumps add a further 5,45,400 kWh. The electrical network is second, at 1,79,751 kWh, followed by conventional ceiling fans and the rooftop solar plant.



Source: Energy, Environment and Green Audit Report, RAM-KALAM Centre, audit of 30 June to 3 July 2025 (data April 2024 to March 2025).

Figure 1. Energy waste identified by the audit, by measure and area

Table 2: Areas of energy waste, ranked by annual energy waste

Rank	Where energy is wasted	Area	Energy waste (kWh/year)	Share (%)
1	Chiller oil fouling	HVAC	425,700	25.8
2	Poor heat transfer in the chilled water system	HVAC	425,700	25.8
3	Conventional AHU blower fans	HVAC	375,000	22.7
4	Cable losses in distribution boards	Electrical	91,434	5.5
5	Belt slippage in AHU blowers	HVAC	56,800	3.4
6	Condenser pumps without VFD (Utility I)	HVAC	52,800	3.2
7	Conventional ceiling fans	Fans	52,500	3.2
8	High input line voltage	Electrical	45,717	2.8
9	Primary pumps without VFD	HVAC	45,600	2.8
10	Worn-out capacitors	Electrical	42,600	2.6
11	Solar plant under-utilisation	Solar	15,686	1.0
12	Dirty AHU filters	HVAC	15,200	0.9
13	Dust on solar panels	Solar	6,227	0.4
	Total		**16,50,964**	**100.0**

The ranking in Table 2 follows the audit's own estimates for each proposal. Totals by area are HVAC 13,96,800 kWh (84.6 percent), electrical network 1,79,751 kWh (10.9 percent), ceiling fans 52,500 kWh (3.2 percent) and rooftop solar 21,913 kWh (1.3 percent).

4. How the Waste Was Found

- **Chillers.** Six chillers (450 TR, 250 TR and 1,000 TR) were measured and together draw an average of 1,418.8 kW. Oil build-up inside the coils and poor heat transfer in the chilled water loop reduce their efficiency, and the audit estimates a 10 percent saving from each fix.
- **Air handling units.** About 102 AHUs serve the buildings, and 48 were running at the time of the audit with an average load of 187.5 kW. The audit found filters that need more frequent cleaning, belt slippage in the blower drives and conventional blower fans that use far more power than electronically commutated (BLDC) fans.
- **Pumps.** The primary pumps and the condenser pumps run at constant speed. A variable frequency drive (VFD) would cut their power by about 20 percent.

- **Electrical network.** About 709 kVAr of capacitors were not injecting their rated current and are worn out, so they only add losses. The supply voltage was also higher than the standard 400 V, which adds a little to the energy used.
- **Thermography.** The infra-red survey recorded overheating at 14 points on transformers, capacitor banks and the chiller, cooling tower and pump panels: 4 critical, 8 severe and 2 moderate. The highest reading was 116 °C at the incoming side of a chiller panel. Hot joints waste energy and are a fire risk.
- **Fans and solar.** Most ceiling fans are already BLDC fans, which draw about 35 W, and the remaining conventional fans are to be changed. The solar plant lost output through dust, and its energy was not used fully.

5. Action on the Findings

Of the 13 proposals, four need no investment: cleaning the solar panels, cleaning the AHU filters, making fuller use of the solar power and correcting the transformer tap position. Together they save 82,830 kWh a year. The rest are low-cost and capital measures, led by the chiller additives, VFDs on pumps, replacement of worn-out capacitors and BLDC blower fans. The audit also sets out best operating practices for energy management, including a Green Energy Team to follow up the actions.

The full set of 13 proposals, with the calculations behind each, is in the detailed energy audit report that is attached.

6. Conclusion

SRM University–AP has undergone an energy review that identifies where its energy waste is highest. The review shows that the air-conditioning system is the largest source of waste, followed by losses in the electrical network. Together the 13 proposals can reduce electrical energy use by 16,50,964 kWh a year (9 percent), saving Rs. 170.0 lakh a year for an investment of Rs. 230.9 lakh. This meets the requirement of metric 7.2.5.

Annexure A

Energy, Environment and Green Audit Report, SRM University, Neerukonda, Mangalagiri, Andhra Pradesh. Audit conducted by RAM-KALAM Centre for Energy Consultancy and Training on 30 June and 1 to 3 July 2025 (data April 2024 to March 2025). The detailed energy audit report is attached.

ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

AUDIT CONDUCTED FOR

SRM UNIVERSITY

NEERUKONDA, MANGALAGIRI MANDAL, GUNTUR DISTRICT, MANGALAGIRI-522 240, ANDHRA PRADESH, INDIA.

DATE OF AUDIT

June 30, July 1, 2 & 3 2025

(Audited and Accounted from April 2024 to March 2025)

SRM UNIVERSITY AP
Andhra Pradesh

AUDIT CONDUCTED BY

RAM-KALAM CENTRE FOR ENERGY CONSULTANCY AND TRAINING

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ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

DISCLAIMER

DISCLAIMER

- This detailed **Energy Audit Report** was prepared based on the;
  - Data collection
  - Field measurements
  - Observations from the audit team and
  - Best Operating Practices (BoP) followed in the industry

  along with the appropriate mathematical tools and scientific analysis by the audit team.

- The **Energy Conservation Proposals (ENCONs)** and **recommendations** represented in this report are based on the **Four-days field measurements** by the audit team, **one year data** provided by the industrial team.

- The accuracy of the calculations are based on best estimations and proven case studies. The actual results may vary depends on the site-specific condition.

- The audit team does not endorse any **specific product** mentioned in the report. Even if it mentioned; it is for illustrative purpose only.

- The audit report and its contents are the property of the audit team and **may not be reproduced or distributed** without prior permission.

ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

1. ACKNOWLEDGEMENT

ACKNOWLEDGEMENT

The Audit Team of RAM-KALAM CENTRE FOR ENERGY CONSULTANCY AND TRAINING, Coimbatore – 641 062 is thankful to the Management, Principal, Faculty and Technical team members of **M/s. SRM UNIVERSITY,** Neerukonda, Mangalagiri Mandal,Guntur District, Mangalagiri – 522240, Andhra Pradesh, India for providing an opportunity to conduct a detailed Energy, Environment and Green Audit process in the university premises.

It is our great pleasure which must be recorded here that the Management of **M/s. SRM UNIVERSITY** extended all possible support and assistance resulting in thorough completion of the audit process. The audit team appreciates the cooperation and guidance extended during the course of site visit and measurements. We are also thankful to all those who gave us the necessary inputs and information to carry out this very vital exercise.

Finally, we offer our sincere thanks to all the members in the engineering division/ technical / non-technical divisions and office members who were directly and indirectly involved with us during collection of data and while conducting field measurements.

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ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

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ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

3. INTRODUCTION

TO

ENERGY-ENVIRONMENT-GREEN

AUDIT PROCESS

3.1: Preface about the Institution:

- **SRM University, Andhra Pradesh (SRM AP),** also known as SRM University, Amaravati, is a state private university located near Neerukonda village in Mangalagiri mandal of Guntur district in Andhra Pradesh, India, in the area of the planned capital city Amaravati. The university **was established in 2017** by the SRM Trust through the Andhra Pradesh Private Universities (Establishment and Regulation) Act, 2016. It offers undergraduate, postgraduate courses and Ph.D programmes in engineering, liberal arts and basic sciences.
- **SRM University**, Andhra Pradesh offers undergraduate, postgraduate courses and Ph.D programmes through its two schools, the School of Engineering & Applied Sciences, launched in 2017, and the School of Liberal Arts & Basic Sciences, which was launched in 2018. In 2018, a three-year BBA Programme was started under the aegis of the School of Liberal Arts and Basic Sciences (SLABS) at SRM University-AP.
- In 2020, an independent school of Business was created as the School of Entrepreneurship and Management Studies (SEAMS) with a BBA (Honours) Programme, MBA Programme in Data Science, Banking and Finance and a PhD Programme.
- In 2021, SEAMS launched a new MBA Programme specialising in Marketing, Finance and Human Resource Management. SEAMS was rechristened as the Paari School of Business with a BBA (Honours) Programme, MBA Programme, and EMBA programme in 2023.

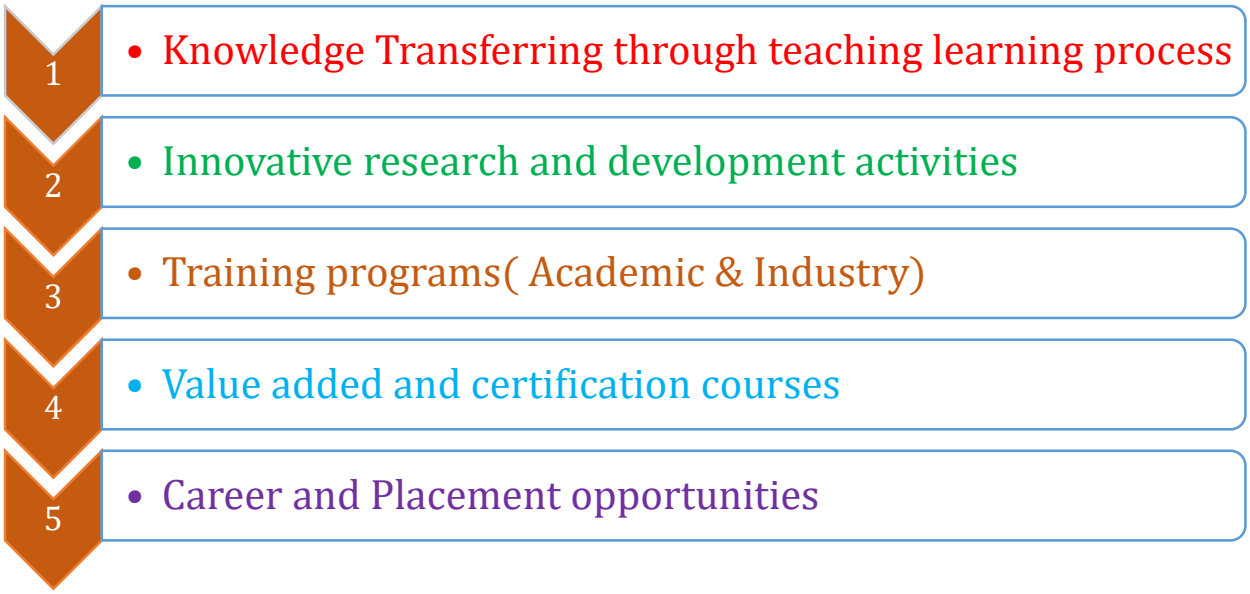
3.2: Vision:

- ✓ To emerge as a world-class University in creating and disseminating knowledge and providing students a unique learning experience in their chosen field of scholarship that would best serve the society and betterment of mankind.

3.3: Mission:

- ☞ Develop into an inter-disciplinary institute combining academic rigour, excitement of discovery, creativity and entrepreneurship.
- ☞ Deliver world-class research-based education, creating new knowledge and innovations.
- ☞ Provide an inspiring and stimulating environment for a diverse campus community of faculty and students.

3.4: Major Activities in the Institution:



3.5: Scope of the Audit Process:

- **Energy Audit:** To conduct a detailed energy audit in the University campus with a main focus to identify judicious usage of electrical and thermal energy (where, when, why and how energy is being utilized.
- To ascertain the best practices to be followed in energy conservation, energy management, recommended safety measures and continuous energy monitoring system.
- **Environmental Audit:** Identification of history of activities, present environmental practices followed, monitoring records and known sources of environmental issues inside the University.
- Adoption of natural resources as input (such as energy and water), processing and utilization and generation of wastes (including hazardous and toxic).
- Handling and storage of all types of wastes (Solid, liquid and gases), transportation of waste from source to yard, reuse and recycling possibilities, storage mechanism and effective disposal.
- Measurement of effectives of pollution control (air, water and soil pollution), maintenance logs, emission test reports and routine analytical reports.
- Providing constant awareness to all stakeholders on Environment impacts, risk analysis and Ecology.
- **Green Audit:** Assessment on Campus greenery in terms of mature trees, flowering shrubs, bushes, medicinal plants, adoption of green energy generation and utilization, reduction of CO_2 due to green energy system and identification of possible implementation and enhancement of current greenery practices.

3.6: Outcomes of the Audit Process:

- Recommendations based on field measurement with achievable **En**ergy **Con**servation (ENCON) proposals under **No cost/Low cost and Cost investment categories**
- **Minimization of present energy cost** by adjusting and optimizing energy usage and reduction of energy wastage without affecting the regular activities
- Determination of operating efficiency of each electrical system, comparison of design values and to identify feasible technical ways to improve it further in a cost-effective manner
- Use as a basis for the development of environmental management policies or efforts to improve the existing plants
- **Identification of possible cost and energy saving** from energy conservation, waste reduction, reuse and recycling
- Development of **rule-based system** to become a sustainable environment inside the University campus and nurture the importance of less energy and less environmental impacts
- **Formation of methodology** for long term road map for maintaining green environment within the campus and encourage the stakeholders for continuous improvements
-

3.7: Audit Approach:

The audit team completed the assessment of energy consumption in the factory premises and operating hours of each machines (system) using two approaches namely **i) Objective Approach** in which a detailed measurement was taken and **ii) Subjective Approach** in which field data is collected from the maintenance department.

ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

4. EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Energy Analysis:

→ A detailed audit was conducted **M/s. SRM UNIVERSITY,** Neerukonda, Mangalagiri Mandal, Guntur District, Mangalagiri – 522 240, Andhra Pradesh, India.

→ The audit team has worked out ***13 Energy Conservation Proposals*** along with their;

- Annual energy and financial savings
- Initial investment required
- Calculation on simple payback period.

→ The summary of all the Energy Conservation Proposals are presented as follows: -

S. No.	Description	Parameters		
		Present	After	Savings
1.	Annual Energy	1,82,86,800 kWh	1,66,35,836 kWh	**16,50,964 kWh**
2.	Annual Energy Cost	Rs. 1,886.5	Rs. 1,716.5 Lakhs	**Rs. 170.0 Lakhs**
3.	Initial Investment	**Rs. 230.9 Lakhs**		
4.	Payback Period	**1.36 Years (16.3 Months)**		
5.	**% Energy and Financial Reduction**		**9 % of Electrical Energy**	

Audit Conducted & Verified by

(Dr. S.R. SIVARASU)

Table-1: Energy Conservation Proposal (ENCON) along with Annual Energy and Financial Savings

S. No.	Proposed Energy Conservation Measures	% Savings	Estimated Annual Savings		Initial Investment (Rs.)	Simple Payback	Page No.
			Energy	Financial (Rs.)			
1.	Increasing the Energy Production from the Roof Top Solar Photovoltaic System using regular Panel Cleaning Schedule	1 % on Solar Energy Generation	6,227 kWh	64,138	Zero Cost	Immediate	18
2.	Energy Savings in the AHU Blowers using Condition Monitoring & Regular Filter Cleaning	2 % of AHU Energy Consumption	15,200 kWh	1,56,560	Zero Cost	Immediate	20
3.	Ensure Maximum Power Generation from Solar PV Plant & Reduction of Active Energy Consumption from the EB Utility	Better Utilization of Solar Energy	15,686 kWh	1,61,566	Zero Cost	Immediate	23
4.	Reduction of Active Energy Consumption & Self-loss on the Worn-out Capacitors in the Electrical Distribution Network	20 W/kVAr on Capacitor Power	42,600 kWh	4,38,780	2,80,000	0.6 Years	25
5.	Energy Saving in Primary Pump by Converting the EE Pumps with Closed Loop VFD Automation	20 % on Primary Pump Consumption	45,600 kWh	4,69,680	6,00,000	1.3 Years	28
6.	Reduction of Higher Input Line Voltage to Standard Value by Adjusting the Tap Position at the Secondary Side	0.25 % of Electrical Consumption	45,717 kWh	4,70,885	Zero Cost	Immediate	31
7.	Replacement of Existing Convention Ceiling Fans in to EC BLDC Fans.	50 % on Fans Load	52,500 kWh	5,40,750	9,00,000	1.7 Years	35
8.	Energy Conservation through Closed Loop Common VFD Automation for Condenser Pumps in Utility I Water Cooled Chillers	20 % on Condenser Pump Consumption	52,800 kWh	5,43,840	4,00,000	0.74 Years	38
9.	Reduction of Mechanical Transmission Losses in Belt Driven AHU Blowers & Condition Monitoring of the Belt Slippage Loss	12 % of Belt Driven AHU Blowers	56,800 kWh	5,85,040	6,80,000	1.2 Years	40

S. No.	Proposed Energy Conservation Measures	% Savings	Estimated Annual Savings		Initial Investment (Rs.)	Simple Payback	Page No.
			Energy	Financial (Rs.)			
10.	Reduction of Cable Losses and Active Power Consumption using Load End Capacitor Compensation (At DB Level)	1 % on Electrical	91,434 kWh	9,41,770	6,00,000	0.64 Years	46
11.	Energy Saving Potentials through the Replacement of Conventional Blower Fans in to Electronically Commutated BLDC Fans in the AHUs.	40 % of Electrical Consumption	3,75,000 kWh	38,62,500	1,34,25,000	3.48 Years	48
12.	Reduction of Energy Consumption in chiller Units through Active Refrigerant additive for removing Oil Fouling	10 % of Chiller Consumption	4,25,700 kWh	43,84,710	32.00.000	0.73 Years	51
13.	Reduction of Energy Consumption in Chillers using Heat Transfer Water Additives in the Chilled Water System	10 % of Chiller Consumption	4,25,700 kWh	43,84,710	32.00.000	0.73 Years	52
Total		**16,50,964 kWh**		**1,70,04,929**	**2,30,85,000**	–	–

ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

5. STUDY
ON
ENERGY CONSUMPTION PATTERN

5.1: Assessment of Existing Electrical and Thermal Energy Systems:

<table>
<tr><th>S. No.</th><th>Description</th><th>Details</th></tr>
<tr><td colspan="3">Electrical Energy Usage</td></tr>
<tr><td>1.</td><td>Name of the customer</td><td>S R M TRUST
(As per Bill)</td></tr>
<tr><td>2.</td><td>Communication Address</td><td>Neerukonda, Mangalagiri Mandal, Guntur District,
Mangalagiri-522 240, Andhra Pradesh, India</td></tr>
<tr><td>3.</td><td>Supply Company</td><td>Andhra Pradesh Central Power Distribution Corporation Limited</td></tr>
<tr><td>4.</td><td>Tariff Type & Contract Demand</td><td>2A1 & Contracted Demand 4,999 kVA</td></tr>
<tr><td>5.</td><td>Electricity Rates</td><td>✦ Rs. 6 .95/kWh
✦ Rs. 475/kVA/Month as Fixed Charges accounted for 80 % of Demand</td></tr>
<tr><td>6.</td><td>Generator Details</td><td>❖ 2,000 kVA – 1 No (Inbuilt fuel tank – 990 L)
❖ 1,500 kVA – 2 NO’s (Inbuilt fuel tank – 990 L)
❖ 1,000 kVA – 1 No (Inbuilt fuel tank – 990 L)</td></tr>
<tr><td colspan="3">Annual Electrical Energy Consumption, Energy Generation from DG & Diesel Consumption</td></tr>
<tr><td colspan="3">Electricity 1,82,86,800 kWh | Diesel for DG 78,980 Litres | Units Generated 2,59,945 kWh</td></tr>
<tr><td colspan="3">Electrical Energy Generation from Roof Top Solar Photovoltaic System</td></tr>
<tr><td colspan="3">→ Total capacity of roof top SPV Plant installed = 532 kW
→ Krishna Block = 67 kW
→ Gothavari Block = 63.7 kW
→ Kaveri Block = 93.8 kW
→ Narmadha & Yamuna Block = 134 kW
→ X Lab = 173.5 kW
→ Synchronized with MV Panel (with separate metering done)</td></tr>
<tr><td colspan="2">Annual Energy Generation</td><td>6,22,714 kWh</td></tr>
<tr><td colspan="2">Total Energy Consumption</td><td>➢ 1,91,69,459 kWh (Electricity + DG energy + Solar)
➢ 95.4 % of is the contribution from electrical utility
➢ 3.2 % is the Contribution from the Green Solar Energy
➢ 1.4 % is the Contribution from the DG Energy</td></tr>
<tr><td colspan="3">Thermal Energy Used</td></tr>
<tr><td rowspan="2">7.</td><td>Liquified Petroleum Gas (LPG)</td><td>Cooking</td></tr>
<tr><td>Diesel (Ordinary)</td><td>Transport+ DG</td></tr>
<tr><td colspan="3">Annual Energy Consumption of Thermal System</td></tr>
<tr><td colspan="3">LPG 1,43,070 kg | Diesel (Transport) 2,56,522 Litres</td></tr>
<tr><td colspan="3">General Loads (Both Electrical and Thermal)</td></tr>
<tr><td>8.</td><td>Lighting System</td><td>❖ Indoor lighting: The management is now committed to convert the existing FTL into LED in a phased manner</td></tr>
</table>

		❖ **Outdoor lighting:** All the street lightings are LED based energy efficient lamps ❖ **Timer ON-OFF** control (ON at 6.00 PM & OFF at 6.00 PM)
FAN LOADS (CEILING)		
9.		❖ Most of the ceiling fans are of **BLDC based Electronically Commutated fans**. ❖ The average power consumption will be **35 W/fan** at maximum position (**More than 50 % reduction**) ❖ The audit team requested to change the remaining conventional fans into **BLDC based Electronically Commutated fans** in a phased manner.
HVAC SYSTEM		
10.		• Cooling load of high-rise buildings are fulfilled by separate AHUs with respective outdoor units (Like Operation Theatres, CSSD, MRI and Central Laboratory). • Apart from AHUs, many unitary air conditioning system installed in the required places. • Mostly **BEE star rated** ACs and the outdoor units are mostly placed in shaded area of the respective building. • A welcome step in the energy conservation is; all the air-conditioned rooms are set with **24^{0}C** as room temperature as per BEE norms. • However; if any medicine related storage requires less temperature setting; that can be done as prescribed by the OEM of the medicine.
MOTORS AND PUMP LOADS		
11.t		• Mainly used for water distribution, purification and waste water treatment. • Small motors are used in hotel kitchen equipment's & in the canteen. • **Recommend to place sensors to on/off to motor; when the overhead tanks filled with water.**
UNINTERRUPTED POWER SYSTEM (UPS)		
12.		• All the computers, server, surveillance, projectors, telephonic units are connected with UPS with nominal back up time of **30. Min.** • Total capacity of the UPS is nearly **703 kVA.**

Table-2: Annual Energy Consumption and Energy Generation (2024-2025)

S. No.	Month	Electricity Consumption (kVAh)	Electricity Consumption (kWh)	Solar Energy (kWh)	LPG Consumed (kg)	Diesel Consumed (L)		
						DG	Transport	Total
1.	Apr-24	14,96,800	14,91,200	64,740	11,590	5,300	26,643	31,943
2.	May-24	15,55,800	15,50,800	55,237	12,635	23,290	29,728	53,018
3.	June-24	11,37,800	11,30,000	49,117	6,213	4,270	18,854	23,124
4.	July-24	10,59,800	10,53,000	54,656	7,581	6,590	7,742	14,332
5.	Aug-24	18,91,800	18,84,800	55,066	12,179	11,820	11,703	23,523
6.	Sep-24	17,24,800	17,18,800	49,362	15,086	3,070	14,017	17,087
7.	Oct-24	18,63,000	18,55,000	56,211	14,279	7,890	29,040	36,930
8.	Nov-24	17,16,200	17,12,000	49,137	14,421	1,020	25,900	26,920
9.	Dec-24	13,63,000	13,59,400	54,370	9,994	3,630	29,864	33,494
10.	Jan-25	11,88,000	11,85,400	49,215	12,103	6,450	18,729	25,179
11.	Feb-25	14,79,200	14,74,000	42,020	12,474	4,030	22,421	26,451
12.	Mar-25	18,80,800	18,72,400	43,583	14,516	1,620	21,881	23,501
Total		**1,83,57,000**	**1,82,86,800**	**6,22,714**	**1,43,070**	**78,980**	**2,56,522**	**3,35,502**
Average		**15,29,750**	**15,23,900**	**51,893**	**11,923**	**6,582**	**21,377**	**27,959**

Table-3: Details of the Electricity Consumption and Cost of Electricity 2024-2025

Month	Electricity		Recorded Demand (kVA)	PF	Cost of Electricity (Rs. /kWh)
	Consumption (kWh)	Amount Paid (Rs. Lakhs)			
Apr-24	14,91,200	148.4	3,838	1.00	9.91
May-24	15,50,800	151.2	3,904	1.00	9.72
Jun-24	11,30,000	114.0	3,101	0.99	10.02
July-24	10,53,000	106.0	2,744	0.99	10.00
Aug-24	18,84,800	179.2	4,447	1.00	9.47
Sep-24	17,18,800	167.7	4,157	1.00	9.72
Oct-24	18,55,000	222.6	4,232	1.00	11.95
Nov-24	17,12,000	170.4	3,883	1.00	9.93
Dec-24	13,59,400	149.5	3,510	1.00	10.97
Jan -25	11,85,400	131.2	3,387	1.00	11.04
Feb-25	14,74,000	155.2	4,046	1.00	10.50
Mar-25	18,72,400	191.1	4,346	1.00	10.16
Total	**1,82,86,800**	**1,886.5**	**–**	**–**	**–**
Average	**15,23,900**	**157.2**	**3,800**	**1.00**	**10.28**

- The cost of electricity for the year 2024-2025 is Rs. 10.28 /kWh Taken as Rs. 10.30/kWh.

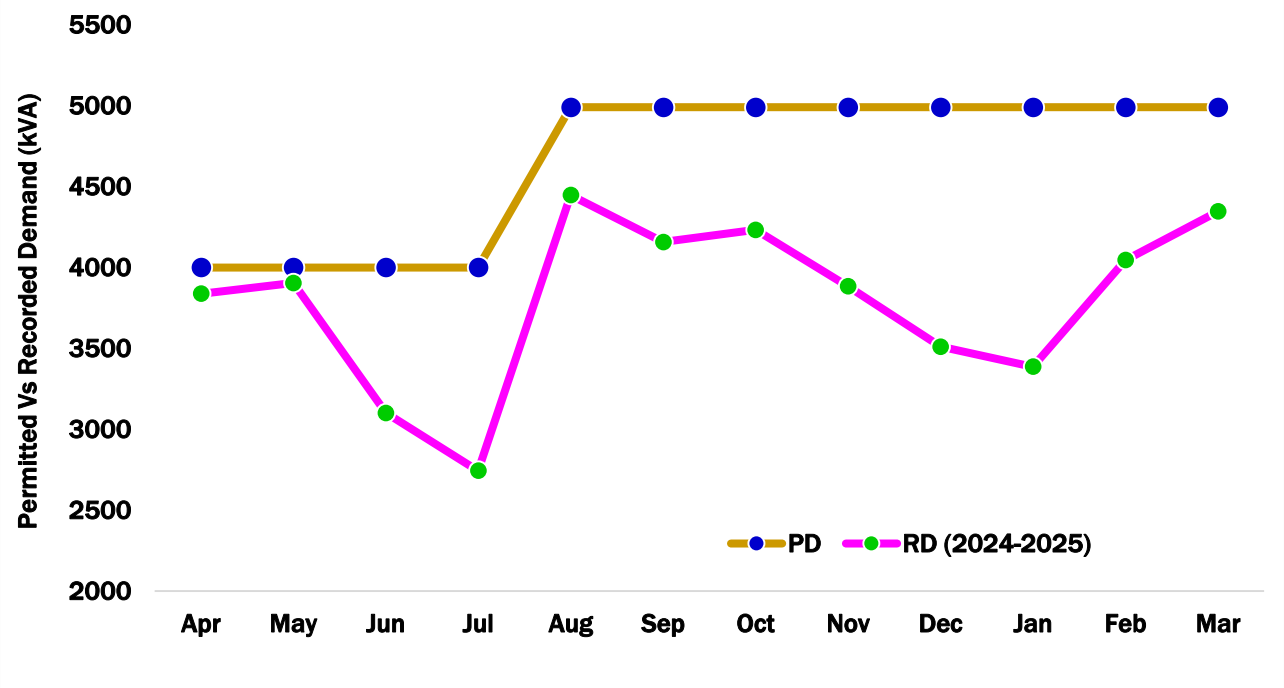


Fig.-1: Variation of Recorded Demand for the year 2024 – 2025

ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

6. ENERGY CONSERVATION PROPOSALS (ENCONs)

ENCON-I	Increasing the Energy Production from the Roof Top Solar Photovoltaic System using regular Panel Cleaning Schedule
Assessment Area	Energy generation from Roof Top Solar Photovoltaic System
ENCON Category	Deviation monitored in the existing practices and must improve in the Best Operating Practices to achieve the Energy Efficiency
Observations	• **532 kW** roof top solar PV plant was installed in most of the roof tops, generating electricity to feeding to MV panel. • The solar panels must be cleaned at regular intervals as the dust accumulation will reduce the expected power output and hence it is a loss of generation. • In general; a minimum of 1 % power generation may be improved by regularly cleaning the panels. Most of the bulk power generating solar PV plant has separate panel cleaning schedule (pipes, cleaning detergents and man power) to operate the same.
Assessments	**Dirty solar panels** • Lose efficiency and lifespan, Reduce overall system performance • May cause permanent module staining, Loss of return on investment • Affect your limited warranty **Whereas Regular cleaning** • Ensures a maximum output and Maintains your warranty • Saves money and Extends the life of the investment • Prevents permanent module staining
Recommendation (Target)	• It is highly recommended to clean the solar panel (Use RO water for cleaning with good mop stick is enough) **monthly twice (15 days once**) which ensures a minimum of 1-2 % higher productivity for the same installed capacity. • Prepare a separate cleaning schedule; assign a team of members with higher degree of supervision. • Ensure the power output before and after cleaning. Visually inspect the panels for any damage, cracks, stains and other abnormalities. • Conduct an IR thermography study on the solar panels, solar DC and AC connectors, AJB and Inverter once in a year. • Identify any thermal hotspot generated to the atmospheric condition or due to the functioning of electrical network and rectify it immediately.

Energy & Financial Saving Calculation:

Parameters	Description	
Installed capacity of SPV Plant	**532 kW (Grid Tied in MV Panel)**	
Location	Roof Top of the most of the Hostel and Lab Blocks	
Energy Calculation	**Before**	**After**
Expected % of Energy Saving	**–**	**1 % Improvement**
Annual Energy Generation (Expected)	6,22,714 kWh	6,28,941 kWh
Annual Energy Saving	–	**6,227 kWh**
Saving proposed is based on the client's feedback from Textile Industry those already audited and implemented this ENCON		
Annual Financial Saving	–	**Rs. 64,138/-**
(6,227 kWh x Rs. 10.30/kWh = **Rs. 64,138/-**)		
Initial Investment	-	**Zero Cost**
Simple Payback	**–**	**Immediate**
CO_2 Reduction	**–**	**5.1 Tons/Annum**
Indirect Benefits: Reduction of electrical energy to CO2 reduction & Lesser Carbon Footprint		



ENCON-II	Energy Savings in the AHU Blowers using Condition Monitoring & Regular Filter Cleaning
Assessment Area	HVAC system: Air Handling Units (AHU) Blower Blades
Observations	• **Nearly 102 Nos** of AHUs are available in the building with various air deliver capacity to provide the chilled air to the consumer premises. At the time of auditing **48 AHUs** only running. • At present the filter cleaning for each AHU is done every month on routine basis. They do not have the spare filters; rather they used to clean the filter (Air and water cleaning) and place the same in the respective AHUs.
Assessments	• Air filters should be cleaned or replaced on a routine schedule. Most HVAC filters should be cleaned or changed every two to three weeks. • More frequent cleaning is needed if you live in an area with lots of dust or in a home with lots of pet hair or if you don't clean regularly. • If the filter is excessively dirty, torn, or otherwise damaged, it's time to replace your air filter. • Disposable filters are designed for one-time use and are less expensive than washable filters. • Washable filters have metal or plastic frames and are more environmentally-friendly, but take more effort to maintain.
Recommendation (Target)	• For best results, plan to **clean the air filters about once in 15 days** and replace them about every six months. • Make sure to check the manufacturer's instructions to determine the best way to clean your air conditioner filter. • Cleaning of the air filters reduces the suction pressure on the blower motor and hence it reduces the power consumption by the blower motor.

Energy and Financial Saving Calculation:

Index	Energy Savings in AHU Blowers using Regular Filter Cleaning
Investment	Condition monitoring of AHU air filter and daily cleaning of the filter will reduce the suction pressure and hence reduces the load on the blower motor with **Zero Cost Investment.**
Energy Savings	Average running power consumption of **48 AHUs = 187.5 kW.**
	2 % of 187.5 kW = 3.8 kW x 4,000 running hours/annum = **15,200 kWh/Annum.**
Financial Savings	Annual cost saving for **15,200 kWh x Rs. 10.30/kWh = Rs. 1,56,560 /-**
Simple Payback	With Zero Cost investment; the payback is **Immediate**
Plan of action	• Always have a spare filter • Spare filter must be replaced with the existing filter









Sample Photos of Chocked AHU Filters

A. INSPECTION AND REMOVAL:

- **Inspect for Damage and Contamination:** Before removing the filters, visually inspect them for any signs of damage, excessive dirt, or unusual odors.
- **Remove Filters:** Carefully remove the filters, taking note of their orientation and location within the AHU.
- **Cover with Polythene Bags:** If the filters are dusty, cover them with polythene bags to prevent further contamination of the environment.

B. CLEANING (MOSTLY FOR WASHABLE FILTERS):

- **Vacuum or Rinse:** If the filters are washable, use a vacuum cleaner with a hose attachment to remove loose dust and debris. You can also rinse them with pressurized water using a spray gun.
- **Dry Thoroughly:** Allow the filters to dry completely before reinstalling them in the AHU.

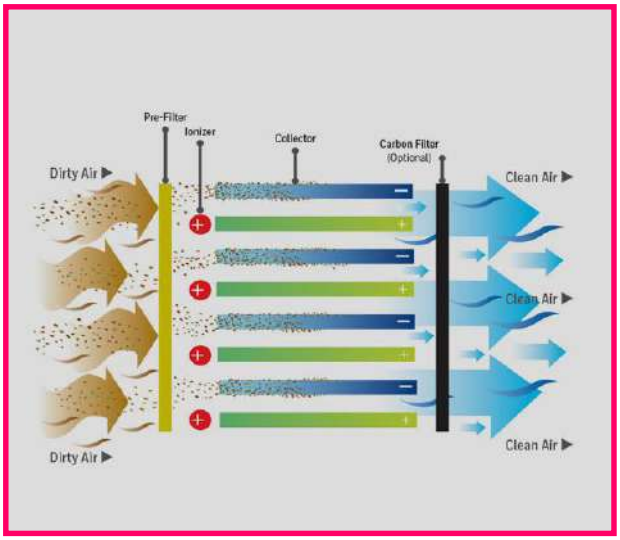
C. REPLACEMENT:

- **Determine When to Replace:** Filters should be replaced when they become excessively dirty or damaged.
- **Dispose of Old Filters:** Dispose of old filters properly, following local regulations.

D. REINSTALLATION AND MAINTENANCE:

- **Reinstall Clean or New Filters:** Ensure the filters are properly reinstalled in their original orientation and position within the AHU.
- **Clean Filter Racks:** Clean the filter racks while the filters are removed.
- **Clean Blower (if necessary):** Clean the blower with a dry cloth.
- **Regular Maintenance:** Implement a regular maintenance schedule, such as monthly filter checks and cleaning or replacement every 2-6 months,





ENCON-III	Ensure Maximum Power Generation from Solar PV Plant & Reduction of Active Energy Consumption from the EB Utility
Assessment Area	Captive Power Generation from the existing Solar PV Plant
ENCON Category	**Deviation monitored in the existing practices and must improve in the Best Operating Practices to achieve the Energy Efficiency**
Observation	• Electrical energy consumption by the industry is being supplied from i) Electricity utility company and ii) Captive power generation from **532 kW** Solar PV plant and iii) Captive power generation from Diesel Generator. • Power generation from the solar PV plant is accounted for nearly **3.2 % during the year 2024-25.** • **Panel cleaning is being done at regular interval (Monthly once and must be appreciated**).
Assessment	• Ensure that the solar PV plant has to connect in all the days and the power generation must be fully utilized by the industry loads during day time in order to achieve quicker payback for the investment made towards setting up of the plant. • The annual energy generation from the solar plant is **6,22,714 kWh** (from April 2024 to March 2025). Considering good amount of sunshine and availability of grid supply; this energy generation is less than compared to its design value.
Recommendation (Target)	• Operate the solar PV during the day time without any failure and also **clean the solar PV panels weekly.** • Make sure that the total power generated from the plant must be fully evacuated and being utilized by the loads, as this step must reduce the energy consumption from the EB utility
Reference	Analysis of one-year electricity utilization & generation data

Energy & Financial Saving Calculation:

Parameters	Description	Value
Annual Energy Generation from the Solar PV Plant	A	6,22,714 kWh
Expected Annual Energy Generation from the Solar PV Plant	B	6,38,400 kWh
For 532 kW solar system; considering the sunshine hours is 4.0 hours/day x 300 days/annum		
Annual Energy Saving	C = (B-A)	**15,686 kWh**
Annual Financial Saving	D= (C*Rs. 10.30/-)	**Rs. 1,61,566/-**
Initial Investment	E	**Almost Zero Cost**
CO_2 Reduction	–	**12.9 Tons/Annum**
Indirect Benefits: Reduction of electrical energy to CO_2 reduction & Lesser Carbon Footprint		

- The total daily incident shortwave solar energy reaching the surface of the ground over a wide area, taking full account of seasonal variations in the length of the day, the elevation of the Sun above the horizon, and absorption by clouds and other atmospheric constituents. Shortwave radiation includes visible light and ultraviolet radiation.

- The average daily incident shortwave solar energy experiences ***some*** seasonal variation over the course of the year.
- The ***brighter*** **period of the year lasts for *2.4 months***, from *February 20* to *May 1*, with an average daily incident shortwave energy per square meter above ***6.3 kWh***. The *brightest* month of the year in Vijayawada is *March*, with an average of ***6.7 kWh***.
- The *darker* period of the year lasts for *4.5 months*, from *May 29* to *October 12*, with an average daily incident shortwave energy per square meter below ***4.6 kWh***. The *darkest* month of the year in Vijayawada is *September*, with an average of ***4.2 kWh***.

(Source: https://weatherspark.com/y/110141/Average-Weather-in-Vijayawada-Andhra-Pradesh-India-Year-Round)



- Energy generation from April-2024 to Mar-2025: **6,22,714 kWh**
- The institution has to correct the solar energy generation and ensure the solar availability must be higher in all days; which directly reduces the electricity consumption from EB Utility.
- Further the higher solar utilization **reduces the payback period**.

ENCON-IV	**Reduction of Active Energy Consumption & Self-loss on the Worn-out Capacitors (In APFC) in the Electrical Distribution Network**
Assessment Area	Electrical Distribution System (Capacitor Banks & Fixed Capacitors)
ENCON Category	**Deviation monitored in the existing practices and must improve in the Best Operating Practices to achieve the Energy Efficiency**
Observations	• Nearly **3,044.2 kVAr** (**870 + 849 + 700.2 + 625 kVAr**) is connected in the electrical distribution system for both Utility I & II. • Entire reactive power is being supplied through APFC with different type capacitors in which **minimum of 3.0 kVAr** and a maximum of **25.0 kVAr** (3-CT configuration). • The detailed measured values of current and voltage are represented separately. • During the testing of APFC; it is found that **Three 3 kVAr + Three 10 kVAr + One 20 kVAr and Twenty-six 25 kVAr** are not injecting its rated current and hence it must be worn-out. • Hence a total of **709 kVAr** are connected in the line which are worn-out and these capacitors must consume more power leading to higher self-loss. • It is a good practice to check the strength of the capacitors at regular interval; as the capacitors are more sensitive to supply voltage.
Assessments	• Testing of capacitor back located at Power house and the results are presented in below.
Recommendation (Target)	• **Recommended to remove the worn-out capacitors and avoid the self-loss generated by these capacitors. Regularly test the current injected & voltage across each capacitor and ascertain its functioning.** • Due to presence of electronic controlled drive system; the supply current harmonics is inevitable. Most of the time, existing of plain capacitors connected in each SSBs must increase the current harmonics. • **This must be avoided by converting the existing plain capacitors into Reactor Coupled Capacitor (RCC) filters**. • This Detuned Reactors prevent harmonic amplification caused due to RESONANCE and avoid the risk of overloading capacitors

Energy & Financial Saving Calculation:

Parameters	Description	Value
Total no. of capacitors in APFC	A	3,044.2 kVAr
Capacity of the worn-out capacitors in the line	B	709 kVAr
Assumed self-loss of the capacitors are **20 W/kVAr;** then cumulative loss for all the worn-out capacitors (nearly 10 % is accounted as self-loss)	C	14.2 kW
Annual Energy Saving	D = (C * 3,000 hours)	**42,600 kWh**
Annual Financial Saving	E = (D * Rs. 10.30/-)	**Rs. 4,38,780/-**
Saving proposed is based on the client's feedback those already audited and implemented this ENCON		
Initial Investment	F	**Rs. 2,80,000/-**
Replacement of worn-out capacitors with their respective values (700 kVAr) would cost of Rs.400/ kVAr = Rs. 2,80,000/-		
Simple Payback Period	G	**0.64 Years**
CO_2 Reduction	–	**34.9 Tons/Annum**
◆ **Indirect Benefits:** Worn out capacitors must take higher power (also energy) and hence it must radiate the heat energy. Hence the temperature in the capacitor enclosure must increase. ◆ Regularly replacing the worn-out capacitors must reduce the risk of fire due to this heat exposure.		

Table-4: Testing of Capacitors (Worn-out) and their Injecting Current

Testing of APFC Capacitors						Location, Capacitor Make & Model
S. No.	Capacitor	Current			Performance Indicator	
		IR (A)	IY (A)	IB (A)		
1.	3+20	23.0	22.3	0.7	Worn-out	U – 1 – APFC – 1: L & T - Round
2.	3+25	0.7	5.1	5.0	Worn-out	U – 1 – APFC – 1: L & T - Round
3.	10+25+25	0.2	61.0	60.5	Worn-out	U – 1 – APFC – 1: L & T - Round
4.	10+25+25	40.9	40.5	41.7	Worn-out	U – 1 – APFC – 1: L & T - Round
5.	10+25+25	37.5	53.5	61.8	Worn-out	U – 1 – APFC – 1: L & T - Round
6.	3	2.8	2.7	2.6	Worn-out	U – 1 – APFC – 2: L & T - Round
7.	25	29.0	30.0	0.5	Worn-out	U – 1 – APFC – 2: L & T - Round
8.	25+25+25+25	0.3	0.5	0.3	Worn-out	U – 2 – APFC – 1: Schneider - Round
9.	25+25+25+25	0.7	0.4	0.5	Worn-out	U – 2 – APFC – 1: Schneider - Round
10.	25+25+25+25	54.3	54.6	0.7	Worn-out	U – 2 – APFC – 1: Schneider - Round
11.	25+25+25+25	0.2	0.5	0.3	Worn-out	U – 2 – APFC – 1: Schneider - Round
12.	25+25	0.5	0.2	0.6	Worn-out	U – 2 – APFC – 2: Schneider - Round

- Online monitoring of the installations **Cos ϕ,** helps to avoid potential penalties on the electric bill.
- Stay informed at all times
- Receive automatic weekly email reports on the status of your bank with the following indicators:
  - → Value of Power factor: OK or Not OK
  - → Average power factor value for the last week
  - → Graphs showing the trend in power factor over the last 12 weeks
  - → Active alerts and notifications



Online monitoring of your installation's Power Factor helps to avoid potential penalties on the electric bill.

