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Central University of Hyderabad

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Administrative Staff College of India

COMPREHENSIVE ENERGY AUDIT REPORT

PHASE - 2

ABOUT THE REPORT

The project aims to assess the current energy consumption and infrastructure within the university campus to identify efficiency improvement opportunities. Led by University Engineer (UE) Lt Col. C.H. Rao, along with a team of energy engineers and sustainability experts, the initiative focuses on implementing practical solutions rather than just reporting findings. The goal is to optimize energy usage, reduce operational costs by up to 25%, and lower maintenance expenses across the campus. Through data-driven strategies and targeted interventions, the project aims to improve long-term sustainability and resource management.

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1 Introduction

Phase 2 of the University of Hyderabad's sustainability initiative builds on the foundational assessments and data collection efforts of Phase 1 to drive actionable, systemic improvements across campus infrastructure. This phase focuses on *strategic audits, technological integration, and automation* to optimize energy use, reduce waste, and align operations with national sustainability benchmarks.

Guided by the insights and infrastructure mapping from Phase 1, Phase 2 prioritizes the following activities:

1. **Comprehensive Energy Audits**: Conduct detailed evaluations of electrical, HVAC, and water systems to identify inefficiencies and recommend equipment upgrades, repairs, or replacements for energy-saving outcomes.

2. **Digitization of the Electricity Grid**: Modernize the campus power distribution network through digitized monitoring systems, enabling real-time management and enhanced grid reliability.

3. **NAAC-Compliant Energy/Green Audit Reporting**: Structure audit findings into standardized templates as per Chapter 7 of the NAAC Assessment Manual, ensuring alignment with institutional goals for net-zero emissions.

4. **Generator Redistribution and Renewable Energy Integration**: Redesign backup power systems by redistricting DG sets and integrating solar or hybrid renewable energy (RE) solutions to reduce fossil fuel dependency.

5. **Automated Defect Monitoring Mechanisms**: Develop systems for proactive detection and resolution of energy-related faults, minimizing downtime and optimizing resource utilization.

6. **Centralized Automation for Energy-Consuming Systems**: Design smart control systems for air conditioners, water pumps, and other high-demand installations to enforce energy discipline through automated scheduling, load balancing, and demand-response protocols.

7. **Implementation-Ready Design Reports**: Prepare technical and financial blueprints for proposed energy efficiency and renewable energy measures, ensuring readiness for funding and execution.

8. **Adoption of Cutting-Edge Technologies**: Incorporate advancements in energy efficiency (e.g., AI-driven predictive maintenance, IoT sensors) and renewable energy systems (e.g., advanced solar PV, energy storage) into a holistic implementation plan.

Phase 2 emphasizes operational transformation through technology, process refinement, and compliance with sustainability frameworks. By systematizing audits, digitizing infrastructure, and embedding automation, the university aims to create a resilient, data-driven ecosystem that prioritizes energy conservation, cost-effectiveness, and environmental stewardship. This phase sets the stage for scalable, long-term sustainability while adhering to national standards and global climate commitments.

Table 1 Progression of Activities Based on Phase 2 of Work Plan

S.No	Activity	Status	Share of progress
1	Conduct a comprehensive audit of installations and recommend equipment replacement/ repairs for energy-saving measures. Propose energy-saving measures at the campus, building, and equipment levels.	Completed	100% Completed
2	Digitize the existing electricity grid of the university for better management and monitoring.	Completed	100% Completed
3	The information collected in the energy audit process should be formulated into the energy/green audit template forms provided in the Chapter 7 of NAAC Assessment Manual to attain net zero results.	In Progress	70% Completed
4	Generators Redistribution and Integration with RE systems.	In Progress	80% Completed
5	Design an automatic defect monitoring mechanism for timely identification and rectification of energy-related issues	Completed	100% Completed
6	Develop a design for a centralized monitoring and automation system for energy-consuming installations such as air conditioning systems and water pumps. Also recommend strategies for enforcing energy discipline through automation.	Completed	100% Completed
7	Develop design reports for proposed energy efficiency and renewable energy measures ready for implementation financing.	Completed	100% Completed
8	Incorporate the latest developments and technologies in energy efficiency and renewable energy systems and develop a comprehensive implementation plan for identified measures.	Completed	100% Completed

2 Electrical Load Assessment and Infrastructure Analysis

An Excel-based inventory has been developed to document the university's existing electrical infrastructure. A room-by-room data collection survey was conducted across academic buildings, administrative offices, lecture halls, and other facilities to record electrical loads. The survey covered fans, lights, air conditioners, laboratory instruments, computers, printers, and other electrical equipment. Sample images of excel based inventory is given in Figure 1.

The inventory includes:

- Rated power consumption of each device to estimate total electrical demand.
- Operational hours of equipment to determine energy consumption patterns.
- Transformer capacity utilization, identifying overloading or underutilization.
- Lighting and HVAC system assessment, reviewing fixture types, automation, and energy-saving potential.
- Age and condition of electrical infrastructure, analyzing the need for replacements or upgrades.
- Unmetered loads, identifying energy consumption outside monitored systems.

This assessment provides a basis for optimizing power distribution, reducing energy wastage, and planning future upgrades. The collected data supports energy efficiency measures, infrastructure planning, and cost reduction strategies.

Room	Name of the Equipments	Units	Model	Capacity (W)	Operational Hours Per Day	Energy Consumption (Month)
G1	Millipore Elix 70	1	Elix 70	1170	5	175.50
	Millipore Elix 20	1	Elix 20	1170	5	175.50
	Milli-Q	1	Milli - EQ 7000	170	5	25.50
	Aqua Diamond Dosing Pump	1	Aqua Diamond Dosing Pump	460	5	69.00
	Eversure Control Panel	1		50	5	7.50
	Surepro PF	1		25	5	3.75
G2	AC	5	LG, 3 Star, 2 TON	10500	24	7560.00
	LED Light	144	4000K Type	3168	24	2280.96
G4	LED Light	39	4000K Type	858	24	617.76
	AC	4		8400	24	6048.00
	PC	1		200	8	48.00
	Microscope Accumal	1		30	3	2.70
	Microscope Compound	1		30	3	2.70
	Microscope Stereo	1		30	3	2.70
	LAF	1		450	5	67.50
G6	Fridge	1	Croma, 2 star , 84l	45	24	32.40
	Incubator	1	Haier, HZP-168	300	8	72.00
	Microscope	2	Zeiss Stemi 305	100	3	9.00
	Laptop	1		45	8	10.80
G9	PC	3		200	8	48.00
	Micro Pipette Puller	1	Sutter Instrument Co, P-97	460	2	27.60
	Spectrofluorometer	1	FP8500	300	2	18.00
	AC	2		4200	24	3024.00
	Circular Di-Chroism	1		200	0.5	3.00
	Electro Retino Graph	1	Kinetic Systems - Vibraplane	150	4	18.00

Figure 1 Sample Image of Inventory

3 Energy Efficiency Solutions

Energy efficiency in cooling systems is essential for reducing power consumption, lowering operational costs, and minimizing environmental impact. By optimizing cooling technologies such as HVAC systems and chillers, significant energy savings can be achieved while maintaining indoor comfort. This section explores various strategies to improve cooling efficiency in commercial and residential settings.

