ENERGY AUDIT REPORT

Name of Organization	Great Ganges institute of technology
Address	Kanpur-Lucknow highway, gram Gadankhera, post Singrausi, Unnao-209801
Contact Person	Dr. Sudhir Singh
Name of Auditor	Ashutosh Tiwari
Audit Date	26/10/2023
Report No.	CIL/20232542

Energy Policy of The Organization:

GREAT GANGES INSTITUTE OF TECHNOLOGY
Affiliated to C.S.J.M. University, Kanpur (College Code - UN51)

Ref. No. *Date*.....

GGES/GGIT/2023-24/01 **Date: 25/07/2023**

Energy Conservation policy

The energy conservation policy aims to reduce energy consumption, lower greenhouse gas emissions, and promote a culture of environmental responsibility within the organization premises.

Here are some common strategies and policies that GGIT implement:

1. **Energy Audits**: Conducting regular energy audits to identify areas where energy is being wasted and to implement improvements.
2. **Energy-Efficient Infrastructure**: Designing and constructing buildings with energy-efficient features, such as proper insulation, efficient lighting, and HVAC systems.
3. **Renewable Energy Sources**: Investing in renewable energy sources like solar panels to generate clean and sustainable energy.
4. **Energy-Efficient Lighting**: Replacing traditional light bulbs with LED lights, which consume significantly less energy and have a longer lifespan.
5. **Smart Building Management Systems**: Implementing advanced systems that monitor and control building operations, including lighting, heating, cooling, and ventilation, to optimize energy usage.
6. **Education and Awareness Programs**: Educating students, faculty, and staff about energy conservation practices and encouraging them to adopt more sustainable behaviors.
7. **Transportation Initiatives**: Promoting sustainable transportation options such as biking, walking, carpooling, and providing electric vehicle charging stations.

Great Ganges Institute of Technology Principal UNNAO

Great Ganges Education Complex
Kanpur - Lucknow Highway, Vill : Gadankhera, PO : Singrausi, Dist. : Unnao 209801
Ph. : 9792909666 / 777 • Fax : 0515-2840888 • Email : ggitcollege@gmail.com

Energy Management Team:	
Dr. Radhe Shyam Jha	Chairperson
Dr. Sudhir Singh	IQAC Coordinator
Dr. Saurabh Gupta	Dean Academics
Mr. Karvendra Singh	Dean Administration & Student Welfare
Mr. Ravi Gupta	Controller of Examination
Ms. Aqsa Khalid	Training and Placement Head
Ms. Amrita Singh	Alumni Cell Head
Ms. Vashishtha Bharti	HR Manager
Mr. Laxmi Singh	IT Head

Mr. Vishwas Saxena	ERP Coordinator
Mr. Satish Kumar Verma	Registrar
Mr. S.S. Mishra	Accounts Department

Building Energy Systems

HVAC systems	
• Are there any leaks or airflow issues in the HVAC system? • How effective is the temperature control in the building? • How much energy does the HVAC system consume? • Are there any upgrades or improvements that can be made to the HVAC system for better energy efficiency?	• During the audit, it was observed that there were no leaks or airflow issues related to the AC system. Reference Pic/Doc: - fig 1 • The temperature control for the building is managed by the air conditioning system, and the temperature is maintained at around 20-22 degrees Celsius. • There are 12 air conditioning systems that consume a total of 840 watts, amounting to a total of 10,080 watts of electricity. Reference Fig/doc: - Appendix 1 • The improvements that can be made to the HVAC system for better energy efficiency are provided below.

Fig 1: Different type of Air conditioning in the rooms

Recommendations:

1. High-Efficiency Air Conditioners: Consider replacing older, less efficient air conditioning units with high-efficiency models. Look for units with a high SEER (Seasonal Energy Efficiency Ratio) rating, which indicates better energy efficiency.

2. Regular Maintenance: Schedule regular maintenance for air conditioning units to ensure they operate at peak efficiency. This includes cleaning coils, changing filters, and inspecting the system for leaks and other issues.

3. Thermostat Upgrades: Install programmable or smart thermostats that allow for temperature scheduling and remote control. This helps to optimize cooling when the building is in use and reduce cooling when it's unoccupied.

4. Zoning System: Implement a zoning system that divides the college into different cooling zones. This enables you to cool only the areas in use, reducing energy consumption in unoccupied spaces.

5. Natural Cooling Strategies: Use natural ventilation during cooler seasons to reduce the reliance on air conditioning. Properly placed windows and ventilation can help circulate fresh air and maintain comfort.

6. Insulation: Improve insulation in the building to reduce heat gain, especially in areas exposed to direct sunlight. Proper insulation minimizes the workload on the air conditioning system.

7. Window Treatments: Install reflective window films or shades to reduce heat gain through windows. This can be particularly effective in sunny areas.

8. Air Duct Inspection and Sealing: Ensure that air ducts are properly sealed and insulated to prevent air leaks. Leaky ducts can significantly reduce the efficiency of the cooling system.

9. Energy Recovery Ventilators (ERVs): Consider installing ERVs to recover cool air from exhaust air and use it to precondition incoming fresh air, reducing the energy required for cooling.

10. Cool Roofing: If applicable, consider using cool roofing materials that reflect more sunlight and absorb less heat, reducing the cooling load on the building.

11. Shade and Landscaping: Use shading devices, such as awnings or trees, to provide natural shade to the building, reducing the need for air conditioning. Well-placed landscaping can also have a cooling effect.

12. Regular Filter Maintenance: Change and maintain air filters regularly to ensure proper airflow. Clogged filters can reduce system efficiency and indoor air quality.

13. Educational Outreach: Promote energy-saving habits among college staff and students, such as turning off air conditioning in unoccupied rooms or using fans to enhance comfort.

14. Monitoring and Control Systems: Implement energy management systems that continuously monitor and control air conditioning systems for optimal performance.

15. Renewable Energy Integration: If feasible, consider integrating renewable energy sources such as solar panels to offset the electricity consumption of the air conditioning system.

16. Incentives and Rebates: Explore government incentives and rebates for energy-efficient air conditioning upgrades to help offset initial costs.

Lighting systems	
• Are the lighting fixtures and bulbs in use energy-efficient? • How much energy does the lighting system consume? • Are there any areas where lighting can be improved or upgraded for better energy efficiency?	• During the audit, it was observed that the bulbs and lighting fixtures were energy-efficient as they mainly used LED technology. Reference Fig/Doc: - Fig 2 • The lighting system consists of 252 bulbs, each with a power rating of 9 watts, using a total of 2268 watts of energy. Reference Fig/Doc: - Fig 3, Appendix 1 • The following upgrades and recommendations can be implemented to enhance energy efficiency.

Fig 2: Various lights in the institute

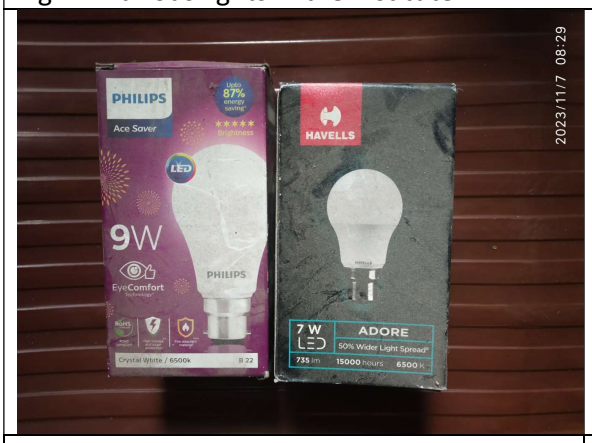

Fig 3: Bulb wrappers used in the college

Recommendations

1. Here are some recommendations for upgrading and improving lighting systems in a college:

2. LED Lighting: Replace incandescent, fluorescent, or older LED lighting fixtures with energy-efficient LED lights. LED bulbs consume significantly less energy, have a longer lifespan, and provide high-quality illumination.

3. Occupancy Sensors: Install occupancy sensors in classrooms, offices, and common areas. These sensors can automatically turn off lights when spaces are unoccupied, reducing unnecessary energy consumption.

4. Daylight Harvesting: Utilize natural daylight through windows and skylights. Combine this with daylight sensors that can adjust artificial lighting levels based on the amount of available natural light, reducing the need for electric lighting during the day.

5. Timers and Dimmers: Use timers and dimmer switches to control lighting in areas where varying light levels are acceptable. For example, in conference rooms or auditoriums, dimming lights can help reduce energy use.

6. High-Efficiency Fixtures: Choose lighting fixtures that are designed for high efficiency and optimal light distribution. Look for fixtures that minimize light spill and direct light where it is needed.

7. Tunable White Lighting: Consider tunable white lighting systems that allow you to adjust the color temperature of the light to match the time of day. Cooler light in the morning and warmer light in the afternoon can enhance productivity and comfort.

8. Task Lighting: Encourage the use of task lighting, which provides focused illumination where needed. This allows users to have control over their lighting environment and can reduce the need for overall room lighting.

9. Lighting Controls: Implement centralized lighting control systems that allow for scheduling and zoning, so lights can be turned off or dimmed when not required.

10. Energy-Efficient Exit Signs: Replace traditional incandescent exit signs with energy-efficient LED exit signs that consume much less energy.

11. Maintenance: Regularly clean fixtures and replace bulbs as needed to ensure they operate at their highest efficiency.

12. LED Retrofit Kits: In spaces with existing fixtures, consider retrofit kits to convert older fixtures into energy-efficient LED fixtures.

13. Lighting Design: Conduct a lighting redesign to ensure optimal lighting levels while reducing energy consumption. Properly designed lighting layouts can provide even illumination and reduce the need for excessive lighting.

14. Educational Outreach: Educate students and staff on the importance of turning off lights when not needed and energy-saving practices.

15. Energy Monitoring: Install energy monitoring systems to track lighting energy consumption and identify areas for further improvement.

16. Incentives and Rebates: Explore available incentives and rebates from local utilities or government programs that may help offset the cost of energy-efficient lighting upgrades.

Plug loads:	
• Evaluate the usage of electrical equipment and appliances, such as computers, printers, and vending machines. • Analyze energy usage and identify areas for improvement. • Recommend energy-efficient replacements or upgrades.	• During the audit, the institute used computers, printers, and UPS for its educational purposes. Reference fig /doc: - fig 4, fig 5 • There are 90 monitors and 5 printers with power ratings of 70W and 250W, respectively. They consume 6300W and 1250W of power, respectively. Reference fig/doc: - Appendix 2 • The following recommendations are provided for energy-efficient replacements and upgrades.

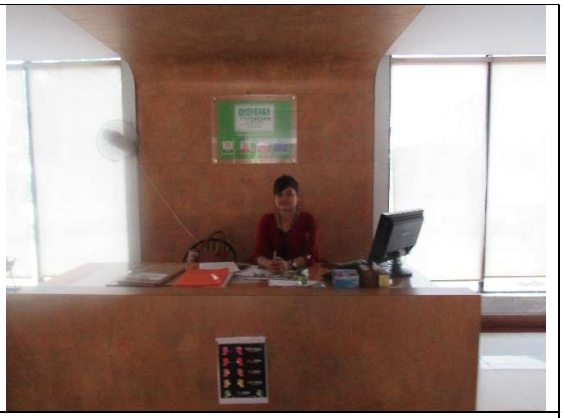

Fig 4: Computer usage with the printer in the various area in the college

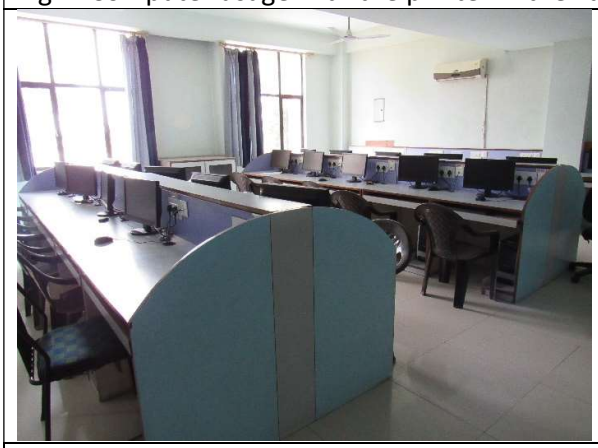

Fig 5: computer Lab photograph

Recommendation

The energy efficiency of monitors and printers in a college without completely replacing them, here are some recommendations:

1. Monitors:

a) Adjust Power Settings: Ensure that all monitors are set to enter sleep or standby mode when not in use. Adjust power settings to have shorter time intervals for screen sleep and display power-off.

b) Screen Brightness: Reduce the screen brightness to an appropriate level. Brighter screens consume more energy.

c) Turn Off When Not in Use: Encourage students and staff to manually turn off monitors when they are not using them, especially at the end of the day.

d) Power Strips: Connect monitors to power strips with an on/off switch. This makes it easy to completely cut power to monitors at the end of the day.

e) Energy-Efficient Screensavers: Set energy-efficient screensavers to activate after a short period of inactivity.

2. Printers:

a) Duplex Printing: Configure printers to default to duplex (double-sided) printing to reduce paper usage and lower energy consumption.

b) Eco-Mode: Many modern printers have an eco-mode or power-saving feature. Enable this mode to reduce energy consumption during idle times.

c) Automatic Sleep Mode: Set printers to enter sleep mode automatically when not in use. Ensure that they wake up quickly when a print job is sent.

d) Printer Consolidation: If possible, consolidate printers to reduce the number of devices in use. Networked printers can serve multiple departments or areas.

e) Printer Efficiency: Replace older, energy-inefficient printers with more energy-efficient models when they are due for replacement.

f) Maintenance: Regularly maintain printers, including cleaning and servicing, to ensure they are operating at peak efficiency.

g) Encourage Responsible Printing: Educate staff and students about responsible printing practices, such as printing only when necessary and using digital alternatives when possible.

h) Power Strips: Use power strips with an on/off switch for printers to easily turn them off when not in use, such as at the end of the day.

i) Ink and Toner Cartridges: Use high-yield, energy-efficient ink and toner cartridges that require less frequent replacement.

j) Remote Printing Solutions: Implement remote printing solutions to reduce the need for physical printing and the associated energy consumption.

k) Energy Monitoring: Install energy monitoring systems to track the energy consumption of printers and identify areas for further improvement.

These recommendations can help improve the energy efficiency of existing monitors and printers in the college without the need for significant investment in new equipment. Additionally, raising awareness about responsible energy use and printing practices among students and staff can contribute to energy savings.

Water heating systems:	
Inspect water heating equipment, including boilers and water heaters. Check for leaks in pipes. Review temperature setpoints and scheduling. Analyze energy usage and identify areas for improvement. Recommend upgrades or replacements as necessary.	The institute does not utilize water heating system.

Other energy-consuming equipment:	
• Evaluate other energy-consuming equipment, such as elevators, escalators, and data centers. • Analyze energy usage and identify areas for improvement.	• There is other equipment such as fan, biometric, electric kettle, camera and lift are there in use. Reference fig/doc: - Fig 6 and fig7

• Recommend energy-efficient replacements or upgrades.	• There were 140 fans, each with a capacity of 75 watts, so the total energy consumed is 10,500 watts. Reference fig/doc: - Appendix 2 • The replacement for the energy efficient replacement or upgrades.

Fig 6: The fig of fans and light in class room

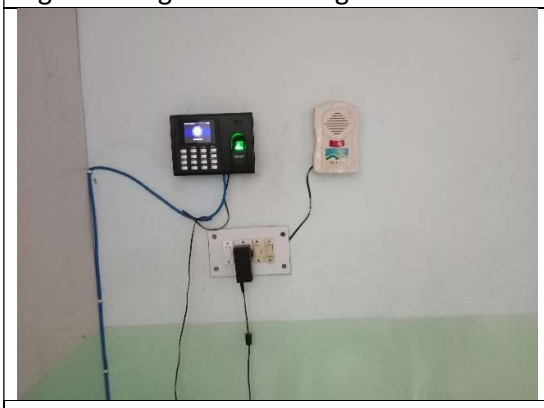

Fig 7: Biometric system wattage consumption

Recommendation

Certainly, here are recommendations for improving the energy efficiency and functionality of various electrical equipment and systems in an existing college:

1. Electric Kettle:

a) Energy-Efficient Models: Consider replacing older electric kettles with energy-efficient models that have quick boiling features and auto shut-off functions.
b) Boiling Water Efficiently: Encourage users to only boil the amount of water they need to reduce energy waste.
c) Regular Maintenance: Ensure that kettles are regularly cleaned and descaled to maintain their efficiency.

d) Educational Outreach: Educate users about energy-saving practices, such as turning off the kettle when not in use.

