GREEN AUDIT REPORT

OF

Dibrugarh University, Assam

Dibrugarh University, Dibrugarh-786004, Assam, India

Prepared By

Audittech Industrial Services Private Limited

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ACKNOWLEDGEMENT

We express our sincere gratitude to **Dibrugarh University Assam** for giving us the opportunity to be a part of their mission towards Energy Conservation. We are thankful to all officers and employees of **Dibrugarh University Assam**, for their whole-hearted support and cooperation in undertaking measurements and eagerness to assess the system/equipment efficiencies and energy saving potential. The cooperation extended by them during the audit is appreciable.

Date: 25.10.2022 Authorized Signatory

Place: Balod For, Audittech Industrial Services Private Limited

CERTIFICATE

This is to certify that Dibrugarh University has conducted a detailed “Green Audit” for its campus during the academic year 2022-2023. The green audit was conducted in accordance with the standards laid out by the Central Pollution Control Board, New Delhi, and the Ministry of Environment, Forest and Climate Change, New Delhi. The audit focused on water, wastewater, energy, air, green inventory, solid waste, etc., and provided an 'Environmental Management Plan', which the university can follow to minimize the impact on the institutional working framework. To the best of our knowledge based on the information provided to us, the green audit show a true and fair view in line with the permissible environmental auditing principles in India.

EXECUTIVE SUMMARY

Green auditing is the process of identifying and determining whether institutions' practices are eco-friendly and sustainable. The main objective to carry out a green audit is to check green practices followed by the university and to submit a detailed audit report highlighting, where the institution stands with regard to protecting the environment. The initiative taken by Dibrugarh University to conduct a Green Audit for their university campus is a commendable sustainable goal. The strategy that was adopted was a set of questionnaires and subsequent action plan to implement the project. Questionnaires prepared to conduct the green audit were based on the guidelines, rules, acts and formats laid out by the Government of India, Ministry of Environment and Forest, New Delhi, and Central Pollution Control Board, New Delhi. Questionnaires were prepared for solid waste, energy, water, hazardous waste, and e-waste. For the ease data collection during the audit, the University campus was grouped into four categories. The audit was carried out for solid waste, electricity and energy, water and wastewater, hazardous waste, air quality, and green inventory including carbon footprints. The study indicates that University has taken lot of green initiatives to save the environmental resources and it also presents an “Environmental Management Plan“.

1. INTRODUCTION

1.1 Green Audit - An Effective Efforts towards Environment Sustainability & Energy Conservation

Modernization and industrialization are the two important outputs of the twentieth century that have made human life more luxurious and comfortable. Simultaneously, they are responsible for voracious use of natural resources, exploitation of forests and wildlife, producing massive solid waste, polluting the scarce and sacred water resources, and finally making our mother Earth ugly and inhospitable. Today, people are more familiar with global issues like global warming, greenhouse effect, ozone depletion, climate change, etc. Now, it is considered as a final call by mother Earth to walk on the path of sustainable development. The time has come to awake, unite and come together for a sustainable environment.

Considering the present environmental problems of pollution and excessive use of natural resources, Honorable Prime Minister, Shri. Narendra Modiji has declared the Mission of Swachch Bharat Abhiyan. Also, University Grants Commission has emphasized the higher educational institution to go for "Green Campus, Clean Campus" mission. As environmental sustainability is becoming an increasing important issue for the nation, the role of higher educational institutions in relation to environmental sustainability is very vital.

Green Audit is the most efficient ecological tool to solve such environmental problems. It is a process of regular identification, quantification, documenting, reporting and monitoring of environmentally important components in a specified area. Through this process, the regular environmental activities are monitored within and outside of the concerned sites which have direct and indirect impacts on the surroundings. A green audit can be one of the initiatives for such institutes to account for their energy, water resource use as well as wastewater, solid waste, hazardous waste generation. The green Audit process can play an important role in the promotion of environmental awareness and sensitization about resource use. It can create consciousness towards ecological values and ethics. Through the green audit, one can get direction about how to improve the condition of the environment.