3.1 HVAC System and Chiller Optimization

Heating, Ventilation, and Air Conditioning (HVAC) systems and chillers play a crucial role in maintaining indoor air quality and temperature control. Optimizing these systems through advanced controls, energy-efficient components, and maintenance strategies helps improve performance while reducing energy usage. This section covers methods such as variable speed drives, demand-based cooling, and thermal energy storage to improve system efficiency and sustainability.

3.1.1 Assessment of Existing Air Conditioning Units

The institution's HVAC system accounts for a significant portion of its total energy consumption. Many of the installed air conditioning units are window and split ACs with a BEE star rating below 2 stars, leading to high energy usage and operational costs. Currently, 110 air conditioners are in operation, each running for an average of 6 hours per day. A 2-star AC consumes approximately 0.83 kW per hour, whereas a 5-star AC requires only 0.58 kW per hour. Upgrading these units to higher-efficiency models would reduce overall power demand and electricity costs while maintaining required cooling levels. Detailed pictures of existing chiller systems are given in figure 2.

Figure 2 Condition of Existing Chiller Systems

3.1.2 Chiller System Overview and Operations

The institution utilizes a centralized chiller system for cooling across multiple facilities. These chillers are maintained at 22°C, but many are aged and operate with lower efficiency. An assessment of these chiller units indicates potential for optimization through equipment upgrades and revised operation schedules to improve energy efficiency. The list of inefficient and poor maintained chiller system is given in Table 3.

Table 2 List of Existing Poorly Maintained Inefficient Chillers

Facility	Total Chillers	Total Capacity (TR)	Backup Capacity (TR)	Operation Details
CMSD	5	173 (including backup)	33	48 TR and 24 TR units operate alternately for day and night
AI Lab	3	66	2 × 22	Operates 7 hours/day, 6 days/week
DST Auditorium	2	100	-	Operates 6 hours/day

3.1.3 Energy Efficiency Recommendations

Implementing specific upgrades and operational changes in cooling systems can improve energy efficiency, reduce costs, and lower carbon emissions. The following measures outline potential impacts:

- Replacing existing air conditioning units with 5-star rated models would result in annual savings of ₹1,63,020 and a reduction of 98.71 metric tons of CO_2 emissions.
- Upgrading old chillers to modern, high-efficiency models would improve system performance while lowering power consumption.
- Implementing an optimized chiller operation schedule based on actual cooling demand would further reduce energy waste, particularly during non-peak hours.
- A structured approach to equipment replacement and operational improvements would contribute to energy efficiency and cost reduction. *(Detailed calculations are provided in Annexure 1.)*

3.2 Ceiling Fan Optimization

Ceiling Fan Optimization focuses on reducing energy consumption and improving efficiency by upgrading traditional fans to modern technologies. Standard ceiling fans consume significant electricity, but switching to BLDC (Brushless DC) motors can drastically lower power usage while enhancing performance. Although the initial cost of BLDC fans is higher, the long-term savings on electricity bills make them a cost-effective and sustainable choice.

3.2.1 Current Ceiling Fan Usage and Power Consumption

The institution has a total of 6,049 ceiling fans installed across various buildings. Of these, 486 fans have been upgraded to Brushless Direct Current (BLDC) models, which operate with higher efficiency compared to conventional ceiling fans. Traditional ceiling fans consume approximately 75 watts per unit, leading to an estimated daily energy usage of 0.6 kWh per fan when operated for an average of 8 hours per day. In contrast, BLDC fans consume only 32 watts per unit, reducing daily energy usage to 0.256 kWh under the same operating conditions.

3.2.2 Energy Savings Potential Through BLDC Fan Replacement

The power consumption difference between traditional and BLDC fans presents an opportunity for significant energy savings. By replacing all remaining conventional fans with BLDC models, the institution can achieve an estimated annual electricity cost reduction of ₹6.07 million. Additionally, this transition would lead to a reduction of approximately 621.90 metric tons of CO_2 emissions annually. These savings are based on a standard electricity rate of ₹8 per unit and the assumption that all 6,049 fans operate for 8 hours daily.

3.2.3 Implementation and Cost Considerations

The transition to BLDC fans would contribute to long-term reductions in operational expenses and support energy conservation objectives. The adoption of energy-efficient ceiling fans aligns with institutional sustainability initiatives and provides measurable financial and environmental benefits. *(Detailed calculations are provided in Annexure 2.)*

4 Digitized Existing Electricity Grid

The University of Hyderabad operates an extensive grid-connected power distribution system, which ensures reliable electricity supply across its campus. The existing infrastructure comprises 14 substations, including a main take-off point that step down power from the grid for distribution. The system is designed to cater to the diverse energy needs of academic buildings, research facilities, administrative offices, hostels, and other campus amenities. Existing grid network of the campus is given in figure 2.

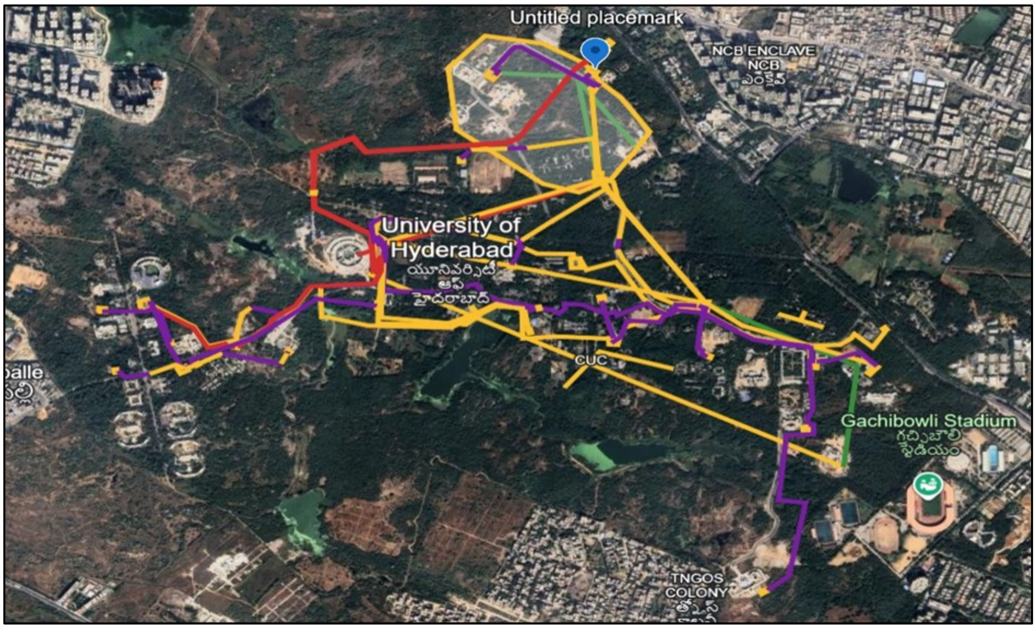

Figure 3 Existing Grid Network

The current system consists of a primary power source, a main receiving station, transformers, and multiple substations. However, with some components exceeding 25 years of operation, there is an urgent need for assessment and possible upgrades to maintain reliability and efficiency.