2. Biometric Systems:

a) Idle Mode: Configure biometric systems to enter idle mode during non-peak hours or when not in use.
b) Power Management: Integrate biometric systems with power management software that turns them off when the facility is closed.
c) Regular Maintenance: Ensure biometric systems are regularly serviced and updated to maintain their efficiency.
d) Education: Educate staff on best practices for using the biometric systems efficiently.

3. Elevators (Lifts):

a) Energy-Efficient Elevators: If possible, consider modernizing or retrofitting older elevators with energy-efficient systems that use regenerative drives and LED lighting.
b) Group Control Systems: Implement advanced group control systems to optimize elevator movement and reduce wait times, which can lead to energy savings.
c) Regular Maintenance: Ensure elevators are properly maintained to prevent breakdowns and energy inefficiencies.
d) Educational Outreach: Educate students and staff on elevator usage best practices, such as using stairs for shorter trips or sharing elevator rides when possible.

4. Uninterruptible Power Supplies (UPS):

a) Energy-Efficient UPS: Consider upgrading to more energy-efficient UPS units that use advanced battery technology and have higher efficiency ratings.
b) Right-Sizing: Ensure that the UPS units are properly sized for the connected load to minimize energy waste.
c) Regular Maintenance: Perform regular maintenance of UPS units to ensure they operate at peak efficiency.
d) Virtualization: If applicable, consider virtualizing critical servers to reduce the load on UPS units.

5. Security Cameras:

a) Energy-Efficient Cameras: Upgrade security cameras to energy-efficient models with motion detection and low-power standby modes.
b) Camera Placement: Optimize camera placement to capture necessary footage without redundant coverage.
c) Networked Cameras: Implement networked cameras to centralize recording and reduce the number of recording devices, which can save energy.
d) Centralized Control Systems: Consider implementing centralized control systems for various equipment and systems (e.g., lighting, HVAC, and security) to provide a unified platform for efficient management and control.

6. Renewable Energy Integration: Explore the possibility of integrating renewable energy sources, such as solar panels, to offset the energy consumption of various equipment and systems in the college.

7. Energy Audits: Conduct periodic energy audits to identify specific areas where improvements can be made, taking into account the college's unique needs and budget constraints.

Customize these recommendations based on the specific equipment and systems in use at your college. Implementing these improvements can lead to energy savings, reduced operational costs, and a more sustainable campus environment.

Building Envelope

Walls, roof, and foundation:	
• Inspect walls, roof, and foundation for air leaks, cracks, and damage. • Check for insulation and evaluate its R-value. • Review construction materials and building design. • Analyze energy usage and identify areas for improvement. • Recommend upgrades or replacements as necessary.	• During the audit, the walls, roof, and foundation were found to be free of air leaks, cracks, and damage. Reference Fig/doc – fig 8 and fig 9 • No written documents were found for the R-values of the walls and roof. • During the audit, the construction materials and building design were found to be satisfactory. • Energy usage of the building for the 6 month is 57231KW and the following table provide the recommendation for the improvement. • Recommend upgrades are given in the table below

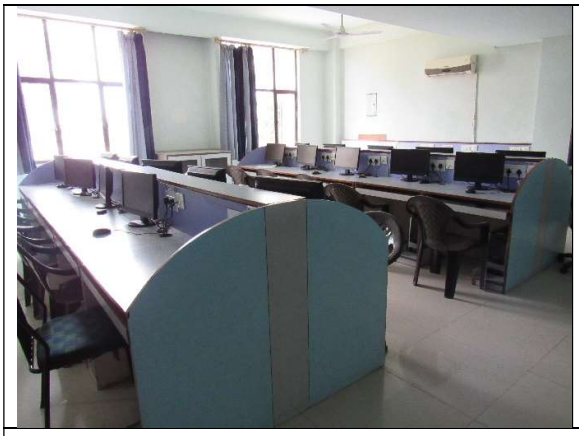

Fig 8: Floor and roof at various room in the computer room and other area

Fig 9: Roof wall

Recommendation

Improving the building envelope can significantly enhance energy efficiency. Here are recommendations for each component:

Walls:

a) Insulation: If the walls are not adequately insulated, consider adding insulation to improve thermal performance. The choice of insulation material will depend on the construction type and budget.
b) Sealing Gaps: Inspect for any gaps or cracks in the walls and seal them to prevent air leakage. This can help maintain a more consistent indoor temperature.
c) Window and Door Efficiency: Upgrade windows and doors to energy-efficient models, including double-glazed windows with low-E coatings and well-sealed, energy-efficient doors.

Roof:

a) Cool Roofing: Consider installing cool roofing materials that reflect more sunlight and absorb less heat. Cool roofs can reduce the cooling load on the building and improve comfort.
b) Roof Insulation: Ensure that the roof is adequately insulated to prevent heat gain in the summer and heat loss in the winter.
c) Skylights: If there are skylights in the roof, ensure that they have energy-efficient glazing to minimize heat transfer.

Foundation:

a) Insulation: If the foundation is exposed and uninsulated, consider adding insulation to reduce heat loss in colder months.
b) Sealing: Check for cracks or openings in the foundation and seal them to prevent moisture infiltration and air leakage.
c) Exterior Cladding:

d) Maintenance: Regularly inspect and maintain the exterior cladding material (e.g., siding, stucco, brick) to ensure it is in good condition and provides proper protection from the elements.

Energy Audits: Perform a comprehensive energy audit to assess the current state of the building envelope, identify areas that need improvement, and determine the most cost-effective solutions.

Renewable Energy Integration: Explore the possibility of integrating renewable energy sources, such as solar panels, on the roof or in the surrounding areas to offset energy consumption and contribute to sustainability.

Educational Outreach: Educate students and staff about the importance of a well-maintained building envelope and their role in energy efficiency. Encourage responsible energy use.

The specific upgrades or replacements needed will depend on the condition of the existing building and budget constraints. An energy audit will provide valuable insights into where improvements are most needed and what measures will provide the best return on investment for the college building's energy efficiency and sustainability.

Non-Conformity: -
Insufficient documentation and assessment of insulation R-values during the audit.

Insulation:

• Evaluate the type and condition of insulation. • Check for gaps or damaged areas. • Evaluate insulation's R-value and its effectiveness. • Analyze energy usage and identify areas for improvement. • Recommend upgrades or replacements as necessary. • Recommend upgrades or replacements as necessary.	• During the audit the wire were found to be good in condition. Reference Fig/doc:- fig 10, fig 11 • During the time of the audit there were no gap or damage area observed in the insulation, but there are wire which are left outwards. Reference fig/doc:- fig 12 • No written evidence found at the time of the audit. • The energy usage of the building for the 6 month is there and this information is not sufficient for the patterns to be drawn • Recommend upgrades or replacement as necessary

Non conformity

- Inadequate evaluation of insulation's R-value and its effectiveness.

Fig 10: The condition of the wire in the various places

Fig 11: Closed wire system in the classroom	Fig 12: Wire hanging out toward the wall facing the building with the new AC installation.

Recommendation:
If you are considering upgrades or replacements for your electrical wiring, it's important to prioritize safety, compliance with local building codes, and the specific needs of your electrical system. Here are some general recommendations:

1. Assessment by a Professional:

   Have a licensed electrician conduct a thorough assessment of your electrical wiring. They can identify any issues, assess the condition of the wiring, and provide tailored recommendations.
2. Replace Outdated Wiring:

   If your building has outdated wiring, such as knob-and-tube or aluminum wiring, consider replacing it with modern copper or aluminum wiring that meets current electrical codes.
3. Upgrade to a Higher Amperage:

   If your electrical demand has increased over the years, you may need to upgrade to a higher amperage service to accommodate additional appliances, devices, or electrical loads.
4. Install Ground Fault Circuit Interrupters (GFCIs):

   Consider installing GFCIs in areas where water is present, such as kitchens, bathrooms, and outdoor outlets. GFCIs help prevent electrical shocks by quickly shutting off power when a ground fault is detected.
5. Upgrade to Arc Fault Circuit Interrupters (AFCIs):

   AFCIs are designed to detect and respond to dangerous electrical arcs, helping prevent electrical fires. Consider upgrading your system to include AFCIs, especially in bedrooms and living spaces.
6. Consider Surge Protection:

   Install surge protectors or whole-house surge protection devices to safeguard your electronic devices and appliances from power surges.
7. Ensure Proper Insulation:

   Make sure that wiring is properly insulated and protected from environmental factors. Replace any damaged or deteriorating insulation promptly.
8. Smart Home Wiring:

If you are integrating smart home technologies, consider installing wiring that supports these systems, such as Cat6 or Cat7 Ethernet cables for high-speed internet and home automation.

9. Compliance with Energy Efficiency Standards:

   Explore wiring options that align with energy efficiency standards. Energy-efficient wiring can contribute to reducing energy consumption in your building.

10. Professional Installation:

    All upgrades and replacements should be performed by licensed and qualified electricians to ensure compliance with safety standards and local regulations.

Remember, electrical work can be complex and potentially dangerous, so it's crucial to consult with a professional electrician before making any decisions or attempting any upgrades or replacements. They can provide guidance based on your specific needs and ensure that the work is done safely and in accordance with applicable codes.

Doors and windows:	
• Inspect doors and windows for air leaks, damage, or gaps. • Evaluate the type and condition of windows and doors. • Review the window-to-wall ratio and the orientation of windows. • Analyze energy usage and identify areas for improvement. • Recommend upgrades or replacements as necessary.	• During the audit, the condition of the doors and windows was found to be satisfactory. Reference fig/doc: - Fig 13 • The window material was found to be made of glass, wood and metal Reference fig/doc: - fig 13 • The window-to-wall ratio is 2:1, and the orientation of the windows is towards the other side to maximize natural daylight. • The energy usage is according to the power schedule and the area of improvement is suggested for the table below. Reference fig/doc: - Appendix 5 • Recommended upgrades and replacement as necessary are as follow

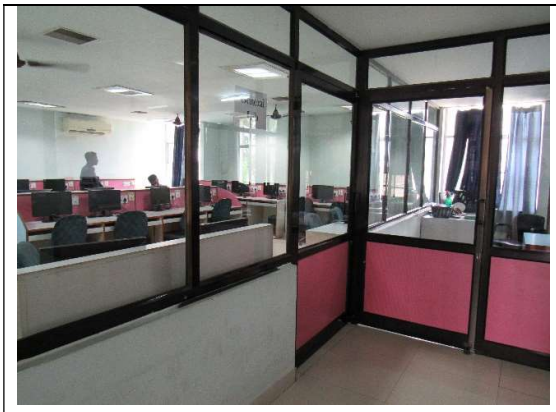

Fig 13: Various door and window installed in the classroom and the computer lab

Recommendation: -

Replacements for doors and windows as part of an energy audit:

Doors:

a) Energy-Efficient Door Materials: Replace existing doors with energy-efficient models that have better insulation properties. Look for doors with a high R-value (resistance to heat flow).
b) Weatherstripping: Ensure that doors are properly weather-stripped to prevent air leaks. Replace worn or damaged weatherstripping as necessary.
c) Thresholds: Install door thresholds to seal the gap between the door bottom and the floor. This helps prevent drafts and air infiltration.
d) Automatic Door Closers: Install automatic door closers to ensure that doors are not left ajar, especially in high-traffic areas.
e) Revolving Doors: Consider installing revolving doors at entrances to minimize air exchange with the outdoors, particularly in areas with extreme weather conditions.

Windows:

a) Energy-Efficient Window Frames: Replace existing window frames with energy-efficient options, such as vinyl, fiberglass, or insulated frames, which provide better thermal performance.
b) Double- or Triple-Glazed Windows: Upgrade to double- or triple-glazed windows with low-E coatings to reduce heat transfer and improve insulation.

c) Gas-Filled Windows: Consider using gas-filled windows, such as argon or krypton, which enhance insulation by reducing heat conduction.
d) Window Films: Apply low-emissivity (low-E) window films to reduce heat gain during hot weather and heat loss during cold weather.
e) Caulking and Sealing: Inspect the window seals and caulking, and reseal any gaps or cracks to prevent air leakage.
f) Window Treatments: Install energy-efficient window coverings, such as blinds, shades, or curtains, to control solar gain and provide additional insulation.
g) Operable Windows: In areas where natural ventilation is possible, consider installing operable windows to reduce the reliance on mechanical HVAC systems.
h) Window Sill Extensions: Extend window sills to create deeper window wells that can accommodate additional insulation and reduce drafts.
i) Window Maintenance: Ensure that windows are properly maintained, including cleaning, lubricating hardware, and replacing damaged or worn parts.
j) Educational Outreach: Educate students and staff about the importance of closing doors and windows when not in use and using window coverings effectively.

Customize these recommendations based on the specific condition and requirements of the college building. The goal is to improve energy efficiency, reduce drafts, and enhance the overall comfort and usability of the space. An energy audit will help determine the most cost-effective solutions for your particular building.

Air leaks:

• Identify areas of air leakage in the building envelope. • Evaluate the effectiveness of weatherstripping and caulking. • Recommend upgrades or replacements as necessary.	• During the audit, air leakage was not observed in areas such as the air conditioning room, classrooms, staffroom, etc. • No evidence was found at the time of the audit. • Recommendations for upgrades or replacements, as necessary, are provided in the table below.

Recommendation
To address air leaks in an existing college building, it's essential to improve energy efficiency and indoor comfort. Here are some recommendations for upgrades or replacements to mitigate air leaks:

1. Comprehensive Air Sealing:

Conduct a thorough inspection of the building envelope to identify and seal air leaks. Focus on common leakage areas, such as around windows, doors, electrical outlets, and HVAC ducts.
Use caulking, weatherstripping, or sealant to close gaps and cracks around windows and doors.
2. Door and Window Seals:

Replace worn or damaged weatherstripping and door sweeps on exterior doors.
Install or upgrade door sweeps to ensure they form a tight seal when doors are closed.
Consider adding door sweeps or threshold seals to doors with large gaps.
3. Window Upgrades:

Replace single-pane windows with double- or triple-glazed, energy-efficient windows. Look for Low-E coatings and argon or krypton gas fills for better insulation.
Install storm windows over existing windows to create an additional barrier against air infiltration.
4. Caulking and Sealing:

Caulk gaps and cracks in exterior walls and the building envelope, including areas around plumbing and electrical penetrations, as well as wall and roof joints.
Reapply or repair caulking as needed, especially in high-wear areas.
5. Duct Sealing:

Inspect HVAC ducts for leaks and seal them with mastic or metallic tape. Leaky ducts can significantly contribute to air infiltration and reduced energy efficiency.
6. Attic and Roof Insulation:

Ensure that the attic and roof spaces are well-insulated to prevent heat loss or gain through the roof.
Seal any gaps or holes in the attic that allow air to escape.
7. Wall Insulation:

Consider adding insulation to exterior walls if they are not adequately insulated. This can help reduce heat transfer and improve energy efficiency.
8. Foundation Sealing:

Seal any gaps or cracks in the foundation to prevent cold air infiltration through the basement or crawl space.
9. Air Leakage Testing:

Conduct a blower door test or use thermal imaging to identify specific areas of air leakage. This can help pinpoint areas that need attention.

10. Professional Assessment: Consider hiring a professional energy auditor or a building envelope specialist to assess and address air leaks comprehensively.

11. Educational Outreach: Educate students and staff on the importance of keeping windows and doors closed when HVAC systems are in operation and on responsible energy use practices.