Stay informed at all times

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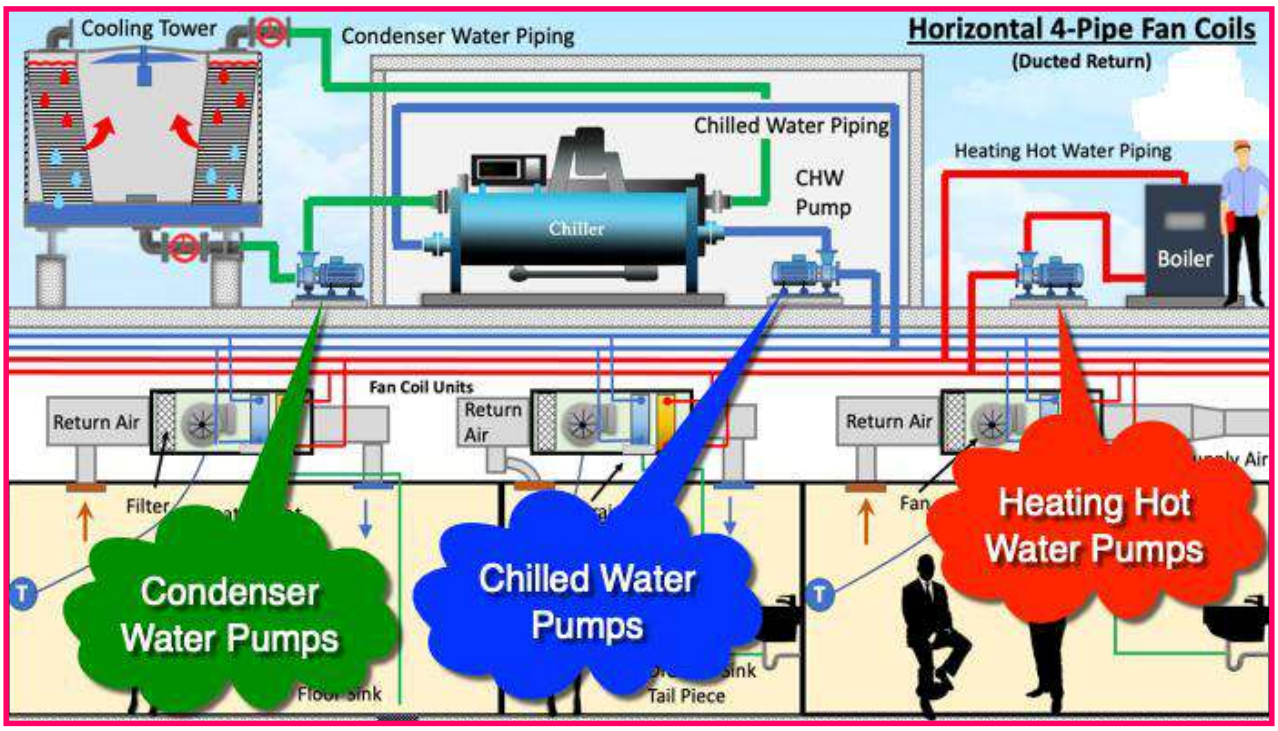


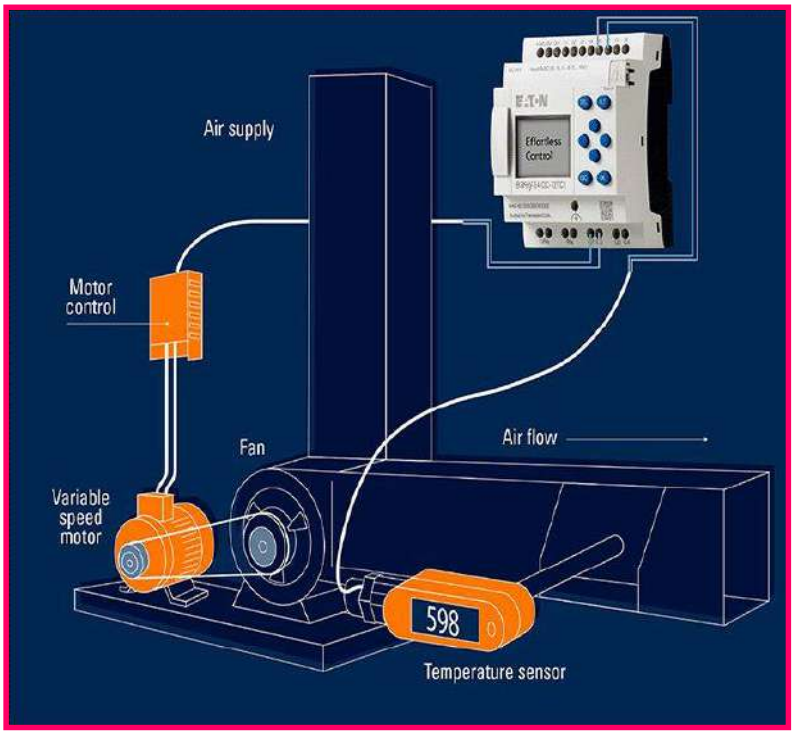
ENCON-V	Energy Saving in Primary Pump by Converting the EE Pumps with Closed Loop VFD Automation
Assessment Area	HVAC Chiller Network - Primary pump
Observations	• In **Utility I; 3 Nos of 450 TR chiller** are available and are running based on the respective connected cooling loads. • **3 no's of primary pumps** are available and are operated based on the chiller operation. These pumps are **22 kW/30 HP/IE-2/1460 rpm/η = 91.6 %;** with Direct driven and no speed control and running at constant speed. • It is recommended to control the water flow and pump head by adjusting the operating frequency using Closed Loop operation (If required; connect and control with BMS).
Assessments	• Primary pumps must also be controlled using VFD system with closed loop operation by considering the water pressure and flow to the chiller units
Recommendation (Target)	• Similar to secondary pumps; it is recommended to replace the existing conventional motor connected with the secondary pump with IE-3 motor (even higher standard also) of same capacity (with good brand). • Higher efficiency motors consume less power for the same work done than compare to the conventional motor. It is expected to save a minimum of 4-5 % higher efficiency and offer good amount of energy saving. • Replace the motor in one pump and ensure the energy savings (based on the operation it may vary); then extent the same to all the secondary pumps • Currently the process industries are moving to IE-3 category having an increased efficiency of up to 94 % (ensures 2 % energy saving). Hence the audit team recommends the concerned authorities to insist the supplier to supply any new installations with IE-3 motors (Premier Efficiency). Also, if the existing motor fails (coil failure, frequent bearing failure and any other mechanical failures), it is better to replace with IE-3 motors. • Connect the operation of these pumps in BMS and control the operation based on the set temperature (and hence adjust the water pressure & flow)

Energy and Financial Saving Calculation:

Index	Energy Saving in Primary Pump by Converting the Motor in to Energy Efficient (IE-3) Motor and Closed Loop VFD Automation (Based on the Static Head)
Investment	VFD with Closed loop control with either fully automatic or semi-automatic total initial investment of **Rs, 2,00,000/-** for one pump for three pumps **3 No's * Rs.2,00,000/- = Rs. 6,00,000/-**
Energy Savings	**20 % of 56.8 kW** (Average power consumption of all primary pumps) **= 11.4 kW x 4,000** running hours/annum = **45,600 kWh/Annum.**
Financial Savings	Annual cost saving for **45,600 kWh x Rs. 10.30/kWh = Rs. 4,69,680/-**
Simple Payback	For the investment of **Rs. 6,00,000/-** & simple payback is **1.28 Years.**

Plan of action	• It is recommended to convert the existing motor (efficiency of 88 %) with IE-3 motor (having an efficiency of 92.6 %) in one primary pump and observe the result. • Then extend the same ENCON to all primary pumps with higher running runs and this cumulate the energy savings.
CO_2 Reduction	• **28.0 Tons/Annum**
Indirect Benefits: Reduction of electrical energy to CO_2 reduction & Lesser Carbon Footprint	





Benefits of VFD Control:

- **Variable Flow:** VFDs enable the secondary pumps to adjust their speed and flow rate to match the cooling load, optimizing energy efficiency and reducing wasted energy during low-load periods.
- **Load Management:** By separating the distribution loop from the primary loop, secondary pumps with VFDs provide better load management and distribution, accommodating changes in cooling requirements throughout the building.
- **Reduced Pump Power:** Adjusting the pump speed to match the cooling load significantly reduces pump power consumption, leading to energy savings.

Control Strategies:

The VFD control system often uses a combination of sensors and feedback loops to adjust pump speed:

→ **Differential Pressure Control:** A differential pressure sensor measures the pressure drop across the system, and the VFD adjusts the pump speed to maintain a constant differential pressure.

→ **Temperature Control:** The leaving chilled water temperature from the chiller can be monitored, and the VFD can adjust the pump speed to maintain the desired temperature.

→ **Flow Control:** Flow transmitters can sense the chilled water flow, and the VFD can adjust the pump speed to maintain a desired flow rate.

Examples of VFD Control:

- **Constant Differential Pressure:** The VFD modulates the pump speed to maintain a constant differential pressure across the system, ensuring adequate flow to all loads.
- **Minimum Flow:** VFDs can be programmed to ensure a minimum flow rate across the chiller to prevent issues like cavitation or overheating.

ENCON-VI	Reduction of Higher Input Line Voltage to Standard Value by Adjusting the Tap Position at the Secondary Side
Assessment Area	Electrical Distribution and Supply Voltage Regulation
Observation	• The university has seven transformers (at the time of audit one transformer was under maintenance located at CV Raman block) of **2,000 kVA** Four Nos, **1,250 kVA** One Number and **1,000 kVA** of One Number feeding the energy to the entire campus. • These transformers are having OLTC & RTCC to control the supply voltage at constant level. Even though OLTC & RTCC are available; all the equipment's are supplied with always higher voltage and applying voltage stress on the all the equipment's. • The average value of the supply voltage from the transformer is varying between **409-438 (RMS-LL) and 236-253** (RMS-Line to Phase) which is higher as against the standard of 230 V & 400 V for 1-Ph & 3-Ph.
Assessment	• Supplying the higher voltage to the machines i) may decrease the life of the insulation available in the system ii) malfunction of electronic control devices and iii) slightly increase the active power consumption. • Even though the presence of OLTC controller by RTCC; the sensing circuit for RTCC may develop some error (either in the feedback or in the threshold setting). • Maintain the supply voltage nearly 400 V line to line (230 V phase voltage) as the most of the electrical equipment's are voltage sensitive in nature. • High voltage at the equipment terminal can damage that equipment through insulation breakdown, overheating, component failure in the equipment, potentially leads to fire, explosions and system instability.
Recommendation (Target)	• Reduction of transformer secondary voltage at least by 10 V using appropriate control (RTCC or concerned tapping) and maintain the line to line voltage. • Also, it is noted that the voltage drops between the power house to end of the electrical network is much lesser & hence maintaining the line to line voltage between **400 V - 405 V** is ideal for the equipment's and also saves considerable energy savings.
Reference	• Screen measurement taken at different supply points shown below.

Energy and Financial Saving Calculation:

Index	**Reduction of Higher Input Line Voltage to Standard Value by Adjusting the Tap Position at the Secondary Side**
Investment	Adjustment of VCB PT/CT sensing a of the OLTC & RTCC optimal position at **Zero Cost Investment**
Energy Savings	**0.25 %** of **1,82,86,800** kWh **= 45,717 kWh/Annum.**
Financial Savings	Annual cost saving for 45,717 kWh x Rs.10.30/kWh **= Rs. 4,70,885/-**
Simple Payback	Since it is a Zero Cost Investment; the payback is **Immediate**
Plan of action	• Immediate payback with optimal voltage • Increases the equipment reliability by reducing the voltage stress

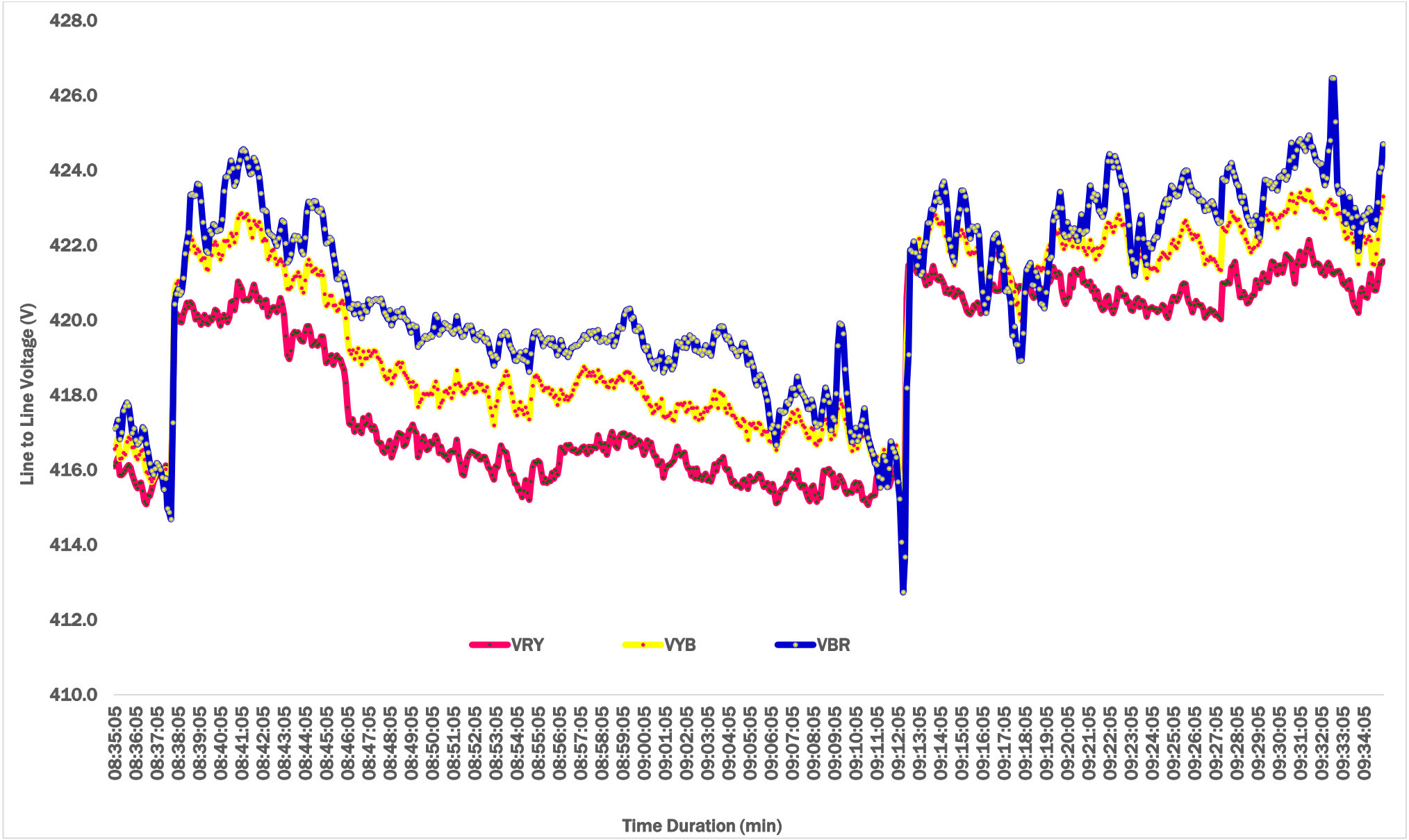


Fig.2: Line to Line Voltage (RMS) measured in the Utility I; Transformer II (LT Side)

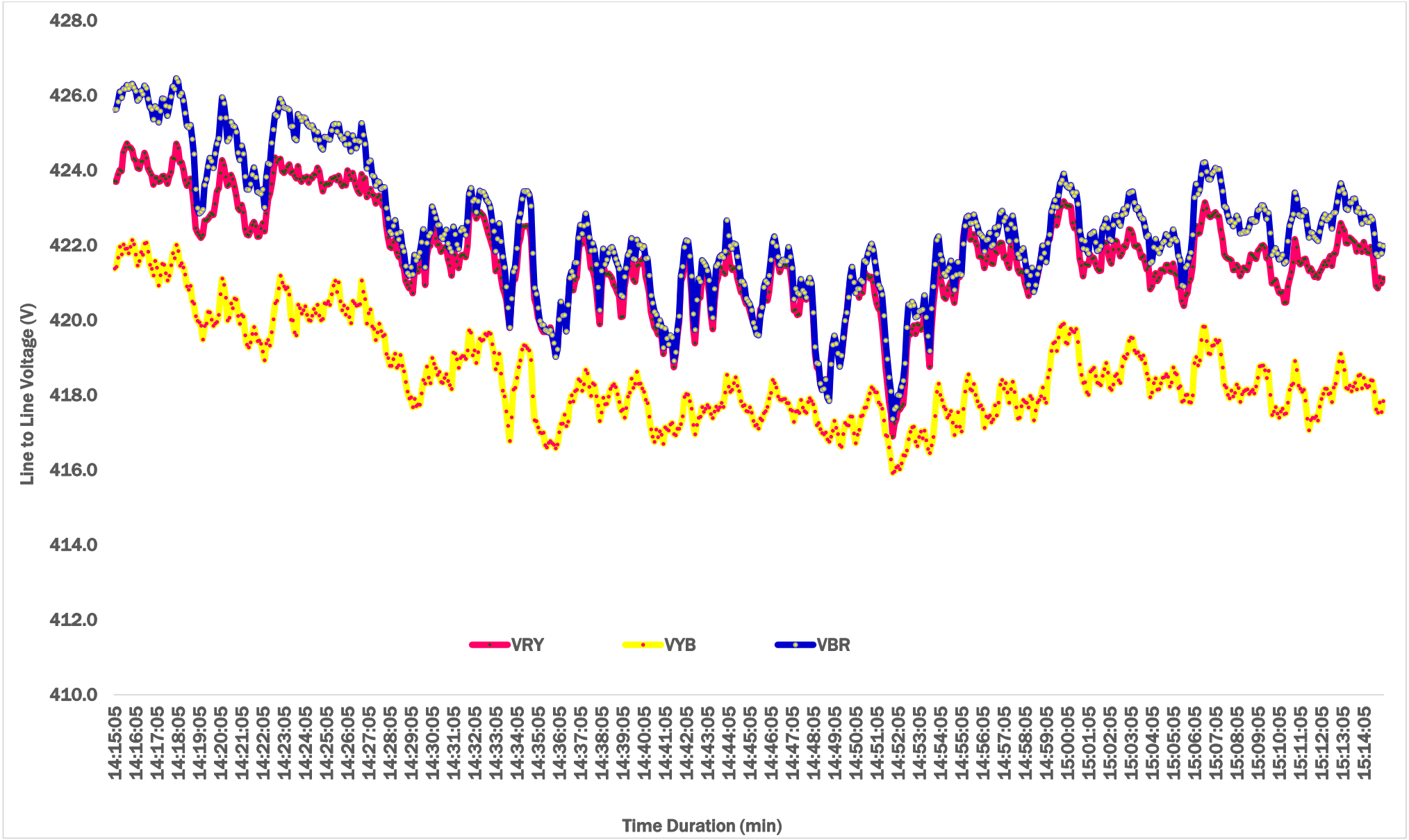
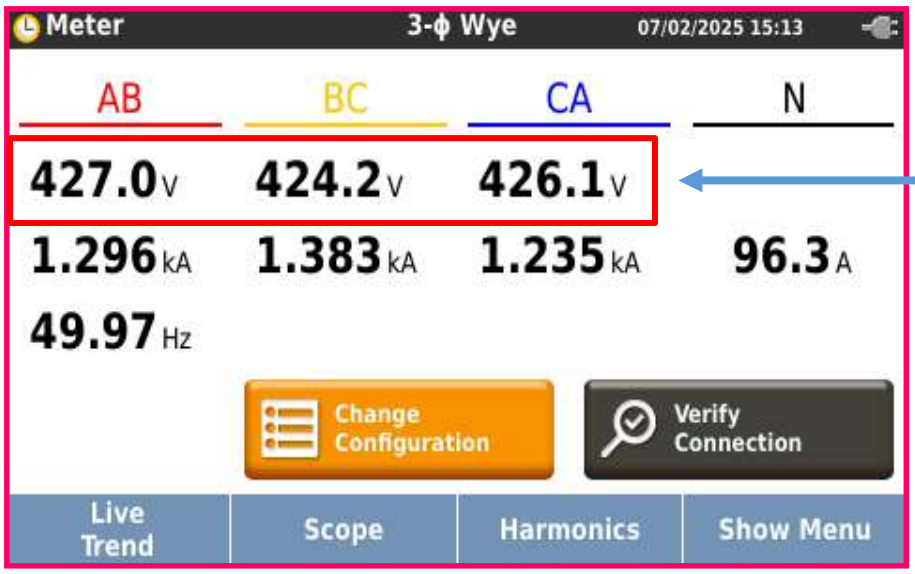
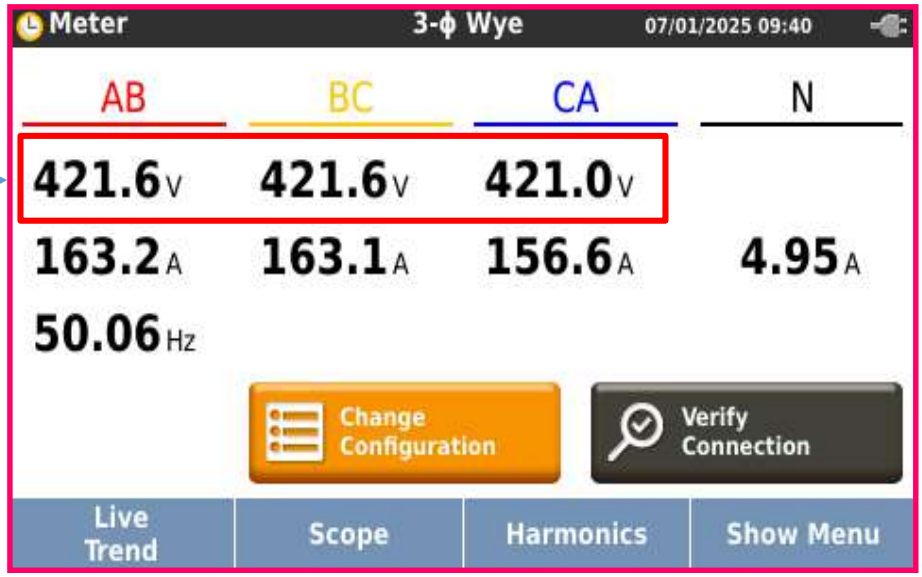


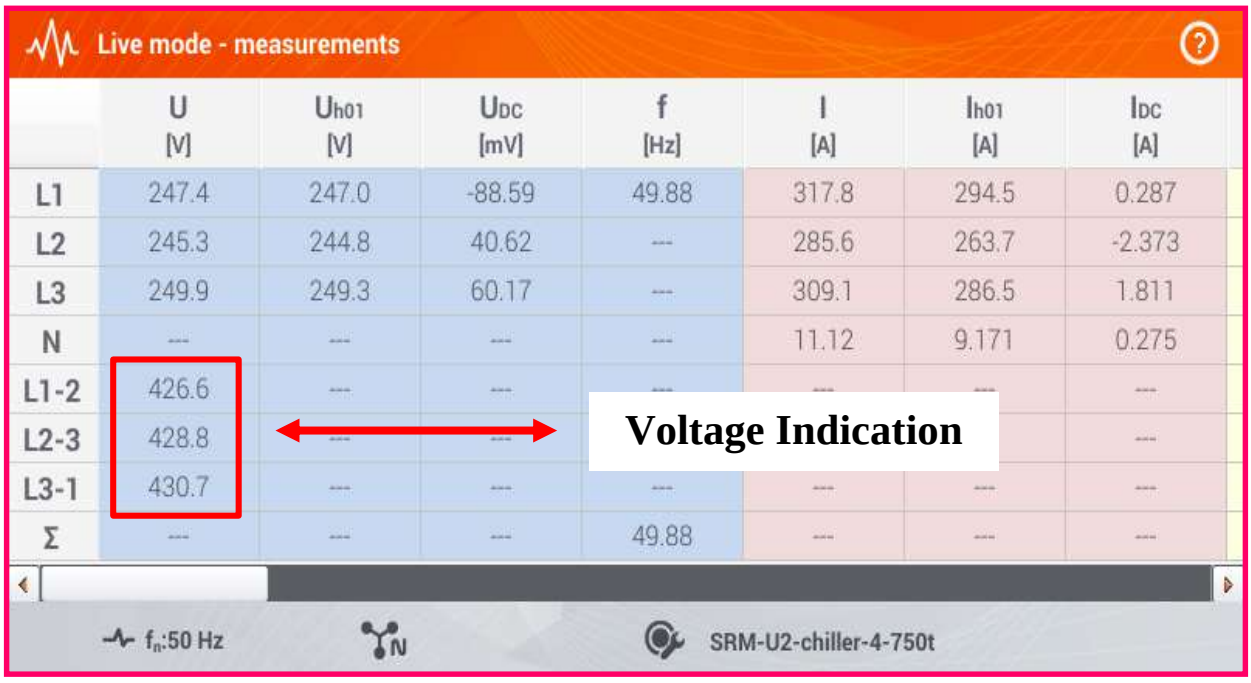
Fig.3: Line to Line Voltage (RMS) measured at the in the Utility II; Transformer III (LT Side)



Voltage Indication

Voltage Indication





Voltage Indication

ENCON-VII	Replacement of Existing Convention Ceiling Fans into Electronically Commutated BLDC Fans
Assessment Area	Energy conservation in ceiling fans located in the university campus
ENCON Category	Deviation monitored in the existing practices and must improve in the Best Operating Practices to achieve the Energy Efficiency
Observations	University area including all Buildings, Class, Lab, Faculty cabins, Auditorium, Hostel rooms & Other areas
Assessments	• BLDC fans operate in less energy with same air delivery. Similarly, these fans generate lesser noise, runs with inverter supply, remote control-based speed control, aesthetic look and better lifespan. • Conventional fans consume 1 unit of electricity for approximately 12-13 hours of running period, whereas the BLDC fans consume the same 1 unit of electricity for nearly 28-29 hours.
Recommendation (Target)	• Recommended to replace the existing conventional fans into EC BLDC fans in a phased manner and ensure good energy saving.

Energy and Financial Saving Calculation:

Parameters	Description	
Total No. of Fans available	**Totally 1,432 Nos** of conventional fans available in both the hostels; and assuming **initially to replace 500 No's** which accounts for **35 kW**	
Approx. Operating Hours (Average assumed value)	**10 hours/day & 300 days/Annum = 3,000 hours/annum** (Actual operating hours may change)	
Energy Calculation	**Before**	**After**
Power Consumed (Approx.)	35 kW	17.5 kW
Expected Reduction of Power	–	**17.5 (50 % ↓)**
Annual Energy Saving	–	**52,500 kWh**
Annual Financial Saving	–	**Rs. 5,40,750/-**
Saving proposed is based on the client's feedback those already implemented this ENCON		
Initial Investment	-	**Rs. 9,00,000/-**
(Considering Rs. 2,000/fan - Salvage value of Rs. 200/fan for old fan = Rs. 1,800/fan)		
Simple Payback	–	**Nearly 1.66 Years**
Indirect Benefits: Reduction of electrical energy to CO2 reduction & Lesser Carbon Footprint		
CO_2 Reduction	–	**43.1 Tons/Annum**

(Note: BLDC fans consume **less power when it operates at low speeds** which further saves energy. Further a conventional fan draws nearly about **100 VA**, whereas the EE fan draws only **30 VA.** This will be more beneficial for HT consumer as direct reduction of kVA rating).

One No-star regular fan's consumption in a year	1 x 2520 x 42 = 105840Wh or 105.84Units/year
For 30 million No-star fans sold in 2022, The energy consumed in a year	105.84 x 30 x 106 = 3.175 BillionUnits.
One 5-star SEE fan's consumption in a year	1 x 2520 x 14 = 35280Wh or 35.28Units/year
If 30 million 5-star SEE fans were sold in 2022,The energy consumed in a year	35.28 x 30 x 106 = 1.058 BillionUnits.
One 1-star fan's consumption in a year	1 x 2520 x 39 = 98,280Wh or 98.28Units/year
If 30 million 1-star fans are sold in 2022,The energy consumed in a year	98.28 x 30 x 106 = 2.948 BillionUnits. Note: (1 Unit = 1kWh)

SERVICE VALUE	STAR RATING	MAX POWER	MONEY SAVING	
x < 4.0	0	>75 W	0	
4.0 ≤ x < 4.5	1	<57 W	>300 Rs/Yr	→ Regular fan
4.5 ≤ x < 5.0	2	<51 W	>600 Rs/Yr	→ Fewer Choices & Low ROI
5.0 ≤ x < 5.5	3	<46 W	>800 Rs/Yr	
5.0 ≤ x < 6	4	<42 W	>900 Rs/Yr	
x > 6.0		<38 W	>1000 Rs/Yr	→ BLDC Motor

(x - Measured Sevice value)

All values are nominal for **48" inch** fan delivering **230 CMM** airflow for **12 hours/day at Rs 6.50 / Unit.**

HOW TO CHOOSE A CEILING FAN?

STEP 1 SIZE

To find the appropriate ceiling fan span, consider the length and breadth of the room

Ceiling Fan Sizes (in inches)

- 36''
- 42''
- 48''
- 56''
- 60''

ROOM LENGTH (IN FEET)

ROOM BREADTH (IN FEET)

	7	8	9	10	11	12	13	14	15	16	17	18	19	20
7	1	1	1	1	1	1	1	2	2	2	2	2	2	2
8	1	1	1	1	1	1	1	1	2	2	2	2	2	2
9	1	1	1	1	1	1	1	1	1	2	2	2	2	2
10	1	1	1	1	1	1	1	1	1	2	2	2	2	2
11	1	1	1	1	1	1	1	1	1	2	2	2	2	2
12	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 2	2 2	2 2	2 2	2 2	2 2
13	1	1	1	1	1	1	1	1	1	1	2	2	2	2
14	1 4	1 4	1 4	1 4	1 4	1 4	1 4	1 4	1 4	1 4	2 4	2 4	2 4	2 4
15	1 4	1 4	1 4	1 4	1 4	1 4	1 4	1 4	1 4	1 4	4	4	4	4
16	1 4	1 4	1 4	4	4	4	4	4	4	4	4	4	4	4

Refer the above table to know the ceiling fan size according to the length and breadth of your room.

HIGH FLOW CEILING FAN

Large volume of air @ Optimal speed



- BREEZY FEEL
- SUITS LONGER USE

Bedroom | AC rooms | Living room | Pooja room | Office space



HIGH SPEED CEILING FAN

Small volume of air @ High speed



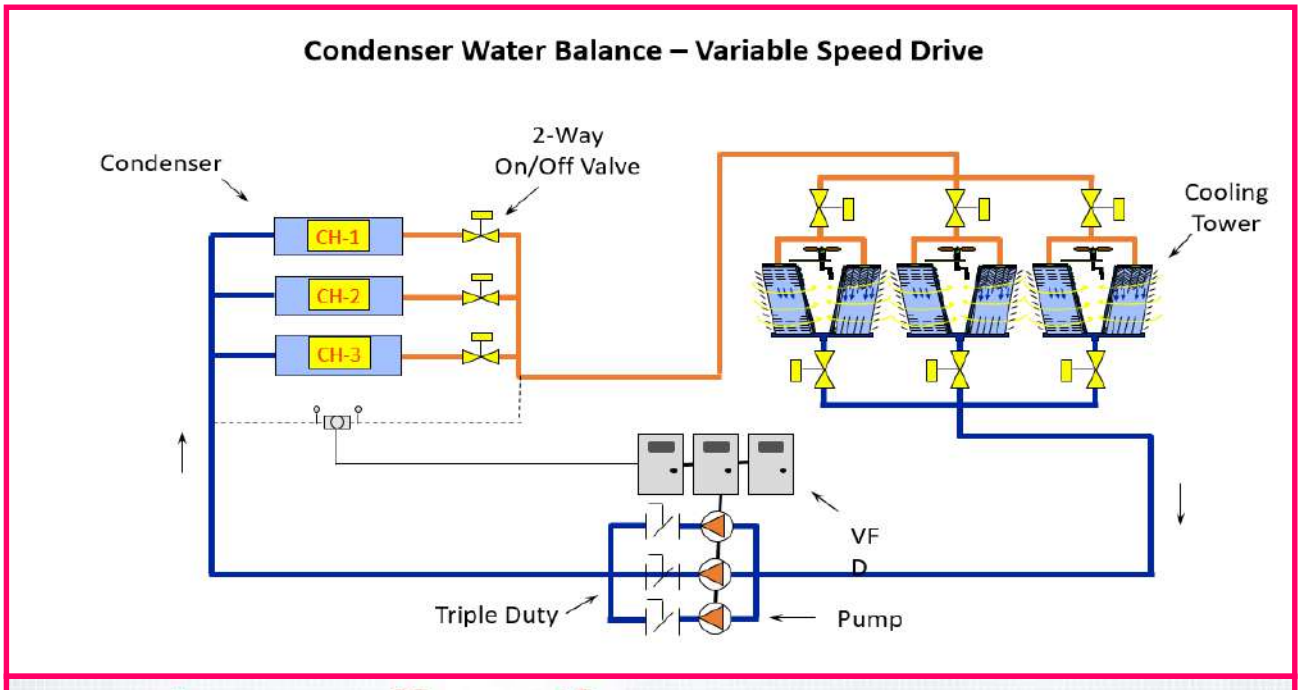
- FORCEFUL FEEL
- SUITS BRIEF USE (<30min)

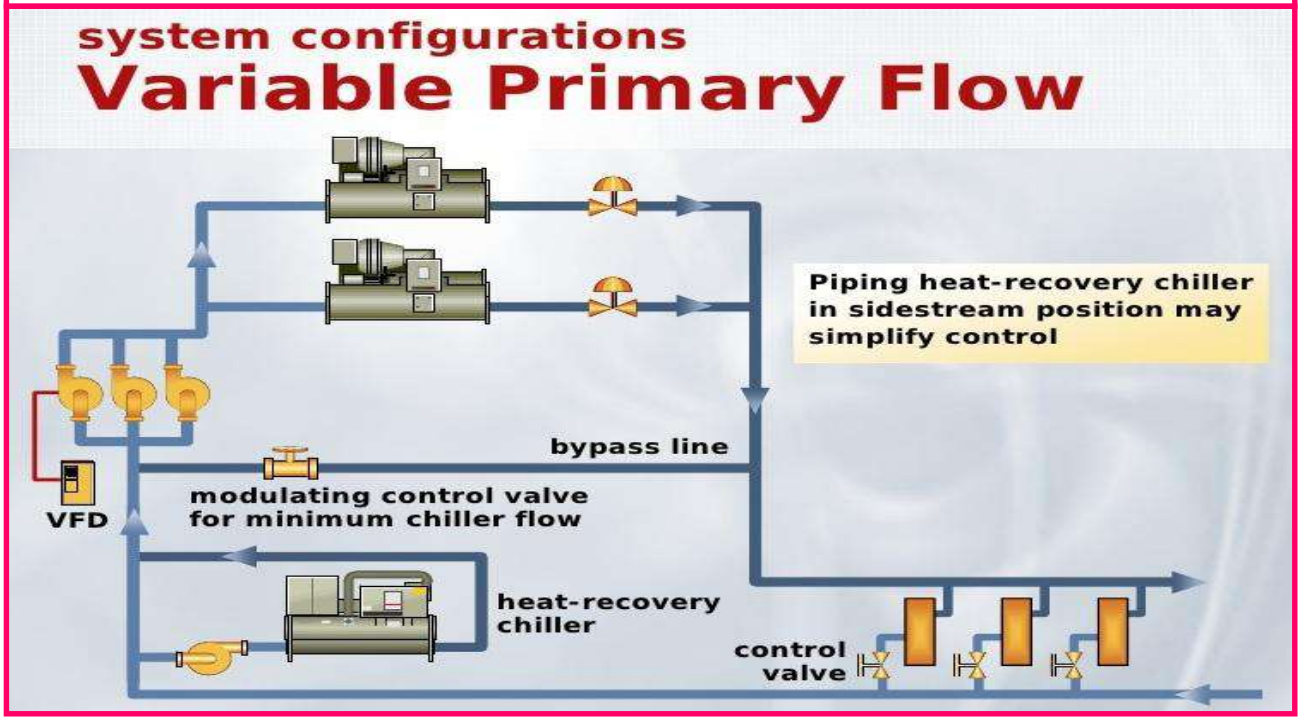
Living room | Dining room | Kitchen | Waiting area

ENCON-VIII	Energy Conservation through Closed Loop Common VFD Automation for Condenser Pumps in Utility I Water Cooled Chillers
Assessment Area	HVAC Chiller Network – Condenser Pump Automation
Observations	• In **Utility I; 3 Nos of 450 TR chiller** are available and are running based on the respective connected cooling loads. • **3 no's of condenser pumps** are available (only 2 is running and 1 is under maintenance) and are operated based on the chiller operation. • These pumps are 30 **kW/40 HP/IE-2/1465 rpm/η = 92.3 %/IE-2; XYLEM make;** with direct driven and no speed control and running at constant speed. • **Pump:** Q = 309 m^3/hr; H = 26 m; Bell & Gossett make. • It is recommended to control the water flow and pump head by adjusting the operating frequency using Closed Loop operation (If required; connect and control with BMS).
Assessments	• Primary pumps must also be controlled using VFD system with closed loop operation by considering the water pressure and flow to the chiller units
Recommendation (Target)	• Variable frequency drives (VFDs) offer significant benefits for condenser pumps, primarily through energy savings and improved system control. • By adjusting pump speed to match the cooling load, VFDs minimize energy consumption, reduce wear and tear, and enhance overall system performance. • Recommended to control One Common VFD for all the three condenser; since only one pump is running at the time. • Even if two pumps are planned to run; then slightly oversize the power capacity of the VFD to accommodate two pump running at the same time. • **Reduced Energy Consumption:** VFDs allow pumps to operate at variable speeds, consuming only the energy required by the system at any given time. • **Optimized Performance:** Instead of running at full speed constantly (and potentially throttling flow with valves), VFDs enable pumps to operate at their most efficient point on the performance curve, minimizing energy waste. • **Significant Savings:** Studies have shown that VFDs can reduce energy consumption by 20-50% compared to fixed-speed pumps. • **Precise Flow Control:** VFDs allow for precise control of pump speed, enabling fine-tuning of flow rates to match the cooling demand. • **Reduced Mechanical Stress:** By soft-starting the pump and avoiding sudden stops and starts, VFDs minimize stress on the motor and other components, extending their lifespan. • **Smoother Operation:** VFDs help to eliminate abrupt changes in pump speed, leading to more stable and reliable system operation. • **Reduced Noise:** Slower pump speeds associated with VFD operation can result in lower noise levels, improving the overall comfort of the building's environment.

Energy and Financial Saving Calculation:

Index	**Energy Conservation through Closed Loop Common VFD Automation for Condenser Pumps in Utility I Water Cooled Chillers**
Investment	VFD with Closed loop control with either fully automatic or semi-automatic total initial investment of **Rs, 4,00,000/-** for a common system.
Energy Savings	**20 % of 66.0 kW** (Average power consumption of two condenser pump running at the time of audit) **= 13.2 kW x 4,000** running hours/annum = **52,800 kWh/Annum.**
Financial Savings	Annual cost saving for **52,800 kWh x Rs. 10.30/kWh = Rs. 5,43,840/-**
Simple Payback	For the investment of **Rs. 4,00,000/-** & simple payback is **0.74 Years.**
CO_2 Reduction	• **43.3 Tons/Annum**
Indirect Benefits: Reduction of electrical energy to CO_2 reduction & Lesser Carbon Footprint	





ENCON-IX	Reduction of Mechanical Transmission Losses in Belt Driven AHU Blowers & Condition Monitoring of the Belt Slippage Loss
Assessment Area	Energy assessment in belt-driven AHU blower motors
ENCON Category	**Deviation monitored in the existing practices and must improve in the Best Operating Practices to achieve the Energy Efficiency**
Observations	• Nearly **102 Nos of AHUs** are available in the building with various air deliver capacity to provide the chilled air to the consumer premises. • At the time of auditing **48 AHUs only running**. Only **34 AHUs** are driven by the Belt configuration; the remaining are direct driven button fan type blowers • All the AHUs are connected with the belt-driven conventional blowers; mostly with 2-Groove/2 Belt configuration. • The audit team observes that the available motor-drive systems are fitted V-belt. Below table represents the motor-machine energy transmission system.
Assessments	• Power measurement taken on all the Rotor Vane, All Roller motors, ID fan and Hot air Fan motor. • Measurement on pulley diameters (both motor and machine side), running speed measurement & estimation of slippage belt driven system under existing load condition.
Observation	☞ The acceptable wear and tear for A & B -section V-belt, typically falls within a range of 10-20% of wear before it needs to be replaced. ☞ This percentage refers to the reduction in the overall thickness or width of the belt due to usage over time. ☞ In general: If the belt has worn down by more than 20%, it should be replaced to avoid potential performance issues, slippage, or even failure. ☞ Regular inspections should focus on checking for signs of cracking, fraying, and loss of flexibility, as these can also indicate wear beyond acceptable levels. ☞ Be sure to follow the manufacturer's specific recommendations for your belt, as the wear tolerance might vary depending on the application and the conditions the belt is used under (e.g., temperature, load or environment).
Recommendation (Target)	• It is recommend replacing the existing V belts into raw cogged belt (also known as Notched belt) which reduces the slippage loss between the motor to machine also provides good life to the system. • Notched V-belts helps reduce the bending resistance of the belt. As a result, they are 2% more efficient than standard V-belts because they run cooler and last longer. • Replacement of cogged belts is much easier and quick to retrofit without any change in the system unlike the flat belt. Raw cogged belts ensure possible savings of around 6 % and also improve the output power for the same motor power consumption. • The change in belt from the conventional to notched belts in all AHUs ensure nearly 6-8 % savings and maintaining less slippages especially in lower HP motors (below 10 HP).

	• Replacement of conventional V-belt into cogged belt provides faster rotating rpm and hence pulley resizing may also be done to further reduce the active power consumption. • Also, it is recommended to measure the speed of the motor and blower (during full load of operation) and estimate the slippage loss at regular interval. If the slippage loss is more than or equal to 2 %; then immediately take necessary action to reduce it to below 2 % since it contributes both energy loss and less output.

S. No.	Motor Description	Belt Make	Belt Type	Remarks
Belt – Pulley mismatch for high-capacity machines				
1.	AHU - 1 - 5 - HJB Block	Eco Drive	V-Belt (A 40)	2G/2B
2.	AHU - 1 - 6 - HJB Block	Eco Drive	V-Belt (A 36)	2G/2B
3.	AHU - 2 - 5 - HJB Block	Eco Drive	V-Belt (A 40)	2G/2B
4.	AHU - 2 - 6 - HJB Block	Eco Drive	V-Belt (A 43)	2G/2B
5.	AHU - 3 - 5 - HJB Block	Eco Drive	V-Belt (A 42)	2G/2B
6.	AHU - 3 - 6 - HJB Block	Eco Drive	V-Belt (A 42)	2G/2B
7.	AHU - 4 - 5 - HJB Block	Eco Drive	V-Belt (A 46)	2G/2B
8.	AHU - 4 - 6 - HJB Block	Eco Drive	V-Belt (A 40)	2G/2B
9.	AHU - 5 - 3 - HJB Block	Eco Drive	V-Belt (A 44)	2G/1B
10.	AHU - 5 - 4 - HJB Block	Eco Drive	V-Belt (A 34)	2G/2B
11.	AHU - 1 - 1- VSB Block	Poly-F	V-Belt (A 43)	2G/2B
12.	AHU -1 - 3 - VSB Block	Eco Drive	V-Belt (A 43)	2G/2B
13.	AHU - 1 - 4 - VSB Block	Turbo Flex	V-Belt (A 34)	2G/2B
14.	AHU - 4 - 1 - VSB Block	Eco Drive	V-Belt (A 44)	2G/1B
15.	AHU - 5- 1 - VSB Block	Eco Drive	V-Belt (A 43)	2G/2B
16.	AHU – 1 – 1 – X-Lab	Turbo Flex	V-Belt (B 104)	3G/3B
17.	AHU – 1 – 2 – X-Lab	Turbo Flex	V-Belt (B 104)	3G/3B
18.	AHU – 1 – 1 – Ganga Hostel	Eco Drive	V-Belt	2G/2B
19.	AHU – 1 – 1 – Annapurna Mess	Eco Drive	V-Belt (A 49)	2G/2B
20.	AHU – 1 – 2 – Annapurna Mess	Eco Drive	V-Belt (A 54)	2G/2B
21.	AHU – 2 – 2 – Annapurna Mess	Eco Drive	V-Belt (A 46)	2G/2B
22.	AHU – 1 – 1 – SRK Block	Escon	V-Belt (B 76)	2G/2B
23.	AHU – 1 – 2 – SRK Block	Eco Drive	V-Belt (B 76)	2G/2B
24.	AHU – 2 – 3 – SRK Block	–	V-Belt	2G/2B
25.	AHU – 2 – 4 – SRK Block	Eco Drive	V-Belt (B 101)	2G/2B
26.	AHU – 3 – 3 – SRK Block	Eco Drive	V-Belt (B 60)	2G/2B
27.	AHU – 3 – 4 – SRK Block	Eco Drive	V-Belt (B 76)	2G/2B
28.	AHU – 4 – 3 – SRK Block	Eco Drive	V-Belt (B 51)	2G/2B
29.	AHU – 4 – 4 – SRK Block	Eco Drive	V-Belt (B 76)	2G/2B
30.	AHU – 5 – 3 – SRK Block	Eco Drive	V-Belt (A 67)	2G/2B

S. No.	Motor Description	Belt Make	Belt Type	Remarks
31.	AHU – 6 – 3 – SRK Block	Eco Drive	V-Belt (B 51)	2G/2B
32.	AHU – 6 – 4 – SRK Block	Eco Drive	V-Belt (B 76)	2G/2B
33.	AHU – 7 – 1.1 – SRK Block	Eco Drive	V-Belt (B 54)	2G/2B
34.	AHU – 7 – 1.2 – SRK Block	Eco Drive	V-Belt (B 55)	2G/2B

(Note: Kindly rectify the belt-pulley mismatch and resize the pulley according to the load)

Table-5: Representation of Speed, Belt slippage & Speed Loss in Belt-Driven Motors

Motor Name	Pulley Dimensions (mm)		Measured Speed (rpm)		Desired Speed (rpm)	% Slip	Speed Loss (RPM)	Motor Power (kW)
	Motor	Machine	Motor	Machine				
HJB Block								
AHU 1 - 5	120	140	1,038	840	890	5.6	50	3.7
AHU 1 - 6	120	140	1,317	1,066	1,129	5.6	63	3.7
AHU 2 - 5	120	140	1,010	810	866	6.4	56	3.7
AHU 2 - 6	120	140	1,054	891	903	1.4	12	3.7
AHU 3 - 5	120	140	1,318	1,115	1,130	1.3	15	3.7
AHU 3 – 6	110	140	1,184	919	930	1.2	11	3.7
AHU 4 – 5	110	140	1,388	1,075	1,091	1.4	16	3.7
AHU 4 - 6	110	140	1,279	981	1,005	2.4	24	2.2
AHU 5 - 3	110	140	1,266	981	995	1.4	14	3.7
AHU 5 - 4	110	110	1,412	1,395	1,412	1.2	17	3.7
VSB Block								
AHU 1 – 1	110	140	1,356	1,024	1,065	3.9	41	3.7
AHU 1 - 3	120	140	1,310	1,049	1,123	6.6	74	3.7
AHU 1 - 4	110	110	1,302	1,285	1,302	1.3	17	2.2
AHU 4 - 1	110	140	1,166	904	916	1.3	12	3.7
AHU 5- 1	110	140	1,164	891	915	2.6	24	3.7
X Lab Block								
AHU 1 – 1	160	340	1,183	545	557	2.1	12	15.0
AHU 1 – 2	160	340	1,179	546	555	1.6	9	15.0
Ganga Hostel								
AHU 1 – 1	130	160	1,471	1,182	1,195	1.1	13	5.5
Annapurna Mess								
AHU 1 – 1	120	180	1,032	678	688	1.5	10	5.5
AHU 1 – 2	100	220	1,031	461	469	1.6	8	5.5
AHU 2 – 2	110	180	1,186	714	725	1.5	11	5.5
SRK Block								
AHU 1 – 1	130	180	1,182	837	854	2.0	17	5.5
AHU 1 – 2	130	180	1,471	1,049	1,062	1.3	13	5.5
AHU 2 – 3	150	220	1,493	995	1,018	2.3	23	7.5

Motor Name	Pulley Dimensions (mm)		Measured Speed (rpm)		Desired Speed (rpm)	% Slip	Speed Loss (RPM)	Motor Power (kW)
	Motor	Machine	Motor	Machine				
AHU 2 – 4	140	260	1,472	783	793	1.2	10	7.5
AHU 3 – 3	130	180	1,148	815	829	1.7	14	5.5
AHU 3 – 4	130	150	1,442	1,210	1,250	3.2	40	5.5
AHU 4 – 3	130	160	1,466	1,175	1,191	1.4	16	5.5
AHU 4 – 4	130	180	1,180	841	852	1.3	11	5.5
AHU 5 – 3	120	140	1,487	1,248	1,275	2.1	27	3.7
AHU 6 – 3	130	160	1,460	1,156	1,186	2.6	30	5.5
AHU 6 – 4	130	180	1,414	1,004	1,021	1.7	17	5.5
AHU 7-1.1	120	100	1,432	1,593	1,718	7.3	125	2.2
AHU 7-1.2	120	100	1,418	1,575	1,702	7.4	127	2.2
Average						4.9	29.2	–

Note: HJB Block AHU 1-5, 1-6, 2-5, VSB Block 1-3, SRK Block 7-1.1 & 7-1.2 are more than 5 %; which leads to productivity loss. The maintenance team has to take immediate action to change the belt (preferably the cogged belt) and try to reduce the existing slippage to less than 2 %

Energy and Financial Saving Calculation:

Parameters	Description	Value
Running power consumption above mentioned motors	A	118.3 kW
% Energy Savings	B	12 %
Power Reduction after Replacement	C = (B * A)	14.2 kW
Approximate Annual Running Hours	D	4,000 hours
Annual Energy Savings	E = (C * D)	**56,800 kWh**
Annual Financial Savings	F = (E * Rs. 10.30/-)	**Rs. 5,85,040/-**
Saving proposed is based on the client's feedback those already implemented this ENCON		
Initial Investment	G	**Rs. 6,80,000/-**
• **20 %** higher cost for **34 motors mentioned** above with an approximate cost of **Rs.6,80,000**/- Including the change of convention pulley into taper lock pulley in all belt driven machines also to correct the groove/belt mismatch corrections. • The above cost is worked out for mixed capacity and size of the belt & pulley combination.		
Simple Payback Period	H = (G/F)	**Nearly 1.16 Years**
Plan of Action	• V belts are vanishing from the industry. It is high time to switch over to this cogged belt for longer run hours.	
CO_2 Reduction	• **46.6 Tons/Annum**	
Indirect Benefits: Reduction of electrical energy to CO_2 reduction & Lesser Carbon Footprint		

Note: These belts and pulleys replacement will give kWh savings and more important the production per machine will increase after, due to the **speed loss by slip is restored back to less than 1 %**

Customer details	M/s. BLUEMOUNT CASTINGS P Ltd., Coimbatore 19.	
e mail ID	bluemountcastings@gmail.com	
Machine details	SAND MIXER - 250 Kg Rated Capacity	
Description	Before Changing Pulleys and Belts	After changing Pulleys and Belts
Motor HP/KW	20/15	20/15
Motor RPM	1440	1440
Type of Motor drive	Star Delta	Star Delta
Motor Pulley Dia. In mm	6.5 Inches	6. 0 Inches.
Machine Pulley dia. In mm	7.5 Inches	6.9 Inches.
Belt Specification	B 64	XPB 1600
No of Belts	4	3
Make of Belt	Mitsuboshi	Mitsuboshi
Machine Pulley RPM - Calculated value.	1248	1250
Sand Mixing done	180 Kgs	215 Kg.
Power consumption	SAME KWH	SAME KWH
Restoration in Productivity		20 % More.
Results Observed for 4 months.	Dec-18	May 2019.

