Energy Audit Report
(2023-2024)

TRIPURA UNIVERSITY
(A Central University)
SURYAMANINAGAR – 799022, TRIPURA, INDIA

प्रो. गंगा प्रसाद प्रसाईं
कुलपति

Prof. Ganga Prasad Prasain
Vice-Chancellor

त्रिपुरा विश्वविद्यालय
(केन्द्रीय विश्वविद्यालय)
सूर्यमणिनगर–799022, त्रिपुरा, भारत
TRIPURA UNIVERSITY
(A Central University)
Suryamaninagar-799022, Tripura, India

No.F.TU/VCS/MISC/01/2022

Foreword from Vice Chancellor

It is with immense pride and responsibility that I introduce the Green/Energy/Environmental Audit Report 2023-24, which mark a transformative step in our institution's commitment to sustainability. This reports represent a comprehensive evaluation of our practices, reflecting our dedication to fostering an environmentally conscious campus and paving the way for a more sustainable future.

In today's world, where global challenges demand collective action, the report embody our commitment to transparency, accountability, and innovation. It serve as a testament to our institution's unwavering efforts to align with sustainability principles, emphasizing the critical role of awareness, knowledge, and collective responsibility in driving meaningful change.

The Green/Energy/Environmental Audit Report 2023-24 is the result of the meticulous efforts of our audit committees, which comprises of researchers/sustainability experts, and campus managers. Through their diligent assessments, this report provides a holistic view of our ecological footprint, evaluating our energy efficiency, waste management, water usage, and overall environmental impact. The report highlight our strengths while identifying opportunities for improvement, enabling us to take informed and impactful steps forward.

As we present this report to our stakeholders, it is with a renewed sense of optimism and determination. We recognize that the choices we make today are vital for securing a sustainable future for the generations to come. The findings outlined in this report challenge us to rethink traditional practices, adopt innovative solutions, and integrate eco-consciousness into every facet of our institution's operations.

I extend my heartfelt gratitude to every individual who has contributed to this audit report. Your dedication to advancing sustainability reflects the collaborative spirit and shared purpose that define our institution.

May this report serve as a compass, guiding us toward more sustainable practices, fostering a culture of environmental awareness, and inspiring collective action. Let us seize this opportunity to champion sustainability, confident that every step we take today will reverberate positively in the years to come.

Together, we embark on this journey toward a greener, cleaner, and more sustainable future, driven by the profound understanding that nurturing our environment is integral to nurturing ourselves.

With gratitude and determination,

(Prof. Ganga Prasad Prasain)

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TO WHOMSOEVER IT MAY CONCERN

This is to certify that the Energy Audit Report 2023-24 of Tripura University is an original internal audit work conducted by the Energy Audit Committee to monitor the environmental management practices adopted in the University, which is in line with the terms of the International Standards of Internal Auditing.

After going through the report, it is evident that adequate and appropriate audit procedures were followed for the Energy Audit, and the gathered evidence supports the conclusions reached and contained in this report.

The suggestions and recommendations prescribed and the conclusions derived are quite genuine and within the achievable limits, and I understand that Tripura University is competent to fulfill those to meet the Sustainable Development Goals.

I recommend and firmly believe that this report meets the requirements prescribed for the development of a Green Campus.

22/1/25

Prof. Nalin B. Dev Choudhury
Dean (Research & Consultancy)
Professor, Electrical Engineering Department
NIT Silchar, Assam 788010

Acknowledgement

In alignment with our enduring commitment to environmental stewardship and sustainability, Tripura University continues to lead the way in organizing impactful initiatives such as environmental campaigns, workshops, and extension programs aimed at driving societal change on both national and global scales. Recognizing the critical importance of conducting an energy audit for the sustainable development of our institution, we remain resolute in our mission to enhance environmental quality while safeguarding the pristine ecosystem of our campus. This dedication reflects our determination to secure a promising legacy for future generations of students and residents.

This report, covering the academic year 2023-24, represents our fifth formal effort to comprehensively document the outcomes of our investigative work and provide an in-depth analysis of the Energy Audit process. In alignment with the climate neutrality goals set by the Government of India, Tripura University aspires to play a significant role in mitigating global ecological challenges. To achieve this vision, we have adopted a holistic approach, including the establishment of an Energy Audit Committee comprised of faculty members with expertise in energy management and sustainability. This committee has diligently collected essential campus-wide energy data and implemented on-site solutions to address energy-related challenges effectively.

The primary mission of the Energy Audit Committee is to identify current and emerging energy concerns, conducting a thorough examination of our energy consumption practices and their overall impact on campus. This report is the product of a collective effort driven by the dedicated members of the Tripura University Energy Audit Committee and its stakeholders. Through detailed evaluations of energy parameters, meticulous data collection, and comprehensive analysis, the committee has identified pressing energy challenges and opportunities for improvement. The recommendations outlined in this report aim to establish a robust framework for the continuous improvement of our energy efficiency standards and practices.

This report highlights the critical role of stakeholder engagement in achieving our energy goals. By fostering a bottom-up approach, we aim to address challenges collaboratively and build a culture of environmental accountability and energy conservation. This report serves as a vital resource to guide meaningful action and inspire a campus-wide commitment to sustainability.

We extend our heartfelt gratitude to Prof. Ganga Prasad Prasain, Hon'ble Vice Chancellor of Tripura University, for his visionary leadership and unwavering support throughout the course of this study. His guidance has been pivotal to the success of this initiative. Our gratitude also extends to the teaching and non-teaching staff, Deans, and Heads of Departments at Tripura University, whose cooperation was instrumental in gathering essential data for this report.

Special recognition is owed to Er. Krishna Das, Executive Engineer, and his team for providing vital campus energy data and technical support.

We also extend our sincere appreciation to Prof. Nalin Behari Dev Choudhury from the Department of Electrical Engineering at NIT Silchar, who served as the External Expert for the Energy Audit 2023-24. His insights, expertise, and dedication significantly enriched the audit process and enhanced the quality of this report.

A heartfelt acknowledgment is reserved for the members of the Energy Audit Committee, whose dedication and hard work have been integral to this report. In particular, we extend special thanks to Dr. Thiru Selvan, Convener of the Energy Audit Committee, for his exceptional leadership and commitment to compiling this report. Thanks are also due to the contribution of Ms. Lumgailu Panmei, Ph. D Scholar, Department of Forestry and Biodiversity in compiling the results of the Questionnaire Survey.

We firmly believe that the collective efforts of the Energy Audit Committee will significantly benefit Tripura University. We sincerely hope that the management plan and recommendations outlined in this report will be embraced by all stakeholders as we work together to reduce our energy footprint and create a more sustainable future for Tripura University in the academic year 2023-24 and beyond.

Prof. Badal K Datta
Chairman

Tripura University Energy Audit Committee
2023-2024

Chairman

Prof. B. K. Datta, Dean, Faculty of Science, Tripura University

Members

Dr. S.S. Singh, Dept. of Zoology, Tripura University
Mr. N. Tripura, Electrical Engineer, Tripura University
Mr. Rajesh Banik, Civil Engineer, Tripura University
Mr. Krishna Das, Executive Engineer, Tripura University

External Expert

Prof. Nalin Behari Dev Choudhury, Department of Electrical Engineering, NIT, Silchar.

Convener

Dr. Thiru Selvan, Dept. Forestry and Biodiversity, Tripura University

CONTENT

Introduction

Tripura University (a central university), established as a State University on October 2nd, 1987, with the enactment of the Tripura University Act in the Tripura Assembly, in deference to the long-cherished aspirations of the people of the state emerged from the renowned Calcutta University starting from the Starting from a modest P.G. Centre of Calcutta University (CUPGC) in 1976. Situated in the North Eastern region of India, the university has been committed to achieving academic excellence by offering quality teaching, learning and cutting-edge research experiences in different disciplines of Arts, Commerce, Humanities, Management, Science and Technology. The campus is nestled in a lush, semi-urban expanse of 75 acres along the National Highway at Suryamaninagar (23°45′40″N; 91°15′58″E), approximately 9 kilometers south of Agartala, the capital city.

Designated as one of the 56 Central Universities in India, Tripura University was founded on July 2nd, 2007, through a parliamentary act with the purpose of establishing a teaching and affiliating institution in the state. With Memorandum of Understandings with several National and International Institutions and numerous patents to its credit, this University, notwithstanding its geographical remoteness and other communicational disadvantages in the past, has always tried to compete with other universities of the country in terms of academic accomplishments, research breakthroughs, innovation and placement records, which have been aptly reflected in its NAAC Assessments and NIRF rankings. Notably, the university has made significant strides, enhancing its infrastructure and academic landscape.