Addressing air leaks not only enhances energy efficiency but also improves indoor comfort and air quality. Regular maintenance and inspections are key to maintaining the effectiveness of air sealing measures in the college building.

Non conformity
Absence of documented evidence or records pertaining to the evaluation of the effectiveness of weatherstripping and caulking during the audit.

Occupant Behavior

Temperature setpoints:	
• Evaluate temperature setpoints for different areas of the building. • Review thermostat settings and schedules. • Identify opportunities to adjust temperature setpoints to optimize energy efficiency while maintaining occupant comfort.	• The set point of the AC room in the building area is set around 20 to 22 degrees Celsius. • No written evidence was found at the time of the audit for the schedules and thermostat settings. • Opportunities to adjust the temperature setpoint to optimize energy efficiency while maintaining occupant comfort are provided below.

Recommendation
some opportunities to consider as part of an energy audit:

1. Setback Temperatures:

Implement setback temperatures during unoccupied hours and when the building is not in use. For example, during evenings, weekends, and holidays, lower the heating temperature setpoint in the winter and raise the cooling setpoint in the summer.
Use programmable thermostats or building automation systems to automate temperature adjustments based on the building's schedule.
2. Zoning Systems:

Implement zoning systems that allow different areas of the building to have individual temperature setpoints. This enables you to heat or cool only the spaces that are in use, reducing energy consumption in unoccupied areas.
3. Seasonal Adjustments:

Adjust the temperature setpoints based on the season. For example, in the winter, lower the heating setpoint and, in the summer, raise the cooling setpoint to maintain comfort while reducing energy usage.
4. Gradual Adjustments:

Instead of making drastic temperature changes, make gradual adjustments. Gradual changes are less noticeable to occupants and are less likely to lead to discomfort.
5. Nighttime Setbacks:

Implement nighttime temperature setbacks, which involve lowering the heating setpoint or raising the cooling setpoint during the overnight hours when most of the building is unoccupied.
6. Personal Comfort Controls:

Consider allowing occupants to have some control over their immediate environment by providing localized heating and cooling options, such as personal heaters or fans.
7. Building Envelope Improvements:

Improve insulation and seal gaps in the building envelope to reduce heat loss in the winter and heat gain in the summer. A well-insulated building requires less heating or cooling to maintain comfort.
8. HVAC System Optimization:

Ensure that HVAC systems are properly maintained and optimized for energy efficiency. This includes regular filter changes, cleaning coils, and checking for system inefficiencies.
9. Monitoring and Data Analysis:

Implement energy management and monitoring systems to continuously track temperature setpoints, energy consumption, and indoor comfort. Analyze data to identify opportunities for optimization.
10. Staff and Occupant Education:

Educate students, faculty, and staff about the importance of responsible energy use and the reasons behind temperature adjustments for energy efficiency. Encourage collaboration to achieve energy-saving goals.
11. Seasonal Considerations:

Recognize that temperature setpoints may need to be adjusted differently during transitional seasons to maintain occupant comfort.
12. Evaluate and Refine: Regularly evaluate the effectiveness of temperature setpoint adjustments and refine the strategies based on feedback and data analysis.

Remember that the goal is to strike a balance between energy efficiency and occupant comfort. By implementing these opportunities, you can optimize energy usage in the college building without sacrificing the well-being of those who use it

Nonconformity
Absence of documentation for the review of thermostat settings and schedules during the audit.

Lighting usage:	
• Evaluate lighting usage and habits. • Review the availability of natural lighting and its use. • Identify opportunities to optimize lighting usage to reduce energy consumption.	• The lighting usage pattern for different areas was not provided. However, the power schedule has been shared by the institute, giving a comprehensive idea of how lighting is used around the institute and what the pattern of light usage might be. Reference fig/doc: - fig14 • During the audit, natural light was found to be utilized during its availability. Reference fig/doc: - Fig 14 • The table below shows recommendations for energy consumption related to the lighting pattern.


Fig 14: Use of natural day light in the campus

Recommendation

To optimize lighting usage and reduce energy consumption in an existing college building, consider the following opportunities as part of an energy audit:

1. Energy-Efficient Lighting Sources:

Replace traditional incandescent bulbs with energy-efficient LED (Light Emitting Diode) or CFL (Compact Fluorescent Lamp) bulbs. LED lighting is the most energy-efficient option and has a longer lifespan.

2. Automatic Lighting Controls:

Install occupancy sensors in classrooms, offices, and common areas. These sensors can automatically turn off lights when a space is unoccupied and turn them on when motion is detected.

3. Daylight Harvesting:

Utilize natural daylight through windows and skylights. Combine this with daylight sensors that can adjust artificial lighting levels based on the amount of available natural light.

4. Task Lighting:

Encourage the use of task lighting in workspaces. Task lighting provides focused illumination where needed, reducing the need for overhead lighting.

5. Timers and Dimmers:

Use timers and dimmer switches to control lighting in areas where varying light levels are acceptable. For example, in conference rooms or auditoriums, dimming lights can reduce energy use.

6. Energy-Efficient Fixtures:

Choose lighting fixtures that are designed for high efficiency and optimal light distribution. Look for fixtures that minimize light spill and direct light where it is needed.

7. Smart Lighting Systems:

Implement smart lighting control systems that allow for scheduling and zoning, so lights can be turned off or dimmed when not required.
8. Lighting Maintenance:

Regularly clean fixtures and replace bulbs as needed to ensure they operate at their highest efficiency. Clean light fixtures allow for more effective light output.
9. Task Scheduling:

Program lighting systems to match the building's schedule. Ensure lights are turned off during non-operational hours.
10. LED Retrofit Kits:
- In spaces with existing fixtures, consider retrofit kits to convert older fixtures into energy-efficient LED fixtures.

11. Energy Management Systems:
- Implement energy management systems that continuously monitor and control lighting for optimal performance.

12. Educational Outreach:
- Educate students and staff on the importance of turning off lights when not needed and responsible energy-saving practices.

13. Energy Audits:
- Conduct periodic energy audits to identify specific areas where lighting improvements can be made.

14. Incentives and Rebates:
- Explore available incentives and rebates from local utilities or government programs for energy-efficient lighting upgrades.

By optimizing lighting usage through these strategies, you can significantly reduce energy consumption in the college building while still providing appropriate lighting levels for occupants.

Equipment usage:	
• Evaluate the usage of electrical equipment and appliances, such as computers, printers, and vending machines.	• No written records were found at the time of the audit. • The opportunities to optimize equipment usage to reduce energy

• Review the availability of energy-efficient equipment. • Identify opportunities to optimize equipment usage to reduce energy consumption.	consumption are provided below in the table.

Recommendation
To optimize lighting usage and reduce energy consumption in an existing college building, consider the following opportunities as part of an energy audit:

1. Energy-Efficient Lighting Sources:

Replace traditional incandescent bulbs with energy-efficient LED (Light Emitting Diode) or CFL (Compact Fluorescent Lamp) bulbs. LED lighting is the most energy-efficient option and has a longer lifespan.
2. Automatic Lighting Controls:

Install occupancy sensors in classrooms, offices, and common areas. These sensors can automatically turn off lights when a space is unoccupied and turn them on when motion is detected.
3. Daylight Harvesting:

Utilize natural daylight through windows and skylights. Combine this with daylight sensors that can adjust artificial lighting levels based on the amount of available natural light.
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- Conduct periodic energy audits to identify specific areas where lighting improvements can be made.

14. Incentives and Rebates:
- Explore available incentives and rebates from local utilities or government programs for energy-efficient lighting upgrades.

By optimizing lighting usage through these strategies, you can significantly reduce energy consumption in the college building while still providing appropriate lighting levels for occupants.

Non conformity • Absence of documented evidence for the evaluation of electrical equipment and appliances, including computers, printers, and vending machines, as well as the review of the availability of energy-efficient equipment during the audit.

Education and awareness:	
• Evaluate educational programs for building occupants regarding energy efficiency and sustainability.	• No written evidence found at the time of the audit • The opportunities to promote awareness and encourage energy -

• Review the availability of resources to educate occupants on energy-saving practices. • Identify opportunities to promote awareness and encourage energy-efficient behaviors among building occupants.	efficient behavior among building occupant are as given below

Recommendation

Promoting awareness and encouraging energy-efficient behaviors among building occupants in an existing college building is crucial for achieving sustainability goals. Here are opportunities to achieve this:

1. Education and Training:

Offer energy efficiency workshops and training sessions for students, faculty, and staff. These sessions can cover energy-saving practices, equipment usage, and the benefits of conservation.

2. Awareness Campaigns:

Launch awareness campaigns to inform building occupants about the importance of energy efficiency. These campaigns can include posters, newsletters, and social media announcements.

3. Energy Challenges and Competitions:

Organize energy-saving challenges and competitions among students, faculty, and staff. Recognize and reward participants for their efforts in conserving energy.

4. Energy Conservation Pledge:

Encourage building occupants to take a pledge to save energy and reduce their environmental impact. Provide an avenue for individuals to commit to specific actions.

5. Green Committees:

Form green committees or sustainability teams composed of students, faculty, and staff. These groups can help plan and implement energy-saving initiatives and educational programs.

6. Building Tours and Demonstrations:

Conduct guided building tours that showcase energy-efficient features and technologies. These tours can educate occupants on the building's sustainability efforts.

7. Real-time Energy Monitoring:

Install real-time energy monitoring systems or displays in prominent locations to show real-time energy consumption. This visual feedback can motivate individuals to reduce energy use.
8. Energy Efficiency Guidelines:

Develop and distribute energy efficiency guidelines or handbooks that outline best practices for lighting, HVAC, and equipment usage.
9. Eco-Friendly Contests:

Host eco-friendly contests, such as energy-efficient room decorating competitions, to engage students and demonstrate creative ways to save energy.
10. Sustainability Workshops:
- Organize workshops on sustainable living and environmental stewardship, covering topics like recycling, reducing waste, and energy conservation.

11. Green Certification Programs:
- Establish a green certification program for campus buildings. Encourage occupants to take specific actions that contribute to energy efficiency and sustainability.

12. Energy Dashboards:
- Provide access to energy dashboards or apps that allow occupants to monitor their energy consumption and track their progress in real time.

13. Energy Conservation Tips:
- Regularly share energy-saving tips via emails, social media, and notice boards to remind occupants of simple actions they can take.

14. Interactive Displays:
- Install interactive displays in common areas that educate occupants on the environmental impact of their actions and how they can make a difference.

15. Recognize and Celebrate Achievements:
- Acknowledge and celebrate the energy-saving achievements of individuals or departments, fostering a culture of recognition for conservation efforts.

16. Sustainability Courses:
- Incorporate sustainability and energy efficiency topics into the curriculum, making it part of the college's educational mission.

By implementing these opportunities, you can create a culture of energy awareness and encourage building occupants to adopt energy-efficient behaviors, which will contribute to a more sustainable and environmentally conscious college community.

Non conformity: -

Lack of documented evidence for the evaluation of educational programs for building occupants regarding energy efficiency and sustainability during the audit.

Energy Bills & Utility Data

Energy bills:	
• Collect energy bills for the past 12 months. • Review energy bills to identify usage patterns and trends. • Analyze energy bills to identify peak usage periods and potential areas for improvement.	• The energy bills for the past 6 months of the institute have been provided. Reference Fig/Doc: - Appendix 9 • Since the energy bills are lower than required, the pattern and trend may not be accurate. • The recommendations for analyzing the energy bills to identify peak usage periods and potential areas for improvement are outlined below. improvement is as follow

Recommendation

Analyzing energy bills to identify peak usage periods and areas for improvement is a valuable exercise for any institution, including colleges. Here's a step-by-step guide on how you can approach this task:

1. Collect Energy Bills:
   Gather a comprehensive set of energy bills for the college over the past year. Ensure you have data for electricity, gas, and any other relevant energy sources.

2. Categorize and Organize Data:
   Organize the data by month and category (e.g., electricity, heating, cooling). This will help you identify patterns and trends over time.

3. Identify Peak Usage Periods:
   Look for months or specific periods within months where energy consumption is significantly higher. This could be due to increased demand, weather conditions, events, or other factors.

4. Correlate Usage with College Activities:
   Overlay the energy usage data with the college's academic calendar and events schedule. Identify if there are any correlations between peak usage and specific activities or events.

5. Weather Normalization:
   Consider the impact of weather on energy consumption. Extreme temperatures may lead to increased heating or cooling needs. Normalize the data to account for weather variations.

6. Benchmarking:
   Compare the college's energy usage to industry benchmarks or similar institutions. This can help identify areas where the college may be overusing energy compared to its peers.

7. Building-Specific Analysis:
   Break down energy usage by buildings or departments. Identify areas with higher energy consumption and assess if there are specific reasons for this. It could be outdated equipment, inefficient systems, or behavioral factors.

8. Review Equipment Efficiency:
   Assess the efficiency of major energy-consuming equipment, such as HVAC systems, lighting, and appliances. Consider conducting energy audits to identify opportunities for improvement.

9. Engage Stakeholders:
   Involve relevant stakeholders, including faculty, staff, and students, in the energy conservation efforts. Raise awareness about the importance of energy efficiency and encourage best practices.

10. Implement Energy Efficiency Measures:
    Based on your analysis, develop and implement energy efficiency measures. This could include upgrading equipment, improving insulation, optimizing lighting systems, and promoting energy-saving practices.

11. Monitor and Evaluate:
    Continuously monitor energy usage after implementing changes. Evaluate the effectiveness of the measures taken and make adjustments as needed.

12. Educational Programs:
    Consider implementing educational programs to promote energy conservation across the college community. This can foster a culture of sustainability and further reduce energy consumption.

By systematically analyzing energy bills and implementing energy-saving measures, colleges can reduce their environmental impact and operational costs while promoting a culture of sustainability.

Non conformity: -

The number of electricity bills found to be less than the required ones, with no documented evidence to support the completeness of the audit records**.**

Utility data:	
• Collect utility data, including gas, water, and electricity usage. • Review utility data to identify usage patterns and trends. • Analyze utility data to identify peak usage periods and potential areas for improvement.	• Gas supply is sourced from cylinders, and water supply is obtained from the borewell. Reference fig/doc: - Fig 15 • The reported consumption is approximately 4 cylinders per month, totaling 48 cylinders in a year. Reference fig/doc: - Appendix 3 • The analysis of utility data to identify peak usage periods and potential areas for improvement is outlined below.

	
Fig 15: Water been extracted from the bore well	

Recommendation

To identify areas of improvement for energy efficiency in the institute's use of cooking gas cylinders, you can conduct an energy audit. Here are some steps and considerations:

Energy Consumption Analysis:

Assess the current energy consumption patterns related to cooking gas. Understand how much gas is used on average per day or per meal.
Equipment Efficiency:

Check the efficiency of the cooking equipment. Older or poorly maintained equipment may consume more gas. Consider upgrading to energy-efficient appliances.
Maintenance:

Ensure that all cooking appliances are well-maintained. Regular maintenance can improve efficiency and reduce gas consumption.
Cooking Practices:

Evaluate cooking practices. Train kitchen staff to use energy-efficient cooking techniques and equipment properly.
Insulation:

Inspect the insulation of cooking areas. Poor insulation can lead to heat loss and increased gas consumption. Improve insulation where necessary.
Appliance Sizing:

Ensure that the size of cooking appliances matches the demand. Using oversized equipment can result in unnecessary energy consumption.
Monitoring and Controls:

Implement monitoring systems to track gas usage over time. Set up controls or timers for appliances to avoid unnecessary operation.
Alternative Energy Sources:

Explore the feasibility of alternative energy sources, such as renewable energy for cooking. Solar cookers or biomass options might be viable depending on the location and requirements.
Employee Awareness:

Educate staff about the importance of energy conservation and provide them with tips on how to minimize gas usage during cooking.
Waste Heat Recovery:

Investigate options for capturing and utilizing waste heat generated during the cooking process. This could contribute to heating water or other areas within the facility.
Energy-Efficient Appliances:

Consider replacing old appliances with newer, more energy-efficient models. Look for appliances with high Energy Star ratings.
Vendor Relationships:

Work with gas suppliers to explore options for more energy-efficient gas sources or negotiate better rates.
Policy Review:

Review and update energy usage policies. Ensure that everyone in the institute is aware of and follows energy-efficient practices.
Feedback Mechanism:

Establish a feedback mechanism to receive suggestions from staff regarding energy-saving measures and improvements.
Benchmarking:

Compare gas usage data with industry benchmarks to identify areas where the institute can improve relative to similar facilities.
Remember that energy efficiency is an ongoing process, and regular monitoring and adjustments are crucial to achieving long-term savings and sustainability.