5 Generator Redistribution and Solar Integration

In the University of Hyderabad (HCU), redundancy is primarily implemented through 30 DG sets spread across the campus, ensuring power availability during grid failures. These DGs vary in capacity from 62 kVA to 600 kVA, with installations dating back to 2004, indicating a mix of older and newer systems. Academic buildings, research labs, hostels, and faculty offices rely on these backup power sources for continued operations. Only 7 out of 30 DG sets are automated; the rest need manual operation, causing delays in power restoration

The generators are manufactured by companies such as Kirloskar, Stamford, and Jakson, with capacities ranging from 62 kVA to 500 kVA. The rated voltage across all DG sets is 415V, and the power factor is maintained at 0.8.

The operational log records instances of DG usage, detailing the start and stop times, operational duration, and fuel consumption. The logs show that the DG sets are used intermittently, often for short durations, indicating their role as backup power sources. Fuel consumption ranges from 5 to 25 litres per session, suggesting varying load demands.

Figure 4 Existing DG Set Inside the Campus

List of DG Set replacement criteria is given in Table 1,

Table 3 DG Set Replacement Criteria

Factor	Description
Age of the DG Set	Standard replacement age is 15–20 years as older DGs have higher maintenance costs, reduced efficiency, and increased fuel consumption.
Operational Efficiency & Performance	DG sets with a low power factor (<0.8) or frequent breakdowns indicate poor efficiency and require replacement.
Emissions & Regulatory Compliance	Older DG sets may not comply with CPCB IV+ norms, leading to regulatory penalties due to excessive emissions.
Maintenance & Spare Parts Availability	Frequent maintenance, high costs, and unavailability of spare parts (e.g., alternator, turbocharger) make replacement more cost-effective.

List of DG Sets that needs to be replaced is given in table 2, while complete list of DG Sets is given in Annexure 3.

Table 4 List of Transformers Needs to be Replaced

Location	Existing DG Set	Capacity (kVA)	Old SFC (L/kWh)	New SFC (L/kWh)
Guest House	Stamford	250	0.194	0.16
Old Science	Kirloskar	500	0.421	0.21
Faculty Sub	Kirloskar	180	0.134	0.12
Chemistry Old	Stamford	500	0.421	0.22
AI Lab	Kirloskar	320	0.3	0.18
Total		**1750**		

5.1.1 Key Challenges Identified

- Aging DG sets consume more fuel, increasing operational costs.
- Only 7 out of 30 generators are automated, leading to delays in power restoration.
- Most DG sets do not meet CPCB IV+ emission norms, contributing to higher pollution levels.
- 2 out of 30 DG sets are completely non-functional, leaving 28 in operation.

5.1.2 Proposed Solution & Impact

- 5 outdated DG sets (1,750 kVA total) to be replaced with modern, energy-efficient alternatives.
- 500 kVA generators (Old Science & Chemistry Old) contribute 80% of total savings, making them the primary targets for replacement.
- Energy Generated During Power Breakdowns: **3,62,000 kWh**

Fuel & Emission Reduction: Over 53,000 Liters of diesel saved annually, leading to substantial operational savings.

Environmental Benefit: 119 metric tons of CO_2 emissions reduced, aligning with global sustainability goals.

By integrating solar energy and modernizing the backup power infrastructure, the university can significantly reduce fuel costs, reduce emissions, and ensure a more reliable, sustainable, and future-ready power system.

6 Water Distribution System – Existing Status

The water distribution system serves as the primary infrastructure for ensuring a reliable water supply across the campus. The system operates through a Main Distribution Line sourced from the Manjeera Municipality Line and is supported by pump houses, borewells, sumps, and overhead tanks (OHTs) strategically located to meet demand. Existing setup has shown in figure 4.

6.1 Components of the Water Distribution System

The components of the water distribution system include, pump houses, borewells & sumps, and existing details of storage tanks.

6.1.1 Pump Houses

The campus has two pump houses responsible for maintaining water pressure and distribution:

- North Pump House – Operates with 4 pumps
- South Pump House – Operates with 8 pumps

These pump houses facilitate water flow from the municipal supply and borewells to storage tanks and buildings.

6.1.2 Borewells & Sumps

To supplement municipal water, the system includes:

- 62 borewells providing additional groundwater supply
- 22 sumps serving as intermediate storage before water is pumped to overhead tanks

6.1.3 Storage Tanks (Overhead & Building Tanks)

The system ensures adequate storage through:

- 54 building tanks, each with a capacity of 2,000 to 5,000 liters
- 4 main Overhead Tanks (OHTs) facilitating gravity-based distribution

Figure 5 Existing Conditions of Water Distribution System

6.2 Existing Pump Infrastructure Overview

The South Pump House operates borewell pumps for 10 hours per day, alternating between two pumps. Additionally, the municipal water pump runs for 4 hours per day, also alternating between two pumps. This results in a total daily operational time of 14 hours for different pumps.

The Main Pump House has four pumps, but only two are operational, running for 4 hours per day, while the remaining two require maintenance. This has shown in figure 5.

Figure 6 Current Condition of Motors & Pumps in the Main Pump House

6.2.1 Challenges in the System

- Aging Equipment – Pumps in the Main Pump House are 40-50 years old, and nameplate details are unavailable for exact specifications.
- High Energy Consumption – Operational pumps in the Main Pump House consume 53,164 kWh annually, resulting in an electricity cost of ₹4.25 lakh per year.

6.2.2 Efficiency Improvement Measures

Upgrading the existing motors from IE1 or lower to IE3 or IE4 motors would:

- Improve energy efficiency
- Reduce operational costs
- Improve system reliability

Additional modernization strategies, including efficient motor replacements and preventive maintenance, can further optimize system performance while reducing energy costs.

