ENERGY AUDIT REPORT

of

"Saraswati Group of Colleges"
Located
At
"NH -05, Ludhiana – Chandigarh NH Gharuan 140413, Punjab (India)"
For
"2023-2024"

Prepared by

restoring eco balance...

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ABBREVIATION

Abbreviation	Full Form
A	Ampere
AC	Alternating Current
APFC	Automatic Power factor Controller
Avg.	Average
BEE	Bureau of Energy Efficiency
CEA	Certified Energy Auditor
CFL	Compact florescent lamp
EER	Energy Efficiency Ratio
FTL	Florescent Tube Light
Kcal	Kilo Calories
Kg.	Kilogram
KL	Kilo Liter
KV	Kilo Volt
kVA	Kilo Volt Ampere
KVAr	Kilo Volt Ampere Reactive
kW	Kilo Watts
kWh	Kilo Watt Hour
M or m	Meter
Mm	Millimeters
Max.	Maximum
Min.	Minimum
MT	Metric Ton
No.	Number
PF	Power Factor
SGC	Saraswati Group of Colleges
TR	Tons of Refrigeration
V	Voltage
W	Wattage (watt)

ACKNOWLEDGEMENT

I, ……, on behalf of M/s Saraswati Group of Colleges, do hereby acknowledge that the information and data provided to Eco Paryavaran Laboratories and Consultants Pvt. Ltd. for the purpose of conducting the energy audit at "Saraswati Group of Colleges" at "NH -05, Ludhiana – Chandigarh NH Gharuan 140413, Punjab (India)" are true and accurate to the best of our knowledge.

We appreciate the diligent efforts of Eco Paryavaran Laboratories and Consultants Pvt. Ltd. in meticulously analysing our energy usage and providing comprehensive findings and recommendations. The insights gained from this audit are invaluable and will be instrumental in our ongoing efforts to enhance the sustainability and energy efficiency of our campus operations.

We extend our sincere gratitude to the team Eco Paryavaran Laboratories and Consultants Pvt. Ltd. for their expertise and guidance. Recommendations in the report will significantly contribute to the advancement of our sustainability initiatives and the betterment of our campus environment, simultaneously these recommendations will also go in a long way for savings in financial terms.

Thank you for your valuable support and partnership.

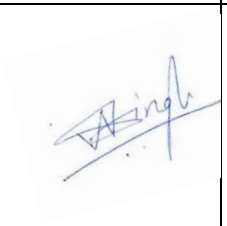
Sincerely,

[Name]
[Designation]
Saraswati Group of Colleges (SGC)

Part A: Declaration by Consultants/Experts Contributing to the Energy Audit

We, the undersigned, hereby certify that the energy audit for SGC 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.	ID of Expert
1.	Dr. Rai Singh (Ph. D. & M. Sc. Env. Sc. P.G. Diploma in Industrial Safety, Health & Env.)	Dy. General Manager (Technical & Environment) • NABL approved authorized signatory • NABET approved Environmental Expert • Worked in CPCB (2001-12) as Research Scientist		
2.	Mr. Navjot Singh (BE Electrical & specialization in MEP)	• Manager (ENERGY Audits) • Energy auditor • MEP Expert • Engineering Design expert		
3.	Dr. Avinash Kumar (Ph.D., M.Tech., M.Sc. in Env. Sc.)	Manager (Environment Management System) • Water quality Expert. • Pollution load assessor. • Carbon foot printing expert. • Green audit expert.		

Part B: Declaration by Head of the Consultants

I, Dr Sandeep Garg, Managing Director of Eco Paryavaran Laboratories & Consultants, hereby declare that the energy audit report prepared for the "Saraswati Group of Colleges" located at NH-05, Ludhiana, Chandigarh NH, Gharuan Punjab, (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.

I 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. Sandeep Garg
(Managing Director)
Eco Paryavaran Laboratories & Consultant Pvt. Ltd.

EXECUTIVE SUMMARY

1. The Institution

The Institute in the name & style of M/s Saraswati Group of Colleges is running an educational campus with multi-faceted colleges providing wide range of education opportunities to the budding scholars of the area. The Institute has been established for more than last 20 years with a trail of success. The institute is spread over 254338.7 sqft of area, with ideal location on NH-05, Ludhiana-Chandigarh road at Vill- Gharuan, Punjab.

The premises is having enormous campus with number of buildings, catering to the students, faculty and support staff. For the successful operations if the institution, power requirement is one of the basic needs, for lighting purpose, AC, heaters, fans, electric motors, electronic equipment's, laboratories and computer networking etc. In the nutshell it can be said that power is such an entity which is required everywhere.

2. Power Requirement

As the power is the primary requirement for almost all the day-to-day activities, the total load of the college is 320KW. The power is chiefly derived/procured from the PSPCL Grid with standby mode in the form of DG sets. As an environment friendly step and energy conservation measure, power is also procured from the solar power plant installed in the premises. The power procurement from the solar power sector is 300KWp.

3. The Energy Audit

The basic concept behind the Energy Audit is as below: -

- Assessment of power/energy requirement on minimum basis.
- Identification of "grey areas" in the field of energy consumption.
- Scope for improvements with financial as well as practical viability.
- Assessment of Infrastructure/installation oriented changes/improvements.
- Assessment of operation-oriented possible changes/improvements.
- Assessment/identification of best practices.

4. Energy Audit Domain

The Energy Audit chiefly compasses all the above mentioned streams under para 3. The Energy Audit of Saraswati Group of Colleges (SGC) was conducted by Eco Paryavaran Laboratories and Consultants Pvt. Ltd. to evaluate current energy consumption patterns, identify opportunities for energy conservation, and recommend strategies to enhance environmental sustainability on the campus. **This comprehensive audit included an in-depth analysis of energy consumption, infrastructure evaluation, and feasibility studies for renewable energy options.**

5. Key Findings with major financial benefits

Key findings revealed significant opportunities for energy efficiency improvements across various sectors of the campus.

The Assessment of current scenario viz-a-viz power consumption would lead us to the following major energy-consuming areas

- Lighting (Interior/Exterior)
- AC
- heaters
- fans
- electric motors
- electronic equipment’s
- laboratories and computer networking

Investment in above sectors leads to the significant monetary benefits which is give in **table A**

Table 1-1 Investment and benefits

S.No.	Sectors of Improvement	Total Investment (in Rs.)	Annual Monetary savings (in Rs.)
1	Renewable Energy (Solar)	50,00,000	12,52,368
2	Fans (replacement with BLDC FANS)	6,00,000	2,35,822
3.	Street lights (Integration with solar panel)	1,41,040	1,56,348
4.	AC system	4,50,000	77,068
5	APFC system	1,00,000	8570(Avg.)

By adopting these recommended measures, the total potential annual savings identified amount to Rs 17.35 Lacs, with an investment requirement of Rs 63 Lacs. Implementing these measures will lead to substantial energy savings, improved sustainability, and reduced operational costs for SGC. **With the above improvements the capital cost will be recoverable in 3- 5 years' span & thereafter and there on the savings will be adding to the overall financial health of the institute.**

The audit underscores the importance of a proactive approach to energy management and sustainability in educational institutions. In this way, SGC can significantly reduce its environmental impact, enhance the campus's learning environment, and position itself as a leader in energy management within the educational sector.

6. Recommendations

To achieve the optimum benefits and in the true spirits of this Energy Audit, the occupier of the institute is required to implement the major improvements/changes at ground level. Needless to say that the purpose and basic spirit of the Energy Audit would be defeated in the absence of transpiring the changes/improvements to practicality at ground level. With all the narrations/calculations/data summed up, following suggestions/recommendations are enlisted:

- Installations of 100KW solar plant.
- Replacement of existing street lights with solar lights.
- Replacement of old inefficient ACs with 5 star inverter ACs.

- Replacement of normal fans with BLDC fans.
- Replacement of old pumps with IE4 power efficient pumps
- Increase the capacity of APFC up to 102KVAr.

This comprehensive approach not only aligns with global sustainability goals but also ensures long-term financial health and operational excellence for SGC

CHAPTER 1

INTRODUCTION

1.1 ABOUT SGC

SGC, with its 20 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.

The Institute offers a wide range of undergraduate and graduate programs in various disciplines, emphasizing rich academic experience and experiential learning opportunities. It is dedicated to providing students with a well-rounded education that includes both theoretical knowledge and hands-on learning opportunities. The college offers a diverse range of academic programs such as Ayurveda, Nursing, Pharmacy, Paramedical sciences & physiotherapy.

Located near the city of Chandigarh, the Institute provides a convenient and accessible location for students. The college aims to ensure the overall growth and development of its students by offering a wide range of extracurricular activities in sports, cultural, social, and technical areas.

In addition to its academic offerings, it has established partnerships with many international universities and colleges such as University of Ghana, Synergy University Russia, Gambia college, School of Nursing & Midwifery, Daffodil international University, Bangladesh, Institution of Education, Baranavichy state university, Belarus. 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, SGC is committed to equipping students with the knowledge, skills, and experiences necessary for successful career development and personal growth.

SGC has continuously strived to:

- Create an environment that nurtures creativity, critical thinking, and problem-solving skills.
- Provide comprehensive and holistic education that focuses on the overall development of students.

- Promote a culture of ethical values, leadership, and social responsibility among students.
- Foster a spirit of innovation and entrepreneurship in students.
- Provide state-of-the-art infrastructure and facilities for research and learning.
- Ensure the continuous professional development of faculty members.
- Establish strong industry linkages for internships, placements, and collaborative research projects.
- Encourage students to participate in extracurricular activities for overall personality development.
- Contribute to society through various community service initiatives.
- Instill a sense of pride and belongingness in students and alumni towards the institution.

The placement season at SGC saw participation from a wide range of companies across various sectors. Some of the prominent companies that visited the campus include Federal Bank Ltd., Whirlpool India, & Hafele India Pvt. Ltd. KPMG Global Services, Grasim Industries Ltd., Deloitte, Puma, Axis Bank, Joyalukkas India LTD, & many others. The average package offered during the placement season stood at Rs. 5 LPA.

The institution witnessed a robust recruitment drive with 9000-plus placement offers and more than 900 companies visiting the campus. The highest package of Rs 14.13 LPA from Federal Bank Ltd. was bagged by a student of SGC. The successful placements at SGC can be attributed to the strong industry connections and collaborations that the institution has in place. The placement cell of the institution works closely with the industry to understand their requirements and tailor the curriculum accordingly.

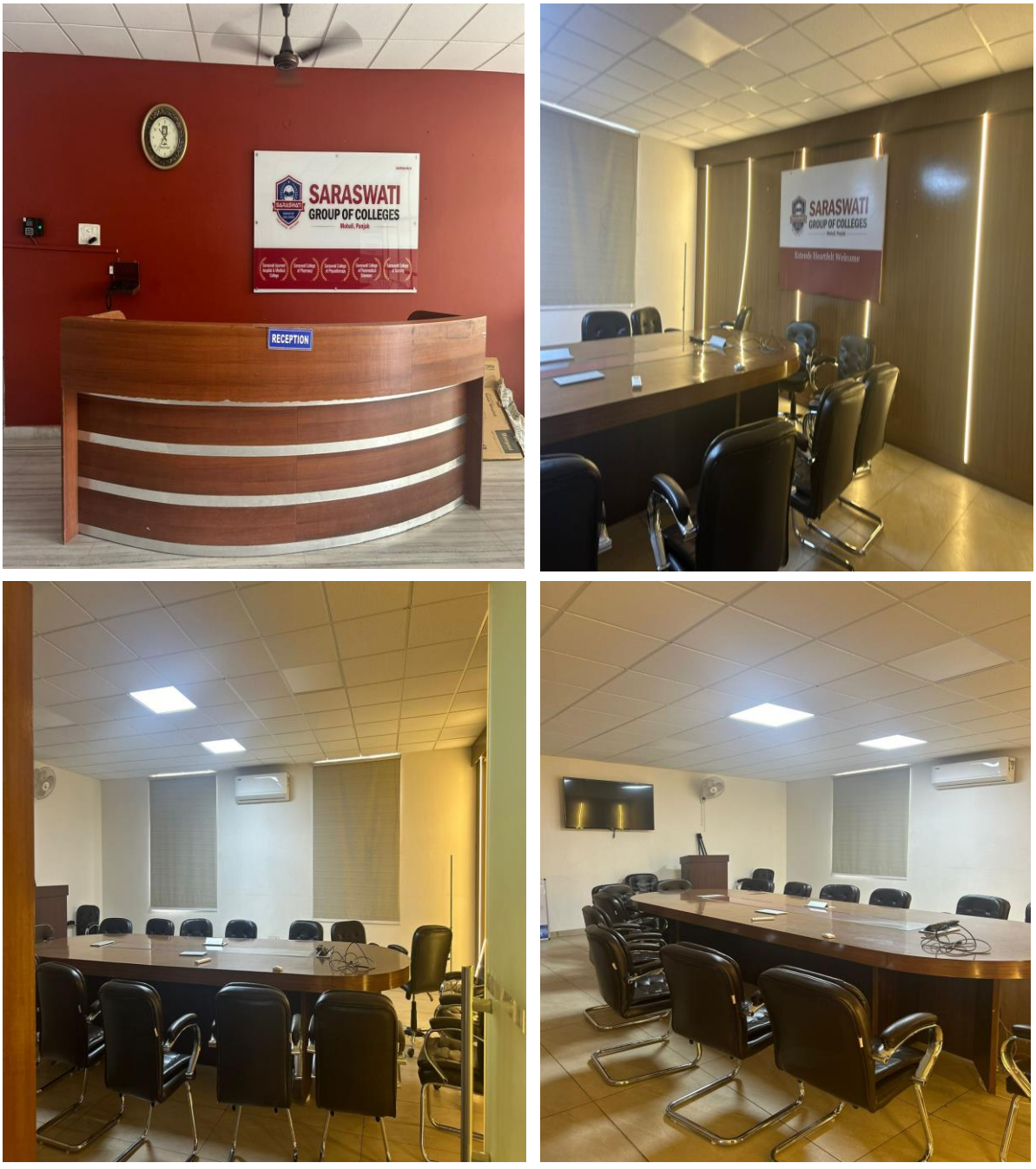


Figure 1-1 Photograph of College Interiors

1.2 ABOUT ENERGY AUDIT

An energy audit is a systematic process aimed at evaluating energy consumption patterns, identifying inefficiencies, and proposing measures to improve energy efficiency and reduce costs. It plays a significant role in promoting sustainability by helping institutions understand their energy usage and implement strategies for conservation. The components of an energy audit typically include data collection, analysis of energy consumption, evaluation of the efficiency of existing systems, and Recommendations for energy-saving measures.

The significance of conducting an energy audit at an educational institution like Saraswati Group of Colleges (SGC) lies in its potential to promote environmental sustainability, reduce operational costs, and enhance the overall efficiency of campus facilities. By systematically assessing energy usage, the audit helps identify key areas where improvements can be made, leading to long-term benefits for both the institution and the environment.

Objectives

The objectives of an energy audit can vary from one facility to another. However, an energy audit is usually conducted to understand how energy is used within the plant and to find opportunities for improvement and energy saving. Sometimes, energy audits are conducted to evaluate the effectiveness of an energy efficiency project or program.

Types of energy audits

The type of facility energy audit conducted depends on the function, size, and type of the facility, the depth to which the audit is needed, and the potential and magnitude of energy savings and cost reduction desired. Based on these criteria, an facility energy audit can be classified into two types: a preliminary audit (walk-through audit) and a detailed audit (diagnostic audit).

Preliminary audit (Walk-through audit)

In a preliminary energy audit, readily-available data are mostly used for a simple analysis of energy use and performance of the plant. This type of audit does not require a lot of measurement and data collection. These audits take a relatively short time and the results are more general, providing common opportunities for energy efficiency. The economic analysis is typically limited to calculation of the simple payback period, or the time required paying back the initial capital investment through realized energy savings.

Detailed audit (Diagnostic audit)

For detailed (or diagnostic) energy audits, more detailed data and information are required. Measurements and a data inventory are usually conducted and different energy systems (pump, fan, compressed air, steam, process heating, etc.) are assessed in detail. Hence, the time required for this type of audit is longer than that of preliminary audits. The results of these audits are more comprehensive and useful since they give a more accurate picture of the energy performance of the plant and more specific recommendation for improvements. The economic analysis conducted for the efficiency measures recommended typically go beyond 3 the simple payback period and usually include the calculation of an internal rate of return (IRR), net present value (NPV), and often also life cycle cost (LCC)

1.3 PURPOSE OF THE REPORT

The primary objective of this energy audit report for Saraswati Group of Colleges (SGC), Mohali, conducted by Eco Paryavaran Laboratories and Consultants, is to provide an in-depth analysis of the current energy consumption patterns and identify opportunities for energy efficiency improvements. This audit aims to:

- Establish a baseline of the present energy consumption pattern
- Identify Energy Efficiency Measures (EEMs) that can lead to sustained energy savings on the campus
- Prepare a comprehensive action plan for implementing these measures.