Presently, the university offers diverse programs through its Science, Literature, Social Sciences, Commerce, Law, Management and Information Science Faculty. Its academic portfolio comprises a total of 65 programs, encompassing Undergraduate, Postgraduate, Doctoral, and other Postgraduate Programs. Additionally, the university provides Ph.D. programs in 41 subjects. With an annual enrollment exceeding about 1500 students, the campus serves as a hub of education and exploration. Moreover, Tripura University fosters pioneering research initiatives spanning various fields.

The university boasts 44 well-equipped departments, seven centres and one school, each furnished with state-of-the-art classrooms, laboratories, continuous internet access, a computer center, library, free Wi-Fi campus-wide, sports facilities, an open-air theater, health services, banking amenities, a cafeteria, post office, food court, hostels, and a guest house. Its esteemed faculty is not only dynamic but also compassionate and approachable. Alongside regular academic sessions, the university promotes a variety of sports and socio-cultural activities, including film screenings, musical performances, art festivals, debates, university fairs, sports tournaments, and wellness walks.

Set against a backdrop of scenic beauty, the campus encompasses lakes, woodlands, hills, flower gardens, and fruit orchards, creating a tranquil environment. The abundance of trees, the fragrance of flora, the chorus of birds, fluttering butterflies, and local wildlife collectively provide a refreshing contrast to academic demands, nurturing and rejuvenating the minds of its student community.

Energy Audit at Tripura University

In a world where governments globally prioritize policies that enhance labour productivity, skill development, and economic growth through knowledge cultivation, Tripura University

continues to serve as a beacon of educational excellence. By acting as a catalyst for knowledge enhancement and skill development, the university strengthens its role in driving the nation's prosperity and fostering substantial economic progress.

As Tripura University advances its pioneering research across diverse scientific and technological disciplines, this growth inevitably leads to increased energy consumption and a corresponding ecological impact. Recognizing this, the university has reaffirmed its commitment to sustainable development by aligning with the Government of India's vision under the leadership of the Honourable Prime Minister Shri Narendra Modi. This commitment resonates with the University Grants Commission's (UGC) emphasis on "Environmental Consciousness" as a critical evaluation criterion (Criterion VII) for academic institutions.

In the era of sustainable development, Tripura University prioritizes responsible resource utilization and environmental stewardship, with energy efficiency as a central pillar of its operational strategy. Through systematic energy audits, the university evaluates energy usage patterns, identifies inefficiencies, and develops strategies for optimization. These efforts aim to reduce the university's carbon footprint and contribute to the broader global mission of environmental conservation.

Tripura University remains steadfast in its commitment to responsible energy management and sustainable academic practices. Guided by the sustainability objectives of the Government of India, the university continually evaluates its research and educational initiatives. These efforts are spearheaded by the diligent work of the Energy Audit Committee, whose mission is to ensure sustainable and efficient energy utilization on campus.

Core Policy Objectives of Tripura University's Energy Audit:

1. **Identifying Strengths and Opportunities for Improvement:** The energy audit process encompasses a comprehensive review of energy consumption across administrative, academic, and research activities. By conducting rigorous analyses, the university aims to identify existing strengths while pinpointing areas for improvement. This will lay the foundation for actionable strategies that drive progress toward achieving sustainability goals.
2. **Promoting Environmental Awareness:** Tripura University is deeply committed to fostering a culture of environmental consciousness across its campus. Engaging stakeholders—including students, faculty, staff, and administration—will help instil the principles of optimized resource utilization. These efforts collectively aim to minimize the institution's ecological footprint while inspiring responsible environmental practices.
3. **Proactive Environmental Management:** Proactive management is critical to the university's environmental strategy. Establishing baseline data on key environmental parameters allows the university to identify potential issues early and address them effectively. This approach ensures the development and maintenance of a sustainable, ecologically balanced campus environment.

Commitment of the Energy Audit Committee

To achieve these objectives, the Energy Audit Committee of Tripura University is dedicated to:

- Identifying existing and emerging challenges related to energy use.
- Monitoring and evaluating energy management practices.
- Assessing policies and guidelines impacting energy consumption.
- Raising awareness among all stakeholders about the importance of energy efficiency.
- Compiling a comprehensive Energy Audit Report that highlights energy-efficient practices adopted across departments, support services, and administrative units.

By advancing these initiatives during the academic year 2023-24, Tripura University reaffirms its commitment to sustainable development, energy efficiency, and environmental stewardship. These efforts represent a shared vision to lead by example in creating a greener, more sustainable future while fostering a culture of accountability and innovation.

METHODOLOGY ADOPTED

Tripura University remains resolute in its pursuit of a sustainable future. Through an innovative and systematic energy audit, we reaffirm our commitment to reducing our carbon footprint, optimizing resource usage, and fostering a greener campus ecosystem. Below is the methodology that reflects our dedication to achieving an energy-efficient and environmentally conscious institution.

Initiating the Audit

The energy audit began with a foundational assessment aimed at collecting comprehensive data on energy consumption. This phase involved analyzing utility bills, monitoring energy-related metrics, and identifying key areas of energy usage across campus facilities, such as HVAC systems, lighting systems, and electrical equipment.

Campus Inspection

To gain a deeper understanding of energy consumption, the team conducted thorough site visits to academic buildings, administrative offices, and other campus facilities. Equipment specifications, operational schedules, and energy utilization were closely examined to ensure an accurate evaluation of the energy profile of the university.

Engaging the Campus Community

The energy audit emphasized collaboration with campus stakeholders. Through interviews, discussions, and questionnaire surveys (**Appendix-I**), we gathered valuable insights from facility managers, maintenance staff, and building occupants. This dialogue allowed us to uncover practical challenges and opportunities for energy conservation while fostering a sense of shared responsibility.

Analyzing Energy Patterns

Energy usage data was systematically analyzed to identify trends, inefficiencies, and areas requiring intervention. This step provided a clear picture of energy flow within the institution, highlighting specific opportunities to enhance energy efficiency and reduce waste.

Evaluating Lighting Systems

Lighting systems were examined as a critical component of energy usage. The audit evaluated existing technologies and identified areas for improvement, such as transitioning to LED lighting. This change promises to significantly reduce energy consumption while providing high-quality illumination across campus.

Renewable Energy Opportunities

The potential for integrating renewable energy was a key focus. Solar energy emerged as a practical and sustainable option for supplementing the university's energy needs, aligning with the institution's broader goal of minimizing reliance on non-renewable energy sources.

Conservation Strategies

The audit led to the development of a suite of energy conservation measures (ECMs) tailored to the university's unique needs. These measures included modernizing outdated equipment, optimizing processes, and encouraging behavioural changes. By prioritizing these strategies, the university can achieve measurable improvements in energy efficiency.

Economic and Environmental Impact Assessment

Recognizing the financial implications of sustainability initiatives, the team conducted a comprehensive cost-benefit analysis. Each proposed measure was evaluated for its implementation cost, potential energy savings, and long-term return on investment (ROI). This analysis ensures that the university's energy conservation efforts are both economically viable and environmentally impactful.

Documenting and Reporting

The energy audit findings were consolidated into a detailed report. This document serves as an essential resource, outlining the analysis, recommendations, and potential benefits of energy-saving initiatives. The report underscores the university's transparency and commitment to continuous improvement.

Sustainable Strategy

The energy audit methodology reflects Tripura University's dedication to creating a sustainable campus that balances academic growth with environmental responsibility. By reducing its ecological footprint, embracing energy-efficient practices, and promoting renewable energy, the university sets a benchmark for responsible resource management.

Through this well-structured roadmap, Tripura University embarks on a journey of transformation, empowering the campus community to contribute to a greener, more sustainable future. This collective effort will not only benefit the university but also serve as an inspiration for institutions nationwide.

AUDIT STAGE

Tripura University remains steadfast in its commitment to sustainability and energy responsibility. To pave the way for a greener, energy-efficient campus, the university

embarked on a well-structured and methodical energy audit. This journey, undertaken with precision and purpose, reflects our dedication to responsible resource management. Below is an updated account of the energy audit methodology.

Phase 1: Data Collection

The energy audit began with an exhaustive collection of data to map the university's energy consumption patterns. This phase included the analysis of utility bills, operational data, and energy usage metrics across all campus facilities to build a holistic understanding of energy dynamics.