Note: A sample case study on Restoration of Productivity after changing the conventional belt-pulley into Cogged Belt (XPB belts).

BLUEMOUNT CASTINGS
PRIVATE LIMITED

To
Mangal Singh Bros (MSB)
Coimbatore-641029

15 May 2019

Attn: Mr KS Subramanian

Dear Sir
We have deployed your belts & pulleys at two of our machines and performance of these are detailed below:

250 Kg Intensive Mixer : Main Motor and Blender

We have installed Pulleys for Main Motor and Blender of our 250 Kgs Intensive Mixer. For same input power, we are able to mix 35 kgs more sand per batch. Due to this number of batches required per shift has considerably reduced and thereby savings in power and maintainence.

Description	Before Installation	After Installing MSB Pulley & Mitsuboshi Belt
Mixing Capacity	180 to 185 Kgs	215 to 220 Kgs
Heat Generation	Yes	Almost Nil
No of Belts	4	3

1000 Kg Shot Blasting Machine : Impellor Motors 2 Nos

We have installed Pulleys for Shot Blasting Machine Impellor x 2 Nos.

Description	Before Installation	After Installing MSB Pulley & Mitsuboshi Belt
Time / Batch	15-20 Minutes	7 to 10 Minutes
No of Belts	3	1

We are appreciate performance of Mituboshi Belts and MSB Pulleys.

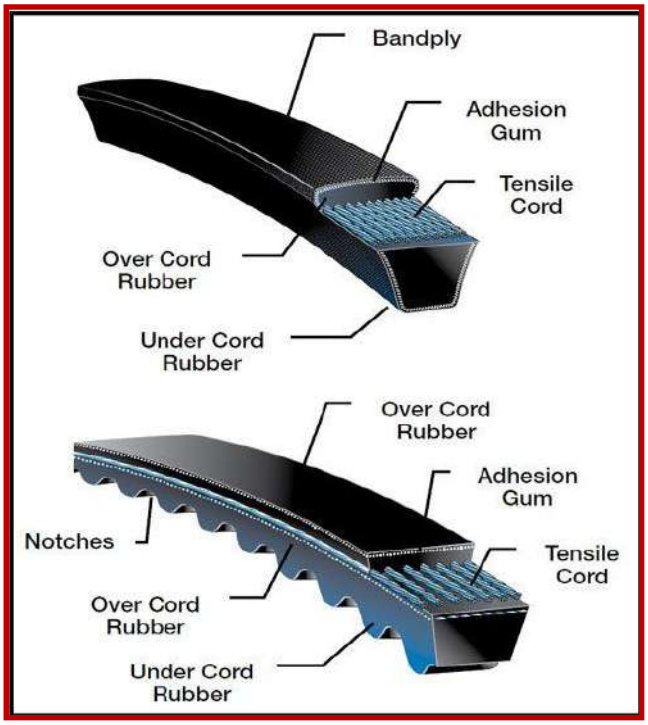
Thanking You
Your's Truly
For Bluemount Castings Private Limited

Dr CB Senthilkumar, Managing Director

159, Mettupalayam Road, Mathampalayam, Coimbatore - 641019, India.
Mobile : +91-93631-44885, Fax : +91-4254-273348
email : bluemountcastings@gmail.com

- The industry can visualize this productivity improvements in your Drier and CTC machines when you go for peak season production workings. This exercise is instantly implementable for **an Investment of a few ten thousand Rs only and payable back to you in just 4 months.**

- Your tea industry has changed all the motors to IE-2 version; for better productive RPM from motors with less power consumption. This exercise is also similar to that, and not with heavy investment, but with minimum affordable investments only to achieve improved & sustainable productivity.





Cogged V-belts offer several advantages over standard V-belts, primarily due to their notched or cogged design. They are more flexible, allowing for use with smaller pulleys, and they generally transmit more power with less heat generation and less slippage. They also tend to have a longer lifespan and a higher efficiency rating than standard V-belts.

1. Enhanced Flexibility:

- **Smaller Pulleys:** The cogs allow the belt to bend around smaller diameter pulleys, which can be crucial for compact designs or cost-saving on pulley sheave materials.
- **Improved Bending:** The cogged design significantly reduces bending resistance, making the belt more adaptable to various pulley configurations.

2. Increased Power Transmission:

- **Higher Efficiency:** Cogged belts generally have a higher efficiency rating compared to standard V-belts.
- **Enhanced Grip:** The cogs increase the surface area in contact with the pulley, improving grip, especially in high-torque applications.
- **Reduced Slippage:** The improved grip translates to less slippage, which is important for consistent power transfer.

3. Lower Heat Generation:

- **Reduced Friction:** The flexibility of the cogged design and the reduced bending resistance contribute to less friction, which results in lower heat generation.
- **Longer Lifespan:** Lower heat generation helps to extend the belt's lifespan.

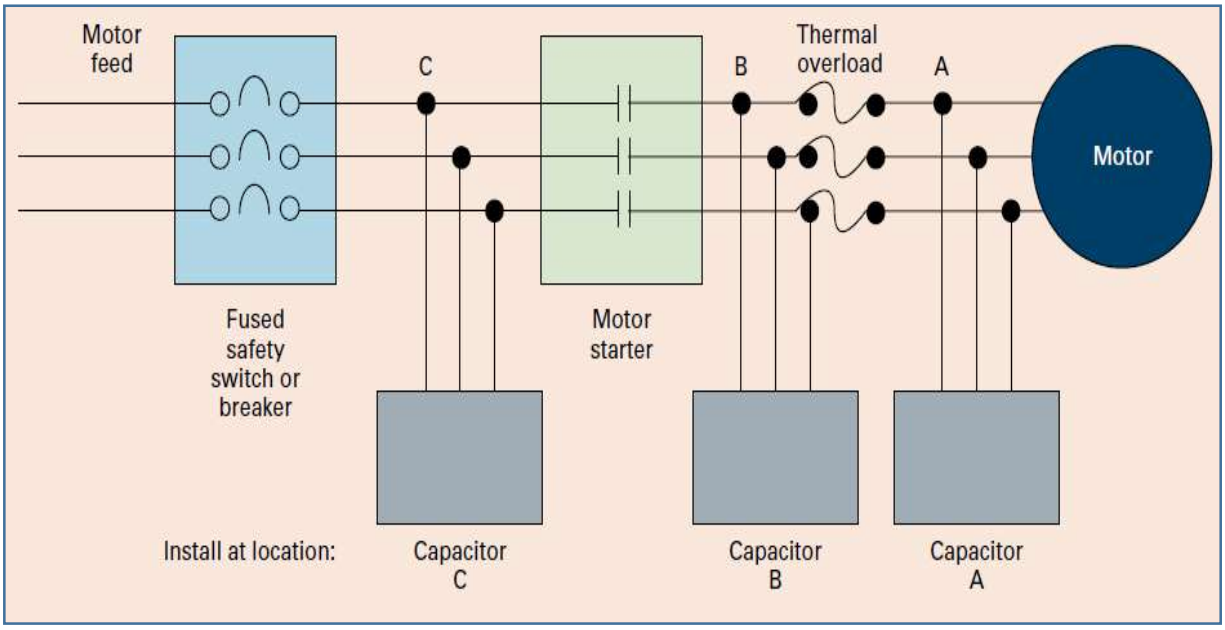
ENCON-X	Reduction of Cable Losses and Active Power Consumption using Load End Capacitor Compensation (At DB Level)
Assessment Area	Electrical Distribution System
ENCON Category	Deviation monitored in the existing practices and must improve in the Best Operating Practices to achieve the Energy Efficiency
Observations	• HT electrical system from power house is being distributed through various electrical distribution panel board conveniently located in each building all over the university campus. • Supply side power factor is maintained by fixed capacitors; whereas the load end PF is to be corrected by connecting suitable values of FC, mostly at the distribution panels.
Assessments	• In any electrical distribution network, the distribution losses may account for 2-6 % and this can be reduced by i) Selecting proper cable size (class 1 or 2) with reduced resistance and ii) Compensate the distribution losses by connecting load end capacitors at each higher capacity load and/or at DB level. • This method has many advantages like i) reduction of kVA demand (applicable for HT consumer), ii) reduction of distribution losses and iii) maintaining the terminal voltage from source to load end.
Recommendation (Target)	• Connect suitable rating of capacitors (Nearly 20 kVAr, 3-Phase, 440/400 V, Heavy Duty) at the PCC and try to reduce the distribution line loss.

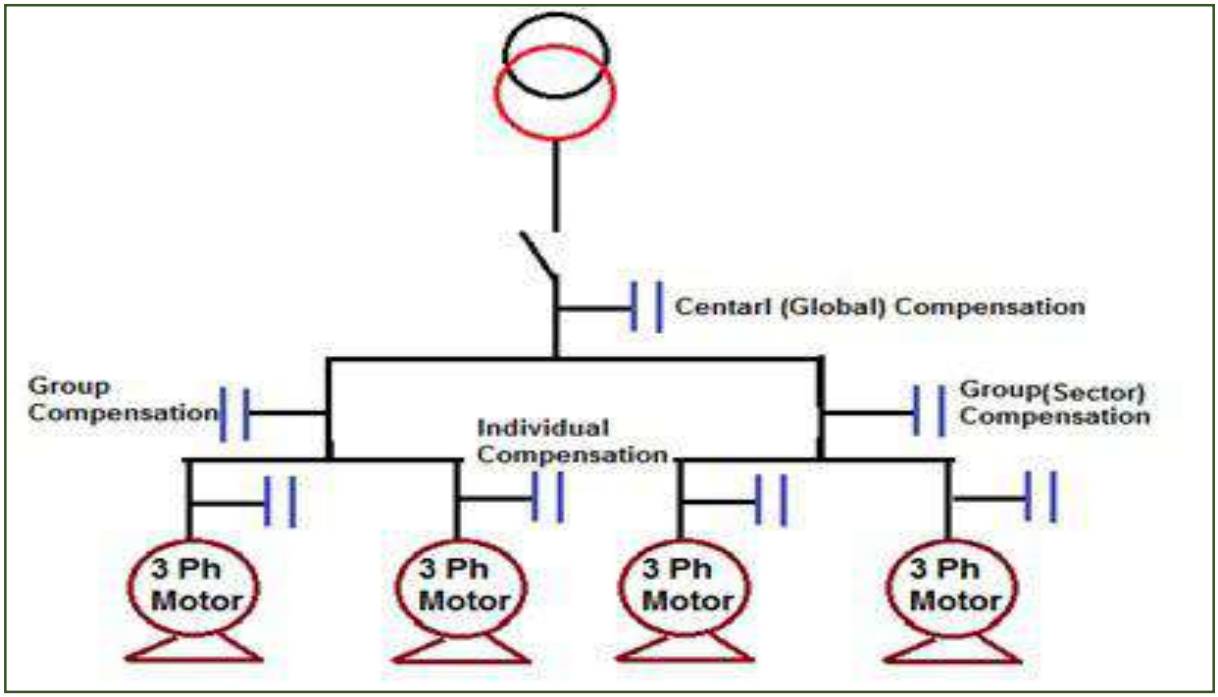
Energy & Financial Saving Calculation:

Parameters	Description	
No. of DBs (Approx. Value)	50 No's. (Fix as a trail at the entry of each block)	
kVAr required to connected	50 kVAr each in all DB	
Energy Calculation	**Before**	**After**
Expected % of Energy Saving	–	**0.5 %**
Annual Energy Consumed	1,82,86,800 kWh	1,81,03,932 kWh
(Annual energy consumption from both the EB services)		
Annual Energy Saving	–	**91,434 kWh**
(91,434 kWh x Rs. 10.30/kWh = **Rs. 9,41,770/-)**		
Saving proposed is based on the client's feedback those already audited and implemented this ENCON		
Annual Financial Saving	–	**Rs. 9,41,770/-**
Initial Investment	-	**Rs. 6,00,000 /-**
Per kVAr charge of Heavy-Duty Standard Make Capacitor is around **Rs. 800/-.** Hence for 50 kVAr x 15 locations = **750 kVAr**; the initial investment is **Rs. 6,00,000/-**		
Simple Payback	–	**0.64 Years**
CO_2 Reduction	–	**75 Tons/Annum**
Indirect Benefits: Reduction of electrical energy to CO_2 reduction & Lesser Carbon Footprint		

CASE STUDY -CAPACITOR BANK AT LOAD END
CONNECTED LOAD 970 KW AT 200 METERS
FROM POWER HOUSE CAPS OFF – 0.8 PF & CAP ON – 0.97 PF

Description	Capacitor at powerhouse	Capacitor at load end
Rating	1211 KVA	1000 KVA
Line current	1715 amps	1443 amps
Cables in I I	5 runs	5 runs
Current /cable	343 mps	289 amps
Cable losses	35 kw	25 kw
cable loss pm	22000 units	15000 units (for 700 hrs)
Net savings	nil	7000 units per month





ENCON-XI	Energy Saving Potentials through the Replacement of Conventional Blower Fans in to Electronically Commutated BLDC Fans in the AHUs.
Assessment Area	HVAC Network; Conventional centrifugal fans to BLDC fans
Observations	• Nearly **102 No's of AHU** of different CFM capacity is available in the mall to deliver the chilled air to the various areas. • At the time of auditing **48 AHUs** only running. • The power capacity of each fan motor is varying from **2.2 kW** to **15 kW** with their respective airflow air flow capacity. • All the AHU fans are belt/pulley configuration (mostly 2 groove-belt) connected with conventional induction motor belt-drives. • The fan blades are backward curved and hence achieve the improved efficiency of nearly **60-70 %.** (As per the design).
Assessments	• Brushless DC motors are electric motors that are electronically commutated (or works based on software commands). Simply, it is a DC motor without mechanical commutators and brushes. • The rapid adoption of these motors in the fields of multi-rotor aircraft, electric vehicles and home appliances like washing machines moved brushed DC motors out of the picture. • It is right time to change the conventional blower fans in to EC fans in the AHUs and ensure at least a 25% savings in energy. However, harmonics prevails in the EC fans and should be taken care. • Because EC motors have no brushes, they do not spark or have a short life due to brushes. Other advantages include the fact that they do not waste power because the electronics control the stator; they provide better performance and controllability, and they run cooler than induction motors.
Recommendation (Target)	• It is recommended slowly replace the conventional AHU motors blower in to EC fans; as it is directly coupled with the fans. • BLDC fans operate in less energy with same air delivery. These fans generate lesser noise, runs with inverter supply, remote control-based speed control, aesthetic look and better lifespan. • "It is right time to change the conventional blower fans in to EC fans in the AHUs and ensure at least a **25% savings** in energy. However, harmonics prevails in the EC fans and should be taken care". • BLDC based EC fans has following advantages: a. Quieter operation b. Narrow impellers for more pressure c. Space-saving external rotor design (High pressure with less space requirement)
Maintenance Implications	**Upon implementing this ENCON proposal;** • **Weekly:** Regular cleaning including vacuuming or brushing of AHU filters. • **Weekly:** Check for any noise and vibration in the blower motors • **Weekly:** Ensure no sweating inside the AHU house and ensure no ICE formation

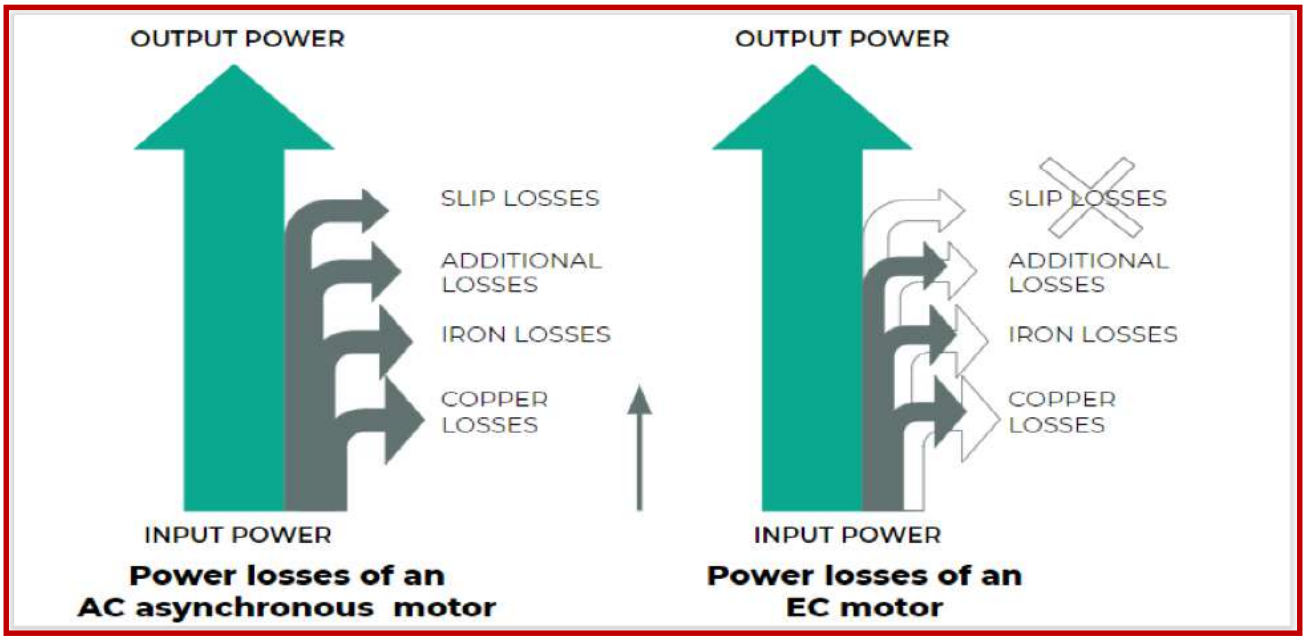
	• **Monthly:** Check electrical parameters of the blower fans like; Voltage, actual current and power consumption of some selected fan blowers and ensure that they are within the limit. • **Yearly:** Using IR Thermography; kindly check for any rise in temperature,.

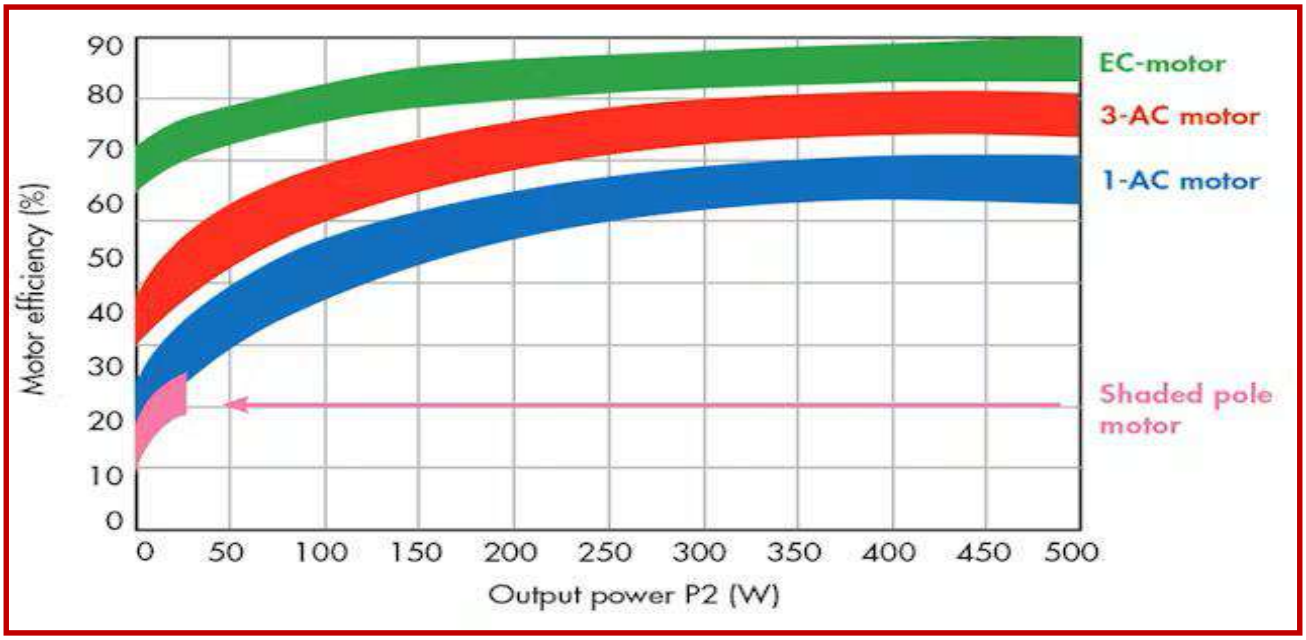
Energy and Financial Saving Calculation:

Index	**Energy Conservation in the Conventional Blower Fans in the AHU by replacing with Electronically Commutated BLDC Fans**		
Investment	Conversion of **48 No's of AHUs** with convention blower into BLDC based electronically commutated fans with an initial investment of as per the **power rating of the blower motor** (and also based on the **air delivery capacity**) is shown below:		
Motor Capacity	**Cost per Motor**	**No. of Blower Motor**	**Total Cost**
2.2 kW	Rs. 2,00,000	5 Nos	Rs. 10,00,000
3.7 kW	Rs. 2,50,000	15 Nos	Rs. 37,50,000
5.5 kW	Rs. 2,75,000	15 Nos	Rs. 41,25,000
7.5 kW	Rs. 3,00,000	2 Nos	Rs. 6,00,000
11 kW	Rs. 3,50,000	9 Nos	Rs. 31,50,000
15 kW	Rs. 4,00,000	2 Nos	Rs. 8,00,000
Total		**48 Nos**	**Rs. 134,25,000**
Energy Savings	**40 % of 187.5 kW** (running power consumption of all the **48 No's** of AHUs) **= 75 kW x 5,000** average running hours/annum = **3,75,000 kWh/Annum.**		
Financial Savings	Annual cost saving for 3,75,000 kWh x Rs. 10.30/kWh **= Rs. 38,62,500/-**		
Simple Payback	Initial investment of **Rs. 134,25,000/-** with simple payback is nearly **3.5 Years.**		
Plan of action	☞ The size and air delivery of each fans varies with respect to the AHU design. ☞ Also ensure the same static pressure and air delivery to be ensured after changing with EC BLDC fans. ☞ Replace one high HP (May be 7.5kW/10 HP); as a trail and ensure the energy savings. Also ensure the same air delivery with adequate static pressure. ☞ Then take this proposal to all other AHUs. ☞ Note: This proposal may deliver longer payback period; when it is replaced for small power capacity motors.		









Parameter	Cage Induction Motor	PM Brushless Motor	SRM
Power density	Satisfactory	Highest	Lower than PM
Maximum shear stress, N/m^2	Up to 20,000	Over 60,000	Up to 35,000
Air gap	Small, fraction of mm	Up to 1mm or more	Small, fraction of mm
Efficiency	Satisfactory; Good for energy efficient motors	Over 90%	About 1% more than that of induction motor
Power factor $cos\phi$	0.8 to 0.9	High, up to 1.0	Switched d.c. motor
Performance at low Speed (VVVF)	Satisfactory	Good	Torque is high, but efficiency low
Torque - voltage characteristic $T=f(V)$	$T \propto V^2$	$T \propto V$	$T \propto V$ at constant peak current
Torque ripple	Less than 7%	About 10%	Over 20%
Overload capacity factor T_{max}/T_{rated}	1.6 to 3.2	About 2	Highest
Power electronics converter	Not necessary for constant speed drive	Necessary	Necessary
Cost	Cost-effective motor	Still expensive motor	Cost-effective motor

<table>
<tr><td>ENCON-XII</td><td colspan="3">Reduction of Energy Consumption in chiller Units through Active Refrigerant additive for removing Oil Fouling</td></tr>
<tr><td>Assessment Area</td><td colspan="3">HVAC Network and Energy Saving in Chiller Units</td></tr>
<tr><td>Observations</td><td colspan="3">• HVAC systems rely on a compressor to convert the refrigerant from a low-temperature, low-pressure, saturated vapour to a high temperature, high pressure, and superheated vapour as a first step in the vapour compression cycle that is used for air conditioning.
• Like most mechanical devices, compressors require a lubricant oil to reduce friction and heat build-up in the moving parts. During the normal course of the refrigeration process, the refrigerant comes into contact with these moving parts and 0.5% to 8% of the compressor's lubricating oil is circulated throughout the system along with the refrigerant</td></tr>
<tr><td>Assessments</td><td colspan="3">• Typically, an A/C & Refrigeration Systems will lose 7% of its efficiency in its first year, 3-5% in the second year and 2% every year afterwards due to OIL FOULING.
• Oil fouling creates a permanent insulating barrier of compressor oil inside the walls of the coil tubing in the air conditioner that impedes the refrigerant's ability to transfer heat.
• According to ASHRAE, the performance is degraded by as much as 30% due to the build-up of lubricants on internal surfaces.
<table>
<tr><th>S. No.</th><th>Chiller No & Tons</th><th>Average Power Taken (kW)</th></tr>
<tr><td>1</td><td>Chiller – 1 – 450 TR</td><td>186.8 kW</td></tr>
<tr><td>2</td><td>Chiller – 2 – 450 TR</td><td>239.1 kW</td></tr>
<tr><td>3</td><td>Chiller – 3 – 450 TR</td><td>211.3 kW</td></tr>
<tr><td>4</td><td>Chiller – 4 – 450 TR</td><td>263.1 kW</td></tr>
<tr><td>5</td><td>Chiller – 5 – 250 TR</td><td>129.3 kW</td></tr>
<tr><td>6</td><td>Chiller – 7 – 1,000 TR</td><td>389.2 kW</td></tr>
<tr><td colspan="2">Total</td><td>1,418.8 kW</td></tr>
</table></td></tr>
<tr><td>Recommendation (Target)</td><td colspan="3">• The best solution in this case is to use a Fouling Inhibitor additive that increases refrigerant side heat transfer efficiency in HVAC systems.
• This additive is an intermetallic compound technology that, when introduced into the refrigerant oil of a system, forms a permanent bond to metal surfaces.
• Active agent (MAX R100) is an intermetallic compound that forms a permanent bond to metal surfaces, which removes oil fouling, changes the thermal nature of the metal and lowers the boiling point of the refrigerant gas, resulting in more efficient operating system with substantial savings of energy nearly up to 10- 30 % from the present consumption.</td></tr>
</table>

Energy and Financial Saving Calculation:

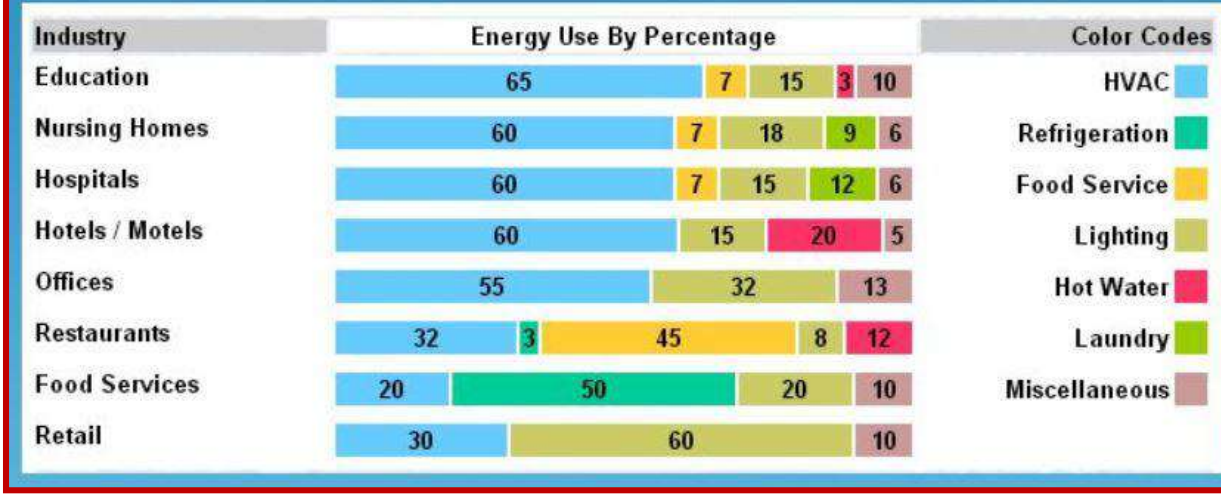
Index	**Reduction of Energy Consumption in chiller Units through Active Refrigerant additive for removing Oil Fouling**
Investment	Active additive agent reconditions, restores and maintain the efficiency of the chillers with a total initial investment of **Rs, 1,000 /- per 1 TR** for **3,050 TR * Rs 1,000/- = Rs. 30,50,000/-.**
Energy Savings	**10 % of 1,419 kW** (Average running power consumption of chiller 1 to 5 & Chiller 7) **= 141.9 kW x 3,000** running hours/annum = **4,25,700 kWh/Annum.**
Financial Savings	Annual cost saving for 4,25,700 kWh x Rs. 10.30/kWh **= Rs. 43,84,710/-**
Simple Payback	For the investment of **Rs. 30,50,000/-** & simple payback is **0.69 Years.**
Plan of action	• It is recommended to do this exercise in one chiller unit as a pilot version; and observe the result. • Conduct the trial and observe the before and after the study. Ascertain the result and expand the same for all other machines.

Typically, an A/C & Refrigeration Systems will lose 7% of its efficiency in its first year, 3–5% in the second year, and 2% every year afterwards due to " OIL FOULING".

MAX R 100 Benefits :

- Restores the lost efficiency
- Enhances heat transfer capacity of the evaporator and condenser.
- Set Point will be reached quickly
- Reduces compressor running time resulting energy saving.
- Energy Savings from 10% to up to 25% .
- MaxR100 can be used from 1.5 TR Split unit to Any Capacity of HVAC systems including centralized / INDUSTRIAL Chillers of all types.
- A minimum 10 % energy savings are guaranteed.
- Typical ROI will be less than 12 –14 months (Depending up on running hours)
- Focused Sectors for MAXR100 – IT Parks/ Hotels/ Hospitals/ Manufacturing / Process Industries, Cold Storages/ Malls/ Show Rooms/ Commercial Buildings etc.

As the following chart details, the highest energy cost for most business units is HVAC/R. MaxR100™ can cut air conditioning costs by up to 40% and overall energy use by up to 15% or more.



<table>
<tr><td>ENCON-XIII</td><td colspan="3">Reduction of Energy Consumption in Chillers using Heat Transfer Water Additives in the Chilled Water System</td></tr>
<tr><td>Assessment Area</td><td colspan="3">HVAC Network and Energy Saving in Chiller Units</td></tr>
<tr><td>Observations</td><td colspan="3">• Effective heat transfer between the fluid and refrigerant is the most important happen in any chiller units. Especially in condenser and the evaporator; these heat transfer not only assist in faster cooling; but also reduces the load on the compressor (and condenser fans); which saves considerable amount of electricity</td></tr>
<tr><td>Assessments</td><td colspan="3">• In the existing air-cooled chiller units; water is the major source of heat transfer interacting with the Refrigerant (R-134 A; GWP = 1,430 & Zero ODP)
• The inlet and outlet temperature of the refrigerant and water to and from the condenser units depends on the set/floor temperature (also depends on the % RH on the floor).
• All the parameters on HVAC system like i) condenser ref. pressure, ii) evaporator ref. pressure, iii) Evaporator approach temperature, iv) chilled water set temperature, v) differential to start/stop are controlled by Building Management System (BMS).
<table>
<tr><th>S. No.</th><th>Chiller No & Tons</th><th>Average Power Taken (kW)</th></tr>
<tr><td>1</td><td>Chiller – 1 – 450 TR (Utility I)</td><td>186.8 kW</td></tr>
<tr><td>2</td><td>Chiller – 2 – 450 TR (Utility I)</td><td>239.1 kW</td></tr>
<tr><td>3</td><td>Chiller – 3 – 450 TR (Utility I)</td><td>211.3 kW</td></tr>
<tr><td>4</td><td>Chiller – 4 – 450 TR (Utility II)</td><td>263.1 kW</td></tr>
<tr><td>5</td><td>Chiller – 5 – 250 TR (Utility II)</td><td>129.3 kW</td></tr>
<tr><td>6</td><td>Chiller – 7 – 1,000 TR (Utility II)</td><td>389.2 kW</td></tr>
<tr><td colspan="2">Total</td><td>1,418.8 kW</td></tr>
</table></td></tr>
<tr><td>Recommendation (Target)</td><td colspan="3">• Water additive is a heat transfer Nano-fluid that provides energy efficiency and complete system protection via proven, innovative products for all closed-loop HVAC Systems both heating and cooling
• Water additive is a revolutionary heat transfer nano-fluid that utilizes Nano-Thermo™ technology.
• It uses nano-particles that are suspended in a stable state to increase the speed of heat transfer, by heating up (or removing heat from) the fluid and transferring energy in a shorter amount of time, thereby requiring significantly less energy, which ultimately helps the clients to save money.
• It is most suitable for closed-loop heating and cooling systems where efficiency is achieved by diminishing run-times of associated equipment.
• This process will extend the life of the HVAC equipment while keeping maintenance cost low.
• In cooling systems, water additives make heat transfer 37% faster – transferring the same amount of heat in a much shorter time.
• The energy efficiency of this water additives is based on reducing the run time of the compressor and increasing the required ambient temperature limits.
• Adding the water additives also provides good protection against;</td></tr>
</table>

	✦ Corrosion, calcification & bacteria in the systems. ✦ Freezing and bursting ✦ Deteriorating system

Energy and Financial Saving Calculation:

Index	**Reduction of Energy Consumption in Chillers using Heat Transfer Water Additives in the Chilled Water System**
Investment	Nano particle-based heat transfer fluid to be mixed with chilled water system using dosing pump with a total initial investment of **Rs, 1,000 /- per 1 TR** for **3,050 TR * Rs 1,000/- = Rs. 30,50,000/-.**
Energy Savings	**10 % of 1,419 kW** (Average running power consumption of chiller 1 to 5 & Chiller 7) **= 141.9 kW x 3,000** running hours/annum = **4,25,700 kWh/Annum.**
Financial Savings	Annual cost saving for 4,25,700 kWh x Rs. 10.30/kWh **= Rs. 43,84,710/-**
Simple Payback	For the investment of **Rs. 30,50,000/-** & simple payback is **0.69 Years.**
Plan of action	• It is recommended to do this exercise in one chiller unit as a pilot version; and observe the result. • Conduct the trial and observe the before and after the study. Ascertain the result and expand the same for all other machines.

NANO Technology – Patented in 171 countries

' Hydromx' invented in turkey is the ONLY patented energy saving product in 171 counties, in global Market. It is a revolutionary heat transfer fluid that uses stably suspended NANO PARTICLES to increase the speed of heat or cold transfer when mixed with water. It is an organic solution which works in 50:50 Ratio with water in heating/cooling system in a closed loop hydronic system. Not only it reduces carbon emission & energy bill, it also prolongs the life of boiler, HVAC & protects 100% against frozen pipes.

Important Features

- Upto 35% Energy Saving. Guaranteed 20 %
- Protection from bacteria, corrosion, Scaling , Calcification & Freezing & Burst Protection
- Increases equipment life & reduces maintenance cost
- Recyclable
- 100% Freeze Protection
- 100% Insured by world's second largest company ACE- 100 Million USD coverage
- Reduces Carbon emission, Help Environment to keep clean

Saving & Payback period (ROI)

' Hydromx' saves energy bill from 20% to 35% and pays for itself from 1-3 Yrs

Warranty

Hydromx' is warranted for 8 years from the date of sale & Life expectancy is 15-20 yrs

Application- Only for closed loop system in secondary side

Hydromx® can be used in any water based closed loop system for heat transfer. The best application for Hydromx® can be in chillers and boilers where water is traditionally used as a medium of heat transfer. With Hydromx®, efficiency of the system and rate of heat transfer improves. Will be helpful for pharmaceutical processes, transportation industry, thermal management of electronics, fuel cells, boiler flue gas temperature reduction, heat exchangers.

Safety

Hydromx® is certified as a non-corrosive, non-flammable, non-toxic and recyclable product.
Green: Hydromx® is environmental friendly and biodegradable. If 5% of the world uses Hydromx® it will lead to 86,505,000 tonnes/year less carbon emission which will be equivalent to planting 247,160,000 trees.

ENERGY AUDIT REPORT

7. BEST OPERATING PRACTICES FOR ENERGY CONSERVATION & MANAGEMENT

Practice-1: Electrical Maintenance:

- Operate the transformer mostly at 50 % load and reduce the self-loss of the transformer.
- Propose a scheme to replace the existing transformer into IS-1180 star rated energy efficient transformer which has lesser self-consumption at 50 % and 100 % load condition. While proposing this ENCON; support the ensured energy saved through the existing readings. Buyback offer is the best option to replace the transformer.
- Procure energy efficient transformer with OCTC & RTCC kits in order to maintain the voltage at constant level (irrespective of the load condition)
- Counter reading in the OLTC must be recorded at regular interval. Proper maintenance (like cleaning of brushes) to be carried out.
- Functioning of the APFC must be checked (test the current and voltage simultaneously). Derating of the capacitors must be recorded & replaced
- Conduct Infrared Thermography audit at regular intervals on all electrical panels, joints, cables, switch gears, boilers skin, steam pipes, and other external parts producing heat. Practice the audit in the maintenance schedule
- Also conduct voltage drop test for the longest electrical path and determine the voltage regulation at each point. This regulation must be within the limit of 5 %.
- Maintenance log book must have the installation details like date of installation, fault history, repair/replacement of system, Mean Time between Failure (MTBF), repetitive faults etc.,
- Kindly follow, practice and maintain the following records either manually or digitally;
    - All SSB must be fitted with digital energy meters and/or connect those meters with EMS and monitor the energy pattern of each building
    - Replace the existing analog meter located in each distribution panels from powerhouse side with smart kWh meter and connect them through networking. This must enable the user to monitor the energy pattern of each block remotely
    - Energy consumption for hostel, seminar hall, auditorium and library must be separately noted
    - Block wise maintenance checklist of electrical and thermal system
    - Condition monitoring of UPS
    - Campus maintenance record
    - STP water input, treatment and waste water record
    - Sludge quantity and usage record

Essentials in PH

- Place the Single Line Diagram (SLD) – Available
- Details of connected load in the campus
- Name of the PH officials along with their contact mobile number & E-mail
- Name of the nearest substation, emergency contact no. of TANGEDCO officials
- Contact details of nearest fire safety office and officials
- Contact details of nearby hospital and emergency contact numbers
- List of members trained for handling Fire Extinguishers along with contact number

Practice-2: Maintenance of Diesel Generators:

- Calculate the UPL monthly for every run of DG and average it
- This must be seriously paid more attention and check the present UPL with Design UPL.

- Connect suitable value of fixed capacitor at the DG input and operate it at maximum kVA capacity. At the same time; monitor the AVR condition
- Conduct flue gas test (emission test) at regular interval (Preferably annual measurement) and ascertain the emitted gas must be with in the CPCB norms

Practice-3: Lighting & Fans System:

- Illumination levels must be tested both indoor and outdoor and must adhere to National Building Code (NBC)-2006
- Similar to lighting; the audit team recommend to implement the replacement of conventional fans into BLDC fans in a phased manner
- Adopt a policy and fix a target to convert the existing conventional lightings and fans into energy efficient lights and fans.
- Ensure the saving of energy by conducting the before and after study. Also conduct a subjective study from the students about the illumination level and thermal comfort inside the classrooms and in the campus

Practice-4: Computers and Server System:

- Recommend to install Power management software's in all the PCs which efficiently manages and optimizes the power consumption of computer hardware thereby saving money and energy
- It allows you to create multiple power schemes that can be deployed to multiple computers
- The advanced options allow you to specify what has to be done when the laptop is closed or when the power button is pressed
- Define and apply appropriate power schemes to reduce power consumption when the system is idle

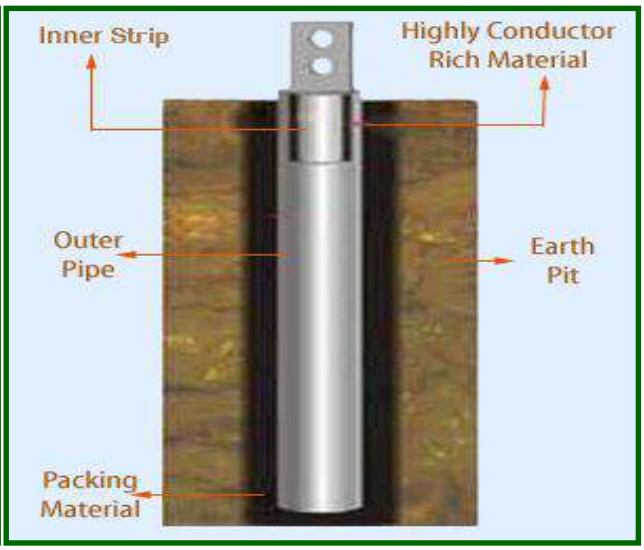
Practice-5: Fire Extinguishers System:

- A good amount of team members should be given training in FE handling and the list (along with photo) must be pasted in prominent places
- The FEs with CO2 will harm the ozone layer or contribute to global warming
- Try with environmental and user-friendly Halons in the FEs

Practice-6: Maintenance Free Earthing System:

University/college earthing system must be in good condition as it is prone to malfunction and gives rise to harmonic and multiply the same into the electrical network. Plan for maintenance free earthing and this maintains the Ohmic values in the long run over decades.





