ENERGY AUDIT REPORT

for

SWAMI RAMA HIMALAYAN UNIVERSITY

Swami Ram Nagar, Doiwala,
Dehradun, Uttarakhand

SESSION 2024-25

Presented & Submitted By

ECOSCIENCE CONSULTANCY

Ecoscience Consultancy
An ISO 9001, 14001, 45001, 17020
& 50001 certified company

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SWAMI RAM HIMALAYAN UNIVERSITY

Swami Ram Nagar, Doiwala, Dehradun, 248140, Uttarakhand India.

(Session 2024-25)

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ACKNOWLEDGEMENT

M/s Ecoscience Consultancy would like to extend its heartfelt gratitude to Swami Rama Himalayan University (SRHU), Doiwala, Dehradun for entrusting us with the responsibility of conducting an 'Energy Audit Study' in academic year 2024-25

We hereby express our sincere thanks to **…………………….** and their team, from Swami Rama Himalayan University for their proactive support and courtesy extended to the M/s Ecoscience Consultancy team during field study. We also thank other officials from Swami Rama Himalayan University for their cooperation and support provided during data collection. We are also grateful to all those we interacted with, during the audit who gave us some operational insights.

Furthermore, we are immensely grateful to all the individuals we interacted with during the audit, as they provided us with valuable operational insights.

We hereby submit the Energy Audit Report for your reference.

DECLARATION – MANAGEMENT SRHU

I, …………………………….…, on behalf of Swami Rama Himalayan University (SRHU), do declare & testify that all the data provided are on factual basis as per the available records and the data has been shared in good faith and is not intended for any other purpose other than Energy audit.

We would like to express our heartfelt gratitude to the team at Ecoscience Consultancy for taking on this important task. We are confident that the upcoming audit will be conducted with the utmost excellence. Thank you for your dedication and expertise!

Sincerely,

Name:
Designation:
Swami Rama Himalayan University (SRHU)

Declaration by Ecoscience Consultancy

Ecoscience Consultancy hereby declare that the energy audit report prepared for the "Swami Rama Himalayan University (SRHU)" located at Swami Ram Nagar, Doiwala, Dehradun, Uttarakhand (India) by our team has been reviewed and approved. The expertise and methodologies used for preparing this audit report are of the highest quality and the experts used their know-how to the optimum level. The recommendations and findings in this report can be considered and implemented where feasible to improve the facility's energy efficiency and sustainability.

We affirm that this report has been prepared in good faith and with the intent of achieving significant energy savings and operational improvements. We are committed to making informed decisions based on the expert analysis provided and to continuously enhancing our energy management practices.

Dr. Gurpreet Singh	**Dr. Avinash Kumar**
(Managing Director)	(Managing Director)
Ecoscience Consultancy	Ecoscience Consultancy

Declaration by Experts/Auditors

We, the undersigned, hereby certify that the energy audit for (SRHU) has been conducted with utmost diligence and professionalism. The data and findings presented in this report are accurate to the best of our knowledge and are based on standard industry practices and methodologies. We further certify that the audit complies with all relevant regulations and standards, and the Recommendations provided are aimed at improving the energy efficiency of the building

Team of Experts for the Study

S. No.	Name of Expert	Area of Expertise	Sign.
1.	**Dr. Gurpreet Singh** (Ph. D. & M. Tech. Env. Sc.)	Technical & Environment • Lead Auditor for Green, Environment audits • Air Quality Expert • Environment Sustainability • Carbon Footprint Expert	
2.	**Dr. Avinash Kumar** (Ph.D., M. Tech., M.Sc. in Env. Sc.)	Environment Management System • Water Quality Expert. • Pollution Load Assessor. • Carbon Footprint Expert. • Environment Audit Expert.	
3.	**Mr. Pankaj Dhote** (M.Tech in Energy & BE Electrical)	Energy & Environment • CEA -Energy Auditor • Energy Economist	

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Executive Summary

Energy Audit is the key to a systematic approach for decision-making in the area of energy management as it attempts to evaluate the energy usage pattern in an establishment. Also, it serves to identify all the energy streams in an establishment, so that potential areas wherein energy savings are practically feasible are identified.

In light of this goal, M/s Ecoscience Consultancy was entrusted by Swami Rama Himalayan University with the responsibility of conducting an energy audit for the institution.

The study primarily encompasses the following key areas:

- Present energy scenario of the building.
- Detailed analysis of the data collected during field visits, trial measurements using portable instruments, and discussions with relevant personnel.
- Majorly area covered during the detailed study i.e Lighting (Interior/Exterior), AC, Heaters, Fans. electric motors, electronic equipment's, laboratories and computer networking
- Recommendations for energy-saving options in all feasible areas, accompanied by cost-benefit analysis.

General Building Details & Energy Consumption

Table 1: General Building Details & Energy Consumption

Sr. No.	Particulars	Value
1	Contract Demand (kVA)	
1.1	Connection-1	3100 kVA
1.2	Connection-2	1000 kVA
2	Installed Solar Capacity	2.5 MW
3	Electricity Consumption, UTTARAKHAND POWER CORPORATION LIMITED (kWh) –**Apr-2024 to March-2025**	
3.1	Connection-1 (3100 kVA)	10933254 kWh
3.2	Connection-2 (1000 kVA)	1944780 kWh

Sr. No.	Particulars	Value
3.3	Solar 2.5 MWh @ 300 Days and 3.8 kWh/kW/day	2850000 kWh
4	Annual average Cost of Electricity per unit -	
	Connection-1 (3100 kVA)	Rs 5.54/kWh
	Connection-2 (1000 kVA)	Rs 7.27/kWh
	Average Unit Cost of Electricity	Rs 6.30 /kWh
5	Working hours	General Lighting (6 to 7 hrs./day, 245 days a year)
		Air Conditioning (7 hrs./day, 150 days a year)
		Fans (7 hrs./day, 210 days a year)
5	Lighting Load in kW	219 kW
6	Fans Load in kW	62.5 kW
7	Air conditioning Load in kW	550-600 kW

Total Energy Consumed in TOE per annum

Period April 2024 to March 2025

Table 2: Total Energy Consumption (April 2024 – March 2025)

Annual Energy Share			
Particulars	**Value of Energy**	**ToE (Tonne of Oil Equivalent)**	**Percentage**
Electricity from Grid	10933254 kWh + 1944780 kWh	940.25 +167.25	75%
Diesel in Ltr	137414	120.9	8%
Solar	2850000 kWh	245.1	17%
Total		**1473.5**	**100%**

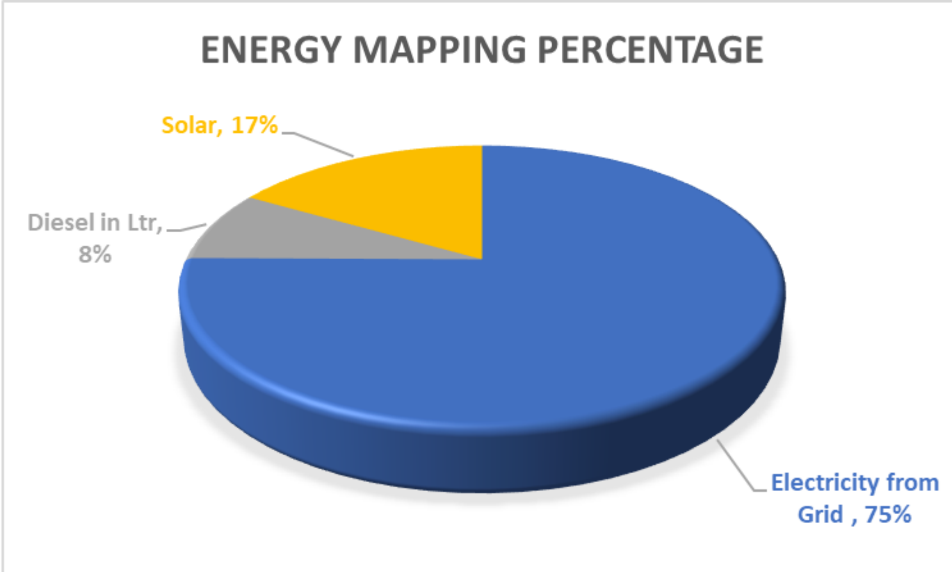


Figure 1: Energy Mapping (%)

Cumulative Energy Saving Opportunities

Table 3: Summary of Energy Saving Opportunities

Particulars	Annual Savings				Estimated Investment
	kWh	TOE	CO2	Saving Rs in Lakh	(Rs in Lakh)
Improve the Power Factor in the system in 3100 kVA				46.50	12.90
Improve the Power Factor in the system in 1000 kVA				2.00	1.00
Replace Existing Ceiling Fans with low wattage Ceiling Fans on Failure Replacement Basis	117600			7.40	61.50
Replace Existing 3 Star ACs with Inverter Technology 5 Star ACs on Failure Replacement Basis	49219			3.10	8.500
Total	**166819**			**59.00**	**83.90**
Observations					
Monitoring of Solar PV System					

Note: The Return on Investment (ROI) for Energy Conservation Measures (ECM) is high, attributed to reduced operating hours and higher initial costs. Therefore, we recommend implementing of ECMs in a phased Manner approach or as failure replacements Policy to get benefits.

Net Saving:

Energy Saving: 166819 kWh per annum

Cost Saving: 59.00 Lakhs per annum

Investment: 83.90 Lakhs

CHAPTER:1 INTRODUCTION

1.1 THE PROJECT

"According to the Energy Conservation Act of 2001, an Energy Audit encompasses the verification, monitoring, and analysis of energy usage. This process includes the submission of a technical report that provides recommendations for enhancing energy efficiency, complete with a cost-benefit analysis and an action plan to reduce energy consumption.

Energy Audits play a pivotal role in adopting a systematic approach to energy management. They aim to assess the energy consumption patterns within an establishment and identify all energy streams. This, in turn, helps in identifying practical areas for energy savings.

With these objectives in mind, M/s Ecoscience Consultancy was entrusted with the task of conducting an energy audit for Swami Rama Himalayan University, to enhance their energy efficiency.

1.2 GENERAL DETAILS

Table 4: General Detail of Swami Rama Himalayan University

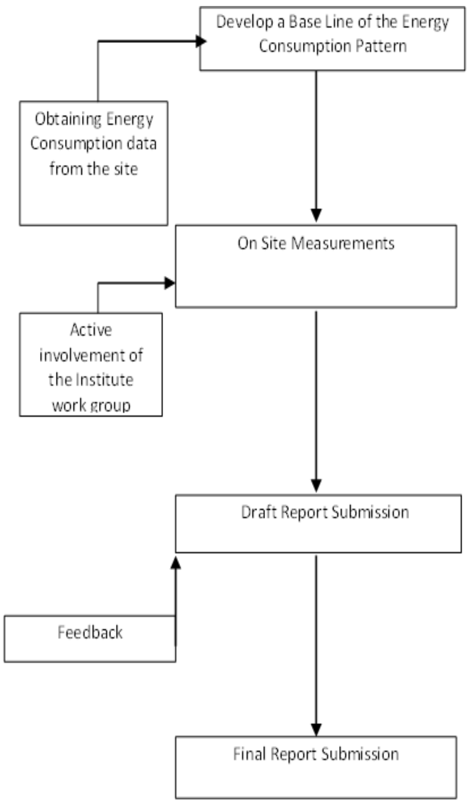
<table>
<tr><th>Particulars</th><th></th><th>Details</th></tr>
<tr><td>Name & Address of Institute</td><td>:</td><td>Swami Rama Himalayan University</td></tr>
<tr><td>Contact Person</td><td>:</td><td></td></tr>
<tr><td>Contact Number</td><td>:</td><td></td></tr>
<tr><td>Contact Email</td><td>:</td><td></td></tr>
<tr><td>Annual Purchased Power Consumption of Swami Rama Himalayan University (Period: April 2024 - Mar 2025)</td><td>:</td><td>10933254 kWh + 1944780 kWh
(2850000 kWp Solar unit Generation)</td></tr>
<tr><td>Basic Purchased Power Rate</td><td>:</td><td><table><tr><th>Units Consumption</th><th>Unit rate in Rs/kWh</th></tr><tr><td>1. 10933254 -3100 kVA
2. 1944780- 1000 kVA
3. 2850000-2500 kWp
4. 440962- DG Set</td><td>Rs 6.3/kWh Including Electricity and DG Set</td></tr></table></td></tr>
<tr><td>Energy Performance Index</td><td>:</td><td>Climate Zone -Composite
Operating 245 Days/ 10 hours
Annual Unit Consumption /Area
1,61,68,996 kWh and 2,44,820 Sq. M
EPI is 66 kWh/Sq. M</td></tr>
</table>

1.3 DELIVERABLES IN THE DETAIL PROJECT REPORT

- Methodology adopted for the study
- Present energy scenario of the building
- Detailed analysis of the data obtained through field visits, trial measurements by portable gadgets, discussions with concerned personnel etc.
- Recommendations for energy savings options in all possible areas with cost benefit analysis.
- Technical specifications for any retrofit options

1.4 METHODOLOGY

Methodology adopted for achieving the desired objectives viz: Assessment of the Current operational status and Energy savings include the following:



- Discussions with the concerned officials for identification of major **areas of focus** and other related systems.
- A team of engineers visited the Institute premises and had discussions with the concerned officials/ supervisors to collect data/ information on the operations and energy distribution in the building. The data was analyzed to arrive at a **base line energy consumption pattern**.
- **Measurements and monitoring** with the help of appropriate instruments including continuous and/ or time-lapse recording, as appropriate and visual observations were made to identify the energy usage pattern and losses in the system.
- Computation and **in-depth analysis** of the collected data, including utilization of computerized analysis and other techniques as appropriate were done to draw inferences and to evolve suitable energy conservation plan/s for improvements/ reduction in specific energy consumption.
- Draft Report submission on the findings of the audit.

Final report submission after incorporating the observations/ comments made by the Institute.

CHAPTER:2 ABOUT THE COLLEGE

SRHU, with its 25+ years of legacy, has established itself as one of the leading higher education institutes in the region. The institution is focused on providing affordable, high-quality education and ensuring academic excellence for its students. In addition to its academic offerings, it has established partnerships with over 50 international universities and colleges. These partnerships provide students with the opportunity to participate in exchange programs and gain exposure to global perspectives and experiences. The college also collaborates with leading organizations in various industries to provide students with practical training and an inside look into the real-world operations of these organizations. Overall, SRHU, Uttarakhand is committed to equipping students with the knowledge, skills, and experiences necessary for successful career development and personal growth.