Phase 2: Identifying Energy-Intensive Areas

Key energy consumption zones were identified through detailed assessments. Major contributors, including lighting systems, HVAC units, and electrical appliances, were mapped to provide insights into high-energy usage areas requiring immediate attention.

Phase 3: Inspections and Field Analysis

The audit team conducted comprehensive onsite evaluations across academic and administrative buildings. This involved real-time assessments of equipment performance, operational hours, and consumption habits. Such inspections provided critical firsthand insights into the energy behavior of campus systems.

Phase 4: Stakeholder Interaction

A collaborative approach was adopted to engage with stakeholders, including students, staff, and facility managers. Through structured questionnaires, interviews, and interactive discussions, we gathered vital perspectives on energy usage, challenges, and opportunities for improvement.

Phase 5: Data Analysis

The gathered data was meticulously synthesized and analyzed to identify trends, inefficiencies, and anomalies. This analysis provided a clear picture of the energy performance of various systems, highlighting opportunities for optimization.

Phase 6: Evaluating Lighting Systems

Lighting systems, being a significant energy consumer, underwent thorough scrutiny. Existing technologies were assessed, and energy-efficient alternatives, such as transitioning to LED lighting, were proposed to ensure significant energy savings while maintaining lighting quality.

Phase 7: Harnessing Renewable Energy

The audit explored the feasibility of harnessing renewable energy sources like solar power to supplement the university's energy needs. Leveraging the campus's renewable energy infrastructure became a focal point for sustainable energy strategies.

Phase 8: Energy Conservation Strategies

A comprehensive set of energy conservation measures (ECMs) was developed. These strategies included upgrading outdated equipment, optimizing operations, and promoting behavioral changes across the campus community to reduce energy consumption effectively.

Phase 9: Cost-Benefit and ROI Analysis

Economic feasibility was carefully assessed to ensure the financial sustainability of proposed measures. Each energy-saving initiative was analyzed for its implementation cost, potential savings, and return on investment (ROI) to balance sustainability goals with fiscal responsibility.

Phase 10: Compilation of Report

The findings of the energy audit were consolidated into a comprehensive report. This document highlights the analysis, recommendations, and actionable energy conservation measures, complete with their anticipated benefits, to serve as a strategic roadmap for a more sustainable campus.

The energy audit at Tripura University stands as a testament to the institution's unwavering commitment to sustainability, environmental consciousness, and proactive energy management. It provides a strategic pathway to a greener, energy-efficient campus while setting an example for the academic community to contribute to a sustainable future. Together, we strive to create a brighter, more sustainable tomorrow.

POST AUDIT STAGE

The post-audit phase of Tripura University's Energy Audit reveals more than just figures and analyses—it paints a vivid picture of a campus deeply rooted in its commitment to sustainability. Framed by the unique contours of our landscape and the collective efforts of our community, this stage reflects our dedication to fostering responsible energy management and creating a greener future.

Land use and land cover

Nestled against a scenic, undulating landscape, the Tripura University campus boasts a serene wetland at its core, gracefully extending toward the southeastern edge. This wetland, nourished by rainwater, remains vibrant throughout the year, supporting a rich ecosystem of aquatic flora and fauna. Scattered trees across the campus create a lively mosaic of biodiversity, while the thoughtful integration of academic departments, residential quarters, and hostels reflects a harmonious balance between infrastructure and nature.

Recent studies reveal that the campus spans an impressive 97 acres, with the main campus covering 75 acres and an additional 22 acres acquired since 2015. Of this, approximately 36.67 acres (37.80%) are dedicated to orchards, wetlands, the Botanical Garden and Forest Park, Jungle area and playgrounds. The lake landscape, the wetland area and the map of the campus and are depicted in Figure 1, 2 and 3. The extended campus is shown in Figure 4. Strategically planned plantations line internal roads, guesthouses, hostels, residential quarters, and green zones. However, challenges have emerged, including the silting of wetlands and

the growth of dense grasses and aquatic weeds in certain areas.

Built-up areas occupy approximately 38.74 acres (~39.94% of the total campus), encompassing academic and administrative buildings, hostels, and residential quarters. Due to limited elevated land, new construction projects have gradually encroached upon the wetland, prompting a shift toward vertical expansion with multistoried structures. Roads connecting these facilities cover approximately 2.82 acres, while playgrounds span nearly 6.43 acres.

Fig1a and 1b. Landscape of lake existing at Tripura University

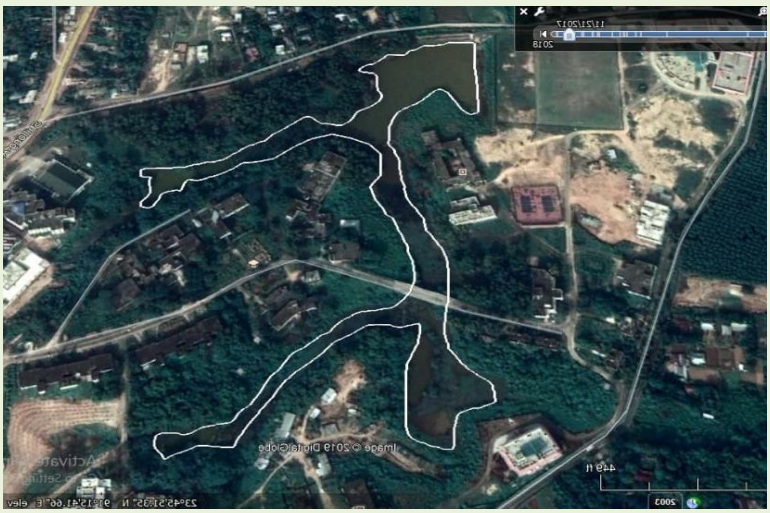


Fig. 2. Map showing the Tripura University Lake

As we step into the post-audit phase, we do so with a deeper appreciation of the unique synergy between our campus and its environment. Tripura University is not merely an educational institution; it is a custodian of a vibrant ecosystem. Our pledge to sustainable energy management is intricately woven into the fabric of our campus, shaping a vision where the landscapes around us become the foundation and inspiration for a greener future.

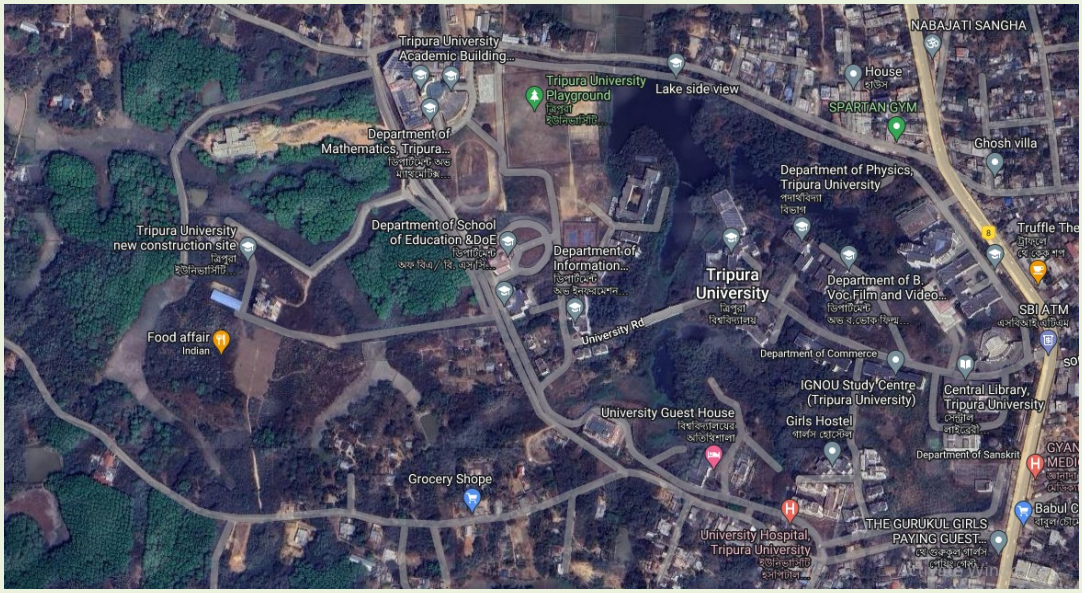


Fig 3: The Map of Tripura University campus

Table 1: Land use categories in Tripura University Campus

Sl. No.	**Land Use Category**	**Area (in approx. Acres)**
1	Botanical Garden and Forest Park	3.75
2	Wetland (Lake area)	10.4
3	Play ground	6.43
4	Orchards	10.94
5	Road	2.82
6	Foot Path	0.21
7	Pump Station	0.20
8	Protection Wall	0.02
9	Drain	0.46
10	Retaining Wall	0.02
11	Culvert	0.02
12	Building Under Construction	2.17
13	Overhead Tank	0.009
14	Car Parking	1.48
15	Garage	0.15
16	Building	29.17
17	Transformer	0.104
18	Generator	0.05
19	Security House	0.012
20	Water Pump	0.04
21	Septic Tank	0.88
22	Jungle Area	5.51
23	Tin Shed	0.06
24	Power Sub Station	0.25
25	Toilet	0.49
26	Garden	0.25
27	Statue	0.001

ENERGY AUDIT

In alignment with the Energy Conservation Act of 2001, Tripura University conducted a detailed energy audit for the academic year 2023-24. This audit involved analyzing energy consumption, identifying inefficiencies, and recommending actionable strategies to enhance energy efficiency. A critical component of this audit included performing a cost-benefit analysis and devising an action plan to reduce energy consumption effectively.