Practice-7: Dedicated Servo Stabilizer for Lighting System:

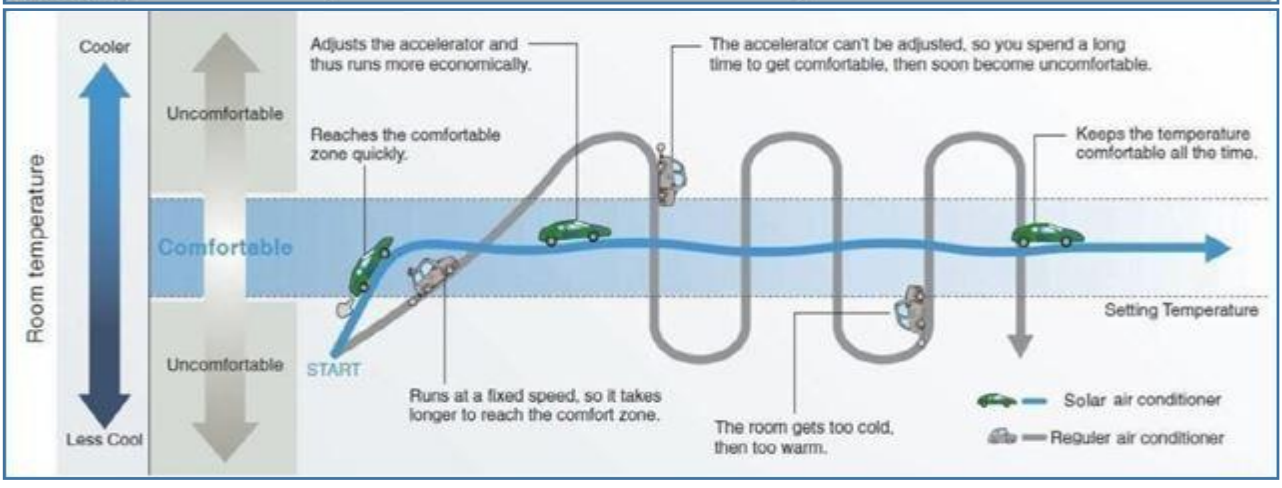
- Life expandability on the lighting system has been achieved by applying regulated voltage to the lighting and their associated circuit components. In order to reduce the lighting failures, it is necessary to supply a safe working voltage through a dedicated Servo Stabilizer (SS) this reduces the failures of bulbs and the circuit components.
- Install a dedicated unbalanced type servo stabilizer (with suitable power rating may be 15 kVA-3-Phase input; 3-Phase output) through which all the lighting loads may be connected to ensure the optimum voltage of say 210 V.

Input Voltage Variations	Possible reduction in Breakdown		Possible Approx. Power Savings	
	Motor Load (Below 10 HP)	Lighting Load	Motor Load (Below 10 HP)	Lighting Load
380-400 V	NIL	NIL	NIL	No SS required
400-420 V	5 %	10 %	3 %	5 %
420-440 V	10 %	20 %	5 %	10 %
440-460 V	40 %	40 %	7 %	20 %
460-480 V	60 %	60 %	10 %	30 %

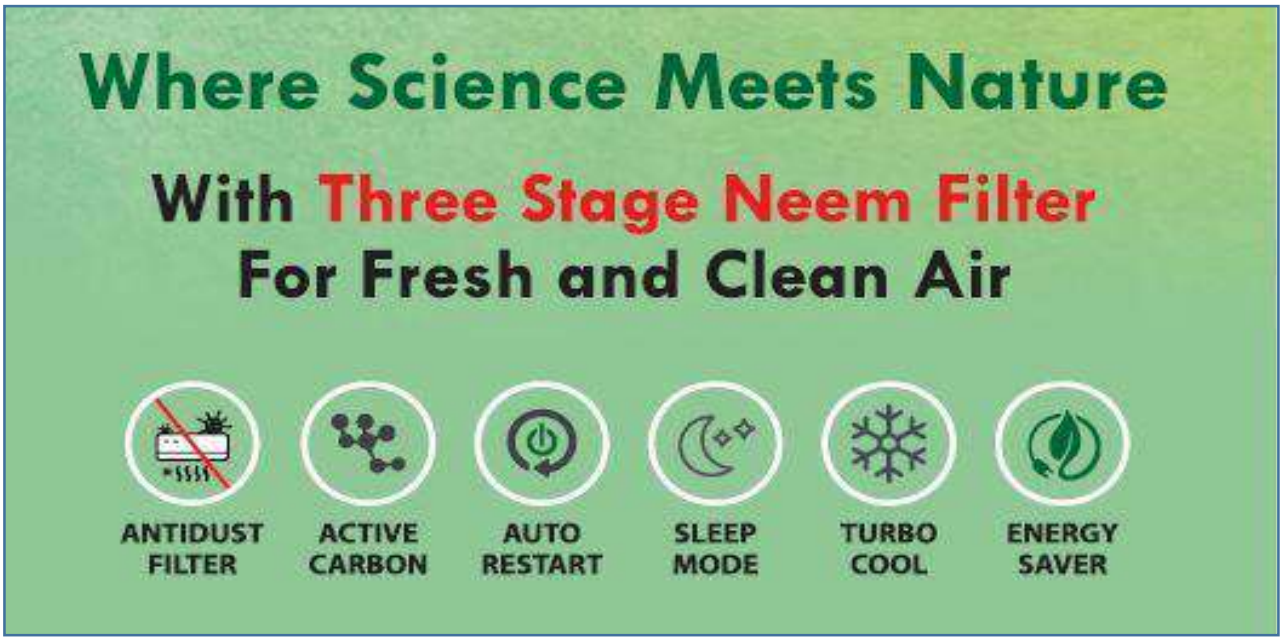
Practice-8: Recommendations for BLDC AC System:

- Similar to Fan, now BLDC based AC is available in the market which consumes less amount of energy (Power) during its starting and running condition. This AC operates at same tonnage capacity and offer 100 % same cooling effect compared to conventional inverter AC
- Because of less power consumption, this AC can also be operated in Solar PV system. Further the noise associated with compressor running is so less and provides quiet operation

	Conventional Air Conditioner	Solar Air Conditioner
Wattage	2000watt	800watt
Starting Load	3500watt	100watt
Running Amp	7 to 9 Amp	2 to 4.5Amp
Electric saving	-------	Upto 80%
Jerk Load	High Jerk	No Jerk
Compressor	Rotary / Hermetic	BLDC MGM
Solar Compatibility		
Direct Solar Compatible	N.A.	1500watt Solar Panel (can run through Solar Panel (DC Voltage)
Solar Compatibility	5kwatt Solar Plant with Inverter & Battery	Only 1.5kwatt & 1750VA PCU
Unit Consumption on Electricty (per 10Hrs)	17 to 20Units	5 to 7 Units







Practice-9: One to One Replacement of Transformer with EE – Star rated Transformer:

- Power supply to all the loads are fed with one HT service supplied with a common transformer.
- The self-losses of the transformers (not having star rated by BEE and/or as per IS 1180 energy efficient level) are quiet high.
- The recent development in the transformer manufacturing process provides lesser energy loss in the transformer at specified load conditions.
- The difference in the **self-losses** between the older and new version of the distribution transformer varies between **3 to 5 %** of the designed power capacity (by assuming the transformer is being operated at 0.9 PF with the same loading pattern).
- Though the replacement of existing transformer into EE transformer leads to higher initial investment, the management has to consider this option in future which may have a simple payback of less than 4 years. The self-loss of a transformer at different load condition as per IS-1180 is given below.

Sl. No.	Rating (KVA)	% Z	Energy Efficiency Level 1		Energy Efficiency Level 2		Energy Efficiency Level 3	
			@ 50%	@ 100%	@ 50%	@ 100%	@ 50%	@ 100%
1	250 KVA	4.5%	1050W	3150W	980W	2930W	920W	2700W
2	315 KVA	4.5%	1100W	3275W	1025W	3100W	955W	2750W
3	400 KVA	4.5%	1300W	3875W	1225W	3450W	1150W	3330 W
4	500 KVA	4.5%	1600W	4750W	1510W	4300W	1430W	4100W
5	630 KVA	4.5%	2000W	5855W	1860W	5300W	1745 W	4850W
6	1000 KVA	5.0%	3000W	9000W	2790W	7700W	2620W	7000W
7	1250 KVA	5.0%	3600W	10750W	3300W	9200W	3220W	8400W
8	1600 KVA	6.25%	4500W	13500W	4200W	11800W	3970W	11300W
9	2000 KVA	6.25%	5400W	17000W	5050W	15000W	4790W	14100W
10	2500 KVA	6.25%	6500W	20000W	6150W	18500W	5900W	17500 W

Practice-10: Operating the Transformer at Optimal Loading Condition:

- Operate the transformer mostly at 50 % load and reduce the self-loss of the transformer.
- If the transformer loading is known, the actual transformer loss at given load can be estimated using the following formula;

$$= \text{No load loss} + \left(\frac{\text{kVA load}}{\text{Rated kVA}}\right)^2 \text{x (Full load loss)}$$

Practice-11: Centralized Fan Speed Control:

- In order to save energy; it is highly recommended to install a centralized fan speed control unit in newly built class rooms (commerce building)
- The speed of all the fans in the class room is being controlled by a single voltage regulator and the control knob is kept at nearly 70 % of speed position



Recommendations:

- Centralized regulator must be implemented in for conventional fan control as Power consumption under low speed operation is not that much appreciable
- Instead of that, BLDC-Electronically commutated fans are more energy efficient; especially when they run at low speed and saves huge amount of energy
- Further the speed was set at 70 % for all sessions. However, it may further be reduced to 50 or 40 % during winter season and enhance the possibility of energy saving

Practice-12: Monitoring of LPG Consumption using Tag System:

- Measure the weight of each cylinder while purchasing & Paste a cylinder history tag on each cylinder (sample is given below)
- Mark the date of service and date of relieving on each cylinder (Mention the time)
- Measure the empty cylinder weight and mark in the tag
- Quantify how many cylinders are completed and how many are line (with kg of LPG) for every month. Convert the consumption with respect to the financial value and obtain Rs./kg
- Display the same in appropriate place and hence motivate to save LPG

Cylinder Status Tag

Cylinder No: .....

Date of Purchase: ..... Weight: .....

Date & Time of Service: ..... Date & Time of Relive: .....

Empty Weight: ..... Gas Used: .....



Practice-13: Reduction of Mechanical Transmission Losses in Kitchen Equipment Motors:

- Kitchen equipment's used for grinding has V-belt-pulley configuration. The audit team inspects some of the machines in the canteen area; which are slightly wobbling
- Even though the operating hours of these machines are less; it is the right time to replace the existing pulley into taper lock pulley with cogged belts
- This increases the lifespan of the belt and pulley and provides superior grip in the mechanical transmission. Also the temperature on driving and non-driving ends are less

Motor drive transmission efficiency :-

Visible Losses seen in Belt Losses from motor to load

The efficiency of mechanical power transmission depends on grip between pulley and belt, further depends on μ (Co-efficient of friction) and strength (Tensile) of the belt. In case of

Table 3.4: Losses in V Belts

Sr. no.	Motor HP	Losses %
1	2	8-15
2	3	7-13
3	4	6-12
4	6	5.5-10
5	8	5-9
6	10	4.5-8.2
7	20	3.5-7
8	30	3.2-6
9	40	3-5.5
10	60	2.8-5
11	80	2.5-4.5
12	100	2.5-4.5

Practice-14: Display of Monthly Energy and Water Consumption:

- Electricity and Water consumption is the major energy utilities consumed in the university premises. The consumption pattern is not constant.
- All the stack holders should know the facts of usage of energy metrics along with its financial debuts.
- Display the monthly consumption of electricity and their cost. Also display the water consumption at appropriate places and encourage to save the energy.

Practice-15: Formation of Green Energy Team (GET):

- In order to train the students to conserve the energy, each section of the loads may be allotted with some group of students with a faculty mentor. These groups may fix up a target for energy conservation and start working on it
- An incentive mechanism to the group of students conserving less energy will be a moral example for other students
- It is essential and the right time to form an Energy Management Team comprising of the following members with their roles and responsibilities as shown in Table-4:

Table-6: Roles of Responsibilities of Green Energy Team (GET)

S. No	Members	Roles	Responsibilities
1.	Management Commitment	Overall Monitoring	• Encourage members to carry out the activities • Propose possible think tank ideas to be implemented in the university campus
2.	Head of the Institution	Team Head	• Monitoring all energy related activities • Report to the Management
3.	Heads of various Departments	Team Manager	• Assessing the energy target • Monitoring the energy performance • Revising the target based on performance • Monitoring energy conservation projects/activities/implementation

S. No	Members	Roles	Responsibilities
4.	Faculty members from various department	Team Members	• Identify the viable energy saving projects • Prepare the detailed work plan/time frame • Project guides for energy related projects • Pre and post project implement study • Rework if there is any deviation
5.	Student volunteers	Energy Ambassadors	• Responsible for energy consumption of identified areas • Floor in-charge for energy utilities • Development of hardware/software model of the energy saving projects • Testing and Implementation

- Energy conservation is a collective effort and involve all the stakeholders of the campus
- Educate all the faculty, staff and students about the need for the energy conservation
- Energy conservation related projects are to be implemented in the university premises
- Nominate brand ambassadors for energy saving among students (for each building/floor)
- Cash incentives/awards may be given to the prominent energy achievers
- Circulate the success stories as energy conservation measures



Practice-16: Integrated Green Building – Future Plan for Today's Requirement:

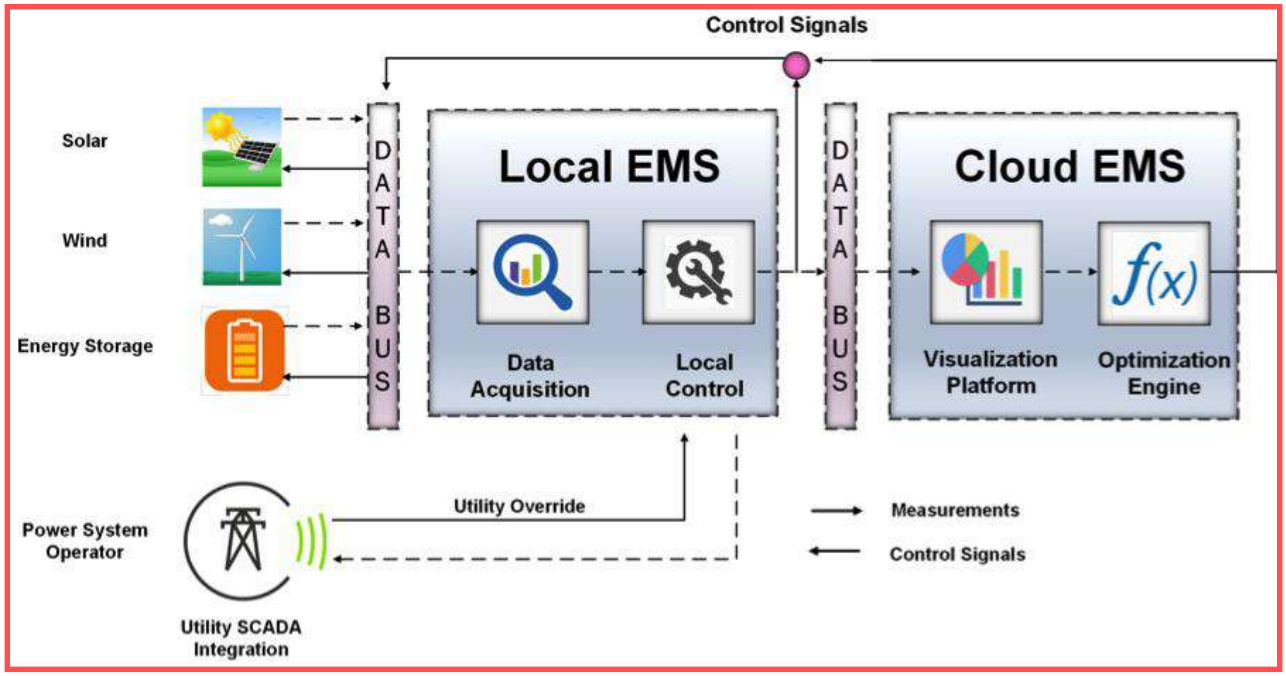
- Introducing green concepts and practices in the building sector must support important national priorities like Enhanced Energy Efficiency, Water Conservation, Reduction of generation of Waste materials (during construction and in occupancy), Best practices on handling organic and non-organic wastes, Water Conservation, Water Efficiency, Rain Water Harvesting, Preservation of Natural Topography and Lesser usage of virgin materials during construction.
- Green concepts also realize some indirect benefits like superior air quality, excellent daylighting, health and well-being of the occupants and visitors. Implementation of Green Building Concepts ensures the energy savings to the tune of 20-30%.

- Hence the audit team recommended to the management, plan and construct the future building as per the guidelines of Green Building System (IGBC/GRIHA/GEM) to save Energy, Environment and Ecology.



Practice-17: Implementation of Energy Management System (EMS):

1. EMS helps to reduce energy consumption nearly about 15-25%. This software-controlled energy management is designed to reduce energy consumption, improve the utilization of the system, increase reliability, predict electrical system performance, and optimize energy usage to reduce cost.
2. Since the university has several departments (with associated laboratories), main administrative buildings, auditorium, boys' hostel, bus shed, canteen, RO plant, & other electrical networks, it is recommended to install a dedicated EMS online energy monitoring system and record the day to day consumption.



ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

8. MEASUREMENT

OF

ELECTRICAL PARAMETERS

ON

TRANSFORMERS FOR 24 HOURS

Table-7: Description of Electrical Parameters measured at Main Incoming for 24 Hours at Utility – 1 – Transformer – 2.

S. No.	Description	Supply Voltage (V)				Supply Current (A)				P (kW)	Q (kVAr)	S (kVA)	PF	% Harmonics	
		–	VRY	VYB	VBR	IR	IY	IB	In					THDV	THDi
1	**Main Incoming for 24s Hours** 24 Hour Unit consumed- **7,761 kWh**	MIN	409.9	411.2	411.3	95.4	107.4	113.9	19.6	78.6	12.2	81.1	-0.99	1.8	5.7
		AVG	423.4	424.5	426.3	464.8	448.6	468.6	37.6	323.4	94.4	337.2	0.89	4.3	15.6
		MAX	435.0	435.9	439.2	1168.9	1141.3	1187.5	72.5	805.9	272.6	844.3	0.99	8.5	30.4
2	**(2.35 pm to 3.35 pm)** Per Hour Unit consumed- **455.0 kWh**	MIN	414.8	415.1	415.5	526.9	498.2	529.4	27.3	366.5	107.2	383.2	-0.97	5.9	22.5
		AVG	417.6	419.2	419.9	673.9	625.7	663.6	38.8	454.9	138.0	475.3	0.00	6.7	29.8
		MAX	423.0	425.0	426.6	925.5	865.7	907.5	56.7	623.3	179.8	648.2	0.97	7.6	32.0
3	**(3.35 pm to 4.35 pm)** Per Hour Unit consumed- **474.0 kWh**	MIN	416.4	418.3	417.7	669.1	613.3	650.2	26.9	457.3	127.7	477.3	0.96	5.9	25.7
		AVG	418.7	420.0	420.8	692.2	650.3	685.4	34.4	473.8	132.4	492.0	0.96	6.2	27.2
		MAX	420.9	422.4	423.3	731.1	685.4	734.9	64.8	499.8	142.3	517.7	0.97	6.7	30.0
4	**(4.35 pm to 5.35 pm)** Per Hour Unit consumed- **315.0 kWh**	MIN	416.7	418.2	418.4	151.0	142.1	140.7	26.3	106.3	28.4	110.1	-0.96	2.7	8.9
		AVG	420.6	421.5	422.9	458.0	428.8	458.5	38.0	315.3	89.4	327.8	0.73	4.7	20.5
		MAX	424.9	425.5	427.6	727.5	691.2	747.2	55.4	505.9	136.9	524.1	0.97	6.2	30.5
5	**(5.35 pm to 6.35 pm)** Per Hour Unit consumed- **134.0 kWh**	MIN	422.6	422.9	422.2	147.7	143.1	156.6	40.2	109.5	30.0	113.6	0.94	2.5	9.7
		AVG	425.3	426.3	428.4	186.7	175.4	199.1	49.6	133.8	41.4	140.1	0.96	2.7	11.5
		MAX	428.2	429.5	432.3	223.3	209.7	259.3	62.3	165.1	50.3	172.0	0.97	3.0	13.6
6	**(6.35 pm to 7.35 pm)** Per Hour Unit consumed- **340.0 kWh**	MIN	419.1	419.8	421.3	202.5	191.0	230.5	51.8	151.2	39.5	157.4	-0.99	2.6	8.6
		AVG	421.5	422.4	425.1	483.8	450.1	501.9	58.0	339.8	90.7	351.8	0.85	4.4	19.3
		MAX	424.6	426.1	429.7	715.8	685.1	723.0	64.8	500.1	135.9	518.3	0.98	5.9	27.1
7	**(7.35 pm to 8.35 pm)** Per Hour Unit consumed- **419.0 kWh**	MIN	419.4	419.6	421.4	321.7	320.7	356.8	42.4	244.7	33.3	247.0	-0.99	3.2	9.4
		AVG	422.1	422.8	425.7	591.3	563.7	603.8	50.7	418.6	101.4	430.8	0.93	4.9	22.4
		MAX	424.3	425.3	428.4	632.0	602.1	655.2	64.8	444.0	110.6	456.7	0.97	5.2	23.9

S. No.	Description	Supply Voltage (V)				Supply Current (A)				P (kW)	Q (kVAr)	S (kVA)	PF	% Harmonics	
		–	VRY	VYB	VBR	IR	IY	IB	In					THDV	THDi
8	(8.35 pm to 9.35 pm) Per Hour Unit consumed- 173.0 kWh	MIN	422.5	421.5	422.3	184.5	180.1	210.5	41.1	140.4	28.1	144.2	-0.99	2.5	7.2
		AVG	424.3	424.7	427.5	229.3	231.3	257.5	50.4	173.4	39.5	178.0	0.67	2.8	10.0
		MAX	426.1	426.6	430.4	360.6	357.2	380.2	64.5	267.1	73.5	269.3	0.98	3.4	15.1
9	(9.35 pm to 10.35 pm) Per Hour Unit consumed- 158.0 kWh	MIN	422.6	423.2	423.9	183.2	192.7	192.4	44.2	139.4	32.3	143.3	0.96	2.1	8.6
		AVG	424.5	425.3	427.9	209.2	215.6	230.0	50.1	157.8	39.2	162.6	0.97	2.4	11.1
		MAX	426.0	427.3	430.9	259.8	266.8	292.4	61.3	196.4	46.7	201.6	0.98	2.8	13.2
10	(10.35 pm to 11.35 pm) Per Hour Unit consumed- 146.0 kWh	MIN	424.9	424.8	425.7	172.1	170.0	172.4	39.4	127.2	28.5	130.6	0.96	1.8	9.0
		AVG	427.5	427.9	430.2	200.0	199.1	201.7	46.4	145.8	35.2	150.0	0.97	2.2	11.4
		MAX	432.1	432.5	436.3	246.8	242.5	252.5	54.4	179.6	42.5	184.5	0.98	2.5	13.4
11	(11.35 pm to 12.35 am) Per Hour Unit consumed- 132.0 kWh	MIN	425.5	425.7	427.0	156.1	174.0	164.5	32.2	122.3	25.9	125.5	0.97	1.9	7.5
		AVG	427.8	428.5	431.1	176.2	187.6	180.1	36.4	131.9	32.0	135.7	0.97	2.1	10.2
		MAX	430.8	431.4	434.8	205.6	214.7	210.5	42.5	151.3	39.7	156.3	0.98	2.2	12.2
12	(12.35 am to 1.35 am) Per Hour Unit consumed- 125.0 kWh	MIN	428.7	429.7	430.6	150.8	165.5	159.9	27.6	118.0	24.6	120.7	0.97	2.0	7.6
		AVG	430.7	431.4	433.9	161.9	177.4	172.8	31.7	125.3	28.7	128.5	0.97	2.2	9.2
		MAX	432.9	433.7	437.7	181.8	200.3	193.3	35.5	139.8	35.3	143.5	0.98	2.3	10.4
13	(1.35 am to 2.35 am) Per Hour Unit consumed- 122.0 kWh	MIN	429.9	430.9	431.9	148.9	155.5	160.2	26.7	114.8	23.4	117.3	0.97	2.1	6.9
		AVG	431.5	432.4	434.7	162.0	166.1	172.0	29.4	122.4	28.4	125.7	0.97	2.3	8.1
		MAX	433.4	434.1	437.7	184.0	194.3	195.4	33.3	139.2	35.8	143.4	0.98	2.5	9.0
14	(2.35 am to 3.35 am) Per Hour Unit consumed- 119.0 kWh	MIN	430.8	432.0	432.1	145.7	142.9	145.7	24.2	108.6	21.1	110.7	0.97	2.1	6.6
		AVG	432.6	433.6	435.6	160.6	158.0	166.7	28.9	119.2	27.1	122.3	0.98	2.3	7.6
		MAX	434.3	435.3	438.8	179.3	171.1	183.4	34.5	131.3	34.0	134.7	0.98	2.5	8.3

S. No.	Description	Supply Voltage (V)				Supply Current (A)				P (kW)	Q (kVAr)	S (kVA)	PF	% Harmonics	
		–	VRY	VYB	VBR	IR	IY	IB	In					THDV	THDi
15	(3.35 am to 4.35 am) Per Hour Unit consumed- 115.0 kWh	MIN	430.3	430.3	429.6	143.4	141.6	143.1	20.1	106.6	19.8	108.6	0.96	2.2	6.7
		AVG	432.8	433.6	435.7	155.0	154.3	157.7	23.7	114.8	24.9	117.5	0.98	2.4	7.8
		MAX	435.0	435.9	439.2	174.1	170.1	180.3	28.7	126.4	33.9	130.7	0.98	2.6	8.6
16	(4.35 am to 5.35 am) Per Hour Unit consumed- 104.0 kWh	MIN	426.9	426.6	426.4	111.4	120.8	119.1	19.6	87.4	12.3	88.3	0.97	2.1	6.9
		AVG	430.2	431.4	433.5	137.1	140.2	143.4	23.3	103.6	19.0	105.4	0.98	2.3	8.1
		MAX	433.1	434.3	437.6	176.3	172.3	183.3	28.2	128.7	34.5	133.3	0.99	2.5	9.6
17	(5.35 am to 6.35 am) Per Hour Unit consumed- 98.0 kWh	MIN	419.2	421.5	422.9	107.9	120.2	116.9	20.5	86.5	12.2	87.4	0.96	2.0	6.2
		AVG	424.9	426.1	428.1	123.2	134.7	144.7	26.1	97.4	22.4	100.0	0.97	2.4	8.0
		MAX	427.4	428.5	431.1	141.7	152.9	169.9	33.7	110.4	29.7	113.9	0.99	2.8	10.3
18	(6.35 am to 7.35 am) Per Hour Unit consumed- 117.0 kWh	MIN	417.9	419.0	417.9	95.4	107.4	113.9	20.1	78.6	15.4	81.1	-0.98	2.4	6.7
		AVG	422.2	423.6	425.0	155.5	163.4	172.4	26.9	116.5	31.3	120.7	0.82	2.8	11.7
		MAX	425.2	426.6	429.5	657.9	647.0	676.1	36.2	462.0	133.0	480.8	0.98	5.9	29.3
19	(7.35 am to 8.35 am) Per Hour Unit consumed- 422.0 kWh	MIN	416.0	417.0	417.9	563.0	551.4	567.6	27.3	397.5	107.4	412.2	-0.96	5.2	24.0
		AVG	419.5	421.2	422.5	601.3	587.4	609.4	35.3	421.6	116.5	437.5	0.92	5.7	26.4
		MAX	422.9	424.4	426.7	665.2	645.6	685.2	49.6	468.3	134.1	486.0	0.97	6.4	28.8
20	(8.35 am to 9.35 am) Per Hour Unit consumed- 676.0 kWh	MIN	415.1	414.1	412.7	603.1	605.3	617.3	28.5	423.8	117.7	439.8	0.95	6.4	22.6
		AVG	418.4	419.8	420.8	985.8	957.7	974.7	37.8	675.7	208.7	707.2	0.96	7.6	24.7
		MAX	422.1	423.5	426.5	1168.9	1141.3	1187.5	47.4	805.9	252.1	844.3	0.97	8.5	27.2
21	(9.35 am to 10.35 am) Per Hour Unit consumed- 560.0 kWh	MIN	414.0	414.2	414.1	773.9	730.8	746.8	22.7	518.9	171.7	549.7	0.94	6.5	24.6
		AVG	417.8	418.7	419.7	832.0	800.0	805.4	31.3	560.3	183.4	589.6	0.95	6.8	27.4
		MAX	422.7	423.9	425.6	960.6	915.7	945.4	44.0	657.7	206.3	689.3	0.95	7.3	30.2

S. No.	Description	Supply Voltage (V)				Supply Current (A)				P (kW)	Q (kVAr)	S (kVA)	PF	% Harmonics	
		–	VRY	VYB	VBR	IR	IY	IB	In					THDV	THDi
22	(10.35 am to 11.35 am) Per Hour Unit consumed- 615.0 kWh	MIN	409.9	411.2	411.3	834.6	810.5	804.8	26.8	561.1	183.2	593.6	0.92	5.8	16.0
		AVG	415.7	417.0	418.3	942.0	892.4	903.6	41.5	614.8	239.3	659.9	0.93	6.2	18.5
		MAX	419.6	421.0	422.6	1041.4	977.1	996.9	72.5	675.3	268.1	724.2	0.95	7.2	26.7
23	(11.35 am to 12.35 pm) Per Hour Unit consumed- 662.0 kWh	MIN	415.8	417.0	418.0	935.3	877.8	921.9	25.6	632.1	182.3	674.6	0.92	6.1	15.2
		AVG	418.2	419.7	421.3	994.5	936.4	967.6	41.8	661.6	235.7	703.0	0.94	6.7	18.3
		MAX	421.5	423.0	424.7	1062.8	1027.2	1027.6	66.9	708.9	272.6	749.2	0.96	7.6	23.9
24	(12.35 pm to 1.35 pm) Per Hour Unit consumed- 663.0 kWh	MIN	414.8	415.3	416.0	912.4	864.0	922.6	26.5	642.4	178.0	666.9	0.96	7.4	21.8
		AVG	419.4	420.8	421.6	957.4	918.0	967.4	36.3	663.4	188.7	690.7	0.96	7.6	23.2
		MAX	423.6	425.6	427.5	1008.0	978.4	1047.6	61.7	703.4	202.1	731.8	0.96	7.8	24.8
25	(1.35 pm to 2.35 pm) Per Hour Unit consumed- 617.0 kWh	MIN	416.1	416.4	416.1	532.4	489.2	545.5	23.0	373.4	87.0	384.7	-0.97	5.4	18.4
		AVG	418.5	419.5	420.3	887.6	853.6	907.2	35.5	617.1	172.1	641.7	0.93	7.3	22.7
		MAX	420.3	422.1	423.7	1008.9	960.6	1040.8	46.0	699.3	197.7	726.2	0.97	7.7	24.2

Table-8: Hour wise Energy Consumption for Utility – 1 – Transformer – 2

Time	Per Hour Unit Consumed (kWh)	RD (kVA)		
		MIN	AVG	MAX
2.35 pm to 3.35 pm	455.0	383.2	475.3	648.2
3.35 pm to 4.35 pm	474.0	477.3	492.0	517.7
4.35 pm to 5.35 pm	315.0	110.1	327.8	524.1
5.35 pm to 6.35 pm	134.0	113.6	140.1	172.0
6.35 pm to 7.35 pm	340.0	157.4	351.8	518.3
7.35 pm to 8.35 pm	419.0	247.0	430.8	456.7
8.35 pm to 9.35 pm	173.0	144.2	178.0	269.3
9.35 pm to 10.35 pm	158.0	143.3	162.6	201.6
10.35 pm to 11.35 pm	146.0	130.6	150.0	184.5
11.35 pm to 12.35 am	132.0	125.5	135.7	156.3
12.35 am to 1.35 am	125.0	120.7	128.5	143.5
1.35 am to 2.35 am	122.0	117.3	125.7	143.4
2.35 am to 3.35 am	119.0	110.7	122.3	134.7
3.35 am to 4.35 am	115.0	108.6	117.5	130.7
4.35 am to 5.35 am	104.0	88.3	105.4	133.3
5.35 am to 6.35 am	98.0	87.4	100.0	113.9
6.35 am to 7.35 am	117.0	81.1	120.7	480.8
7.35 am to 8.35 am	422.0	412.2	437.5	486.0
8.35 am to 9.35 am	676.0	439.8	707.2	844.3
9.35 am to 10.35 am	560.0	549.7	589.6	689.3
10.35 am to 11.35 am	615.0	593.6	659.9	724.2
11.35 am to 12.35 pm	662.0	674.6	703.0	749.2
12.35 pm to 1.35 pm	663.0	666.9	690.7	731.8
1.35 pm to 2.35 pm	617.0	384.7	641.7	726.2
24 Hour Unit consumed	7,761 kWh	–	–	–

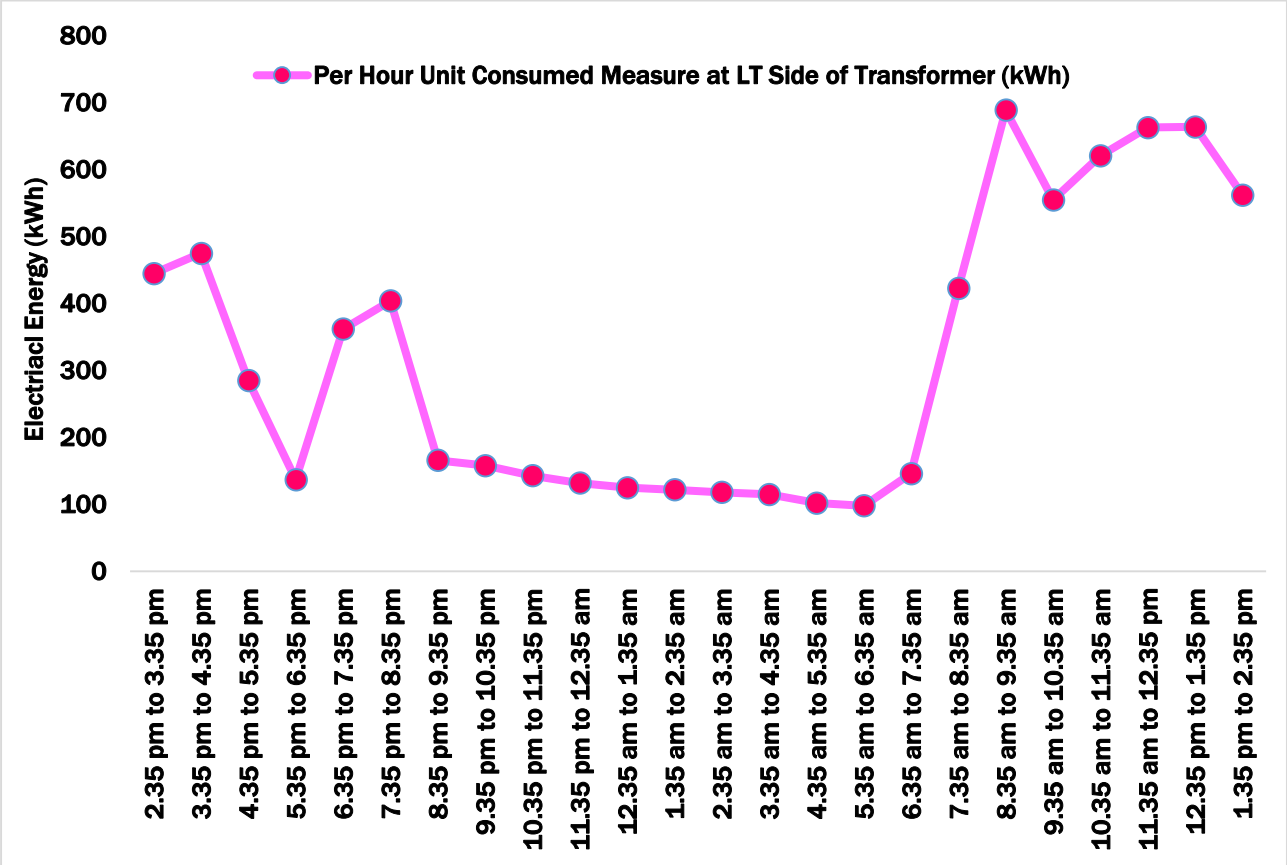
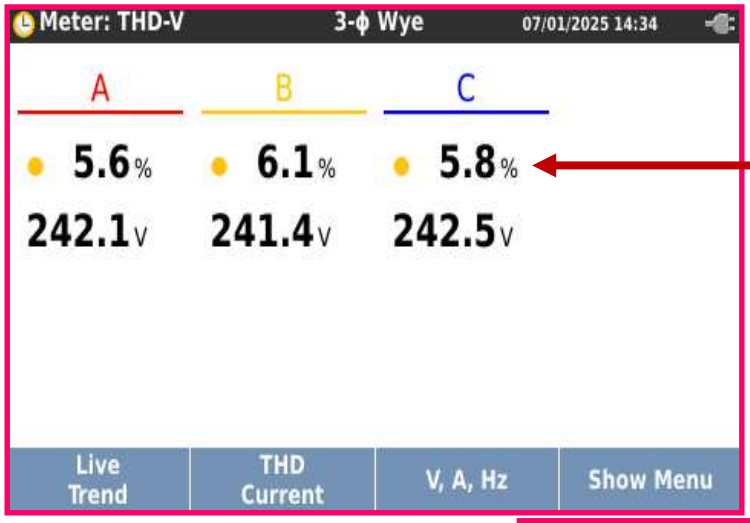


Fig.4. Electrical energy consumption during 24 Hours for Utility: I; Transformer – 2



% Voltage THD
(Must be less than 3 %)

% Current THD
(Must be less than 8 %)

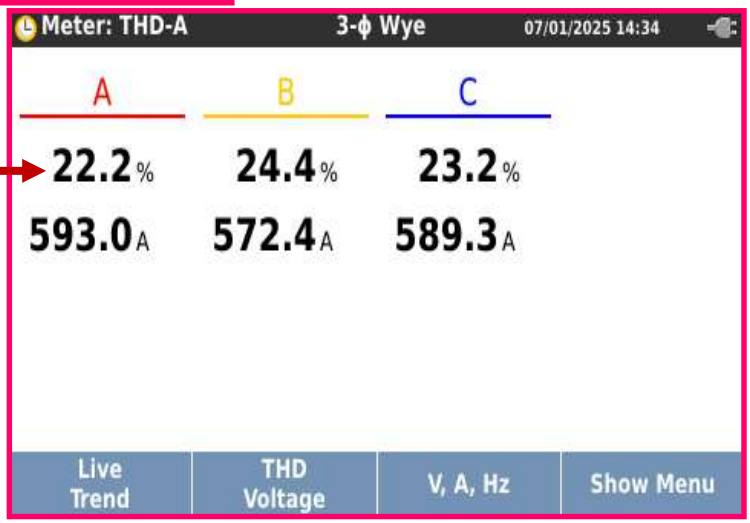


Table-9: Description of Electrical Parameters measured at Main Incoming for 24 Hours at Utility – 2 – Transformer – 3.

S. No.	Description	Supply Voltage (V)				Supply Current (A)				P (kW)	Q (kVAr)	S (kVA)	PF	% Harmonics	
		–	VRY	VYB	VBR	IR	IY	IB	In					THDV	THDI
1	Transformer 3 for 24s Hours 24 Hour Unit consumed- 14,450 kWh	MIN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.99	1.5	4.6
		AVG	418.7	415.5	416.9	859.5	900.2	798.1	54.9	602.1	163.8	624.2	0.92	5.3	21.9
		MAX	438.6	433.4	435.6	2039.3	2174.7	1957.9	156.8	1441.7	358.5	1472.1	0.99	9.1	29.0
		The Minimum Values are Zero Because of power cut during the durations of (5.36 am to 5.43 am) & (8.30 am to 8.38 am)													
2	(3.15 pm to 4.15 pm) Per Hour Unit consumed- 933.0 kWh	MIN	423.9	423.9	424.5	1163.5	1282.1	1145.0	58.3	866.9	233.8	897.9	0.96	6.9	19.4
		AVG	428.9	426.1	427.5	1285.7	1384.2	1240.0	96.5	932.8	255.0	967.0	0.96	7.4	20.7
		MAX	431.8	428.3	430.2	1401.6	1506.0	1341.8	156.3	1012.4	276.7	1049.5	0.97	7.8	21.8
3	(4.15 pm to 5.15 pm) Per Hour Unit consumed- 910.0 kWh	MIN	425.7	423.1	424.7	1175.1	1269.2	1132.3	49.1	862.1	231.9	894.3	0.96	7.0	19.7
		AVG	429.8	426.4	428.1	1263.4	1341.4	1204.6	83.1	909.7	249.3	943.3	0.96	7.4	20.7
		MAX	434.2	429.8	431.9	1363.2	1454.4	1329.8	133.5	984.6	271.0	1020.5	0.97	7.7	22.2
4	(5.15 pm to 6.15 pm) Per Hour Unit consumed- 655.0 kWh	MIN	426.4	423.7	425.6	758.7	791.3	702.5	44.0	548.2	140.0	567.7	0.96	4.9	20.2
		AVG	430.7	427.2	428.8	916.6	961.1	852.9	66.3	655.4	173.7	678.1	0.97	5.6	21.8
		MAX	438.6	433.4	435.6	1325.3	1382.3	1240.0	105.5	947.5	257.7	981.9	0.97	7.5	23.6
5	(6.15 pm to 7.15 pm) Per Hour Unit consumed- 575.0 kWh	MIN	415.3	411.8	412.7	772.8	810.2	698.9	32.4	548.5	135.5	567.2	0.96	4.8	20.9
		AVG	422.5	418.9	420.1	835.8	849.0	755.0	49.5	575.4	145.3	593.5	0.97	5.1	22.3
		MAX	434.4	429.4	430.7	898.3	903.8	834.1	75.4	623.8	159.6	642.9	0.97	5.6	23.9
6	(7.15 pm to 8.15 pm) Per Hour Unit consumed- 558.0 kWh	MIN	412.5	410.8	411.0	767.1	781.8	699.0	31.0	530.1	131.3	546.1	0.96	5.2	21.8
		AVG	417.2	413.3	414.4	825.9	831.4	742.3	41.3	557.6	144.4	576.0	0.97	5.5	23.2
		MAX	420.1	415.4	416.4	878.7	884.5	826.0	59.0	595.2	154.0	613.1	0.97	5.8	24.4
7	(8.15 pm to 9.15 pm) Per Hour Unit consumed- 546.0 kWh	MIN	414.5	412.8	413.0	764.4	794.0	694.1	27.2	524.9	137.0	544.7	0.96	5.3	22.9
		AVG	417.9	414.6	415.2	800.1	818.8	729.8	39.0	546.2	144.4	564.9	0.97	5.5	23.9
		MAX	421.8	417.0	418.1	845.8	864.1	791.0	53.5	575.0	154.9	593.5	0.97	5.7	25.6

S. No.	Description	Supply Voltage (V)				Supply Current (A)				P (kW)	Q (kVAr)	S (kVA)	PF	% Harmonics	
		–	VRY	VYB	VBR	IR	IY	IB	In					THDV	THDI
8	(9.15 pm to 10.15 pm) Per Hour Unit consumed- 538.0 kWh	MIN	414.3	412.6	413.2	752.0	777.4	679.9	21.4	524.6	140.1	543.3	0.96	4.9	22.9
		AVG	419.0	415.2	416.0	785.9	809.0	719.7	29.9	537.7	148.5	557.8	0.96	5.3	24.7
		MAX	421.9	416.8	418.0	823.5	844.8	765.5	52.1	561.6	161.1	581.1	0.97	5.6	26.3
9	(10.15 pm to 11.15 pm) Per Hour Unit consumed- 519.0 kWh	MIN	414.1	414.6	413.6	707.5	766.6	659.9	22.9	506.6	144.4	528.2	0.95	4.8	24.6
		AVG	420.1	417.3	417.5	748.2	786.8	701.3	31.6	519.4	151.1	540.9	0.96	5.1	26.8
		MAX	423.3	419.9	420.2	796.3	819.4	763.1	45.5	535.8	161.3	558.1	0.96	5.4	29.0
10	(11.15 pm to 12.15 am) Per Hour Unit consumed- 546.0 kWh	MIN	415.5	412.8	414.1	740.4	764.8	660.0	24.0	511.2	148.4	534.7	0.96	4.7	23.2
		AVG	421.0	417.3	418.3	795.6	822.5	724.0	32.7	545.7	155.2	567.4	0.96	4.9	25.6
		MAX	426.3	422.1	422.8	844.5	866.4	787.2	45.1	575.0	163.2	595.5	0.97	5.2	28.4
11	(12.15 am to 1.15 am) Per Hour Unit consumed- 562.0 kWh	MIN	416.0	413.6	414.9	792.9	822.1	714.7	25.1	546.5	149.3	567.8	0.96	4.7	23.1
		AVG	419.6	415.6	416.9	825.0	845.5	744.4	36.4	561.8	155.9	583.0	0.96	5.0	24.4
		MAX	422.3	417.5	419.0	855.5	870.0	787.3	48.7	582.0	162.1	603.5	0.97	5.2	25.9
12	(1.15 am to 2.15 am) Per Hour Unit consumed- 551.0 kWh	MIN	418.9	416.3	417.3	767.8	783.4	688.6	26.6	534.6	146.5	554.9	0.96	4.8	23.0
		AVG	422.2	418.3	419.9	806.9	820.2	727.2	34.5	551.0	153.7	572.1	0.96	5.0	24.6
		MAX	425.3	420.3	422.3	844.7	858.6	778.0	48.1	574.5	164.3	595.0	0.97	5.3	26.4
13	(2.15 am to 3.15 am) Per Hour Unit consumed- 539.0 kWh	MIN	419.0	417.4	418.2	752.2	771.8	680.7	29.9	523.2	146.3	543.7	0.96	4.8	23.3
		AVG	423.0	419.6	420.9	787.3	801.1	711.6	37.4	539.3	151.9	560.3	0.96	5.0	25.2
		MAX	425.4	421.2	422.4	837.4	843.2	757.8	49.6	561.0	163.8	581.3	0.97	5.3	26.7
14	(3.15 am to 4.15 am) Per Hour Unit consumed- 538.0 kWh	MIN	421.0	419.0	420.2	745.8	777.5	685.1	21.3	523.1	145.7	545.1	0.96	4.9	23.9
		AVG	423.7	420.5	421.4	777.8	799.6	712.1	35.3	537.8	150.9	558.5	0.96	5.1	25.0
		MAX	426.1	421.9	422.8	807.4	829.8	751.6	53.1	552.7	158.3	574.0	0.97	5.4	26.5