6.3 Passive Cooling Measures

Passive Cooling Strategies are energy-efficient techniques used to maintain indoor comfort by reducing heat gain and enhancing natural cooling without relying on active cooling systems like air conditioners. One effective method is using cool roof paint, which reflects sunlight and reduces heat absorption, keeping buildings cooler. Another approach is cool roof tiles, which are designed with reflective surfaces and heat-resistant materials to lower indoor temperatures. These strategies help in cutting down energy costs and improving overall thermal comfort.

6.3.1 Cool Roof Paints

Cool roof paints, with a high Solar Reflectance Index (SRI), reflect more sunlight and absorb less heat, making them an effective solution for reducing indoor temperatures and improving thermal comfort. These coatings also provide protection against UV radiation and water exposure, enhancing roof durability.

As part of our recommendation to implement cool roof coatings across campus buildings to reduce heat gain and improve energy efficiency, the initiative was carried out in Ladies Hostel 1, 2, and 3. The roofs were coated with cool roof paint, and temperature measurements were taken using contact surface temperature monitors before and after the application. This assessment aimed to evaluate the impact on surface and indoor temperatures. The following images figure 7 & 8 shows markings of locations in which the sensors has been utilized to identify accurate surface temperature.

Figure 7 Locations Selected for Monitoring Temperature in Ladies Hostel 1 & 2

Figure 8 Locations Selected for Monitoring Temperature in Ladies Hostel 3

The below given figures 9 & 10 shows cool roof painting during progression and after completion.

Figure 9 Cool Roof Painting During Progression

Figure 10 Cool Roof Painting After Completion

Measurements taken using surface temperatures in roof and inside room is given in figures 11,12 & 13.

Figure 11 Surface Temperature Logger Placed in Ladies Hostel 2 Roof

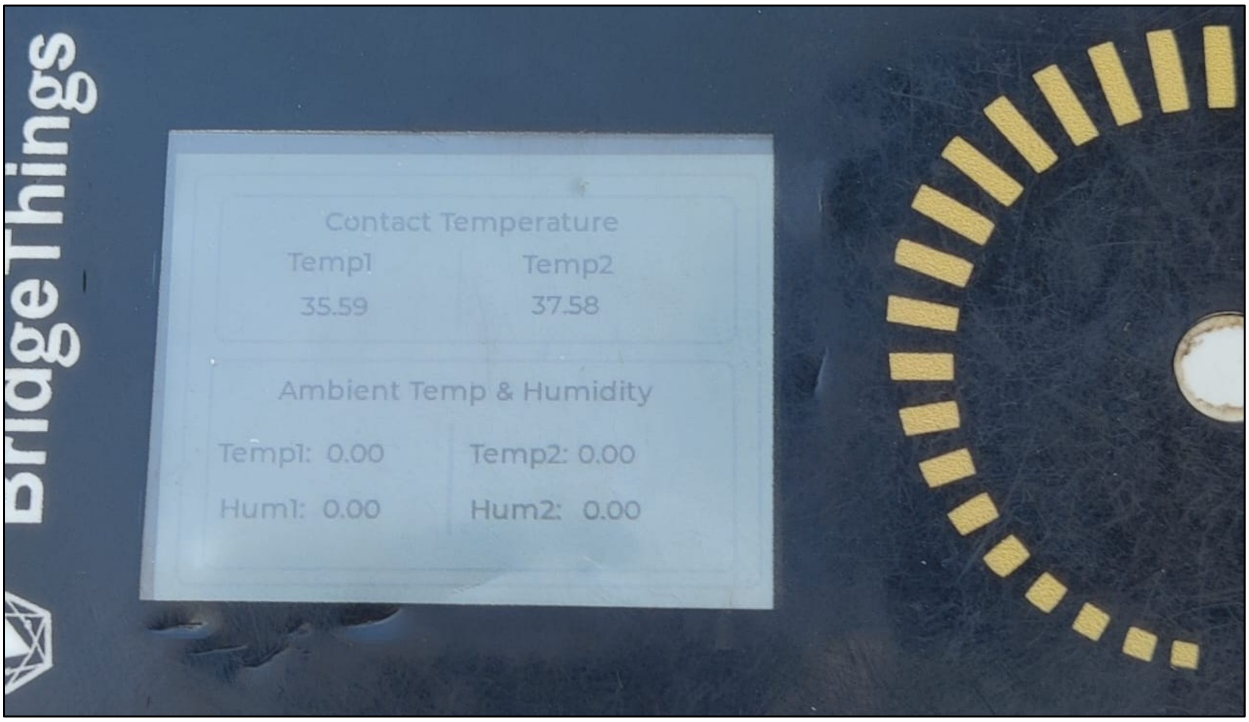

Figure 12 Measurements from Surface Temperature Logger

Figure 13 Measurements Taken Inside Hostel Room Using IR-Thermometer

6.3.2 Cool Roof Tiles

Cool roof tiles are designed to reflect a significant portion of sunlight, reducing heat absorption and improving indoor thermal comfort. These tiles are coated with reflective pigments that bounce back up to 85% of UV and infrared radiation, lowering indoor temperatures.

They are particularly effective for new buildings where they can be integrated during construction. By reducing heat retention, cool roof tiles help extend the lifespan of roofs by 5-15 years.

Additionally, using these tiles supports compliance with green building certifications such as LEED, making them a sustainable option for modern construction projects. Images of cool roof painted roofs are given in figure 14.

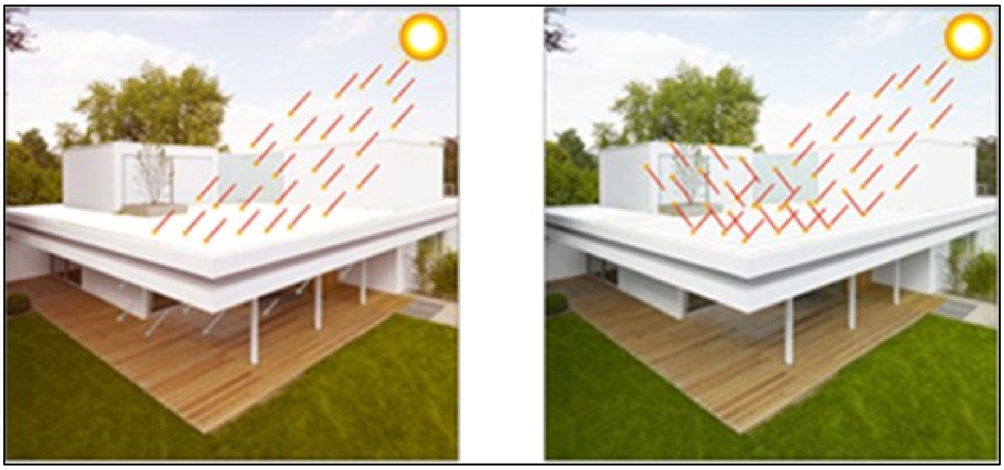

Figure 14 Difference Between Normal Roof & Cool Tiled Roof

Image Source: https://www.whitefeet.in/Laying-Instructions.html

6.3.3 Solar Reflective Windows

Solar reflective windows are a proposed measure to improve thermal comfort and energy efficiency in student hostels and other campus buildings. These windows incorporate reflective coatings that improve insulation and minimize heat transfer, reducing the need for additional cooling solutions. Image of solar reflective window is given in figure 15.