Campus Energy Footprint

The audit comprehensively assessed all electrical and natural gas consumption across Tripura University's academic and administrative precincts. Key insights include:

LPG Usage: LPG cylinders serve as the primary cooking fuel in hostels, with an average of 45 cylinders consumed monthly in hostels and guest houses. Domestic LPG connections were excluded from the audit.

No Fossil Fuels: The campus relies solely on electricity and LPG, with no use of coal, firewood, or other fossil fuels for energy generation.

Eco-Conscious Architecture: The university's buildings are designed to maximize natural light and ventilation, eliminating the need for artificial lighting during the day and exemplifying energy-efficient design.

Harnessing Solar Energy

Tripura University has firmly embraced renewable energy through the installation of 600 KWp rooftop solar panels (Fig. 4 and 5) across 14 campus buildings. This initiative has yielded remarkable outcomes:

Savings: From July 2023 to June 2024, solar power resulted in savings of ₹42,00,000, averaging ₹3,50,000 per month.

Sustainability Impact: This strategic move underscores the university's commitment to reducing its carbon footprint and achieving long-term energy security.

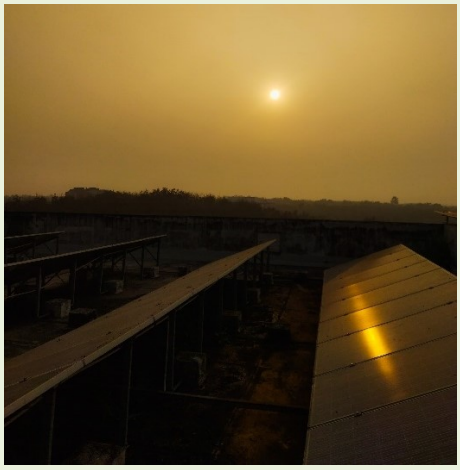


Fig. 4: Use of solar power panels in TU Campus

Fig. 5: Use of solar power panels in TU Campus

Sustainable Lighting

The university has revamped its lighting systems to incorporate energy-efficient technology:

LED Street Lighting: All High-Pressure Sodium Vapour (HP-SV) and High-Pressure Metal Halide (HP-MH) streetlights have been replaced with LEDs.

Floodlights: 104 LED floodlights (200 Watts each) were installed in the sports grounds, replacing older, less efficient fixtures.

Green Initiatives: Mushroom head LED lights were added to enhance sustainability.

Savings: This lighting overhaul, covering 258 fixtures, resulted in ₹20,00,000 in annual savings, averaging ₹1,67,000 per month.

Upgraded Lighting Inventory: Across academic and administrative blocks, the university now has 600 LED bulbs and panels, replacing older CFLs and halogen bulbs.

Cooling and Ventilation

The campus houses 500 air conditioners and 3,500 fans distributed across various buildings to ensure comfort for students and staff.

Gastronomic Usage

Within the vibrant tapestry of our campus, an average of 45 natural gas (LPG cylinders) worth of cooking fuel per month is utilized across different hostels and guest houses.

Energy Consumption Trends

During the academic year 2023-24, Tripura University's monthly electricity consumption averaged 110,000 units, inclusive of residential quarters. A comparison with previous years reveals a notable downward trend:

2018-19: 220,000 units
2019-20: 110,000 units
2020-21: 110,000 units
2021-22: 110,000 units
2022-23: 110,000 units
2023-24: 110,000 units

This demonstrates a significant 46% reduction in electricity consumption compared to the 2018-19 baseline. The decline is attributed to the university's strategic initiatives, including the installation of solar panels in key zones and the adoption of energy-efficient practices, such as LED lighting and renewable energy solutions (Fig. 6, Fig. 7, and Fig. 8).

Tripura University's 2023-24 energy audit highlights its steadfast dedication to sustainability. Through proactive investments in renewable energy, the implementation of energy-efficient lighting systems, and the promotion of innovative energy-saving practices, the university has set a benchmark in responsible energy management. These efforts reinforce the institution's mission to foster a greener, more sustainable future for all.

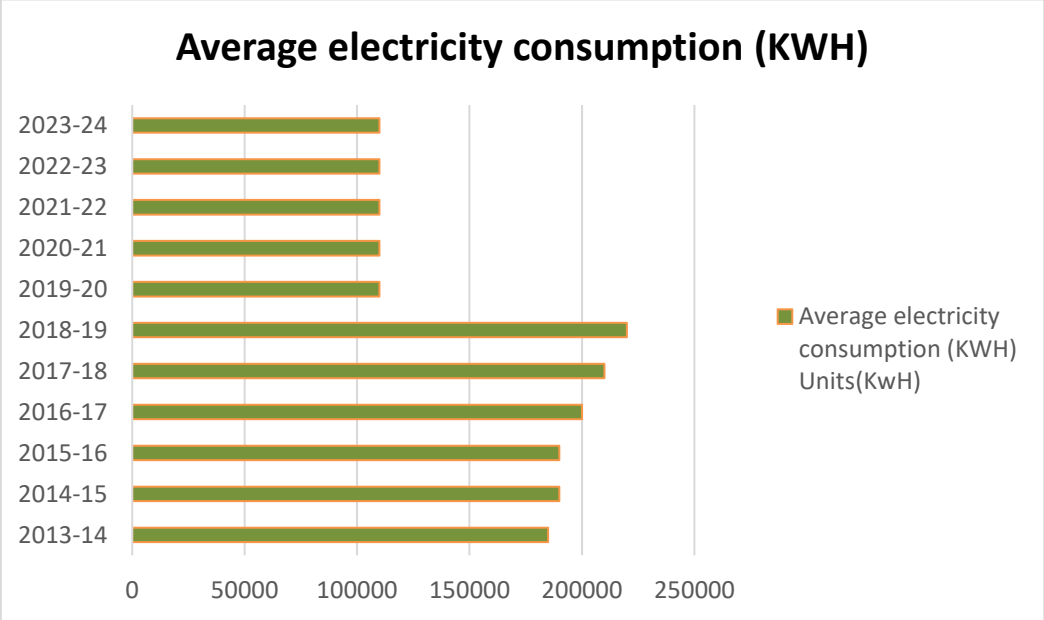


Fig. 6: Average electricity consumption in TU campus from 2013-14 to 2023-24

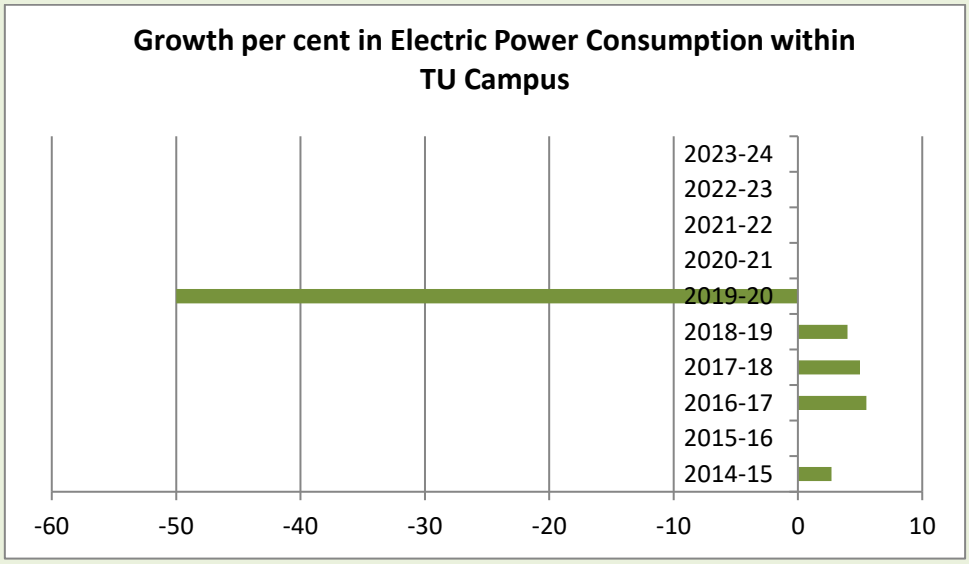


Fig. 7: Percentage growth in Electric Power consumption in TU campus from 2014-15 to 2023-24