S. No.	Description	Supply Voltage (V)				Supply Current (A)				P (kW)	Q (kVAr)	S (kVA)	PF	% Harmonics	
		–	VRY	VYB	VBR	IR	IY	IB	In					THDV	THDI
15	(4.15 am to 5.15 am) Per Hour Unit consumed- 529.0 kWh	MIN	420.7	418.6	419.1	740.1	763.0	660.0	23.4	514.8	143.4	535.3	0.96	4.9	24.2
		AVG	423.3	419.9	421.0	766.7	789.1	701.4	32.1	529.4	149.2	550.1	0.96	5.2	25.3
		MAX	425.6	421.0	422.4	797.0	819.1	740.5	41.0	544.4	158.4	564.4	0.97	5.5	26.9
16	(5.15 am to 6.15 am) Per Hour Unit consumed- 351.0 kWh	MIN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.99	1.5	7.8
		AVG	373.0	370.4	371.5	505.4	522.5	471.1	29.0	350.8	80.7	360.4	0.77	3.7	19.2
		MAX	424.8	421.1	421.8	787.0	813.3	778.3	44.4	541.5	153.2	561.3	0.99	5.6	26.1
		The Minimum Values are Zero Because Of power cut during the durations of (5.36 am to 5.43 am)													
17	(6.15 am to 7.15 am) Per Hour Unit consumed- 407.0 kWh	MIN	407.1	404.6	406.5	388.2	402.8	365.4	19.5	271.3	47.8	276.0	-0.99	2.7	16.2
		AVG	414.9	412.7	413.8	593.4	605.3	562.5	26.6	407.3	108.2	421.9	0.32	4.2	23.5
		MAX	423.7	421.2	422.0	736.4	745.7	703.5	45.8	505.6	149.0	526.6	0.99	5.3	28.6
18	(7.15 am to 8.15 am) Per Hour Unit consumed- 368.0 kWh	MIN	419.2	416.7	418.5	301.3	308.6	282.9	18.1	213.3	42.9	217.8	0.85	3.1	14.4
		AVG	422.1	420.4	421.4	524.1	533.1	502.2	25.3	367.7	92.6	379.5	0.97	4.1	20.6
		MAX	425.4	422.8	423.6	1077.7	1072.7	1015.4	35.7	733.1	298.0	764.7	0.98	6.6	27.8
19	(8.15 am to 9.15 am) Per Hour Unit consumed- 462.0 kWh	MIN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.99	1.7	12.1
		AVG	367.0	365.2	366.1	653.4	680.3	631.7	35.9	462.0	120.9	477.8	0.81	5.1	19.4
		MAX	433.2	429.4	430.6	1409.2	1453.8	1371.9	76.8	989.1	358.5	1034.3	0.98	8.7	22.4
		The Minimum Values are Zero Because Of power cut during the durations of (8.30 am to 8.38 am)													
20	(9.15 am to 10.15 am) Per Hour Unit consumed- 654.0 kWh	MIN	420.8	418.9	420.2	726.8	792.5	717.2	44.1	537.0	145.5	556.7	0.95	5.6	18.7
		AVG	426.1	423.6	425.1	903.7	979.8	883.5	71.2	654.2	185.6	680.1	0.96	6.2	20.7
		MAX	429.1	425.6	427.7	1514.5	1574.3	1446.4	110.5	1053.2	342.5	1103.0	0.97	9.1	22.6
21	(10.15 am to 11.15 am) Per Hour Unit consumed- 607.0 kWh	MIN	422.7	420.3	421.5	758.5	857.9	752.2	51.7	563.2	163.4	588.4	0.95	5.6	19.4
		AVG	425.4	422.5	424.3	829.3	927.1	817.9	84.7	606.7	178.3	632.4	0.96	5.8	20.8
		MAX	429.1	424.4	426.7	922.7	1016.2	903.7	127.0	668.8	193.7	696.3	0.96	6.0	22.2

S. No.	Description	Supply Voltage (V)				Supply Current (A)				P (kW)	Q (kVAr)	S (kVA)	PF	% Harmonics	
		–	VRY	VYB	VBR	IR	IY	IB	In					THDV	THDI
22	(11.15 am to 12.15 pm) Per Hour Unit consumed- 563.0 kWh	MIN	423.3	420.1	422.1	724.7	803.9	699.5	56.7	529.9	161.5	556.3	0.95	5.5	19.4
		AVG	426.7	423.0	425.3	779.1	863.6	754.0	83.8	563.4	175.7	590.2	0.95	5.7	21.5
		MAX	429.7	425.5	428.2	905.1	983.7	864.2	120.7	644.4	196.8	672.0	0.96	6.0	23.0
23	(12.15 pm to 1.15 pm) Per Hour Unit consumed- 607.0 kWh	MIN	417.6	416.3	418.8	624.4	719.7	585.1	69.0	460.0	159.2	487.0	0.94	5.4	14.1
		AVG	424.6	421.0	423.5	858.2	938.9	817.5	98.0	607.1	204.5	640.7	0.95	5.8	19.7
		MAX	433.2	427.6	430.5	1104.0	1175.7	1033.2	130.1	761.6	257.3	803.1	0.96	6.3	25.2
24	(1.15 pm to 2.15 pm) Per Hour Unit consumed- 651.0 kWh	MIN	422.9	420.1	424.1	698.5	794.2	646.5	68.9	507.9	157.5	536.9	0.95	4.6	9.8
		AVG	427.9	425.2	427.4	909.7	982.2	836.9	98.5	650.9	180.0	675.5	0.96	5.5	18.3
		MAX	431.4	428.3	430.0	1497.2	1491.8	1183.6	136.3	1000.3	231.2	1024.7	0.98	6.0	22.7
25	(2.15 pm to 3.15 pm) Per Hour Unit consumed- 1,281.0 kWh	MIN	416.9	415.9	417.4	1403.1	1420.8	1092.2	85.0	942.4	201.0	968.6	0.97	4.2	4.6
		AVG	421.7	418.6	422.4	1850.4	1911.5	1610.2	118.1	1280.9	276.6	1309.8	0.98	4.5	6.5
		MAX	424.7	422.1	426.5	2039.3	2174.7	1957.9	156.8	1441.7	318.0	1472.1	0.98	5.0	11.7

Table-10: Hour wise Energy Consumption for Utility II; Transformer – 3

Time	Per Hour Unit Consumed (kWh)	RD (kVA)		
		MIN	AVG	MAX
3.15 pm to 4.15 pm	933.0	897.9	967.0	1,049.5
4.15 pm to 5.15 pm	910.0	894.3	943.3	1,020.5
5.15 pm to 6.15 pm	655.0	567.7	678.1	981.9
6.15 pm to 7.15 pm	575.0	567.2	593.5	642.9
7.15 pm to 8.15 pm	558.0	546.1	576.0	613.1
8.15 pm to 9.15 pm	546.0	544.7	564.9	593.5
9.15 pm to 10.15 pm	538.0	543.3	557.8	581.1
10.15 pm to 11.15 pm	519.0	528.2	540.9	558.1
11.15 pm to 12.15 am	546.0	534.7	567.4	595.5
12.15 am to 1.15 am	562.0	567.8	583.0	603.5
1.15 am to 2.15 am	551.0	554.9	572.1	595.0
2.15 am to 3.15 am	539.0	543.7	560.3	581.3
3.15 am to 4.15 am	538.0	545.1	558.5	574.0
4.15 am to 5.15 am	529.0	535.3	550.1	564.4
5.15 am to 6.15 am	351.0	0.0	360.4	561.3
6.15 am to 7.15 am	407.0	276.0	421.9	526.6
7.15 am to 8.15 am	368.0	217.8	379.5	764.7
8.15 am to 9.15 am	462.0	0.0	477.8	1,034.3
9.15 am to 10.15 am	654.0	556.7	680.1	1,103.0
10.15 am to 11.15 am	607.0	588.4	632.4	696.3
11.15 am to 12.15 pm	563.0	556.3	590.2	672.0
12.15 pm to 1.15 pm	607.0	487.0	640.7	803.1
1.15 pm to 2.15 pm	651.0	536.9	675.5	1,024.7
2.15 pm to 3.15 pm	1,281.0	968.6	1,309.8	1,472.1
24 Hour Unit consumed	14,450 kWh	–	–	–

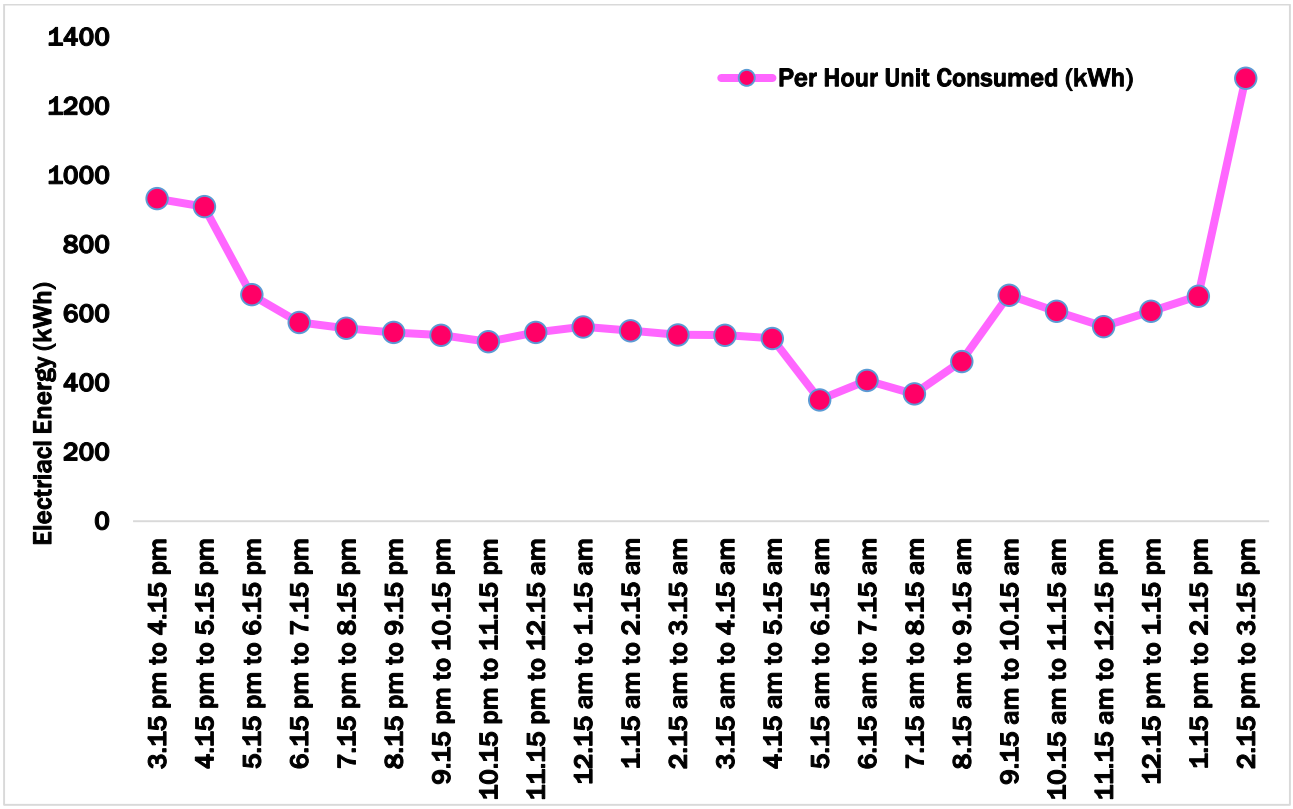
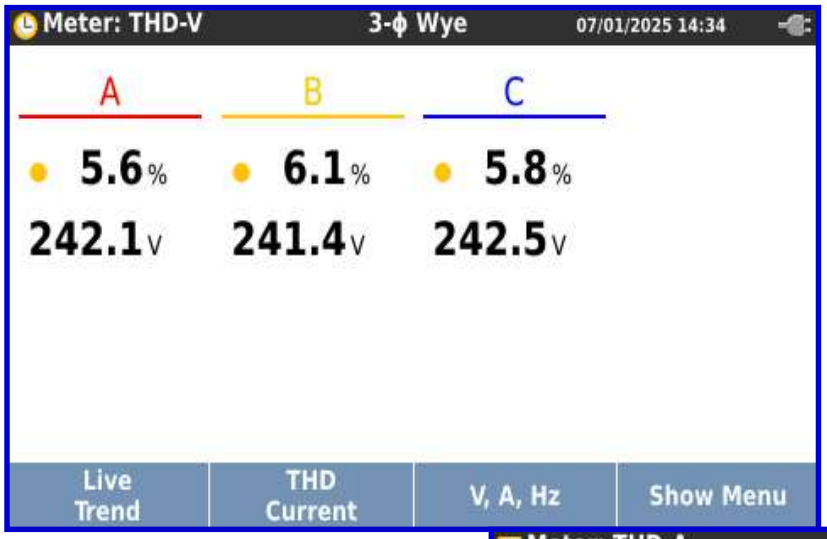
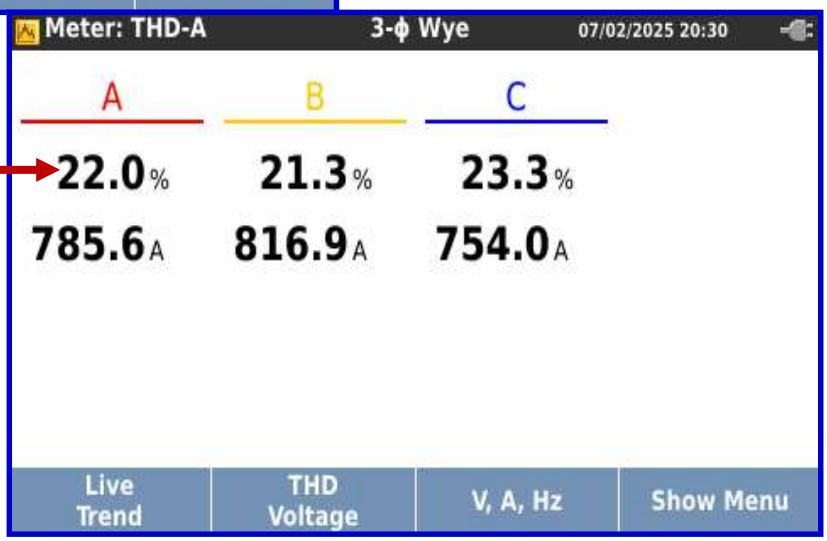


Fig.-5: Electrical energy consumption during 24 Hours for Utility II; Transformer – 3



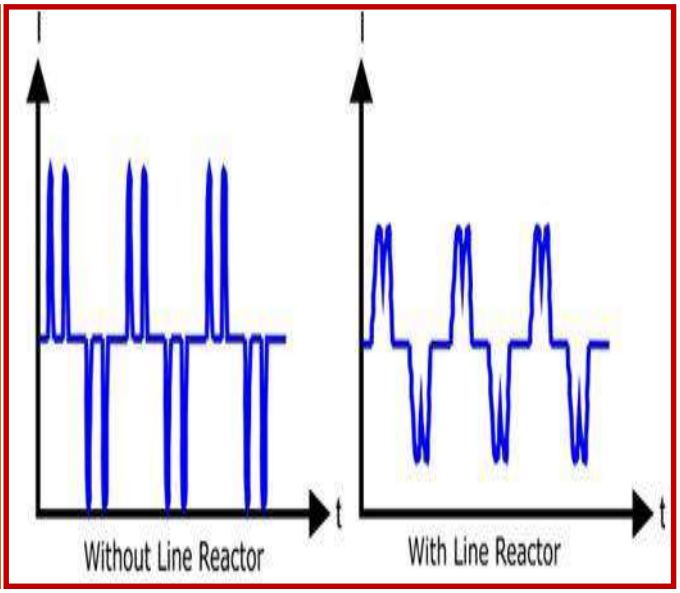
% Current THD
(Must be less than 8 %)

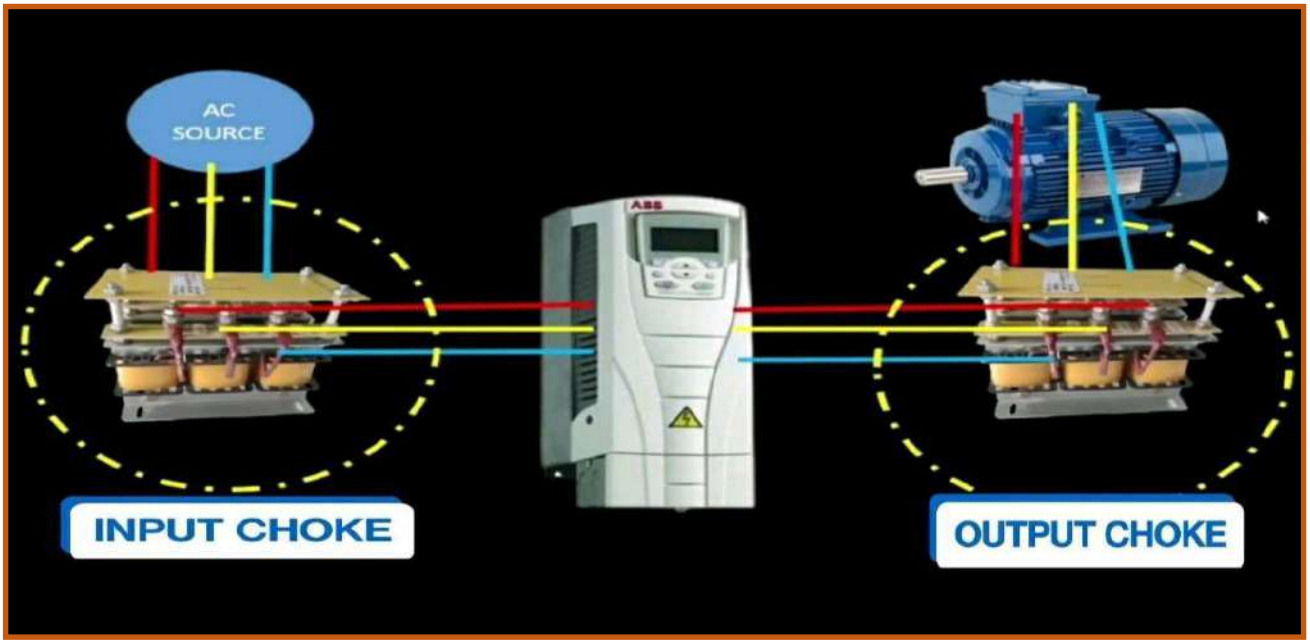


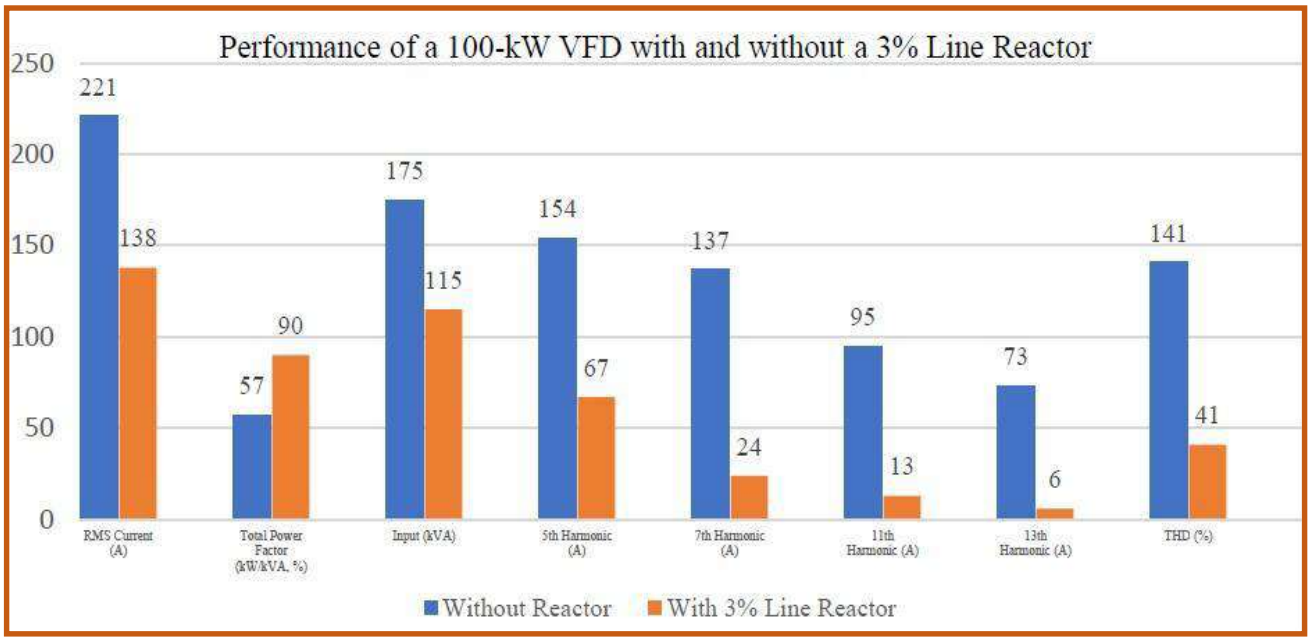
Installation of Line Reactance Choke:

- ☞ It is an iron-cored coil that represents an Inductive impedance added to the system. Line and load reactors are used in Variable Frequency Drives (VFD) to smooth the voltage surges and provide harmonics filtration.
- ☞ Line Reactors are inserted before the VFD line side. It helps filter out the system harmonics and smooth the voltage fluctuations, spikes and surges to protect the drive.
- ☞ Load Reactor: Inserted after the VFD to protect the motor from the harmful dv/dt stress and the inverter induced harmonics; especially with long connecting cables.
- ☞ There is one more possibility to reduce the THD level (both voltage and current) is to install properly sized line reactance choke (preferably 3-5 % impedance) at the input of each machine.
- ☞ The choke will block the polluted harmonics component and not to allow to intrude in the main power source.
- ☞ This also safeguards the machine electronic components from the spikes and surges surrounding the machine.





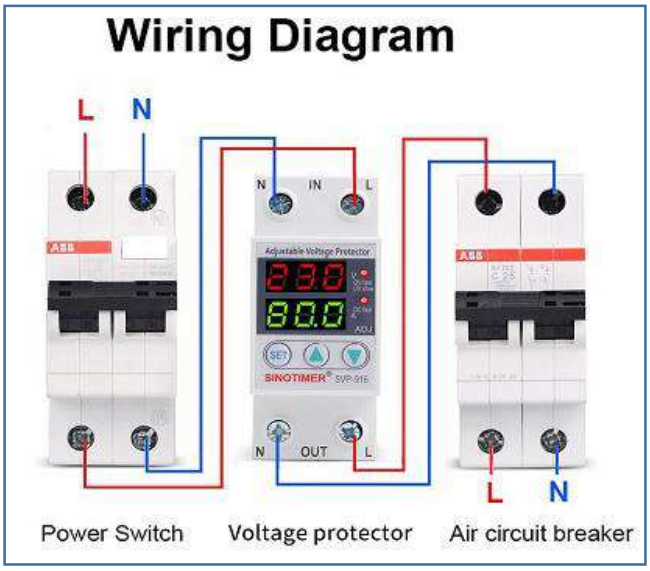




Installation of Surge Protection Devices (SPD) at the Input Side:

- → SPD is designed to limit transient over voltages of atmospheric origin and divert current waves to earth, so as to limit the amplitude of this overvoltage to a value that is not hazardous for the electrical installation and electric switchgear and control gear.
- → It eliminates the over voltages in two different modes i) Common Mode: Between phase and neutral or earth and ii) Differential Mode:
- → Between phase and neutral. Also in the over voltage exceeds the threshold level; then i) Common Mode: it conducts the energy to earth and ii) Differential Mode: distributes the energy to the other live conductor.





ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

9. MEASUREMENT OF ELECTRICAL PARAMETERS AT LOADS

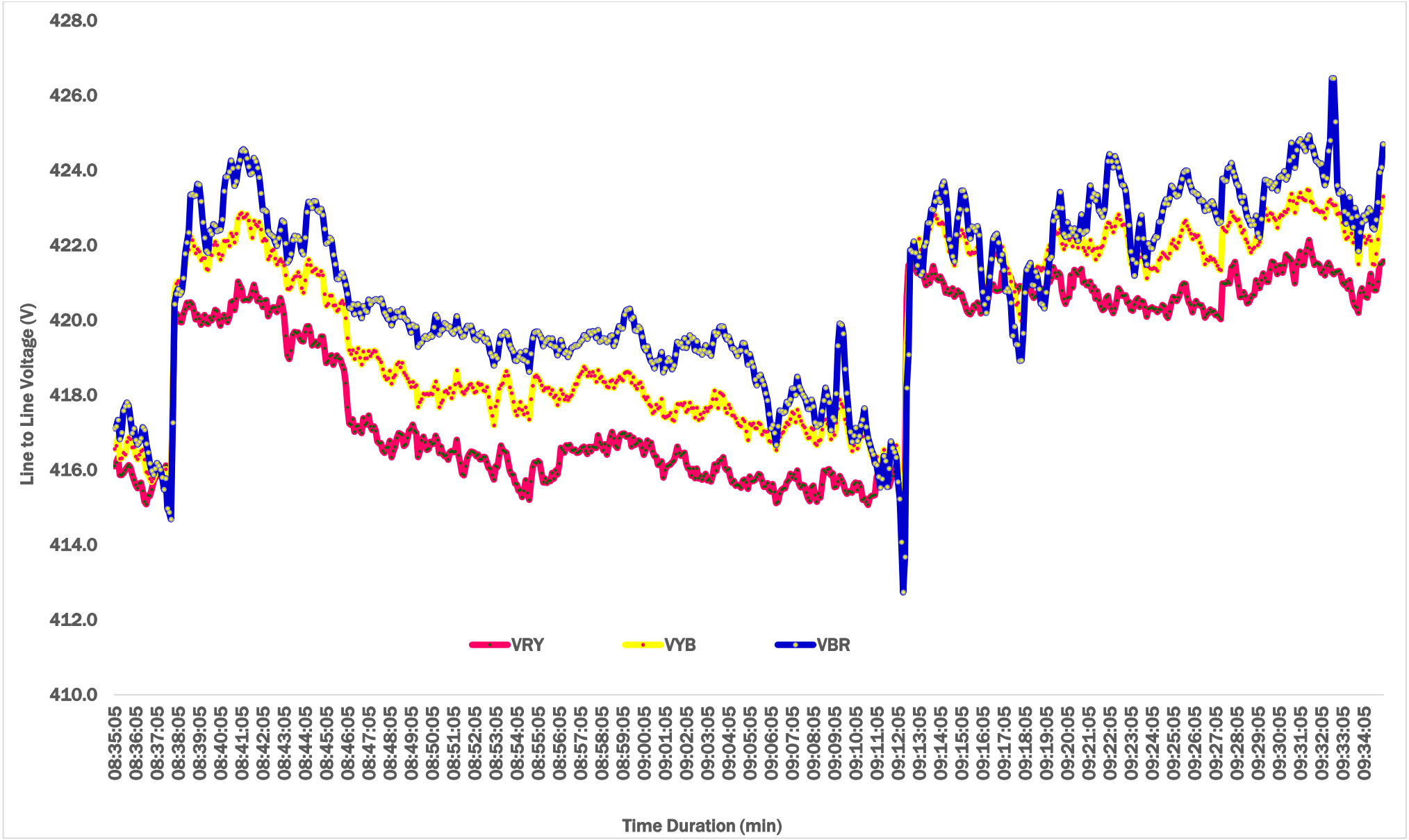


Fig.6: Line to Line Voltage (RMS) measured at the 2,000 kVA Transformer LT Side of Utility 1 – 2

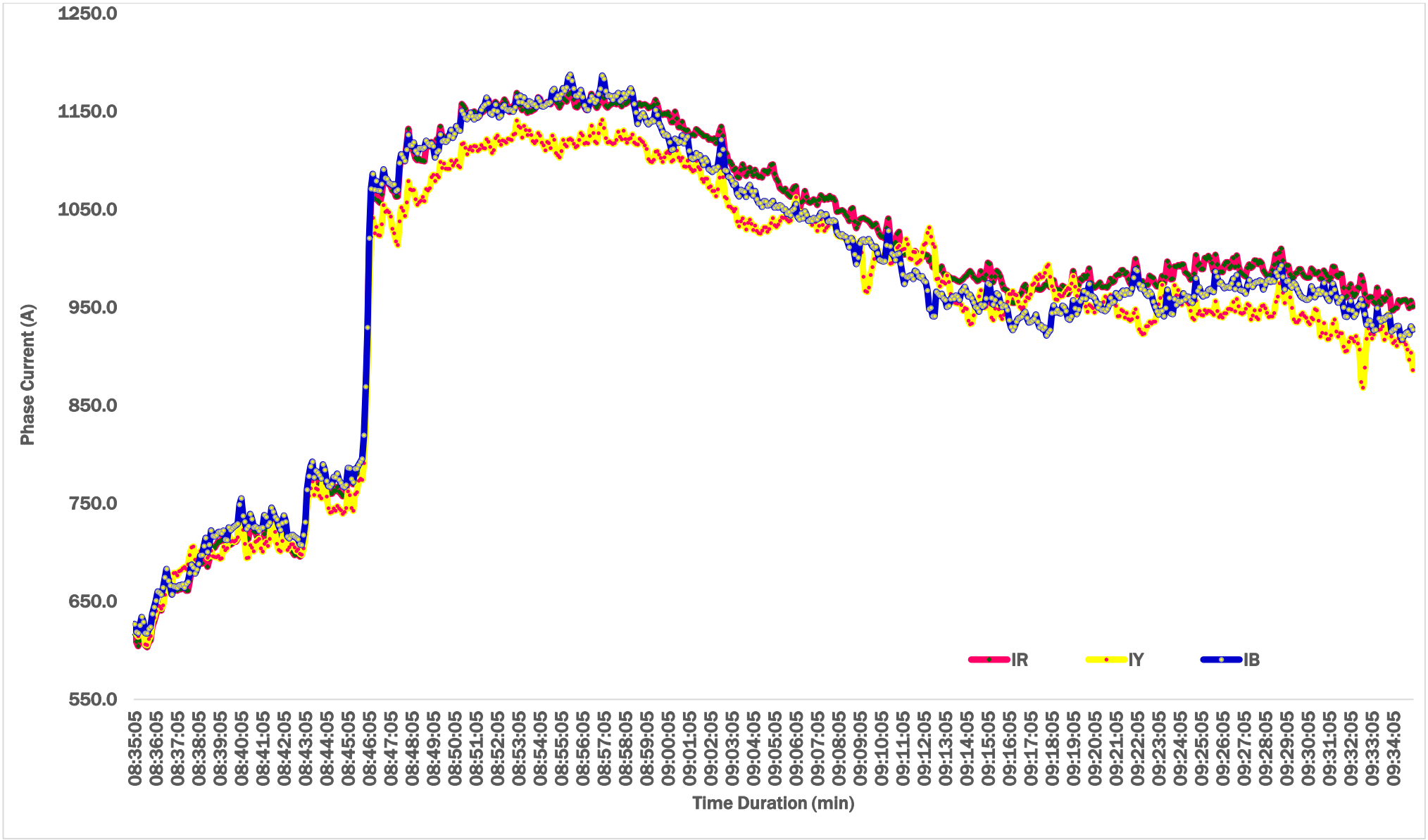


Fig.7: Phase Current measured at the 2,000 kVA LT Side of Utility 1 – Transformer 2

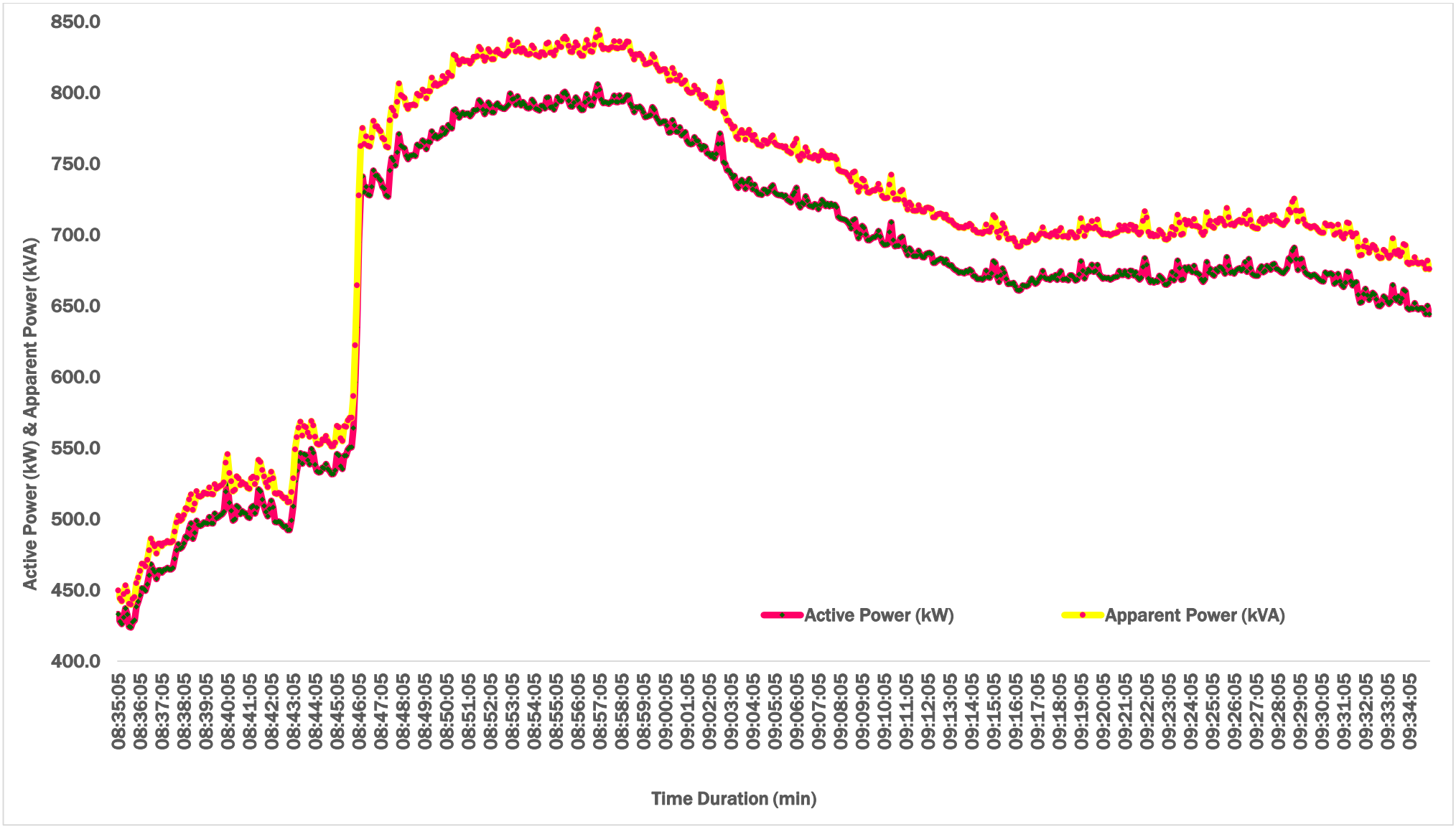


Fig.8: Active & Apparent Power measured at the 2,000 kVA LT Side of Utility 1 – Transformer 2

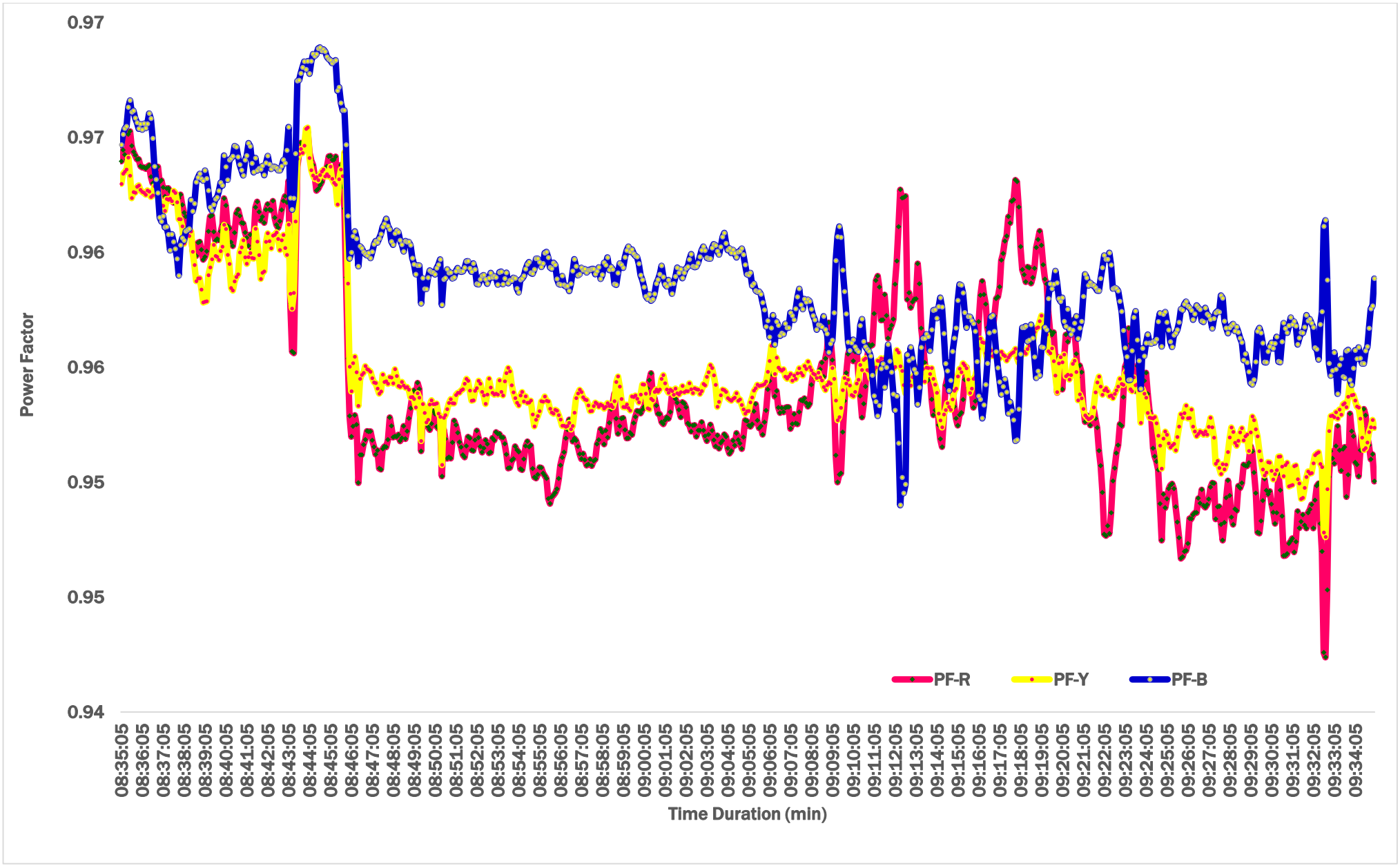


Fig.9: Supply Power Factor measured at the 2,000 kVA LT Side of Utility 1 – Transformer 2

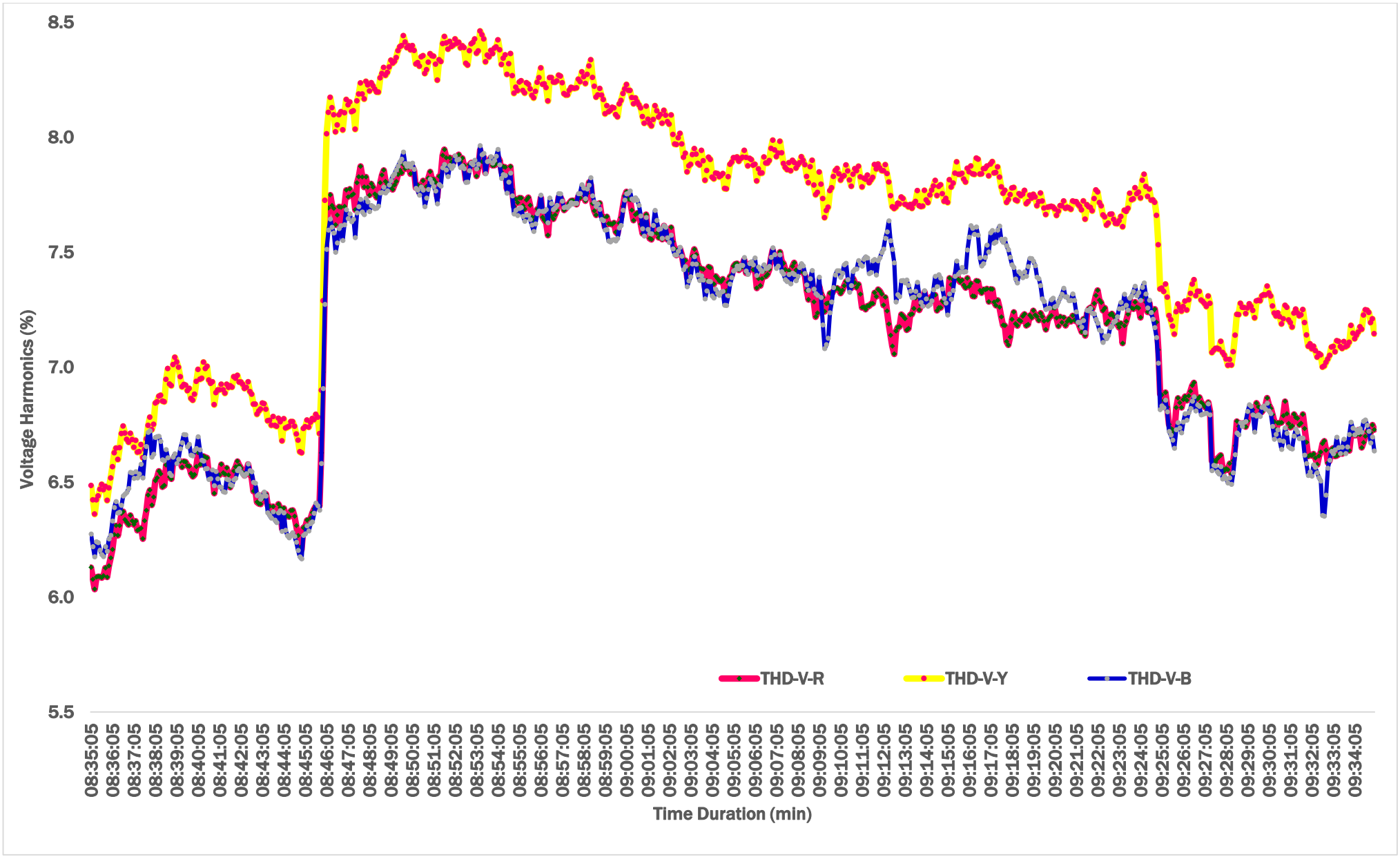


Fig.10: Voltage Harmonics (THD-V) measured at the 2,000 kVA LT Side of Utility 1 – Transformer 2

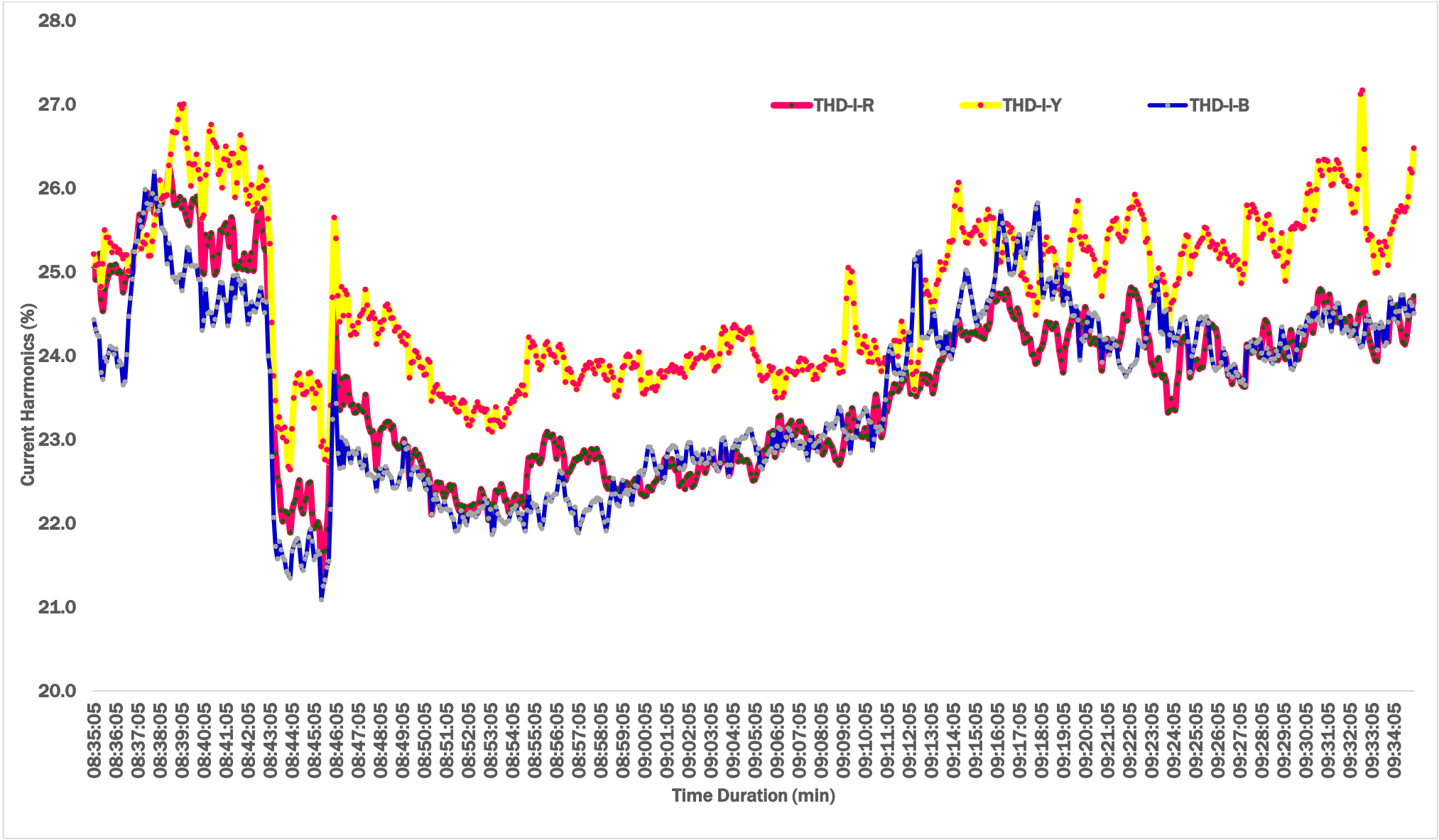


Fig.11: Current Harmonics (THD-I) measured at the 2,000 kVA LT Side of Utility 1 – Transformer 2