CHAPTER 2

PROJECT DESCRIPTION

2.1 PROJECT LOCATION

Saraswati Group of Colleges (SGC), Gharuan, Mohali, is a prominent educational institution situated in the city of Mohali, Punjab. The campus is strategically located in a region that experiences a typical North Indian climate characterized by hot summers, mild 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 2-1 Location details of the project

S.No.	Particulars	Details
1.	**Location**	NH-05, Ludhiana, Chandigarh NH, Gharuan Punjab (India)
a)	**Place**	Punjab
b)	**Tehsil**	Mohali,
c)	**District**	Mohali,
d)	**State**	Punjab
e)	**Latitude**	30°46’45.2’’N
f)	**Longitude**	76°33’24.8’’E

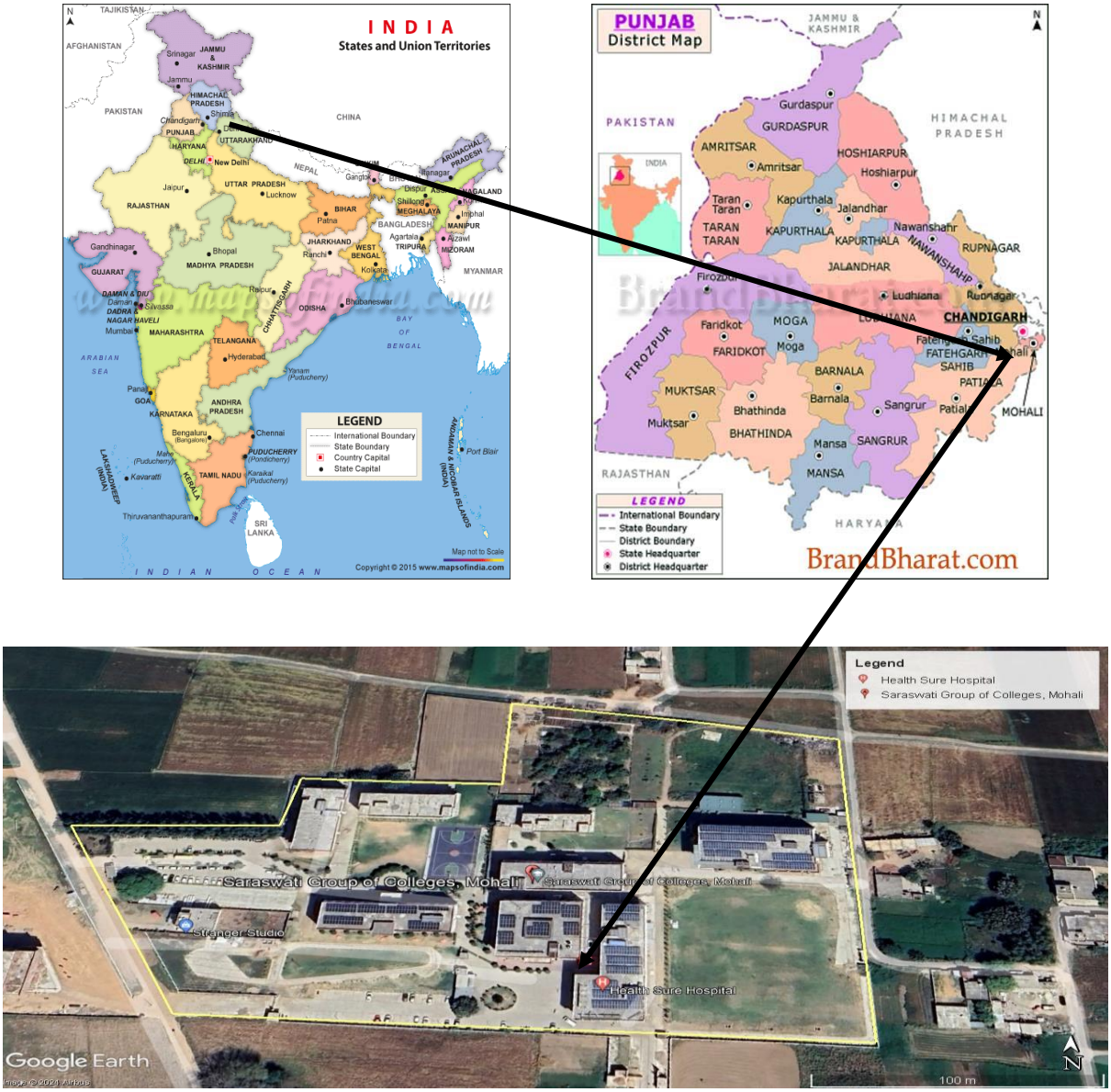


Figure 2-1 Location of the project

2.2 METEOROLOGICAL DATA

The climate data for SGC, Mohali, 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: Hot and dry, with temperatures often exceeding 40°C.
- Winters: Mild and pleasant, with temperatures ranging between 5°C to 20°C.

- Monsoon: Moderate rainfall, primarily occurring from July to September.

Site reference conditions

Climate data location	India - Chandigarh - Chandīgarh		Facility location	India - PB - Sahibzada Ajit Singh Nagar

	Unit	Climate data location	Facility location	Source
Latitude		30.8	30.7	
Longitude		76.8	76.7	
Climate zone		2A - Hot - Humid		NASA
Elevation	m	586	302	NASA – Map
Heating design temperature	°C	4.9		NASA
Cooling design temperature	°C	33.4		NASA
Earth temperature amplitude	°C	22.4		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	12.3	39.6%	23.25	3.57	94.9	2.8	11.0	177	71
February	15.0	39.0%	33.88	4.61	94.8	3.2	14.2	84	140
March	20.6	31.9%	22.63	5.71	94.5	3.4	20.4	0	329
April	26.7	23.9%	17.70	6.81	94.2	3.5	27.2	0	501
May	31.9	20.4%	27.59	7.42	93.8	3.5	33.1	0	679
June	33.1	32.9%	115.50	7.12	93.4	3.0	34.5	0	693
July	30.3	59.7%	232.19	5.89	93.4	2.5	31.2	0	629
August	28.0	71.8%	234.36	5.46	93.7	2.2	28.3	0	558
September	26.2	64.8%	132.00	5.62	94.0	2.2	26.0	0	486
October	22.6	44.6%	13.64	5.29	94.5	2.5	21.6	0	391
November	18.1	35.5%	3.90	4.32	94.8	2.6	16.4	0	243
December	14.1	36.2%	11.16	3.45	95.0	2.7	12.2	121	127
Annual	**23.3**	**41.7%**	**867.80**	**5.44**	**94.3**	**2.8**	**23.0**	**382**	**4,847**
Source	NASA	NASA	NASA	NASA	NASA	NASA	NASA	NASA	NASA
Measured at					m	10	0		

Figure 2-2 Monthly representation of the above mentioned Parameters

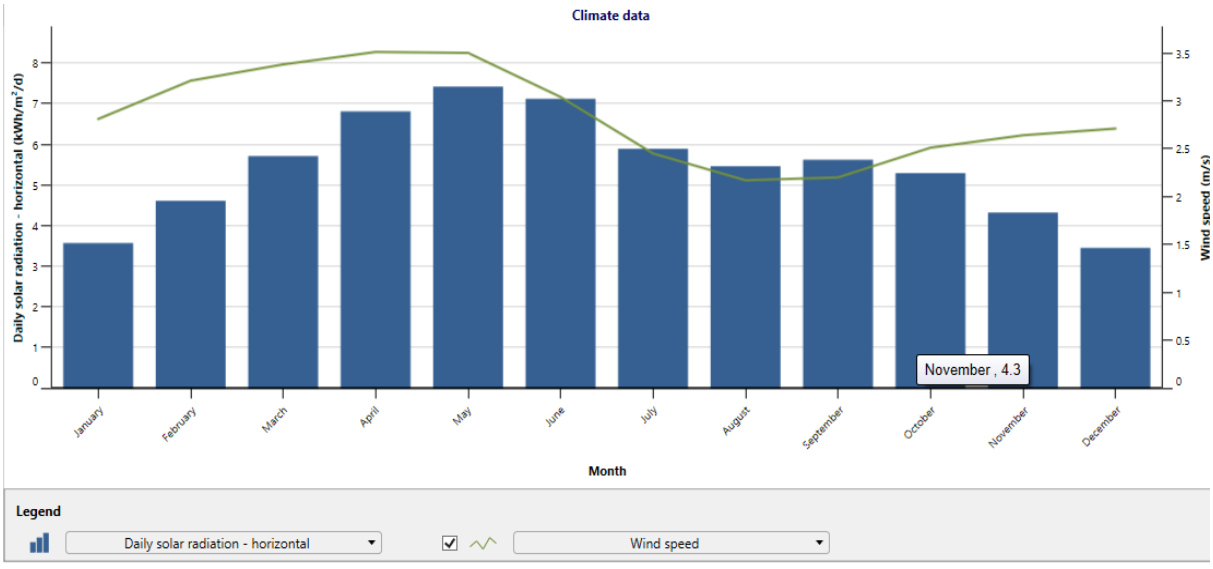


Figure 2-3 Graphical Representation of Solar Radiation & Wind Speed Month Wise

Wind Energy

Operating a wind power plant is more complex than simply erecting wind turbines in a windy area. Wind power plant owners must carefully plan where to position wind turbines and must consider how fast and how often the wind blows at the site.

Good places for wind turbines are where the annual average wind speed is at least 9 miles per hour (mph)—or 4 meters per second (m/s)—for small wind turbines and 13 mph (5.8 m/s) for utility-scale turbines. Favourable sites include the tops of smooth, rounded hills; open plains and water; and mountain gaps that funnel and intensify wind. Wind speeds generally increase with increasing elevation above the earth's surface. Large wind turbines are placed on towers that range from about 500 feet to as high as 900 feet tall.

The wind speed data in different states of data has been depicted in figure 2.4. Wind energy potential in the area of SGC is limited due to the relatively low average wind speeds. However, solar energy remains a viable and effective renewable energy source for the campus.

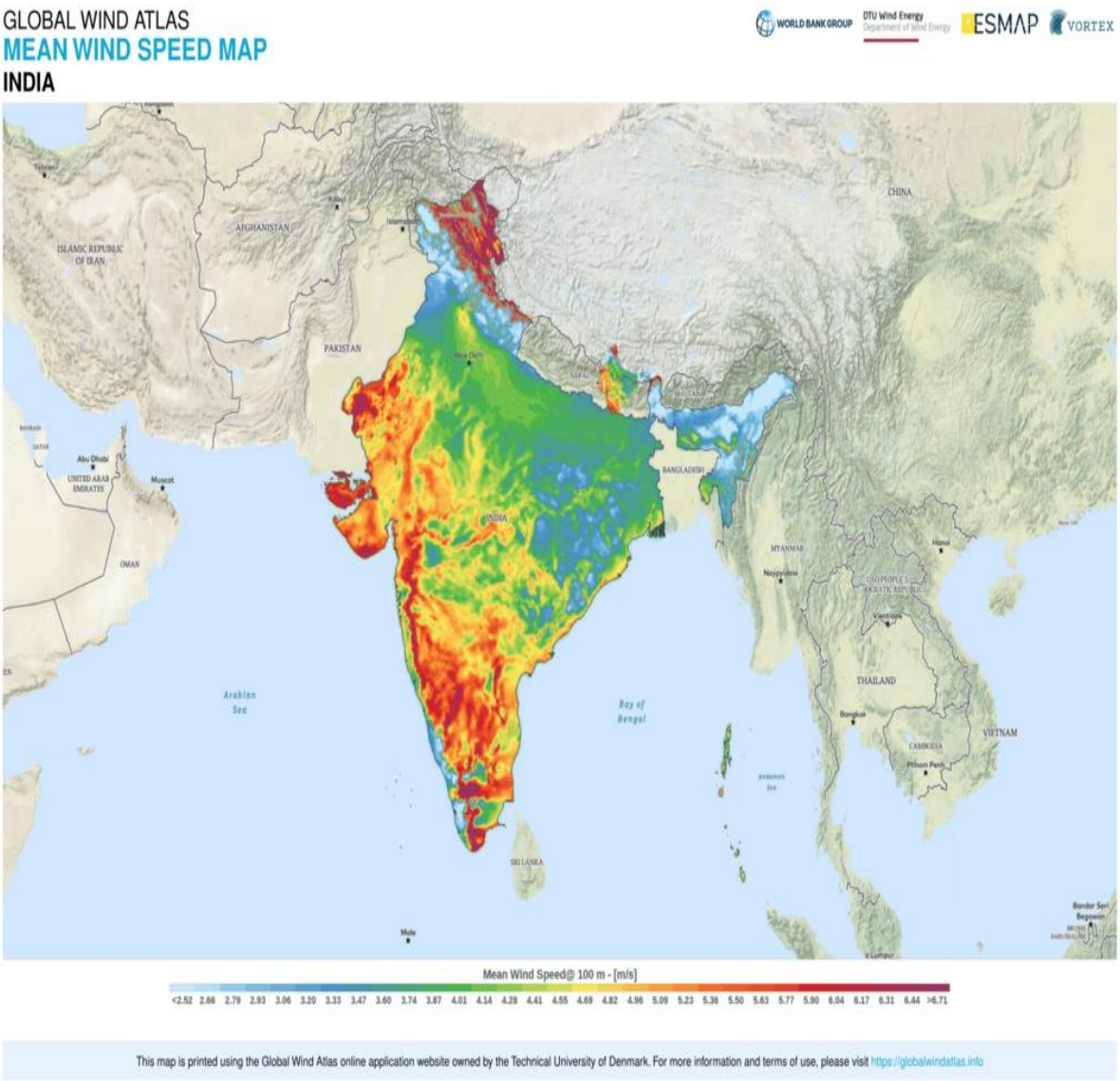


Figure 2-4 wind speed data in various states of India

2.3 BRIEF PROJECT DETAILS

The energy audit conducted at Saraswati Group of Colleges (SGC), Mohali, aimed to evaluate the current energy consumption patterns and identify opportunities for energy efficiency improvement. The details of the project are listed below in Table 2.2.

Table 2-2 Project Details

S.No.	Particulars	Details
1.	**Project Details**	
a.	**Name of the Block/Building**	Saraswati Group of Colleges
b.	**Ground Covered Area**	254338.7 sq ft
c.	**Connected load/Contracted demand of building**	319.6KW/320 KVA
d.	**Alternate source of energy (Solar/ Wind) in institute (Type and capacity)**	Solar Panels • 180KWp • 120KWp This solar energy is being purchased @ Rs.4.5 & Rs.5.5/unit respectively.
2.	**Components contributing power Load in the Campus**	
a.	**Type/ No. of Lights**	Tube lights-857No.s. (34.2KW), Flood light-16No.s. (2.4KW), Street Lights-28No.s. (2.8KW)
b.	**Type/ No. of Air Conditioner**	28 No's. (47.1KW)
c.	**Type/ No Fans**	Fans -1001 No's. (75KW)
d.	**Type/ No DG**	1 (200KW)
e.	**Type/ No -Other equipment and electrical appliances**	Exhaust fan-35 No's. (1.4KW), Iron 3 (500w), Refrigerator 1 (400w)
f.	**Type/ No E-vehicles**	N/A

2.4 IMPORTANCE OF THE STUDY

The energy audit and subsequent implementation of energy efficiency measures at Saraswati Group of Colleges (SGC), Mohali, hold significant importance for several reasons:

1. Energy Efficiency and Cost Savings:
    - Conducting a comprehensive energy audit helps identify areas where energy consumption can be reduced. This leads to significant cost savings on utility bills, which can be redirected towards other essential academic and operational activities.
2. Environmental Sustainability:
    - By implementing energy-efficient technologies and renewable energy solutions, SGC can significantly reduce its carbon footprint. This aligns with global sustainability goals and demonstrates the institution's commitment to environmental stewardship.
3. Enhanced Learning Environment:
    - Improving energy efficiency ensures a more comfortable and conducive learning environment for students and staff. Better lighting, climate control, and reliable power sources contribute to overall well-being and productivity.
4. Compliance with Regulations:
    - The project ensures that the institution complies with national and local energy regulations and standards. This not only avoids potential legal issues but also positions SGC as a leader in energy management in the educational sector.
5. Educational Impact:
    - The project serves as a live case study for students, particularly those studying environmental science, engineering, and related fields. It provides practical insights into energy management, sustainability practices, and the implementation of green technologies.
6. Community Leadership:
    - By undertaking such a project, SGC sets an example for other educational institutions and organizations in the region. It showcases how proactive measures can lead to substantial benefits, encouraging others to follow suit.
7. Long-term Benefits:
    - The long-term benefits of reduced energy consumption and lower operational costs contribute to the financial health of the institution. This ensures that SGC can continue to invest in quality education and infrastructure improvements.