Figure 15 Solar Reflective Windows

Image Source:https://www.amazon.de/TENCMG-Unidirektional-privatsph%C3%A4re-Isolationsfolie-Selbst-klebefolie/dp/B0837H9DZL

6.3.3.1 Existing Window Status in Student Hostels

The campus has 23 student hostels, where the current window design presents challenges in maintaining indoor comfort and energy efficiency. Traditional casement windows with single glazing allow excessive heat penetration, particularly in warm climates. This results in increased indoor temperatures, reduced thermal comfort, and higher cooling energy consumption. The impact extends to student productivity, as elevated indoor temperatures can affect concentration and rest. Images of existing conditions of windows in hostels are given in figure 16.

Figure 16 Existing Condition of Windows in Hostels

6.3.3.2 Comparison of Thermal Insulation Performance (U-Values)

Upgrading to solar reflective glass or applying solar reflective films can improve indoor comfort, reduce heat gain, and lower energy costs.

- Traditional single-glazed windows: U-value of 4.8 to 5.8 W/m²K, indicating high heat transfer and poor insulation.
- Solar reflective glass: U-value of 1.2 to 1.6 W/m²K, offering better insulation and reduced heat gain.

These measures provide a cost-effective and sustainable approach to enhancing student living conditions while reducing overall cooling demand on campus.

6.4 EESL – Solar-Powered Induction Stoves

The EESL Solar-Powered Induction Stove is an innovative cooking solution developed by Energy Efficiency Services Limited (EESL) to promote sustainable and energy-efficient cooking. This stove operates using solar power, reducing dependence on conventional electricity and fossil fuels. By leveraging renewable energy, it helps lower electricity bills, minimize carbon emissions, and provide an eco-friendly alternative for households, especially in regions with unreliable power supply. This initiative aligns with India's push towards clean energy and energy conservation.

6.4.1 Feasibility and Implementation Plan

Energy Efficiency Services Limited (EESL) has launched a Solar-Based Induction Cooking Solution which is aimed at optimizing energy consumption in hostel. This initiative is designed to reduce unaccounted electricity usage, promote sustainability, and encourage energy-efficient cooking practices within institutional settings.

Key Observations & Need for the Initiative:

- Many students in hostels use electric kettles and induction stoves for personal cooking, leading to excessive, unmonitored, and often inefficient power usage. This uncontrolled consumption contributes to higher electricity bills for the institution, as such appliances are not integrated into the monitored power infrastructure.
- The proposed solar-powered induction cooking system offers a structured solution by ensuring energy-efficient, cost-effective, and accounted electricity usage.
- By transitioning to a solar-powered system, the institution can minimize dependency on grid electricity, optimize power distribution, and promote renewable energy adoption among students.

This initiative aligns with national goals for sustainability and energy conservation, making it an ideal model for hostel-based cooking solutions. Illustration of solar based induction system is given in figure 16.

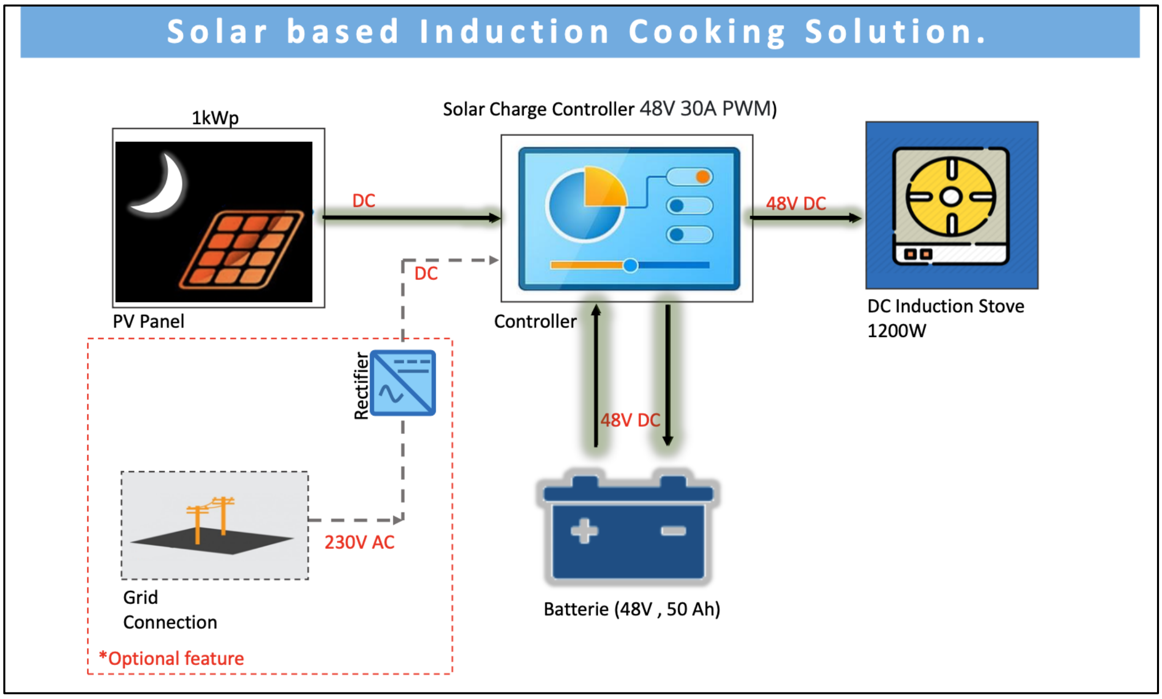

Figure 17 Solar Based Induction Cooking System

6.4.2 Specifications given by EESL

Specifications for the solar based induction cooking solution is given in table 4.

Table 5 Specifications for the Solar Based Induction Cooking System

Component	Specifications
Solar Panel	2 × 500W / 3 × 335W Mono Crystalline Solar Panels with mounting structure and accessories
Solar Charge Controller	48V, 30A PWM controller (supports 2-hour backup)
Battery	48V, 50Ah Lithium Iron Phosphate Battery (cycle life >2000) with BMS and enclosure
Induction Cookstove	48V, 1200W DC Induction Cookstove (efficiency equivalent to 5-star BEE rating)

7 Sustainable Mobility Solutions

Universities can play a key role in promoting sustainable mobility by adopting eco-friendly transportation strategies that reduce carbon footprints and improve campus accessibility. Implementing solutions such as electric shuttle services, bicycle-sharing programs, pedestrian-friendly pathways, and incentives for public transport use can significantly lower emissions and ease traffic congestion.