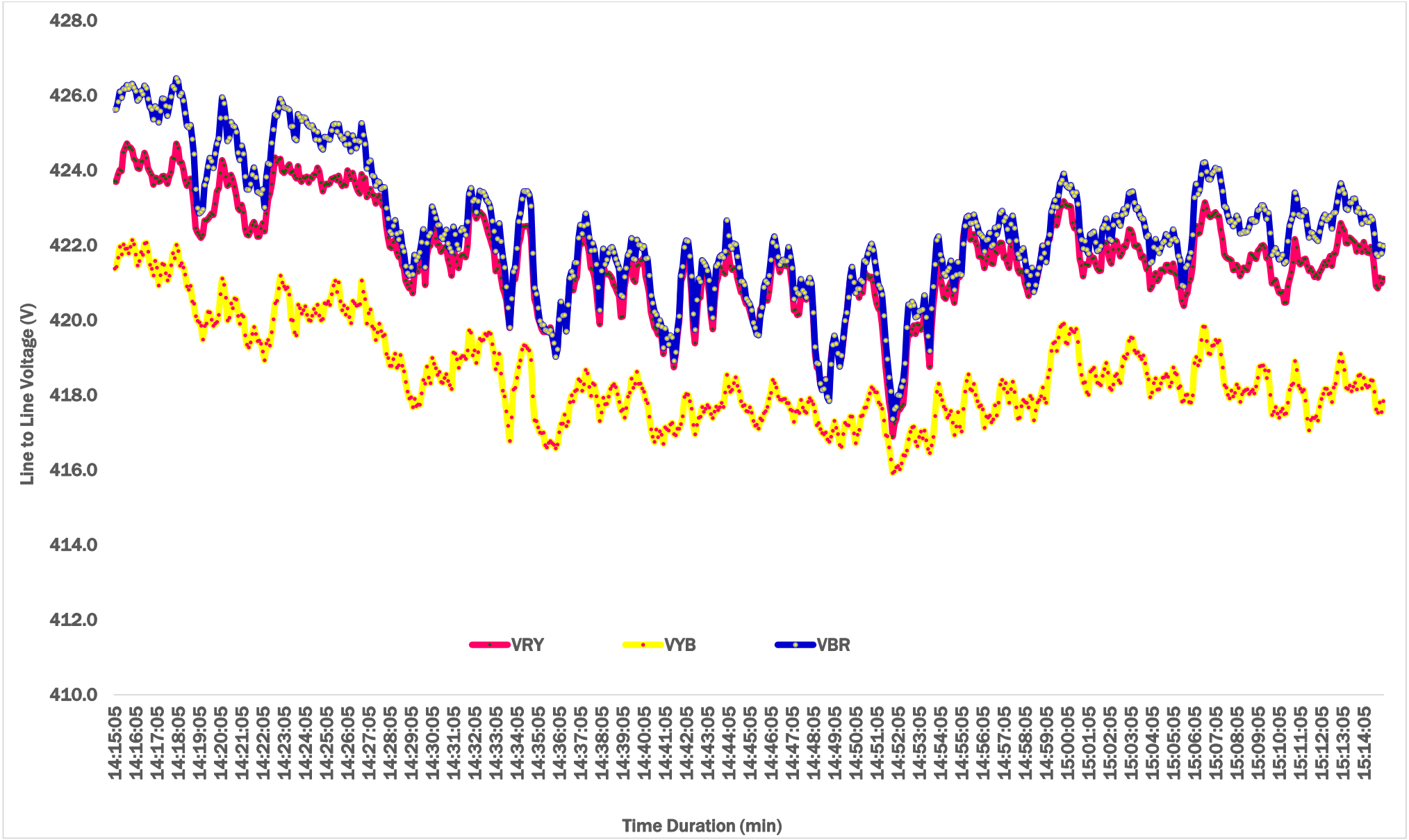


Fig.12: Line to Line Voltage (RMS) measured at the 2,000 kVA LT Side of Utility 2 – Transformer 3

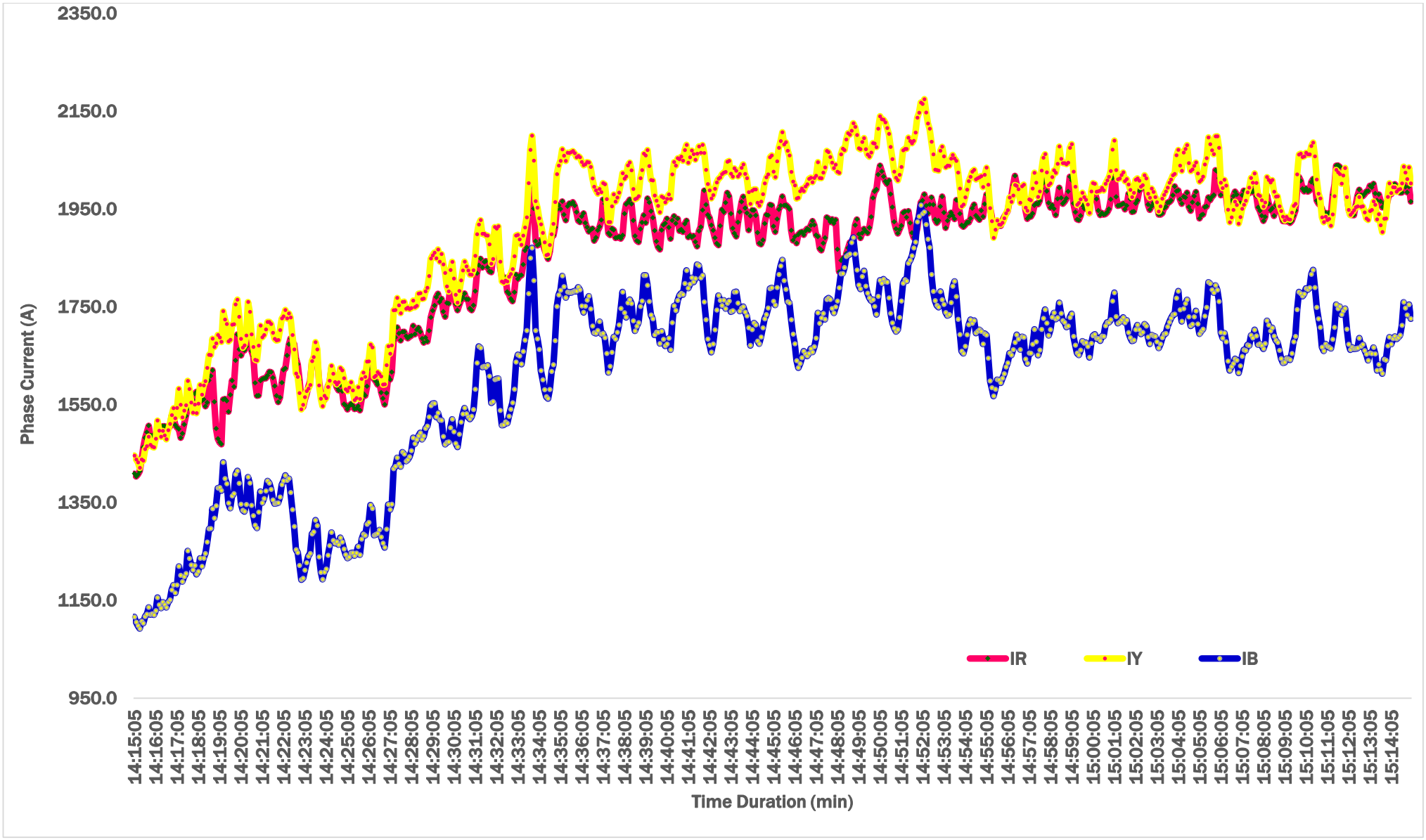


Fig.10: Phase Current measured at the 2,000 kVA LT Side of Utility 2 – Transformer 3

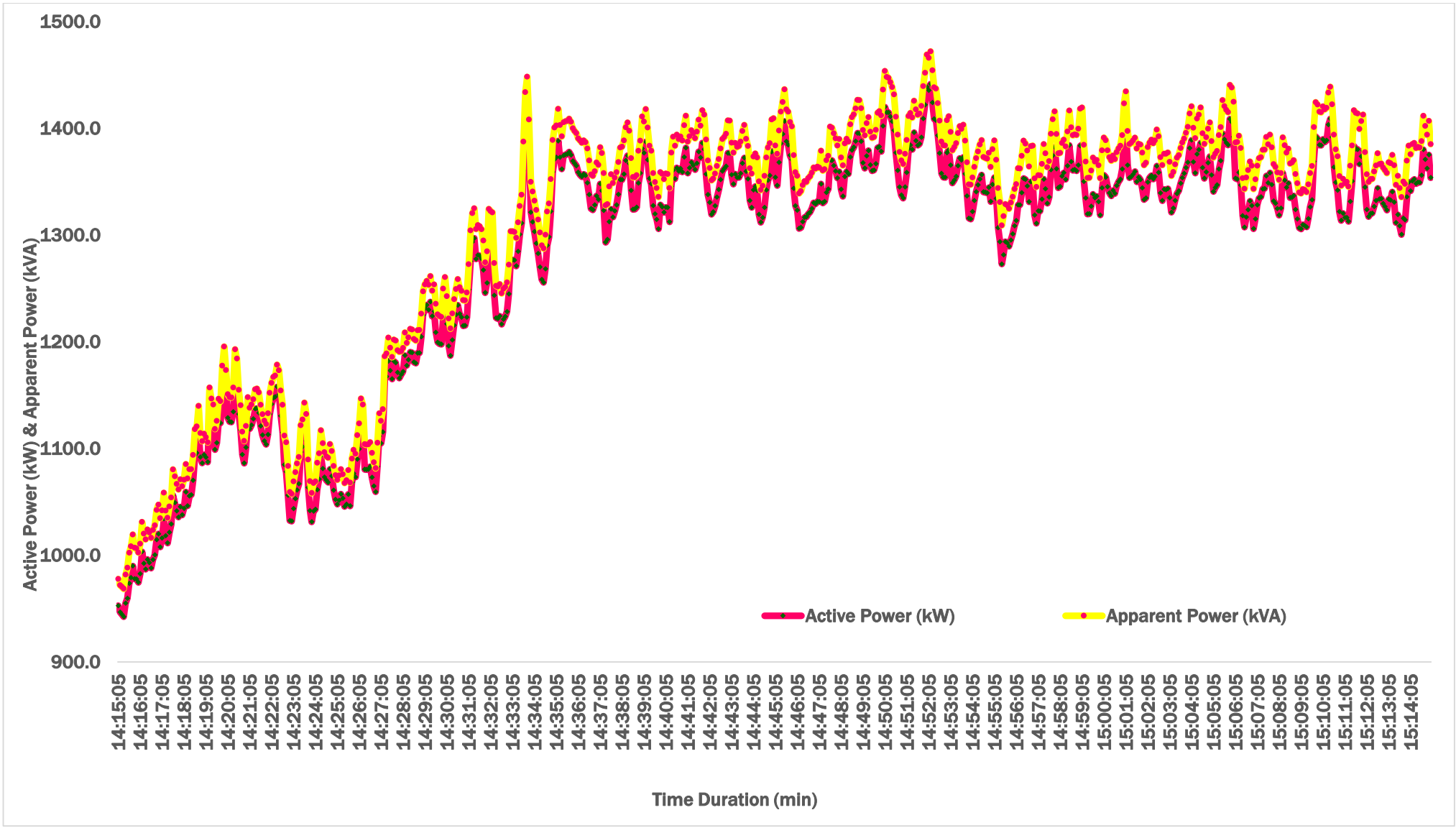


Fig.11: Active & Apparent Power measured at the 2,000 kVA LT Side of Utility 2 – Transformer 3

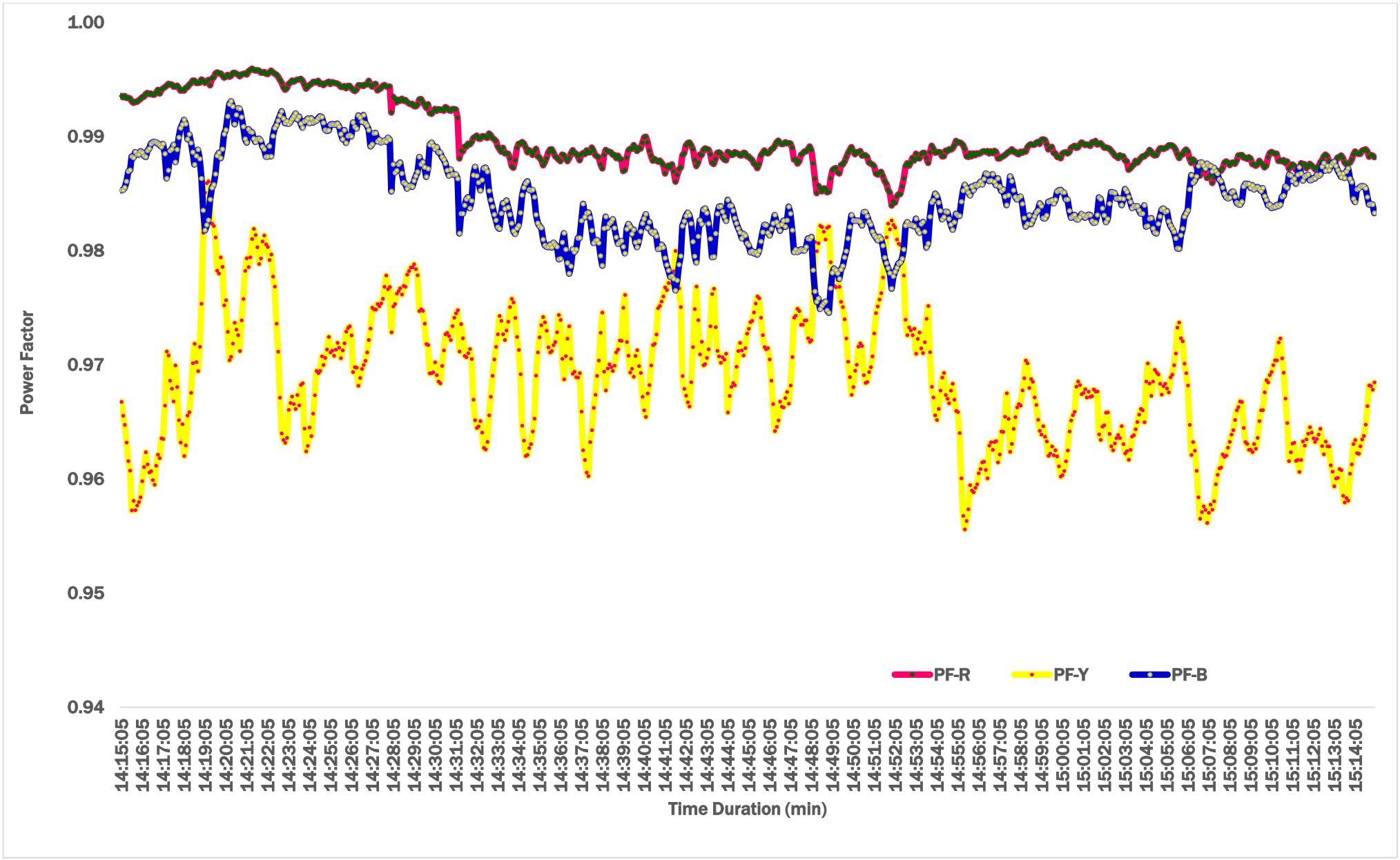


Fig.12: Supply Power Factor measured at the 2,000 kVA LT Side of Utility 2 – Transformer 3

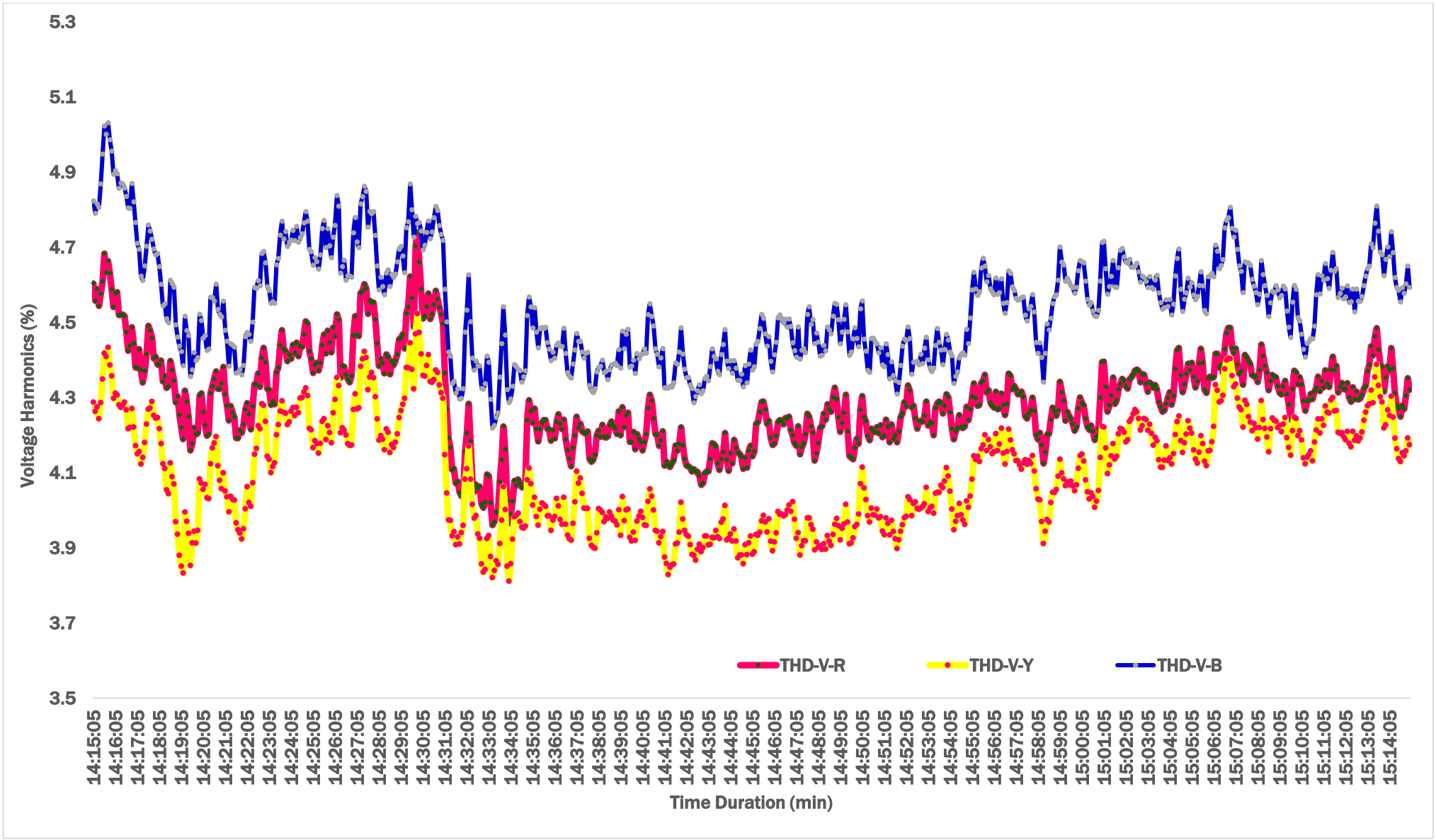


Fig.13: Voltage Harmonics (THD-V) measured at the 2,000 kVA LT Side of Utility 2 – Transformer 3

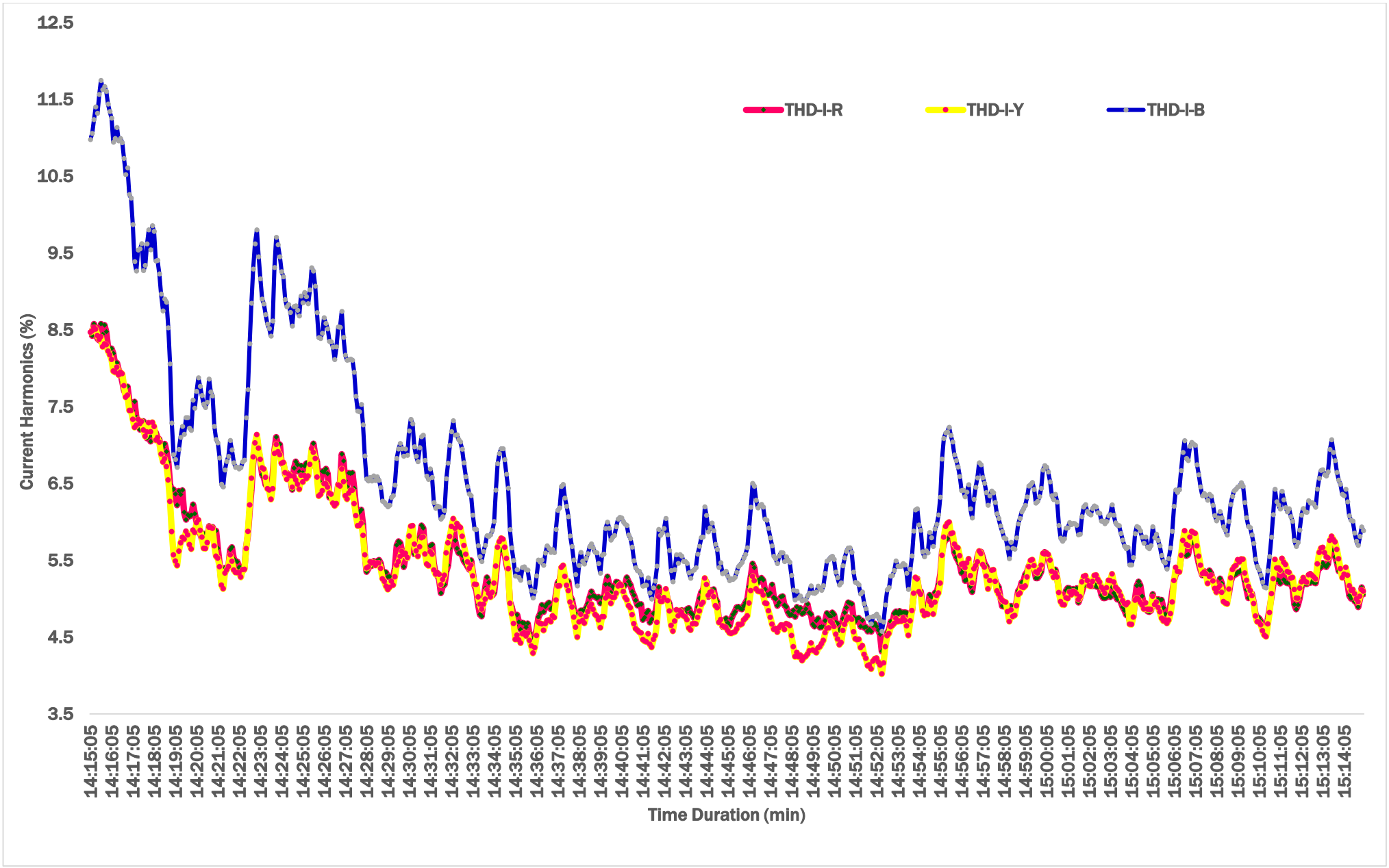


Fig.14: Current Harmonics (THD-I) measured at the 2,000 kVA LT Side of Utility 2 – Transformer 3

Table-11: Description of Electrical Parameters measured at Different Load Points

S. No.	Description	Supply Voltage (V)				Supply Current (A)				P (kW)	Q (kVAr)	S (kVA)	PF	% Harmonics	
		–	VRY	VYB	VBR	IR	IY	IB	In					THDv	THDi
Transformers LT Side															
1.	**Utility I; Transformer – 2** Per Hour Unit consumed- **323.4 kWh**	MIN	409.9	411.2	411.3	95.4	107.4	113.9	19.6	78.6	12.2	81.1	-0.99	1.8	5.2
		AVG	423.4	424.5	426.3	464.8	448.6	468.6	37.6	323.4	94.4	337.2	0.89	4.3	16.0
		MAX	435.0	435.9	439.2	1168.9	1141.3	1187.5	72.5	805.9	272.6	844.3	0.99	8.5	32.0
2.	**Utility I; Transformer – 3** Per Hour Unit consumed- **602.1 kWh**	MIN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.99	1.5	4.6
		AVG	418.7	415.5	416.9	859.5	900.2	798.1	54.9	602.1	163.8	624.2	0.92	5.3	21.9
		MAX	438.6	433.4	435.6	2039.3	2174.7	1957.9	156.8	1441.7	358.5	1472.1	0.99	9.1	29.0
		The Minimum Values are Zero Because of power cut during the durations of (5.36 am to 5.43 am) & (8.30 am to 8.38 am)													
3.	**Transformer 5 Vedavathi Hostel** Per Hour Unit consumed- **207.8 kWh**	MIN	416.1	417.3	414.9	269.2	174.1	223.7	64.3	166.3	44.5	181.8	-0.98	2.5	5.1
		AVG	419.3	421.4	421.3	346.7	224.1	305.3	119.8	207.8	78.5	222.6	-0.46	3.0	13.2
		MAX	422.3	424.5	425.3	450.7	316.1	403.8	187.0	262.3	126.2	276.8	0.97	3.5	19.1
4.	**Transformer 6 Ganga Hostel** Per Hour Unit consumed- **62.3 kWh**	MIN	411.2	412.2	412.2	73.1	62.1	83.1	11.2	55.5	0.4	57.1	0.95	3.7	9.6
		AVG	416.3	418.4	418.9	88.7	78.1	94.4	19.6	62.3	3.1	63.9	0.98	3.8	13.5
		MAX	420.9	423.3	425.7	145.5	123.4	133.9	34.8	96.3	9.1	98.3	0.99	4.8	17.6
Utility 1 – Chillers															
5.	**Chiller 1 – 450 TR** Per Hour Unit consumed- **184.6 kWh**	MIN	401.8	396.3	407.2	0.2	0.1	0.1	0.2	0.1	0.0	0.6	0.11	1.4	12.7
		AVG	415.6	416.8	418.4	287.5	270.9	282.0	1.9	186.8	33.6	201.9	0.82	7.9	48.0
		MAX	427.3	428.0	429.0	478.7	456.9	469.3	323.1	313.7	63.4	336.8	0.93	11.2	327.7
6.	**Chiller 2 – 450 TR** Per Hour Unit consumed- **239.1 kWh**	MIN	410.9	411.3	410.0	285.6	261.0	270.2	1.4	182.9	27.3	200.0	0.91	6.6	33.7
		AVG	413.6	415.1	416.2	375.6	346.9	358.0	2.3	239.1	40.0	259.0	0.92	7.3	34.8
		MAX	420.6	421.5	423.5	403.5	369.3	375.2	17.1	250.1	43.2	270.0	0.93	7.7	37.9

S. No.	Description	Supply Voltage (V)				Supply Current (A)				P (kW)	Q (kVAr)	S (kVA)	PF	% Harmonics	
		–	VRY	VYB	VBR	IR	IY	IB	In					THDv	THDi
7.	**Chiller 3 – 450 TR** Per Hour Unit consumed- **211.3 kWh**	MIN	408.4	410.2	410.0	281.9	263.5	277.1	1.3	184.1	8.1	196.2	0.93	7.0	27.3
		AVG	412.8	414.0	415.5	321.5	300.9	318.4	1.5	211.3	13.5	225.0	0.94	8.5	29.6
		MAX	419.2	421.4	422.5	435.6	402.1	423.2	7.1	283.0	20.3	301.0	0.94	9.7	32.3
Utility 2 – Chillers															
8.	**Chiller 4 – 450 TR** Per Hour Unit consumed- **263.1 kWh**	MIN	415.9	416.8	419.0	354.3	289.2	347.1	12.3	220.4	36.8	245.4	0.88	5.6	35.8
		AVG	419.7	421.4	424.1	419.6	361.5	405.7	14.3	263.1	47.1	289.7	0.91	6.1	39.0
		MAX	428.1	430.3	433.4	483.2	448.2	467.6	16.7	306.3	65.5	338.9	0.92	7.0	43.5
9.	**Chiller 5 – 250 TR** Per Hour Unit consumed- **129.3 kWh**	MIN	402.9	404.0	406.6	156.8	144.5	172.7	2.0	93.3	71.5	117.8	0.79	2.4	4.2
		AVG	414.3	415.1	418.1	205.6	203.6	224.2	2.7	129.3	80.2	152.2	0.85	2.9	5.3
		MAX	422.8	424.4	428.4	218.7	218.8	238.8	2.9	135.7	86.6	159.5	0.87	3.7	7.8
10.	**Chiller 7 – 1000 TR** Per Hour Unit consumed- **389.2 kWh**	MIN	417.8	418.7	417.9	522.0	502.3	514.9	15.9	355.5	133.4	379.8	0.93	5.6	32.1
		AVG	424.2	425.5	426.7	571.6	553.7	565.1	17.3	389.2	145.0	415.4	0.94	6.2	33.6
		MAX	431.4	433.4	435.1	601.1	578.7	601.3	18.1	415.7	154.8	443.5	0.94	6.5	36.6
Utility 1 – Primary Pump (Non-VFD)															
11.	**Primary Pump – 1** Per Hour Unit consumed- **18.6 kWh**	MIN	410.6	411.2	412.3	30.4	29.3	31.2	0.1	18.4	12.1	22.1	0.83	8.4	15.9
		AVG	413.8	414.6	416.5	30.9	29.9	32.4	0.1	18.6	12.4	22.3	0.83	8.6	16.7
		MAX	417.1	418.0	420.7	31.6	30.6	33.5	0.1	19.0	12.6	22.7	0.84	8.9	17.3
		22 kW; 1,480 rpm, η - 91.6 %, S_1 Duty; F Class; IE 2; XYLEM Make								**% Load: Minimum: 76.6 % to Maximum: 79.1 %**					
12.	**Primary Pump – 2** Per Hour Unit consumed- **18.1 kWh**	MIN	410.0	411.1	410.6	30.6	29.8	33.4	0.4	17.9	13.6	22.8	0.77	7.2	14.4
		AVG	413.0	414.5	415.8	31.0	30.8	34.7	0.4	18.1	13.9	23.1	0.78	7.5	15.1
		MAX	415.4	417.4	419.8	31.4	32.0	35.6	0.5	18.2	14.2	23.4	0.79	7.8	15.7
		22 kW; 1,460 rpm, η - 91.6 %, S_1 Duty; F Class; IE 2; XYLEM Make								**% Load: Minimum: 74.5 % to Maximum: 75.8 %**					

S. No.	Description	Supply Voltage (V)				Supply Current (A)				P (kW)	Q (kVAr)	S (kVA)	PF	% Harmonics	
		–	VRY	VYB	VBR	IR	IY	IB	In					THDv	THDi
13.	**Primary Pump – 3** Per Hour Unit consumed- **20.1 kWh**	MIN	414.4	414.8	415.2	33.7	33.1	34.5	0.1	20.0	14.4	24.6	0.81	8.5	14.0
		AVG	415.6	416.8	418.6	34.1	33.6	35.5	0.1	20.1	14.6	24.9	0.81	8.7	14.5
		MAX	417.0	418.8	421.4	34.7	34.4	36.4	0.1	20.2	14.8	25.0	0.81	8.9	14.9
		22 kW; 1,480 rpm, η - 91.6 %, S_1 Duty; F Class; IE 2; XYLEM Make								% Load: Minimum: 83.3 % to Maximum: 84.1 %					
Utility 1 – Secondary Pump (VFD Driven)															
14.	**Admin** **Secondary Pump - 1** Per Hour Unit consumed- **11.9 kWh (Freq. 35Hz)**	MIN	416.4	417.3	418.2	18.3	15.0	18.0	0.3	8.7	-3.7	13.3	0.56	8.0	32.7
		AVG	417.8	418.9	420.2	18.7	17.4	18.7	1.9	12.0	-0.4	13.5	0.90	8.2	33.6
		MAX	419.7	420.7	421.7	19.1	18.6	19.4	22.0	12.4	-0.1	15.7	0.93	8.3	35.2
		37 kW; 2,960 rpm, η - 92.5 %, S_1 Duty; F Class; IE 2; XYLEM Make								% Load: Minimum: 21.8 % to Maximum: 31.0 %					
15.	**Admin** **Secondary Pump - 2** Per Hour Unit consumed- **18.7 kWh (Freq. 35Hz)**	MIN	410.8	412.4	412.7	27.9	24.6	27.7	0.1	18.6	6.9	19.9	0.92	6.4	31.9
		AVG	411.9	413.4	414.8	28.9	26.1	28.8	0.1	18.7	7.3	20.0	0.93	6.7	36.4
		MAX	413.2	414.3	416.9	30.1	27.9	29.9	0.1	18.8	7.9	20.3	0.94	8.5	41.8
		37 kW; 2,960 rpm, η - 92.5 %, S_1 Duty; F Class; IE 2; XYLEM Make								% Load: Minimum: 46.5 % to Maximum: 47.0 %					
16.	**X-Lab** **Secondary Pump – 1** Per Hour Unit consumed- **8.7 kWh (Freq. 35Hz)**	MIN	413.1	413.3	413.8	12.7	11.1	12.5	0.2	8.5	-0.3	9.2	0.90	5.6	29.2
		AVG	416.0	416.8	418.0	13.3	12.3	13.3	0.3	8.7	-0.1	9.3	0.93	7.5	34.2
		MAX	418.5	420.6	422.2	14.0	13.4	14.1	0.3	8.8	0.2	9.5	0.93	8.1	45.7
		22 kW; 2,942 rpm, η - 91.3 %, S_1 Duty; F Class; IE 2; XYLEM Make								% Load: Minimum: 35.3 % to Maximum: 36.5 %					
17.	**X-Lab** **Secondary Pump – 2** Per Hour Unit consumed- **8.9 kWh (Freq. 35Hz)**	MIN	412.7	413.9	414.9	12.9	11.9	12.8	0.1	8.8	3.5	9.5	0.92	6.7	32.3
		AVG	415.2	416.5	417.9	13.8	12.5	13.3	0.1	8.9	3.6	9.6	0.93	7.1	37.8
		MAX	420.3	420.7	423.3	14.6	13.5	13.7	0.1	8.9	3.9	9.7	0.93	7.4	42.3
		22 kW; 2,945 rpm, η - 91.3 %, S_1 Duty; F Class; IE 2; XYLEM Make								% Load: Minimum: 36.5 % to Maximum: 36.9 %					

S. No.	Description	Supply Voltage (V)				Supply Current (A)				P	Q	S	PF	% Harmonics	
		–	VRY	VYB	VBR	IR	IY	IB	In	(kW)	(kVAr)	(kVA)		THDv	THDi
18.	X-Lab Secondary Pump – 3 Per Hour Unit consumed- 8.7 kWh (Freq. 35Hz)	MIN	411.8	412.0	413.4	13.0	11.8	13.1	0.3	8.7	-0.2	9.4	0.92	7.9	32.3
		AVG	415.2	416.4	417.9	13.5	12.4	13.4	0.3	8.7	-0.2	9.5	0.92	8.1	33.5
		MAX	419.0	420.8	423.0	13.9	13.1	13.9	0.6	8.8	-0.1	9.5	0.93	8.3	34.4
		22 kW; 2,942 rpm, η - 91.3 %, S_1 Duty; F Class; IE 2; XYLEM Make								% Load: Minimum: 36.1 % to Maximum: 36.5 %					
19.	Annapoorna Mess Secondary Pump – 1 Per Hour Unit consumed- 8.2 kWh (Freq. 35Hz)	MIN	410.5	411.7	412.0	12.3	11.4	12.1	0.1	8.2	3.2	8.9	0.92	7.1	32.5
		AVG	411.7	413.1	414.2	13.0	11.8	12.5	0.1	8.2	3.4	8.9	0.93	7.3	38.0
		MAX	413.3	414.6	416.7	13.6	12.8	12.8	0.1	8.3	3.5	9.0	0.93	7.6	41.5
		22 kW; 2,945 rpm, η - 91.3 %, S_1 Duty; F Class; IE 2; XYLEM Make								% Load: Minimum: 34.0 % to Maximum: 34.4 %					
20.	Annapoorna Mess Secondary Pump – 2 Per Hour Unit consumed- 8.4 kWh (Freq. 35Hz)	MIN	412.9	414.4	415.8	9.6	7.1	9.4	0.1	5.7	3.1	6.4	0.85	5.9	38.9
		AVG	415.9	417.5	419.6	14.0	10.9	13.5	0.1	8.4	4.1	9.3	0.90	7.2	49.8
		MAX	421.7	422.6	425.2	15.3	12.2	14.5	0.1	8.7	4.8	9.9	0.92	7.8	64.2
		22 kW; 2,945 rpm, η - 91.3 %, S_1 Duty; F Class; IE 2; XYLEM Make								% Load: Minimum: 23.7 % to Maximum: 36.1 %					
Utility 1 – Condenser Pump (Non-VFD)															
21.	Condenser Pump - 2 Per Hour Unit consumed- 33.0 kWh	MIN	406.7	407.4	408.5	51.1	51.6	52.1	0.1	32.0	19.5	37.5	0.85	6.8	9.2
		AVG	412.6	414.1	415.8	53.1	53.6	54.3	0.1	33.0	19.9	38.5	0.86	9.1	11.9
		MAX	415.4	417.3	419.7	55.8	56.0	56.8	0.2	34.0	20.5	39.6	0.86	10.3	13.6
		30 kW; 1,465 rpm, η - 92.3 %, S_1 Duty; F Class; IE 2; XYLEM Make								% Load: Minimum: 98.5 % to Maximum: 104.6 %					
22.	Condenser Pump - 3 Per Hour Unit consumed- 33.0 kWh	MIN	414.3	414.9	415.7	53.0	52.9	53.9	0.1	32.9	20.9	39.0	0.84	8.7	12.0
		AVG	416.9	418.0	419.6	53.6	53.7	55.1	0.1	33.0	21.2	39.2	0.84	8.9	12.4
		MAX	420.7	422.0	424.5	54.5	54.7	56.1	0.1	33.1	21.5	39.4	0.84	9.4	13.0
		30 kW; 1,465 rpm, η - 92.3 %, S_1 Duty; F Class; IE 2; XYLEM Make								% Load: Minimum: 101.2 % to Maximum: 101.8 %					

S. No.	Description	Supply Voltage (V)				Supply Current (A)				P (kW)	Q (kVAr)	S (kVA)	PF	% Harmonics	
		–	VRY	VYB	VBR	IR	IY	IB	In					THDv	THDi
Utility 2 – Primary Pump (VFD)															
23.	**Primary Pump – 1** Per Hour Unit consumed- **13.5 kWh (Freq. 33.5 Hz)**	MIN	415.4	417.2	419.2	20.0	15.7	19.2	0.4	12.2	0.4	13.4	0.87	5.0	32.9
		AVG	420.2	421.8	423.3	21.1	17.9	20.9	0.4	13.5	0.8	14.6	0.92	6.4	41.7
		MAX	422.0	423.5	426.9	24.2	19.4	22.9	0.9	13.9	1.0	15.6	0.94	8.4	64.2
		30 kW; 1,475 rpm, η - 93.6 %, S_1 Duty; F Class; IE 3; XYLEM Make								% Load: Minimum: 38.1 % to Maximum: 43.4 %					
24.	**Primary Pump – 2** Per Hour Unit consumed- **17.1 kWh (Freq. 41 Hz)**	MIN	414.1	416.3	417.2	25.1	23.9	26.1	0.1	17.0	6.7	18.3	0.93	8.5	34.1
		AVG	415.2	417.9	419.4	25.4	24.3	26.7	0.1	17.1	6.8	18.4	0.93	8.7	35.0
		MAX	417.3	419.7	421.3	25.8	25.0	27.2	0.1	17.3	7.0	18.6	0.93	9.6	35.9
		37 kW; 1,475 rpm, η - 93.9 %, S_1 Duty; F Class; IE 3; Hindustan								% Load: Minimum: 43.1 % to Maximum: 43.9 %					
25.	**Primary Pump – 3** Per Hour Unit consumed- **14.9 kWh (Freq. 31.9 Hz)**	MIN	416.6	417.0	418.0	21.7	20.0	22.1	0.1	14.7	6.0	15.9	0.91	6.7	35.0
		AVG	421.3	422.8	424.3	22.6	21.1	22.8	0.1	14.9	6.5	16.3	0.92	7.4	40.8
		MAX	424.7	426.7	429.5	23.5	22.2	23.5	0.1	15.0	6.9	16.5	0.93	9.4	45.1
		37 kW; 1,475 rpm, η - 93.9 %, S_1 Duty; F Class; IE 3; Hindustan								% Load: Minimum: 37.3 % to Maximum: 38.1 %					
26.	**Primary Pump – 4** Per Hour Unit consumed- **8.2 kWh (Freq. 45 Hz)**	MIN	419.4	420.0	418.1	15.1	15.6	15.9	0.2	8.1	-1.6	11.4	0.70	6.1	90.0
		AVG	420.4	422.7	419.0	15.5	15.9	16.2	0.2	8.2	-1.5	11.6	0.71	6.3	96.6
		MAX	421.5	423.8	420.0	16.0	16.1	16.5	0.9	8.2	-1.5	11.7	0.72	6.5	99.7
		11 kW; 1,460 rpm, η - 91.4 %, S_1 Duty; F Class; IE 2; Hindustan								% Load: Minimum: 67.3 % to Maximum: 68.1 %					
27.	**Primary Pump – 5** Per Hour Unit consumed- **5.0 kWh (Freq. 40 Hz)**	MIN	419.7	421.6	417.8	10.1	11.4	11.0	0.3	5.0	-1.2	8.0	0.60	6.1	115.7
		AVG	421.0	423.3	419.1	10.7	11.8	11.4	0.3	5.0	-1.1	8.3	0.61	6.2	123.1
		MAX	421.9	424.7	419.7	11.0	12.1	11.7	0.4	5.1	-1.0	8.4	0.63	6.4	128.6
		11 kW; 1,460 rpm, η - 91.4 %, S_1 Duty; F Class; IE 2; Hindustan								% Load: Minimum: 41.5 % to Maximum: 42.4 %					

S. No.	Description	Supply Voltage (V)				Supply Current (A)				P (kW)	Q (kVAr)	S (kVA)	PF	% Harmonics	
		–	VRY	VYB	VBR	IR	IY	IB	In					THDv	THDi
Utility 2 – Secondary Pump (VFD Driven)															
28.	JS Bose Block Secondary Pump – 1 Per Hour Unit consumed- 9.8 kWh (rpm 1,450)	MIN	418.3	420.2	417.1	10.9	13.9	14.6	0.3	8.8	0.4	9.8	0.87	6.2	40.0
		AVG	419.9	422.3	418.2	13.2	15.3	15.8	0.3	9.8	0.5	10.8	0.91	6.4	46.5
		MAX	421.2	424.5	419.5	14.2	15.9	16.7	1.1	10.0	0.6	11.1	0.92	6.6	62.0
		22 kW; 1,470 rpm, η - 93.0 %, S_1 Duty; F Class; IE 3; Hindustan								% Load: Minimum: 37.2 % to Maximum: 42.3 %					
29.	JS Bose Block Secondary Pump – 2 Per Hour Unit consumed- 10.6 kWh (rpm 1,450)	MIN	416.0	418.1	412.8	11.9	14.0	14.7	0.2	9.0	0.1	10.0	0.90	6.4	36.2
		AVG	417.7	420.1	415.8	14.2	16.8	16.6	0.3	10.6	0.2	11.5	0.92	8.2	39.3
		MAX	420.6	423.4	418.9	14.8	17.8	17.3	0.7	10.7	0.4	11.8	0.93	9.0	49.3
		22 kW; 1,470 rpm, η - 93.0 %, S_1 Duty; F Class; IE 3; Hindustan								% Load: Minimum: 38.0 % to Maximum: 45.2 %					
30.	CV Block Secondary Pump – 1 Per Hour Unit consumed- 50.5 kWh (rpm 1,352)	MIN	424.3	425.4	426.0	73.3	69.5	72.1	0.4	50.3	3.3	53.6	0.94	5.7	32.2
		AVG	425.0	427.0	428.6	74.6	70.9	72.7	0.4	50.5	3.5	53.8	0.94	5.9	33.3
		MAX	425.9	428.2	430.8	75.9	72.9	73.4	0.6	50.7	3.6	54.0	0.94	6.1	34.5
		75 kW; 1,482 rpm, η - 95.0 %, S_1 Duty; F Class; IE 3; Hindustan								% Load: Minimum: 63.7 % to Maximum: 64.2 %					
31.	CV Block Secondary Pump – 2 Per Hour Unit consumed- 33.4 kWh (rpm 1,200)	MIN	424.0	424.9	425.7	48.5	45.1	47.1	0.3	32.8	1.3	35.4	0.92	4.9	34.2
		AVG	425.5	427.1	428.5	50.0	47.0	48.7	0.3	33.4	1.8	35.9	0.93	6.5	37.2
		MAX	427.9	429.7	431.6	51.9	48.7	50.1	1.1	33.7	2.6	36.5	0.93	7.3	42.4
		75 kW; 1,482 rpm, η - 95.0 %, S_1 Duty; F Class; IE 3; Hindustan								% Load: Minimum: 41.5 % to Maximum: 42.7 %					
32.	SR Block Secondary Pump – 1 Per Hour Unit consumed- 23.6 kWh (Freq. 44.5 Hz)	MIN	423.4	425.3	425.4	33.9	30.3	34.6	0.3	23.5	1.2	25.0	0.93	6.4	30.3
		AVG	424.3	426.4	428.1	34.6	31.5	36.0	0.3	23.6	1.3	25.2	0.94	6.6	34.0
		MAX	425.1	427.2	429.8	35.4	33.1	37.2	0.5	23.7	1.4	25.4	0.94	6.7	37.6
		30 kW; 1,475 rpm, η - 93.6 %, S_1 Duty; F Class; IE 3; XYLEM Make								% Load: Minimum: 73.3 % to Maximum: 73.9 %					