In summary, the energy audit and implementation project at SGC, Mohali, is crucial for promoting energy efficiency, sustainability, and overall institutional excellence. It reflects a forward-thinking approach that balances economic, environmental, and educational benefits.

CHAPTER 3

METHODOLOGY

3.1 METHODOLOGY

This section outlines the methodology used to conduct the energy audit at Saraswati Group of Colleges (SGC), Mohali. The methodology includes systematic data collection, analysis, and identification of energy efficiency measures aimed at reducing energy consumption and enhancing sustainability on the campus.

3.2 DATA COLLECTION

A team of engineers/Experts visited the SGC 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 Punjab 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.

3.3 ANALYSIS

3.3.1 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.

3.3.2 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.

3.3.3 Benchmarking

SGC'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.

3.4 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.

3.5 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 4

OBSERVATION AND FINDINGS

4.1 INTRODUCTION

This chapter presents the key findings from the energy audit conducted at Saraswati Group of Colleges (SGC), Mohali. The findings are categorized into various aspects of energy consumption, environmental impact, and sustainability practices. Each section highlights the current state, potential areas for improvement, and recommendations for achieving energy efficiency and sustainability goals.

4.2 ENERGY CONSUMPTION ANALYSIS

The total energy consumption for the SGC campus is primarily met through electricity supplied by the Punjab Electricity Board and supplemented by solar energy installations and diesel generators.

Major energy-consuming areas include lighting, AC systems, and electrical equipment used in classrooms, laboratories, and administrative buildings.

There are two sources of electricity source in the facility

1. Main electricity with tariff rate of Rs. 6.69 Kw/h
2. Electricity from Generators
3. Electricity from Solar

The whole electrical bill per month of SGC come as a single. The KW rating of SGC is 320KW out of which 300KW is from solar panel. However campus is not using their own but they are purchasing the 300KW of solar energy from external source @ 4.50-5.15 per unit.

4.2.1 Main electricity consumption in college

It is the main electricity that is purchase from the “Punjab State Power Corporation Limited”. Electric power has two components- active power (kWh) & reactive power(kVArh). The combination of Active power & Reactive power forms Apparent power (KVAH). The six-month energy consumption of the college is shown in below table 4.1:

Table 4-1Monthly Electrical Bill

S.NO.	BILL MONTH	RATE/KWH	ACTIVE POWER (KWH)	APPARENT POWER (KVAH)	TOTAL COST (IN RS)	BILL NO.
1	JULY-2023	6.69	241055	249534	519740	20230721030002
2	AUG-2023	6.69	260919	269636	729230	20230821030004
3	SEP-2023	6.69	285347	294341	892910	20230926030007
4	OCT-2023	6.69	299468	308747	490460	20231023030154
5	NOV-2023	6.69	307032	306432	255190	20231123030159
6	DEC-2023	6.69	314715	324184	264350	20231220030009
7	JAN-2024	6.69	324337	333855	335680	20240123030040
8	FEB-2024	6.69	333019	342588	299790	20240220030020
9	MAR-2024	6.69	340341	349964	207150	20240321030013
10	APRIL-2024	6.69	349796	359513	225640	20240422030091
11	MAY-2024	6.69	365413	375384	493380	20240523030002

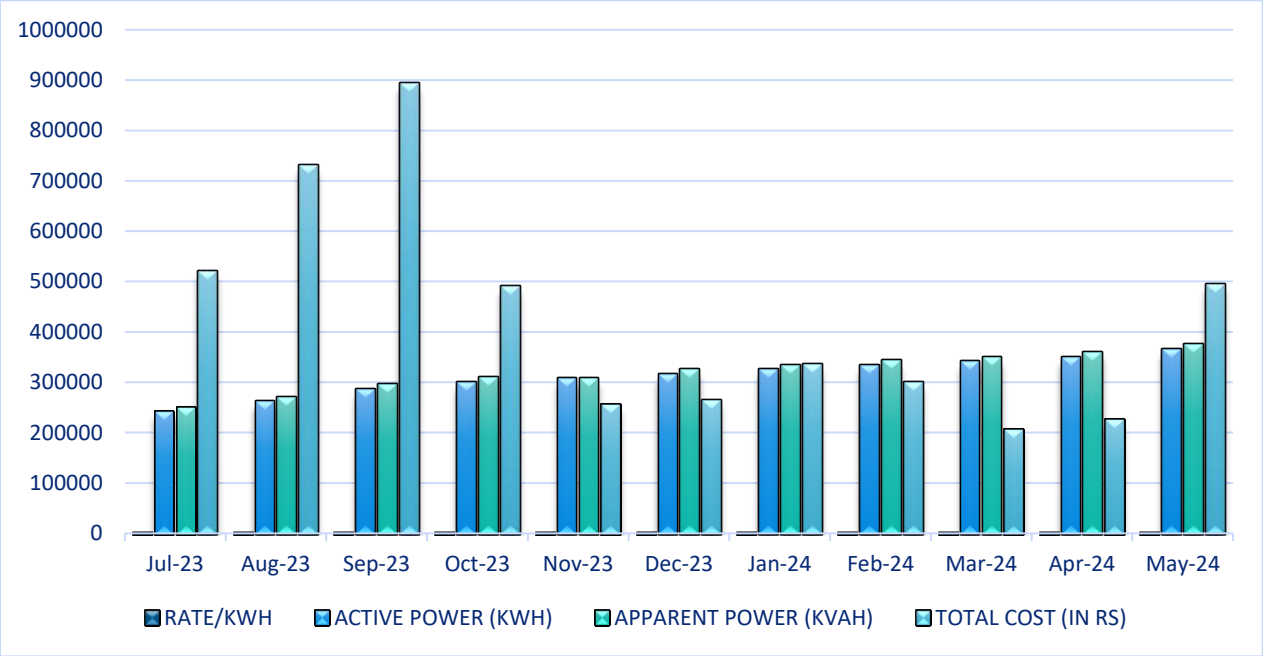


Figure 4-1 One year bill and energy consumption

From electricity bill, it is observed that there is the need to reduce the total KW load of the college. Because as per the Actual Demand given in the bill is only 197.44KVA only. Therefore, it is recommended to reduce the contract demand to 280 saving 32 units per month which would further lead to the saving of approximately Rs. 2300 per year.

4.2.1.1 Energy performance index of the campus (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/sq m/year. This index provides a straightforward and relevant indicator of whether a campus is energy efficient. For educational institutes like SGC, 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 4.2, which illustrates the energy benchmarks for commercial buildings. This comparison allows SGC to assess its energy efficiency relative to similar institutions and set targets for energy conservation.

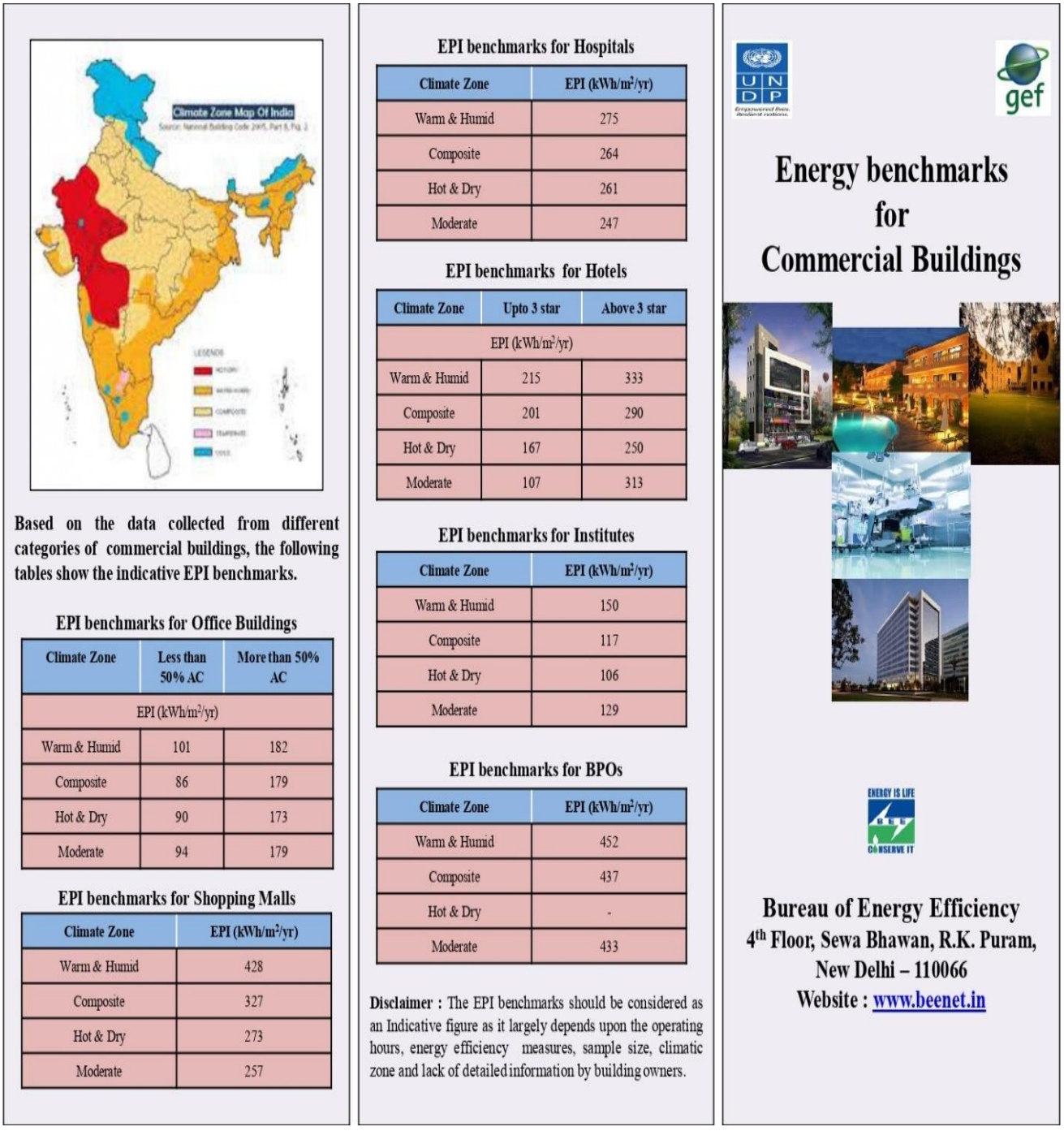


Figure 4-2 Energy benchmarks for commercial buildings

4.2.1.2 Calculations of EPI

To understand the energy performance of SGC, 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 4.2, the required EPI for an educational institution is 150 kWh/sq m/year. The calculations for SGC's EPI for the year 2023-24 are as follows:

Annual energy consumption during year 2023-24 = 3421442kWh

Total build up area of the campus = 23628.83sqm

EPI = 3421442/23628.83

EPI = 144kWh/sqm/year

The calculated EPI for SGC is 144 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 SGC in achieving its sustainability goals.

4.2.2 Energy source derived from fuel

SGC utilizes diesel generators (DG sets) as a backup energy source to ensure uninterrupted power supply during grid outages. SGC's campus has one DG set with a capacity of 200 KVA. This generator is installed in acoustic covers to minimize noise and is primarily used during power cuts
to provide in-house power generation. The following figure 4.3 illustrates the DG set installed at the college.

Figure 4-3: DG set at SGC

4.2.2.1 HSD Consumption of DG Sets

The diesel consumption of the DG set was monitored to evaluate its efficiency. The details for the fiscal year 2023-24 are presented below:

Table 4-2Diesel Consumption Details

Diesel consumption details	FY 23-24
Annual- Lts	137
Average cost per litre (Rs /lts)	78
Total Amount (Rs)	10686

4.2.2.2 Technical details of DG set of 200 kva

The technical specifications of the 200 KVA DG set are detailed in the table below:

Table 4-3Rated parameters of DG Sets

S.No.	Description	Details
1.	Make	SUDHIR
2.	Capacity-KVA	200
3.	Volts	415
4.	Amps	226.3
5.	Power factor	0.8 lag
6.	Rpm	1500
7.	Connection	Series
8.	Rated Power-KW	190
9.	Frequency-HZ	50

The voltage profile of the 200 KVA DG set during the one-hour test run is summarized below:

Table 4-4Voltage Profile DG-1

VOLTS	DATE	TIME	AVG	MINI	MAX	UNITS
U12 rms	6-05-2024	14:30:00.0	420.04	410.5	428.8	V
U23 rms	6-05-2024	14:30:00.0	424.17	415.9	430.4	V
U31 rms	6-05-2024	14:30:00.0	423.37	413.7	430.8	V
	Average	14:30:00.0	**422.53**	**VOLTS**		

The current profile of the 200 KVA DG set during the test run is detailed below:

Table 4-5Current Profile DG-1

AMPS	DATE	TIME	AVG	MINI	MAX	UNITS
A1 rms	6-05-2024	14:30:00.0	119.97	100	143	A
A2 rms	6-05-2024	14:30:00.0	635.706	512	781	A
A3 rms	6-05-2024	14:30:00.0	423.915	355.5	521.5	A
	Average	14:30:00.0	**393.19**	**AMPS**		

The power factor profile of the 200 KVA DG set during the one-hour test run is as follows:

Table 4-6Power Factor Profile DG-1

PF	DATE	TIME	AVG	MINI	MAX
PF1	6-05-2024	14:30:00.0	0.977	0.972	0.98
PF2	6-05-2024	14:30:00.0	0.97	0.964	0.979
PF3	6-05-2024	14:30:00.0	0.977	0.973	0.981
Average	6-05-2024	14:30:00.0	**0.974**		

4.2.2.3 Details of energy generated by 200 kva generator during trial :-

The performance of the 200 KVA DG set was analyzed during a trial run. The following data was collected and represented graphically in Figure 4.4.

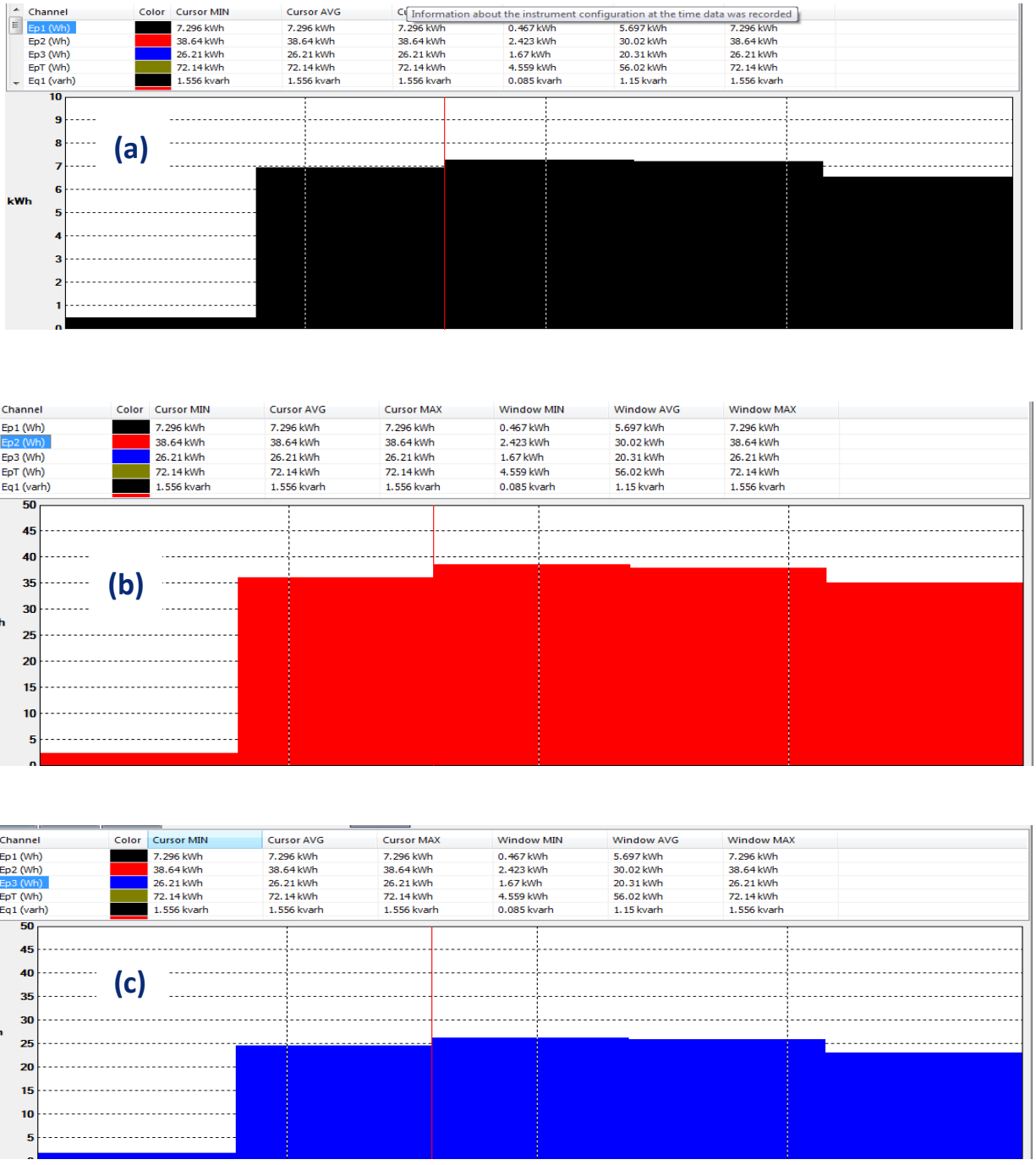


Figure 4-4 Energy Generated by 200 KVA DG Set on trial – (a) Phase-1, (b) Phase-2, and (c) Phase-3.