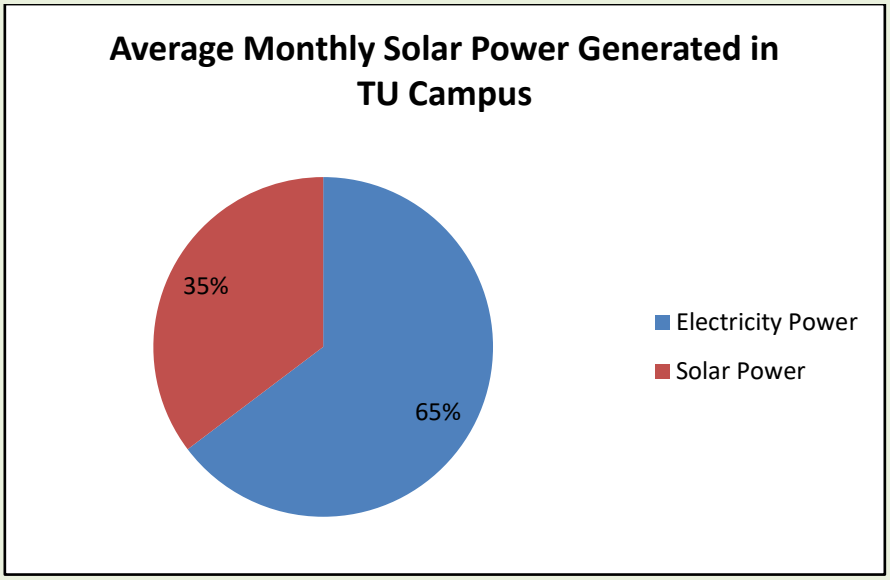


Fig. 8: Monthly Solar power generated within TU campus

Observations

Metering Gaps: The absence of separate electricity meters in hostels, academic blocks, and administrative buildings limits the ability to monitor energy usage at a granular level.

Behavioural Insights: Greater community engagement is needed to foster a culture of energy conservation.

Suggestions and Recommendations

Metering Infrastructure: Install individual electricity meters for each building to accurately monitor and manage energy consumption.

Expanding Solar Power: Introduce solar-powered roadside poles and additional rooftop solar panels to further harness renewable energy, reducing dependency on non-renewable electricity sources.

Energy Awareness Campaigns: Conduct regular awareness drives to educate students and staff on energy conservation practices, such as turning off lights and appliances when not in use.

Smart Energy Management: Leverage energy management systems to track and analyse energy consumption trends, enabling data-driven decision-making.

Tripura University's energy audit for 2023-24 reaffirms its commitment to sustainable energy management. By integrating renewable energy, adopting efficient technologies, and fostering community-driven conservation efforts, the university is setting a benchmark for sustainability in higher education. These initiatives not only enhance energy efficiency but also pave the way for a greener, more sustainable future.

Summary

Energy auditing is a strategic journey towards optimizing energy consumption and bolstering sustainability. In pursuit of this goal, Tripura University conducted its annual "Energy Audit" for 2023-2024. The overarching objective of this audit was to craft a comprehensive narrative of the university's energy practices and to deliver a meticulously curated energy audit report.

This intricate energy audit embarked on a multifaceted exploration, commencing with a meticulous analysis of diverse facets, encompassing energy consumption patterns, conservation strategies, and the efficiency of energy-related utilities that power the university's operations. Our audit team conducted a diligent examination of various facilities spanning our sprawling campus, identifying a myriad of appliances and utilities, including but not limited to lighting systems, water coolers, faucets, restrooms, fans, and air conditioning units. Each item underwent scrutiny, with energy usage quantified regarding appliance wattage or water flow rates. The scrutiny extended to the frequency of appliance utilization and their consequential impacts. Engaging our faculty members and students enriched our data collection, offering insights into usage frequencies and general characteristics. This thorough data gathering amalgamated onsite visits and direct measurements, forming the bedrock of this comprehensive energy audit report for Tripura University.

One remarkable facet of our university's infrastructure is its conscious design to minimize electricity consumption during daylight hours. Abundant daylight and ventilation negate the need for electric lighting, marking a commendable stride toward energy efficiency. Furthermore, we've embraced renewable energy with open arms. Our installation of rooftop solar panels across 14 buildings, boasting a collective capacity of 600 KWp, is a testament to our commitment to sustainability. This strategic move has borne fruit, significantly offsetting our electricity needs. From July 2023 to June 2024, we saved a substantial Rs. 42,00,000/-, averaging Rs. 350000/- per month. In line with our green initiatives, mushroom head LED lights were adopted, accumulating savings of Rs. 20,00,000/- approximately, from July 2023 to June 2024, averaging Rs. 167,000/- per month approximately. Our inventory includes 600 LED bulbs and panels, surpassing 600 CFLs and 150 T-8 Type Tube Light/Halogen bulbs across our academic and administrative edifices.

In 2023-24, our monthly average electricity consumption stood at 110,000 units, encompassing residential quarters. Yet, our audit team spotted a missing link in our energy management - the absence of separate electricity meters in hostels, academic blocks, and administrative buildings. Our recommendations, therefore, include the imperative need for energy consumption recording facilities in all university buildings. Furthermore, we envision additional solar power generation soon, contemplating the installation of roadside solar poles. To reinforce these efforts, we advocate regular campaigns promoting the responsible practice of switching off lights and electrical appliances after use.

In conclusion, Tripura University's energy audit report illuminates our energy landscape and the path to a more efficient, sustainable, and conscientious future.

APPENDIX-I

Green/Energy/Environmental Audit Questionnaire - Tripura University – 2023-2024

Instructions: Please provide accurate and detailed information to aid in the Green/Energy/Environmental Audit Report's data collection and analysis. Your responses are crucial in assessing the university's environmental practices and sustainability efforts.

Section 1: Stakeholder Survey

Please specify if you are a:

Teaching Staff	
Non-Teaching Staff	
Student	
Other	

Section 2: General Awareness

a) Whether TU/ any department has conducted awareness/responsibility programme among the staff/student members:

Yes		No		Maybe	

b) Whether all the departments/teachers/non-teaching members/students are aware about the need of the environmental protection and audit:

Yes		No		Maybe	

c) Whether TU has involved the students as volunteers in green activities/ programme:

Yes		No	

d) Whether TU has conducted any workshop/seminar/lecture on environmental awareness programme inside and/or outside the campus:

Yes		No		Maybe	

Section 3: Water Consumption, Usage and Management

a) Whether TU has an efficient and hygiene water storage facility/ structure/ mechanism to minimize the loss of water during storage:

Yes		No	

b) Whether TU has installed/ is using water filter with RO, Aqua Guard and/or large water filter with cooler at strategic locations in the departments/ Central library/ other centres within the campus:

Yes		No	

c) Whether TU has its own mechanism and/ or technical personnel to repair water leakage/ carry out routine inspection:

Yes		No		Don’t know	

d) Whether rainwater harvesting units are installed in TU Campus:

Yes		No		Maybe		Don’t know	

e) Whether TU has developed/ is developing a system for reuse and recycle of water:

Yes		No		Don’t know	

f) Whether there is any of necessity for assessing the Water Quality Index (parameters: pH, EC, TDS, Turbidity, metal contaminants- Iron, Arsenic, etc.) of water used in hostel, lab, office, canteen, tap water:

Yes		No		Maybe		Don't know	

g) Whether TU has adequate/ sufficient drainage system:

Yes		No	

h) Do you have any knowledge of the university's water availability and usage patterns?