7.1 Existing Transportation Challenges

The Hyderabad University campus, covering over 2,300 acres, relies on a transportation network consisting of requirements of students, faculty, and visitors. The limited availability of buses results in inefficiencies, long travel times, and accessibility issues. With over 5,000 students and 400 faculty members moving between 80 buildings, the current transportation system does not support an optimal mobility framework. Addressing these issues with sustainable alternatives can improve accessibility, reduce travel time, and align with the university's sustainability goals. Existing bus route and stops have been given in the figure 18.

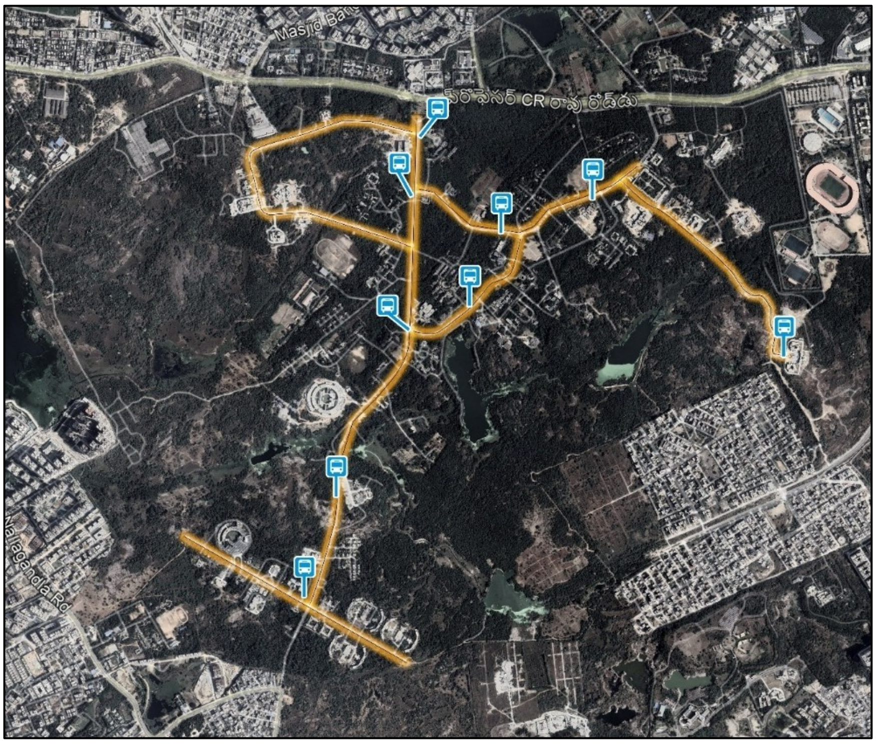

Figure 18 Existing Mobility Network of the University

7.2 Proposed Cycle Sharing System

A Cycle Sharing System is proposed to introduce a sustainable and accessible mobility alternative within the campus. The system will include smart cycle stations at key locations, enabling users to access cycles through an app-based platform or a permit card system. Visitors can use the cycles by providing a refundable deposit, ensuring both accessibility and security. Shown in figure 19.

Figure 19 User Interface Setup

A pilot phase with a limited number of cycles will be initiated to assess user demand and system feasibility before scaling up. This initiative provides an eco-friendly and cost-effective transport option, reducing carbon emissions and alleviating on-campus traffic congestion while promoting a healthier mode of commuting. Station set up is shown in figure 20.

Figure 20 Smart Bike Stations

8 Solar Heater & RO System Integration

This system integrates solar water heating with reverse osmosis (RO) filtration to improve energy efficiency and reduce operational costs. By using solar-heated water in the RO system, the need for conventional heating is minimized, leading to lower energy consumption, reduced carbon footprint, and cost savings. Graphical illustration of integrated solar water heating with reverse osmosis (RO) is given in figure 21.

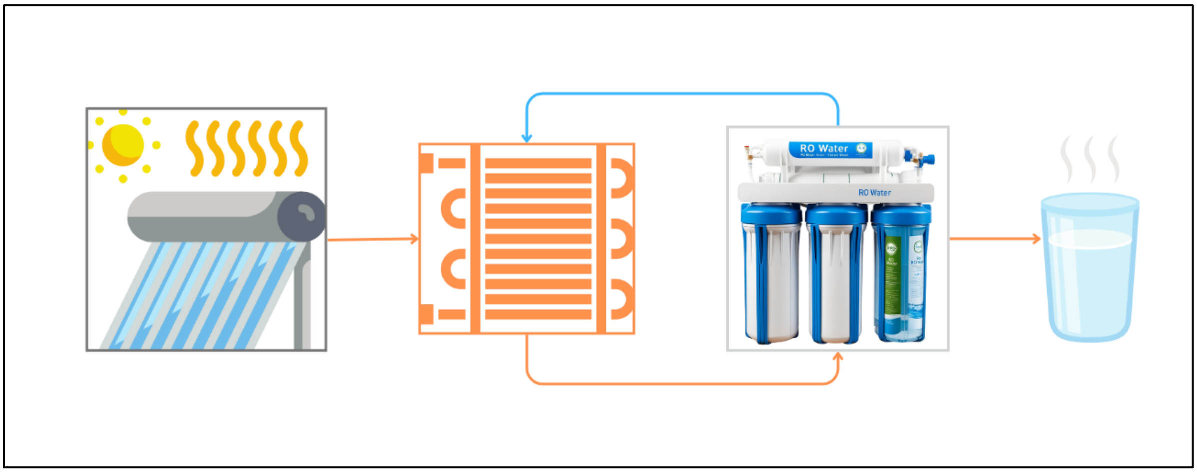

Figure 21 Integrated Solar Water Heating with Reverse Osmosis (RO)

The solar heater-RO integration system works by first heating water using a solar thermal system, which is then circulated through a heat exchanger. Here, cold RO feed water absorbs heat from the solar-heated water, raising its temperature before entering the RO filtration system. This process improves filtration efficiency, reduces energy consumption, and lowers operational costs by minimizing the need for additional heating. Flow of temperature has been shown in figure 22.