- SRHU, Uniqueness •
- First to introduce Ph.D. program in medical sciences in Uttarakhand •
- First Private University in India to launch EDP-Homestay Program for the village youth.
- First in the state to offer Health / Actuarial Sciences specialization in M.Sc. Statistics.
  - First in the State and Largest in Northern India 1200 bed super-specialty Post Graduate Teaching Hospital.
  - First and only NABH accredited hospital in Uttarakhand.
  - First and only Private Hospital in India to receive Ayushman Gold Certificate for providing quality services to patients under the scheme
  - First and only Cadaver Lab in the state.
- First and only Comprehensive Cardiac Care Centre in the state.
  - First to introduce Bone Marrow Transplant Program in Uttarakhand.
  - Instill a sense of pride and belongingness in students and alumni towards the institution.
  - To create facilities& ambience for advance level of pharmaceutical teaching & practical skills.
- To constantly strive for research, development & innovation in pharmaceutical sciences, thereby providing the faculty & students the right platform to showcase their talents & achieve laurels.
- To collaborate with industry, academia & healthcare organizations that ensures the best placement opportunities, promote entrepreneurial development activities & also provide international exposure.
- To make students socially vibrant &committed pharmaceutical professionals.

Table 5: General Building Details & Energy Consumption

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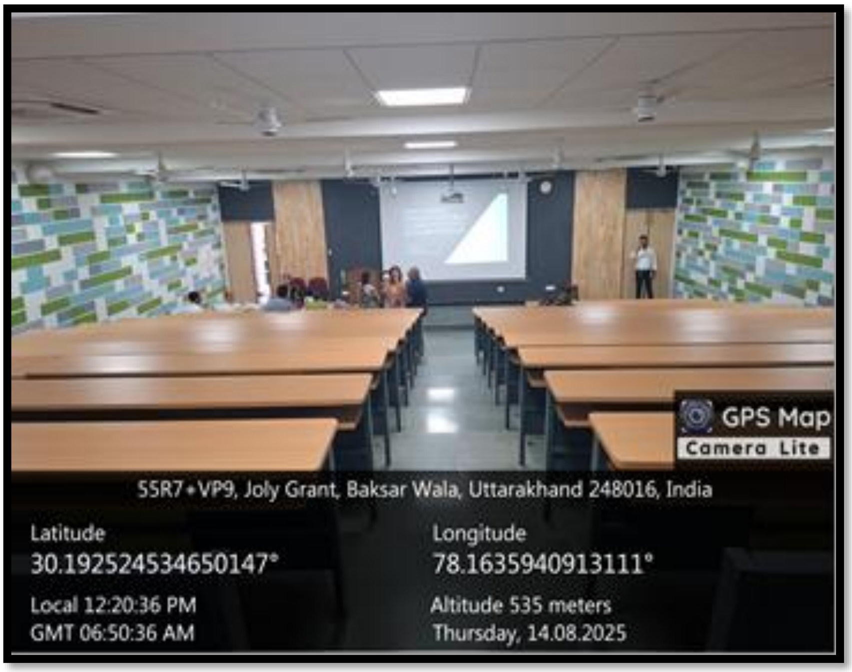
2.1 ENERGY CONSERVATION ACTIVITY TAKEN BY THE COLLEGE

- 2500 kWp Solar PV system installed at rooftop

Picture: 1:Solar Panels Installed at Rooftop

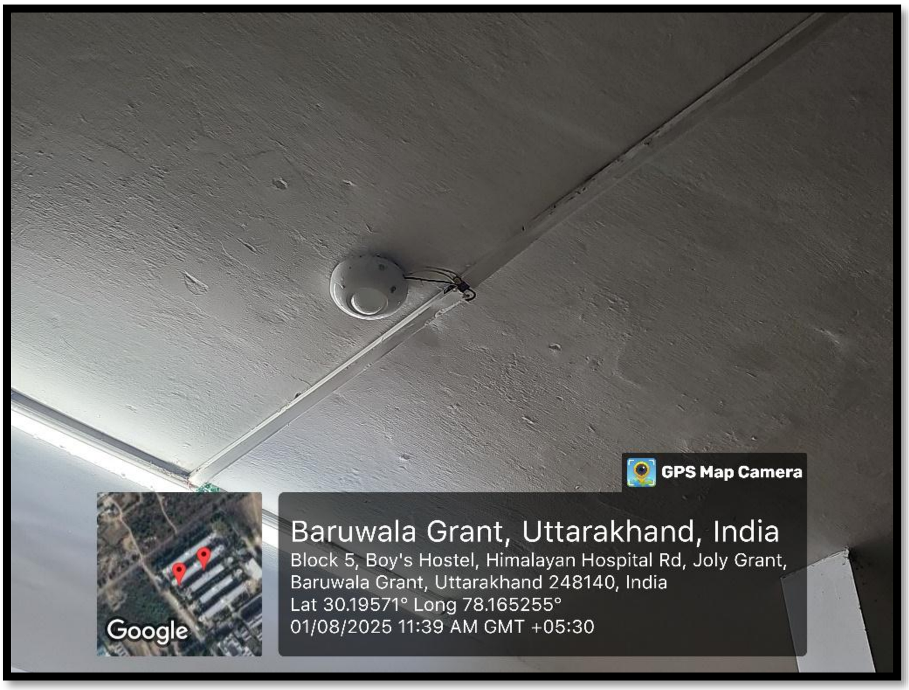
- Solar street lights are installed in Street of University Campus
- LED type Lighting Lamps is installed inside the campus and blocks & BLDC Fans are installed for Energy saving

Picture: 2: LED Lighting Lamp



- Motion sensor are installed in different area for energy saving

Picture: 3:Motion Sensor for Lights



CHAPTER:3 PROJECT DESCRIPTION

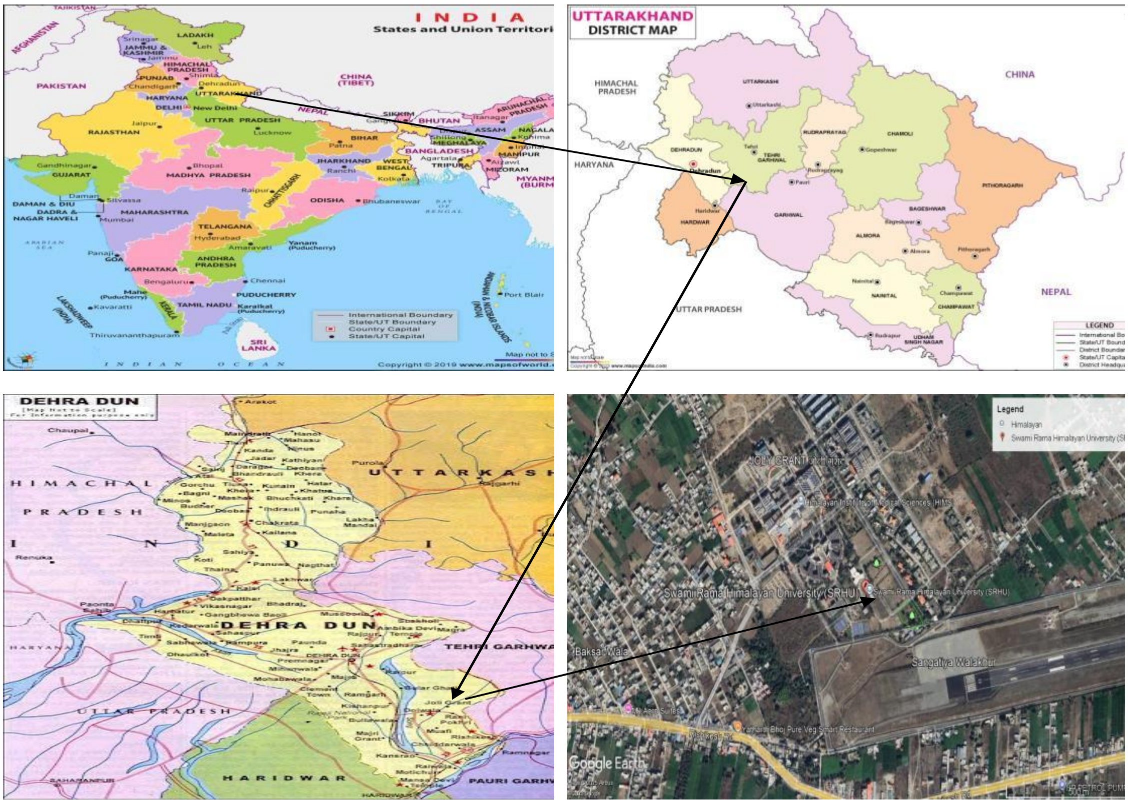
3.1 PROJECT LOCATION

Swami Rama Himalayan University (SRHU), Uttarakhand, is a prominent educational institution situated in the city of Uttarakhand. The campus is strategically located in a region that experiences a typical Hill area climate characterized by hot summers, winters, and moderate monsoon seasons. The facility spans a substantial ground-covered area and is well-equipped with modern infrastructure to support its diverse academic programs and extracurricular activities.

Table 6: Location details of the project

S. No.	Particulars	Details
a)	Location	Swami Rama Nagar, Doiwala
b)	District	Dehradun
c)	State	Uttarakhand
d)	Coordinates	Lat.: 30°11’26.98’’N; Long.: 78°10’03.03’’E
e)	Elevation	554 m amsl

Picture: 4:Location of the project



3.2 METEOROLOGICAL DATA

The climate data for SRHU, Uttarakhand, provides insights into the solar radiation and wind speed experienced throughout the year. This information is crucial for optimizing the energy efficiency and sustainability measures implemented on the campus.

Climate Details

The region experiences:

- Summers: Moderate hot & humidity, with temperatures often exceeding 29.6°C.
- Winters: Mild and pleasant, with temperatures ranging between 7.7°C to 16°C.
- Monsoon: Moderate rainfall, primarily occurring from July to September

	Unit	Climate data location	Facility location	Source
Latitude		30.3	30.2	
Longitude		78.1	78.2	
Climate zone		2A - Hot - Humid		NASA
Elevation	m	1131	537	NASA - Map
Heating design temperature	°C	-3.1		NASA
Cooling design temperature	°C	21.8		NASA
Earth temperature amplitude	°C	19.6		NASA

Month	Air temperature	Relative humidity	Precipitation	Daily solar radiation - horizontal	Atmospheric pressure	Wind speed	Earth temperature	Heating degree-days 18 °C	Cooling degree-days 10 °C
	°C	%	mm	kWh/m²/d	kPa	m/s	°C	°C-d	°C-d
January	10.2	42.8%	25.11	3.75	89.2	2.1	7.7	242	6
February	12.4	42.5%	36.40	4.50	89.0	2.5	10.8	157	67
March	17.5	34.9%	23.56	5.64	88.9	2.8	16.6	16	233
April	23.1	26.8%	20.40	6.76	88.7	3.1	23.1	0	393
May	27.5	24.8%	36.58	7.42	88.4	3.3	28.3	0	543
June	28.5	40.5%	138.30	6.73	88.1	2.9	29.6	0	555
July	25.8	71.5%	317.44	5.36	88.1	2.3	26.4	0	490
August	24.1	81.5%	332.32	4.83	88.2	2.0	24.2	0	437
September	22.4	75.9%	170.40	5.25	88.6	1.9	21.9	0	372
October	18.8	56.5%	21.70	5.42	89.0	2.1	17.1	0	273
November	15.0	44.4%	4.50	4.49	89.2	2.0	12.2	90	150
December	11.7	41.2%	9.92	3.69	89.2	2.0	8.6	195	53
Annual	**19.8**	**48.7%**	**1,136.63**	**5.32**	**88.7**	**2.4**	**18.9**	**699**	**3,571**
Source	NASA	NASA	NASA	NASA	NASA	NASA	NASA	NASA	NASA
Measured at					m	10	0		