1.2 Why Green Audit

Green auditing is the process of identifying and determining whether an institution's practices are eco-friendly and sustainable. Traditionally, we are good and efficient users of natural resources. However, over the period of time excess use of resources like energy, water, chemicals have become habitual for everyone especially, in common areas. Now, it is necessary to check whether our processes are consuming more than the required resources? Whether we are handling waste carefully? Green audit regulates all such practices and gives an efficient way of natural resource utilization. In the era of climate change and resource depletion, it is necessary to verify the processes and convert them into green and clean ones. The green audit provides an approach for it. It also increases overall consciousness among the people working in institutions towards an environment.

1.3 Goals of Green audit

University has conducted a green audit with specific goals as:

- Assess the facilities of different types of waste management.
- Enhance the environmental awareness throughout the campus.
- Identify and document the green practices followed by University.
- Identify the strengths and weaknesses in green practices.
- Conduct a survey to know the ground reality about green practices.
- Analyze and suggest solutions for problems identified from the survey.
- Identify and assess environmental risk.
- The long-term goal of the environmental audit program is to collect baseline data of environmental parameters and resolve environmental issues.
- To motivate the staff for optimum utilization of sustainable resources.

1.4 Objectives of Green audit

- To examine the current practices which can impact the environment such as resource utilization, waste management, etc.
- To prepare an Environmental Statement Report on green practices followed by different departments, support services, and administration building.
- To set goals, vision, and mission for Green practices on the campus.
- To identify and analyze significant environmental issues.
- To establish and implement Environmental Management Plan in various departments.
- To assess for better performance in green practices and its evaluation.

1.5 About Criteria 7 of NAAC

Universities are playing a key role in the development of human resources worldwide. Higher education institutes campus run various activities with the aim to percolate the knowledge along with practical dimension among the society. Likewise, different technological solutions related to the environment are also provided by the higher education institutes. Different types of evolutionary methods are used to assess the problem concerning the environment. It includes Environmental Impact Assessment (EIA), Social Impact Assessment (SIA), Carbon Footprint Mapping, Green audit, etc.

National Assessment and Accreditation Council (NAAC) is a self-governing organization that evaluate the institutions based on the grades in various criteria. Green Audit has become a mandatory procedure for educational institutes under Criterion VII of NAAC. The intention of the green audit is to upgrade the environmental condition inside and around the institution. It is performed by considering environmental parameters like water and wastewater accounting, energy conservation, waste management, air, noise monitoring, etc. for making the institution eco-friendlier.

Students are the major strength of any academic institution. Incorporating green practices in any educational institution will inculcate the good habit of caring for natural resources and our mother planet, among the student community. Many environmental activities like plantation and nurturing saplings and trees, Cleanliness drives, Bird watching camps, no vehicle day, Rainwater harvesting, etc. will make the students good citizens of the country. Through Green Audit, higher educational institutions can ensure that they contribute towards the reduction of global warming through Carbon Footprint reduction measures.

1.6 Benefits of Green Audit to an Educational Institute

There are many advantages of green audit to an Educational Institute.

- It would help to protect the environment in and around the campus.
- Recognize the cost-saving methods through waste minimization and energy conservation.
- Empower the organization to frame a better environmental performance.
- It portrays a good image of the institution through its clean and green campus.
- More efficient resource management.
- To create a green campus.
- To enable waste management through reduction of waste generation, solid and waste.
- To create plastic-free campus and evolve health consciousness among the stakeholder.
- Recognize the cost-saving methods through waste minimizing and managing.
- Authenticate conformity with the implemented laws.
- Empower the organizations to frame a better environmental performance.
- Enhance the alertness for environmental guidelines and duties
- Impart environmental education through systematic environmental management approach and Improving environmental standards
- Benchmarking for environmental protection initiatives
- Financial savings through a reduction in resource use
- Development of ownership, personal and social responsibility for the University and its environment
- Developing an environmental ethics and value systems in youngsters.
- Green auditing should become a valuable tool in the management and monitoring of environmental and sustainable development programs of the University.
- Finally, it will help to build a positive impression through green initiatives for the upcoming NAAC visit.