Cost analysis:

• Evaluate the cost of energy consumption. • Review the cost of energy bills and utility data. • Analyze the cost of energy consumption and identify potential areas for improvement.	• The cost of energy consumption for the 6 months is Rs 860,729. Reference doc/fig: - table 1 • The cost analyses of the 6 months show that the energy bill is highest during the September time and lowest in April but the utility of the gas cylinder is same. Reference doc/fig: down table 3 • The cost of energy consumption could not be identified due to the lack of a bill, but potential areas for improvement are given below.

Recommendation

Analyzing the cost of energy consumption in a college building and identifying areas for improvement involves a detailed examination of energy usage patterns, equipment efficiency, and potential opportunities for energy savings. Here's a step-by-step guide:

1. Gather Energy Bills:

Collect detailed energy bills for the college building, covering electricity, gas, and any other relevant energy sources. Ensure you have a sufficient historical dataset to analyze trends.

2. Categorize Energy Costs:
   Break down energy costs by category, such as heating, cooling, lighting, and equipment. This categorization helps identify the major contributors to energy consumption.

3. Normalize for External Factors:
   Normalize the energy consumption data to account for external factors that may influence energy use, such as changes in occupancy, weather conditions, or special events. This helps identify consistent patterns.

4. Benchmarking:
   Compare the college building's energy consumption and costs to industry benchmarks or similar institutions. This provides context and helps identify areas where the building may be underperforming.

5. Identify Peak Demand Periods:
   Analyze the energy bills to identify peak demand periods. Peak demand can significantly contribute to electricity costs, and understanding when these peaks occur can inform strategies to manage and reduce them.

6. Equipment Efficiency:
   Assess the efficiency of major energy-consuming equipment, including HVAC systems, lighting, and appliances. Outdated or inefficient equipment can contribute to higher energy costs.

7. Energy Audits:
   Consider conducting a detailed energy audit of the building. This involves a thorough examination of the building's energy systems, insulation, and equipment to identify areas for improvement.

8. Demand Response Programs:
   Investigate the possibility of participating in demand response programs. These programs often provide financial incentives for reducing energy consumption during peak demand periods.

9. Energy-Efficient Lighting:
   Evaluate the lighting system for energy efficiency. Consider replacing traditional lighting with LED technology, which is more energy-efficient and has a longer lifespan.

10. HVAC Optimization:
    Optimize the heating, ventilation, and air conditioning (HVAC) systems. This may include regular maintenance, upgrading to more energy-efficient equipment, and implementing smart controls.

11. Renewable Energy Sources:
    Explore the feasibility of incorporating renewable energy sources, such as solar panels or wind turbines, to offset traditional energy consumption and reduce costs over the long term.

12. Behavioral Changes:
    Engage building occupants in energy conservation efforts. Implement awareness programs and encourage energy-saving practices, such as turning off lights and equipment when not in use.

13. Investigate Energy Tariffs:
    Analyze the energy tariffs and pricing structures to identify opportunities for cost savings. Consider negotiating with energy providers for more favorable rates or exploring time-of-use pricing options.

14. Lifecycle Cost Analysis:
    Conduct a lifecycle cost analysis for potential energy-efficient upgrades. This involves considering not only the upfront costs but also the long-term savings and return on investment.

15. Monitor and Evaluate:
    Implement changes based on the identified areas for improvement and continuously monitor energy consumption. Regularly evaluate the impact of implemented measures and adjust strategies as needed.

By systematically analyzing the cost of energy consumption and implementing targeted improvements, colleges can enhance sustainability, reduce operational costs, and contribute to environmental conservation.

Benchmarking:	
• Compare energy consumption and cost to industry benchmarks and best practices. • Identify areas where energy consumption and cost are above industry benchmarks.	• Institute does not have any benchmark for the energy consumption. • The solution to bring energy consumption and cost in line with industry benchmarks are given in the following recommendation

• Recommend solutions to bring energy consumption and cost in line with industry benchmarks.	

Recommendation

To bring energy consumption and cost in line with industry benchmarks for an existing college, consider the following solutions:

Energy Benchmarking: Begin by benchmarking the college's energy consumption against industry standards and peers. This will help identify areas where improvements are needed.

Energy Audits: Conduct comprehensive energy audits to identify specific areas within the college building where energy-saving measures can be implemented.

Energy Efficiency Upgrades: Implement energy-efficient lighting, HVAC systems, and building envelope improvements to reduce energy consumption. These upgrades can align the college's performance with industry benchmarks.

Building Automation Systems: Install or upgrade building automation systems (BAS) to optimize energy use through advanced control and monitoring of HVAC, lighting, and other systems.

LED Lighting: Replace traditional lighting with energy-efficient LED fixtures. LED lighting not only reduces energy consumption but also lowers maintenance costs.

Occupancy Sensors: Install occupancy sensors to control lighting and HVAC systems based on the presence of occupants. This prevents energy waste in unoccupied spaces.

Smart HVAC Controls: Upgrade HVAC controls to include smart thermostats, variable-speed drives, and demand-controlled ventilation to match heating and cooling needs with building occupancy.

Renewable Energy Integration: Install renewable energy systems such as solar panels or wind turbines to generate clean energy on-site, reducing reliance on fossil fuels.

Energy Management Software: Implement energy management software to monitor, analyze, and control energy usage in real time, allowing for proactive energy-saving measures.

Energy-Efficient Appliances: Replace outdated electrical appliances and equipment with Energy Star-rated or energy-efficient models.

HVAC System Retrofits: Consider retrofitting or upgrading HVAC systems to improve energy efficiency, airflow distribution, and thermal comfort.

Insulation and Weatherization: Improve insulation and weatherization to reduce heat loss in the winter and heat gain in the summer, ultimately decreasing the energy required for heating and cooling.

Water Efficiency: Implement water-saving fixtures, such as low-flow toilets and faucets, to reduce water heating and usage costs.

Behavioral Changes: Promote energy-efficient behaviors among building occupants through education and awareness campaigns. Encourage staff and students to participate in energy conservation efforts.

Energy Procurement Strategies: Explore opportunities to procure renewable energy or participate in green energy purchasing programs to lower the carbon footprint and energy costs.

Financing Programs: Investigate energy efficiency financing programs that provide loans or incentives for energy-saving projects with favorable terms.

Performance Contracts: Consider energy performance contracts (ESCOs) where a third party finances and implements energy-saving measures, with the college repaying the contractor from the energy savings.

Regular Maintenance: Ensure that building systems and equipment are regularly maintained to maximize efficiency and prevent energy waste.

Metering and Submetering: Install energy meters and submeters to monitor and track energy consumption in specific areas, allowing for better understanding and management of usage.

Continuous Improvement: Establish a culture of continuous improvement in energy management by setting specific energy reduction goals, regularly reviewing progress, and adjusting strategies as needed.

By implementing these solutions and continuously monitoring and optimizing energy consumption, colleges can align their energy performance with industry benchmarks, reduce energy costs, and contribute to a more sustainable and environmentally responsible campus.

Nonconformity

Absence of documented evidence for the comparison of energy consumption and cost to industry benchmarks and best practices during the audit, and failure to identify areas where energy consumption and cost are above industry benchmarks.

Financial incentives:	
• Review available financial incentives for energy efficiency improvements. • Identify potential incentives for energy efficiency improvements. • Recommend solutions to take advantage of available financial incentives.	• No written evidence found at the time of the audit • Recommend solution to take advantage financial incentives are:

Recommendation

To take advantage of available financial incentives for an existing college building, consider the following solutions:

1. Research Incentives: Conduct thorough research to identify available financial incentives at the local, state, and federal levels that apply to energy efficiency, renewable energy, and sustainability initiatives. Explore programs offered by utility companies and government agencies.

2. Energy Audits: Conduct comprehensive energy audits of the college building to identify potential energy-saving opportunities. Many incentives require an audit to assess the building's energy performance.

3. Utility Rebates: Check with local utility companies for energy efficiency rebates and incentives. These can include rebates for lighting upgrades, HVAC improvements, and energy-efficient equipment.

4. Renewable Energy Credits (RECs): Explore the possibility of selling renewable energy credits generated from on-site renewable energy installations. This can generate additional revenue.

5. Tax Credits: Take advantage of available federal and state tax credits for energy efficiency upgrades and renewable energy installations. These credits can significantly reduce project costs.

6. Grants and Funding Programs: Investigate grants and funding programs available for energy efficiency and sustainability projects. These can come from government agencies, private foundations, and non-profit organizations.

7. PACE Financing: Consider Property Assessed Clean Energy (PACE) financing programs that provide low-interest loans for energy-efficient upgrades. Repayments are typically made through property taxes.

8. Power Purchase Agreements (PPAs): Explore the possibility of entering into PPAs for renewable energy installations. This allows a third party to finance and operate renewable systems on the college's property, often at no upfront cost.

9. Performance Contracts: Consider energy performance contracts (ESCOs) that allow private companies to finance and implement energy-saving measures. The college repays the contractor from the energy savings.

10. Net Metering: If renewable energy systems are installed, take advantage of net metering programs that allow the college to receive credits for excess energy generated and fed back into the grid.

11. Sustainable Building Certifications: Achieve sustainable building certifications like LEED or ENERGY STAR, which can make the college eligible for additional incentives and recognition.

12. ESCO Partnerships: Partner with energy service companies (ESCOs) that specialize in identifying and implementing energy-saving projects while leveraging available incentives.

13. Public-Private Partnerships (PPPs): Explore partnerships with private sector companies for funding and implementing energy efficiency and renewable energy projects.

14. Community Engagement: Engage with the local community and alumni to raise funds and gather support for sustainability projects. Crowdfunding and donor campaigns can provide financial resources.

15. Energy Efficiency Financing Programs: Utilize financing programs specifically designed for energy efficiency improvements, often offered by banks or financial institutions.

16. Educational Initiatives: Incorporate sustainability and energy efficiency projects into the curriculum and research activities, potentially attracting academic grants and sponsorship.

By implementing these solutions and actively seeking available financial incentives, colleges can make energy efficiency and sustainability projects more affordable and contribute to long-term cost savings while reducing their environmental footprint.

Nonconformity Lack of documented evidence for the review of available financial incentives for energy efficiency improvements and the failure to identify potential incentives for energy efficiency improvements during the audit.

Building automation system

HVAC control:	
• Evaluate the HVAC control system and its programming. • Review the performance of the HVAC control system. • Identify opportunities to optimize HVAC performance and reduce energy consumption.	The institute does not have the HVAC control system

Lighting control:	
• Evaluate the lighting control system and its programming. • Review the performance of the lighting control system. • Identify opportunities to optimize lighting performance and reduce energy consumption.	The institute has is not using the lighting control system

Energy monitoring:	
• Evaluate the building's energy monitoring systems. • Review the accuracy and effectiveness of energy monitoring systems.	• The building's energy monitoring system consists of electric meters installed at various locations in the building. Reference fig/doc: - fig 16 • At the time of the audit, the effectiveness of the energy

• Identify opportunities to improve energy monitoring and identify energy-saving opportunities.	monitoring system was found to be satisfactory and functional. Reference fig/doc: - fig 16 • The opportunities to improve energy monitoring and identify energy-saving opportunities are outlined below.

Fig 16: Electric meter photograph inside and outside the premises

Recommendation

Improving energy monitoring and identifying energy-saving opportunities involve implementing systems and practices that provide better visibility into energy consumption patterns. Here are some improvement opportunities:

Smart Metering and Monitoring Systems:

Install smart meters and monitoring systems to track energy consumption in real-time. These systems can provide detailed insights into when and where energy is being used, enabling proactive management.

Energy Management Software:

Implement energy management software to collect, analyze, and visualize energy data. This can help in identifying trends, setting benchmarks, and generating reports for better decision-making.

Submetering:

Use submeters to measure energy consumption in specific areas or equipment. This allows for a more granular understanding of energy usage, helping to pinpoint areas that need attention.
Automated Energy Audits:

Utilize automated energy audit tools that can analyze energy data and provide recommendations for energy-saving opportunities. These tools can streamline the auditing process and highlight areas for improvement.
Interval Data Analysis:

Analyze interval data, which provides energy consumption information at regular intervals (e.g., every 15 minutes). This can reveal peak usage times and help in optimizing energy consumption during those periods.
Energy Dashboards:

Develop energy dashboards accessible to relevant stakeholders. These dashboards can display real-time energy usage, historical trends, and performance against energy efficiency targets.
Energy Benchmarking:

Benchmark energy usage against industry standards or similar facilities. This comparison can help identify areas where energy performance can be improved.
Employee Training:

Train employees on the use of energy monitoring systems and emphasize the importance of their role in energy conservation. Staff awareness can lead to more conscientious energy use.
Set Energy Performance Goals:

Establish clear energy performance goals for the organization. Regularly review and assess progress toward these goals, adjusting strategies as needed.
Energy Audits by Professionals:

Conduct periodic energy audits by hiring professionals who specialize in energy management. They can provide expert insights and recommendations for improvement.
Demand Response Programs:

Explore participation in demand response programs, which involve adjusting energy usage in response to signals from the grid. This can result in cost savings and support grid stability.
Remote Monitoring and Control:

Implement remote monitoring and control capabilities for equipment and systems. This allows for adjustments to be made without physical presence, optimizing energy use.
Energy Conservation Policies:

Develop and enforce energy conservation policies within the organization. Clearly communicate expectations regarding energy efficiency to all staff members.
Regular Energy Review Meetings:

Schedule regular meetings to review energy consumption data, discuss findings, and brainstorm additional energy-saving opportunities.
Continuous Improvement Culture:

Foster a culture of continuous improvement regarding energy efficiency. Encourage employees to propose and implement ideas for reducing energy consumption.
By combining these strategies, the institute can enhance its energy monitoring capabilities and identify a range of opportunities for energy savings. Regularly reviewing and updating these measures will contribute to ongoing energy efficiency improvements

Equipment control:	
• Evaluate the building's equipment control systems. • Review the performance of equipment control systems. • Identify opportunities to optimize equipment performance and reduce energy consumption.	The institute does not use the equipment control

Optimization Strategies:	
• Evaluate the building's optimization strategies, such as occupancy sensors, demand response, and night setbacks. • Review the effectiveness of optimization strategies. • Identify opportunities to optimize optimization strategies and reduce energy consumption.	• The institute does not have any written evidence on the building optimization strategies and it does not use the occupancy sensor, demand response and night setback. • The opportunities for the optimization strategies and to reduce the energy consumption is given in the below table.

Recommendation:

Enhancing optimization strategies and reducing energy consumption in a college involves a systematic approach. Here's a detailed guide:

1. Conduct an Energy Audit:
   Start by conducting a comprehensive energy audit of the college. This involves analyzing energy usage patterns, identifying areas of high consumption, and understanding the performance of existing systems.

2. Data Collection:
   Gather data on electricity, gas, and other energy sources used in the college. Collect historical energy bills, occupancy patterns, and information about major energy-consuming systems and equipment.

3. Benchmarking:
   Compare the college's energy consumption to industry benchmarks or similar institutions. This helps to identify areas where the college may be underperforming or has opportunities for improvement.

4. Building Systems Analysis:
   Evaluate the efficiency of major building systems, including HVAC (Heating, Ventilation, and Air Conditioning), lighting, and water heating. Identify outdated or inefficient equipment.

5. Renewable Energy Opportunities:
   Explore opportunities to incorporate renewable energy sources. Assess the feasibility of installing solar panels, wind turbines, or other renewable technologies on campus.