Figure 2: Monthly representation of the climatic conditions

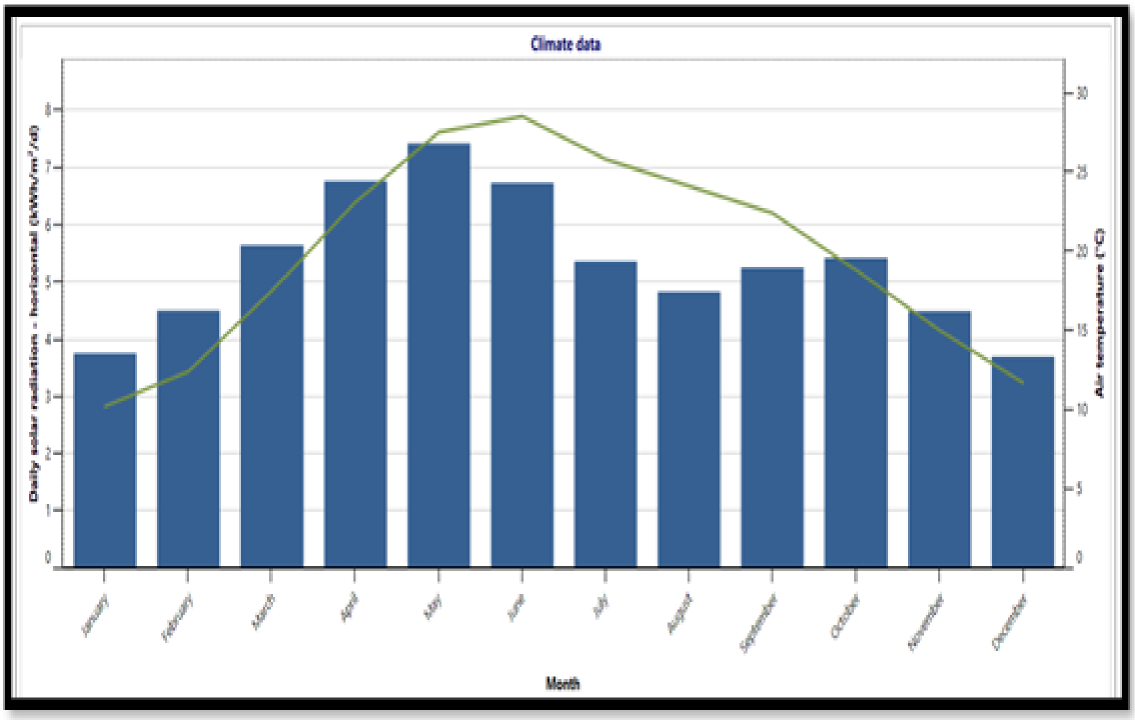


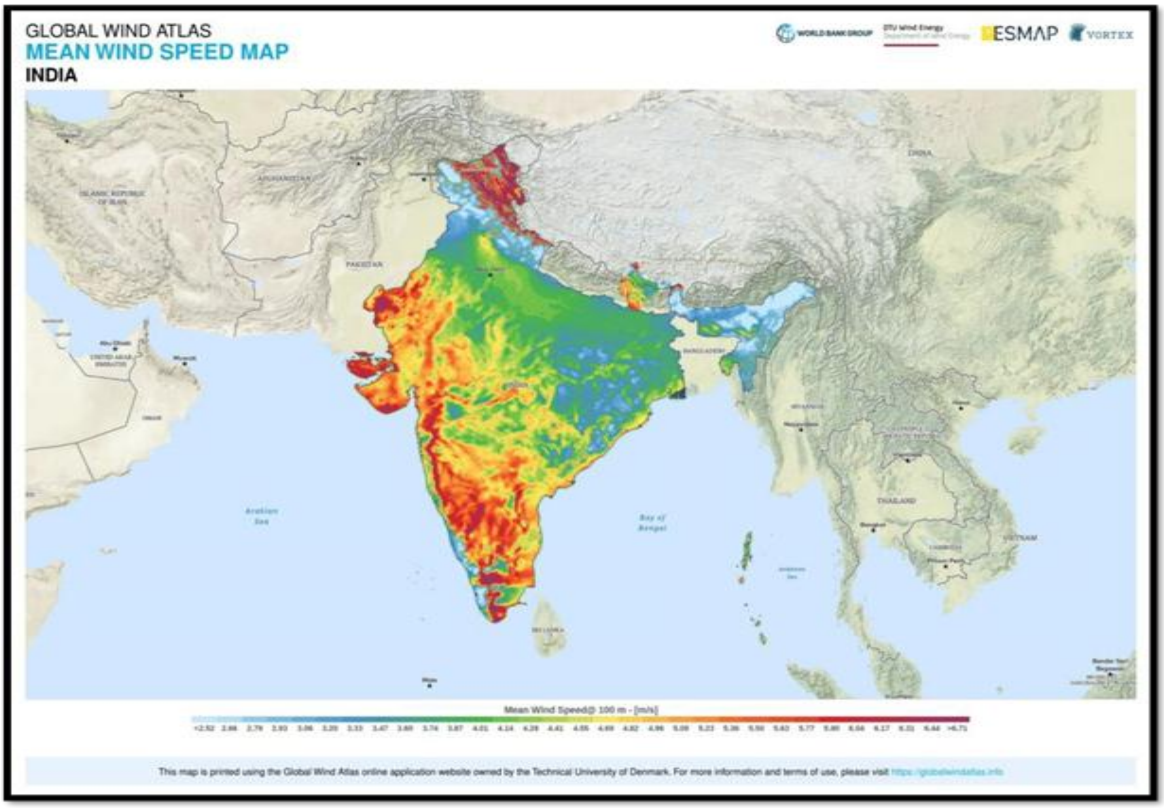
Figure 3: Graphical Representation of Solar Radiation & Wind Speed Month Wise

Wind Energy

Operating a wind power plant involves more than just installing turbines; it requires careful planning and analysis of wind patterns. Ideal locations for wind turbines typically have an annual average wind speed of at least 9 mph (4 m/s) for small turbines and 13 mph (5.8 m/s) for utility-scale turbines. Unfortunately, the wind speed in the region is below 2 m/s, making it unsuitable for wind energy generation. The following Fig 2.4 shows the wind speed data in various states of India.

In Uttarakhand, the wind energy potential is low due to these inadequate wind speeds, which is why detailed studies on wind energy have not been included in the audit report. However, solar energy remains a promising and effective renewable energy option for the campus, offering a viable alternative in the region.

Picture 1: wind speed data in various states of India



CHAPTER:4 METHODOLOGY

This section outlines the methodology used to conduct the energy audit at Swami Rama Himalayan University (SRHU), Uttarakhand. The methodology includes systematic data collection, analysis, and identification of energy efficiency measures aimed at reducing energy consumption and enhancing sustainability on the campus.

4.1 DATA COLLECTION

A team of engineers/Experts visited the SRHU campus to conduct thorough on-site inspections. These inspections focused on evaluating the current state of energy consumption and environmental practices across various facilities, including classrooms, laboratories, administrative buildings, hostels, and common areas. The inspections involved visual observations, measurements, and discussions with the concerned officials and supervisors to gather detailed information on operations and load distribution.

Energy Consumption Data:

Data on historical and current energy consumption was collected through:

- Electricity Bills: Analysis of electricity bills from the Uttarakhand Electricity Board to establish a baseline of energy usage.
- Generator Usage: Monitoring the performance and fuel consumption of diesel generators (DG sets) on campus.
- Renewable Energy Contributions: Evaluating the contribution of solar energy installations in meeting the campus's energy demands.

4.2 ANALYSIS

4.2.1 ENERGY EFFICIENCY ASSESSMENT

The efficiency of existing energy systems was evaluated, including:

- Lighting Systems: Assessment of lighting fixtures and identification of energy-saving opportunities through retrofitting with LED lights.
- AC Systems: Evaluation of heating, ventilation, and air conditioning systems for potential improvements.

- Electrical Equipment: Analysis of the performance of electrical equipment and identification of inefficiencies.

4.3 ENVIRONMENTAL IMPACT ASSESSMENT

The environmental impact of current practices was analyzed, focusing on:

- Carbon Footprint: Estimation of the carbon footprint of the campus.
- Resource Utilization: Evaluation of resource utilization and potential areas for improvement in sustainability practices.

4.4 BENCHMARKING

SRHU's energy and environmental performance were compared against industry standards and best practices. This involved:

- Performance Metrics: Establishing performance metrics and identifying gaps.
- Opportunities for Improvement: Highlighting areas with significant potential for energy savings and environmental impact reduction.

4.5 IDENTIFICATION OF ENERGY EFFICIENCY MEASURES (EEMS)

Potential energy efficiency measures were identified based on the data collected and analyzed. These measures focus on improving the efficiency of lighting systems, HVAC systems, and other electrical equipment, as well as enhancing waste management and water conservation practices.

4.6 IMPLEMENTATION PLAN

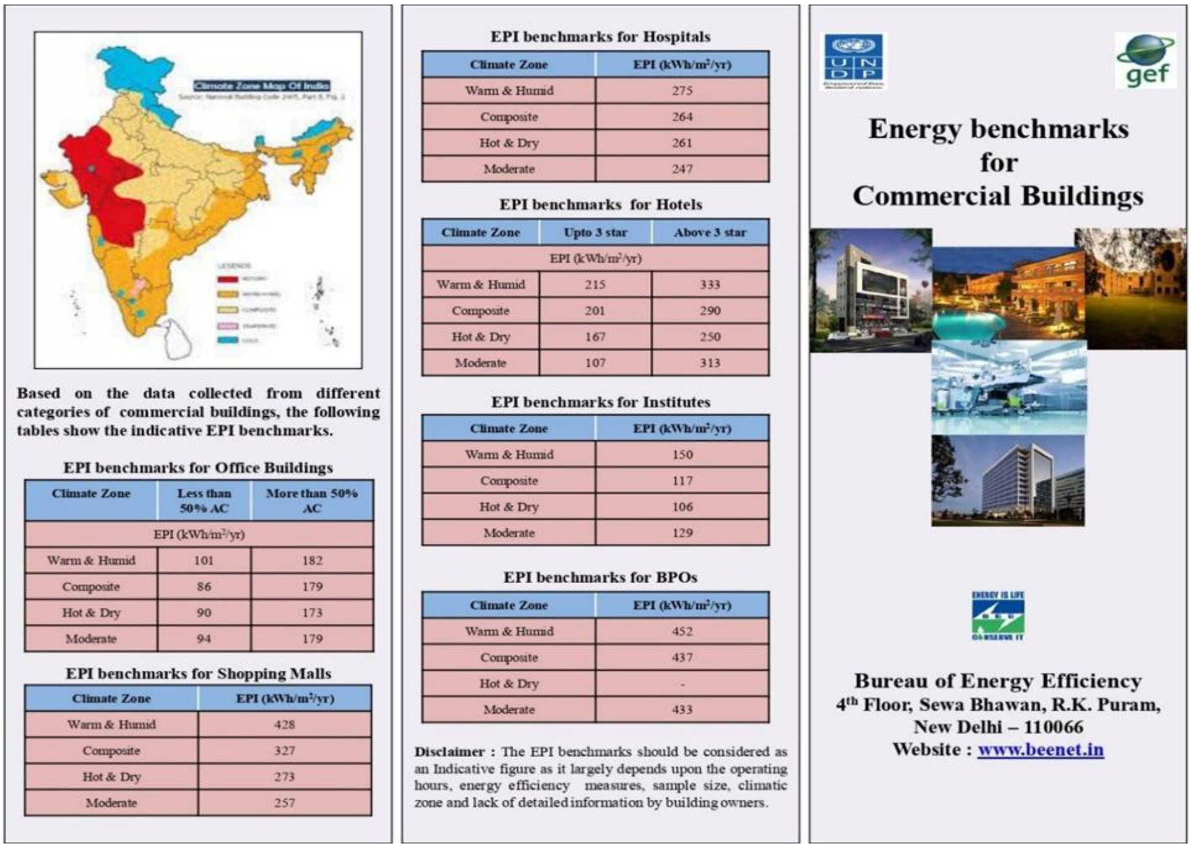
An actionable implementation plan was developed, detailing the steps required to implement the recommended energy efficiency measures. The plan includes timelines, responsible parties, and estimated costs for each measure.

CHAPTER:5 BUILDING ENERGY PERFORMANCE

5.1 ENERGY PERFORMANCE INDEX (EPI)

The Energy Performance Index (EPI) is a key metric used to evaluate the energy efficiency of a campus. It represents the total energy consumed over a year divided by the total built-up area, measured in kWh/sqm/year. This index provides a straightforward and relevant indicator of whether a campus is energy efficient. For educational institutes like SRHU, benchmarking the EPI helps in comparing the energy performance against established standards and identifying areas for improvement.

The benchmarking for EPI is presented in figure which illustrates the energy benchmarks for commercial buildings. This comparison allows SRHU to assess its energy efficiency relative to similar institutions and set targets for energy conservation.



Based on the data collected from different categories of commercial buildings, the following tables show the indicative EPI benchmarks.

EPI benchmarks for Office Buildings

Climate Zone	Less than 50% AC	More than 50% AC
	EPI (kWh/m²/yr)	
Warm & Humid	101	182
Composite	86	179
Hot & Dry	90	173
Moderate	94	179

EPI benchmarks for Shopping Malls

Climate Zone	EPI (kWh/m²/yr)
Warm & Humid	428
Composite	327
Hot & Dry	273
Moderate	257

EPI benchmarks for Hospitals

Climate Zone	EPI (kWh/m²/yr)
Warm & Humid	275
Composite	264
Hot & Dry	261
Moderate	247

EPI benchmarks for Hotels

Climate Zone	Upto 3 star	Above 3 star
	EPI (kWh/m²/yr)	
Warm & Humid	215	333
Composite	201	290
Hot & Dry	167	250
Moderate	107	313

EPI benchmarks for Institutes

Climate Zone	EPI (kWh/m²/yr)
Warm & Humid	150
Composite	117
Hot & Dry	106
Moderate	129

EPI benchmarks for BPOs

Climate Zone	EPI (kWh/m²/yr)
Warm & Humid	452
Composite	437
Hot & Dry	-
Moderate	433

Disclaimer : The EPI benchmarks should be considered as an Indicative figure as it largely depends upon the operating hours, energy efficiency measures, sample size, climatic zone and lack of detailed information by building owners.

Figure 4: Energy benchmarks for commercial buildings

5.2 CALCULATIONS OF EPI

To understand the energy performance of SRHU, we calculate the Energy Performance Index (EPI) based on the annual energy consumption and the total built-up area of the campus.

According to figure, the required EPI for an educational institution is 150 kWh/sq m/year. The calculations for SRHU's EPI for the year 2024-25 are as follows:

Table 7: Energy Performance Index

Energy performance Index	Values
Annual energy consumption during year 2024-25	= 1,61,68,996 kWh
Total build up area of the campus	= 2,44,820 sqm
EPI	=1,61,68,996 kWh /2,44,820 sqm
EPI	= 66 kWh/sqm/year

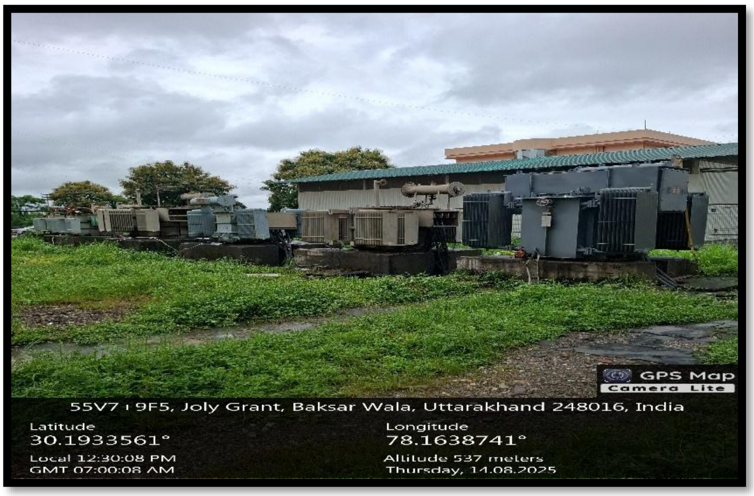
The calculated EPI for SRHU is 66 kWh/sq m/year, which is within the desired limit of 150 kWh/sq m/year. This indicates that the institution is operating within an acceptable range of energy efficiency for its climate zone, which is classified as composite. Maintaining or further improving this EPI will help SRHU in achieving its sustainability goals.

CHAPTER:6 POWER SUPPLY SYSTEM AND ENERGY CONSUMPTION PATTERN

6.1 POWER SUPPLY SYSTEM

The campus currently sources power from **UPCL** at 11 kV with two connections of 3100 kVA and 1000 kVA, which was stepped down to 433 V through **18 transformers** of various capacities (4 MVA, 2000 kVA, 1250 kVA, 750 kVA, 500 kVA, 315 kVA, 250 kVA, and 200 kVA). Metering is carried out at the 11-kV level.

Picture 2: Transformer Area



In addition to grid supply, backup power is provided by **nine 500 kVA DG sets with AMF panels**.

Picture 3: Diesel Generator

A **2.5 MW rooftop solar power plant** is also installed, though it operates without battery storage; hence, **grid connection is required at night** and during low solar generation. On average, a **1 kW SPV system generates about 4–5 kWh/day**. The available rooftop area across hostels, the auditorium, and other buildings offers further scope for solar expansion.