During the trial, the energy generation and efficiency metrics of the DG set were monitored and recorded. The complete data has been graphically represented to provide a clear view of the generator's performance under operational conditions.

4.2.2.4 Analysis of DG Set Performance

All the measurement data from the DG set trial has been analyzed to supplement management's efforts in further reducing energy costs. The following aspects were evaluated:

1. Specific Energy Consumption: It is crucial to monitor the specific energy consumption of the DG set. Energy meters installed on the set provide real-time data, and a logbook is maintained to record hours of operation and diesel consumption.
2. Effect of Temperature & Suction Pressure: For every 3.5°C increase in inlet air temperature, fuel consumption increases by 1%. The DG set is designed for an ambient temperature of 25 to 30°C. Higher temperatures and lower suction pressures decrease efficiency. The current status of the set is as follows:

    - Exhaust Pipes: Insulated to prevent heat loss.
    - Expansion Joint & Bend: Insulated to maintain efficiency.
    - Oil Pressure: Varied from 4.9 to 5.1 kg/sq cm, found satisfactory.
    - Water Temperature: Ranged from 40 to 48°C, found on the lower side.
    - Load Handling: With a balanced load, the set can be loaded up to 75% of its capacity. With power factor control, it can be loaded up to 85%.
    - Supply Voltage: The average voltage of the DG set is 422.5V.
    - Power Factor: The DG set operates at a power factor of 0.973, which is higher than the standard 0.8.

The load power factor is dependent on the load, and the AC generator is designed for a power factor of 0.8 lag as specified by standards. Regular monitoring and maintenance of these parameters are essential to ensure optimal performance and efficiency of the DG set.

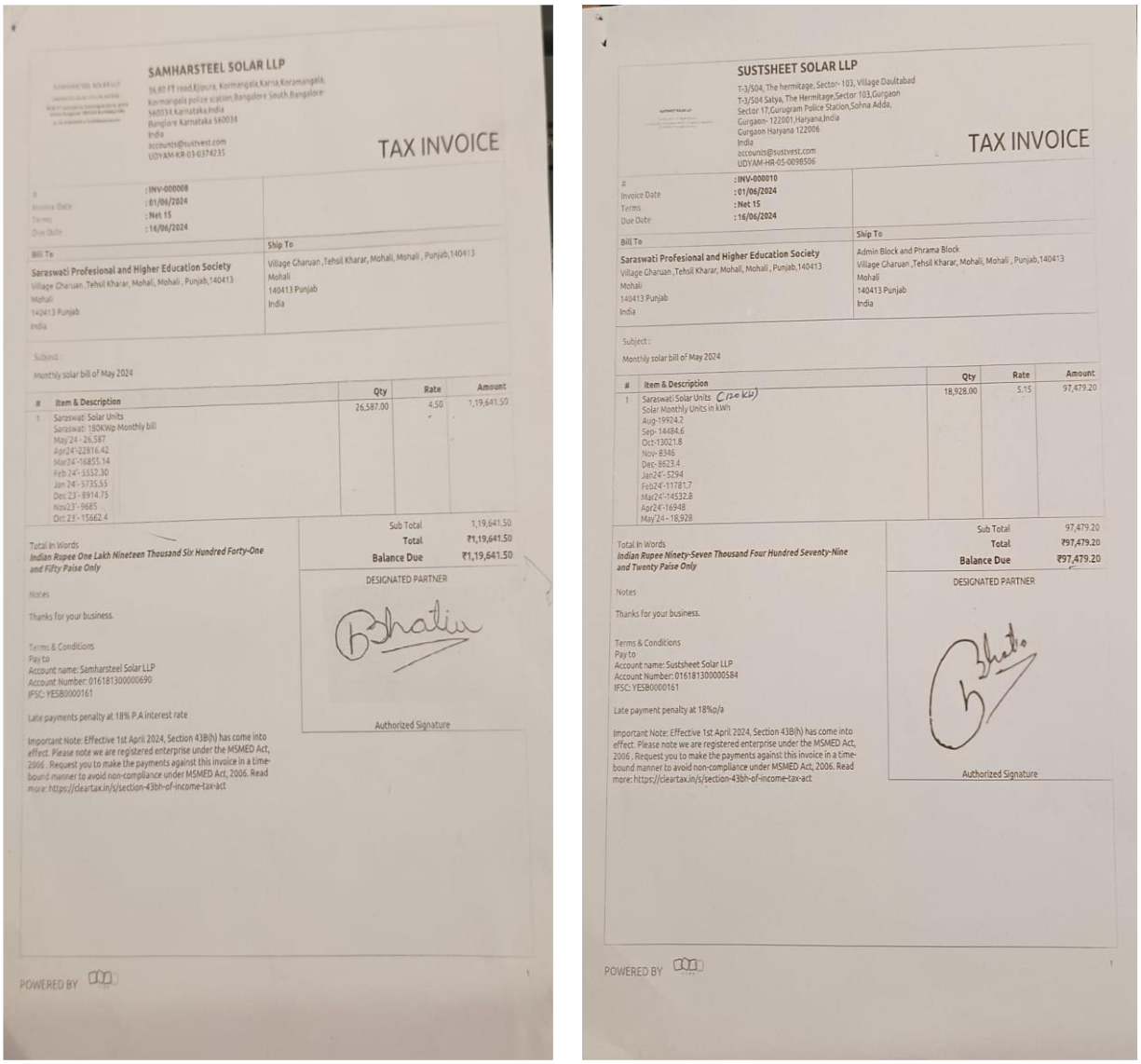
4.2.3 Renewable energy options

SGC has actively integrated solar energy into its energy mix, demonstrating a strong commitment to renewable energy. The campus currently has solar panels installed with a capacity of 100 KW. These solar panels are strategically positioned to maximize exposure to sunlight, ensuring optimal energy production. The generated solar energy significantly reduces the campus's dependence on grid electricity, leading to substantial cost savings and a reduction in the carbon footprint. During the audit period, it was noted that the solar panels are performing efficiently, contributing a notable portion of the campus's energy requirements. Plans are in place to expand the solar energy capacity from 100 KW to 150 KW. This expansion is expected to further enhance the sustainability of the campus and increase the share of renewable energy in the total energy mix. The details of Solar Panels installed are as follows:

Figure 4-5: Picture showing the installed solar panel

4.2.3.1 Monthly expenditure of Solar Power System

Solar energy is one of the most widely used renewable source of energy one can use renewable energy technologies to convert solar energy in to electricity, it is very reliable source of energy and can significantly reduce the electricity bills. Currently the college is purchasing the solar energy from "SUSTSHEET SOLAR LLP". The institution has taken two solar units one of 120KW and other of 180KW. The bills of which are demonstrated below :-



SAMHARSTEEL SOLAR LLP

TAX INVOICE

Saraswati Profesional and Higher Education Society

Monthly solar bill of May 2024

#	Item & Description	Qty	Rate	Amount
1	Saraswati Solar Units Saraswati 180KWp Monthly bill May'24 - 26,587 Apr24'-22816.42 Mar24'-16855.14 Feb 24'-5552.30 Jan 24'- 5735.55 Dec 23 - 8914.75 Nov23'- 9685 Oct 23'- 15662.4	26,587.00	4.50	1,19,641.50

Sub Total 1,19,641.50
Total ₹1,19,641.50
Balance Due ₹1,19,641.50

Total in Words
Indian Rupee One Lakh Nineteen Thousand Six Hundred Forty-One and Fifty Paise Only

DESIGNATED PARTNER

Authorized Signature

Notes
Thanks for your business.

Terms & Conditions
Pay to
Account name: Samharsteel Solar LLP
Account Number: 016181300000690
IFSC: YESB0000161

Late payments penalty at 18% P.A interest rate

Important Note: Effective 1st April 2024, Section 43B(h) has come into effect. Please note we are registered enterprise under the MSMED Act, 2006 . Request you to make the payments against this invoice in a time-bound manner to avoid non-compliance under MSMED Act, 2006. Read more: https://cleartax.in/s/section-43bh-of-income-tax-act

POWERED BY

SUSTSHEET SOLAR LLP

TAX INVOICE

Saraswati Profesional and Higher Education Society

Monthly solar bill of May 2024

#	Item & Description	Qty	Rate	Amount
1	Saraswati Solar Units (120 kW) Solar Monthly Units in kWh Aug-19924.2 Sep-14484.6 Oct-13021.8 Nov-8346 Dec-8623.4 Jan24'-5294 Feb24'-11781.7 Mar24'-14532.8 Apr24'-16948 May'24 - 18,928	18,928.00	5.15	97,479.20

Sub Total 97,479.20
Total ₹97,479.20
Balance Due ₹97,479.20

Total in Words
Indian Rupee Ninety-Seven Thousand Four Hundred Seventy-Nine and Twenty Paise Only

DESIGNATED PARTNER

Authorized Signature

Notes
Thanks for your business.

Terms & Conditions
Pay to
Account name: Sustsheet Solar LLP
Account Number: 016181300000584
IFSC: YESB0000161

Late payment penalty at 18%p/a

Important Note: Effective 1st April 2024, Section 43B(h) has come into effect. Please note we are registered enterprise under the MSMED Act, 2006 . Request you to make the payments against this invoice in a time-bound manner to avoid non-compliance under MSMED Act, 2006. Read more: https://cleartax.in/s/section-43bh-of-income-tax-act

POWERED BY

Figure 4-6 showing the bill of solar power purchased

The tables and figures below demonstrate the monthly power consumption bills for the 180KW and 120KW solar systems for the year 2023-24.

Table 4-7Monthly power consumption bill of 180 KWH

S.No	Month	Power Consumption (KWH)	Rate	Amount
1	Aug-23	-	-	-
2	Sep-23	-	-	-
3	Oct-23	15662.4	4.5	70480.8
4	Nov-23	9685	4.5	43582.5
5	Dec-23	8914.75	4.5	40116.375
6	Jan-24	5735.55	4.5	25809.975
7	Feb-24	5552.3	4.5	24985.35
8	Mar-24	16855.14	4.5	75848.13
9	Apr-24	22816.42	4.5	102673.89
10	May-24	26587	4.5	119641.5

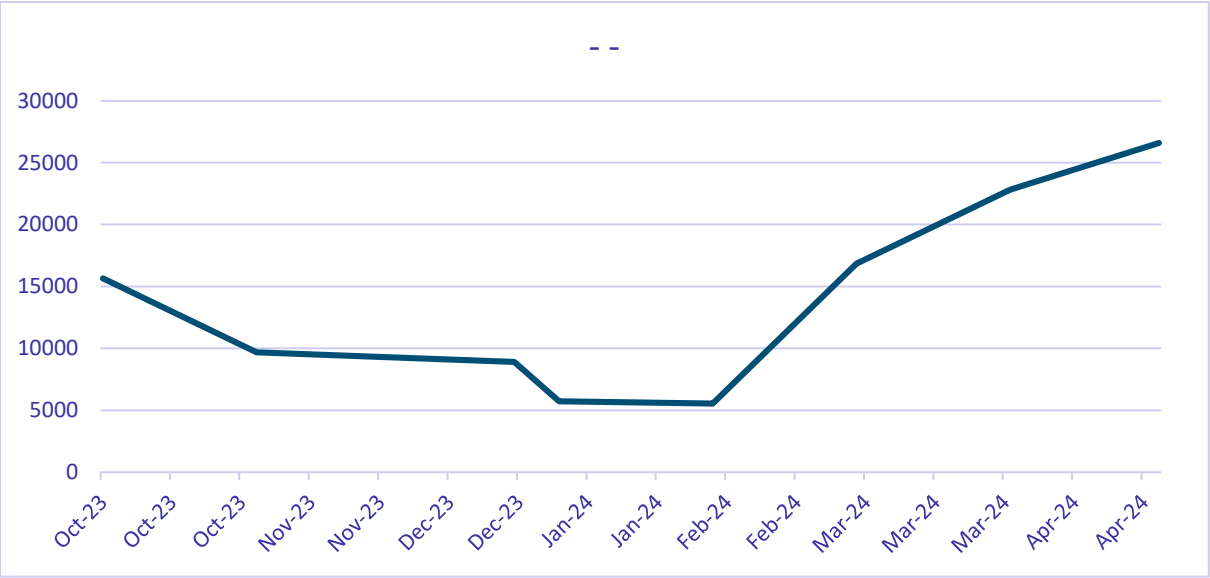


Figure 4-7 Monthly power consumption bill of 180 KWH

Table 4-8Monthly power consumption bill of 120 KWH

S.No	Month	Power Consumption (KWH)	Rate	Amount
1	Aug-23	19924.2	5.15	102609.63
2	Sep-23	14484.6	5.15	74595.69
3	Oct-23	13021.8	5.15	67062.27
4	Nov-23	8346	5.15	42981.9
5	Dec-23	8623.4	5.15	44410.51
6	Jan-24	5294	5.15	27264.1
7	Feb-24	11781.7	5.15	60675.755
8	Mar-24	14532.8	5.15	74843.92
9	Apr-24	16948	5.15	87282.2
10	May-24	18928	5.15	97479.2

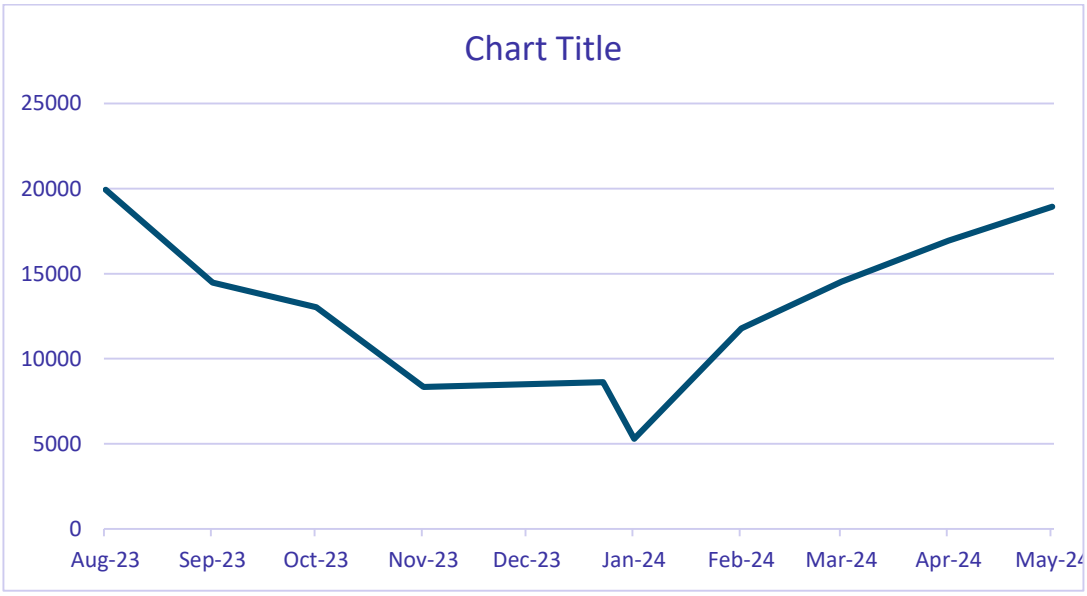


Figure 4-8. Monthly power consumption bill of 120 KWH

The above figures illustrate the annual solar energy bill assessment of SGC for the 180KWp and 120KWp solar systems. Currently, power is sourced from the PSPCL at 11 kV, which is subsequently stepped down to 433 V using one transformer of 400 KVA. Power is also generated using one DG set of 200KVA.

It is recommended to install a 100 KW rooftop solar power plant (without battery backup). The college building has ample rooftop space on hostels and auditorium buildings. The average power generation from a 1 KW SPV system is around 4-5 kWh per day. Since the proposed SPV system does not have a battery backup, grid connection would be required to meet the power requirements during the night. Also, the SPV power generation varies with the time of day, and the balance power requirements are automatically met by the grid supply during this period.