1.7 Introduction of Auditing Firm

M/s. Audittech is an empaneled Accredited Energy Audit Firm from the Bureau of Energy Efficiency, Ministry of Power, Government of India. It is one of the fast-growing Energy Audit & Energy services providing company executed several projects covering all the energy Intensive Sectors & states of India. The directors and associate team members are very well experienced in the field of Energy Audit and executed more than 100 no's Detailed Energy Audit & More than 10 No's of Green Audit so far. The associate team and experts are highly qualified and experienced in the field of Energy Audit and Services. Individual credential of each member in the field of Energy Audit is very rich due to their past association with the very reputed organization of Energy Audit Services. The company has Head office at Balod (C.G.) & Branch offices at Raipur, Durg, Bhopal, Mumbai, and Delhi.

Name of Firm	Audittech Industrial Services Private Limited
Address	C/o Aashish Bafna, Opp Mahavir Bhawan, Tikra Para, Balod, Chhattisgarh- 491226
Contact details	9827143100 / 8103651115 Email id: info@audittech.co.in

Directors Details

Sr. No.	Name	esignation / Technical Experience	Technical Experience /Qualification
1	Mr. Aashish Bafna	Managing Director – 11 yrs	B.E (E&I). , MBA(Energy Management), Certified Energy Auditor, Surveyor & Loss Assessor
2	Mr. Rakesh Khichariya	Director- 27 Yrs	(Elect.)., Accredited Energy Auditor
3	Mr. Ramesh Patel	Director- 27 Yrs	B.E.(Mech), Government approved Valuer, Competent Person for Factory Act
4	Mr. Isshant Chainani	Director- 11 Yrs	B.E. (Elect & telecom)
5	Mrs. Shikha Golchha	Director- 10 yrs	B.E., MBA (Finance)

M/s. Audittech Recognized as "Startup" from Department of Promotion of Industry and Internal Trade, Ministry of Commerce & Industry, Government of India and also Registered in Ministry of Micro, Small & Medium Enterprises (MSME) as Micro unit.

Energy audit team

The energy audit team involved in the energy audit of Dibrugarh University, Assam details are in the following.

SN	Name	Designation/ Qualification	Experience	Contact Details
1	Mr. Rakesh Khichariya	Accredited Energy Auditor (AEA-0295)	25 yrs.	9827411444
2	Mr. Aashish Bafna	Certified Energy Auditor (EA-28916)	10 yrs.	9827143100
3	Mr. SK Pathak	Sr. Energy Consultant (AIME-ELECTRICAL)	38 yrs.	9407981067
4	Mr. Mahaveer Bafna	Energy Engineer	4 yrs.	8962369293
5.	Mr. Chandra Prakash	Energy Engineer	4 Yrs.	8817255897
6.	Mr. Mirza Kamran Baig	Energy Engineer	2 Yrs.	7000090120
7	Mr. Tukeshwar Yadav	Energy Engineer	1 Yrs.	6260777416

List of Instruments

Following are the instrument used at the time of the Energy Audit.

Sr.No.	Instrument	Make/Sr.No.
1	Power & Harmonics Analyzer, 1 Set (With CT, PT) HT	Krykard ALM 31/ 123673RCH
2	Power & Harmonics Analyzer, 1 Set (With CT, PT) HT	Krykard ALM 20/ 28107280
3	Temperature gun 1 Set (infrared Thermometer)	MECO 550 T/ IRT550T_17120136
4	Lux Meter 1Set (Digital Lux Meter)	MECO G 930P/201704004601
5	Ultrasonic Flow Meter	Chinese/ 28107280

1.8 About Dibrugarh University

Dibrugarh University was established by an Act of Parliament in 1965. The objective of this Central University as envisaged in the statutes are that it shall strive to offer employment oriented and interdisciplinary courses to meet the local and regional aspirations and the development needs of the state of Assam and also offer courses and promote research in areas which are of special and direct relevance to the region and in emerging areas in Science and Technology.