S. No.	Description	Supply Voltage (V)				Supply Current (A)				P (kW)	Q (kVAr)	S (kVA)	PF	% Harmonics	
		–	VRY	VYB	VBR	IR	IY	IB	In					THDv	THDi
33.	SR Block Secondary Pump – 2 Per Hour Unit consumed- 24.0 kWh (Freq. 44.5 Hz)	MIN	423.6	424.8	425.3	34.6	30.7	34.1	0.5	23.9	1.3	25.4	0.93	6.3	29.8
		AVG	424.6	426.5	428.3	35.2	32.2	36.2	0.6	24.0	1.4	25.5	0.94	6.6	33.4
		MAX	425.6	427.5	430.6	35.9	34.3	37.7	0.6	24.1	1.4	25.8	0.94	6.8	37.1
		30 kW; 1,475 rpm, η - 93.6 %, S_1 Duty; F Class; IE 3; XYLEM Make								% Load: Minimum: 74.6 % to Maximum: 75.2 %					
34.	SR Block Secondary Pump – 3 Per Hour Unit consumed- 23.3 kWh (Freq. 45 Hz)	MIN	414.7	416.4	417.4	34.3	29.7	33.9	0.6	23.0	1.5	24.4	0.93	6.1	30.7
		AVG	416.5	418.0	419.6	35.3	31.6	35.6	0.7	23.3	1.6	24.8	0.94	6.4	34.6
		MAX	417.9	419.5	422.1	36.7	34.5	37.6	0.8	24.4	2.0	25.9	0.95	7.0	38.9
		30 kW; 1,475 rpm, η - 93.6 %, S_1 Duty; F Class; IE 3; XYLEM Make								% Load: Minimum: 71.8 % to Maximum: 76.1 %					
35.	Ganga Secondary Pump – 2 Per Hour Unit consumed- 45.8 kWh (rpm 1,300)	MIN	420.6	422.4	423.9	66.8	62.6	66.1	0.8	45.6	2.3	48.4	0.94	7.5	29.4
		AVG	423.1	424.6	426.7	67.3	63.9	67.0	0.8	45.8	2.5	48.6	0.94	7.9	30.4
		MAX	426.1	427.9	430.4	68.0	65.2	68.3	0.9	46.0	2.6	48.8	0.94	8.2	31.3
		55 kW; 1,482 rpm, η - 94.6 %, S_1 Duty; F Class; IE 3; Hindustan								% Load: Minimum: 78.4 % to Maximum: 79.1 %					
Utility 2 – Condenser Pump (VFD Driven)															
36.	Condenser Pump - 1 Per Hour Unit consumed- 22.4 kWh (Freq. 40Hz)	MIN	414.4	415.3	416.1	26.5	25.7	25.7	0.3	16.4	1.1	17.9	0.91	5.1	29.8
		AVG	416.6	417.9	419.7	33.8	31.7	33.4	0.3	22.4	1.3	23.9	0.94	7.8	31.8
		MAX	421.1	422.5	424.6	34.5	32.9	34.3	0.5	22.5	1.9	24.2	0.94	8.3	39.0
		37 kW; 1,475 rpm, η - 93.9 %, S_1 Duty; F Class; IE 3; XYLEM Make								% Load: Minimum: 41.6 % to Maximum: 57.1 %					
37.	Condenser Pump - 2 Per Hour Unit consumed- 22.2 kWh (Freq. 40Hz)	MIN	416.4	418.7	419.1	33.0	30.4	32.5	0.6	22.2	1.4	23.6	0.94	7.6	30.0
		AVG	418.6	420.3	422.3	33.3	31.1	33.1	0.6	22.2	1.5	23.7	0.94	7.8	31.7
		MAX	420.1	421.8	424.3	33.8	32.1	33.6	0.6	22.3	1.5	23.8	0.94	8.1	33.2
		37 kW; 1,475 rpm, η - 93.9 %, S_1 Duty; F Class; IE 3; XYLEM Make								% Load: Minimum: 56.3 % to Maximum: 56.6 %					

S. No.	Description	Supply Voltage (V)				Supply Current (A)				P (kW)	Q (kVAr)	S (kVA)	PF	% Harmonics	
		–	VRY	VYB	VBR	IR	IY	IB	In					THDv	THDi
38.	**Condenser Pump - 3** Per Hour Unit consumed- **17.7 kWh**	MIN	412.4	415.1	416.1	27.6	22.9	28.4	0.2	17.4	1.6	19.4	0.88	8.0	40.7
		AVG	414.2	417.0	418.4	28.8	24.1	29.8	0.3	17.7	1.7	20.0	0.89	8.6	49.5
		MAX	415.6	418.6	420.1	39.5	34.7	40.0	0.7	25.2	1.9	27.5	0.92	8.9	53.3
		90 kW; Assume IE-1 η - 93.0 %, No Name Plate								% Load: Minimum: 18.0 % to Maximum: 26.0 %					
39.	**Condenser Pump - 4** Per Hour Unit consumed- **63.3 kWh**	MIN	413.7	416.5	417.1	85.9	81.3	84.5	1.1	56.8	3.7	60.6	0.93	8.3	29.5
		AVG	415.4	418.1	419.3	95.5	89.6	94.2	1.2	63.3	4.9	67.4	0.94	8.8	30.7
		MAX	417.5	420.0	421.6	104.2	101.0	103.9	1.3	69.9	5.6	74.4	0.94	9.8	31.5
		90 kW; Assume IE-1 η - 93.0 %, No Name Plate								% Load: Minimum: 58.7 % to Maximum: 72.2 %					

S. No.	Description	Supply Voltage (V)			Supply Current (A)			P (kW)	Q (kVAr)	S (kVA)	PF
		VRY	VYB	VBR	IR	IY	IB				
1.	AHU – 1 – 5 – HJB Block (3.7 kW/ η = 86.3%); (% Load = 84.0 %); IE 2; **APEX Make;** Frequency=35 Hz	417.1	418.1	419.2	5.1	5.0	5.1	3.6	0.2	3.7	0.98
2.	AHU – 1 – 6 – HJB Block (3.7 kW/ η = 86.3%); (% Load = 58.3 %); IE 2; **APEX Make;** Frequency=45 Hz	421.1	421.6	421.5	3.6	3.6	3.7	2.5	1.3	2.7	0.74
3.	AHU – 2 – 5 – HJB Block (3.7 kW/ η = 86.3%); (% Load = 65.3 %); IE 2; **APEX Make;** Frequency=35 Hz	410.1	411.2	410.1	4.0	4.0	4.0	2.8	0.5	2.8	0.98
4.	AHU – 2 – 6 – HJB Block (3.7 kW/ η = 86.3%); (% Load = 77.0 %); IE 2; **APEX Make;** Frequency=40 Hz	411.2	411.4	415.2	4.6	4.6	4.6	3.3	0.2	3.3	0.99
5.	AHU – 3 – 5 – HJB Block (3.7 kW/ η = 86.3%); (% Load = 51.3 %); IE 2; **APEX Make;** Frequency=45 Hz	407.0	408.1	409.3	3.1	3.2	3.2	2.2	0.1	2.1	0.99
6.	AHU – 3 – 6 – HJB Block (3.7 kW/ η = 86.3%); (% Load = 39.7 %); IE 2; **APEX Make;** Frequency=40 Hz	407.6	408.1	407.6	2.3	2.4	2.3	1.7	0.2	1.7	0.99

S. No.	Description	Supply Voltage (V)			Supply Current (A)			P (kW)	Q (kVAr)	S (kVA)	PF
		VRY	VYB	VBR	IR	IY	IB				
7.	AHU – 4 – 5 – HJB Block (3.7 kW/ η = 86.3%); (% Load = 65.3 %); IE 2; **APEX Make;** **Frequency=48 Hz**	413.2	411.2	413.0	5.3	5.3	5.2	2.8	0.1	3.7	0.75
8.	AHU – 4 – 6 – HJB Block (2.2 kW/ η = 84.3%); (% Load = 72.8 %); IE 2; **CG Make;** **Frequency=44 Hz**	411.9	412.8	413.9	3.0	3.0	2.9	1.9	0.2	2.1	0.94
9.	AHU – 5 – 3 – HJB Block (3.7 kW/ η = 86.3%); (% Load = 79.3 %); IE 2; **Bharath Bijli Make;** **Frequency=43.1 Hz**	410.5	411.1	411.1	5.0	5.0	5.0	3.4	0.2	3.5	0.97
10.	AHU – 5 – 4 – HJB Block (3.7 kW/ η = 86.3%); (% Load = 51.3 %); IE 2; **Bharath Bijli Make;** **Frequency=48 Hz**	409.9	409.8	410.2	4.5	4.6	4.6	2.2	0.4	3.2	0.74
11.	AHU – 1 – 1 – VSB Block (3.7 kW/ η = 86.3%); (% Load = 77.0 %); IE 2; **CG Make;** **Frequency=47 Hz**	413.8	412.2	411.8	5.7	5.7	5.7	3.3	0.5	4.0	0.77
12.	AHU – 1 – 3 – VSB Block (3.7 kW/ η = 86.3%); (% Load = 81.6 %); IE 2; **CG Make;** **Frequency=45 Hz**	412.8	410.2	410.7	5.3	5.2	5.2	3.5	0.1	3.7	0.99
13.	AHU – 1 – 4 – VSB Block (2.2 kW/ η = 84.3%); (% Load = 80.5 %); IE 2; **CG Make;** **Frequency=45 Hz**	415.9	413.4	412.5	3.5	3.5	3.5	2.1	0.1	2.5	0.94
14.	AHU – 4 – 1 – VSB Block (3.7 kW/ η = 86.3%); (% Load = 77.0 %); IE 2; **CG Make;** **Frequency=40 Hz**	417.2	415.3	412.4	4.6	4.5	4.5	3.3	0.1	3.2	0.99
15.	AHU – 5 – 1 – VSB Block (3.7 kW/ η = 86.3%); (% Load = 72.3 %); IE 2; **CG Make;** **Frequency=40 Hz**	420.0	418.0	417.0	4.2	4.2	4.2	3.1	0.1	3.1	0.99
16.	AHU – 2 – 1 – JC BOSE Block (5.5 kW/ η = 89.6%); (% Load = 73.3 %); IE 3; **CG Make;** **Frequency=45 Hz**	416.2	416.6	415.0	6.5	6.2	6.2	4.5	0.2	4.5	0.98
17.	AHU – 2 – 2 – JC BOSE Block (2.2 kW/ η = 86.7%); (% Load = 70.9 %); IE 3; **CG Make;** **Frequency=44.5 Hz**	417.6	420.8	416.1	2.6	2.6	2.6	1.8	0.1	1.9	0.97

S. No.	Description	Supply Voltage (V)			Supply Current (A)			P (kW)	Q (kVAr)	S (kVA)	PF
		VRY	VYB	VBR	IR	IY	IB				
18.	AHU – 3 – 1 – JC BOSE Block (5.5 kW/ η = 89.6%); (% Load = 66.8 %); IE 3; **CG Make;** **Frequency=40 Hz**	417.0	417.8	416.2	5.6	5.8	5.8	4.1	0.7	4.1	0.98
19.	AHU – 3 – 2 – JC BOSE Block (3.7 kW/ η = 88.4%); (% Load = 71.7 %); IE 3; **CG Make;** **Frequency=45 Hz**	417.7	416.7	415.9	4.3	4.0	4.0	3.0	0.1	3.0	0.99
20.	AHU – 1 – 1 – X-Lab (15 kW/ η = 92.1%); (% Load = 47.9 %); IE 2; **CG Make;** **Frequency=40 Hz**	409.8	410.9	408.8	10.9	10.8	10.9	7.8	0.3	7.7	0.99
21.	AHU – 1 – 2 – X-Lab (15 kW/ η = 92.1%); (% Load = 46.1 %); IE 3; **APEX Make;** **Frequency=40 Hz**	408.4	408.7	408.2	10.6	10.7	10.7	7.5	0.5	7.5	0.99
22.	AHU – 1 – 1 – Ganga Hostel (5.5 kW/ η = 89.6%); (% Load = 53.8 %); IE 3; **ABB Make;** **Frequency=47 Hz**	407.8	407.8	407.9	4.0	4.0	4.0	3.3	0.1	3.3	0.99
23.	AHU – 1 – 1 – Annapurna Mess (5.5 kW/ η = 87.7%); (% Load = 27.1 %); IE 2; **CG Make;** **Frequency=35 Hz**	409.6	408.6	408.7	2.0	2.0	2.1	1.7	0.1	1.7	0.99
24.	AHU – 1 – 2 – Annapurna Mess (5.5 kW/ η = 87.7%); (% Load = 25.5 %); IE 2; **CG Make;** **Frequency=35 Hz**	408.6	409.7	408.6	2.5	2.2	2.3	1.6	0.2	1.6	0.98
25.	AHU – 2 – 2 – Annapurna Mess (5.5 kW/ η = 87.7%); (% Load = 39.9 %); IE 2; **CG Make;** **Frequency=40 Hz**	409.8	411.3	412.3	3.9	3.4	3.4	2.5	0.2	2.5	0.99
26.	AHU – 1 – 1 – SRK Block (5.5 kW/ η = 89.6%); (% Load = 74.9 %); IE 3; **ABB Make;** **Frequency=39 Hz**	419.3	417.3	418.4	6.3	6.3	6.3	4.6	0.2	4.6	0.99
27.	AHU – 1 – 2 – SRK Block (5.5 kW/ η = 89.6%); (% Load = 99.4 %); IE 3; **ABB Make;** **Frequency=50 Hz**	415.4	415.8	416.0	8.8	8.5	8.6	6.1	0.3	6.0	0.99
28.	AHU – 2 – 3 – SRK Block (7.5 kW/ η = 90.7%); (% Load = 84.7 %); IE 3; **Siemens Make;** **Frequency=50 Hz**	417.0	418.2	420.2	10.0	9.9	9.8	7.0	0.1	7.0	0.99

S. No.	Description	Supply Voltage (V)			Supply Current (A)			P (kW)	Q (kVAr)	S (kVA)	PF
		VRY	VYB	VBR	IR	IY	IB				
29.	AHU – 2 – 4 – SRK Block (7.5 kW/ η = 90.4%); (% Load = 65.1 %); IE 3; **ABB Make;**	417.8	419.6	418.6	12.2	11.9	12.3	5.4	6.6	8.6	0.63
30.	AHU – 3 – 3 – SRK Block (5.5 kW/ η = 90.1%); (% Load = 63.9 %); IE 3; **Siemens Make; Frequency=37 Hz**	418.1	417.2	417.9	5.6	5.6	5.4	3.9	0.1	4.0	0.98
31.	AHU – 3 – 4 – SRK Block (5.5 kW/ η = 89.6%); (% Load = 60.3 %); IE 3; **ABB Make; Frequency=48.9 Hz**	422.4	419.3	420.2	5.1	5.2	5.1	3.7	0.1	3.7	0.99
32.	AHU – 4 – 3 – SRK Block (5.5 kW/ η = 90.1%); (% Load = 70.4 %); IE 3; **Siemens Make; Frequency=48.9 Hz**	418.5	415.8	418.3	5.6	5.5	5.7	4.3	0.4	4.2	0.99
33.	AHU – 4 – 4 – SRK Block (5.5 kW/ η = 89.6%); (% Load = 32.6 %); IE 3; **ABB Make; Frequency=40 Hz**	416.3	417.2	413.1	2.8	2.7	2.7	2.0	0.1	2.0	0.99
34.	AHU – 5 – 3 – SRK Block (3.7 kW/ η = 84.8%); (% Load = 96.3 %); IE 3; **ABB Make; Frequency=50 Hz**	417.7	416.5	417.3	5.7	5.6	5.7	4.2	0.1	4.1	0.99
35.	AHU – 6 – 3 – SRK Block (5.5 kW/ η = 90.1%); (% Load = 55.7 %); IE 3; **Siemens Make; Frequency=47 Hz**	417.1	415.1	416.3	4.7	4.6	4.7	3.4	0.2	3.3	0.99
36.	AHU – 6 – 4 – SRK Block (5.5 kW/ η = 89.6%); (% Load = 55.4 %); IE 3; **ABB Make; Frequency=48 Hz**	418.4	415.5	416.7	4.7	4.9	4.9	3.4	0.2	3.2	0.99
37.	AHU – 7 – 1.1 – SRK Block (2.2 kW/ η = 86.7%); (% Load = 78.8 %); IE 3; **Havells Make; Frequency=48.7 Hz**	417.4	421.4	421.0	2.8	2.9	2.9	2.0	0.1	2.0	0.99
38.	AHU – 7 – 1.2 – SRK Block (2.2 kW/ η = 86.7%); (% Load = 86.7 %); IE 3; **Havells Make; Frequency=48.8 Hz**	421.8	418.9	419.4	2.9	2.9	2.8	2.2	0.1	2.1	0.99
39.	AHU – 2 - 1 – CV Block (11 kW/ η = 91.4%); (% Load = 23.3 %); IE 3; **CG Make; Frequency=30.2 Hz**	415.5	416.3	417.0	4.4	4.4	3.9	2.8	0.1	2.8	0.99

S. No.	Description	Supply Voltage (V)			Supply Current (A)			P (kW)	Q (kVAr)	S (kVA)	PF
		VRY	VYB	VBR	IR	IY	IB				
40.	AHU – 2 - 4 – CV Block (11 kW/ η = 91.4%); (% Load = 37.4 %); IE 3; **CG Make; Frequency=43 Hz**	415.5	416.6	417.3	6.4	6.2	6.3	4.5	0.1	4.6	0.99
41.	AHU – 3 - 1 – CV Block (11 kW/ η = 91.4%); (% Load = 53.2 %); IE 3; **CG Make; Frequency=43 Hz**	410.8	411.2	410.9	9.1	9.0	9.1	6.4	0.2	6.4	0.99
42.	AHU – 4 - 1 – CV Block (11 kW/ η = 91.4%); (% Load = 37.4 %); IE 3; **CG Make; Frequency=35.3 Hz**	410.5	411.2	412.3	6.5	6.4	6.4	4.5	0.3	4.4	0.99
43.	AHU – 8 - 3 – CV Block (11 kW/ η = 91.4%); (% Load = 29.9 %); IE 3; **CG Make; Frequency=40 Hz**	415.5	413.1	414.2	5.3	5.4	5.3	3.6	0.3	3.6	0.99
44.	AHU – 8 - 4 – CV Block (5.5 kW/ η = 89.6%); (% Load = 50.5 %); IE 3; **CG Make; Frequency=35 Hz**	412.5	410.6	411.9	4.3	4.8	4.5	3.1	0.3	3.1	0.99
45.	AHU – 12 - 1 – CV Block (11 kW/ η = 91.4%); (% Load = 55.7 %); IE 3; **CG Make; Frequency=38.3 Hz**	411.2	410.8	411.6	11.2	11.2	11.3	6.7	0.2	7.4	0.99
46.	AHU – 12 - 2 – CV Block (11 kW/ η = 91.4%); (% Load = 70.6 %); IE 3; **CG Make; Frequency=45.5 Hz**	410.2	412.9	410.9	12.5	11.7	11.9	8.5	0.6	8.5	0.99
47.	AHU – 12 - 3 – CV Block (11 kW/ η = 91.4%); (% Load = 64.0 %); IE 3; **CG Make; Frequency=38.9 Hz**	408.7	407.3	407.9	11.2	11.3	11.2	7.7	0.4	7.8	0.99
48.	AHU – 12 - 4 – CV Block (11 kW/ η = 91.4%); (% Load = 66.5 %); IE 3; **CG Make; Frequency=38.9 Hz**	407.7	410.6	411.6	10.5	10.6	10.5	8.0	0.1	8.0	0.99
Utility – 1 – Chiller – Cooling Tower Fans											
49.	Cooling Tower - 1 – 1 (5.5 kW/ Assume IE-1 η = 84.7); (% Load = 49.3 %)	416.6	416.5	416.1	9.5	9.6	9.6	3.2	6.1	6.8	0.46
50.	Cooling Tower - 1 – 2 (5.5 kW/ Assume IE-1 η = 84.7); (% Load = 38.5 %); **Frequency=45 Hz**	413.8	418.2	417.5	3.5	3.6	3.5	2.5	0.1	2.6	0.99

S. No.	Description	Supply Voltage (V)			Supply Current (A)			P (kW)	Q (kVAr)	S (kVA)	PF
		VRY	VYB	VBR	IR	IY	IB				
51.	Cooling Tower - 1 – 3 (5.5 kW/ Assume IE-1 η = 84.7); (% Load = 44.7 %); **Frequency=45 Hz**	416.7	417.5	416.6	4.2	4.3	4.3	2.9	0.1	2.9	0.99
52.	Cooling Tower - 1 – 4 (5.5 kW/ Assume IE-1 η = 84.7); (% Load = 55.4 %)	417.0	416.3	419.6	9.8	9.1	9.1	3.6	5.8	6.7	0.52
53.	Cooling Tower - 3 – 1 (5.5 kW/ Assume IE-1 η = 84.7); (% Load = 64.7 %)	420.6	417.3	418.6	10.4	11.0	10.9	4.2	6.5	7.7	0.52
54.	Cooling Tower - 3 – 2 (5.5 kW/ Assume IE-1 η = 84.7); (% Load = 64.7 %)	419.9	417.2	418.0	11.5	11.8	11.3	4.2	7.4	8.5	0.49
Utility – 2 – Chiller – Cooling Tower Fans											
55.	1,000 TR Chiller - 1 - Cooling Tower - 1 (7.5 kW/ Assume IE-1 η = 86.0); **(% Load = 102.1 %)**	417.9	417.2	421.0	17.5	17.9	18.0	**8.9**	9.3	12.9	0.69
56.	1,000 TR Chiller – 1 - Cooling Tower - 2 (7.5 kW/ Assume IE-1 η = 86.0); (% Load = 91.7 %)	422.8	421.9	422.0	15.5	15.9	15.6	8.0	8.2	11.4	0.70
57.	1,000 TR Chiller - 1 - Cooling Tower – 4 (7.5 kW/ Assume IE-1 η = 86.0); (% Load = 63.1 %)	421.0	420.7	420.1	12.6	13.0	12.9	5.5	7.5	9.3	0.61
58.	1,000 TR Chiller - 1 - Cooling Tower - 6 (7.5 kW/ Assume IE-1 η = 86.0); (% Load = 86.0 %)	424.5	420.2	421.3	15.8	16.4	15.9	7.5	8.8	11.8	0.65
59.	1,000 TR Chiller - 2 - Cooling Tower - 7 (7.5 kW/ Assume IE-1 η = 86.0); (% Load = 50.5 %)	421.9	419.9	420.1	11.4	12.2	12.3	4.4	7.5	8.5	0.49
60.	1,000 TR Chiller - 2 - Cooling Tower - 8 (7.5 kW/ Assume IE-1 η = 86.0); (% Load = 58.5 %)	420.8	419.4	420.1	12.2	12.9	12.6	5.1	7.5	9.1	0.57
61.	1,000 TR Chiller - 2 - Cooling Tower - 9 (7.5 kW/ Assume IE-1 η = 86.0); (% Load = 87.1 %); **Frequency=49 Hz**	419.8	418.5	419.6	10.6	10.7	10.6	7.6	0.8	7.6	0.99

S. No.	Description	Supply Voltage (V)			Supply Current (A)			P (kW)	Q (kVAr)	S (kVA)	PF
		VRY	VYB	VBR	IR	IY	IB				
62.	1,000 TR Chiller - 2 - Cooling Tower - 10 (7.5 kW/ Assume IE-1 η = 86.0); (% Load = 79.1 %); **Frequency=50 Hz**	416.2	417.7	417.6	9.6	9.8	9.7	6.9	0.8	7.2	0.99
63.	1,000 TR Chiller - 2 - Cooling Tower - 11 (7.5 kW/ Assume IE-1 η = 86.0); (% Load = 83.7 %); **Frequency=50 Hz**	418.6	419.6	420.6	9.8	9.9	9.7	7.3	0.7	7.4	0.99
64.	1,000 TR Chiller - 2 - Cooling Tower - 12 (7.5 kW/ Assume IE-1 η = 86.0); (% Load = 48.2 %)	417.3	416.9	416.7	11.5	11.0	10.9	4.2	7.2	8.3	0.51
65.	750, 250 TR Chiller - Cooling Tower - 13 (7.5 kW/ Assume IE-1 η = 86.0); (% Load = 73.4 %); **Frequency=45 Hz**	419.1	419.1	419.6	8.8	8.6	8.8	6.4	0.1	6.4	0.99
66.	750,250 TR Chiller - 2 - Cooling Tower - 14 (7.5 kW/ Assume IE-1 η = 86.0); (% Load = 98.6 %); **Frequency=50 Hz**	419.6	418.4	419.6	11.5	11.7	11.6	8.6	0.1	8.6	0.99
67.	750,250 TR Chiller - 2 - Cooling Tower - 15 (7.5 kW/ Assume IE-1 η = 86.0); (% Load = 73.4 %); **Frequency=45 Hz**	420.2	418.7	419.6	8.6	8.9	8.9	6.4	0.1	6.4	0.99
68.	750,250 TR Chiller - 2 - Cooling Tower - 16 (7.5 kW/ Assume IE-1 η = 86.0); (% Load = 94.0 %); **Frequency=50 Hz**	418.8	419.1	418.6	11.5	11.3	11.2	8.2	0.1	8.2	0.99

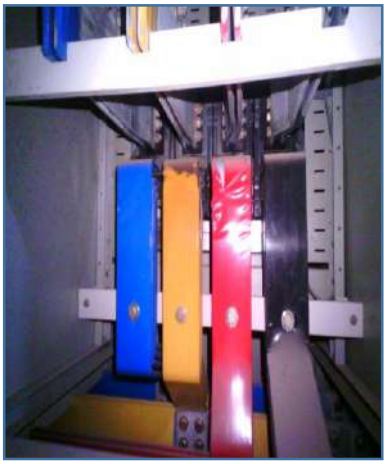
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10. INFRA-RED THERMOGRAPHY ANALYSIS

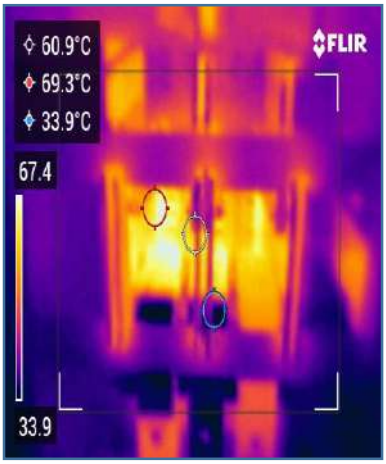
10.1: ANALYSIS OF ELECTRICAL SYSTEM USING IR THERMOGRAPHY:

IR Infrared Thermography is a scientific method of detecting infrared the energy emitted from an object which then converted in to apparent temperature and then displaying the result as an infrared image along with the original image. The displayed image indicates the temperature distribution over the focused (or captured) area. The audit team has IR Thermal Imager (Sonel KT-400) to measure the temperature variations and generation of hotspots on the electrical equipment/system and the results are shown below.

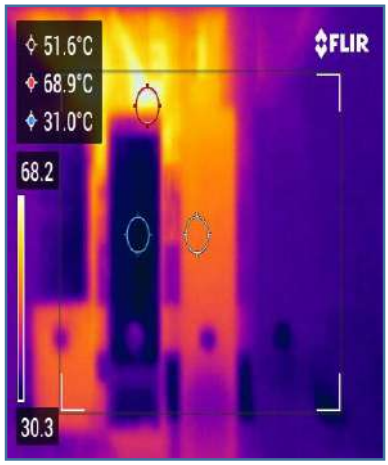




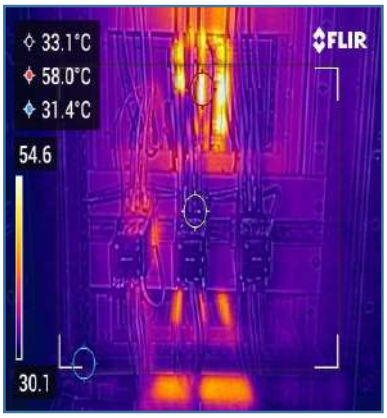
U1- Transformer- 1		Y-Phase	
MIN	**MAX**	**Ambient Temperature**	**Technical Term**
69.2^{0}C	89.2 ^{0}C	29 ^{0}C	Severely Overheated



U1- Transformer- 2		R-Phase	
MIN	**MAX**	**Ambient Temperature**	**Technical Term**
60.9^{0}C	69.3^{0}C	29 ^{0}C	Severely Overheated

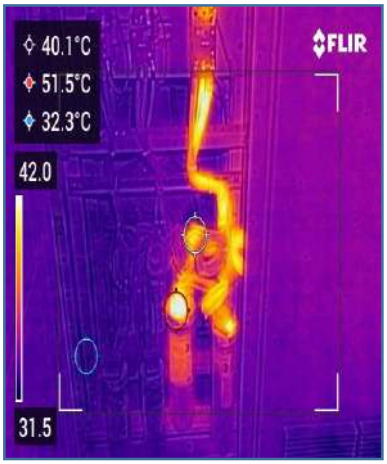


U1- Transformer- 2		Y-Phase	
MIN	**MAX**	**Ambient Temperature**	**Technical Term**
51.6^{0}C	68.9 ^{0}C	29 ^{0}C	Severely Overheated



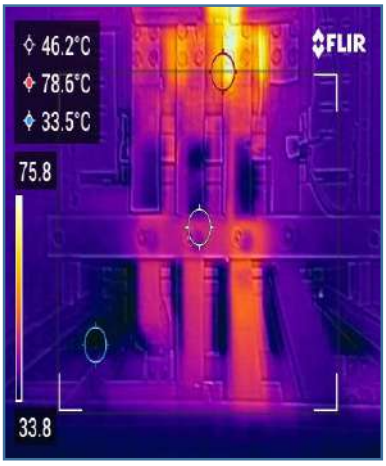


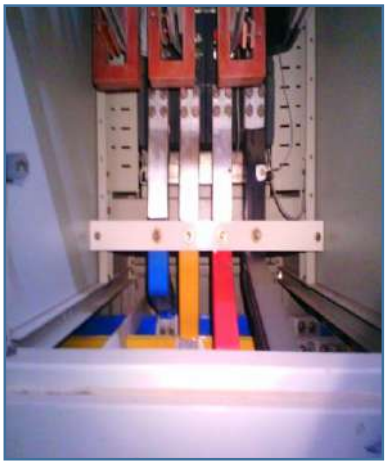
U1- 750 Capacitor power plant-2		Step -1, 2 Incoming	
MIN	**MAX**	**Ambient Temperature**	**Technical Term**
33.1 ^{0}C	58.0 ^{0}C	29 ^{0}C	Moderately Overheated



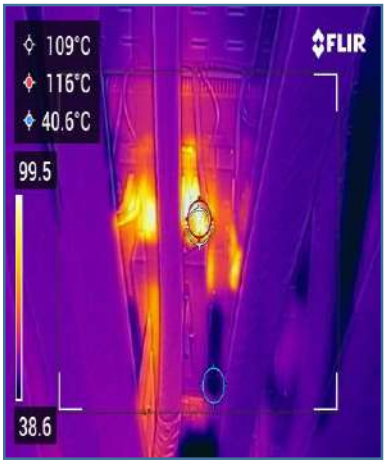


U1-750 Capacitor power plant-2		Step-6	
MIN	**MAX**	**Ambient Temperature**	**Technical Term**
40.1 ^{0}C	51.5 ^{0}C	29 ^{0}C	Moderately Overheated





U1-Mv Panel HVAC		R-Phase	
MIN	**MAX**	**Ambient Temperature**	**Technical Term**
46.2 °C	78.6 °C	29 °C	Severely Overheated





U1-Chiller Panel Incoming		Y-Phase	
MIN	**MAX**	**Ambient Temperature**	**Technical Term**
109.0 °C	116.0 °C	29 °C	Critical Overheating



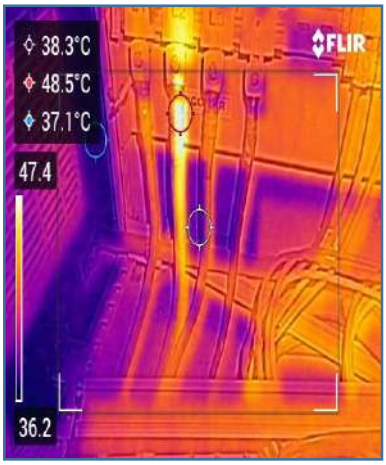


U1-Chiller Panel Chiller - 2		R-Phase	
MIN	**MAX**	**Ambient Temperature**	**Technical Term**
40.2 °C	55.1 °C	29 °C	Severely Overheated





U1-Chiller Panel Chiller - 3		Y-Phase	
MIN	**MAX**	**Ambient Temperature**	**Technical Term**
51.8 ^{0}C	59.0 ^{0}C	29 ^{0}C	Severely Overheated



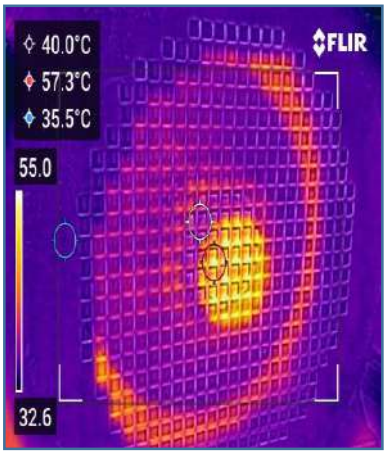


U1-X Lab Panel		Y-Phase	
MIN	**MAX**	**Ambient Temperature**	**Technical Term**
38.3^{0}C	48.5 ^{0}C	29 ^{0}C	Severely Overheated



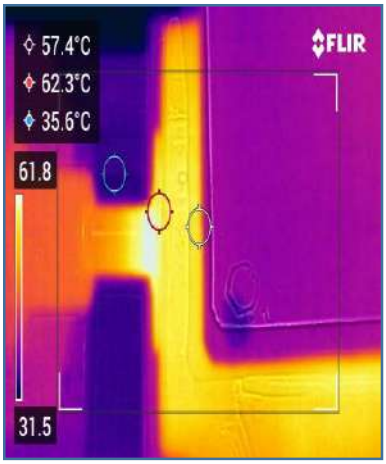


U1-Condensor Pump- 3		Driving End	
MIN	**MAX**	**Ambient Temperature**	**Technical Term**
73.7 ^{0}C	78.9 ^{0}C	29 ^{0}C	Elevated Differential



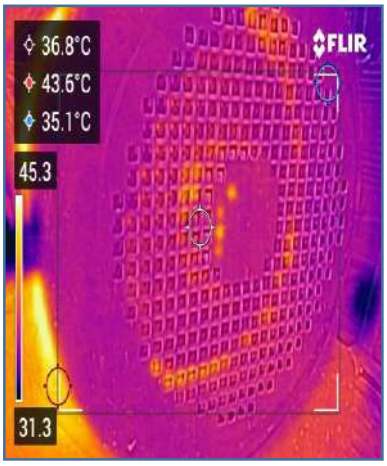


U1-Condensor Pump- 3		Non-Driving End	
MIN	**MAX**	**Ambient Temperature**	**Technical Term**
40.0 ^{0}C	57.3 ^{0}C	29 ^{0}C	Elevated Differential





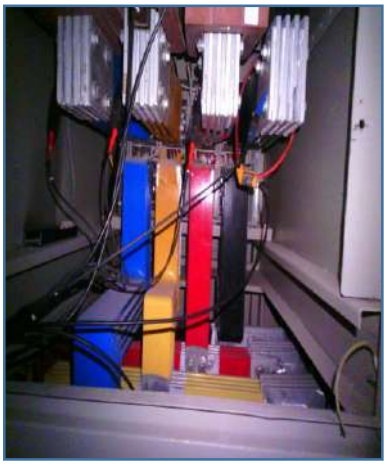
U1-Primary Pump - 1		Driving End	
MIN	**MAX**	**Ambient Temperature**	**Technical Term**
57.4 ^{0}C	62.3 ^{0}C	29 ^{0}C	Elevated Differential





U1-Primary Pump - 1		Non-Driving End	
MIN	**MAX**	**Ambient Temperature**	**Technical Term**
36.8 ^{0}C	43.6 ^{0}C	29 ^{0}C	Elevated Differential





U2- Transformer- 3		R-Phase	
MIN	**MAX**	**Ambient Temperature**	**Technical Term**
68.4^{0}C	85.9 ^{0}C	29 ^{0}C	Critical Overheating





U2- Transformer- 3		R-Phase	
MIN	**MAX**	**Ambient Temperature**	**Technical Term**
48.9 ^{0}C	67.9 ^{0}C	29 ^{0}C	Critical Overheating



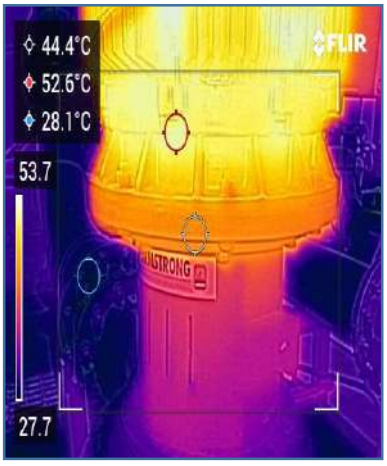


U2-SR Block Pump-1		Y-Phase	
MIN	**MAX**	**Ambient Temperature**	**Technical Term**
44.4 ^{0}C	102.0 ^{0}C	29 ^{0}C	Critical Overheating



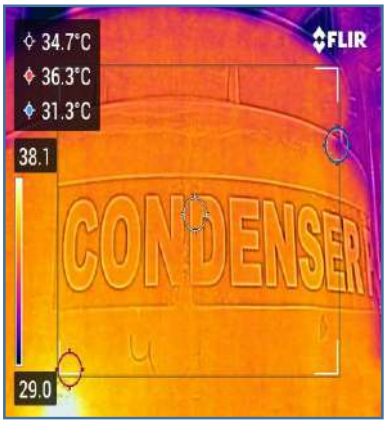


U2-Cooling Tower Panel Terrace		B-Phase	
MIN	**MAX**	**Ambient Temperature**	**Technical Term**
59.9 °C	72.2 °C	29 °C	Severely Overheated





U2-Condensor Pump- 4		Driving End	
MIN	**MAX**	**Ambient Temperature**	**Technical Term**
44.4 °C	52.6 °C	29 °C	Elevated Differential





U2-Condensor Pump- 4		Non-Driving End	
MIN	**MAX**	**Ambient Temperature**	**Technical Term**
34.7 °C	36.3 °C	29 °C	Elevated Differential

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11. ESTIMATION OF CO_2 EMISSION & NEUTRALIZATION

(ELECTRICITY, LPG, DIESEL & MATURE TREES)

11.1: Assessment of Annual Energy Usage:

Table-12 shows the types of energy carriers used for their regular operation in the university campus along with application area and their source.

Table-12: Energy Carriers, Application area and their sources used for University Operation

S. No.	Type of Energy Carrier	Application Area	Source of Procurement
1.	Electricity (HT Service - 01 No)	Powering to all electrical / electronic / HVAC equipment's	From state electrical distribution company
2.	Solar PV System (532 kW)		Installed in Roof Top and Captive Power Generation
3.	Diesel	Transport vehicles and Diesel Generator (Captive Generation)	From authorised distributor
4.	Liquified Petroleum Gas (LPG)	Used only for cooking	
5.	Mature Trees, Bushes & shrubs	The university has nearly **5,019 mature trees** of different varieties which are more than **10 years old.**	

11.2: Environmental System: CO_2 Balance Sheet:

→ CO_2 Balance sheet is the indicator on the carbon emission and their neutralization in a year

→ As per the Environmental Management System (EMS); only Scope-1 & Scope-2 based energy consumption is accounted.

→ The following tables provide the balance sheet indicating various energy carriers associated with the regular activities and their CO_2 mapping.

Table-13: Environmental System: CO_2 Balance Sheet (2024-25)

S. No.	Annual Energy Consumption & CO_2 Emission			Annual CO_2 Neutralization		
	Description	Energy Quantity	Emission (Tons)	Description	Parameters	Neutralized (Tons)
1.	Electricity	1,82,86,800 kWh	14,995.2	Solar	6,22,714 kWh	510.6
2.	Diesel	3,35,502 Litres	885.7	Electricity (DG)	2,59,945 kWh	213.2
3.	LPG	1,43,070 kg	429.2	Mature Tree	5,398 Nos	117.7
Total Emission			16,310.1	Total-Neutralized		841.5
Balance CO_2 to be Neutralized = 15,468.6 Tons/Annum						

11.3: Calculation Table:

For Electricity $= \left[\text{kWh x } \frac{0.82 \text{ kg of CO2 emission}}{\text{kWh}}\right]$

For Diesel $= \left[\text{Diesel Consumption (Litre) x } \frac{2.64 \text{ kg of CO2 emission}}{\text{Litre of Fuel Consumption}}\right]$

For LPG $= \left[\text{LPG Consumption (kg) x } \frac{3.0 \text{ kg of CO2 emission}}{\text{kg of LPG Consumption}}\right]$

A mature tree is able to absorb nearly CO_2 at a rate of 21.8 kg/annum; $\frac{(21.8\ x\ 5{,}019)}{1{,}000} = 109.4\ \frac{\text{Tons}}{\text{Annum}}$

11.4: Recommendations:

From the above discussion points; it is evident that activities taken forward to neutralize the CO_2 is predominant and to become a Net-Zero Carbon Emission buildings. The management has to plan several activities achieve the target.

- Increase the foot print of trees planted inside the university campus.
- Encourage the students to plant more trees and account them all.
- Convert existing convention street lightings into solar based battery-operated lightings.
- Identify higher fuel consuming vehicle and either rework or replace it.
- Conduct training programmes for the transport staffs at regular interval and encourage them to maintain the vehicles at good condition throughout the year.

11.5: References:

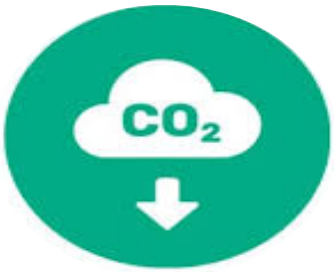
[1] https://ecoscore.be/en/info/ecoscore/co2

[3]http://www.tenmilliontrees.org/trees/#:~:text=A%20mature%20tree%20absorbs%20carbon,the%20average%20car's%20annual%20mileage



CO_2 Emission:

16,310.1 Tons/Annum



Planned CO_2 Reduction

841.5 Tons/Annum



CO_2 to be Neutralized

15,468.6 Tons/Annum

11.6: References:

→ The list of matured trees, Shurbs, Mexican Grass and Ground Covers are represented in the below table.

S. No.	Descriptions	Maintenance	Projects	Total (Nos)
1.	Matured Trees	1,249	4,149	5,398
2.	Flowering Shrubs	11,918	70,144	82,062
3.	Mexican Grass	16,956	17,075	34,031
4.	Ground Covers	10,850	95,482	1,06,332

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12. WATER UTILIZATION, CONSERVATION & WATER MANAGEMENT

12.1: Source of Water, Storage and Distribution:

Table-8 shows the source of water, location of storage along with their application.

Table-14: Source of Water, Location of Storage and Application

Type of Water	Source	Application
Fresh Water	Product RO Plant	Drinking application
Nature of Water	From Krishna River (CRDA) 300 KLD – UG Cement Tank	Utensil Cleaning, Bathing, Cloth Washing & RO Plant
Rain Water Harvesting System (RWHS)	Collected from rooftop of all the buildings and road run-off	↗ Used to increase the ground water ↗ To store building run-off only

12.2: Details of the Water Utilities, Storage, Motor Capacity and Approximate Run Hours:

The following table provides the details of the Water Utilities, Storage, Motor Capacity and Approximate Run Hours available inside the university for regular application.

Table-15: Details of the Water Utilities, Storage and Motor Capacity

S. No.	Location	Motor Capacity	Storage - I	Motor Capacity	Storage – II
1.	300 KLD UG Tank (Concrete)	15 kW – 2 No's (1-Standby) **(PTP - 1)**	**Raw Water** (70 KL) – Cement	15 kW **(WTP - 1)**	**Raw Water Tank** (87.5 KL) – Cement
					Treated Water Tank (89.25 KL) – Cement
			Treatment Tank (60 KL) – Cement		**Final Tank 1 & 2** (89.5 + 87.5 KL) Output – **Tower – 1 & Tower – 2** 11 kW * 2 No's (1 Stand by) – Circulating pump 2.2 kW * 1 No – Booster Pump Tower – 3 5.5 kW * 2 No's (1 Stand by) – Circulating pump
			Final Tank (25 KL) – Cement		
		3.7 kW – 2 No's (1-Standby) **(PTP - 2)**	**Treatment Tank** (60 KL) – GI Tank	3.7 kW – 2 No's (1-Standby) **(WTP - 3)**	**Raw Water Tank** (2 * 35 KL) – GI Tank
			Final Tank (2 KL) – Sintex Tank		**Treated Water Tank** (2 * 35 KL) – GI Tank Output – WTP – 1 3.7 kW * 2 No's (1 Standby)
		(PTP – 3)	**Raw Water** (350 KL * 2 No's) – Cement	2.2 kW – 2 No's (1 Standby)	**Final Tank** (349 KL) – Cement Output –

			Treatment Tank (200 KL) – Cement **Clarified Storage Tank** (20 KL) – GI Tank	**(WTP - 2)**	**SR Block** **CV Raman Block** **JC Bose Block** **Ganga Block** 5.5 kW * 3 No's (1 Standby)
	From PTP – 3 Raw Water Tank 3.7kW – 2 N0's (1 Standby)	3.7 kW – 2 No's (1-Standby) **(PTP - 4)**	**Raw Water** (120 KL) – Cement **Treatment Tank** (60 KL) – GI Tank **Clarified Storage Tank** (3 * 2 KL) – Sintex Tank	3.7 kW – 2 No's (1-Standby) **(WTP - 4)**	**Final Tank** (150 KL) – Cement **Vedavathi Hostel** 5.5kW * 3 No's (1 Standby) 1 to 7th Floor 7.5kW * 3 No's (1 Standby) 8 to 15th Floor

Table-16: Details of the Water Utilities, Storage, Motor Capacity and Approximate Run Hours

Location	Type and capacity of tank	Output
Inside WTP Plant (Input from WTP – 3)	1,000 Litre – SS Tank	Waste water to STP final tank
Annapurna Mess (Input from WTP - 3)	3,000 Litre – SS Tank	Waste water to garden
CV Raman Block Basement (Input from WTP - 2) (2*7.5 kW – 1 Standby)	1,000 Litre – SS Tank	Waste water to garden
Vedavathi Block Basement (Input from WTP – 4) (2*1.2 kW – 1 Standby)	2 x 1,000 Litre – SS Tank	Waste water to STP final

Note:

- Maximum of tanks are made using cement construction.
- The maintenance team ensure to clean the tank for monthly once.
- Bleaching power is mostly used to clean the inside tank.