Yes		No	

i) If your response to the above question is 'Yes' please provide any details you are aware of regarding water usage and conservation efforts: _____

Section 4: Energy Conservation Strategies and practices

a) Whether TU has any provision/choice of renewable and carbon-neutral electricity options:

Yes		No		Maybe	

b) Whether TU is planning / has installed solar panels for harnessing solar energy:

Yes		No		Maybe	

c) Whether TU has efficient water heating system:

Yes		No		Maybe		Don't know	

d) Whether you are concerned in turning off electrical appliances when not in use either in institutional and/ or commercial and/ or residential area:

Yes		No	

e) Whether there is monitoring system to switch off the power mains when not in use:

Yes		No		Don't know	

f) Whether the users follow the appropriate and measurable targets for a reduction of energy, such as, computer, printers, lab equipment when not in use

Yes		No		Maybe		Don't know	

g) Whether there any options for equipment's running on standby mode:

Yes		No		Maybe		Don't know	

h) Whether TU has taken initiative to purchase efficient and environmentally sound appliances in order to fulfill the green budget:

Yes		No		Maybe		Don't know	

i) Whether TU has its own mechanism in repairing of electrical fault:

Yes		No		Maybe		Don't know	

j) Whether the class rooms are with sufficient illumination in day time and ventilation

Yes		No	

k) How many (%) e-notice generated by the university for academic/administrative purposes in a month? _____

l) Whether TU has organized lectures on energy conservation in order to give awareness to the students:

Yes		No		Maybe	

m) How frequently do you use appliances/equipment within the university premises?

Daily		Rarely		Few times a week		Few times a month	

Other: _____

n) Can you provide general characteristics of the appliances/equipment you use regularly? (eg., lighting, computers, printers, etc.) _____

o) Whether the architectural design for TU is based upon use of natural lighting & ventilation, to save extra power for bulbs and fans:

Yes		No	

p) Whether florescent bulbs are replaced with CFL bulbs/LEDs:

Yes		No		Don't know	

q) Are you aware of any energy conservation strategies or practices implemented within Tripura University?

Yes		No	

r) If your response to the above question is Yes, could you briefly describe these strategies or practices? _____

s) Whether TU has any common car sharing/car pool among the students and faculty:

Yes		No		Maybe		Don't know	

t) Mode of commute to TU:

Public		Private		Walking	

u) If you use private vehicle to commute, please specify the type of vehicle:

4-Wheeler with CNG		4-Wheeler without CNG	

2-Wheeler		Bicycle	

Section 5: Waste Management and Sustainability

a) How familiar are you with the waste disposal practices followed within the university?

Very Familiar		Somewhat Familiar		Not Familiar	

b) Is there any method of segregation of waste materials?

Yes		No		Maybe		Don't know	

c) Have you observed any waste reduction or recycling initiatives on campus?

Yes		No	

d) Whether TU has arranged any workshop/seminar/conference for awareness of the students/staff for specific arrangements for recyclable wastes:

Yes		No		Maybe		Don't know	

e) Whether TU follow specific disposal method for solid or liquid waste in specific manner:

Yes		No		Maybe		Don't know	

f) Whether the recycling/collection facilities are provided by the Agartala Municipality Council and/or private individuals/ organisations (recyclables including glass, white plastic bottle, printer cartridges, cardboard, furniture, plastics, thermocol, waste papers, electrical goods & appliances, electronic gadgets, instruments, equipment, packing materials):

Yes		No		Maybe		Don't know	

g) Whether TU has any composting ground/ waste collection from every household or any collection unit, etc.:

Yes		No		Don't know	

h) Is there any mechanism of treatment/uses of domestic influent in the college campus

Yes		No		Don't know	

i) If the response to the above question is Yes, what is the capacity of treatment plant/composting etc.? _____

j) Are there any incidents of burning of plastics containing garbage within the campus for necessary reduction?

Yes		No		Maybe		Don't know	

k) Whether the cleaning products used by the TU staff are eco-friendly and under the COSHH (Control of Substances Hazard to Health) regulations:

Yes		No		Don't know	

l) Whether TU is using fertilizers, pesticides for any purposes

Yes		No		Don't know	

m) If your response to the above is Yes, please specify amount used per month and places of uses: _____

E-WASTE MANAGEMENT

n) Is there any means of disposal of unused computers, printers and electronic wastes through authorized agents?

Yes		No		Maybe		Don't know	

Section 6: Biodiversity and Land Use

a) Is there any garden inside/outside the campus under TU custody?

Yes		No	

b) Whether the garden is watered by using drip/sprinkler irrigation system:

Yes		No		Maybe		Don't know	

c) Have you come across migratory birds and wild animals in the TU campus?

Yes		No	

d) Have you come across stray animals (dogs, cats) in the TU campus?

Yes		No	

e) Have you noticed any efforts to preserve or enhance biodiversity within the university campus?

Yes		No		Maybe		Don't know	

f) If the response to the above question is 'Yes', please provide any information about those efforts? _____

g) Is there any mechanism of review or periodical monitoring of tree species?

Yes		No		Don't know	

h) Whether TU has taken any programme for plantation of some fruit trees which can attract birds, bees etc.:

Yes		No		Don't know	

Section 7: Environmental Quality Assessment

a) Have you observed any changes in the ambient environmental quality within the university campus?

Yes		No	

b) If your response to the above question is Yes, please describe the changes you've observed: _____

Section 8: Conservation Strategies and Practices

a) Are you aware of any conservation strategies or practices implemented within Tripura University?

Yes		No	

b) If your response to the above question is Yes, please briefly describe these strategies or practices? _____

Thank you for taking the time to complete this questionnaire. Your input are invaluable in shaping the Green/ Energy/Environmental Audit Report and contributing to Tripura University's commitment to environmental sustainability.

APPENDIX-II

The Energy Audit was performed through a questionnaire survey which was communicated through email to the teaching staff, non-teaching staff, students and other stakeholders of the university. The questionnaire was sub-divided into several sections encompassing different aspects which can bring about the general idea of awareness, consciousness, and motivation for environmental sustainability in the campus. The comprehensive questionnaire is attached as APPENDIX-I of this report. The questions pertaining to the energy audit are included in Section 4 *Energy Conservation Strategies and Practices* of the questionnaire. The data being derived as responses for each question is given with pie-chart. This set of responses gives a general picture of awareness and sense of motivation to efficiently utilize energy. This is indicative of the realization of the efforts of the university to develop into an energy efficient campus. But it also shows that there is a need for more active promotion, sensitization and participation among the stakeholders. The data being collected also shows the need for the university to persevere with more effective means and budget allocation for developing into a model/ world class energy efficient campus.

Some important observations from the results on the questionnaire survey are discussed under:

Most of the stakeholders are aware of solar power facilities within the campus to harness the energy. The awareness programmes on energy efficiency are widely acknowledged and appreciated. A very good number of the stakeholder expressed their concern for the economic use of electricity in institutional, commercial and commercial areas. Moreover, a good proportion of the stakeholders also acknowledge the presence of monitoring systems or extensions to switch off the power mains when not in use. A majority of the stakeholder uses electrical appliances/ equipment within the university premises on a daily basis and the most commonly utilized being computers, lightings, laboratory equipment, fans, charging adaptors.

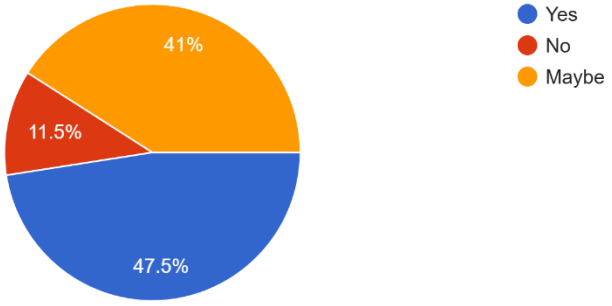
Another thing which can confirm the energy savvy nature of the stakeholders is that more than half of them follow appropriate measures to reduce consumption of electrical energy from their appliances. The positive attitude towards proficient use of energy can be seen.

The university has well and properly planned architectural design which saves electrical energy usage during daytime by making building designs based upon natural lighting and ventilation for proper illumination and air circulation. The classrooms thus are well lit and ventilated. The fluorescent bulbs have been replaced with CFL bulbs/ LEDs. The number of CNG fueled 4-wheeler vehicles are high while a significant section of the stakeholders of the uses bicycle. Thus, this survey highlighted energy efficiency in the Tripura University campus.