Because SPV output varies with time of day, **any shortfall is automatically met by the grid**, ensuring uninterrupted power supply

Table 8: Transformers Details

S. No	Location	Equipment	Qty
1	33 kV Sub-station	4 MVA Transformer	2
		33 kV Breaker	1
2	DG House (Hospital)	500 kVA DG sets with AMF panels	9
3	Hospital Sub-station	750 kVA Transformer	3
		1250 kVA Transformer	2
		2000 kVA Transformer	1
		11 kV Breaker	1
		LT Electrical Panel Room	1
4	Residence Sub-station	11 kV Breaker	2
		500 kVA Transformer	1
		250 kVA Transformer	2
		200 kVA Transformer	1
		750 kVA Transformer	1
5	Medical College S/S	500 kVA Transformer	1
		LT Panels	2
		315 kVA Transformer	1
		11 kV Oil Circuit Breaker	1
6	Tube well	250 kVA Transformer	1
7	MBBS Hostel	750 kVA Transformer	1
		315 kVA Transformer	1
8	Hospital & CRI	Lifts	18

The University Facility have Nine DG set of rating given below in table:

Table 9: DG Specifications

Particulars	DG No -1 To 9
Rating in kVA	500
Nos	9
Current in Amp	NA
Voltage in Volt	415
Frequency	50 Hz

6.2 PERFORMANCE ASSESSMENT

The performance assessment of transformer was conducted during the study. Power Factor (PF) of the facility is analyzed from last one-year electricity bills and also by electrical measurement on transformers. The demand and power factor of the facility studied at transformer are presented below.

Table 10: Electrical Connection and Energy Consumption Details of Bill analysis of 3100 kVA

Month-year	Contractual load in kVA	Billable Demand in kVA	MDI in kVA	Energy Consumption in kVAh	Energy Consumption in kWH	Power factor	Demand Charges in Rs	Energy charges in Rs	Total pay amount in Rs	Unit rate in Rs
Apr-24	3100	2325	2532.0	927480	871380	0.940	310000	5101140	3636457	3.9
May-24	3100	2325	3234.0	1304280	1227720	0.941	310000	7173540	7730707	5.9
Jun-24	3100	2325	3492.0	1380420	1262220	0.914	310000	7592310	8718552	6.3
Jul-24	3100	2325	3306.0	1445520	1341960	0.928	310000	7950360	7960560	5.5
Aug-24	3100	2325	3150.0	1348680	1224900	0.908	310000	7417740	7076832	5.2
Sep-24	3100	2325	3018.0	987032	907614	0.920	310000	6920760	7243269	7.3
Oct-24	3100	2325	2814.0	979260	849120	0.867	310000	5385930	4970540	5.1
Nov-24	3100	2325	1918.0	731760	663540	0.907	310000	4024680	3664780	5.0
Dec-24	3100	2325	1990.0	756600	734400	0.971	310000	4160970	3842024	5.1
Jan-25	3100	2325	1807.0	770160	759660	0.986	310000	4235550	4733260	6.1
Feb-25	3100	2325	1594.0	552240	540660	0.979	310000	3031050	3538638	6.4
Mar-25	3100	2325	1648.0	597300	550080	0.933	310000	3266340	2662329	4.5
12 Months Total				**11780732**	**10933254**		**3720000**	**66260370**	**65777948**	
12 Months Average			**2543**			**0.932**				**5.68**

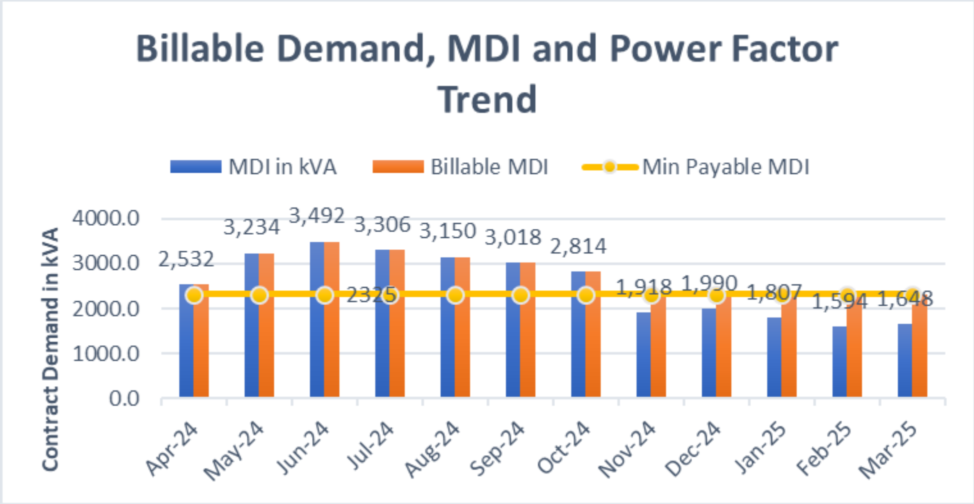


Figure 5: Contract Demand Details of 3100 kVA

The graph shows the trend of Maximum Demand Indicator (MDI), Billable MDI, and Minimum Payable MDI from April 2024 to March 2025. MDI peaked in June 2024 at 3,492 kVA and showed a gradual decline thereafter, reaching around 1,660 kVA by March 2025. The Billable MDI closely follows actual MDI, while the Minimum Payable MDI remains constant at approximately 2,250 kVA. This indicates that in the latter months, when actual demand dropped below the contractual minimum, charges were based on the fixed minimum demand rather than actual usage.

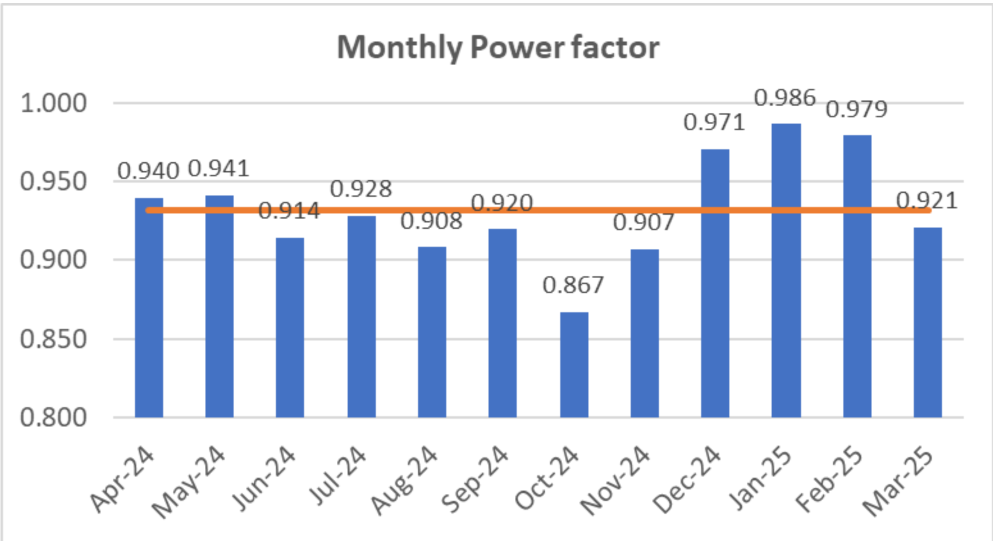


Figure 6: Monthly power factor Details

The graph illustrates the monthly power factor trend from April 2024 to March 2025. The power factor mostly hovers around the target line of approximately 0.92, with the lowest point at 0.867 in October 2024 and the highest at 0.986 in January 2025. While performance improved significantly during December 2024 to February 2025, several months—especially June to November—showed values below the desired level, indicating scope for power factor correction to maintain consistent efficiency.

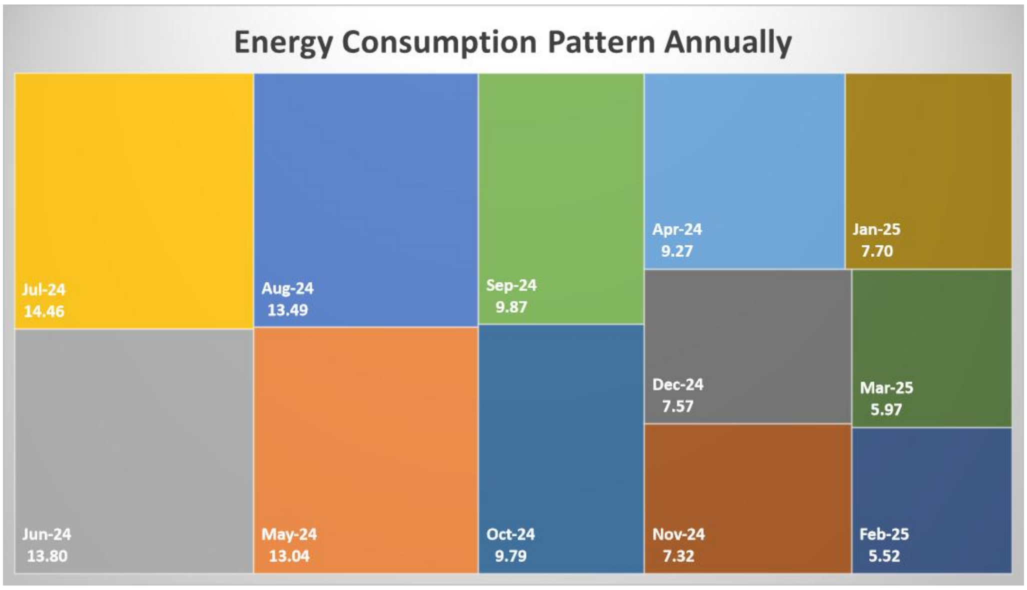


Figure 7: Energy Consumption Pattern Annually

The energy consumption pattern chart shows monthly variations from April 2024 to March 2025. Consumption peaked in July 2024 at 14.46 units (highest block), followed by consistently high usage in May, June, and August (around 13–14 units). After September, consumption steadily declined, dropping to the lowest level of 5.52 units in February 2025. This trend indicates a strong seasonal variation in energy demand, with higher loads during mid-summer months and significantly reduced consumption during winter and early spring.

Table 11: Electrical Connection and Energy Consumption Details of Bill Analysis of 1000 kVA

Month-year	Contractual load in kVA	Billable Demand in kVA	MDI in kVA	Energy Consumption in kVAh	Energy Consumption in kWH	Power factor	Demand Charges	Energy charges	Total pay amount	Unit rate
Apr-24	1000	750	329.0	98172	97536	0.994	120000	489216	624162	6.4
May-24	1000	750	820.0	199500	196296	0.984	120000	1323168	1479534	7.4
Jun-24	1000	750	714.0	246468	240192	0.975	120000	17,19,312	1946469	7.9
Jul-24	1000	750	590.0	208140	204756	0.984	120000	1433712	1599375	7.7
Aug-24	1000	750	536.0	173340	170724	0.985	120000	1154076	1283624	7.4
Sep-24	1000	750	461.5	153780	151404	0.985	120000	1026060	1186137	7.7
Oct-24	1000	750	450.7	106752	105504	0.988	120000	641508	745767	7.0
Nov-24	1000	750	511.9	108864	107220	0.985	120000	671328	768679	7.1
Dec-24	1000	750	753.1	228492	226056	0.989	120000	1571388	1670500	7.3
Jan-25	1000	750	794.0	227916	225756	0.991	120000	1569960	1738520	7.6
Feb-25	1000	750	606.0	123012	121764	0.990	120000	803460	940672	7.6
Mar-25	1000	750	636.0	98772	97572	0.986	120000	473844	518689	5.3
12 Months Total				**1973208**	**1944780**		**1440000**	**12877032**	**14502128**	
12 Months Average			**625**			**0.986**				**7.27**

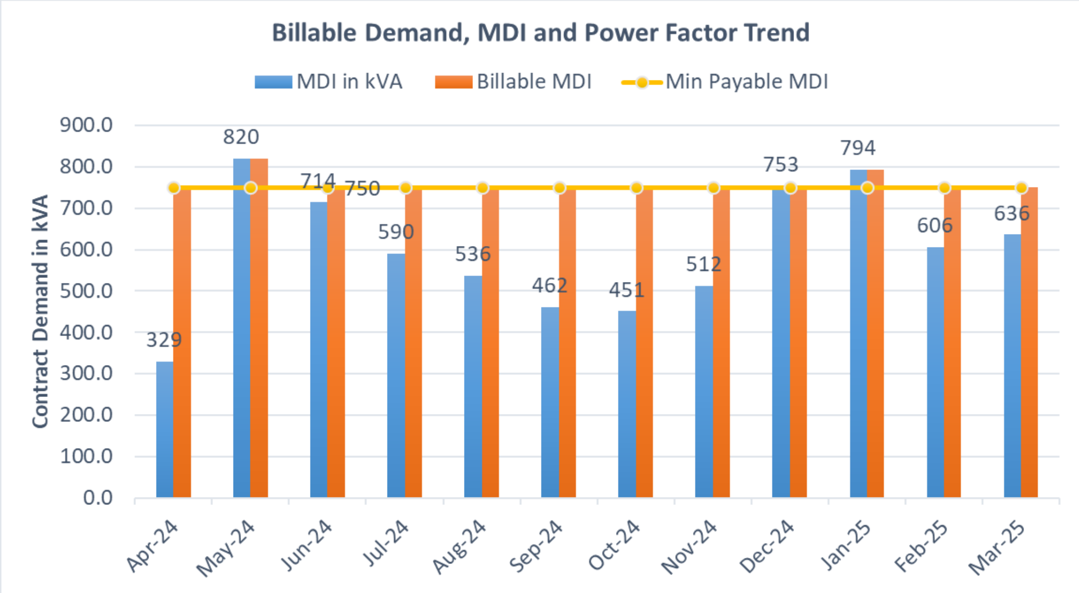


Figure 8: Contract Demand Details of 1000 kVA

This chart illustrates the trend of Maximum Demand Indicator (MDI), Billable MDI, and Minimum Payable MDI from April 2024 to March 2025. MDI peaked in May 2024 at 820 kVA and reached another high of 794 kVA in January 2025, while it dipped to its lowest level of 329 kVA in April 2024. The billable MDI closely follows actual MDI, but whenever actual demand drops below the minimum payable demand (750 kVA), charges are based on this fixed minimum level. This shows that for most months after June 2024, the plant was billed at 750 kVA despite lower actual demand.