The present location of University is at Rajabheta, a suburb, which is about 5.5 km (3.4 mi) south of Dibrugarh town, with an area totaling 2023428 m2 (500 acres). Dibrugarh is an urban area surrounded by people of diverse caste, religions, and languages. The campus is bounded by pucca walls. Dibrugarh University is linked by a PWD road from the National Highway No. 15. Dibrugarh is linked by road and rail with the rest of the state and the country. There is a tri-weekly train Kamrup express between Kolkata and Dibrugarh.

Over the years, it has steadily evolved itself as one of the leading centers of comprehensive learning with its exposure to and linkages with its peers at national and international levels. With its state-of-the-art infrastructure, well-equipped laboratories, and highly qualified and dedicated faculty, the University is committed to the task of harnessing and cultivating the capabilities of young students with a view to enabling them to carve suitable space for themselves in the modern economic world. During the last few years' plan, the introduction of many learning courses keeping in pace with the changing demands of the society and also for human resources development was planned. Now, there are various schools including the School of Engineering, School of Humanities & Social Sciences, School of Management Sciences, and School of Sciences comprises 32 academic departments equipped with more than 40 job-oriented courses along with approximately 4500 students on the campus. There are 280 faculties on the University Campus. There is a separate cell for Student welfare, Research & Development, and the Centre for Distance and Online Education. The University Building Campus is categorized mainly into 4 Building Blocks. The details of all departments are mentioned in the below table of Buildings:

- Academic Buildings
- Facilities Buildings
- Hostel Buildings
- Residential Buildings

1.8.1 Campus Building & Departments

Name of the Building Blocks and their coding	
Academic Buildings	
Building / Blocks	Name of the Departments
Departments	Department of Anthropology
	Department of Applied Geology
	Department of Assamese
	Department of Chemistry
	Department of Commerce
	Department of Economics
	Department of Education
	Department of English
	Department of History
	Department of Life Sciences
	Department of Mathematics
	Department of Petroleum Technology
	Department of Pharmaceutical Sciences
	Department of Physics and Centre for Studies in Atmospheric Studies
	Department of Political Science
	Department of Sociology
	Department of Statistics
Centers	Centre for Computer Science and Applications
	Centre for Juridical Studies
	Centre for Library and Information Science
	Centre for Management Studies
	Centre for Social Works Studies
	Centre for Studies in Biotechnology and Bioinformatics
	Centre for Studies in DUIET
	Centre for Studies in Behavioral Sciences
	Centre for Studies in Applied Psychology
	Centre for Studies in Geography
	Centre for Studies in Journalism and Mass Communication
	Centre for Studies in Languages
	Centre for Studies in Philosophy
	Centre for Studies in Physical Education and Sports
	Centre for Tea and Agro Studies
	Centre for Women's Studies
	Dr. Bhupen Hazarika Centre for Studies in Performing Arts

Facilities	
Facilities	Sophisticated Analytical Instrumentation Centre
	Engineering Workshop
	Water Pumping and Treatment Facility
	Vishranta- Guest House
	Central Library
	Administrative Building
	Health Care Center
	Hitendranath Barua Science and Culture Park
	Auditorium
	Indira Miri Conference Hall
	Student Activity Center
	Canteen, Shopping Complex
	Teaching and Learning Center
Hostels	
Boys Hostel	Padmanath Gohain Baruah Chatra Hostel
	Mafijuddin Ahmed Hazarika Chatra Nivas
	Boys Hostel for Professional Courses
	Leela Gogoi Memorial Gobeshak Chatra Nivas
	DUIET hostel- I
	DUIET hostel- II
	Maniram Dewan Chatra Niwas
Girls Hostel	Jyomati Chatri Nivas
	Nalinibala Devi Chatri Nivas
	Aideo Handique Chatri Nivas
	New Girls Hostel
	Girls Hostel for Professional Courses (Pushpalata Das Chatri Nivas)
	Aideo Handique Chatri Nivas (New extende)
	Padmakumari Gohain Women's Hostel
	Swarnalata Baruah Chatri Nivas
	MRGCN
International Hostel	International Hostel- I
	International Hostel- II