Energy Conservation Strategies and Practices

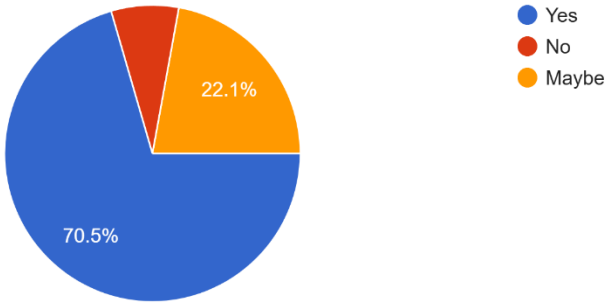
a) Whether TU has any provision/ choice of renewable and carbon-neutral electricity options:

122 responses



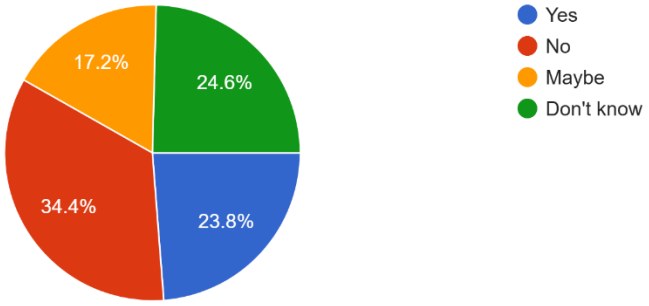
b) Whether TU is planning/ has installed solar panels for harnessing solar energy:

122 responses



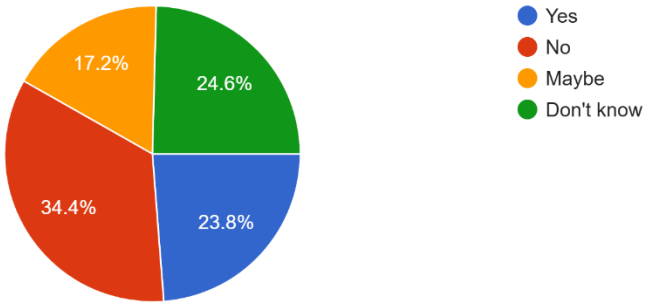
c) Whether TU has efficient water heating system:

122 responses



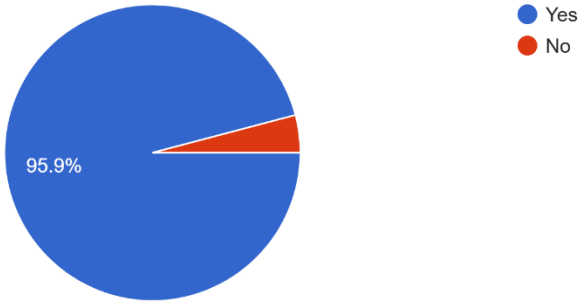
c) Whether TU has efficient water heating system:

122 responses



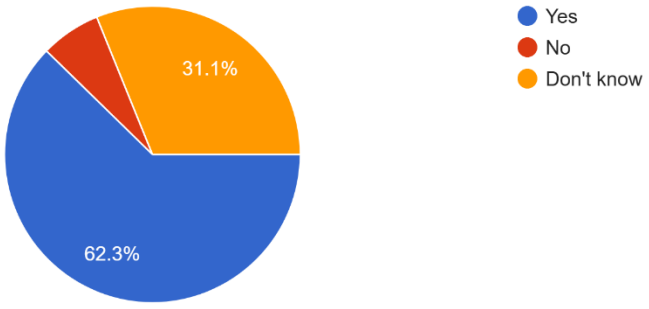
d) Whether you are concerned in turning off electrical appliances when not in use in either institutional and/ or commercial and/ or residential area:

122 responses



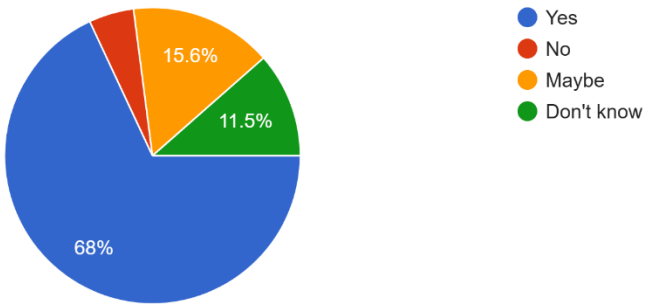
e) Whether there is monitoring system or extensions to switch off the power mains when not in use:

122 responses



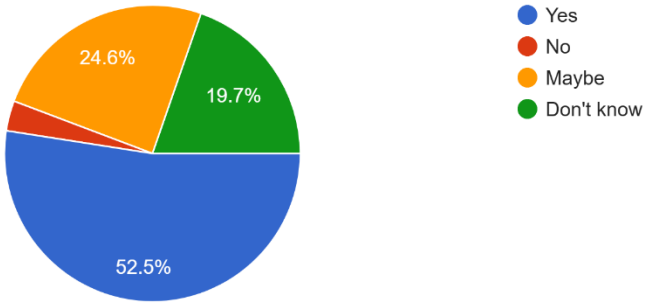
f) Whether the users follow the appropriate and measurable targets for a reduction in energy usage/ consumption from devices like computers, printers, lab instruments when not in use:

122 responses



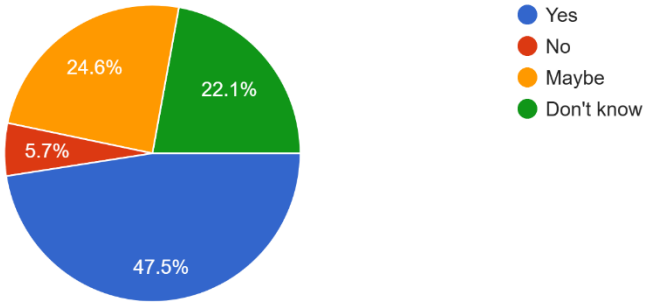
g) Whether there are options to keep equipments/ appliances running on standby mode:

122 responses



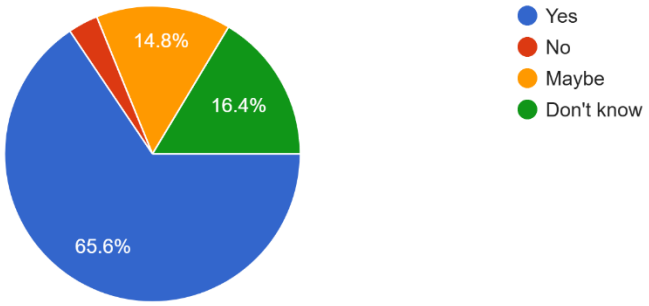
h) Whether TU has taken initiative to purchase efficient and environmentally sound appliances in order to fulfill the green budget:

122 responses



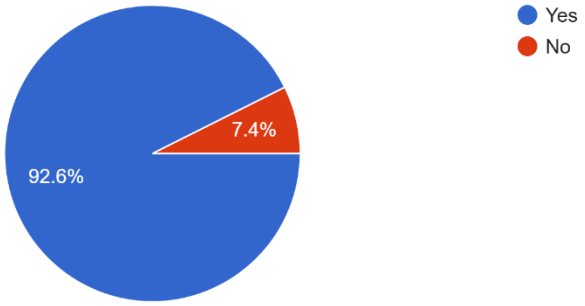
i) Whether TU has its own mechanism in repairing of electrical fault:

122 responses



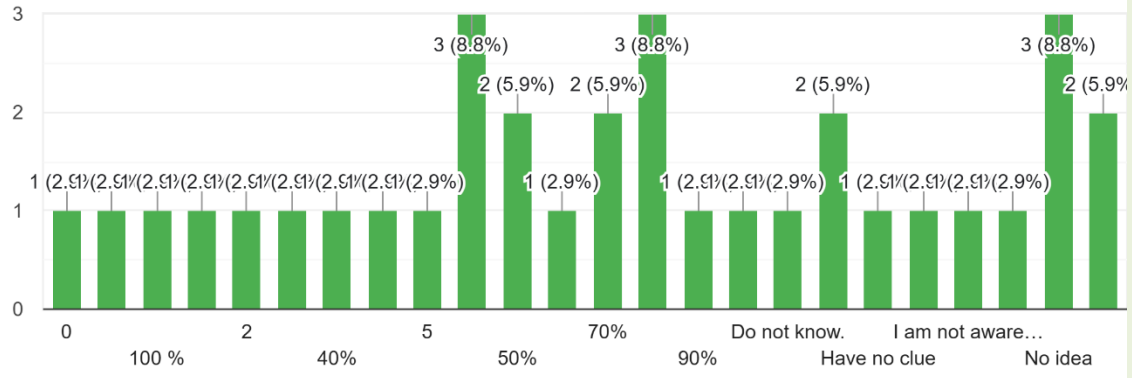
j) Whether the class rooms are with sufficient illumination in day time and ventilation:

122 responses



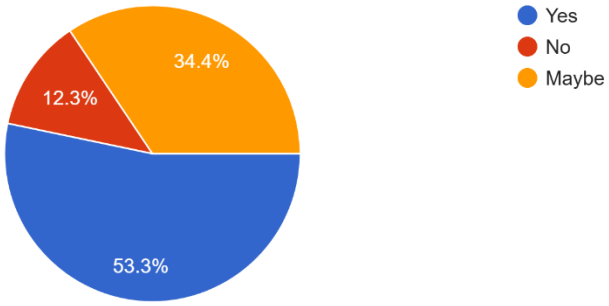
k) How many (%) e-notice generated by the TU for academic/administrative purposes in a month?