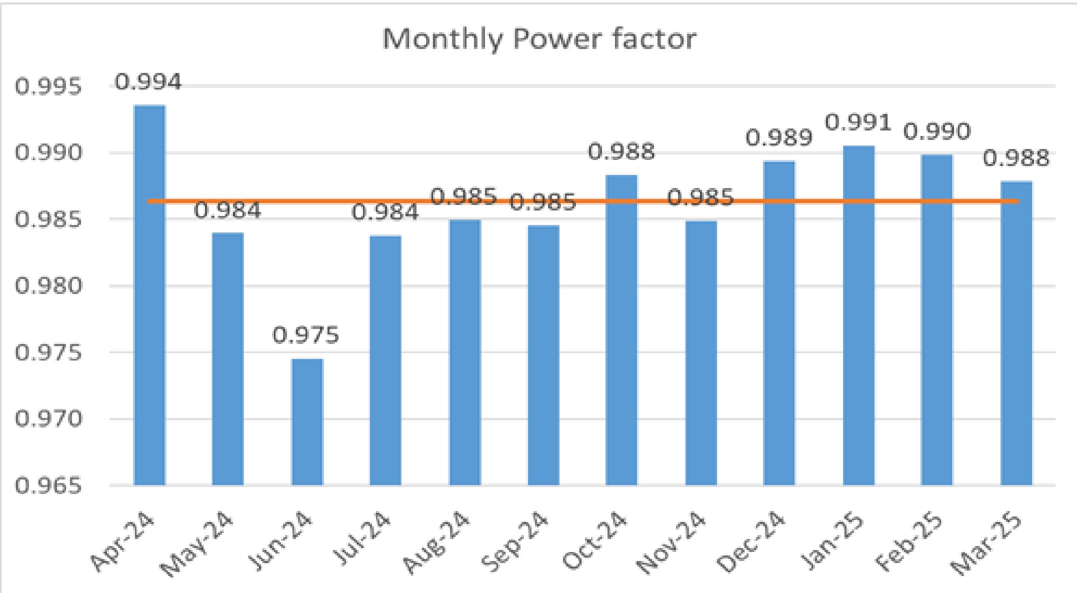


Figure 9: Annual Power Factor Details of 1000 kVA

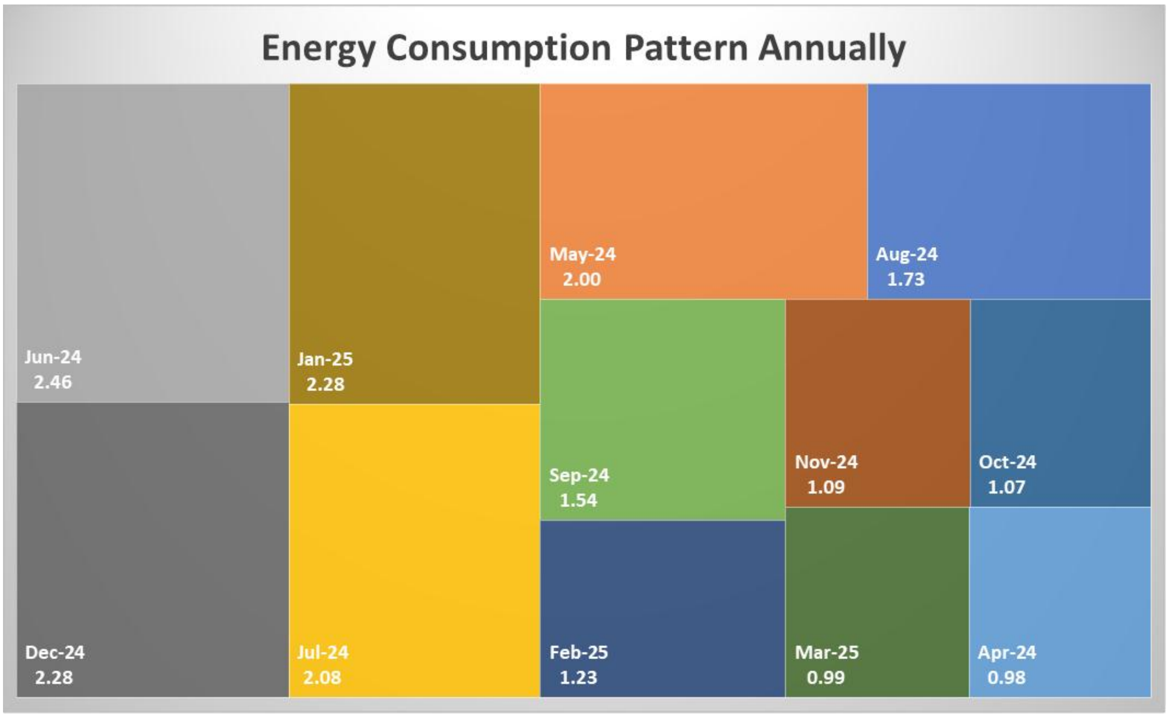


Figure 10: Energy Consumption pattern yearly of 1000 kVA

From Electricity Bills analysis, showing on facility power consumption

Table 12: General Details & Energy Consumption

S.No.	Particulars	Details
1.	**Project Details**	
	Audit Duration	April 2024 -March 2025
a.	**Name of the Institution**	**Swami Rama Himalayan University**
b.	**Building Covered Area**	**2,44,820 sqm**
c.	**Connected load/ contract demand of the college**	**1000 kW / 3100 KVA**
d.	**Alternate source of energy (Solar/ Wind) in institute (Type and capacity)**	**2.5 MW Solar**
	Annual Units in kWh	**26718288 kWh**
	Electricity Amount Paid in Lakhs	**80280076 INR/Annum**
	Power Rate Rs/kWh only for Grid Power	**Rs 6.30 /kVAh**
2.	**Components contributing power Load in the Campus**	
a.	**Type/ No. of Florescent Lights**	**525**
b.	**Type/ No. of LED Lights**	**8949**
c.	**Type/ No. of Air Conditioner**	**900 No's, 3 star**
d.	**Type/ No Fans**	**2500 normal &2200 BLDC fans installed.**

S.No.	Particulars	Details
e.	**Type/ No DG**	**9 (500 KVA)**
f.	**Type/ No -Other equipment and electrical appliances**	**Exhaust Fan- 850 No's (40w Each)**

Total Annual Electricity Consumption of Facility

Table 13: Energy consumption share from Grid, Diesel and PV Panels

Particulars	Percentage
Electricity from Grid	75%
Diesel in Ltr	8%
Solar	17%
Total	**100%**

Table 14: Energy in TOE Distribution

Annual Energy Share			
Particulars	**Value of Energy**	**ToE (Tonne of Oil Equivalent)**	**Percentage**
Electricity from Grid	10933254 kWh + 1944780 kWh	940.25 +167.25	75%
Diesel in Ltr	137414	120.9	8%
Solar	2850000 kWh	245.1	17%
Total		**1473.5**	**100%**

The below graph showing the power consumption of Swami Rama Himalayan University Facility

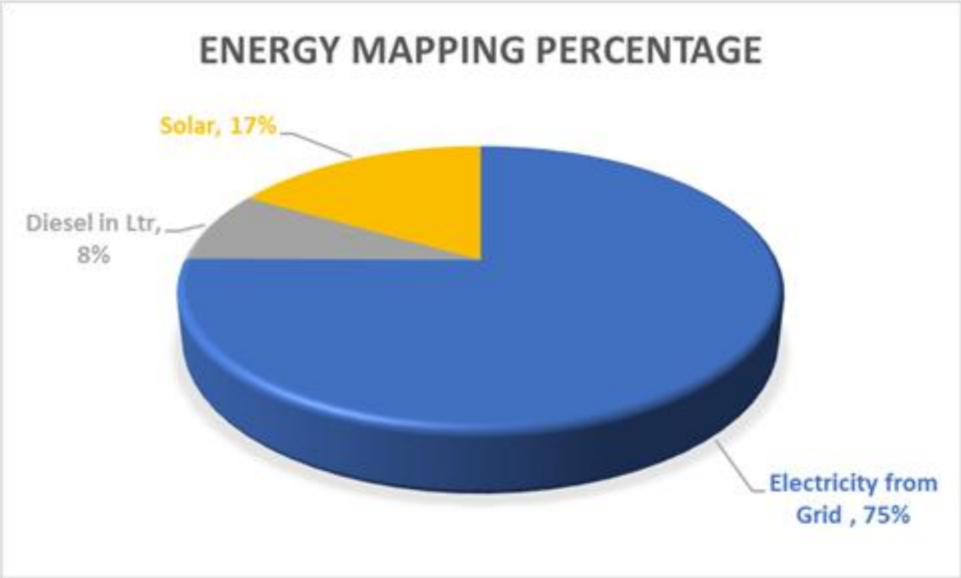


Figure 11: Energy Mapping (%)

CHAPTER:7 ELECTRICAL SYSTEM AND POWER FACTOR

7.1 TRANSFORMER SECTION

The campus currently sources power from **UPCL** at 11 kV with two connections of 3100 kVA and 1000 kVA, which was stepped down to 433 V through **18 transformers** of various capacities (4 MVA, 2000 kVA, 1250 kVA, 750 kVA, 500 kVA, 315 kVA, 250 kVA, and 200 kVA). Metering is carried out at the 11-kV level.

Table 15: Transformer Details

S. No	Location	Equipment	Qty
1	33 kV Sub-station	4 MVA Transformer	2
		33 kV Breaker	1
2	DG House (Hospital)	500 kVA DG sets with AMF panels	9
3	Hospital Sub-station	750 kVA Transformer	3
		1250 kVA Transformer	2
		2000 kVA Transformer	1
		11 kV Breaker	1
		LT Electrical Panel Room	1
4	Residence Sub-station	11 kV Breaker	2
		500 kVA Transformer	1
		250 kVA Transformer	2
		200 kVA Transformer	1
		750 kVA Transformer	1
5	Medical College S/S	500 kVA Transformer	1
		LT Panels	2
		315 kVA Transformer	1
		11 kV Oil Circuit Breaker	1
6	Tube well	250 kVA Transformer	1
7	MBBS Hostel	750 kVA Transformer	1
		315 kVA Transformer	1

7.2 POWER FACTOR AT MAIN INCOMING OF 3100 KVA AND 1000 KVA

Apart from safety and reliability, several other goals, including efficiency, should be pursued in the design and implementation of electrical systems. One of the measures of efficiency in an electrical system is the efficiency with which the system transforms the energy it receives into useful work. This efficiency is indicated by a component of electrical systems known as the Power Factor. The power factor indicates how much power is actually being used to perform useful work by a load and how much power it is "wasting". As trivial as its name sounds, it is one of the major factors behind high electricity bills, power failures, and sometimes the imbalance in electrical networks.

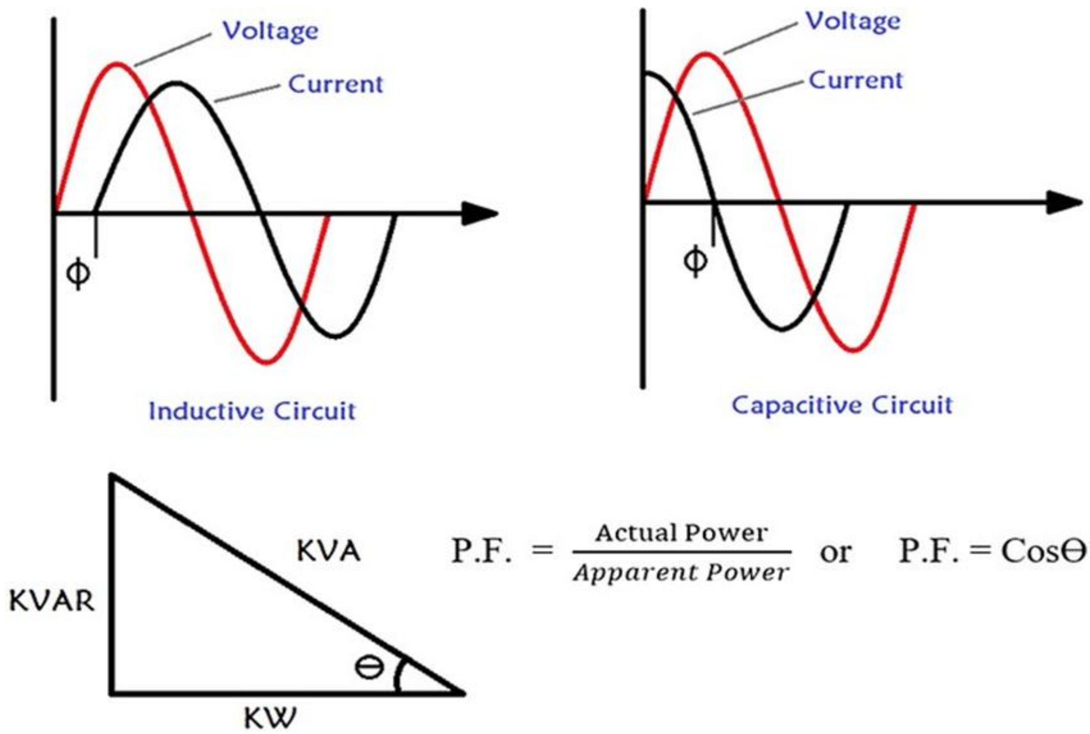


Figure 12: Power Factor Waveform

To properly describe power factor and its practical significance, it is important to understand the different types of electrical loads and components of power that exist.

From basic electricity classes, electrical loads are essentially of two types:

1. Resistive Loads
2. Reactive Loads

7.2.1 RESISTIVE LOADS

Resistive loads, as the name implies, are made up of purely resistive elements. For these loads (considering ideal conditions), all the power supplied to them is dissipated for useful work because the current is usually in phase with the voltage. Examples of resistive loads include incandescent light bulbs and batteries.

7.2.2 REACTIVE LOADS

Reactive loads, on the other hand, are more complex. While they cause a drop in voltage and draw current from the source like resistive loads, they dissipate no useful power (no work is done). Reactive loads can either be capacitive or inductive. In inductive loads, the power drawn is used to set up magnetic flux without any direct work performed, while in capacitive loads, the power is used in charging the capacitor and not directly producing work. The power dissipated in reactive loads is referred to as reactive power. Reactive loads are characterized by the current leading (capacitive loads) or lagging (inductive loads) behind the voltage, resulting in a phase difference between the current and the voltage.