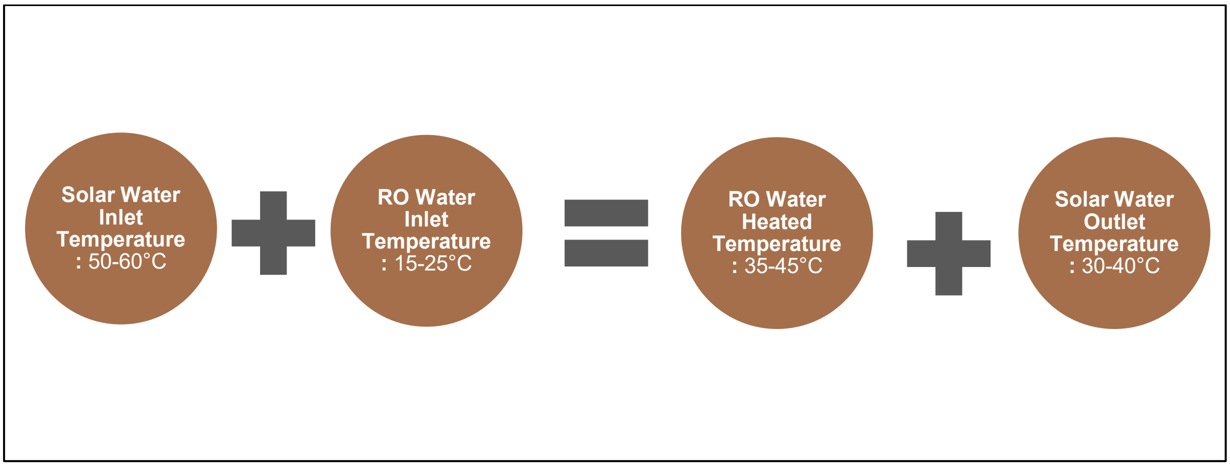

Figure 22 Solar Water Heater Methodology

The solar heater-RO integration system incorporates advanced heat exchange mechanisms to improve efficiency. The Counterflow Configuration optimizes heat transfer by ensuring that hot solar water and cold RO feed water flow in opposite directions, maximizing energy absorption and improving overall system performance.

Additionally, the Shell and Tube Heat Exchanger is utilized for large-scale applications, providing high thermal efficiency by facilitating effective heat exchange between fluids. However, it requires more installation space, making it suitable for larger setups with higher water demand. These features collectively improve energy efficiency, reduce operational costs, and improve RO filtration performance. Advantages were given in the figure 23.

Reduced Energy Consumption: Less reliance on electric or gas heating.

Lower Carbon Footprint: Utilization of renewable solar energy.

Cost Efficiency: Estimated **20-30% savings** on heating energy costs.

Figure 23: Advantages of the Integrated RO System

9 Storm Water Management

The Hyderabad University campus experiences an annual rainfall of approximately 919 mm, with the southwest monsoon contributing nearly 80% of the total precipitation. However, due to the diverse topography, which ranges from 583 meters in the west to 643 meters in the east, stormwater runoff is unevenly distributed. The higher elevation areas in the eastern region receive heavy runoff, while the lower western areas are more prone to waterlogging.

The current drainage infrastructure is inadequate to manage excess rainfall effectively, leading to localized flooding, soil erosion, and inefficient groundwater recharge. Additionally, rapid urbanization and the construction of impermeable surfaces have reduced natural infiltration, increasing dependency on external water sources.

To address these challenges, a comprehensive stormwater management plan is essential. Implementing borewell recharge systems, percolation pits, rainwater harvesting, permeable pavements, and bioswales will help optimize water conservation, reduce runoff, and improve groundwater replenishment. These sustainable measures will mitigate the adverse impacts of excessive rainfall while improving the campus's resilience to changing climatic conditions. Annual rainfall and contour level of campus is given in figure 24.

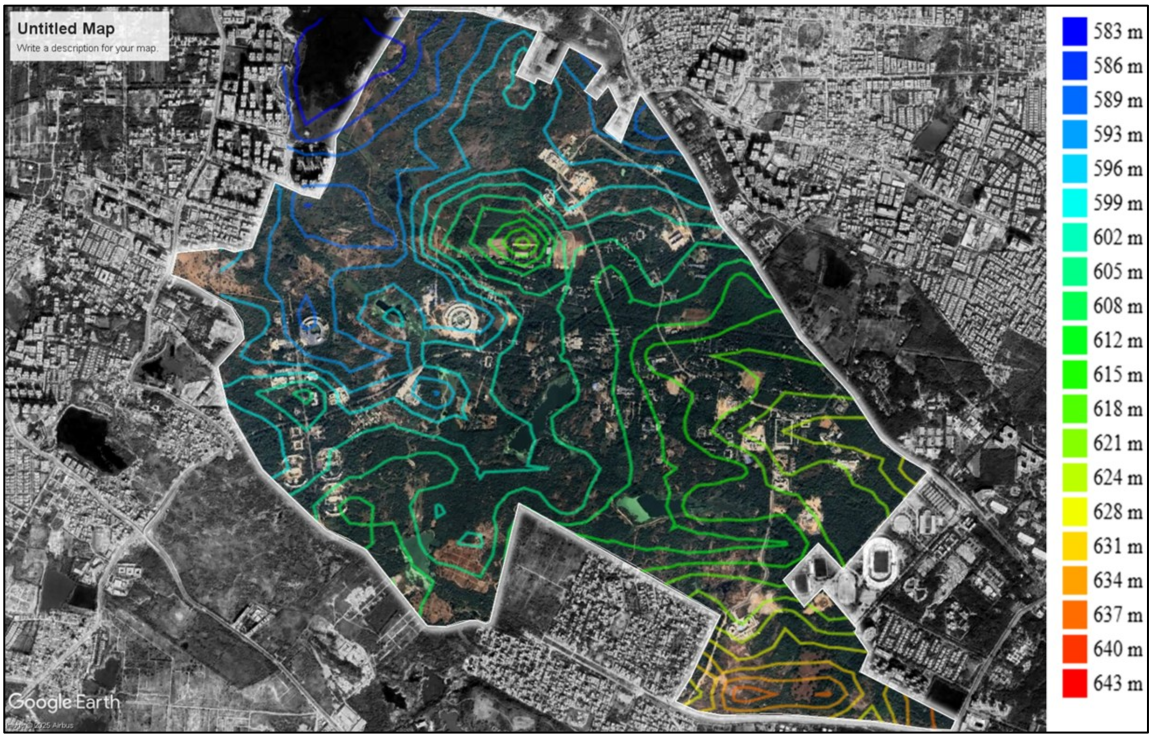

Figure 24 Annual Rainfall and Contour Level of Campus

9.1 Implementation Plan for Stormwater Management

The stormwater management strategy will be implemented in phases to improve groundwater recharge, reduce runoff, and minimize the risk of flooding.

9.1.1 Borewell Recharge System

Identify existing borewell points or pump houses for recharge system installation. Implement recharge wells with proper filtration to ensure 30-80% efficiency.

9.1.2 Percolation Pits & Rainwater Harvesting

Construct percolation pits near existing buildings. Integrate rainwater harvesting structures to improve groundwater recharge by 10-50% and achieve 30-70% water savings.