Photo Voltaic Overview

The following are the salient features of the photovoltaic project

Table 4-9Solar plant details of 100KW

Item	Description	Details
1	Project Type	CAPTIVE USE
2	Approval Scheme of Project	MNRE
3	Plant Capacity	100 kW
4	Project Location	Mohali
5	Project Applicant Name	SGC College ,Punjab
6	Technology – Modules	Polycrystalline Silicon Technology
7	Inverter type	String inverters
8	Mounting Structure	Fixed Tilt- Rooftop
9	Evacuation Voltage	440 V
10	Area Required	Approx. 700 Sq. m
11	Annual Energy generation estimated end of 1st year	187200 kWh in the first year with Crystalline Silicon Module with fixedmounting structure.

The cost of installing a solar PV system has reduced considerably over the years, making grid-interactive solar PV plants increasingly popular. The proposed 100 KW system would be integrated with the existing LT supply and operate under auto synchronism with the grid. Batteries are not required as the utilization is focused during the daytime. Some of the salient features include:

- Provides uninterrupted & stable DC/AC power supply to dedicated load.
- No noise and easy to install.
- Simple to operate and pollution-free working.
- Low maintenance cost with long-life generating panels.
- Soft loan availability/installation under ESCO mode is also available.

4.2.3.2 Operation and Maintenance

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.

4.2.3.3 Calculations for the monetary benefits by the proposed 100KWp solar system

The following table presents the installation and energy savings calculations for a proposed 100 KW solar rooftop grid-interactive power plant.

Table 4-10Installation of a 100 KW Solar Roof Top Grid Interactive Power & Plant Energy Savings Calculations

Parameters	**Units**	**Values / Inputs**
Source of Power	-	Solar PV
Rated capacity of the Solar PV System-KW	kW	100
Estimated number of Modules-nos.	No.	220
Expected Annul Power Generation	kWh /Year	187200
Overall Purchased Power Rate	Rs. /kWh	6.69
Monetary Benefits	Rs. /Year	**1252368**
Investment Required @ Rs.0.50 Lakh /kW	Rs. Lakh	50
Simple Payback Period	Years	3.99

If the college installs the proposed 100KW solar panels on the grid, the total project cost would be Rs. 50 Lakhs, and the annual power generation would be 187,200 kWh. The payback time would be 3.99 years, after which the energy would be free. It is also suggested to optimize the utilization of solar energy, as the college currently takes 300KW of solar energy while having an overall contract demand of 320KW. Analysis of electrical bills indicates low utilization of solar energy, resulting in higher electricity bills.

4.3 INFRASTRUCTURE AND EQUIPMENT ASSESSMENT

4.3.1 Transformers

The SGC campus has one distribution transformer with a capacity of 400 KVA, which steps down the voltage from 11 KV to 433V. This transformer is critical for managing the electrical distribution across the campus. Below is a picture of the 400 KVA transformer.

Figure 4-9 400KVA Transformer

The image in Figure 4.9 shows the 400 KVA transformer and its information plate. Using an Energy Analyzer, we recorded the voltage profile and the current profile of the transformer, as detailed below.

4.3.2 Transformers Readings (400 KVA)

The voltage unbalance for the transformer was measured at 0.82%, which is within the acceptable limit as per IEEE standards (an unbalance of up to 2% is generally acceptable and does not affect the cable significantly).

Table 4-11 Voltage profile of transformer

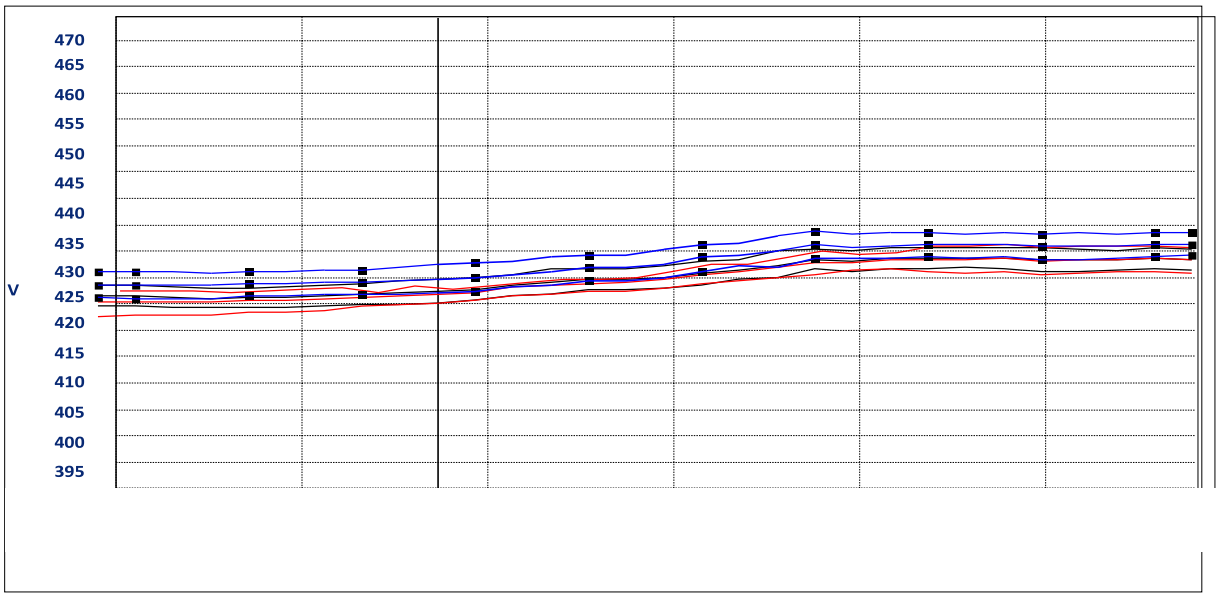


Table 4-12Description of lines from voltage profile (figure 4.10).

Urms Line 1	Urms Line 2	Urms Line 3	Average	%age im- balance
438.50	441.02	438.60	439.37	**0.82**

The current profile for the transformer showed an unbalance (as shown in figure 4.11), which could lead to overheating of electrical components if not addressed.

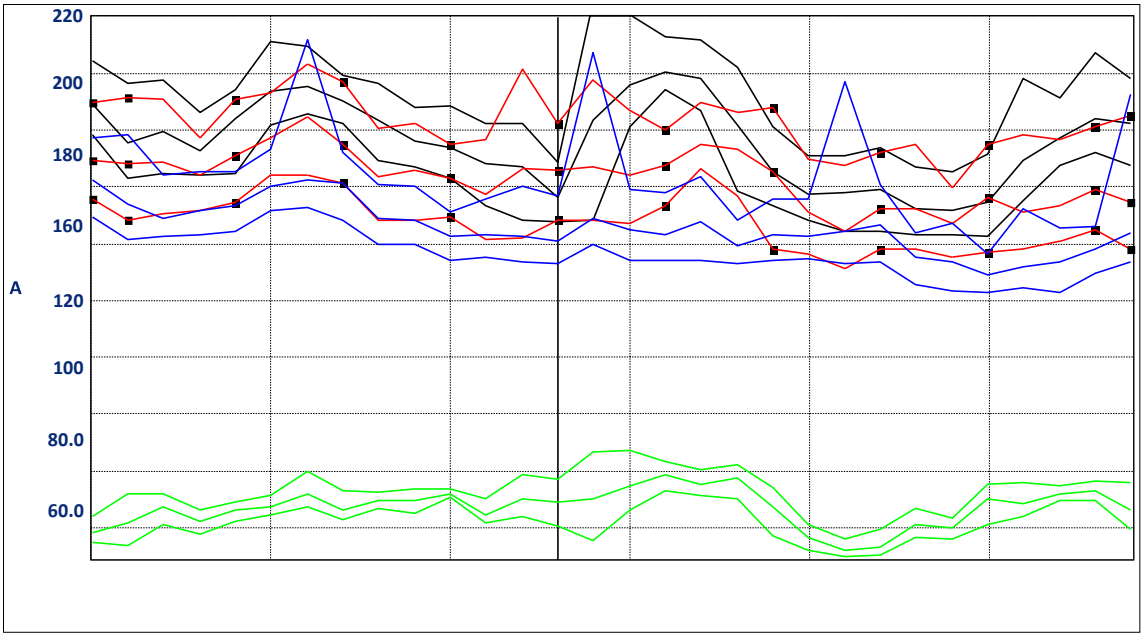


Figure 4-10: Current profile of transformer 3

Table 4-13Description of lines from above figure

Arms	Arms	Arms	Average	%age
Line 1	**Line 2**	**Line 3**		**im- balance**
193.5	210.6	306.5	236.8	47.49

An unbalanced load occurs when significantly more power is drawn from one phase compared to others. This can lead to overheating and potential overloading of the electrical components. The unbalanced current was observed to be 8.6%, which does not indicate a fault but highlights the need for better load distribution. All single-phase loads should be distributed across the three-phase system to ensure balanced loading on the transformer.

4.3.3 Mechanical systems

The assessment included evaluating mechanical systems such as water pumps, compressors, and ventilation fans. These systems were found to be in good condition. However, periodic maintenance is essential to maintain their efficiency and ensure optimal performance.

4.3.4 Building envelope

The inspection of the building envelope, which includes walls, roofs, windows, and doors, revealed that the insulation and sealing are generally adequate. However, there are opportunities to improve energy efficiency by enhancing insulation in certain areas. Improving insulation and sealing can significantly reduce energy loss and improve overall energy efficiency.

4.3.5 Office/classroom equipment

The review of energy consumption by office equipment (computers, printers, etc.) and classroom equipment (projectors, smart boards, etc.) indicated that most devices are relatively energy-efficient. However, upgrading to more energy-efficient models and implementing policies for turning off equipment when not in use can further reduce energy consumption.

By implementing these measures, SGC can significantly enhance its energy efficiency, reduce operational costs, and minimize its environmental impact. Regular monitoring and maintenance will ensure sustained improvements and help maintain the efficiency of infrastructure and equipment.

4.4 LIGHTING SYSTEMS & OTHER POWER CONSUMPTIONS

4.4.1 Street lights & flood lights

Street lights are a crucial component of energy management within the campus. It has been observed that the institution has adopted 15% of solar street lights to meet their total lighting needs. Below is an image showing the street lights used by the college.

Figure 4-11 Street light used by the college in the campus

4.4.2 Calculations for street lights

The following table details the calculations for energy consumption and potential savings associated with street lights and flood lights on campus:

Table 4-14Calculation of Street Lights

Description	Quantity	Wattage (W)	Total Wattage (W)
Total street lights used in the campus	28	100	2800
Total high mast flood lights used in the campus	16	150	2400
Total wattage of all the lights			**5200** or 5.2 kW
One unit of electricity		1000 W/h	
Operating hours per day		12 hours	
Units consumed in one day			62.4
Units consumed in one month			1872
Electrical charges for one month			Rs. 13,029
Electrical charges for 12 months			Rs. 156,348
Cost of installing 28 solar street lights (100W each)			Rs. 53,200
Cost of installing 16 solar flood lights (150W each)			Rs. 87,840
Total cost of replacement			**Rs. 141,040**

From the above calculations, it is observed that there is significant potential for cost savings by installing solar street lights. Replacing the normal street lights and flood lights with solar-powered ones would cost about Rs. 141,040, with a monthly saving of Rs. 13,029. Thus, the payback period would be approximately 11 months i.e. within 01 year itself.

4.4.2 Benefits of using solar street lights

- **Automatic Operation**: Solar LED flood lights are powered by sunlight, turning on at dusk and off at dawn automatically. Equipped with a built-in 12000mAh LifePO4 battery, they can provide continuous lighting for up to 15 hours once fully charged.
- **High Efficiency**: The 200W solar flood light comes with 918SMD 5730 chipset LEDs, offering up to 15 hours of continuous and bright lighting. The automatic sensor switch

ensures it turns on at night and off in the morning, making it an economical and innovative lighting solution.

- **Energy Saving**: These lights can convert up to 19% of sunlight into electricity, sustaining ample battery life even under rainy weather. Using solar flood lights is a smart, eco-friendly choice.
- **Easy Installation**: Solar flood lights for home outdoor use are wireless and can be self-installed. They can be easily mounted on walls or poles using the included screws.
- **Durability and Weather Resistance**: Solar rechargeable flood lights are extremely durable, constructed with ABS material, and designed to be IP65 waterproof. They can withstand extreme weather conditions, making them suitable for patios, lawns, gardens, decks, yards, driveways, and fences.
- **Maintenance free**: Solar lights are relatively maintenance free with almost zero finance involvement. Only regular cleaning of solar panel with de-ionized water is required which is a low cost affair.

By implementing these recommendations, SGC can significantly enhance its energy efficiency, reduce operational costs, and minimize its environmental impact. Regular monitoring and maintenance will ensure sustained improvements and help maintain the efficiency of lighting systems and other power consumptions.

4.5 INDOOR LUX LEVEL

A high-quality DIGITAL LUX METER was used to measure the illumination levels at various locations of SGC College. The recommended lighting levels for these areas are provided in the table below:

Table 4-15The recommended light level as per standard

Location	Recommended LUX
Normal work station space, open or closed office	500
Conference Rooms	300
Training Rooms	500
Internal Corridors	200
Auditorium	150-200
Entrance Lobbies, Atria`	200
Stairwells	200
Toilets	200
Dining Area	150-200

4.5.1 Lux level of different indoor locations in the campus

The college authorities provided details of luminaries installed within their building premises. The auditors surveyed the area and compared the type of fittings, their height, and type of reflectors. Based on this survey, the Lux levels of various locations within the college are summarized in the table below:

Table 4-16Assessment of the Lighting

SL.No	Location	Measured Lux	Recommended lux level	Remarks
1	Admin Office	449	500	Good
2	Accounts	300	500	Satisfactory
3	Principal office	513	500	Satisfactory
4	Chairman office	500	500	Good
5	Conference room	300	300	Good

6	Staff room	300	500	Satisfactory
7	Library	500	500	Good
8	Admission cell	310	500	Satisfactory
15	Pantries	194	150-200	Satisfactory
16	Classroom	400	500	Satisfactory
17	washrooms	160	200	Satisfactory

- During Audit, it was observed that college is using all the LED lights.
- Lack of proper cleaning of lighting fixtures was observed resulting in lower ILER and Lux Levels.
- As per study findings of Lux, it is recommended for converting the existing installation to use more efficient lighting equipment.

4.5.2 Use of BLDC fans

During the audit, it was observed that the college is using normal fans. It is recommended to replace these with BLDC fans for better energy efficiency. The energy saving calculation for BLDC fans is provided below:

Table 4-17: Energy Saving Calculation

Energy Saving Calculation	**Units**	**Value**
Total Number of fittings	Nos.	500
Annual electricity Consumption of 75-watt normal fan (500nox75wx8hrx250daysx0.75LF/1000=56250Kwh)	kWh	56250
Annual electricity Consumption of proposed 28W BLDC Fans (500nox28wx8hrx250daysx0.75LF/1000=21000Kwh)	kWh	21000
Proposed Annual Energy Savings potential	kWh	35250
Per Unit cost	Rs.	6.69
Proposed Annual Monetary Savings	Rs.	235822
Investment/ fixture (including replacement cost)	Rs.	1000-1200

Total Investment	Rs.	600000
Simple Payback Period	Years	2.5

From the above data, it is seen that the college has 1001 normal fans. According to our recommendation, the college should replace at least 50% of these normal fans with BLDC fans. The cost of replacement would be Rs. 6,00,000. The annual monetary savings would be Rs. 2,35,822. The payback time would be 2.5 years.

Implementing these changes will not only lead to significant energy savings but also improve the overall efficiency and sustainability of the college's operations.

4.6 POWER CONSUMPTION ASSESSMENT OF SGC

During the onsite assessment, the audit team conducted a campus-wide electrical load survey at various locations in SGC College. The table below summarizes the power consumption of the college campus.

Table 4-18Power consumption of college campus

Type of LOAD	No.	Watt	Hrs	Days	LF	TOTAL KWH/Year	KW
LED Tube lights	857	40	8	250	0.75	68400	34.2
Coolers	237	125	8	250	0.75	59200	29.6
FAN	1001	75	8	230	0.6	46000	75
EXHAUST	35	40	4	230	0.4	1288	1.4
Geezers	41	2000	4	230	0.4	75440	82
COMPUTER	50	150	5	200	0.3	75000	75

4.6.1 Motion sensors

Currently, the college has not installed any motion sensors. It is recommended to install motion sensors to save up to 6% of energy by reducing unnecessary power usage when areas are unoccupied.

4.6.2 AC Systems

The evaluation of heating, ventilation, and air conditioning (AC) systems at SGC revealed several inefficiencies in energy consumption. The AC systems are critical for maintaining a comfortable environment within the campus buildings but are also significant energy consumers. The audit indicated that the existing AC units are not operating at optimal efficiency. Many of the units are older models that lack modern energy-saving features. During peak usage times, the AC systems were found to consume a substantial portion of the campus's total energy, contributing to high energy bills and increased operational costs. Temperature control across different areas of the campus was inconsistent, with some areas experiencing overcooling or overheating, indicating potential issues with the HVAC system's zoning and control mechanisms.