6. Building Envelope Optimization:
   Inspect and optimize the building envelope (walls, roof, windows) for energy efficiency. Ensure proper insulation, seal any air leaks, and consider upgrading windows to more energy-efficient options.

7. HVAC System Optimization:
   Optimize the HVAC system by implementing energy-efficient practices, such as regular maintenance, using programmable thermostats, and upgrading to more efficient equipment if necessary.

8. Energy-Efficient Lighting:
   Upgrade lighting systems to energy-efficient options, such as LED bulbs. Implement smart lighting controls, occupancy sensors, and daylight harvesting strategies to reduce unnecessary energy consumption.

9. Behavioral Changes:

Educate building occupants about energy-saving practices. Encourage turning off lights and equipment when not in use, promoting responsible use of heating and cooling systems, and raising awareness about energy conservation.

10. Implement Smart Building Technologies:
    Integrate smart building technologies to optimize energy use. This may include building automation systems, energy management software, and data analytics to monitor and control energy consumption.

11. Energy-Efficient Appliances and Equipment:
    Replace outdated and inefficient appliances and equipment with energy-efficient models. This applies to computers, printers, kitchen appliances, and any other devices that contribute to energy consumption.

12. Regular Monitoring and Adjustments:
    Establish a system for continuous monitoring of energy usage. Regularly review and analyze data to identify any deviations from the optimized strategies. Adjust strategies as needed based on performance feedback.

13. Employee and Student Engagement:
    Engage employees and students in energy conservation efforts. Encourage the adoption of sustainable practices and involve the community in initiatives promoting energy efficiency.

14. Government Incentives:
    Research and take advantage of government incentives, grants, or programs that support energy efficiency improvements. These can provide financial assistance and resources for implementing energy-saving measures.

15. Documentation and Reporting:
    Maintain detailed records of energy consumption, improvements made, and their impact. Regularly report on energy savings achievements to stakeholders and decision-makers.

By systematically implementing these steps, the college can enhance its optimization strategies and reduce overall energy consumption, contributing to sustainability goals and cost savings.

Building Design

Orientation and layout:	
• Evaluate the building's orientation and layout. • Review the building's exposure to sunlight and wind. • Identify opportunities to optimize orientation and layout to reduce energy consumption.	• The college provided the building orientation and layout. Reference fig/doc: Fig 16 • During the audit, the building's exposure to wind and light was found to be satisfactory. Reference fig/doc: - Fig 17 • Opportunities to optimize orientation and layout to reduce energy consumption are provided below.

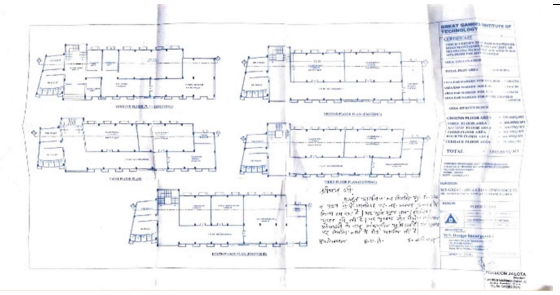


Fig 16: The building plan

Fig 17: The exposure to the air and light

Recommendation

Optimizing the orientation and layout of an existing college building can help reduce energy consumption by taking advantage of natural elements and sustainable design principles. Here are opportunities to consider:

Passive Solar Design:

Optimize building orientation to take advantage of passive solar heating. Design the building with south-facing windows to capture winter sunlight and reduce heating requirements. Use shading elements to block direct sunlight in the summer to prevent overheating.

Natural Ventilation:

Design the building's layout to facilitate natural cross-ventilation. Place windows strategically to encourage airflow and reduce the need for mechanical ventilation.

Awnings and Overhangs:

Use awnings and overhangs on windows to provide shade during the summer months, reducing cooling demands while allowing sunlight in during the winter.
Insulated Roof and Walls:

Ensure that the building has well-insulated roofs and walls to prevent heat gain in the summer and heat loss in the winter.
Optimal Window Placement:

Place windows and glazing to maximize natural daylighting. Consider the use of high-performance, energy-efficient windows to minimize heat transfer.
Building Shape and Massing:

Optimize the building's shape and massing to reduce exposure to prevailing winds and promote natural ventilation while minimizing heat loss.
Cool Roofs:

Consider cool roofing materials with high solar reflectance to reduce heat absorption and keep the building cooler in warm weather.
Green Roof and Vegetation:

Implement green roofs and vertical gardens to provide insulation and reduce heat gain while improving air quality.
Renewable Energy Placement:

Optimize the location for renewable energy installations, such as solar panels, wind turbines, or geothermal systems, based on the building's orientation and surroundings.
Sustainable Landscaping:

Plant trees and vegetation strategically to provide natural shade, reducing the building's cooling load.
Curtains and Blinds:

Use curtains, blinds, or shades to control the amount of sunlight entering the building, reducing the need for artificial lighting and cooling.
Shading Devices:

Install external shading devices like louvers or sunshades to block direct sunlight and prevent heat buildup.
Solar Heat Gain Coefficient (SHGC):

Choose windows and glazing with low solar heat gain coefficients to minimize heat gain while maintaining visibility and daylight.
Solar Reflectance Index (SRI):

Select cool roofing materials and paving with high Solar Reflectance Index values to reduce heat absorption from the sun. Zoning and Layout: Plan the layout of spaces and rooms with consideration for their energy needs. Group similar functions together to minimize HVAC demands and improve energy efficiency. Operable Windows: Provide operable windows in offices and workspaces to allow occupants to control their individual comfort. By optimizing the orientation and layout of the college building, you can enhance its energy efficiency and reduce energy consumption, ultimately promoting a sustainable and environmentally conscious campus.

Insulation:	
• Evaluate the building's insulation and weatherization. • Review the building's insulation materials and installation. • Identify opportunities to optimize insulation and weatherization to reduce energy consumption.	The institute does not use the insulation

Glazing:	
• Evaluate the building's glazing, including windows and skylights. • Review the glazing materials and their performance. • Identify opportunities to optimize glazing to reduce energy consumption.	• Building glazing is achieved through the use of glass material in the building and on the building front. Reference fig/doc: - fig 18 • No written records were found at the time of the audit for the documentation part of the glazing material. • Opportunities to optimize glazing to reduce energy consumption are outlined below.

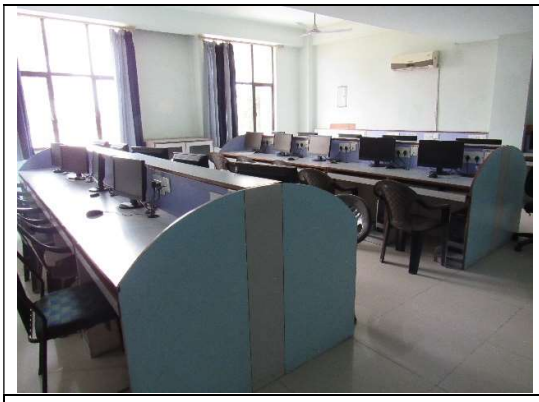


Fig 18: Window glazing material

Recommendation

Optimizing glazing (windows and other transparent materials) is an effective way to reduce energy consumption in a college building. Here are steps and considerations to identify opportunities for glazing optimization:

1. Energy Audit:
   Conduct a comprehensive energy audit of the college building. This involves assessing the current energy performance, identifying areas of energy loss, and understanding the building's overall energy use.

2. Window Types and Placement:
   Evaluate the types of windows in the building and their placement. Consider factors such as orientation, size, and material. South-facing windows, for example, can capture more sunlight during the winter, while west-facing windows may lead to excessive heat gain in the afternoons.

3. Energy Performance of Windows:
   Assess the energy performance of existing windows. Look for signs of air leakage, poor insulation, or outdated glazing technology. Energy-efficient windows with low-emissivity (low-E) coatings and double or triple glazing can significantly improve insulation.

4. Solar Heat Gain Coefficient (SHGC):
   Examine the Solar Heat Gain Coefficient of windows. This metric indicates the amount of solar radiation that enters a building through the windows. Lower SHGC values are desirable, especially in warm climates, to reduce cooling needs.

5. U-Factor:

Consider the U-Factor, which measures the rate of heat transfer through a window. A lower U-Factor indicates better insulation. Select windows with a U-Factor suitable for the local climate.

6. Window Shading:
   Evaluate the effectiveness of existing shading devices such as blinds, shades, or awnings. Proper shading can prevent excessive heat gain during hot periods and reduce the need for air conditioning.

7. Natural Ventilation:
   Explore opportunities to enhance natural ventilation. Well-designed windows can facilitate the flow of fresh air, reducing reliance on mechanical ventilation systems.

8. Consider Local Climate:
   Take into account the local climate conditions. In colder climates, maximizing solar gain may be beneficial, while in warmer climates, reducing solar heat gain might be a priority.

9. Smart Glass Technologies:
   Investigate the feasibility of incorporating smart glass technologies. These windows can dynamically adjust their tint based on external conditions, optimizing natural light and heat gain.

10. Window Seal and Maintenance:
    Ensure that windows are properly sealed to prevent air leaks. Regular maintenance is essential to keep windows in good condition and to maximize their energy efficiency over time.

11. Cost-Benefit Analysis:
    Conduct a cost-benefit analysis of potential glazing optimizations. Evaluate the upfront costs of upgrades against the expected energy savings over time. Consider the lifespan of the improvements and available incentives or rebates.

12. Consult with Experts:
    Seek advice from energy consultants, architects, or specialists in sustainable design. They can provide valuable insights into the latest technologies and best practices for optimizing glazing in buildings.

By systematically evaluating and optimizing glazing, colleges can create a more energy-efficient and sustainable building environment, reducing both energy consumption and associated costs.

Lighting systems:	
• Evaluate the building's glazing, including windows and skylights. • Review the glazing materials and their performance. • Identify opportunities to optimize glazing to reduce energy consumption.	Not applicable

Renewable energy:	
• Evaluate the potential for renewable energy sources, such as solar or wind power. • Review the feasibility and cost-effectiveness of renewable energy options. • Identify opportunities to implement renewable energy solutions to reduce energy consumption and lower carbon emissions.	• The renewable energy source that the institute uses is the solar energy. It amounts to the 50kw power plant that is installed on the top of the institute. Reference fig/doc: - fig 19 • The feasibility of the renewable energy for the institute is higher and the data of the 13 month shows that institute has save the 56936 unit of electricity. Reference fig/doc: - Appendix 8 • Opportunities to implement renewable energy solution to reduce the energy consumption and lower carbon emission

Recommendation

Implementing renewable energy solutions is a proactive approach to reducing energy consumption and lowering carbon emissions in a college building. Here are steps to identify and implement renewable energy opportunities:

1. Energy Audit:
   Conduct a comprehensive energy audit to understand the current energy consumption patterns and identify areas where renewable energy solutions could be integrated effectively.

2. Site Assessment:

Evaluate the college building site for its renewable energy potential. Assess factors such as solar exposure, wind patterns, and available space for renewable energy installations.

3. Solar Photovoltaic (PV) Systems:
   Explore the feasibility of installing solar PV systems on the college building's roof or on nearby open spaces. Solar panels can generate electricity from sunlight, reducing reliance on conventional power sources.

4. Wind Turbines:
   If the site has favorable wind conditions, consider installing wind turbines. Wind energy can be harnessed to generate electricity, especially in areas with consistent wind patterns.

5. Geothermal Systems:
   Investigate the possibility of implementing geothermal heating and cooling systems. Geothermal energy utilizes the Earth's natural heat to regulate building temperatures more efficiently.

6. Biomass Energy:
   Assess the viability of using biomass energy sources, such as wood pellets or organic waste, for heating or electricity generation. Biomass can be a sustainable and carbon-neutral energy option.

7. Hydroelectric Systems:
   If there's a water source nearby, evaluate the potential for small-scale hydroelectric systems. This can be particularly effective in areas with rivers or streams.

8. Energy Storage Systems:
   Consider integrating energy storage systems, such as batteries, to store excess energy generated by renewable sources. This stored energy can be used during periods of low renewable energy production.

9. Feasibility Studies:
   Conduct detailed feasibility studies for each renewable energy option. Consider factors like upfront costs, available incentives, system efficiency, and the local climate.

10. Government Incentives:
    Research available government incentives, grants, or tax credits that may support the implementation of renewable energy solutions. Many regions offer financial support to encourage the adoption of sustainable practices.

11. Educational Initiatives:
    Involve the college community in renewable energy initiatives. Educational programs can raise awareness about the environmental benefits of renewable energy and garner support for implementation.

12. Collaborate with Experts:
    Consult with renewable energy experts, engineers, and environmental consultants to ensure that the chosen solutions align with the specific needs and conditions of the college building.

13. Partnerships and Funding:
    Explore partnerships with local utilities, businesses, or organizations that may be interested in supporting renewable energy projects. Collaborative efforts can provide additional funding and expertise.

14. Integration with Smart Building Technologies:
    Integrate renewable energy systems with smart building technologies to optimize energy use. Automation and data analytics can enhance efficiency and reduce overall energy consumption.

15. Monitor and Evaluate:
    Implement renewable energy solutions and establish a monitoring system to track performance. Regularly evaluate the effectiveness of these solutions and make adjustments as needed.

By identifying and implementing renewable energy solutions, colleges can not only reduce their carbon footprint but also set an example for sustainable practices, educate the community, and contribute to a cleaner and more resilient energy future.

Nonconformity

Lack of documented evidence for the evaluation of the potential for renewable energy sources, such as solar or wind power, and the review of the feasibility and cost-effectiveness of renewable energy options during the audit.

Energy-Efficient Equipment

Energy Efficient Equipment:	
• Check the energy efficiency of all the equipment viz: lighting equipment, including bulbs and fixtures, HVAC equipment, including	No written evidence found at the time of the audit

boilers, chillers, and air handlers. water heaters, including boilers and hot water tanks. office equipment, including computers, printers, and copiers, etc. kitchen equipment, including refrigerators, dishwashers, and ovens. laundry equipment, including washers and dryers, any other equipment	

Nonconformity

Absence of documented evidence for the check on the energy efficiency of various equipment, including lighting equipment, HVAC equipment, water heaters, office equipment, kitchen equipment, laundry equipment, and any other equipment, during the audit.

Renewable Energy Sources

Solar energy:	
• Evaluate the potential for solar energy, including photovoltaic (PV) panels and solar thermal systems. • Review the feasibility and cost-effectiveness of solar energy options. • Identify opportunities to implement solar energy solutions to reduce energy consumption and lower carbon emissions.	• The institute has a 50-kW solar energy power plant installed on its roof. Reference fig/Doc: - fig 19 • The collected data shows that the total solar energy generated during the 13-month period is 56,693 kW. Reference fig/doc: - appendix 8 and appendix 7 • Opportunities to implement solar energy solutions to reduce energy consumption and lower carbon emissions are provided below.

Fig 19: solar power plant on the roof top

Recommendation

Implementing solar energy solutions in an existing college can significantly reduce energy consumption and lower carbon emissions. Here are opportunities to consider:

1. Solar Photovoltaic (PV) Panels:

Install solar PV panels on rooftops and other suitable locations to generate electricity from sunlight. This renewable energy source can offset a portion of the college's electricity demand.

2. Solar Hot Water Systems:

Implement solar hot water systems to heat water for domestic use, such as showers and kitchens. Solar thermal collectors can be installed on rooftops to harness solar heat.

3. Solar-Powered Lighting:

Use solar-powered outdoor lighting for pathways, parking lots, and common areas. These lights charge during the day and illuminate the campus at night.

4. Building-Integrated Photovoltaics (BIPV):

Consider integrating solar panels into building elements like windows, facades, and shading structures. BIPV systems generate electricity while serving functional architectural purposes.

5. Solar Carports:

Install solar carports in parking lots to provide shaded parking and generate solar electricity simultaneously.

6. Energy Storage Systems:

Combine solar PV systems with energy storage solutions, such as batteries, to store excess energy for use during cloudy days or at night.