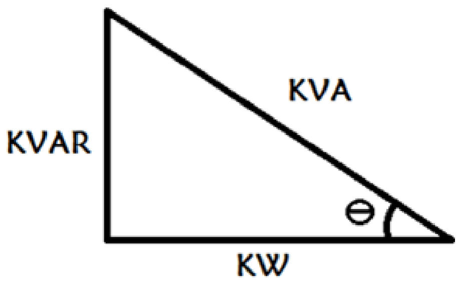
Relationship between Voltage and Current for an Inductive Load

The variations in these two types of loads lead to three power components in electrical systems:

1. Actual Power
2. Reactive Power
3. Apparent Power

i. Actual Power This is the power associated with resistive loads. It is the power component dissipated for performing actual work in electrical systems, such as heating and lighting. It is expressed in Watts (W) and symbolically represented by the letter P.

ii. Reactive Power This is the power associated with reactive loads. Due to the delay between voltage and current in reactive loads (either capacitive or inductive), the energy dissipated produces no work. It is referred to as reactive power and its unit is Volt-Ampere Reactive (VAR).



iii. Apparent Power Typical electrical systems comprise both resistive and inductive loads. Thus, the total power in an electrical system is a combination of the actual and reactive power components, known as Apparent Power. Its unit is volt-amps (VA) and it is represented mathematically by the equation:

Apparent Power= Square Root of {(Actual Power) ^2 + (Reactive Power) ^2}

This combination leading to the apparent power is what brings about the power factor. In ideal situations, the actual power dissipated in an electrical system is usually greater than the reactive power.

By obtaining the cosine of the angle theta, we can determine the efficiency of the system in using the power it receives for work. This efficiency, evaluated as the ratio of the actual power to the apparent power, is referred to as the power factor, with values between 0 and 1. From the power triangle, according to the cosine rule (Adjacent over Hypotenuse), the power factor can be estimated as the ratio of actual power to the apparent power:

P.F. = Actual Power / Apparent Power or P.F. =CosΘ

An increase in reactive power (presence of a high number of reactive loads) leads to an increase in apparent power and a larger value for angle theta, resulting in a low power factor. Conversely, a reduction in reactive loads leads to an increased power factor, indicating high efficiency in systems with fewer reactive loads.

7.3 APFC FOR THE COLLEGE

During the Audit process the power factor of the college comes out to be 0.98 which is quite which is quite good as there are 6 APFC installed of following capacity

Table 16: Details of Capacitors

S.No.	Capacity of APFC (in KVAR)	QTY.	Total
1.	450	1	450
2.	350	1	350
3.	200	1	200
4.	250	3	750
	Total		**1750**

7.4 POWER FACTOR ACCORDING TO UTTARAKHAND STATE ELECTRICITY REGULATORY COMMISSION (UPCL)

- The power factor of electricity consumers is monitored to ensure efficient energy usage. A power factor below the optimal level can lead to increased losses in the electrical system. To address this, the Uttarakhand Power Corporation Limited (UPCL) implements surcharges for low power factors and offers incentives for maintaining higher power factors.

- Surcharges for Low Power Factor:
- Consumers without Electronic Tri Vector Meters: If such consumers have not installed shunt capacitors of appropriate ratings and specifications, a surcharge is levied on the current energy charges.
- Consumers with Electronic Tri Vector Meters:
- A surcharge of 5% on current energy charges is applied for a power factor below 0.90 and up to 0.85.
- A surcharge of 10% on current energy charges is applied for a power factor below 0.85.
- Incentives for High Power Factor:
- While specific incentives for maintaining a high-power factor are not detailed in the provided sources, consumers are encouraged to maintain an optimal power factor to avoid surcharges and potentially benefit from lower energy losses and improved efficiency.
- It's important to note that these regulations are subject to change. For the most current information, consumers should refer to the latest tariff orders and notifications issued by UPCL and the Uttarakhand Electricity Regulatory Commission (UERC).

7.5 SOLUTION TO THE POWER FACTOR PROBLEM

To improve the power factor, it is recommended to install an Automatic Power Factor Control (APFC) panel that can maintain the power factor above 0.999 and help generate power factor incentives, reducing the electricity bill. We recommended to install more APFC panel at both transformer ends and maintain power factor.

Certainly, if existing capacitors are faulty and the Automatic Power Factor Correction (APFC) relay has a slow response due to age, there are several suggestions to improve the power factor:

1. **Capacitor Replacement:**
    - Replace faulty capacitors with new ones to ensure efficient reactive power compensation. This will enhance the power factor correction capability.
    - We suggest to install Mix type of capacitors i.e. 5, 7.5, 10, 12.5, 15, 20, 25 kVAr also in the APFC panel to enhance the better controlling.
2. **Upgrade APFC Relay:**

- Consider upgrading the APFC relay to a newer model with faster response times. This will enable more accurate and timely adjustments to the power factor, ensuring better performance.

3. **Regular Maintenance:**
    - Implement a regular maintenance schedule for both capacitors and the APFC relay. This includes cleaning, inspection, and testing to identify and address potential issues before they lead to malfunctions.
4. **Advanced APFC System:**
    - Explore the possibility of installing a more advanced APFC system that incorporates modern technology for quicker and more precise power factor correction.
5. **Monitoring and Control:**
    - Implement a comprehensive monitoring and control system to continuously assess the power factor and capacitor health. This allows for proactive measures and early detection of issues.
6. **Capacity Assessment:**
    - Conduct a thorough assessment of the power requirements and the capacity of the existing APFC system. This ensures that the system is appropriately sized to handle the reactive power demands.

7.6 ENERGY & COST SAVING CALCULATION FOR ECM#1

Table 17: Power Factor Saving Calculation of 3100 kVA Connection

S No	Particular	UoM	Present Status	Proposed Status-Install APFC
1	Power Consumption in System	kW	3100	
2	Energy consumption per Annum	kVAh	11780732	10933254
3	Energy consumption per Annum	kWh	10933254	10933254
4	Average pf for past 12 months	PF	0.932	0.999
5	Difference in unit's consumption due to low PF		847478.0	0
6	Unit Cost	Rs/Unit	5.54	5.54
7	Extra Avoidable Charges due to low pf	Rupees	4691457.2	0

S No	Particular	UoM	Present Status	Proposed Status-Install APFC
9	Required kVAR to Improve Power Factor	kVAr	1064.6	
10	**Annual Energy Savings in Cost**	**Rs. Lakhs**	**46.9**	
11	**Investment on capacitor for APFC Panel**	**Rs. Lakhs**	**12.8**	
12	**Payback Period**	**Months**	**3.3**	

Table 18: Power Factor Saving Calculation of 1000 kVA Connection

S No	Particular	UoM	Present Status	Proposed Status-Install APFC
1	Power Consumption in System	kW	1000	
2	Energy consumption per Annum	kVAh	1973208	1944780
3	Energy consumption per Annum	kWh	1944780	1944780
4	Average pf for past 12 months	PF	0.986	0.999
5	Difference in units consumption due to low PF		28428.0	0
6	Unit Cost	Rs/Unit	7.20	7.196517819
7	Extra Avoidable Charges due to low pf	Rupees	204582.6	0
9	Required kVAR to Improve Power Factor	kVAr	127.3	
10	**Annual Energy Savings in Cost**	**Rs. Lakhs**	**2.0**	
11	**Investment on capacitor for APFC Panel**	**Rs. Lakhs**	**1.5**	
12	**Payback Period**	**Months**	**9.0**	

7.7 DIRECT DEMAND MONITORING & CONTROL SYSTEM

Maximum demand tends to reach present limit, shedding some of non-essential loads temporarily can help to reduce it. It is possible to install direct demand monitoring & control system, which will switch off non-essential loads when a present demand is reached. Simple system gives an alarm, and the loads are shed manually. Sophisticated microprocessor-controlled system is also available, which will provide a wide variety of control options like:

- Accurate prediction of demand
- Graphical display of present load, available load, demand limit.
- Visual and audible alarm
- Automatic load shedding in predetermined sequence.
- Automatic restoration of load

7.8 INTEGRATED MANAGEMENT SYSTEM WITH IOT BASED

7.8.1 OBSERVATION

- The university currently tracks energy and resource usage manually
- There is no system in place to monitor energy consumption or predict issues in real-time.
- Resource data (electricity, water, gas, etc.) is stored in scattered formats (registers, Excel sheets, etc.).
- It is difficult to analyse trends or compare performance across departments or buildings.
- No early warnings for equipment failure, energy spikes, or leakages.
- Without accurate tracking, there is a risk of overuse or underuse of resources.
- Potential savings and improvements go unrealized.

7.8.2 RECOMMENDATION

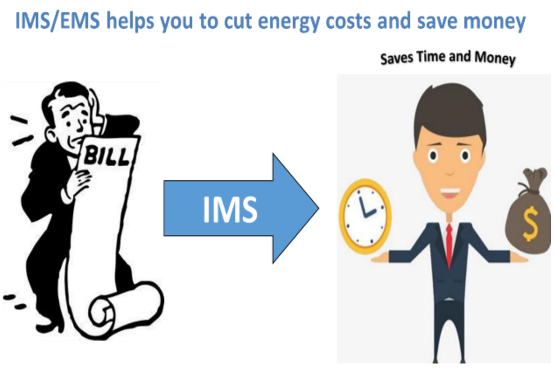
We recommend implementing an **IoT-Based Integrated Management System (IMS)**.

Power System Management

- Install IoT sensors on power lines and major equipment.
- Monitor voltage, current, and power quality.
- Ensure energy compliance and prevent overuse or surges.

Resource Accounting

- Track how much energy, water, gas, etc., is used in each department or building.
- Know where exactly the energy is going – lights, ACs, labs, etc.



Resource Productivity

- Analyze usage vs. output.
- Find which departments are using energy efficiently and which are wasting it.

Resource Cost Saving

- Detect unusual spikes, leaks, or idle equipment consuming power.
- Find and fix energy losses.
- Save money by identifying high-cost areas and optimizing them.

Predictive Maintenance

- Use smart sensors to detect early signs of equipment issues (like overheating, vibration, etc.).
- Get alerts before breakdowns happen.
- Plan maintenance in advance, saving time and money.

Multi-Resource Management

- Integrate air, water, gas, steam, and fuel usage into a single platform.
- View all resource data on a dashboard – real-time, historical, and predictive.

Better Decision Making

- With proper data, the administration can make informed decisions.
- Helps in budgeting, planning energy-efficient upgrades, and meeting sustainability goals.

CHAPTER:8 STUDY OF CEILING FANS SYSTEMS

8.1 CELLING FANS DETAILS

The University currently has approximately 2500 conventional ceiling fans, each consuming 60 watts of power and New BLDC Celling of 2200 Nos are installed. Many of these fans are quite old, and some may not be in working condition. To improve energy efficiency, it is recommended to replace these outdated fans with modern technology ceiling fans rated at 28 watts. This switch will result in a significant reduction in power consumption.

Table 19: Details of existing Installed Fans in the campus

S. No	Specification Items	Total Nos	Watt.	Total Load (kW)
1	Ceiling Fans	2500	60	150

8.2 REPLACE EXISTING CEILING FANS WITH NEW BLDC CEILING FANS ON FAILURE REPLACEMENT BASIS

The new energy-efficient BLDC fans consume significantly less power while delivering the same level of airflow. Additionally, they offer various advantages, such as reduced noise levels and longer operational lifespans.

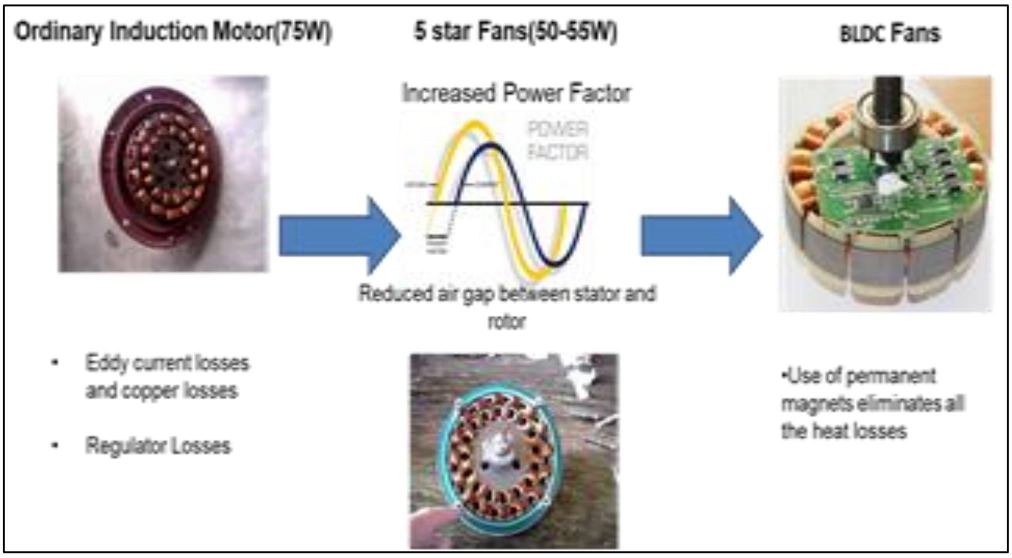


Figure 13: New Technology Energy Efficient BLDC Fans

A brushless DC (BLDC) motor is a synchronous electric Motor powered by direct-current (DC) electricity and having an electronic commutation system, rather than mechanical commutator and brushes. In BLDC motors, current to torque and voltage to rpm are linear relationships. This linearity provides an excellent opportunity to use the BLDC motor in the conventional ceiling fans.

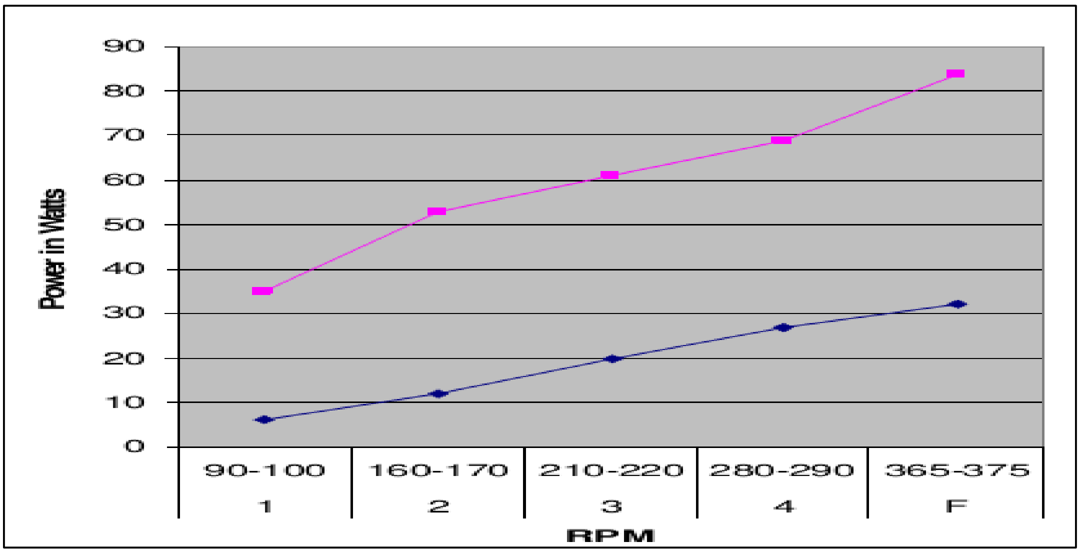


Figure 14: RPM Vs Power Consumption of Fans

This paper presents practical implementation of such BLDC motor for ceiling fan application along with the actual power measurements in comparison with conventional ceiling fans. Complete electronics and the associated advantages and disadvantages of this BLDC ceiling fans are also presented.