Table 4-19AC systems in the college

Air conditioner							
Type of LOAD	No.	WATT	STAR RATING	HRS	DAYS	TOTAL KWH/Year	KW
AC	19	1500	0	5	180	25650	28.5
AC	13	1270	2	5	180	14850	16.5
AC	2	1077	3	5	180	1935	2.1

4.6.2.1 Benefits of 5 star rating inverter type air conditioners

Every air conditioner comes with a BEE star rating label that indicates its efficiency. ACs are rated on a scale of 1-5, with 5-star ACs being the most energy-efficient. Investing in 5-star air conditioners, though more expensive initially, can lead to significant energy savings over time. The BEE star rating is determined by the Indian Seasonal Energy Efficiency Ratio (ISEER) or Energy Efficiency Ratio (EER). Higher values of these ratios correspond to higher star ratings and greater energy savings.

The government mandates BEE star ratings for most home appliances, including air conditioners, washing machines, refrigerators, and microwave ovens. Over the years, BEE has made the star ratings more stringent. For example, an AC with a 5-star rating in 2018 may not even qualify for a 1-star rating in 2023 due to updated efficiency standards.

Table 4-20Consumption table of different star rating AC

AC type Non Inverter/Inverter	0.75 Ton	1 Ton	1.5 Ton	2 Ton
3 Star Non-inverter	627	828	1235	1548
3 Star Inverter	550	726	1077	1344
5 Star Non-inverter	576	760	1130	1412
5 Star Inverter	421	557	815	1005

There are a total of 34 air conditioners in the college, out of which 19 are non-star rated. It is recommended to replace these with more efficient 5-star inverter ACs. The comparison of energy consumption between non-star and 5-star ACs is shown below:

Table 4-21Comparison between non-star and 5 star AC

S. No	Parameters	0 Star (19 No)	5 star (19 No)
1	KW	28.5	15.7
2	Running Hour	5	5
3	Days	180	180
4	KWH/ Year	25650	14130

From Table 4.17, it is seen that the consumption of 19 non-star ACs is 25,650 kWh/Year, resulting in a total cost of Rs. 37,798.5. After replacing these with 5-star inverter ACs, the consumption would be 14,130 kWh/Year, resulting in a reduction of 11,520 kWh/Year and a saving of Rs. 77,068. The cost of replacing 19 non-star ACs with 5-star inverter ACs would be Rs. 4,50,000. The annual saving after the replacement would be Rs. 77,068, leading to a payback period of 5.8 years.

It is recommended to replace at least 19 non-star ACs with 5-star inverter ACs. The cost of replacement would be Rs. 4,50,000, with an annual saving of Rs. 77,068, resulting in a payback time of 5.8 years.

By implementing these recommendations, SGC can improve its energy efficiency, reduce operational costs, and minimize its environmental impact. Regular monitoring and maintenance will ensure sustained improvements and help maintain the efficiency of infrastructure and equipment.

4.7 POWER FACTOR

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.

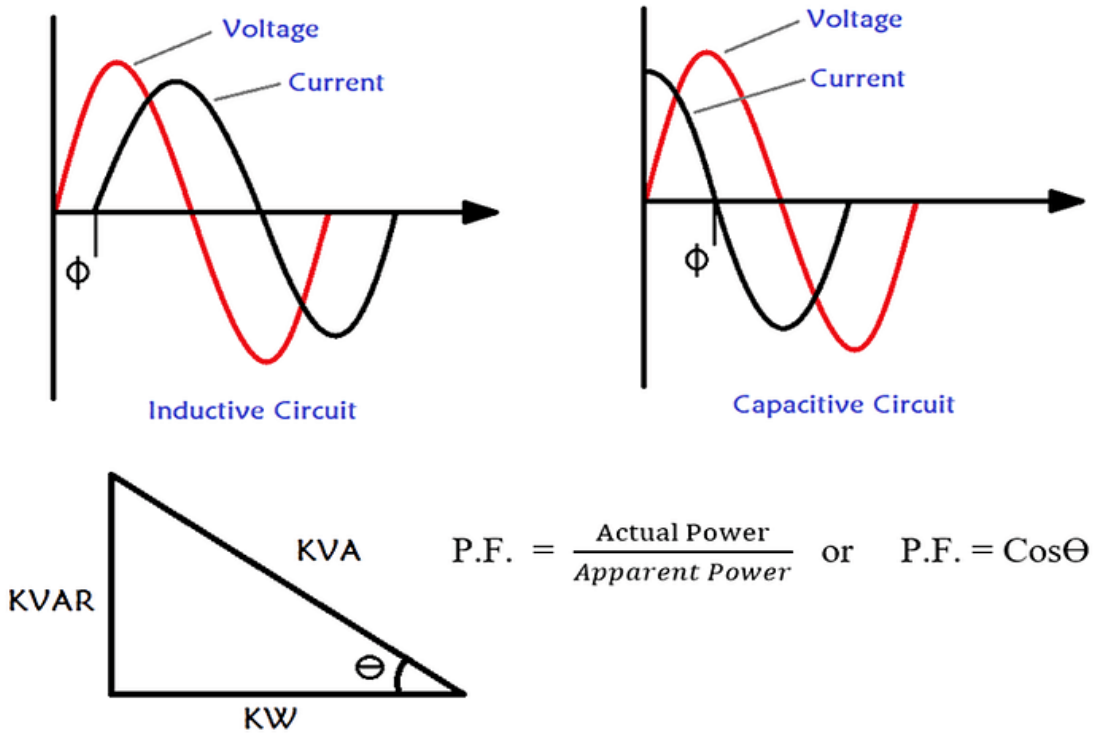


Figure 4-12 Power Factor Waveform

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**

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.

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=Actual Power +Reactive Power

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.

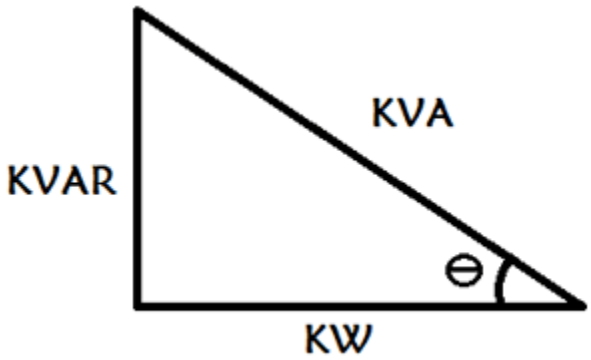


Figure 4-13 Power Triangle

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.

4.7.1 Power Factor According to Punjab State Electricity Regulatory Commission (P.S.E.R.C)

At very low power factor values, a large quantity of energy from the mains is wasted as much of it will not be used for meaningful work due to the presence of more reactive loads. This places a strain on the supply system as both the real power required by the load and the reactive power used to satisfy reactive loads will be drawn from the system. This strain and wastage typically lead to high electricity bills for consumers, especially industrial consumers, as utility companies calculate consumption in terms of apparent power. The following clauses are according to P.S.E.R.C:

- **Para SXI.6 Power Factor Surcharge/Incentive** Consumers are required to maintain a monthly average power factor of 0.90. The monthly average power factor is the ratio of total kWh to total kVAh supplied during the month, rounded to two decimal points.
- **Low Power Factor Surcharge** If the monthly average power factor falls below 0.90, the consumer shall pay a surcharge of 1% for each 0.01 decrease in the monthly average power factor below 0.90. The surcharge shall be 2% for each 0.01 decrease below 0.80.
- **Power Factor Incentive** If the monthly average power factor exceeds 0.90, an incentive of 0.25% for each increase of 0.01 above 0.90 shall be allowed on the energy charges.

4.7.2 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 0.9 and help generate power factor incentives, reducing the electricity bill. The college has already installed an APFC panel with a capacity of 50 KVAR, but it is recommended to increase the capacity to 102 KVAR.

Example Calculation

Let the bill amount	=	Rs. 20000
From load list avg. PF	=	0.75
Desired power factor	=	0.9

For 0.9 to 0.8 % cap. Charge = 10 x 1% = 10%

For 0.8 to 0.75 % cap. Charge = 5 x 2% = 10%

So, total cap. Charge would be = 10+10% = 20%

If power factor is 0.9 then reduction in bill would be

20% of total bill amount = 16000

So reduced bill amount = 331980-265584= Rs. 4000

After using the APFC panel the average power factor will be 0.97.

So, total hike in power factor = 7%

According to para SXI. 6.2 Power Factor Incentive will be 0.25% for increase of 0.01

So, 7% of Rs. 16000 rebates will be = Rs. 1400

Total bill amount = Rs. 14600

Total saving after installing APFC panel = Rs. 6000

Cost of installing APFC panel = Rs. 32000 approx.

4.7.1 Calculations of APFC for the college

During the Audit process the power factor of the college comes out to be 0.86 which is quite low. In order the achieve the power factor of 0.99 following calculations are made:

The kw rating of the campus = 319.667KW

Correction power factor = Tan $\emptyset_1$ - Tan $\emptyset_2$

Current power factor, Cos$\emptyset_1$ = 0.90

So, $\emptyset_1$ = 25

Required power factor, Cos $\emptyset_2$ = 0.99

So, $\emptyset_2$ = 8.1

Hence, correction factor (C.F) = 0.32

So, capacitor rating in KVAR = 102KVAR

4.7.2 Saving potential

The bill amount FOR July-2023 = Rs. 519740

From load list avg. PF =0.91

Desired power factor =0.99

For 0.99 to 0.91 % cap. Charge =8 x 0.25% = 2.24%

If power factor is 0.9 then reduction in bill would be

2.25% of total bill amount =11642

So reduced bill amount **=519740-11642= Rs. 508098**

However, SGC has already installed the APFC of 50 KVAR capacity, but it is recommended to increase the capacity of the APFC system to 102 KVAR to improve the power factor in peek conditions. The cost of increasing then capacity of APFC would be Rs. 100000 Approx. and the reduction of Rs.11642 in the monthly bill. So the payback period would be 8.5 months.

4.8 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 are also available, which will provide a wide variety of control options like:

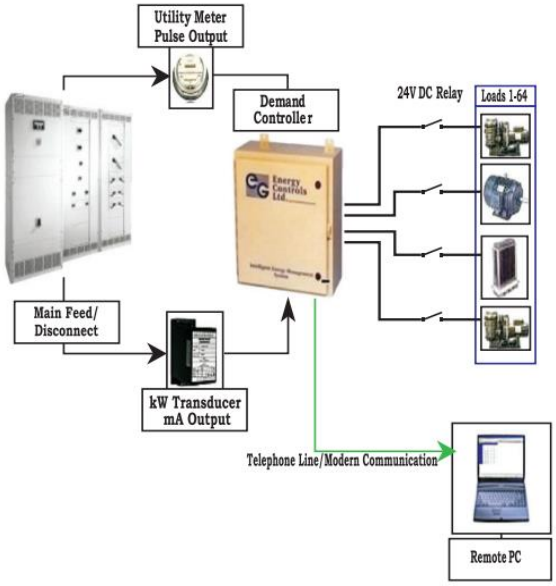


Figure 4-14 Direct demand monitoring

- 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

4.9 ENVIRONMENTAL IMPACT ASSESSMENT ASSOCIATED WITH ENERGY RESOURCES

The environmental impact assessment of Saraswati Group of Colleges (SGC) aims to evaluate the campus's environmental footprint and identify opportunities for enhancing sustainability. This assessment focuses on several key areas, including carbon footprint, air quality, water usage, waste management, and biodiversity. By understanding and addressing the environmental impacts associated with its operations, SGC can implement effective strategies to promote a greener and more sustainable campus.

4.9.1 Carbon footprint

The energy audit conducted at SGC highlighted the campus's carbon footprint, which is influenced by its energy consumption patterns. The use of grid electricity, diesel generators, and other fossil fuel-based energy sources contributes to greenhouse gas (GHG) emissions. The integration of renewable energy sources, particularly solar panels, has significantly mitigated the carbon footprint. The current solar installations have reduced the reliance on grid electricity and diesel generators, thereby lowering GHG emissions. Continued investment in renewable energy and energy efficiency measures will further decrease GHG emissions.

4.9.2 Air quality

The operation of diesel generators has an impact on local air quality, releasing pollutants such as nitrogen oxides (NOx) and particulate matter (PM). Although the generators are essential for backup power, their use should be minimized to reduce air pollution. Solar energy systems do not produce air pollutants, making them a cleaner alternative to traditional energy sources. Regular maintenance of generators and the adoption of cleaner technologies are essential for reducing air pollutants.

4.10 RECOMMENDATIONS

Following the comprehensive energy audit of Saraswati Group of Colleges (SGC), several key recommendations have been identified to enhance energy efficiency and sustainability across the campus. Implementing these recommendations will lead to significant energy savings, reduced operational costs, and a minimized environmental footprint.

1. Renewable Energy Integration

SGC has made commendable progress in integrating solar energy into its energy mix. To further enhance sustainability, it is recommended to:

- Install at least 100 KWp of solar system of their own
- Explore the feasibility of integrating wind energy systems to diversify the renewable energy portfolio and ensure a stable energy supply.

2. Lighting Systems (Indoor & Outdoor)

The existing indoor lighting systems in campus are LED and there is no further scope of improvement. But the exterior Lighting systems (Street Lights & High mast lights) are not solar based. There is a good saving potential if the normal streets lights are replaced with the solar street lights as shown in the topic 4.4.2. currently there are 28 normal street lights and 16 high mast lights. It is recommended to replace the current Exterior lighting system with the Solar one

3. Fans

The evaluation of fans on the campus highlighted the potential for energy savings through the replacement of 50% of 1001 normal fans with energy-efficient BLDC fans. This replacement would cause in the significant reduction in the energy bills.

4. AC Systems

The AC systems at SGC are critical for maintaining a comfortable environment but are significant energy consumers. The audit revealed inefficiencies in the current systems, many of which are older models and less star rating, lacking modern energy-saving features. It is recommended to:

- Replace older AC units with more efficient 5-star inverter ac.
- Install programmable thermostats to optimize operations and reduce unnecessary energy use.
- Conduct regular maintenance to ensure optimal performance and longevity of AC systems.

5. Power factor

The current power factor of the SGC is 0.90 due to lower capacity of APFC. The current rating of APFC is 50KVAr. It is recommended to increase the capacity to 102KVAr.

6. Direct demand monitoring & control system

Installation of direct demand monitoring & control system for maintaining the contract demand by shredding of the non-essential loads when the present demand limits are reached.

7. Electricity Consumption

To optimize electricity consumption, the following measures are recommended:

- Optimize the tariff structure with utility supplier.
- Schedule your operations to maintain a high load factor.
- Shift load to off peak time if possible.
- Minimize maximum demand by tripping loads through a demand controller.
- Stagger start up times for equipment with large starting currents to minimize load peaking.
- Use standby electric generation equipment for on peak high load periods.
- Correct power factor to at least 0.90 under rated load condition.
- Relocate transformers close to main loads.
- Set transformer taps to optimum settings.
- Disconnect primary power to transformers that do not serve any active loads.
- Consider on site electric generation or cogeneration.
- Export power to grid if you have any surplus in your captive generation.
- Check utility electric meter with your own meter.
- Shut off unnecessary computers, printers & copiers at night.

8. Motors

To improve motor efficiency and lifespan, the following actions are recommended:

- Properly size to the load for optimum efficiency.
- High efficiency motors offer of 4-5% higher efficiency than standard motors.
- Use energy efficient motors where economical.

- Use synchronous motors to improve power factor.
- Check alignment.
- Provide proper ventilation.
- For every 10 ℃ increase in motor operating temperature over recommended peak, the motor life is estimated to be halved.
- Check for under voltage and over voltage conditions.
- Balance three phase power supply.
- An imbalance voltage can reduce 3-5% in motor input power.
- Demand efficiency restoration after motor rewinding.

9. Pumps

To optimize pump performance and energy efficiency, the following recommendations are made:

- Operate pumping near best efficiency point.
- Modify pumping to minimize throttling.
- Adapt to wide load variation with variable with variable speed drives or sequenced control of smaller units.
- Stop running both pumps, add an auto-start for an on-line spare or add a booster pump in the problem area.
- Use booster pumps for small loads requiring higher pressure.
- Increasing fluid temperature differentials to reduce pumping rates.
- Repair seals and packing to minimize flow and reduce pump power requirements

Implementing these recommendations will help SGCs achieve significant energy savings, reduce operational costs, and minimize their environmental footprint, fostering a more sustainable campus environment.

CHAPTER 5

CONCLUSIONS

5.1 CONCLUSIONS

The energy audit conducted at Saraswati Group of Colleges (SGC) revealed several key findings and recommendations that, if implemented, can significantly enhance the institution's energy efficiency and sustainability. This detailed analysis has identified major energy-consuming areas, inefficiencies in current practices, and potential areas for significant savings.