7. Power Purchase Agreements (PPAs):

Explore partnerships with solar developers who can install and maintain solar PV systems on campus, with the college purchasing the generated electricity through a PPA.
8. Solar Training and Education:

Integrate solar technology education into the curriculum and offer training programs in solar energy for students interested in renewable energy careers.
9. Research and Development:

Collaborate with local research institutions or industry partners to develop and test advanced solar technologies and applications on campus.
10. Sustainable Landscaping:
- Design and maintain sustainable landscapes with native plants and trees to provide shade and reduce the cooling load on buildings, thus increasing the efficiency of solar panels.

11. Financial Incentives:
- Research available incentives, tax credits, and rebates at the local, state, and federal levels to reduce the cost of solar installations.

12. Energy Efficiency Upgrades:
- Prioritize energy efficiency measures before implementing solar solutions. Reducing energy consumption through efficient building design and operations can make solar installations more effective.

13. Solar Awareness Campaigns:
- Launch awareness campaigns to educate the campus community about the benefits of solar energy and how it contributes to sustainability and carbon emissions reduction.

14. Collaboration with Utilities:
- Partner with local utilities to explore options for net metering, which allows the college to export excess solar-generated electricity to the grid and receive credit.

15. Maintenance and Monitoring:
- Implement regular maintenance and monitoring of solar installations to ensure they perform optimally.

By implementing these opportunities, colleges can harness the power of solar energy to reduce their carbon footprint, save on energy costs, and contribute to a more sustainable future.

Biomass energy:

• Evaluate the potential for biomass energy, including wood chips, agricultural waste, and other organic materials. • Review the feasibility and cost-effectiveness of biomass energy options. • Identify opportunities to implement biomass energy solutions to reduce energy consumption and lower carbon emissions.	Institute does not use the biomass energy

Water Usage

Plumbing fixtures:	
• Evaluate the efficiency of plumbing fixtures, including faucets, toilets, and showers. • Review the performance of plumbing fixtures and their water consumption. • Identify opportunities to optimize plumbing fixtures and reduce water consumption.	• During the audit, the plumbing fixtures, including faucets, toilets, and showers, were found to be in good condition. Reference fig/doc: - fig 20, fig21, fig 23 • The performance of plumbing fixtures, including faucets, toilets, and showers, was found to be satisfactory. Reference fig/doc: - fig 20, fig21, fig 23 • Opportunities to optimize plumbing fixtures and reduce water consumption are outlined below.

Fig 20: plumbing fixture toilet

Fig 21: Plumbing of the water tap

Fig 22: Plumbing fixture for wash basin

Recommendation

To optimize plumbing fixtures and reduce water consumption in an existing college building, consider the following opportunities:

1. Low-Flow Fixtures:

Replace older, high-flow plumbing fixtures with low-flow alternatives. This includes low-flow toilets, urinals, faucets, and showerheads. Look for Water Sense-certified fixtures that meet water efficiency standards.

2. Dual-Flush Toilets:

Install dual-flush toilets, which allow users to choose a lower flush volume for liquid waste and a higher volume for solid waste.

3. Waterless Urinals:

Consider switching to waterless urinals, which use no water for flushing and can result in significant water savings.

4. Sensor-Activated Fixtures:

Install sensor-activated faucets and flush valves in restrooms to ensure that water is used only when necessary. These fixtures help prevent wasteful habits, such as leaving taps running.
5. Leak Detection Systems:

Implement water leak detection systems that use sensors to identify and alert maintenance staff to leaks, reducing water loss from undetected leaks.
6. Dual Plumbing Systems:

Install dual plumbing systems that separate potable water from non-potable water, allowing non-potable water sources to be used for appropriate purposes.
7. Pressure-Reducing Valves:

Install pressure-reducing valves to regulate water pressure, which can prevent water waste and reduce the risk of leaks.
8. Faucet Aerators:

Use faucet aerators to reduce water flow while maintaining adequate water pressure, especially in areas like kitchens.
9. Smart Irrigation Systems:

Implement smart irrigation systems for landscaping that use weather data and soil moisture sensors to optimize watering schedules and reduce water waste.
10. Rainwater Harvesting:
- Collect and store rainwater from rooftops for landscape irrigation and non-potable water use in the building.

11. Greywater Recycling:
- Implement greywater recycling systems that treat and reuse wastewater from sinks and showers for flushing toilets and irrigating landscapes.

12. Water Recycling in Laboratories:
- In science and research buildings, implement water recycling systems that capture and treat laboratory wastewater for reuse in experiments or other non-potable purposes.

13. Education and Awareness:
- Educate building occupants, maintenance staff, and custodians about water-saving practices and the importance of reporting leaks promptly.

14. Water-Use Policies:
- Implement water-use policies and guidelines for building occupants and maintenance staff to follow, emphasizing the importance of water conservation.

15. Periodic Inspections:
- Schedule regular inspections of the plumbing system to check for leaks, worn components, or signs of water damage.

16. Submetering:
- Install water submeters on different parts of the building to track water consumption in specific areas, helping to identify and address high-use locations.

By optimizing plumbing fixtures and reducing water consumption, colleges can save water resources, lower utility costs, and contribute to sustainability efforts.

Irrigation systems:	
• Evaluate the efficiency of irrigation systems, including sprinklers and drip systems. • Review the performance of irrigation systems and their water consumption. • Identify opportunities to optimize irrigation systems and reduce water consumption.	• Since the institute has the small garden area so it uses the manual method of the irrigation.

Water reuse:	
• Evaluate the potential for water reuse, including greywater and rainwater harvesting. • Review the feasibility and cost-effectiveness of water reuse options. • Identify opportunities to implement water reuse solutions to reduce water consumption.	• No written document found at the time od the audit. • The opportunity to implement water reuse solution to reduce water consumption

Recommendation

Implementing water reuse solutions in an existing college building can significantly reduce water consumption and contribute to sustainability. Here are some opportunities to consider:

1. Rainwater Harvesting:

Install rainwater harvesting systems to collect and store rainwater from rooftops. This harvested rainwater can be treated and used for non-potable purposes, such as landscape irrigation, toilet flushing, and cooling systems.
2. Greywater Recycling:

Implement greywater recycling systems that treat and reuse wastewater from sinks, showers, and laundry for flushing toilets and irrigating landscapes.
3. Dual Plumbing Systems:

Install dual plumbing systems that separate potable water from non-potable water, allowing non-potable water sources to be used for appropriate purposes.
4. Low-Flow Fixtures:

Replace older plumbing fixtures with low-flow or high-efficiency fixtures, including faucets, showerheads, and toilets. These fixtures use less water without compromising functionality.
5. Smart Irrigation:

Implement smart irrigation systems that use weather data and soil moisture sensors to optimize watering schedules and reduce water waste in landscaped areas.
6. Water Leak Detection:

Install water leak detection systems that can identify and alert maintenance staff to leaks, reducing water loss from undetected leaks.
7. Water Recycling in Laboratories:

In science and research buildings, implement water recycling systems that capture and treat laboratory wastewater for reuse in experiments or other non-potable purposes.
8. Education and Awareness:

Raise awareness among students, faculty, and staff about the importance of water conservation and the benefits of water reuse. Provide information on how the college is using these technologies.
9. Water Reuse Policies:

Develop and enforce water reuse policies and guidelines to ensure that water-saving technologies are used effectively.
10. Building Retrofitting:
- Retrofit existing buildings with water-saving technologies and reuse systems during renovation or maintenance projects.

11. Water Reuse in Cooling Systems:

- Implement water reuse in HVAC (heating, ventilation, and air conditioning) cooling systems to reduce the consumption of freshwater for cooling towers.

12. Building-Specific Solutions:
- Identify building-specific opportunities for water reuse based on the unique requirements and water use patterns of each facility on the college campus.

13. Sustainable Landscaping:
- Use native and drought-resistant plants in landscaping to reduce the need for extensive irrigation.

14. Water Use Monitoring:
- Install water metering systems to monitor and track water use in real time, helping to identify areas where water reuse can be most effective.

15. Recycling Water in Sports Facilities:
- Implement water reuse solutions in sports facilities, such as collecting and treating water from swimming pools for reuse in toilets or irrigation.

By incorporating these water reuse solutions, colleges can conserve water resources and reduce their environmental impact while promoting a culture of sustainability among the campus community.

Nonconformity

Absence of documented evidence for the evaluation of the potential for water reuse, including greywater and rainwater harvesting.

Leak detection:	
• Conduct a leak detection survey to identify potential leaks in the plumbing system. • Review the performance of the plumbing system and identify opportunities to fix leaks and reduce water consumption.	• During the audit the leak detection survey there was a plumbing issue, as at the place of bore well submersible the water was leaking out in drop let form from the pipe where the water moves toward the supply area. Reference Fig/Doc: - Fig 23 • The performance of the plumbing system and identify opportunities to fix leaks and reduce the water consumption

Fig 23: The location of the water leak

Recommendation

Reviewing the performance of the plumbing system in an existing college building and identifying opportunities to fix leaks and reduce water consumption is essential for conserving water resources and promoting sustainability. Here are steps to assess and improve the plumbing system:

1. Leak Detection and Repair:

Conduct a comprehensive survey of the plumbing system to identify and repair leaks. Leaks can occur in pipes, fixtures, and connections, and addressing them promptly is crucial to reduce water waste.

2. Smart Leak Detection Systems:

Install smart leak detection systems that use sensors and real-time monitoring to identify leaks quickly. These systems can send alerts to maintenance staff when a leak is detected.

3. Faucet and Fixture Upgrades:

Replace old and inefficient faucets, showerheads, and toilets with water-saving fixtures. Look for fixtures that are EPA Water Sense certified, as they meet strict water efficiency standards.

4. Pipe Insulation:

Insulate hot water pipes to prevent heat loss and reduce the time it takes to get hot water to fixtures, thereby conserving water.

5. Low-Flow Aerators:

Install low-flow aerators on faucets to reduce water consumption while maintaining adequate water pressure.

6. Dual-Flush Toilets:

Replace standard toilets with dual-flush models that allow users to choose a lower flush volume for liquid waste and a higher volume for solid waste.
7. Automatic Sensors:

Install automatic sensor faucets and flush valves in restrooms to ensure that water is used only when necessary. These fixtures help prevent wasteful habits, such as leaving taps running.
8. Greywater Recycling:

Consider greywater recycling systems that treat and reuse wastewater from sinks and showers for flushing toilets or landscape irrigation.
9. Pressure Regulation:

Ensure that water pressure is properly regulated to prevent water hammer and reduce water waste due to high pressure.
10. Education and Training:
- Educate building occupants, maintenance staff, and custodians about water-saving practices and the importance of reporting leaks promptly.

11. Water-Use Policies:
- Implement water-use policies and guidelines for building occupants and maintenance staff to follow, emphasizing the importance of water conservation.

12. Periodic Inspections:
- Schedule regular inspections of the plumbing system to check for leaks, worn components, or signs of water damage.

13. Submetering:
- Install water submeters on different parts of the building to track water consumption in specific areas, helping to identify and address high-use locations.

14. Water Recycling in Labs:
- In science and research buildings, implement water recycling systems to capture and treat laboratory wastewater for reuse or safe disposal.

15. Benchmarking and Data Analysis:
- Compare water consumption data over time to identify trends and areas for improvement. Analyze data to assess the effectiveness of water conservation efforts.

By implementing these measures and regularly assessing the plumbing system's performance, colleges can not only reduce water consumption but also save on water bills and promote sustainable practices among the campus community.

Nonconformity

Identified leak issue in the pipe connecting the bore well, which needs immediate attention to prevent water storage problems in the tank.

Education and awareness:	
• Develop education and awareness programs to promote water conservation and encourage sustainable water usage. • Identify opportunities to engage occupants and stakeholders in water conservation efforts.	• No written record found at the time of audit • Opportunities to engage occupant and stakeholder in water conservation effort is given below.

Recommendation

Engaging occupants and stakeholders in water conservation efforts for an existing college building is essential for promoting sustainable practices. Here are opportunities to encourage their involvement in water conservation:

1. Awareness Campaigns:

Launch awareness campaigns to inform students, faculty, staff, and visitors about the importance of water conservation and the role they can play.

2. Educational Workshops:

Organize workshops, seminars, and educational events focused on water conservation, where experts or environmental organizations can provide information and guidance.

3. Campus Sustainability Groups:

Establish campus sustainability groups or committees that focus on water conservation initiatives. Encourage participation from students, faculty, and staff.

4. Water Conservation Pledge:

Encourage individuals to take a water conservation pledge to commit to specific actions that help reduce water consumption.

5. Inclusive Decision-Making:

Involve students, faculty, and staff in the decision-making process for water conservation initiatives, allowing them to have a say in how resources are managed.

6. Student Projects:

Incorporate water conservation projects into the curriculum for students to research, design, and implement. This hands-on approach promotes active participation.
7. Water Efficiency Competitions:

Organize water conservation competitions among departments or buildings to encourage friendly rivalry and recognition for saving water.
8. Feedback Systems:

Provide feedback systems that show water consumption data and track progress in real time. This transparency motivates occupants to reduce their water use.
9. Water Audits:

Conduct water audits and involve students or interested stakeholders in the audit process to understand how water is used and how it can be saved.
10. Campus Sustainability Events:
- Host events or sustainability fairs where water conservation practices and technologies are showcased, and participants can learn about water-saving measures.

11. Student Environmental Clubs:
- Support and sponsor student environmental clubs that focus on sustainability, including water conservation initiatives.

12. Sustainable Landscape Projects:
- Engage stakeholders in the planning and maintenance of sustainable landscaping, which may include drought-tolerant plantings and efficient irrigation systems.

13. Green Building Tours:
- Offer guided tours of green and sustainable college buildings, where stakeholders can learn about the water-saving features and technologies.

14. Community Engagement:
- Collaborate with local communities and environmental organizations to extend water conservation efforts beyond the campus and involve a broader audience.

15. Communication Channels:
- Use various communication channels, such as newsletters, social media, and campus websites, to keep occupants and stakeholders informed about water conservation initiatives, progress, and tips.

16. Recognition and Awards:
- Recognize and celebrate the achievements of individuals, departments, or buildings that excel in water conservation, creating an incentive for others to follow suit.

Engaging occupants and stakeholders in water conservation efforts not only reduces water consumption but also fosters a culture of environmental responsibility and sustainability within the college community.

Nonconformity Absence of documented evidence for the development of education and awareness programs to promote water conservation and encourage sustainable water usage during the audit.

Energy Audits & Assessments

Energy data collection:	
• Collect data on the building's energy consumption, including electricity, natural gas, and other fuels. • Collect data on the building's operational schedules, occupancy levels, and other factors that may impact energy consumption.	• The data for building energy consumption is as follows: electricity for the 6 months is given as 860,729 units, natural gas for 12 months is 48 cylinders, and fuel oil for the 13 months is 2,374 liters. Reference fig/doc: - • The building is primarily occupied for 240 days, but in several locations, it is occupied for 365 days. The power schedule for this time period is shown in Table Appendix 5.