Why BLDC Fans?

Today the typical ceiling fan is based on AC motors which are more power consuming. Along with this the typical AC motor-based fans have the rpm control through the capacitor or resistor-based regulators and is not efficient as there is loss in the regulator itself to some extent. In addition, the RPM control is by controlling the voltage and the voltage fluctuations of the mains make it very challenging to have constant RPM based on the AC mains supply. Further, existing AC motor solution, results in power factor (PF) degradation with no improvement for PF and there are other side effects like harmonics injection to the AC mains, etc.

The total amount of air flow or displacement is based on the blade size & rpm and does not change due to any other factor. The proposed solution is to keep the same air flow or displacement with less of energy usage along with improving the PF using the BLDC motor-based ceiling fans. Typical BLDC motor-based ceiling fan has much better efficiency and excellent constant RPM control as it operates out of fixed DC voltage. The proposed BLDC motor and the control electronics operates out of 24 V DC through an SMPS (switched mode power supply) having input AC which can vary from 90 V to 270 V. Following graph shows the comparison between BLDC and conventional ceiling fans

The power consumption is less than half at full speed and is about 20% at low speed for the BLDC motor compared to the conventional motor-based ceiling fan, as can be seen from the graph above. The Power Supply (PS) used is at 85% efficiency and the electronics circuit consumes less than 0.5 Watt. Generally, 210-220 RPM conventional fans are used which consumes almost 50-Watt power. From graph, as can be seen that same RPM BLDC motor consumes almost half power.

	Gorilla 900 mm	Gorilla 1050 mm	Gorilla 1200 mm	Gorilla 1400 mm	Gorilla Premium Earth brown	Gorilla Premium Sand Grey
Power Consumption (Watts)	28	32	28	35	28	28
Air Delivery (CMM)	175	210	220	270	220	220
RPM	450	430	350	270	350	350
Service Value	7.1	6.6	7.8	7.7	7.8	7.8
Power Factor	0.98	0.98	0.98	0.99	0.98	0.98
Blade Span (mm/inch)	900/36	1050/42	1200/48	1400/56	1200/48	1200/48

Figure 15: Rated specifications of various sizes are given below for ready reference:

8.3 ENERGY & COSTING CALCULATION FOR ECM#2

We recommend to,

- Replace existing ceiling fans of 60 – 70 Watts with 28 watts BLDC fan.

Table 20: Energy and Cost Saving Calculation

Particulars	Parameters	Future Scenario
Type of Recommendations	-	Install new technology BLDC ceiling fan
Present Ceiling fan	Nos	**2500**
Present Ceiling Fan Power	Watts	60.0
Annual Operational Days	Days/Annum	210.0
Daily Operational Hours	Hours/Day	7.0
Plant's Present ceiling fan energy Consumption	kWh/Annum	220500
Proposed New Ceiling Fan Power	Watts	28.0
Proposed Ceiling Fan Energy Consumption	kWh/Annum	102900

Particulars	Parameters	Future Scenario
Annual Energy Saving Potential	kWh/Annum	117600
Unit cost	Rs/Unit	6.30
Savings in Energy Bill Per Annum	Rs. Lakh/Annum	7.40
Investment	Lakhs Rupees	61.5

Note: The Return on Investment (ROI) for Energy Conservation Measures (ECM) is high, attributed to reduced operating hours and higher initial costs. Therefore, we recommend implementing of ECMs in a phased Manner approach or as failure replacements Policy to get benefits.

CHAPTER:9 STUDY OF AIR CONDITIONING SYSTEMS

9.1 AIR CONDITIONING STUDY & PERFORMANCE ANALYSIS

The University has split and window of around 900 Nos air conditioners are installed in the building. Performance measurements and analysis were conducted during the audit to calculate the air conditioner performance in kW/TR. Based on these findings, we recommend replacing the existing ACs with new 5 Star ACs

Table 21: Air Conditioning installed at Institute

Description	Total
Air conditioner, Make LG, Blue star, Voltas, Dakin	900

9.2 REPLACE EXISTING 3 STAR ACS WITH INVERTER TECHNOLOGY 5 STAR ACS ON FAILURE REPLACEMENT BASIS

The lower be the kW/TR value, lower will be the power consumption of AC and hence lower will be impact on energy cost. So, if we can see in above table 5 Stars ACs, have lower SEC i.e., kW/ TR as compared to 3-star ACs of the same rating. Thus, obviously it is recommended to install 5-star AC preferably to reduce operational cost.

Now -a – Days new star rated inverter-based air conditioners are coming in market having lower values of kW/ TR. this means lower specific energy consumption for the same output. The rated Specific energy consumption of split Air conditioner is in the range of 0.90-1.0 kW/ TR. this is much lower than the specific energy consumption of installed air conditioner. In addition to this these air conditioners are coming with inverter-based technology.

What is inverter technology?

A regular air conditioner will always run at peak power requirement when the compressor is running. An air conditioner with inverter technology will run continuously but will draw only that much power that is required to keep the temperature stable at the level desired. So, it is kind of automatically adjusts its capacity based on the requirement of the room it is cooling. Thus, drawing much less power and consuming lesser units of electricity.

Thus, it is advisable to replace air conditioners which are old and having higher specific energy consumption. Since the operational hours of air conditioners are very less, it will be beneficial if facility team replace old air conditioner having higher running hours on priority basis.

We recommend to

- Replace old air conditioner having higher running hours on priority on failure replacement basis
- Procure new air conditioner based on energy efficiency ratings provided by Bureau of energy efficiency.
- Replace rest other non-energy efficient air conditioner based on failure basis.

9.3 ENERGY & COST SAVING CALCULATION OF ECM# 3 FOR AIR CONDITIONING

Table 22: Energy and Cost Saving Calculation

Particulars	Parameters	Future Scenario
Type of Recommendations for 5 Star Inverter	-	5-Star Split AC
Considering 25 no of AC for 3 Start Non-Inverter	Nos	25
Total Cooling LOAD	TR	37.5
Present Split AC Power	kW/TR	2
Present Power Consumption	kW	75
Annual Operational Days	Days/Annum	150
Daily Operational Hours	Hours/Day	7
Plant's Present AC energy Consumption	kWh/Annum	78750
Proposed 5-Star AC Power	kW/TR	0.75
Proposed Power Consumption	kW	28.125
Proposed 5-Star AC Energy Consumption	kWh/Annum	29531
Annual Energy Saving Potential	kWh/Annum	49219
Unit cost	Rs/Unit	6.30
Savings in Energy Bill Per Annum	Rs. Lakh/Annum	3.10
Investment	Lakhs Rupees	8.75
Payback period	Months	34

CHAPTER:10 LIGHTING SYSTEM AND LUX LEVEL STUDY

The lux level study of different areas or rooms were done during the audit in the College. Some area has good lux level but some has to improve.

Table 23: Light Load Details of different Section of College

Sl. No	Location	2x16 W LED	16 W D.L	20 watt LED	18 Watt LED	12 w LED Bulb	(2'x2') 36 W	Surface Light-12 W LED	2'x2' 48 Watt	30 watt Street Light	45 Watt Street Light	Flood Light 50 watt	Flood Light 150 watt
					Corridor		Recessed						
1	Himalayan School of Scienece & Technology (HSST)	299	274		148		32						
2	Himalayan School of Management Studies (HSMS)	299	274		148		32						
3	Himalayan Hospital_New OPD Building				1746(4' long)								
4	Activity center (Creche / Shoping Mall)		270		37			110					

Sl. No	Location	2x16 W LED	16 W D.L	20 watt LED	18 Watt LED Corridor	12 w LED Bulb	(2'x2') 36 W Recessed	Surface Light-12 W LED	2'x2' 48 Watt	30 watt Street Light	45 Watt Street Light	Flood Light 50 watt	Flood Light 150 watt
5	Himalayan Hospital, Laboratory, Central Library building		600		310		100		934				
6	Cancer Research Institure (CRI)						183						
7	Himalayan Institute of Medical Sciences (HIMS)				127	49	42		49				
8	Himalayan College of Nursing (HCN)				25		49		32				
9	Himalayan school of Yoga Sciences (HSYS)				101								
	Himalayan												

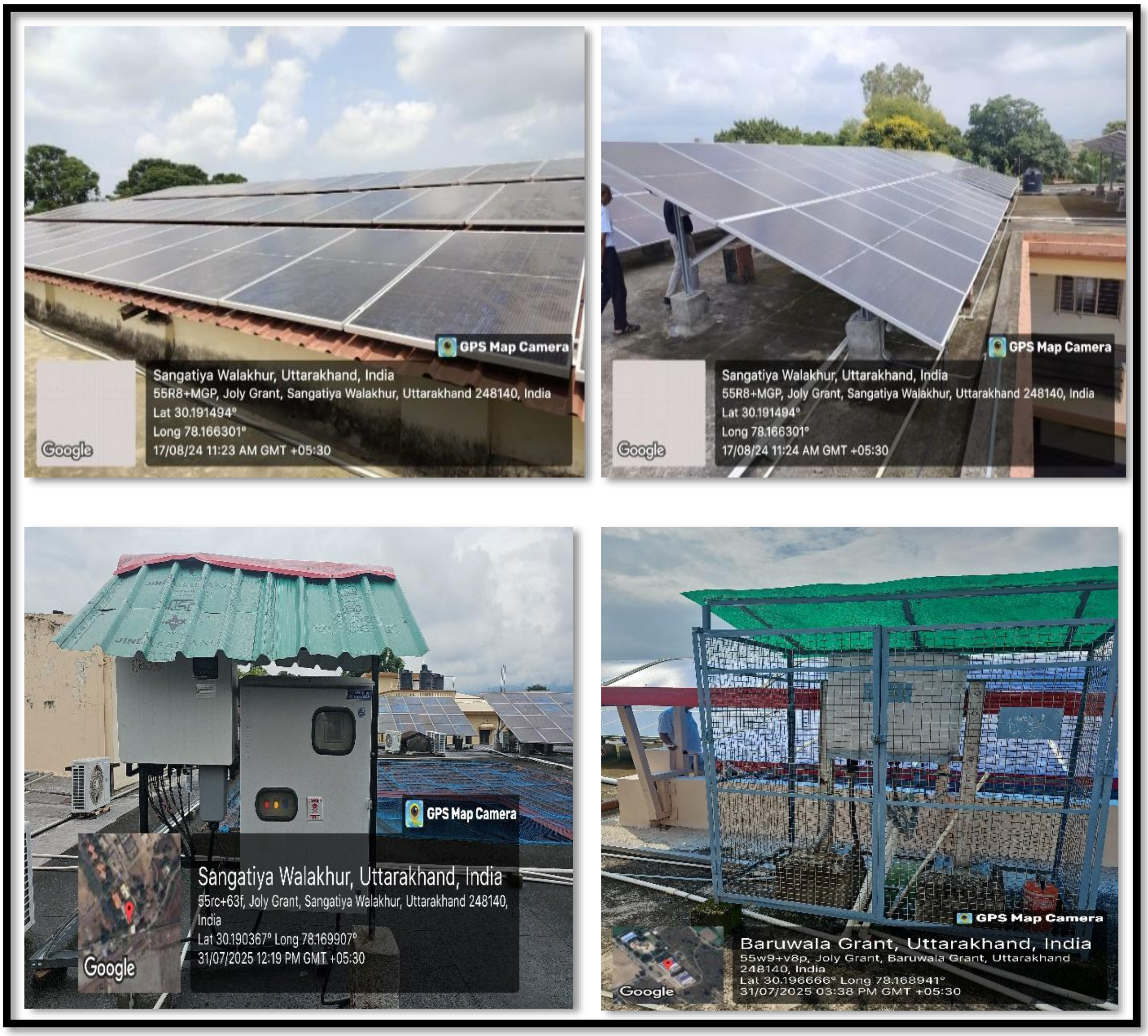
Sl. No	Location	2x16 W LED	16 W D.L	20 watt LED	18 Watt LED Corridor	12 w LED Bulb	(2'x2') 36 W Recessed	Surface Light-12 W LED	2'x2' 48 Watt	30 watt Street Light	45 Watt Street Light	Flood Light 50 watt	Flood Light 150 watt
10	School of Bio sciences (HSBS)				154	33							
11	Trauma Center Hospital		195		20		100						
12	Campus Lighting									250	51	70	30
13	WWR			209									
14	WMR			150									
15	New PG Hostel (Boys & Girls)			258									
16	Old PG hostel			109									
17	MBBS Hostel			700									
18	Residence			350									
	Total Qty	598	1613	1776	2816	82	538	110	1015	250	51	70	30
	Total Watt	19136	25808	35520	50728	984	19368	1320	48720	7500	2295	3500	4500

CHAPTER:11 STUDY OF SOLAR SYSTEM

11.1 EXISTING SYSTEM

During the detailed energy Swami Rama Himalayan University audit team and the facility team jointly studied the 2500 kWp solar PV system that had been installed. The college building has ample of space i.e. Roof top area on hostels auditorium buildings. The average power generation from a 1 KW SPV System is around 4-5 kWh per day. Also, the SPV power generation varies with time of day, the balance power requirements are automatically met by the grid supply during this period. However, it was noted that the generation of this system is managed by university and reduction due to electricity generation was reflected in electricity bill.

Picture 4: Solar Panels



11.2 RECOMMENDATION

We recommended to University to kindly maintain record on day by day based for solar PV plant to know the performance and plan the cleaning of solar panels accordingly. Regular operation and maintenance of the SPV power plant after commissioning is essential. This includes the supply of consumable items as necessary and the submission of daily analysis and evaluation of operational plant data through remote monitoring. Key activities include:

- Visual inspections.
- Data recording using a robust data-logger and related sensors to measure irradiation, ambient and module temperature, and energy output of the power plant. Information is accessible through a web interface from any location.
- Monthly/yearly energy and performance reporting.
- Plant health monitoring and troubleshooting measures.
- Module cleaning, preventive and scheduled maintenance, and replacement work as required.
- Emergency response.
- Refurbishments & warranty claim management and redressal system.