The audit revealed that lighting, AC systems, and electrical equipment are the primary energy consumers on the campus. The existing lighting systems, primarily consisting of outdated fixtures, contribute to high energy consumption. Retrofitting these with energy-efficient LED lights can lead to substantial energy savings. Similarly, the current AC systems are not operating at optimal efficiency. Upgrading to modern, energy-efficient units, along with regular maintenance and the use of programmable thermostats, can greatly enhance performance and reduce energy use.

SGC has already made strides in integrating renewable energy by utilizing solar power. The campus currently has a solar installation capacity of 300KW, purchased from external sources. Replacing this capacity by installing 100KW of solar panels of their own can further reduce reliance on non-renewable energy sources and decrease overall energy costs. The feasibility study indicated that this expansion is both technically and economically viable, providing a sustainable energy solution for the future.

The evaluation of fans on the campus highlighted the potential for energy savings through the replacement of 1001 normal fans with energy-efficient BLDC fans. This replacement would reduce annual electricity consumption from 56,250 kWh to 21,000 kWh, resulting in annual monetary savings of Rs 2,35,822. The investment required for this replacement is Rs 6,00,000, with a simple payback period of 2.5 years.

Additionally, the audit identified opportunities to enhance the energy management system on campus. Implementing a robust system for real-time monitoring and control of energy usage

will ensure sustained efficiency improvements. This system should include practices such as regular energy audits, continuous performance tracking, and the adoption of energy-efficient practices across all campus operations.

Table 5-11 provides a summary of the potential savings and investments for various energy efficiency measures recommended in the audit

In-text **Reference (Section No.)**	**Current Installation in College**	**Recommendations**	**Annual Cost to the College before Recommendation (Rs)**	**Monetary Saving after Recommendation (Rs)**	**Total Investment (Rs)**	**Payback Time (Years)**
4.2	The current KW rating of college is 320 KW	Reduce to 280 KW	N/A	2569 per year	N/A	N/A
5.2	Currently installed 300 KWp of Solar System on rental basis	Install 100 KWp of own Solar System	6,79,205.00	12,52,368.00	50,00,000.00	3.99
6.2	Installed 28 solar lights and 16 high mast lights	Replace with solar lights	1,56,348.00	1,56,348.00	1,41,040.00	0.9
6.5	34 AC units (19 non-star, 2 three-star, rest two-star)	Replace with 5-star inverter AC	37,798.50	77,068.00	4,50,000.00	5.8

Implementing these recommended measures will not only improve the energy efficiency of the campus but also contribute to substantial cost savings and a reduced environmental footprint. The proposed investments, totalling Rs 63 Lacs, have a payback period ranging from 0.9 to 5.8 years, with expected annual savings of Rs 17.35 Lacs.

The audit underscores the importance of a proactive approach to energy management and sustainability in educational institutions. By adopting these recommendations, SGC can significantly reduce its environmental impact, enhance the campus's learning environment, and position itself as a leader in energy management within the educational sector. This comprehensive approach aligns with global sustainability goals and ensures long-term financial health and operational excellence for Saraswati Group of Colleges.

The detailed action plan provided in this report serves as a roadmap for achieving these goals and fostering a culture of energy conservation at SGC. This forward-thinking approach balances economic, environmental, and educational benefits, ensuring that SGC can continue to provide high-quality education while maintaining a commitment to sustainability.

CHAPTER 6

DISCLOSURE OF CONSULTANT ENGAGED

6.1 INTRODUCTION ABOUT CONSULTANT

Eco Group is a reputed business house working in the field of environment in North India since 1999 with Vision & Mission of "Preventing pollution with Purpose-Bringing profit and goodwill in equal measure". The group aims that the customers achieve effective compliance with legislation including a better public image and earn from waste. The group comprises of Eco Paryavaran Laboratories & Consultants Pvt. Ltd. - engaged in consultancy & analytical services; Eco Paryavaran Engineers & Consultants Pvt. Ltd. - engaged in providing engineering solutions and Environment Matters – undertaking capacity building programs in the field of environment**.**

MAJOR MILESTONES

- 1999: Eco Engineers established
- 2001: Er. Sandeep Garg (CEO) appointed as National Director, Institute of Environmental Sciences & Technology (IEST), USA
- 2003: First one to be registered as Environmental Consultant with Himachal Pollution Control Board (HPCB)
- 2004: Establishment of Environmental Testing Lab
- 2007: Approval from Punjab Pollution Control Board (PPCB)

- 2009: Approval from Ministry of Environment, Forests and Climate Change (MoEF &CC)
- 2010: Accredited by NABL
- 2013: Designated as a State Lab by Himachal Pradesh Government
- 2017: Affiliated from Skill Council for Green Jobs, National Skill Development Council, GoI
- 2018: Accredited EIA Consultant from NABET, Quality Council of India.
- 2019: Approval from Jammu and Kashmir State Pollution Control Board (J&KSPCB)
- 2021: 10 Sectors (with cat. A) covered NABET accreditation**.**

Eco Paryavaran Laboratories & Consultants Pvt. Ltd. - LABORATORY SERVICES DIVISION is known for excellence in monitoring and analysis of environmental, building material and microbiological parameters. Some of the key analytical services provided are Ambient Air Sampling and Analysis; Stack Monitoring – Process stack, DG Stack etc.; Noise and Lux Monitoring; Indoor & work zone monitoring; Water and Wastewater analysis; Soil & Sludge Testing; Testing of Cement – all grades; Testing of Concrete – Cubes, beams, cores, Paver blocks; Testing of Aggregates – Coarse and fine; Testing of Bricks – Burnt Clay, Fly ash; Soil Testing – Both physical and Chemical; Steel Testing – Tensile, Yield, Elongation, Bend and Rebend testing; Swab testing and Indoor air quality etc. ENVIRONMENT SERVICES DIVISION undertakes various activities as - Environmental Impact Assessment/Environmental Clearances; Environmental/Green/Energy/Water Audits; Pollution Control Systems Engineering & Design Services; Performance Evaluation of Pollution Control Systems; Benchmarking and Environment due diligence, CGWA/PWRDA/HWRA approval, Action Plan on Plastic Waste Management, EHS Audits, Consent to Establish, Consent to Operate (CTO), HW Authorization, BMW authorization, Feasibility Reports for various pollution control Boards including Punjab, Haryana, Himachal, Chandigarh, J&K, UP, Uttarakhand, Delhi etc.

Eco Group operates from an independent 10,000 square feet built-up area on three levels each in Mohali, Punjab (India). A dedicated team of thirty engineers, scientists along with the support staff qualified in areas as environment, civil, electrical, mechanical, chemical engineering, biotechnology, chemistry and microbiology oversees the various activities.

6.2 Special Facility of Eco Group for Environmental Testing & Management

Onsite Environmental Testing

Mobile Testing Laboratory

Noise Dose Monitoring in Work Zone Environment

Noise Dosimeter – SVANTEK SV104IS, Intrinsically Safe

Flue Gas Emissions from Stack/ Source/ Duct

Flue Gas Analyzer – MRU, Optima 7

Calibration of Online CEMS (Emission/ Effluent)

Calibration for Particulate Matter (Emissions) & pH, BOD, COD, TSS (Effluents)

Aerosol Dust in Ambient/ Indoor/ Work zone Environment

(TSI Side Pak™ AM520i Real Time Aerosol Sampler for PM_{10}, $PM_{5.0}$, $PM_{2.5}$, $PM_{1.0}$ and $PM_{0.8}$ **- DPM), Intrinsically Safe**

Milk Powder Emission Loss Monitoring in Dairy Industry

Quantification of Milk Powder Emission Loss form Milk Dryers/ Fugitive

Emissions/ General Leakage

VOCs & Toxic Gases in Ambient/ Indoor/ Work zone Environment

Real Time VOC/Toxic Gas Meter (PID) - TIGER Pho Check, Ion Science, UK, Intrinsically Safe

Carbon Monoxide (CO) in Ambient/ Indoor/ Work zone Environment

Real Time NDIR CO Monitor - Horiba APMA-370

Validation of Indoor Environment in Hospitals/ Operation Theaters

As per ISO 14664 standard, services are delivered as Air Change/ Ventilation Rate, Air Velocity at filtration unit, Pressure Differential, Validation of HEPA Filters by DOP /POA testing, Temp. and Humidity

Industrial Hygiene & Occupational Health and Safety Study in Work zone Environment

Industrial Hygiene, Ventilation Rate, Heat Stress, Health and Safety Study as per OSHA/ NIOSH/ Indian Factories Act, 1948

Noise & Vibration Monitoring

Sound level meters and octave brands

Biohazard Testing

Air Quality Testing for Bacteria. Yeast & Mould Count

Eco Paryavaran Engineers and Consultants Private Limited - is a certified ISO 9001:2015 organization providing engineering & turnkey solutions for overall pollution abatement. Committed to a green planet, we strive to use our world-class resources to give environmentally safe solutions to our customers. We provide engineering and turnkey solutions for pollution control and recycling including:

- Sewage Treatment Plants.
- Effluent Treatment Plants.

- Ultra Filtration-RO Combination Systems for Effluent recycling.
- Wastewater Treatment Equipment's & Components- Aeration Systems.
- Nano Bubble Technology
- Disinfection Systems-Ozone/UV based.
- Sludge Handling Systems-Filter Press/Bags.
- Air Pollution Control Systems.
- Noise Attenuation.
- Solid Waste Management Systems- Ecoster.
- **CETPs on ZLD basis**
- **Bio-Toilets & Bio-Digester Tanks**

Environment Matters undertakes various Education & Awareness Campaigns in Schools and Universities, plantation drives, Training of People from Economically Weaker Sections, Capacity-building of qualified professionals from universities, Generating Reliable Data Pitching for Sustainable Development. Glimpses of activities are shown below:

Sensitized more than 1,00,000 people through Social Media. Facebook: env matters; Twitter: Eco Group Mohali; LinkedIn: Environment Matters; Instagram: environmentmatters34; You tube: Eco Group

6.3 ASSOCIATIONS WITH ACADEMIA

- **PUNJAB** ENGINEERING COLLEGE (PEC), CHANDIGARH
  - ✓ *Name of Project: MoU for Testing and R & D in our laboratories*
  - ✓ *Date of Project: 11th July 2017*
- ***THAPAR UNIVERSITY, PATIALA***
  - ✓ *Name of Project: R & D Support for Bio N; Industrial Training Programme for M. Tech. Students*
  - ✓ *Date of Project: March 2012*
- ***IIT, MANDI, HIMACHAL PRADESH***
  - ✓ *Name of Project: MoU for R & D projects under IMPRINT Scheme of MHRD, GoI.*
  - ✓ *Date of Project: 8th July 2016*

KEY RECOGNITIONS/ACCREDITATIONS OF CONSULTANT

- QCI NABET accreditation vide Certificate No. NABET/EIA/22-23/RA 0324 dated 17.04.2024
- Lab Approved by NABL in the field of Testing vide Certificate No. TC-11818 dated 26.06.2023.
- Recognition Letter from CPCB vide File No. LB/99/7/2021-INST LAB-HO-CPCB-HO/Pvt./2945 dated 08.08.2023.
- ISO 9000:2015, ISO 14001:2015, ISO 45001:2018. ISO 50001:2015, ISO/IEC 17020:2012 certified.

भारतीय गुणवत्ता परिषद्
QUALITY COUNCIL® OF INDIA
QCI Creating an Ecosystem for Quality

NABET

National Accreditation Board for Education and Training

Certificate of Accreditation

Eco Paryavaran Laboratories & Consultants Pvt. Ltd, Mohali

E 207, Phase VIII B, Sector 74, Industrial Area, S.A.S. Nagar (Mohali), Punjab- 160071

*The organization is accredited as **Category-A** under the QCI-NABET **Scheme for Accreditation of EIA Consultant Organization, Version 3**: for preparing EIA/EMP reports in the following Sectors*

S.No	Sector Description	Sector (as per)		Cat.
		NABET	MoEFCC	
1.	Mining of minerals- open cast mining only	1	1 (a) (i)	A
2.	Metallurgical industries	8	3 (a)	A
3.	Cement plants	9	3 (b)	A
4.	Synthetic organic chemicals industry (dyes & dye intermediates; bulk drugs and intermediates excluding drug formulations; synthetic rubbers; basic organic chemicals, other synthetic organic chemicals, and chemical intermediates)	21	5 (f)	A
5.	Distilleries	22	5 (g)	A
6.	Sugar Industry	25	5 (j)	B
7.	Industrial estates/ parks/ complexes/areas, export processing Zones (EPZs), Special Economic Zones (SEZs), Biotech Parks, Leather Complexes	31	7 (c)	A
8.	Common Effluent Treatment Plants (CETPs)	36	7 (h)	B
9.	Building and construction projects	38	8 (a)	B
10.	Townships and Area Development projects	39	8 (b)	B

Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in RAAC minutes dated March 21, 2024, posted on QCI-NABET website.

The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in QCI-NABET's letter of accreditation bearing no QCI/NABET/ENV/ACO/24/3196 dated April 17, 2024. The accreditation needs to be renewed before the expiry date by Eco Paryavaran Laboratories and Consultants Pvt Ltd, Mohali following due process of assessment.

Issue Date
April 17, 2024

Valid up to
December 17, 2026

Mr. Ajay Kumar Jha
Sr. Director, NABET

Certificate No.
NABET/EIA/23-26/RA 0324

Prof (Dr) Varinder S Kanwar
(CEO NABET)

For the updated List of Accredited EIA Consultant Organizations with approved Sectors please refer to QCI-NABET website.

National Accreditation Board for Testing and Calibration Laboratories

CERTIFICATE OF ACCREDITATION

ECO PARYAVARAN LABORATORIES & CONSULTANTS PRIVATE LIMITED

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2017

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

ECO GROUP, ECO BHAWAN, E-207, INDUSTRIAL AREA, PHASE VIIIB (SECTOR 74), SAS NAGAR, MOHALI, PUNJAB, INDIA

in the field of

TESTING

Certificate Number: TC-11818

Issue Date: 26/06/2023 **Valid Until:** 25/06/2025

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the relevant requirements of NABL.
(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Name of Legal Identity : Eco Paryavaran Laboratories & Consultants Private Limited

Signed for and on behalf of NABL

N. Venkateswaran
Chief Executive Officer

केन्द्रीय प्रदूषण नियंत्रण बोर्ड
CENTRAL POLLUTION CONTROL BOARD
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय भारत सरकार
MINISTRY OF ENVIRONMENT FOREST & CLIMATE CHANGE GOVT OF INDIA

F.No. LB/99/7/2021-INST LAB-HO-CPCB-HO/Pvt./ 2945 **Dated: 8th August 2023**

Recognition Letter

To,

Head of Laboratory,
M/s Eco Paryavaran Laboratories & Consultants Private Limited,
E-207, Phase VIII-B, Industrial Area / Sector 74, Mohali- 160071.
Punjab.

Subject: Recognition of M/s Eco Paryavaran Laboratories & Consultants Private Limited, E-207, Phase VIII-B, Industrial Area / Sector 74, Mohali- 160071, Punjab as Environmental laboratory under the Environmental (Protection) Act- 1986.