34 responses



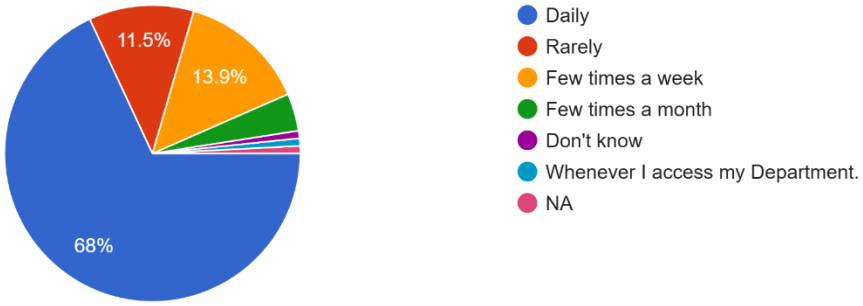
l) Whether TU has organized lectures on energy conservation in order to give awareness to the students:

122 responses



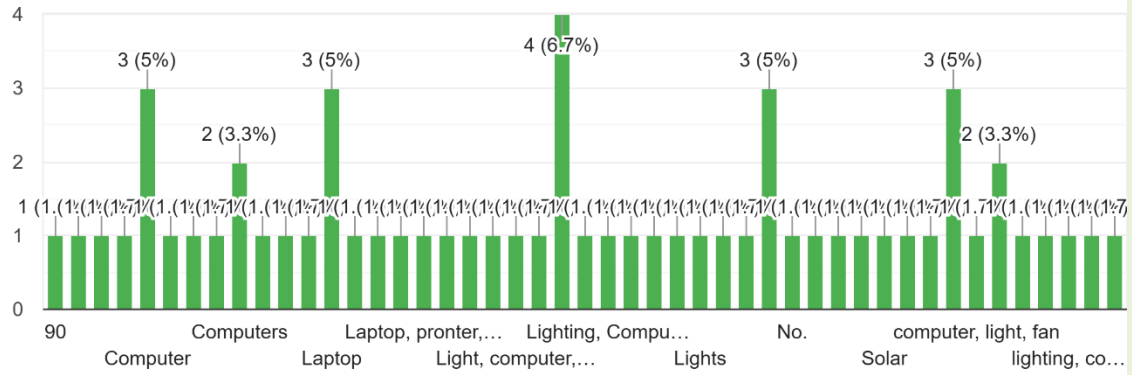
m) How frequently do you use appliances/equipment within the university premises?

122 responses



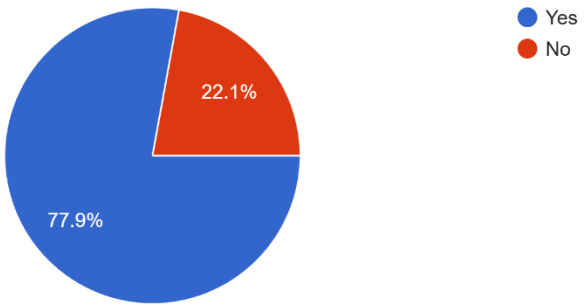
n) Can you provide general characteristics of the appliances/ equipment you use regularly? (eg., lighting, computers, printers, etc.)

60 responses



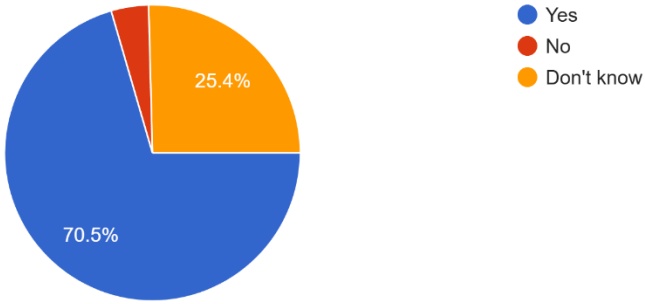
o) Whether the architectural design for TU is based upon use of natural lighting & ventilation, to save extra power for bulbs and fans:

122 responses



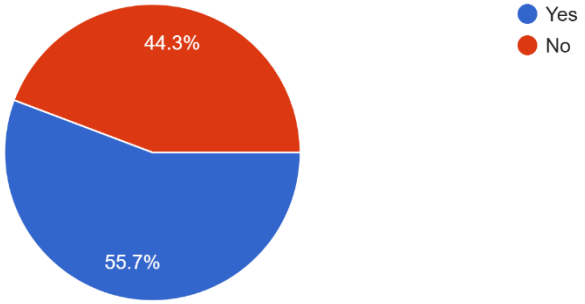
p) Whether florescent bulbs are replaced with CFL bulbs/LEDs:

122 responses



q) Are you aware of any energy conservation strategies or practices implemented within TU?

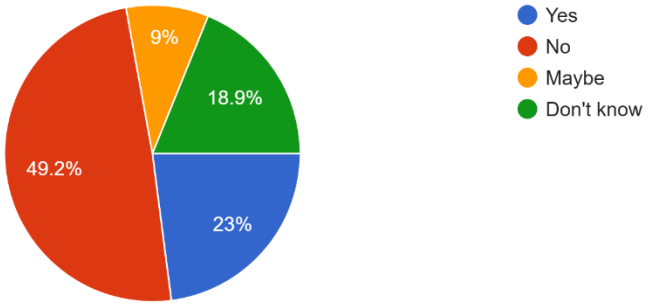
122 responses



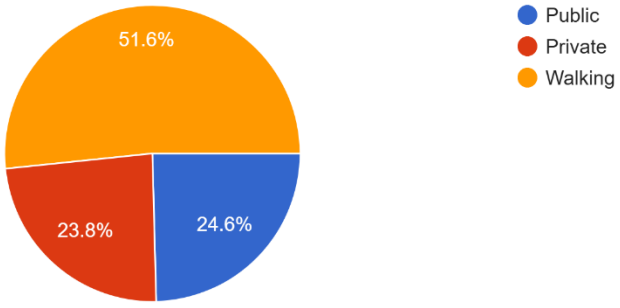
r) If your response to the above question is Yes, could you briefly describe these strategies or practices?

Awareness programmes held
Solar electricity generation system has been installed on the roof of Academic building 1 and 2 respectively.
The facilities are good enough except One indoor sports multitasking hall
Electrical appliances work perfectly with effectively placed machineries and good power supply and using of solar power is also installed
Solar panels to save energy
Energy Park, within the university campus

s) Whether TU has any common car sharing/car pool among the students and faculty:
122 responses

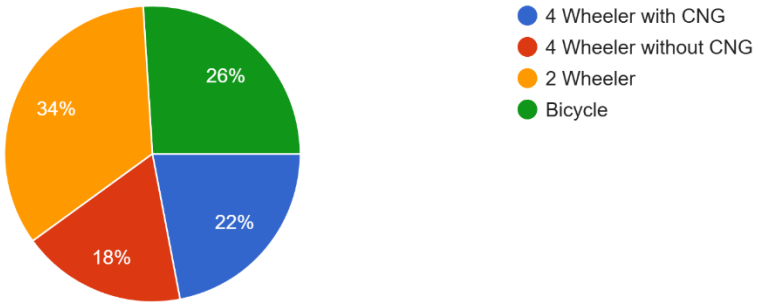


t) Mode of commute to TU:
122 responses



u) If you use private vehicle to commute please specify the type of vehicle:

50 responses



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TRIPURA, INDIA