9.1.3 Permeable Pavements

Introduce permeable pavements in new pathways to reduce runoff by 70-100%. Design pavements to allow water infiltration, preventing excessive stormwater drainage.

9.1.4 Bioswales and Rain Gardens

Develop bioswales or rain gardens in courtyards and landscape areas. Reduce runoff volume by 50-90% and slow peak flow by 30-60%, lowering flood risks.

These measures will be integrated with the natural topography of the campus to ensure effective stormwater management while supporting sustainability initiatives.

10 Recommendations

To improve sustainability, reduce operational costs, and align with climate goals, the University of Hyderabad should implement the following prioritized actions:

10.1 Priority Actions for Immediate Savings

- Replace old transformers with low-loss energy-efficient models.
- Install capacitor banks for power factor improvement and lower energy bills.
- Implement solar-based induction cooking to reduce electricity demand.
- Upgrade cool roof coatings and reflective windows to improve thermal comfort.
- Introduce cycle-sharing programs and electric buses for sustainable mobility.

10.2 Long-Term Strategic Initiatives

- Optimize HVAC systems for energy-efficient cooling solutions.
- Integrate smart metering and energy monitoring systems.
- Phase out diesel generators in favour of solar + battery storage solutions.
- Strengthen stormwater management through permeable pavements and rainwater harvesting.
- Implement a campus-wide renewable energy roadmap to ensure long-term sustainability.

These measures can reduce annual energy costs by 20–30%, cut CO_2 emissions by 15–25%, and position the university as a leader in sustainable campus management.

11 Conclusion

Phase 2 of the University of Hyderabad's sustainability initiative builds on the groundwork of Phase 1 to implement practical, data-driven improvements across campus infrastructure. Focused on energy audits, equipment upgrades, and system optimization, this phase aims to reduce energy waste, lower operational costs, and align with national sustainability standards.

Key actions include conducting detailed audits of electrical, HVAC, and water systems to identify inefficiencies, replacing outdated equipment like low-star ACs and conventional fans with energy-efficient models (e.g., 5-star ACs and BLDC fans), and digitizing the electricity grid for better monitoring. The integration of solar solutions—such as solar-powered induction stoves and solar-heated RO systems—addresses unmetered loads and reduces reliance on fossil fuels. Sustainable mobility measures, like the proposed cycle-sharing system, aim to reduce emissions and improve campus accessibility.

Improvements to water infrastructure, including upgrades to aging pumps and stormwater management strategies like permeable pavements and rainwater harvesting, prioritize resource conservation. Automation of energy-consuming systems (e.g., centralized HVAC controls) and defect monitoring mechanisms further enhance efficiency.

By adopting these measures, the university is positioned to achieve measurable reductions in energy costs (20–30%) and carbon emissions (15–25%), as outlined in the recommendations. Collaboration between university engineers, sustainability experts, and external advisors ensures solutions are tailored to institutional needs while adhering to NAAC compliance frameworks.

Moving forward, timely implementation, stakeholder engagement, and continuous monitoring will be critical to sustaining these improvements. This phase underscores the university's commitment to balancing operational efficiency with environmental responsibility, setting a foundation for long-term sustainability.

I.Annexure: Calculation of AC

Energy Consumption Calculation

Total Daily Power Consumption:

- 2-Star ACs: 110 × 0.83 × 6 × 0.65 = 356.07 kWh/day
- 5-Star ACs: 110 × 0.58 × 6 × 0.65 = 248.82 kWh/day

Daily Energy Savings: 356.07-248.82=107.25 kWh/day

Monetary Savings (Considering unit cost ₹8/kWh):

- Daily: 107.25×8= ₹858
- Monthly (30 Days): 107.25 × 30 = 3,217.5 kWh/month
- 3,217.5 × 8 = ₹25,740

For 190 Operational Days:

- 107.25 × 190 = 20,377.5
- 20,377.5 × 8 = ₹1,63,020

Annual Carbon Savings

Calculation (Emission Factor: 0.82 kg CO_2 per kWh):

- 20,377.5 × 0.82 = 16,709.55 kg CO_2 = 16.70 metric tons CO_2

II.Annexure: Calculation of Fans

1.Energy Consumption Calculation

Daily Energy Consumption

For Normal Fans:

Energy=Fan Count ×Power Consumption ×Operating Hours

=6,049×0.075×8

=3,629.4 kWh per day

For BLDC Fans:

=6,049×0.028×8

=1,354.88 kWh per day

Daily Energy Savings:

=3,629.4−1,354.88

=2,274.42 kWh per day

Annual Energy Savings (for 190 days)

=2,274.42×190

=4,32,140.56 kWh per year

2. Cost Savings Calculation

Daily Cost Savings

=2,274.52×8

=₹18,196 per day

Annual Cost Savings (for 190 days)

=4,32,140.56×8

=₹34,57,124.48 per year

3. Carbon Emissions Savings Calculation

Annual Carbon Savings

=4,32,140.56×0.82

=3,54,355.26 kg CO_2

Convert to Metric Tons

=3,54,355.26/1000

=354.36 metric tons CO_2

- **Final Savings Summary for 190 Days**
- **Energy Savings:** 4,32,140.56 kWh
- **Cost Reduction**: ₹34,57,124.48
- **Carbon Emission Savings:** 354.36 metric tons CO_2

III.Annexure: Complete List of Generators

Table 6 Complete List of Generators

S.no	Location	Make	Capacity	Year
1	Primary	Kirloskar	250	2007
2	Guest House	Stamford	250	2005
3	Domestic Sub	Kirloskar	320	2009
4	Domestic Sub	Jakson	320	2007
5	SLS-1	Stamford	500	2012
6	SLS-2	Stamford	500	2012
7	SLS-3	Stamford	500	2012
8	South Commercial	Kirloskar	250	2008
9	C-Hostel 1	Kirloskar	320	NA
10	C-Hostel 2	Kirloskar	500	NA
11	Earth Science	Kirloskar	160	NA
12	Zakir Hussain	Kirloskar	125	2015
13	Amenities	Kirloskar	125	NA
14	Old Science	Kirloskar	500	20040
15	CIL Sub	Kirloskar	500	2014
16	Faculty Sub	Kirloskar	180	2005
17	CMSD Sub 1	Kirloskar	500	2013
18	CMSD Sub 2	Stamford	500	2013
19	BSL iii 1	Stamford	500	NA
20	BSL iii 2	Stamford	500	NA
21	Chemistry Old	Stamford	500	2006
22	New Chemistry	Stamford	500	2014
23	RTGR	NA	160	2013
24	CNF	NA	200	2010
25	AI Lab	NA	320	2005
26	SN School Old	Stamford	320	2007
27	SN School New	Stamford	125	NA
28	Main Pump House	Kirloskar	NA	NA