Sir,

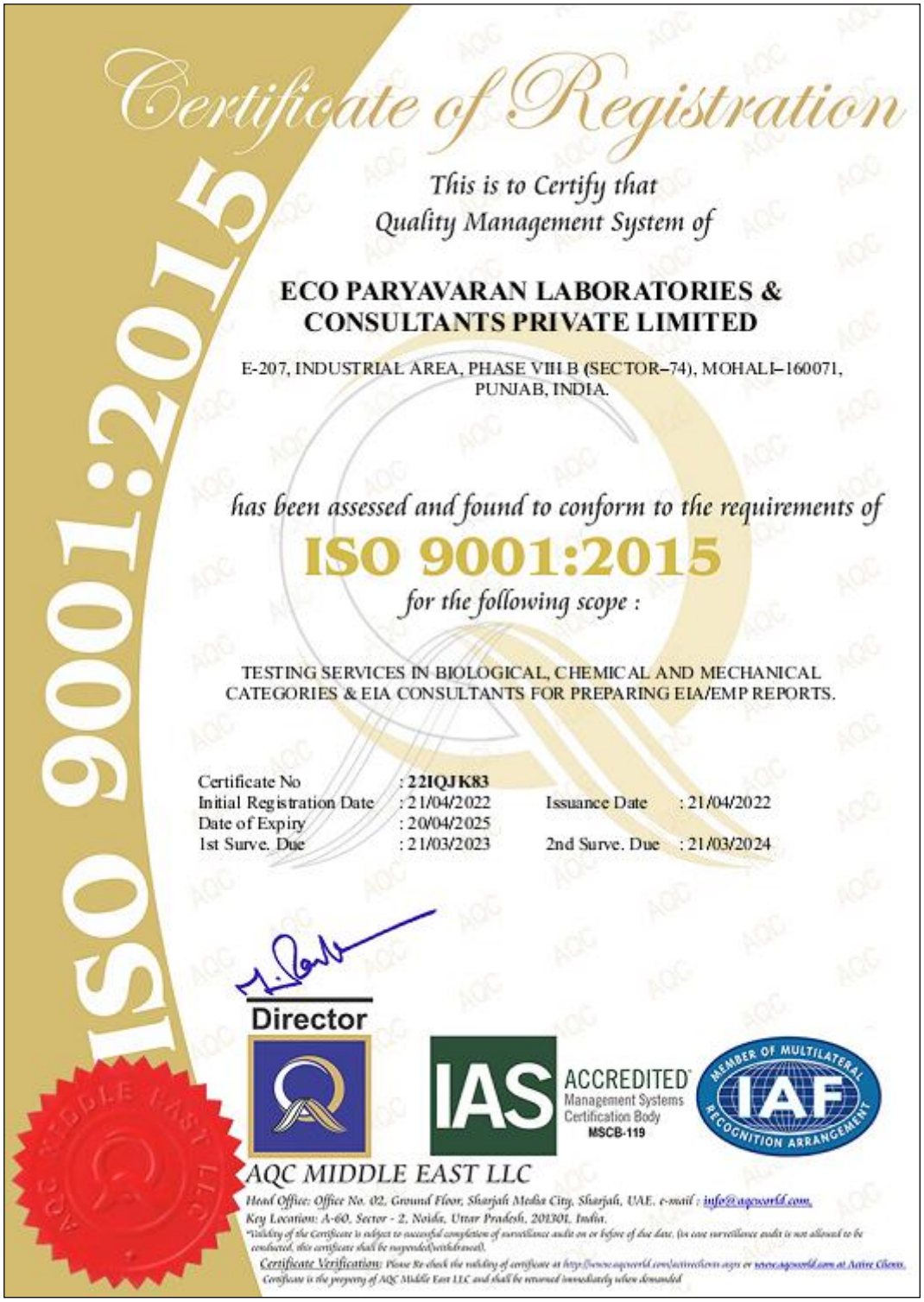
I am directed to refer the online application, dated 24/05/2022 for the recognition of your laboratory under Environmental (Protection) Act, 1986. Based on the recommendations of the concerned Division, approval of Competent Authority for recognition of Environmental laboratories and your acceptance of the revised terms and conditions at Annexure-III & IV of the guidelines for recognition of environmental laboratories, CPCB approves the recognition of **M/s Eco Paryavaran Laboratories & Consultants Private Limited, E-207, Phase VIII-B, Industrial Area / Sector 74, Mohali- 160071, Punjab** and shall be notified in the Gazette of India. Considering the current requirement of mandatory accreditation/ certifications of the laboratory, **this recognition shall be valid up to 31/05/2025.**

2. As sought in the aforementioned application, **M/s Eco Paryavaran Laboratories & Consultants Private Limited, E-207, Phase VIII-B, Industrial Area / Sector 74, Mohali- 160071, Punjab,** may undertake the following tests:

i. **Physical Tests-**Conductivity, Colour, pH, Fixed & Volatile Solids, Total Solids, Total Dissolved Solids, Total Suspended Solids, Turbidity, Temperature, Velocity & Discharge Measurement of Industrial Effluent Stream, Flocculation Test (Jar test), Odour, Salinity, Settleable Solids and Sludge Volume Index.
ii. **Inorganic (General and Non-metallic):** Acidity, Alkalinity, Ammonical Nitrogen, Chloride, Chlorine Residual, Dissolved Oxygen, Fluoride, Total Hardness, Total Kjeldahl Nitrogen (TKN), Nitrite Nitrogen, Nitrate Nitrogen, Phosphate, Sulphate, Carbon Dioxide, Silica, Cyanide and Sulphide.
iii. **Inorganic (Trace Metals):** Boron, Cadmium, Calcium, Total Chromium, Chromium Hexavalent, Copper, Iron, Lead, Magnesium, Mercury, Nickel, Potassium, Sodium, Sodium Absorption Ratio, Zinc, Arsenic, Aluminium, Barium, Manganese, Selenium, Silver and Antimony.
iv. **Organics (General) and Trace Organics:** Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Oil and Grease, Phenolic Compounds, Pesticides (each) (Organo-Chlorine and Organo Nitrogen-Phosphorus), Surfactants, Poly-Chlorinated Biphenyl (PCB's) each, Poly-Nuclear Aromatic Hydrocarbon (PAH) and Organic Carbon (in Solid).
v. **Microbiological Test:** Total Coliform, Faecal Coliform, *E. coli, Faecal Streptococci* and Total Plate Count and *Enterococcus*.
vi. **Toxicological Tests:** Bioassay Method for Evaluation of Toxicity using Fish, Measurement of Toxicity using Daphnia or Other Organism and Measurement of Toxicity Factor Using Zebra Fish (Dimensionless Toxicity Test).
vii. **Biological Test:** Benthic Organism Identification and Count, Macrophytic Identification, Planktonic identification count.
viii. **Characterization of Hazardous waste:** Preparation of Leachate (TCLP extract/ Water extract), Ignibility (Flash Point), Toxicity and Measurement of heavy metals/ pesticides in the waste and leachate.

Contd.

'परिवेश भवन' पर्वी अर्जुन नगर, दिल्ली-110032
Parivesh Bhawan, East Arjun Nagar, Delhi-110032
दूरभाष/Tel : 43102030, 22305792, वेबसाईट/Website : www.cpcb.nic.in



Certificate of Registration

ISO 9001:2015

This is to Certify that
Quality Management System of

ECO PARYAVARAN LABORATORIES & CONSULTANTS PRIVATE LIMITED

E-207, INDUSTRIAL AREA, PHASE VIII B (SECTOR–74), MOHALI–160071, PUNJAB, INDIA.

has been assessed and found to conform to the requirements of

ISO 9001:2015

for the following scope :

TESTING SERVICES IN BIOLOGICAL, CHEMICAL AND MECHANICAL CATEGORIES & EIA CONSULTANTS FOR PREPARING EIA/EMP REPORTS.

Certificate No	: 22IQJK83		
Initial Registration Date	: 21/04/2022	Issuance Date	: 21/04/2022
Date of Expiry	: 20/04/2025		
1st Surve. Due	: 21/03/2023	2nd Surve. Due	: 21/03/2024

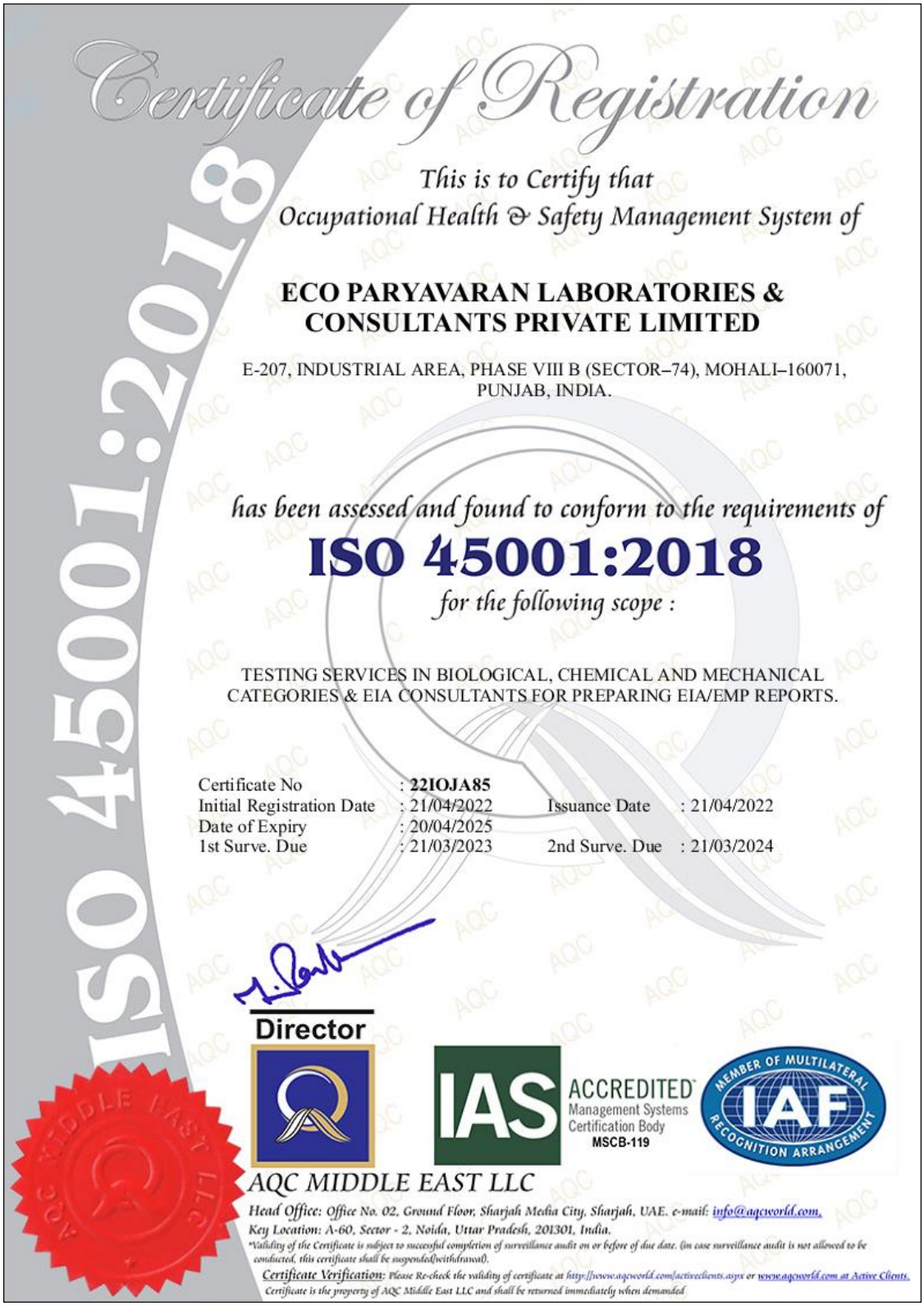
Director

IAS ACCREDITED Management Systems Certification Body MSCB-119

MEMBER OF MULTILATERAL RECOGNITION ARRANGEMENT IAF

AQC MIDDLE EAST LLC

Head Office: Office No. 02, Ground Floor, Sharjah Media City, Sharjah, UAE. e-mail : info@aqcworld.com,
Key Location: A-60, Sector - 2, Noida, Uttar Pradesh, 201301, India.
*Validity of the Certificate is subject to successful completion of surveillance audit on or before of due date. (in case surveillance audit is not allowed to be conducted, this certificate shall be suspended/withdrawal).
Certificate Verification: Please Re-check the validity of certificate at https://www.aqcworld.com/activecliews.aspx or www.aqcworld.com at Active Clients.
Certificate is the property of AQC Middle East LLC and shall be returned immediately when demanded



Certificate of Registration

ISO 45001:2018

This is to Certify that
Occupational Health & Safety Management System of

ECO PARYAVARAN LABORATORIES & CONSULTANTS PRIVATE LIMITED

E-207, INDUSTRIAL AREA, PHASE VIII B (SECTOR–74), MOHALI–160071, PUNJAB, INDIA.

has been assessed and found to conform to the requirements of

ISO 45001:2018

for the following scope :

TESTING SERVICES IN BIOLOGICAL, CHEMICAL AND MECHANICAL CATEGORIES & EIA CONSULTANTS FOR PREPARING EIA/EMP REPORTS.

Certificate No	: **22IOJA85**		
Initial Registration Date	: 21/04/2022	Issuance Date	: 21/04/2022
Date of Expiry	: 20/04/2025		
1st Surve. Due	: 21/03/2023	2nd Surve. Due	: 21/03/2024

Director

IAS ACCREDITED Management Systems Certification Body MSCB-119

MEMBER OF MULTILATERAL RECOGNITION ARRANGEMENT IAF

AQC MIDDLE EAST LLC

Head Office: Office No. 02, Ground Floor, Sharjah Media City, Sharjah, UAE. e-mail: info@aqcworld.com,
Key Location: A-60, Sector - 2, Noida, Uttar Pradesh, 201301, India.
**Validity of the Certificate is subject to successful completion of surveillance audit on or before of due date. (in case surveillance audit is not allowed to be conducted, this certificate shall be suspended/withdrawal).*
Certificate Verification: Please Re-check the validity of certificate at http://www.aqcworld.com/activeclients.aspx or www.aqcworld.com at Active Clients.
Certificate is the property of AQC Middle East LLC and shall be returned immediately when demanded.

Certificate of Registration

ISO 14001:2015

This is to Certify that
Environmental Management System of

ECO PARYAVARAN LABORATORIES & CONSULTANTS PRIVATE LIMITED

E-207, INDUSTRIAL AREA, PHASE VIII B (SECTOR–74), MOHALI–160071, PUNJAB, INDIA.

has been assessed and found to conform to the requirements of

ISO 14001:2015

for the following scope :

TESTING SERVICES IN BIOLOGICAL, CHEMICAL AND MECHANICAL CATEGORIES & EIA CONSULTANTS FOR PREPARING EIA/EMP REPORTS.

Certificate No	: **22IEJS76**		
Initial Registration Date	: 21/04/2022	Issuance Date	: 21/04/2022
Date of Expiry	: 20/04/2025		
1st Surve. Due	: 21/03/2023	2nd Surve. Due	: 21/03/2024

Director

IAS ACCREDITED Management Systems Certification Body MSCB-119

MEMBER OF MULTILATERAL RECOGNITION ARRANGEMENT IAF

AQC MIDDLE EAST LLC

Head Office: Office No. 02, Ground Floor, Sharjah Media City, Sharjah, UAE. e-mail: info@aqcworld.com,
Key Location: A-60, Sector - 2, Noida, Uttar Pradesh, 201301, India.
**Validity of the Certificate is subject to successful completion of surveillance audit on or before of due date. (in case surveillance audit is not allowed to be conducted, this certificate shall be suspended/withdrawal).*
Certificate Verification: Please Re-check the validity of certificate at http://www.aqcworld.com/activeclients.aspx or www.aqcworld.com at Active Clients.
Certificate is the property of AQC Middle East LLC and shall be returned immediately when demanded

Fig. 12.1: Accreditation Certificates

CERTIFICATE
OF REGISTRATION

This is to Certify that

ECO PARYAVARAN LABORATORIES AND CONSULTANTS PRIVATE LIMITED

E-207, PHASE VIII B, MOHALI, SAS NAGAR, PUNJAB - 160055, INDIA

has been independently assessed by UICL and found to be complied with the requirements of

ISO 50001:2018
(Energy Management System)

For the Following Scope of Activities

Providing Energy Audits and Consultancy Services to Industries, Educational Institutes and Commercial Establishments for the Management of Energy Performance and Environmental Carbon Footprints

Certificate No:- 206383/2024/U

Issue date : 05-06-2024 **1st Surveillance date : 04-05-2025**
Expiry date : 05-06-2027 **2nd Surveillance date : 03-04-2026**

Auth. Signatory

UNIQ INTERNATIONAL CERTIFICATIONS LIMITED
71-75, Shelton Street, Covent Garden, London, WC2H 9JQ
Web:- www.ukuicl.com, Mail:- info@ukuicl.com

Validity of this certificate is subject to successful completion of Surveillance Audits.
This certificate is property of UICL Limited.
You can check the validity of certificate at www.ukuicl.com/clients.

CERTIFICATE
OF REGISTRATION

This is to Certify that

ECO PARYAVARAN LABORATORIES AND CONSULTANTS PRIVATE LIMITED

E-207, PHASE VIII B, MOHALI, SAS NAGAR, PUNJAB - 160055, INDIA

has been independently assessed by UICL and found to be complied with the requirements of

ISO/IEC 17020:2012

(Conformity assessment — Requirements for the operation of various types of bodies performing inspection)

For the Following Scope of Activities

Providing Audits & Certification Services to Industries, Educational Institutes and Commercial Establishments for Environment Management, Green Management, Energy Management, Environmental Carbon Footprints, Industrial Hygiene, Occupational Health and Safety".

Certificate No:- 506376/2024/U

Issue date : 05-06-2024 **1st Surveillance date : 04-05-2025**

Expiry date : 05-06-2027 **2nd Surveillance date : 03-04-2026**

Auth. Signatory

UNIQ INTERNATIONAL CERTIFICATIONS LIMITED
71-75, Shelton Street, Covent Garden, London, WC2H 9JQ
Web:- www.ukuicl.com, Mail:- info@ukuicl.com

Validity of this certificate is subject to successful completion of Surveillance Audits.
This certificate is property of UICL Limited.
You can check the validity of certificate at www.ukuicl.com/clients.

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