12.3: Treated Water for Drinking Application:

- The university management is keen on providing uninterrupted, safe and healthy drinking water to all; throughout the year.
- Water dispenser are provided at appropriate places offering the treated water for the students (Both Normal and Hot temperature)

- The overhead tanks storing the well water are cleaned at regular intervals and the water management team has been maintaining a cleaning schedule Utensil Cleaning, Bathing & Cloth Washing.



PVC and Metal Based Taping System for Water Distribution Line

Table-17: Details of the Tap Water Flow Timing at Various Location

(Godavari)				
S. No.	**Floor No.**	**Water Quantity (L)**	**Time Taken (Sec)**	**LPM**
1.	9	5	80	4.1
2.	5	5	45	6.7
3.	1	5	20	15.0
(Krishna)				
4.	9	5	60	5.0
5.	5	5	34	8.8
6.	1	5	45	6.7
(Vedhavathi-Higher Zone)				
7.	15	5	56	5.4
8.	8	5	14	21.4
(Vedhavathi-Lower Zone)				
9.	7	5	44	6.8
10.	3	5	17	17.6
(Ganga-Higher Zone)				
11.	26	5	19	15.8
(Ganga-Lower Zone)				
12.	7	5	60	5.0
13.	5	5	25	12.0
14.	1	5	10	30.0

Table-18: Details of the Wash basin Water Flow Timing at Various Location

(Godavari)				
S. No.	**Floor No.**	**Water Quantity (L)**	**Time Taken (Sec)**	**LPM**
1.	9	0.75	10	4.5
2.	5	1.75	10	10.5
3.	1	1	05	12.0
(Krishna)				
4.	9	0.75	10	4.5
5.	5	0.75	5	9.0
6.	1	1	10	6.0
(Vedhavathi-Higher Zone)				
7.	15	1.25	10	7.5
8.	8	2.25	10	13.5

S. No.	Floor No.	Water Quantity (L)	Time Taken (Sec)	LPM
(Vedhavathi-Lower Zone)				
9.	7	1.25	10	7.5
10.	3	1	10	6.0
(Ganga-Higher Zone)				
11.	26	2	10	12.0
(Ganga-Lower Zone)				
12.	7	2.2	10	13.2
13.	5	1.5	10	9.0
14.	1	2.8	10	16.8
SRK Block				
15.	7	0.5	10	3.0
16.	4	1	10	6.0
17.	1	2.5	10	15.0
CV Block				
18.	7	1.3	10	7.8
19.	4	1.5	10	9.0
20.	1	1.2	10	7.5

Table-19: Details of the Health Faucet Water Flow Timing at Various Location

(Godavari)					
S. No.	Floor No	Water Quantity (L)	Time Taken (Sec)	LPM	Pressure (bar)
1.	9	1	9	6.7	0.8
2.	5	1	8	7.5	2.8
3.	1	1	18	3.3	3.4
(Krishna)					
4.	9	1	10	6.0	0.6
5.	5	1	5	12	2.0
6.	1	1	4	15	3.2
(Vedhavathi-Higher Zone)					
7.	15	1.1	10	6.6	1.9
8.	8	3.1	10	18.6	5.0
(Vedhavathi-Lower Zone)					
9.	7	0.75	10	4.5	2.5
10.	3	1.45	10	8.7	3.4

S. No.	Floor No	Water Quantity (L)	Time Taken (Sec)	LPM	Pressure (bar)
(Ganga-Higher Zone)					
11.	26	1.60	10	9.6	2.8
(Ganga-Lower Zone)					
12.	7	1.7	10	10.2	9.0
13.	5	2.1	10	12.6	3.2
14.	1	2.6	10	15.6	4.3
SRK Block					
15.	7	0.85	10	5.1	1.0
16.	4	1	10	6.0	2.3
17.	1	2.2	10	13.2	3.4
CV Block					
18.	7	0.80	10	4.8	2.6
19.	4	1.75	10	10.5	4.0
20.	1	2	10	6	5.2

12.4: Water Savings in Foreign Toilets:

- The list of availability of Indian & Foreign style toilets are presented in the below Table-20.

Table-20: List of Indian & Foreign Style Toilets

S. No.	Location	Description (Quantity)	
		Indian	Foreign
1.	Krishna Tower	–	137
2.	Godavari Tower	–	129
3.	Kaveri Tower	–	144
4.	Narmada Tower	–	135
5.	Yamuna Tower	–	133
6.	Annapurna Mess	–	8
7.	Homi J Bhabha Block	–	48
8.	Vikram Sarabhai Block	–	72
9.	J C Bose Block	–	49
10.	X-Lab	–	27
11.	Vedavathi Hostel	–	572
12.	Ganga Hostel	–	182
13.	S R Block	–	109
14.	CV Raman Block – 7floor	–	41
15.	Food Court	–	2
Total		**–**	**1,788**

- In general, the flush tank capacity may be 8 to 10 Litres (depends on make and model). Water savings also leads to power saving it saves the operating duration of the water pumps directly.



Table-21: List of Pressure Cage Location and Set Pressure

S.NO	WTP & Location	Set Pressure (Bar)
1.	WTP-1,3 (Admin & Academic)	4.1
2.	WTP-1,3 (Tower 1,2,3)	4.0
3.	WTP-1,3 (Tower 4,5)	4.2
4.	WTP-2,5 (SR Block)	4.0
5.	WTP-2,5 (Ganga)	4.0
6.	WTP-4 (Vedhavathi Lower)	4.0
7.	WTP-4 (Vedhavathi Higher)	7.0

*During the Time of Audit Those Values are Fixed

12.5: Rain Water Harvesting (RWH) – from Building Roof Area & Run-off Area:

- The audit team appreciates the effects taken by the management of **SRM UNIVERSITY** for harvesting the rain water almost in all buildings.
- The roof area is so arranged to collect the rainwater and then passed through proper piping system, and then bring back to the RWH pits which are located close to each pit
- The building run off are collected through each pit mostly located in each building. Common area and road run-off are properly collected and routed to nearby water body.





Existing Rain Water Harvesting (RWH) available in the University Campus

12.6: General Recommendations for Rain Water Harvesting:

- RWH has been fitted with their specifications indicating their i) year of installation, ii) approximate average rainfall and duration in the RWH location and iii) filter cleaning schedule (if any).
- Conduct a GIS based study on the improvement of ground water table especially before the rainy session and after rainy session. Compare the data and ensure that the water table improves due to percolation of rain water.
- Similar study mast be conducted (in future) before installing an RWH and after RWH.
- Increase the no. of RWH pits and may be developed to place at least 2 per building.



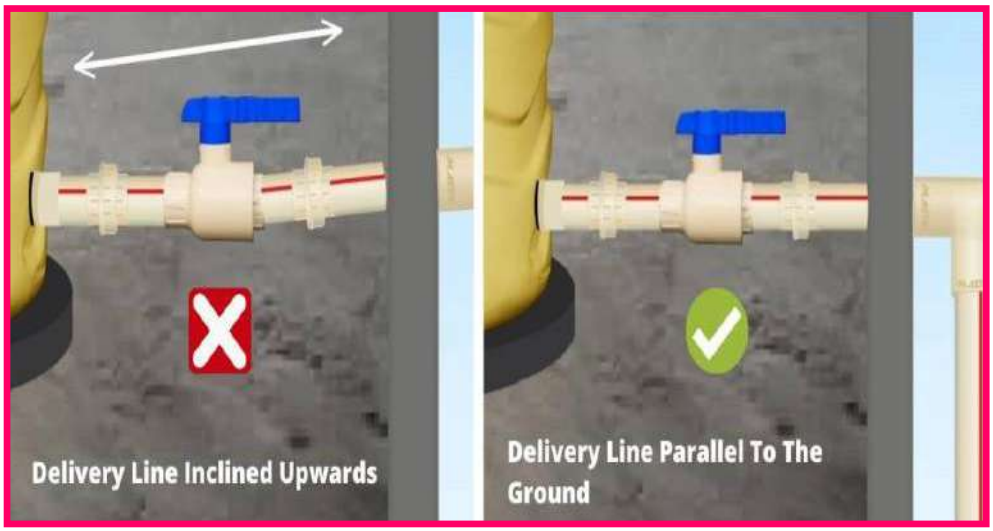
Sample Name Board in front a Rain Water Harvesting System

12.7: Tips of Increased Water Pressure:

- The most common issue of Indian plumbing is less water pressure. Less water pressure at university can become really frustrating at the time of an emergency.
- Because of less water pressure, the buckets may take a lot of time to fill, pressure of shower spray may be less, the faucets may get less water pressure and many of such water problems may arise. There are solutions to increase water pressure with minimal efforts.

1. Delivery line from the tank should be horizontal:

→ Delivery line from the tank should be horizontal or slightly downwards to the ground to avoid air traps.



2. Use CPVC/UPVC pipes instead of GI pipes:

- ❖ GI pipes get rusted when they come in contact with the moisture. This rust can lead to less water pressure.
- ❖ There are various health related issues that are caused due to rust in the pipeline such as cholera and diarrhea. GI pipes degrade overtime and can ultimately break after certain years.



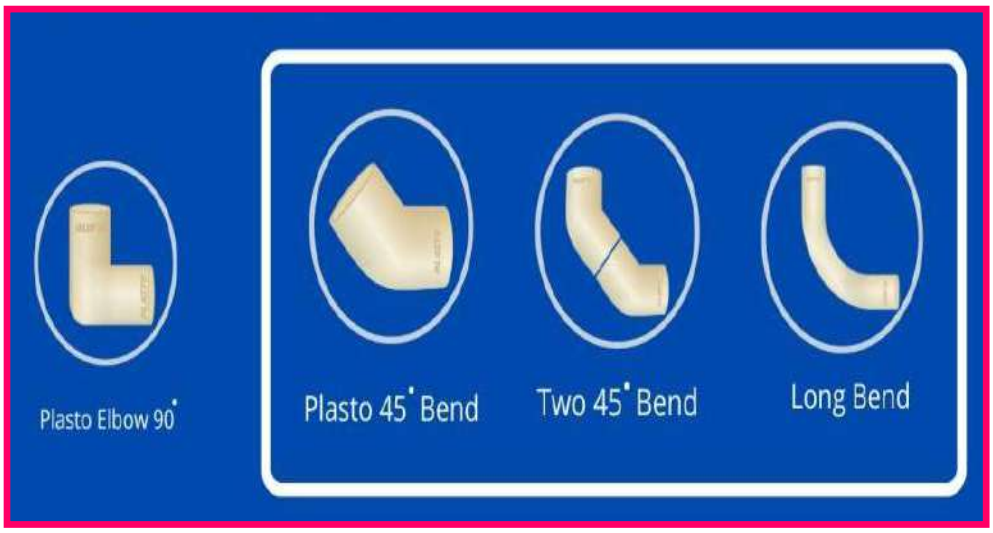
3. Higher diameter of pipe, more the water pressure:

☞ A **1/2" inch pipeline**, get 1 litter of water pressure and if use **1" pipeline**, this water pressure increases to 4 litre. This indicates when there is an increase in the size of the pipe, the water pressure also increases.



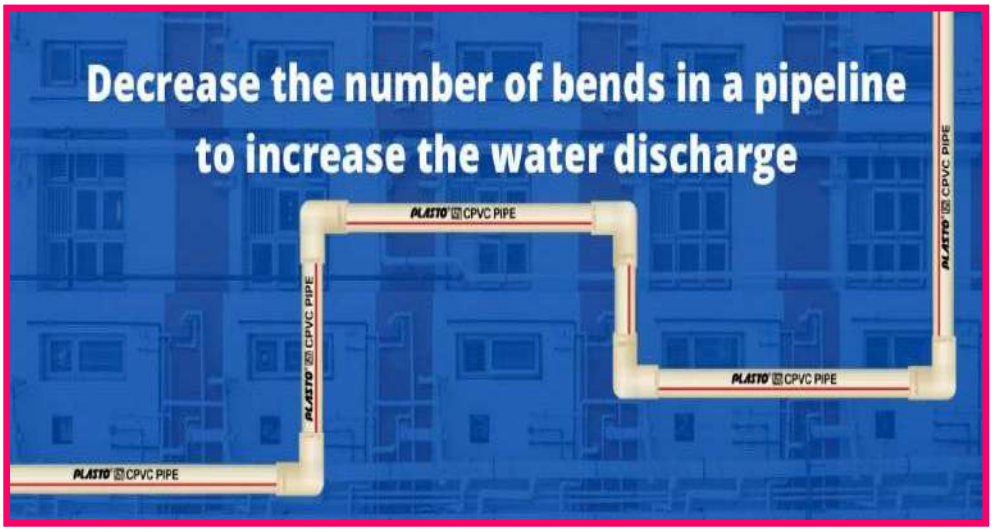
4. Recommended to use 45 Degree shoe bend:

- There is a friction loss on every bend. This means on every bend, the flow of the water will reduce by a certain level.



5. Increase the water pressure rate we should decrease the number of bends in a pipeline:

- In a 1/2" pipeline, where no bend is used, we get a water pressure of **38.24 L/min**. And when we add **9 elbows** in this pipeline, this pressure rate reduces to **16.36 L/min** which is **22% less**.



ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

13. ASSESSMENT ON MATURE TREES, BIO-DIVERSITY & GREEN SUSTAINABILITY

13.1: Campus Greenery:

The university is completely covered with mature trees grown for more than 10 years. The total number of mature trees available in the university campus is ***5,019 with many varieties of trees.***

Table-22: List of Mature Trees available in the University Campus

S. No.	Location	Name of the Tree	Quantity
1.0	Entire Campus Location	Variety of Mature Trees	5,398



Total No. of Mature Trees available in the university campus is **5,398** which contributes for reduction of **1117.7** Tons of CO_2 emission/Annum





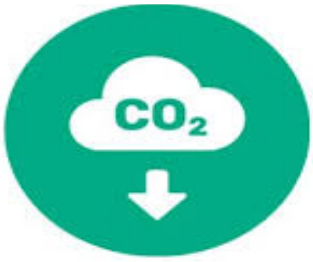
Campus Greenery Initiatives Taken by the University Management

13.2: Roof Top Solar Photovoltaic System:

- The university has installed solar PV plants with a capacity of **912 kW;** generate and feed power to the respective HT services and are utilized by the campus load.
- All the conductive parts are properly earthed at respective buildings and ensures safety.
- Table-23 shows the Specifications of Roof Top Solar PV Plant.

Table-23: Specifications of Roof Top Solar PV Plant

Total Capacity (kWp)					**912 kW**				
Panel Make/Model					Renewsys / DESERV 3M6H-330				
P_{max}	335	V_{max}	37.90	I_{max}	8.85	V_{oc}	46.27	I_{sc}	9.41
Location of SPV Plant					Krishna, Godavari, Kaveri, Narmada, Yamuna, X-Lab Block, SR Block, CV Raman, & Vedavathi op				
Availability of Tracking					Available but not working				
Synchronizing Point					MV Panel				
Number of DC & Inverter Earthing					3 Each				
Panel Mounting Direction & Angle					15° North-South; Fixed Orientation				
Frequency of Panel Cleaning					Weekly Once				
Average Units Generated per Day					**3,650 – 4,100 kWh**				



Energy saving from solar PV system (from the installation) is ***6,22,714 kWh*** which reduces **510.6 Tons of CO_2 Emission.**





13.3: Bio-gas Plant Generating Cooking Gas (Green Energy Generation-I):

- Again, to voice for Green Energy; **SRM-AP** has implemented a Bio-gas (natural fuel) plant generating energy from food and vegetable wastes daily generated in mess and canteen.
- Production of biogas obtained from **"anaerobic digestion"** which consists in micro-organisms breaking down complex organic substances (lipids, protides, and glucides), contained in plants, sludge and by-products of animal origin.
- Biogas is primarily methane (CH_4) and carbon dioxide (CO_2) and may have small amounts of hydrogen sulphide (H_2S), moisture and siloxanes. The gases methane, hydrogen, and carbon monoxide (CO) can be combusted or oxidized with oxygen.
- Food waste generated from cooked rice, cut portions of vegetables and non-used vegetables waste. This waste is crushed by mixer grinder and slurry was prepared by adding water.
- SRM –AP has implemented nearly 6.0 m^3; biogas system; generating the gas which is used to cook food for the in the **Annapurani Mess.**
- The specifications of the Bio-gas system are represented below:

Plant Size	Waste Quantity	Waste & Water Mixing	Output gas Quantity
6 m^3	100 kg/day	100 kg mixed with 100 litre or water (1:1 Ratio)	Nearly 6 - 8 m^3/day





13.4: Waste to Wealth: Vermicompost Plant:

- **SRM – AP** has a vision to properly dispose the food and dead leaves waste into manure by implementing a comprehensive Vermicomposite yard.
- Vermicomposting is a natural process whereby earthworms convert waste material with rigid structures into compost. The compost produced in this green process is traditionally and popularly used as a natural fertilizer for enhancing plant growth.
- Food waste from all mess & quarters are collected and mixed with the dead leaves collected inside the campus are mixed with proper ratio.
- They fed into a dedicated machine through which sand and saw dust are mixed into it. Then they kept in cement bags and to allow to decompose it for a specified period of time.
- After it tuned in to its original colour (mostly a thick black); then they packed in a small bag with appropriate quantity and given to the gardening people for manuring application.
- Since the waste are decomposed in a natural manner; this will be treated as an **Organic Manure** and **will not produce any harmful effects for the soil.**



Food Waste mixed with Sand + Saw Dust to generate Organic Manure

13.5: Sustainable Transportation through E- Vehicles in the Campus:

- → **SRM** is more conscious about locally created environment pollution and encouraged the students and faculty to use **Battery-Operated Electrical Vehicle** (**BOEV**).
- → In-campus electric vehicles are battery-powered, emission-free transportation solutions designed specifically for use within enclosed or semi-enclosed spaces inside the university campuses,
- → These vehicles are optimized for short distances and low-speed environments, making them ideal for reducing carbon footprint in controlled spaces where traditional vehicles might not be practical.
- → This must be a **welcome step** and more awareness must be created among all the faculty and students.
- → **Eco-Friendly:** Electric vehicles produce zero tailpipe emissions, helping institutions achieve their sustainability goals.
- → **Cost-Efficient:** With lower maintenance and operational costs compared to traditional fuel-powered vehicles, electric options offer financial savings over time.
- → **Quiet Operation:** Electric vehicles operate with minimal noise, reducing sound pollution on campuses and in residential areas.
- → **Customizable:** These vehicles can be designed for specific functions, such as transporting passengers, carrying cargo, or even serving as emergency response vehicles.

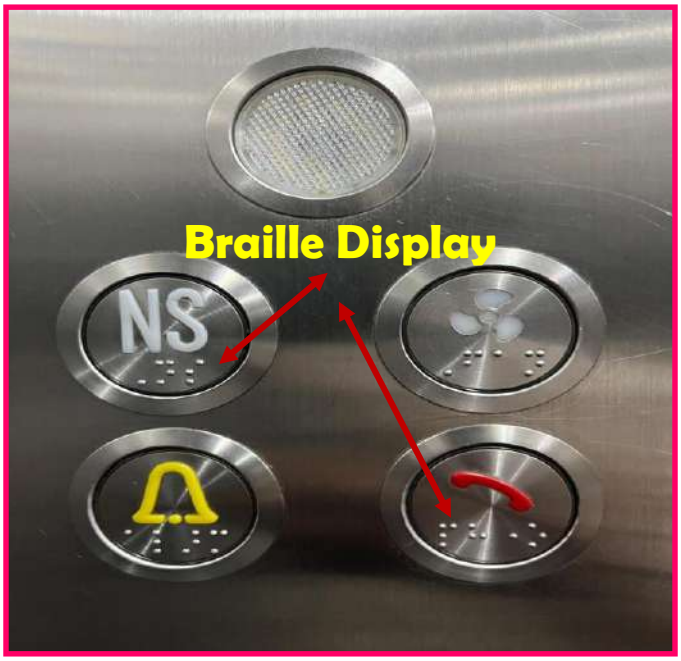


Vehicle Type	Primary Application	Seating Capacity	Main Features
Electric Min—Bus	Group Transportation	Up to 20	Compact, quiet, low maintenance

13.6: Disabled friendly University Campus Infrastructure:

- → A disabled-friendly university campus is designed to be accessible and inclusive for students with disabilities.
- → This includes physical accessibility features like ramps and elevators, accessible restrooms, and assistive technologies.
- → It also involves creating a supportive environment with accessible information, services, and inclusive teaching practices.
- → SRM AP developed many infrastructure for Disabled persons to be used hassle free inside the university campus.







13.7: Visual Inspection of Fire extinguishers in the University Campus:

- The university has installed Fire extinguishers at all the vulnerable points.
- They are also refilled and in good condition (with adequate pressure indicated in the meter)
- However the audit team found some mismatch in terms of quantity and also the gas pressure status which are represented in the below table.

Table-24: Fire Extinguisher Mismatch List indicating its Location ad Status

S. No.	Location	Type	As per the List	Actual	Pressure Status
HOMJI BABA					
1.	4th Floor	ABC	3	2	Found Ok
2.	6th Floor	ABC	3	2	Found Ok
3.	6th Floor	CO_2	3	2	Found Ok
VSB BLOCK					
4.	1th Floor	CO_2	6	4	Found Ok
5.	2th Floor	ABC	6	4	Found Ok
6.	3th Floor	ABC	12	4	Found Ok
X LAB					
7.	2th Floor	ABC	10	2	Discharged
8.	3th Floor	ABC	8	10	Found Ok
SR BLOCK					
9.	1th Floor	ABC	13	7	Found Ok
10.	1th Floor	CO_2	13	8	Found Ok
11.	2th Floor	ABC	11	8	Found Ok
12.	2th Floor	CO_2	12	8	Found Ok
13.	3th Floor	ABC	11	8	Found Ok
14.	3th Floor	CO_2	12	8	Found Ok
15.	4th Floor	ABC	11	8	Found Ok
16.	4th Floor	CO_2	12	8	Found Ok
17.	5th Floor	ABC	11	8	Found Ok
18.	5th Floor	CO_2	12	8	Found Ok
19.	6th Floor	ABC	12	8	Found Ok
20.	6th Floor	ABC	12	1	Discharged
21.	6th Floor	CO_2	12	8	Found Ok
22.	7th Floor	ABC	11	8	Found Ok
23.	7th Floor	CO_2	12	8	Found Ok

S. No.	Location	Type	As per the List	Actual	Pressure Status
CV RAMAN					
24.	Basement	ABC	2	3	OK
25.	Basement	CO_2	6	3	OK
26.	1th Floor	ABC	4	2	OK
27.	1th Floor	CO_2	13	8	OK
28.	2th Floor	ABC	4	3	OK
29.	2th Floor	CO_2	6	5	OK
30.	7th Floor	ABC	2	1	OK
Vedavathi					
31.	1th Floor	ABC	15	1	Discharged
32.	3th Floor	ABC	3	4	OK
33.	3th Floor	CO_2	7	5	OK
34.	4th Floor	CO_2	7	5	OK
35.	5th Floor	CO_2	7	5	OK
36.	6th Floor	CO_2	7	5	OK
37.	7th Floor	CO_2	7	5	OK
38.	8th Floor	CO_2	7	5	OK
39.	9th Floor	CO_2	7	6	OK
40.	10th Floor	CO_2	7	6	OK
41.	11th Floor	CO_2	7	5	OK
42.	12th Floor	CO_2	4	5	OK
43.	13th Floor	CO_2	7	5	OK
44.	14th Floor	CO_2	7	5	OK
45.	15th Floor	CO_2	7	5	OK
Ganga					
46.	1th Floor	ABC	8	2	OK
47.	1th Floor	CO_2	12	2	OK
48.	8th Floor	ABC	3	2	OK
49.	9th Floor	ABC	3	2	OK
50.	10th Floor	ABC	3	2	OK
51.	12th Floor	ABC	3	2	OK
52.	13th Floor	ABC	3	2	OK
53.	14th Floor	ABC	3	2	OK

S. No.	Location	Type	As per the List	Actual	Pressure Status
Ganga					
54.	15th Floor	ABC	3	2	OK
55.	16th Floor	ABC	3	2	OK
56.	17th Floor	ABC	3	2	OK
57.	18th Floor	ABC	3	2	OK
58.	19th Floor	ABC	3	2	OK
59.	19th Floor	ABC	3	2	OK
60.	20th Floor	ABC	3	2	OK
61.	21th Floor	ABC	3	2	OK
62.	22th Floor	ABC	3	2	OK
63.	23th Floor	ABC	3	2	OK
64.	24th Floor	ABC	3	2	OK
65.	25th Floor	ABC	3	2	OK
66.	26th Floor	ABC	3	2	OK

Monthly Visual Inspections:

- Ensure the extinguisher is accessible and not obstructed.
- Check for any damage, such as dents, cracks, or rust.
- Verify the pressure gauge reading is in the green zone.
- Inspect the locking pin and tamper seal for damage or missing parts.

Recharging and Replacement:

- Extinguishers should be recharged immediately after use.
- They should also be recharged if the pressure is low, or if any damage or leaks are detected.
- Eventually, extinguishers will need to be replaced, typically after 5-15 years, depending on the type.

Other Important Considerations:

- Extinguishers should be kept in a designated, visible, and easily accessible location.
- The operating instructions should be clearly visible.
- Keep a record of all maintenance and testing.
- In dusty or corrosive environments, more frequent inspections may be necessary.

13.8: Fire and Safety in the University Campus:

- **SRM - AP** has a commitment to provide fire accident free zone for their stakeholders and placed adequate fire extinguishers, fire buckets and fire pipes inside the university and hospital premises.
- **SRM - AP** is ensuring a carefully designed system to ensure safety of life and property from explosive forces.
- Some key points reflecting the importance of fire safety training are;
  - ✓ Contributes to the safety of employees at the workplace
  - ✓ Legal requirements
  - ✓ Protecting assets
  - ✓ Quicker response time in emergency situations









13.9: Recommendations to Grow Indoor Plants as Natural Air Purifier:

- Indoor plants not only do plants look good while bringing life to our living space, they also help purify the air, according to a NASA study that explains that even a small plant inside the workspace can help remove at least three household toxins (benzene, formaldehyde, and trichloroethylene)



TULSI: Generates more oxygen per day



Aloe Vera:

- **Removes benzene and formaldehyde**
- **Eliminate harmful microorganism and absorb dust**



Snake Plant:

- **Removes Xylene, Benzene, Formaldehyde, Trichloroethylene toxins.**



Spider Plant:

- **Removes CO and Formaldehyde**
- **Absorbs Nicotine**



Money Plant (Devil IVY):

- **Best air purifying plant**
- **Remove benzene & Formaldehyde**



Bosten Fern:

- **High humidity application**
- **Remove xylene & Formaldehyde**



Chrysanthemum:

- **Removes Ammonia, Xylene, Benzene & Formaldehyde**



Kimberly Queen Fern:

- **Works well in carriage**
- **Absorb vehicular exhaust**

13.10: Recommendations for Miyawaki Forest:

Miyawaki is a technique (also called *Potted Seedling Method*) as that helps build dense, native, multi-layered forests. The approach is supposed to ensure that plant growth is 10 times faster and the resulting plantation is 30 times denser than usual. It involves planting dozens of native species in the same area, and becomes maintenance-free after the first three years. The overall density of the forest is beneficial in lowering temperature, making soil nutritious, supporting local wildlife and sequestration of carbon.





13.11: Bio-Diversity in the Campus:

- Biodiversity is all the different kinds of life you'll find in one area—the variety of animals, plants, fungi, and even microorganisms like bacteria that make up our natural world.
- Each of these species and organisms work together in ecosystems, like an intricate web, to maintain balance and support life.

13.12: Recommendations to maintain Bio-Diversity:

- **Bird Sighting and Survey:** Conduct a dedicated bird sighting and identify the list of birds both residing birds and migratory birds available in the university campus
- Prepare the list of birds with their local name, scientific name, their average life time, nesting facility created by the bird and photo of the bird. Show case the result to all the stake holder and inculcate a habit of friendly environment
- Discuss with the ornithologists and facilitate the environment with more birds coming to the campus and especially migratory birds.
- **Reptile & Amphibian survey:** Similar to bird survey; conduct a survey to list the amphibians available in the campus
- Amphibian and reptile surveys are often performed as part of the Green Audit process or terrestrial survey. These surveys are effective at detecting the presence of even the most elusive species.

ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

14. BEE TIPS

FOR

ENERGY CONSERVATION

I. ELECTRICAL SYSTEM

Operational and Housekeeping Measures

- Review production schedule so that all major equipment does not operate simultaneously.
- Maximize load factor according to demand.
- Match transformer with the load:
- Utilise off – peak hours to balance the load – apply a thermal storage system such as ice storage (bank) so as to reduce peak demand.
- Shift the operating time of non – critical equipment to the off – peak period if possible.
- Disconnect transformers when not in use.
- Properly adjust the voltage

  Power reduction = No load loss power * $[(V_1/V_2)^2 - 1]$ kW

  Where V_1= Voltage before adjustment

  V_2 = Voltage after adjustment



- Set transformer taps to optimum settings.
- Verify utility meters for accuracy on a regular basis.

Low - Cost Measure

- Maintain PF of at least 0.95.
- Avail incentives from utility company / electricity board by maintaining PF at 0.999
- Match the size of equipment with the task.
- Use a demand controller to minimize power demand by trapping load using automated controllers.

Retrofit Measures

- Use energy efficient transformer.
- Review replacing very old transformer say > 35 years old with newer efficient transformer. Energy efficient transformers will reduce the amount of no – load currents and reactive power losses.
- Change old equipment with energy efficient ones so they draw less energy.
- Select the production process, machines or equipment that consumes low power. Test their power consumption before the operation.
- Relocate transformer close to the major load.

II. ELECTRIC MOTORS

Operational and Housekeeping Measures

- Operate at rated voltage and balanced supply. Motor performance is significantly affected when motor operates ± 10% from its rated voltage. Voltage unbalance also results in current unbalance which can reduce 3-5% in motor input power. Unbalance also generates excessive heat and reduces life of motor.
- Measure motor load in terms of input namely kW, kVA, kVAr, V, A, PF.
- Ensure proper ventilation measures are in place (every 10^0C rise in temperature above the recommended peak is estimated to reduce motor life by 50%).
- Switch off conveyor (motor) when not in use.
- Setup preventive maintenance programme for conveyor motor system comprising of lubrication of reducers, chains, bearings. There are six major causes of drive failure namely bearing failure, winding failures, rotor failures, improper speed – reducer lubrication, improper use of reducer, and poor alignment of the reducer with the motor or conveyor drive.

Low - Cost Measure



- Replace oversized motors with those of lower ratings.
- Apply energy savers for applications where
  Motors run idle or at a light load for a long time.
- Use sensors, e.g. an interruptible light
  Beam or motor current sensors, to detect
  When the conveyor is unloaded and switches motor off.

Retrofit Measures

- Ensure efficiency restoration after motor rewinding. If rewinding is not done properly, motor efficiency can be reduced by about 3 – 4%.

- Select proper size of conveyor motor so that motor runs at 70 – 80 percent loading at all times. If load weights vary, two – speed motor or adjustable – speed drives should be used to enable motors to run near full capacity.
- Use gravity feed system to avoid conveyor wherever feasible.
- Use proper controls (VFD, Soft starters).
- Institute a motor repair / replace policy.
- Replace existing motors with energy efficient motors. High efficiency motors are at least 3% more efficient than standard motors.
- Avoid use of belts for power transmission from motor to driven equipment whenever feasible.
- Replace motor and drives which are older than 10 years.
- Adopt advanced systems with features such as 'sleep' mode, which reduces drive pull and current draw significantly. This provides significant energy savings as well as reducing wear and tear on components.
- Replace old, worn – out conveyor with newer energy – efficient models.

III. LIGHTING SYSTEM

Operational and Housekeeping Measures

- Reducing lighting voltage.
- **Reduce the number of lamps operating:** Reduce lamp numbers and at the same time maintain lighting levels by using more efficient lamp types.
- **Improve maintenance practices:** lamps fail at fairly predictable intervals, so planned mass-replacement of lamps is a good option and can be less expensive than spot replacement.
- **Improve data management:** Energy management and other asset management tasks will be simplified if records of lamp and luminaries types are kept up to date.
- Measure light levels and adjust to the minimum required using switches, de-lamping etc.
- Use day lighting to the extent possible.
- Clean lamp and luminaries regularly.
- Disconnect ballast where lights have been eliminated.



Low-cost Measures

- Reduce operating hours-use daylight sensors or time clocks to ensure to ON when required.
- Replacing inefficient lamps-more efficient lamps allow to save energy while maintaining or improving light levels. If it is decided to replace the lamp, along with them, control gears also will have to be replaced.
- Replacing inefficient switching equipment-replace out dated cadmium sulphide light photo sensors with electronic sensors.
- Use task lighting and lower lamp mounting heights.
- Setup group re-lamping programme.
- Review light switches to allow more localized control of lighting.
- Use timer controls. Consider painting the walls a lighter colour and using less lighting fixtures or lower voltages.

Retrofit Measures

- Consider using light tubes to bring sun light in the room / shop floor or canteen.
- Consider incorporating renewable energy e.g. solar or wind or hybrid solar and wind for lighting.
- Use higher-efficiency, lower wattage lamps in existing fixtures.
- Install efficient alternatives to incandescent lighting, mercury vapour lighting etc.
- Use high efficiency electronic ballast instead of standard ballast.
- Use high efficiency luminaries such as mirrored reflectors or thermally controlled fixtures.
- Control lighting with clock timers, delay timers, photocells and/or occupancy sensors.

IV. DIESEL GENERATOR

Operational and Housekeeping Measures



- Ensure steady load conditions on the DG set;
- avoid load fluctuations, voltage imbalance
- Optimise voltage and frequency.
- Ensure compliance with OEM maintenance checklist.
- Improve air filtration (provide dust – free air at intake).

Low - Cost Measure

- Consider fuel oil additives in case they benefit fuel oil properties.
- Calibrate fuel injection pumps frequently.
- Provide adequate instrumentation for monitoring performance, and plan for operations and maintenance accordingly.

Retrofit Measures

- In case of base load, consider recovering waste heat from hot exhaust gases and hot jacket cooling water for producing chilled water using vapour absorption machines.
- Consider parallel operation among the DG sets for improved loading and fuel efficiency.
- Explore cooling inlet air.

V. PUMPING SYSTEM

Operational and Housekeeping Measures

- Turn off pump when it is not needed. This can be done automatically with installation of controls.
- Inspect pump impeller periodically to remove external debris which will improve flow.

Low - Cost Measure

- Use pump at best efficiency point by trimming or changing the impeller especially if head is higher than necessary. If a pump is continuously throttled to 10% less than its design flow rate, trim the impeller to reduce electrical demand by up to 25%.
- Restore internal clearances in pump if performance has changed significantly.
- Balance the system to minimise flows and reduce pump power requirements.
- Use a small booster pump for small loads requiring high pressures.
- Avoid frequent on / off cycling of a pump as it increases power consumption during start – up. Soft starter can be provided if frequent on / off cycling is unavoidable.

Retrofit Measures

- Use low friction coatings on the internal surfaces of pumps to improve efficiency.
- Replace oversized pumped.
- Apply VFD for wide load variations (VFD changes the speed of the pump for the most efficient match of horsepower requirements with output).
- Use multiple pumps instead of one large pump.
- Replace standard efficiency pump drive motor with premium high efficiency motor.
- Review and re-optimise pumping systems when plant's water requirements change. When a pump is selected for the application, specifications and parameters are set for the pump for that application, if the design operating point is changed with the same pump, flow rate and energy cost is altered.
- Adopt parallel pumping for varying flow requirements.
- Review ad change pipe diameter. A 15% increase in pipe diameter can reduce pressure drop by 50%. This allows pump size to be used.

VI. FAN SYSTEM

Operational and Housekeeping Measures



- Turn off fan when it is not needed.
- Clean filters and reduce pressure drop across them.
- Check and adjust belt tension (motor-fan) regularly.
- Arrest any leaks in the duct.
- Clean fan blades regularly.
- Check flow balance.

Low-cost Measures

- Reduce fan speed by changing motor or fan pulley.
- Consider impeller change where applicable for fixed flow applications.
- Improve fan inlet and outlet duct connection to ensure proper flow distribution and losses at the inlet and outlet.
- Explore use of low-slip belt such as flat, cogged belts.
- Avoid damper operation through speed control (motor/fan pully change).

Retrofit Measures

- Avoid damper operation through speed control (inlet guide vane/VFD) to adjust for charges in system requirements. Reducing a fan's speed by 20% can reduce its power requirements by nearly 50%.
- Replacing existing fan with energy efficient fan operating closer to BEP.
- Review and increase duct size if feasible. A 15% increase in duct diameter can reduce pressure drop by 50%. This allows smaller fan motor to be used.
- Use Smooth, well-rounded air inlet cones for fan inlet air intakes.
- Reduce bends in the ductwork.
- Replace fan motor with energy efficient motor.
- Replace outdated equipment with newer and optimal sized units.
- Use energy efficient aerofoil backward curved fans if feasible.
- Use simulation tools like computational Fluid Dynamics (CFD) to improve fan system.
- Switch over to FRP blades in cooling tower fans.

VII. BUILDINGS

Operational and Housekeeping Measures

- Set the air conditioning area temperature within a range of 24-26^{0}C to have better human comfort and hence to save power.
- Increase the evaporator chilled water temperature setting in the chillier from 6.5-10^{0}C to achieve a 10% reduction in power consumption in chiller reducing contract demand after improving the power factor.
- Optimise evaporator temperature to 22^{0}C.
- Set up thermostat temperature for cooling applications.
- Avoid use of heating applications in cool spaces.
- De-lamping
- Turn off lights in unoccupied spaces.
- Avoid running the pumps during peak period.

Low-cost Measures

- Apply thermal insulation (for building surfaces without thermal insulation).
- Improve air tightness (e.g. caulking holes and cracks) and the insulation of the buildings. Reduce ventilation losses.
- Provide efficient barriers to avoid hot air leakage into cool spaces.
- Install programmable thermostats for better control of heating and air-conditioning.
- Insulate damaged/un insulated chilled waterlines.
- Provide interlocks to stop condensers when compressors stop.
- Install VFDs for condenser water pumps and improving range in cooling towers.

- Provide VFDs for the major AHU's, chilled water pumps and cooling tower fans.
- Select office equipment with reduced heat output.
- Install motion sensors in conference rooms, closets and rest rooms and break rooms. Motion sensors can reduce lighting costs up to 40% in areas where lights are generally left on all the time.
- Use energy-efficient lighting lamps and ballasts: replace 40W tubes with ordinary chokes by T5 lamps/LED lamps.
- Select lamps with a high efficiency and provide effective controls so as to prevent lights being left on unnecessarily.
- Provide electronic energy meters and run-hour meters for each pump.
- Use water –saving equipment instead of the conventional fixtures for toilets, faucets, showerheads, etc.
- Improve power factor to at least 0.98 or more. Rectify harmonics distortion.
- Install sub-metering to monitor power consumption in various sections.

Retrofit Measures

- Use heat recovery technologies such as rotary heat wheels and heat pipes that can recover 50-80% of the energy used to heat or cool ventilation air supplied to the building.
- Apply thermal energy storage systems (ice storage or ice bank) that offers a mean of using less-expensive off-peak power to produce cooling or heating to condition the building during on-peak periods,
- Replace glass panes with laminated insulation boards as glass panes results in large solar heat gain and heat transmission.
- Replace existing window with energy efficient window (high R-value, low solar heat gain coefficient, low conductivity, low-emissivity glazing, airtight, etc.).
- Augment thermal insulation.
- Replace old reciprocating compressors with energy efficient screw compressors.
- Optimise air conditioning requirements by measures such as use of false ceiling and segregation of critical areas for air conditioning by providing partitions.
- Retrofit central chillier system with energy efficient chillers.
- Retrofit constant air volume (CAV) systems with variable air volume (VAV) systems.

COMPLETION OF THE REPORT

This report is prepared as a part of the Energy, Environment and Green Audit process conducted at **M/s. SRM UNIVERSITY,** Neerukonda, Mangalagiri Mandal, Guntur District, Mangalagiri – 522 240, Andhra Pradesh, India. by **RAM-KALAM CENTRE FOR ENERGY CONSULTANCY AND TRAINING,** Coimbatore - 641 109 Tamil Nadu, India.

ENERGY, ENVIRONMENT & GREEN AUDIT REPORT

ANNEXURE:

AUTHORISED CERTIFICATES OF THE AUDITOR

ZERTIFIKAT ◆ CERTIFICATE ◆ 認証書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

South Asia

CERTIFICATE

The Certification Body
of TÜV SÜD South Asia Private Limited

certifies that

M/S RAMKALAM CENTRE FOR ENERGY CONSULTANCY & TRAINING

No.8, VPK Garden, Velanaipatti, Coimbatore – 641 062, India

has implemented Quality Management System

in accordance with **ISO 9001:2015**

for the scope of

Providing Energy, Environment, Green audits to industry, Academic institutions and organizations

The certificate is valid from **2023-11-22** until **2026-11-21**

Subject to successful completion of annual periodic audits

The present status of this certificate can be obtained through TUV SUD website by scanning below QR code and by entering the certificate number (without spaces) on web page. Further clarifications regarding the status & scope of this certificate may be obtained by consulting the certification body at info.in@tuvsud.com

Certificate Registration No. **99 100 23573**

Date of Initial certification: **2023-11-22**

Issue Date: **2023-11-22** Rev. **00**

Rahul Kale
Head of Certification Body
of TÜV SÜD South Asia Private Limited,
Mumbai
Member of TÜV SÜD Group

NABCB QM011

Reg No.: EA-27299

Certificate No.: 9645/19

NATIONAL PRODUCTIVITY COUNCIL

National Productivity Council

(National Certifying Agency)

PROVISIONAL CERTIFICATE

This is to certify that Mr./ Mrs./ Ms. **SIVARASU SULUR RATHINAVELU**

son / daughter of Mr. **P RATHINAVELU** *has passed the National certification Examination for Energy Auditors held in September 2018, conducted on behalf of the Bureau of Energy Efficiency, Ministry of Power, Government of India. He / She is qualified as* ***Certified Energy Manager*** *as well as* ***Certified Energy Auditor****.*

He / She shall be entitled to practice as Energy Auditor under the Energy Conservation Act 2001, subject to the fulfillment of qualifications for Accredited Energy Auditor and issuance of certificate of Accreditation by the Bureau of Energy Efficiency under the said Act.

This certificate is valid till the Bureau of Energy Efficiency issues an official certificate.

Digitally Signed by:K V R RAJU
Mon Apr 22 16:22:42 IST 2019
Controller of Examination, NPC AIP Chennai

Place : Chennai, India
Date : **22nd April, 2019**

Controller of Examination

TÜV NORD

ISO 14001:2015 Lead Auditor
(Environmental Management Systems)
Training course

it is hereby certified that

Dr. S. R. Sivarasu

has successfully completed the above mentioned course and examination

08th - 12th December 2017

Coimbatore, India

Certificate No. 3521 2982 02
Delegate No. 71968

for TÜV NORD CERT GmbH

Essen, 2018-01-11

Course 18125 is certified by CQI/IRCA and meets the training requirements for those seeking certification under the IRCA EMS auditor certification scheme.

TÜV NORD CERT GmbH Langemarckstraße 20 45141 Essen www.tuev-nord-cert.com

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CQI | IRCA APPROVED TRAINING PARTNER

IGBC

Confederation of Indian Industry

The Indian Green Building Council

hereby certifies that

Sivarasu S R

has successfully demonstrated knowledge on the Green Building Design & Construction, Building Standards & Codes, IGBC Resources & Processes and Green Design Strategies & their Impacts, required to be awarded the title of

IGBC Accredited Professional

K S Venkatagiri
Executive Director
CII-Godrej GBC

V Suresh
Chairman
Indian Green Building Council

Gurmit Singh Arora
Vice-Chairman
Indian Green Building Council

200239

20 June 2020

GRIHA

GREEN RATING FOR INTEGRATED HABITAT ASSESSMENT

GRIHA CERTIFIED PROFESSIONAL CERTIFICATE

This is to certify that

Sivarasu sr

has qualified as a **GRIHA** Certified Professional For V. 2015

Date of issue: 18th September 2020

Note : This certification is valid only for GRIHA version 2015.

Chief Executive Officer
GRIHA Council



Confederation of Indian Industry

This is to certify that

SIVARASU S R

is a

CII Certified Professional in Sustainable Waste Management

K S Venkatagiri
Executive Director
CII - Godrej GBC

Pradeep Bhargava
Chairman
CII GreenCo Council

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THIS CERTIFICATE IS AWARDED TO

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ISO 14064-1:2018
ISO 14064-2:2019
ISO 14064-3:2019
ISO 14066:2011
ISO 14067:2018

AND CERTIFY HIM/ HER AS

IMPLEMENTOR & AUDITOR
CARBON FOOTPRINT MANAGEMENT

This certificate is awarded for successful completion of Global Virtual Training course conducted from August 27, 2021 to September 01, 2021. It's serves as a proof of his/her knowledge, competence and ability to implement, verify and validate carbon footprint as per above mentioned standards and methods. This certificate was awarded on August 01, 2021.

01.09.21
DATE

SIGNATURE

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