Energy Consumption (Total consumption of last 12 months)					
Building name	**Building size (square footage)**	**Electricity consumption (kWh)**	**Natural gas consumption (therms)**	**Fuel oil consumption (gallons)**	**Solar Energy**
GGIT	1700 sq. m	860729	48 Cylinder	2374 liters	56936

Energy Consumption (Average monthly consumption)					
Building name	**Building size (square footage)**	**Electricity consumption (kWh)**	**Natural gas consumption (therms)**	**Fuel oil consumption (gallons)**	**Solar Energy**

GGIT	1700 sq. m	71727	4 cylinders	182.61litres	4379.692

Metering Information:

Electricity meter number	Natural gas meter number:	Other Source meter number		
4672303864	Not applicable	Not applicable		

Cost/Billing Information (Data Collection Period Nov 2022 To Oct 2023)

Electricity billing period (month/year)	Electricity provider:	Electricity account number:	Electricity cost (Rs/kWh)
November 2022	Madhyanchal Vidyut Vitran Nigam limited	4672303864	0
December 2022	Madhyanchal Vidyut Vitran Nigam limited	4672303864	0
January 2023	Madhyanchal Vidyut Vitran Nigam limited	4672303864	0
February 2023	Madhyanchal Vidyut Vitran Nigam limited	4672303864	0
March 2023	Madhyanchal Vidyut Vitran Nigam limited	4672303864	0
April 2023	Madhyanchal Vidyut Vitran Nigam limited	4672303864	53134
May 2023	Madhyanchal Vidyut Vitran Nigam limited	4672303864	95662
June 2023	Madhyanchal Vidyut Vitran Nigam limited	4672303864	128120
July 2023	Madhyanchal Vidyut Vitran Nigam limited	4672303864	0
August 2023	Madhyanchal Vidyut Vitran Nigam limited	4672303864	138068
September 2023	Madhyanchal Vidyut Vitran Nigam limited	4672303864	300350
October 2023	Madhyanchal Vidyut Vitran Nigam limited	4672303864	145395

Total Annual Cost- 860729

Average Monthly Cost- 71727.42

Energy modeling and simulation:	
• Use energy modeling software to simulate the building's energy performance and identify opportunities for energy savings. • Evaluate the performance of various energy-saving measures, such as upgrading HVAC systems, improving insulation, and implementing renewable energy sources.	Institute is not using the energy modeling and simulation software.

Cost-benefit analysis:	
• Evaluate the cost-effectiveness of potential energy-saving measures. • Consider the upfront costs of implementation, as well as the long-term savings in energy costs and carbon emissions.	• The institute has saved around Rs 4,72,569(approx.) taking into account the cost of 1-unit electricity as Rs 8.3 and 56936 unit of unit of electricity produce Reference fig/doc: - Appendix 8 • The upfront cost of implementation of the it also helps in saving the cost now if the plant runs for the 130 months so the cost would be Rs 4725688(approx.) and so on and it also help in the reduction of the energy blue print.

Energy conservation related certifications / awards

No award received

Appendix 1: The detail shared by the Great ganga institute of technology

	Infra strcuture									240	200	90	
							Daily			Yearly			Total Electrcity Consumption
S.No.	Particulars	No.	Size	No. of Bulbs	No. of Fans	No. of AC	Consumption unit of Bulbs	Consumption Elecricity units of Fans	Consumption Electricity units of AC	Consumption unit of Bulbs	Consumption Elecricity units of Fans	Consumption Electricity units of AC	
1	Class Room	12	85.05 Sq.Mtr.	96	72	4	96	144	24	23040	28800	2073600	2125440
2	Library & Reading Room	1	180 Sq.Mtr.	12	8	0	12	16	0	2880	3200	0	6080
3	Computer Lab	2	85.05 Sq.Mtr.	16	12	2	16	24	12	3840	4800	1080	9720
4	Girls Common Room	1	40 Sq.Mtr.	4	2	0	4	4	0	960	800	0	1760
5	Boys Common Room	1	40 Sq.Mtr.	4	2	0	4	4	0	960	800	0	1760
6	Principal Room	1	23 Sq.Mtr.	2	1	1	2	2	6	480	400	540	1420
7	Administrative & admission Office	1	67 Sq.Mtr.	8	4	2	8	8	12	1920	1600	1080	4600
8	Accounts Office	1	16 Sq.Mtr.	2	1	0	2	2	0	480	400	0	880
9	Faculty Room	14	10 Sq.Mtr.	14	14	0	14	28	0	3360	5600	0	8960
10	Girls Toilet	4	25 Sq.Mtr.	8	0	0	8	0	0	1920	0	0	1920
11	Boys Toilet	4	25 Sq.Mtr.	8	0	0	8	0	0	1920	0	0	1920
12	Staff Toilet	6	3.5 Sq.Mtr.	12	0	0	12	0	0	2880	0	0	2880
13	Varanda	1	160 Sq.Mtr.	8	0	0	8	0	0	1920	0	0	1920
14	Corridor Ground Floor	1	150 Sq.Mtr.	6	0	0	6	0	0	1440	0	0	1440
15	Corridor First Floor	1	150 Sq.Mtr.	6	0	0	6	0	0	1440	0	0	1440
16	Corridor Second Floor	1	150 Sq.Mtr.	6	0	0	6	0	0	1440	0	0	1440
17	Seminar Hall	1	169 Sq.Mtr.	12	8	0	12	16	0	2880	3200	0	6080
18	Store Room	1	12 Sq.Mtr.	2	1	0	4	2	0	960	400	0	1360
19	Management Room	3	27 Sq.Mtr.	4	2	1	4	4	0	960	800	0	1760
20	Examination Controller Room	1	35 Sq.Mtr.	2	2	0	2	4	0	480	800	0	1280
21	Examination Strong Room	1	35 Sq.Mtr	2	1	0	2	2	0	480	400	0	880
22	Conference / Meeting Room	1	83.07 Sq.Mtr.	6	2	2	6	4	12	1440	800	1080	3320
23	Canteen	1	415.36 Sq.Mtr.	12	8	0	12	16	0	2880	3200	0	6080
				252	140	12	254	280	66	60960	56000	2077380	2194340
				9	75	840							
				2268	10500	10080							

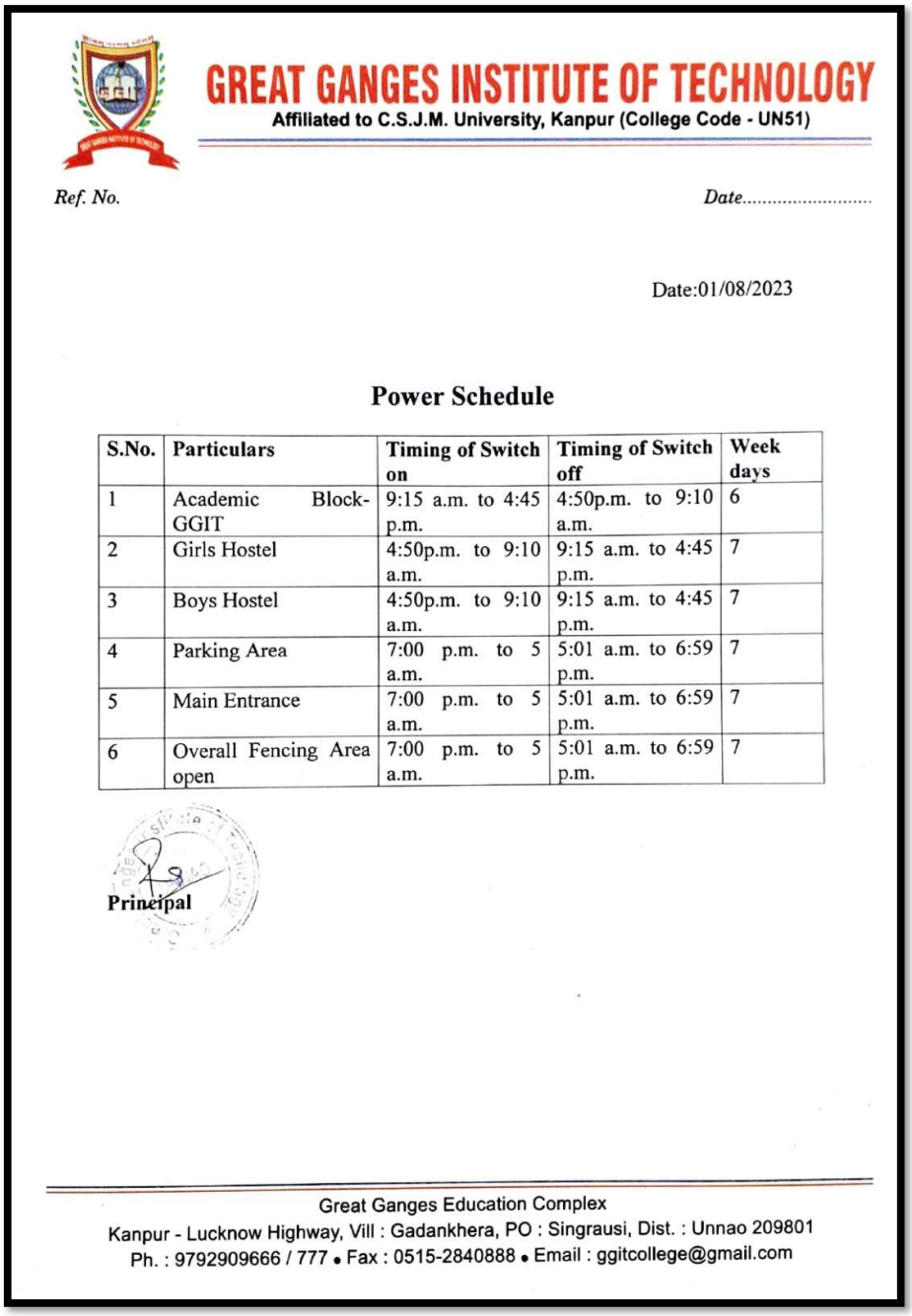
Appendix 2: Detail about the usage of the energy

		Computer Lab Equipments annd other equip				200
		S.No.	**Particulars**	**No.**	**No. of Units Consume daily**	**No. of Units Consume yearly**
6300	70	1	PC's	90	150	30000
1250	250	2	Printers	5	5	1000
		3	Main UPS	1	8	1600
		4	Camera	30	10	2000
		5	Biometric	1	1	200
		6	Electrci Ke	1	1	100
		7	Lifts	1	1	100
					Total Electrcity Consumption	34900

Appendix 3 -Gas cylinder consumption

Gas Cylinder Consumption		
S.No.	Particulars	Monthly Consumption
1	Canteen	4 Cylinders

Appendix 5: Power schedule of great ganga institute of technology



GREAT GANGES INSTITUTE OF TECHNOLOGY

Affiliated to C.S.J.M. University, Kanpur (College Code - UN51)

Ref. No. *Date.....*

Date:01/08/2023

Power Schedule

S.No.	Particulars	Timing of Switch on	Timing of Switch off	Week days
1	Academic Block-GGIT	9:15 a.m. to 4:45 p.m.	4:50p.m. to 9:10 a.m.	6
2	Girls Hostel	4:50p.m. to 9:10 a.m.	9:15 a.m. to 4:45 p.m.	7
3	Boys Hostel	4:50p.m. to 9:10 a.m.	9:15 a.m. to 4:45 p.m.	7
4	Parking Area	7:00 p.m. to 5 a.m.	5:01 a.m. to 6:59 p.m.	7
5	Main Entrance	7:00 p.m. to 5 a.m.	5:01 a.m. to 6:59 p.m.	7
6	Overall Fencing Area open	7:00 p.m. to 5 a.m.	5:01 a.m. to 6:59 p.m.	7

Principal

Great Ganges Education Complex

Kanpur - Lucknow Highway, Vill : Gadankhera, PO : Singrausi, Dist. : Unnao 209801

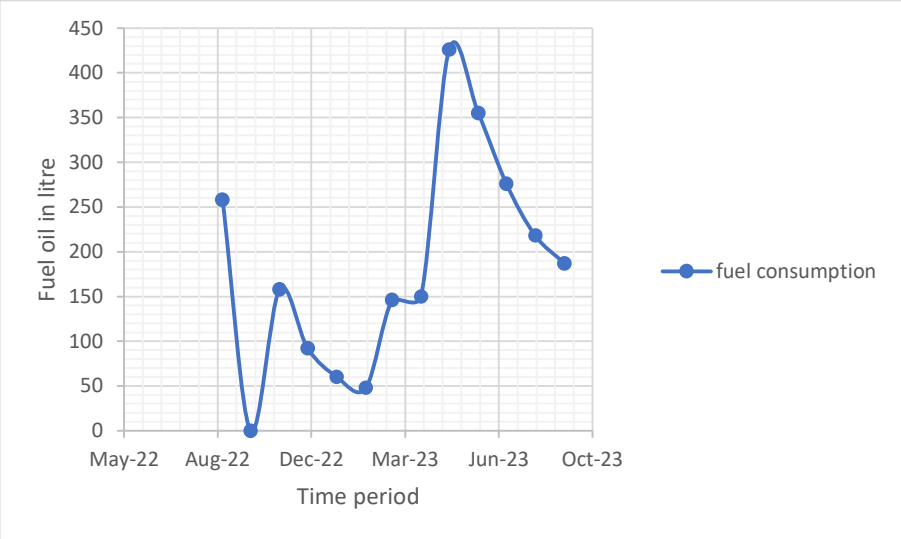
Ph. : 9792909666 / 777 • Fax : 0515-2840888 • Email : ggitcollege@gmail.com

Appendix 6: fuel oil consumption and solar energy consumption

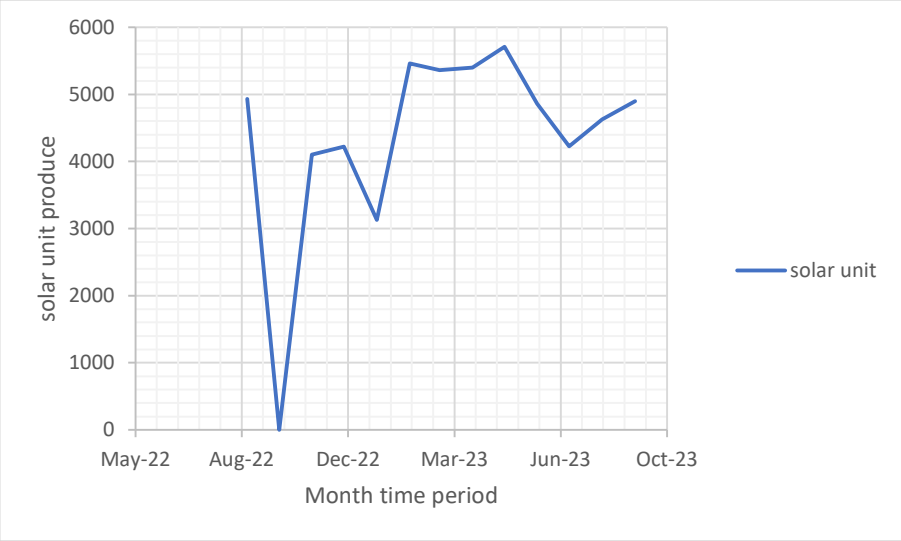
S.NO	month	fuel consumption	solar unit
1	Sep-23	187	4897

2	Aug-23	218	4629
3	Jul-23	276	4227
4	Jun-23	355	4861
5	May-23	426	5710
6	Apr-23	150	5398
7	Mar-23	146	5363
8	Feb-23	48	5460
9	Jan-23	60	3131
10	Dec-22	92	4222
11	Nov-22	158	4105
12	Oct-22	0	0
13	Sep-22	258	4933

Appendix 7 graph showing the fuel oil consumption in the September 2022 till september 2023 time period



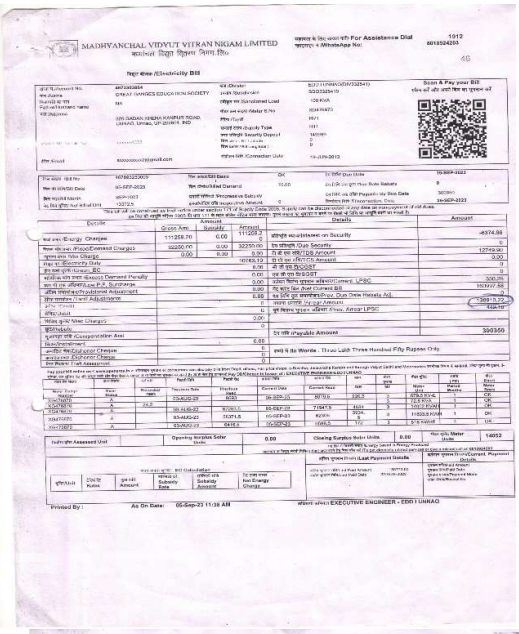
Appendix 8 graph showing the solar energy unit produce for Sep 2022 till Sep 2023