Preventive inspection and maintenance of system components according to manufacturer's specifications, documentation of events and measures, and provision of small parts and operating material are also included. Fault detection and analysis involve function checks after fault messages are received, immediate start of fault removal measures, and long-term trend analysis. Analysis of interruptions and incidents, and supply chain management for spare parts such as modules, inverters, cabling, and mechanical components are essential.

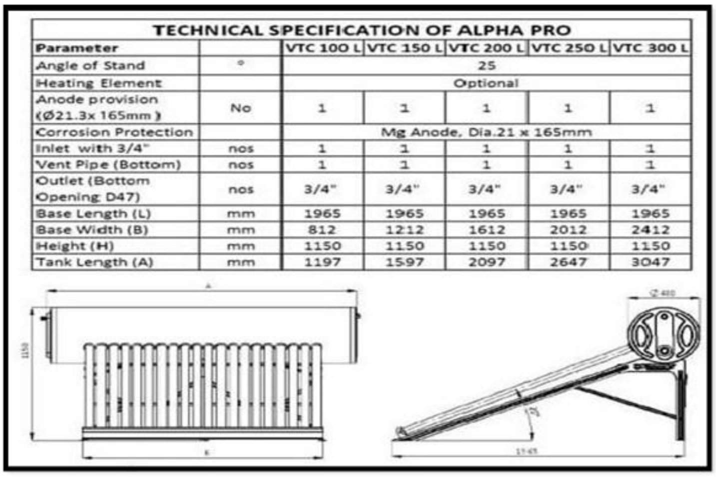
CHAPTER:12 SOLAR WATER HEATING SYSTEM

12.1 EXISTING SYSTEM

Solar water heaters sometimes called solar domestic hot water systems can be a cost-effective way to generate hot water. They can be used in any climate, and the fuel they use sunshine is free. There are solar water boilers in the facility. Following is the comparison of solar heater with electricity.

From the data given by the college we absorb that the facility has installed 450 numbers of solar water heater of capacity 2.5 KW which is sufficient

Picture 5: Solar Water Heater



TECHNICAL SPECIFICATION OF ALPHA PRO

Parameter		VTC 100 L	VTC 150 L	VTC 200 L	VTC 250 L	VTC 300 L
Angle of Stand	°	25				
Heating Element		Optional				
Anode provision (Ø21.3x 165mm)	No	1	1	1	1	1
Corrosion Protection		Mg Anode, Dia.21 x 165mm				
Inlet with 3/4"	nos	1	1	1	1	1
Vent Pipe (Bottom)	nos	1	1	1	1	1
Outlet (Bottom Opening D47)	nos	3/4"	3/4"	3/4"	3/4"	3/4"
Base Length (L)	mm	1965	1965	1965	1965	1965
Base Width (B)	mm	812	1212	1612	2012	2412
Height (H)	mm	1150	1150	1150	1150	1150
Tank Length (A)	mm	1197	1597	2097	2647	3047

Figure 16: Technical specifications of solar water boiler

CHAPTER:13 CONCLUSION

13.1 CUMULATIVE ENERGY SAVING OPPORTUNITIES

Table 24: Summary of Energy Saving Opportunities

Particulars	Annual Savings				Estimated Investment
	kWh	TOE	CO2	Saving Rs in Lakh	(Rs in Lakh)
Improve the Power Factor in the system in 3100 kVA				46.5	12.90
Improve the Power Factor in the system in 1000 kVA				2.00	1.00
Replace Existing Ceiling Fans with low wattage Ceiling Fans on Failure Replacement Basis	117600			7.40	61.50
Replace Existing 3 Star ACs with Inverter Technology 5 Star ACs on Failure Replacement Basis	49219			3.10	8.50
Total	**166819**			**59.00**	**83.90**
Monitoring of Solar PV System					

Note: The Return on Investment (ROI) for Energy Conservation Measures (ECM) is high, attributed to reduced operating hours and higher initial costs. Therefore, we recommend implementing of ECMs in a phased Manner approach or as failure replacements Policy to get benefits.

Net Saving:

Energy Saving: 166819 kWh per annum

Cost Saving: 59.00 Lakhs per annum

Investment: 83.90 Lakhs

ANNEXURE

ANNEXURE-1: AUDIT CERTIFICATE

ECOSCIENCE CONSULTANCY

ENERGY AUDIT CERTIFICATE

(FOR THE YEAR 2024-25)

IS ISSUED TO

Swami Rama Himalayan University

LOCATED AT SWAMI RAM NAGAR, DOIWALA, DEHRADUN, UTTARAKHAND

for the successful completion of the **Energy Audit** for the year **2024-25**, conducted by M/s Ecoscience Consultancy. This recognition underscores the institution's commitment to sustainability and energy efficiency.
The University is certified to have done exceptionally well to conserve energy and sustainable development for the assessment period.

Mr. Pankaj Dhote
Lead Auditor
(BEE Approved Energy Auditor)

Award Date: 18th August 2025

ANNEXURE-2: AUDITOR CERTIFICATE AND ISO CERTIFICATES

Reg No.: **EA-28926** Certificate No.: **9782/19**

NATIONAL PRODUCTIVITY COUNCIL

National Productivity Council

(National Certifying Agency)

PROVISIONAL CERTIFICATE

This is to certify that Mr./ Mrs./ Ms. **PANKAJ DHOTE** *son / daughter of Mr.* **PANDURANG DHOTE** *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 fulfilment 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 16:23:40 IST 2019
Controller of Examination, NPC AIP Chennai

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

Controller of Examination

QUALITY RESEARCH ORGANIZATION

Certificate of Registration

This is to certify that

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LAKSHMI VIHAR COLONY, BAHADRABAD, HARIDWAR
UTTARAKHAND STATE -249402, INDIA.

has been independently assessed by QRO
and is compliant with the requirement of:

ISO 9001:2015

Quality Management System

For the following scope of activities:

PROVIDING EXPERT SOLUTION IN THE FIELD OF ENVIRONMENT MONITORING, WASTEWATER MANAGEMENT (ETP/STP INSTALLATION AND MAINTENANCE), THIRD PARTY AUDITS (FOR WASTE MANAGEMENT), GREEN AUDITS, ENERGY AUDITS, CARBON FOOTPRINT.

Date of Certification: 14th January 2025
1st Surveillance Audit Due: 13th January 2026
2nd Surveillance Audit Due: 13th January 2027
Certificate Expiry: 13th January 2028

Certificate Number: 305025011408Q

EGAC
CAB # 011905

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Occupational Health and Safety Management System

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Certificate Expiry: 13th January 2028

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UKcert
Certification & Inspection

Certificate of Compliance

This is to certify that the

Conformity Assessment Certification

of

ECOSCIENCE CONSULTANCY

at

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UTTARAKHAND STATE -249402, INDIA.

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ISO/IEC 17020:2012

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Date of Certification	14th January 2025
1st Surveillance Audit Due	13th January 2026
2nd Surveillance Audit Due	13th January 2027
Certificate Expiry	13th January 2028

Authorised Signatory

UKAF

UK Certification & Inspection Ltd.

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Website:- www.ukcertifications.org.uk, email:- info@ukcertifications.org.uk
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Date of Certification: 14th January 2025
1st Surveillance Audit Due: 13th January 2026
2nd Surveillance Audit Due: 13th January 2027
Certificate Expiry: 13th January 2028

Certificate Number: 305025011411EN

المجلس الوطني للاعتماد
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Website : www.qrocert.org, E-mail : info@qrocert.org

ANNEXURE-3: ENERGY EFFICIENT EQUIPMENT SUPPLIERS

Product/ Equipment	Name	Website
Capacitors and APFC Panels	Standard Capacitors	www.standardcapacitors.com
Capacitors and APFC Panels	Ashish Consultant	www.ashishconsultant.com
Capacitors/ Switch Gears/ Reactors etc.	Shreem Electric Ltd	www.shreemelectric.com
Lighting Systems	Asian Electronics Ltd.	www.aelgroup.com
Lighting Systems	Philips India Ltd	www.india.philips.com
Lighting Systems	OSRAM India Ltd.	www.osram.in
Lighting Systems	Wipro Lighting	www.wiprolighting.com
Solar Products	Synergy Solar (P) ltd	www.synergysolar.net
Solar Products	Inter Solar Systems (P) Limited	www.intersolarsystems.com
Energy Efficient Pumps	Danfoss Industries Pvt. Ltd.	www.danfoss.com
Energy Efficient Pumps	Mather & Platt Pumps Ltd.	www.matherplatt.com
Energy Efficient Pumps	Xylem Water Solutions India Pvt. Ltd. (Distributor of Lowara, Italy)	www.lowara.com

Note: -The suppliers mentioned above are not the only ones or the best in the market. The management may contact other suppliers for competitive rates/ specifications.

ANNEXURE-4: RECOMMENDED LUX LEVELS

- **Entrance**

Entrance halls, lobbies, waiting rooms = 200
Enquiry Desks = 500
Gate Houses = 200

- **Circulation Areas**

Lifts = 100
Corridors, passageways, stairs = 100
Escalators, revelators = 150

- **Staff Rooms**

Offices = 300

Changing, locker and cleaners' room, Cloak rooms, lavatories = 100
Rest Rooms = 150

- **Staff Restaurants**

Canteens, Cafeterias, dining rooms, mess rooms = 200

- **Communication**

Switch board rooms = 300
Telephone, apparatus rooms = 150
Telex room, post rooms = 500
Reprographic room = 300

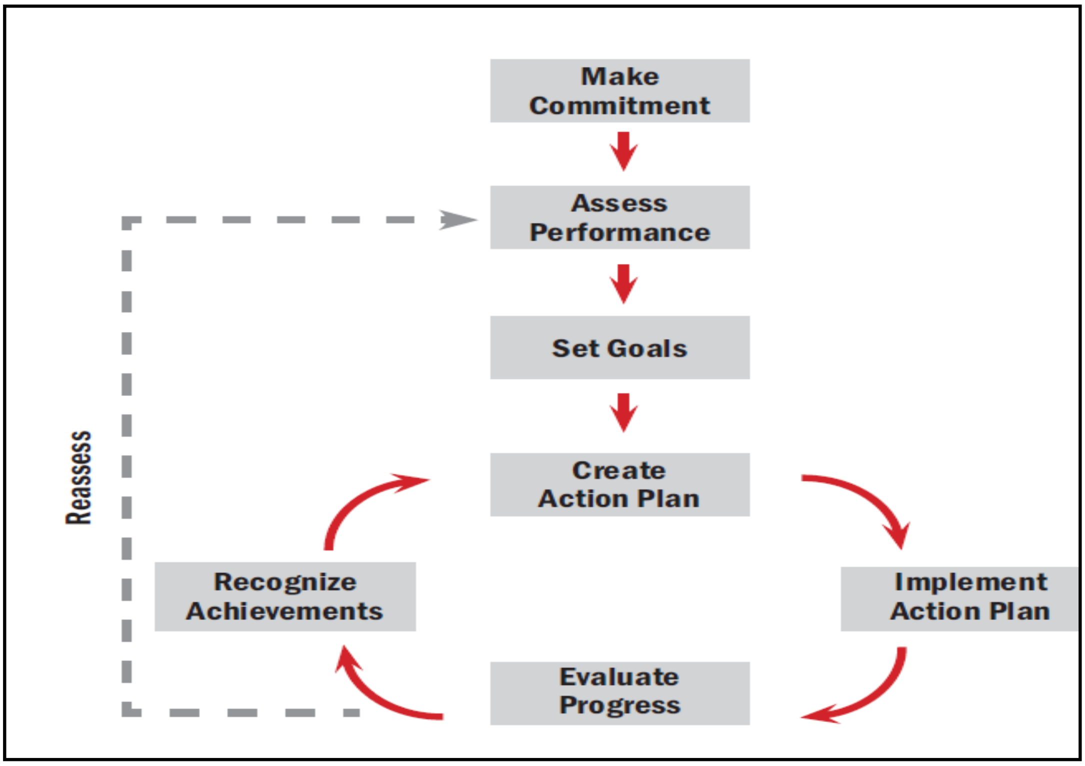
- **Education**

Assembly Halls = 200-500 (average 300)
Teaching Places = 200-500 (average 300)
Lecture Theatres = 200-500 (average 300)
Seminar Rooms = 300-750 (average 500)
Art Rooms = 300-750 (average 500)
Needle Work Rooms = 300-750 (average 500)
Laboratories = 300-750 (average 500)
Libraries = 200-500 (average 300)
Music Rooms = 200-500 (average 300)
Sports Halls = 200-500 (average 300)
Workshops = 200-500 (average 300)

ANNEXURE-5: ENERGY MONITORING AND ACCOUNTING

Present Energy Monitoring & Accounting System: There is a proper metering system for the purchased power. However, the data related to the power generated using DG sets is not being monitored monthly. There are no prescribed formats available to maintain such records. Because of this, there is no periodic performance analysis of the energy consumption in the building.

Recommended Energy Monitoring & Accounting System



Energy Management should be seen as a continuous process. Strategies should be reviewed annually and revised as necessary. The key activities suggested have been outlined below:

- Clear **accountability for energy consumption** needs to be established, appropriate financial and staffing resources must be allocated and reporting procedures initiated. An energy management programme requires commitment from the whole organization to be successful.

- A **record of Energy consumption** both Electrical must be kept and monitored on a regular basis. For this, sub meter on the DG set is required. This will enable an overview of energy use and its related costs, as well as facilitating the identification of savings that might otherwise not be detected. The system needs to record both historical and ongoing energy use, as well as cost information from billing data, and capable of producing summary reports on a regular basis. This information will provide the means by which trends can be analyzed and reviewed for corrective measures.

- Some facts and figures related with energy may be displayed on boards or **posters in the premises**, to create awareness among the workmen and staff. A key ingredient to the success of an energy management program is maintaining a high level of awareness among staff. This can be achieved in a number of ways, including formal training, newsletters, posters and publications. It is important to communicate program plans and case studies that demonstrate savings, and to report results at least at 12-month intervals. As an incentive, new ideas and implementation of energy saving point must be recognized and awarded.
- The findings and **implementation status of Energy audits** should be reviewed periodically/annually for further action plan.

Table 25: Format for Maintaining a Monthly Record of the Purchased Power Consumption

Particulars	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Actual Demand (KVA)												
KWH Consumption												
KVAh Consumption												
Operating Power factor												
Fixed Demand Charges (Rs)												
Energy Charges (Rs)												
Penalty / Rebate, if any (Rs)												
Other Charges (Rs)												
Total Amount Payable (Rs)												

-: End of Report: -