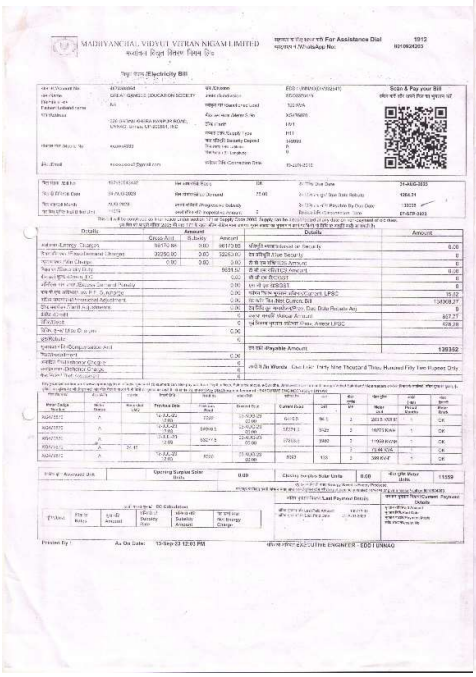


Appendix 9 Electricity bill

ENERGY AUDIT REPORT


MADHYANCHAL VIDYUT VITRAN NIGAM LIMITED


MADHYANCHAL VIDYUT VITRAN NIGAM LIMITED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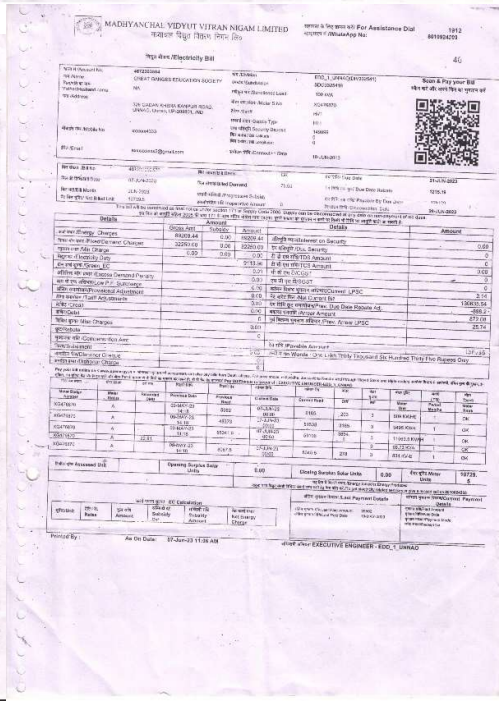
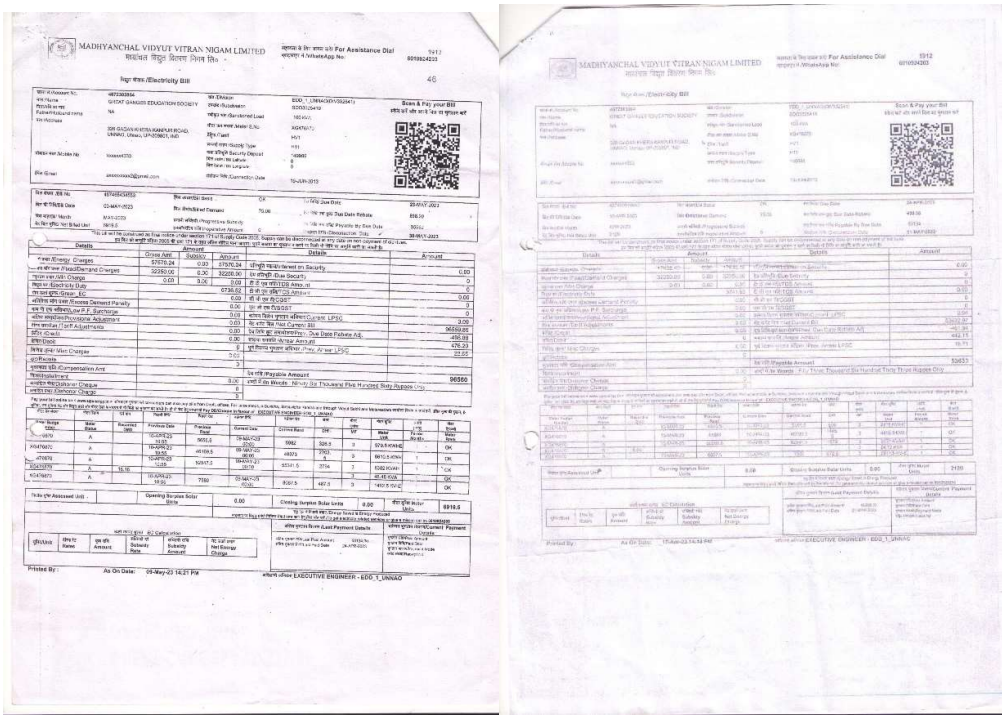

MADHYANCHAL VIDYUT VITRAN NIGAM LIMITED



Appendix 10

General Energy Conservation Tips

1. Electricity
   - 1.1. Schedule your operations to maintain a high load factor
   - 1.2. Minimize maximum demand by tripping loads through a demand controller
   - 1.3. Use standby electric generation equipment for on-peak high load periods.
   - 1.4. Correct power factor to at least 0.99 under rated load conditions.
   - 1.5. Set transformer taps to optimum settings.
   - 1.6. Shut off unnecessary computers, printers, and copiers at night.
2. Motors
   - 2.1. Properly size to the load for optimum efficiency.
   - 2.2. (High efficiency motors offer of 4 - 5% higher efficiency than standard motors)
   - 2.3. Check alignment.
   - 2.4. Provide proper ventilation.
   - 2.5. (For every 10°C increase in motor operating temperature over recommended peak, the motor life is estimated to be halved)
   - 2.6. Check for under-voltage and over-voltage conditions.
   - 2.7. Balance the three-phase power supply.
   - 2.8. (An Imbalanced voltage can reduce 3 - 5% in motor input power)
   - 2.9. Demand efficiency restoration after motor rewinding.
3. Fans
   - 3.1. Use smooth, well-rounded air inlet cones for fan air intakes.
   - 3.2. Avoid poor flow distribution at the fan inlet.
   - 3.3. Minimize fan inlet and outlet obstructions.

3.4. Clean screens, filters, and fan blades regularly.
3.5. Use aero foil-shaped fan blades.
3.6. Minimize fan speed.
3.7. Use low-slip or flat belts.
3.8. Check belt tension regularly.
3.9. Eliminate variable pitch pulleys.
3.10. Use variable speed drives for large variable fan loads.
3.11. Use energy-efficient motors for continuous or near-continuous operation
3.12. Eliminate leaks in ductwork.
3.13. Minimize bends in ductwork
3.14. Turn fans off when not needed.

4. Pumps
4.1. Operate pumping near best efficiency point.
4.2. Modify pumping to minimize throttling.
4.3. Adapt to wide load variation with variable speed drives or sequenced control of smaller offices.
4.4. Stop running both pumps -- add an auto-start for an on-line spare or add a booster pump in the problem area.
4.5. Use booster pumps for small loads requiring higher pressures.
4.6. Increase fluid temperature differentials to reduce pumping rates.
4.7. Repair seals and packing to minimize water waste.
4.8. Balance the system to minimize flows and reduce pump power requirements.
4.9. Use siphon effect to advantage: don't waste pumping head with a free-fall (gravity) return.

5. HVAC (Heating / Ventilation / Air Conditioning)
5.1. Tune up the HVAC control system.
5.2. Consider installing a building automation system (BAS) or energy management
5.3. system (EMS) or restoring an out-of-service one.
5.4. Balance the system to minimize flows and reduce blower/fan/pump power requirements.
5.5. Eliminate or reduce reheat whenever possible.
5.6. Use appropriate HVAC thermostat setback.
5.7. Use building thermal lag to minimize HVAC equipment operating time.
5.8. In winter during unoccupied periods, allow temperatures to fall as low as possible without freezing water lines or damaging stored materials.
5.9. In summer during unoccupied periods, allow temperatures to rise as high as possible without damaging stored materials.
5.10. Improve control and utilization of outside air.
5.11. Use air-to-air heat exchangers to reduce energy requirements for heating and cooling of outside air.
5.12. Reduce HVAC system operating hours (e.g. -- night, weekend).
5.13. Optimize ventilation.

5.14. Ventilate only when necessary. To allow some areas to be shut down when unoccupied, install dedicated HVAC systems on continuous loads (e.g. - computer rooms).
5.15. Provide dedicated outside air supply to kitchens, cleaning rooms, combustion equipment, etc. to avoid excessive exhausting of conditioned air.
5.16. Use evaporative cooling in dry climates.
5.17. Clean HVAC office coils periodically and comb mashed fins.
5.18. Upgrade filter banks to reduce pressure drop and thus lower fan power requirements.
5.19. Check HVAC filters on a schedule (at least monthly) and clean/change if appropriate.
5.20. Check pneumatic controls air compressors for proper operation, cycling, and maintenance.
5.21. Isolate air-conditioned loading dock areas and cool storage areas using high speed doors or clear PVC strip curtains.
5.22. Install ceiling fans to minimize thermal stratification in high-bay areas.
5.23. Relocate air diffusers to optimum heights in areas with high ceilings.
5.24. Consider reducing ceiling heights.
5.25. Eliminate obstructions in front of radiators, baseboard heaters, etc.
5.26. Check reflectors on infrared heaters for cleanliness and proper beam direction.
5.27. Use professionally-designed industrial ventilation hoods for dust and vapor control.
5.28. Use local infrared heat for personnel rather than heating the entire area.
5.29. Use spot cooling and heating (e.g. -- use ceiling fans for personnel rather than cooling the entire area).
5.30. Purchase only high-efficiency models for HVAC offices.
5.31. Put HVAC window offices on timer control.
5.32. Don't oversize cooling offices. (Oversized offices will "short cycle" which results in poor humidity control.)
5.33. Install multi-fueling capability and run with the cheapest fuel available at the time.
5.34. Consider dedicated make-up air for exhaust hoods. (Why exhaust the air conditioning or heat if you don't need to?)
5.35. Minimize HVAC fan speeds.
5.36. Consider desiccant drying of outside air to reduce cooling requirements I humid climates.
5.37. Seal leaky HVAC ductwork.
5.38. Seal all leaks around coils.
5.39. Repair loose or damaged flexible connections (including those under air handling offices).
5.40. Eliminate simultaneous heating and cooling during seasonal transition periods.
5.41. Zone HVAC air and water systems to minimize energy use.
5.42. Inspect, clean, lubricate, and adjust damper blades and linkages.

5.43. Establish an HVAC efficiency-maintenance program. Start with an energy audit and follow-up, then make an HVAC efficiency-maintenance program a part of your continuous energy management program.

6. Lighting
   6.1. Reduce excessive illumination levels to standard levels using switching; decamping, etc. (Know the electrical effects before doing de-lamping.)
   6.2. Aggressively control lighting with clock timers, delay timers, photocells, and/or occupancy sensors.
   6.3. Install efficient alternatives to incandescent lighting, mercury vapour lighting, etc. Efficiency (lumens/watt) of various technologies range from best to worst
   6.4. approximately as follows: low pressure sodium, high-pressure sodium, metal halide, fluorescent, mercury vapour, incandescent.
   6.5. Select ballasts and lamps carefully with high power factor and long-term efficiency in mind.
   6.6. Upgrade obsolete fluorescent systems to Compact fluorescents and electronic ballasts
   6.7. Consider lowering the fixtures to enable using less of them.
   6.8. Consider day lighting, sky lights, etc.
   6.9. Consider painting the walls a lighter color and using less lighting fixtures o lower wattages.
   6.10. Use task lighting and reduce background illumination.
   6.11. Re-evaluate exterior lighting strategy, type, and control. Control it aggressively.
   6.12. Change exit signs from incandescent to LED.
7. DG sets
   7.1. Optimize loading
   7.2. Use waste heat to generate steam/hot water /power an absorption chiller or
   7.3. preheat process or utility feeds.
   7.4. Use jacket and head cooling water for process needs
   7.5. Clean air filters regularly
   7.6. Insulate exhaust pipes to reduce DG set room temperatures
   7.7. Use cheaper heavy fuel oil for capacities more than 1MW
8. Buildings
   8.1. Seal exterior cracks / openings / gaps with caulk, gasketing, weather stripping, etc.
   8.2. Consider new thermal doors, thermal windows, roofing insulation, etc.
   8.3. Install windbreaks near exterior doors.
   8.4. Replace single-pane glass with insulating glass.
   8.5. Consider covering some window and skylight areas with insulated wall panel inside the building.
   8.6. If visibility is not required but light is required, consider replacing exterior windows with insulated glass block.
   8.7. Consider tinted glass, reflective glass, coatings, awnings, overhangs, draperies, blinds, and shades for sunlit exterior windows.
   8.8. Use landscaping to advantage.

8.9. Add vestibules or revolving doors to primary exterior personnel doors.
8.10. Consider automatic doors, air curtains, strip doors, etc. at high-traffic passages between conditioned and non-conditioned spaces. Use self-closing doors if possible.
8.11. Use intermediate doors in stairways and vertical passages to minimize building stack effect.
8.12. Use dock seals at shipping and receiving doors.
8.13. Bring cleaning personnel in during the working day or as soon after as possible to minimize lighting and HVAC costs.

9. Water & Wastewater
9.1. Recycle water, particularly for uses with less-critical quality requirements.
9.2. Recycle water, especially if sewer costs are based on water consumption.
9.3. Balance closed systems to minimize flows and reduce pump power requirements.
9.4. Eliminate once-through cooling with water.
9.5. Use the least expensive type of water that will satisfy the requirement.
9.6. Fix water leaks.
9.7. Test for underground water leaks. (It's easy to do over a holiday shutdown.)
9.8. Check water overflow pipes for proper operating level.
9.9. Automate blow down to minimize it.
9.10. Provide proper tools for wash down -- especially self-closing nozzles.
9.11. Install efficient irrigation.
9.12. Reduce flows at water sampling stations.
9.13. Eliminate continuous overflow at water tanks.
9.14. Promptly repair leaking toilets and faucets.
9.15. Use water restrictors on faucets, showers, etc.
9.16. Use self-closing type faucets in restrooms.
9.17. Use the lowest possible hot water temperature.
9.18. Do not use a heating system hot water boiler to provide service hot water during the cooling season -- install a smaller, more-efficient system for the cooling season service hot water.
9.19. If water must be heated electrically, consider accumulation in a large insulated storage tank to minimize heating at on-peak electric rates.
9.20. Use multiple, distributed, small water heaters to minimize thermal losses in large piping systems.
9.21. Use freeze protection valves rather than manual bleeding of lines.
9.22. Consider leased and mobile water treatment systems, especially for deionized water.
9.23. Seal sumps to prevent seepage inward from necessitating extra sump pump operation.
9.24. Install pre-treatment to reduce TOC and BOD surcharges.
9.25. Verify the water meter readings. (You'd be amazed how long a meter reading can be estimated after the meter breaks or the meter pit fills with water!)
9.26. Verify the sewer flows if the sewer bills are based on them

10. Miscellaneous

10.1. Meter any unmetered utilities to know what normal efficient use is. Track down causes of deviations.

10.2. Shut down spare, idling, or unneeded equipment.

10.3. Make sure that all of the utilities to redundant areas are turned off – including utilities like compressed air and cooling water.

10.4. Install automatic control to efficiently coordinate multiple air compressors, chillers, cooling tower cells, boilers, etc.

10.5. Renegotiate utilities contracts to reflect current loads and variations.

10.6. Consider buying utilities from neighbors, particularly to handle peaks.

10.7. Leased space often has low-bid inefficient equipment. Consider upgrades if your lease will continue for several more years.

10.8. Adjust fluid temperatures within acceptable limits to minimize undesirable heat transfer in long pipelines.

10.9. Minimize use of flow bypasses and minimize bypass flow rates.

10.10. Provide restriction orifices in purges (nitrogen, steam, etc.).

10.11. Eliminate unnecessary flow measurement orifices.

10.12. Consider alternatives to high-pressure drops across valves.

10.13. Turn off winter heat tracing that is on in summer.

Name of auditor: **Ashutosh Tiwari**

Signature: Ashutosh tiwari