The University has also adopted the 'Green Campus' system for environmental conservation and sustainability. The 'Green Campus' has been active for the last several years as an assembly group of sub committees along with the Horticulture section that actively promotes the various projects. The University administration works on several activities for 'Green Campus' including Renewable Energy, Water Conservation, Tree Plantation, Waste Management, Paperless Work, etc.

1.8.2 Campus Infrastructure

Dibrugarh University has a very good and systematic building infrastructure. All classrooms are fully ventilated and comfortable. The University from the outside looks great and is quite unique keeping the architecture of other universities in mind. The University has also an interesting historical legacy which is interesting to learn about.

Presently, it is one of the premier educational institutions of the country encompassing a vast, beautiful, and pollution-free campus which sprawls over 500 acres of land having vast playgrounds and experimental fields, botanical garden, ornamental and fruits garden with Indoor Stadium, well equipped Central Library, hostels for both girls and boys, Administrative Block, Spacious Auditorium, Guest House, Computer Center, Health Center, Food Quality Control Laboratory, Horticulture Section, Residential Quarters for faculty members and employees, Canteen and Bank. The teaching department belonging to different faculties, are housed in spacious buildings and have well-equipped laboratories and advanced facilities.

The University Campus is itself is a combination of all standards and amenities required as far as great educational infrastructure is concerned such as Bank, School, Health Centre, etc. Hitendranath Borua Science and Culture Park, Badminton Court, Computer Centers are the center of attraction. The Central library has a large number of books to issue or read in the library itself. There is ample sitting space also available. Students can get Internet access at the library and power back up. University has provided a Wi-Fi facility to all students and residential blocks. The University Campus also has a book bank facility that enables students to use the books, for the entire academic session and the computer laboratories have access to advance web activity with its subscription to E-resources through a digital Network that links students and researchers to the databases required for research. There are total 7 boys hostel and 9 girls hostels. University has facilities for both outdoor and indoor games. The campus also has sports facilities which include a well-maintained Cricket ground, football ground, and basketball court. Students also use this platform for their cultural competitions etc. Very beautiful auditorium i.e. Rangghar is available for seminars and conferences on the University Campus. University has a dedicated health center building with all the necessary first aid facilities. The existing facilities are continuously upgrading and improving.

1.8.3 Dibrugarh University – Campus Highlights

1.8.3.1 Internal Quality Assurance Cell

The campus has a dedicated IQAC that takes care of all green activities including plantation, maintenance of the botanical garden, nursery, areas of all department buildings, and new plantations in the campus. This section plays a major role to make the campus Green and Environment friendly. The entire green activities in the campus are managed by the Internal Quality Assurance Cell under the monitoring and guidance of The Vice Chancellor (Chairperson), Prof. Kalyan Bhuyan (Director, IQAC) and other members.

1.8.3.2 Hitendranath Barua Science and Culture Park

The campus has a very vast and beautiful Science and Culture Park. There is a park in about 38 bighas of land within the University campus. It is an education cum recreational park with various types of scientific models which are great representation of what is studied in science. There is a great representation of various dance forms and various ethnicity of northeast India. The park is now becoming a point of attraction for the inhabitants of the campus as well as visitors.

Different Infrastructure of the Garden

- Various science models
- A house representation
- A small pond with a boat.
- Boundary of pucca walls
- Concrete approach road and the inside track
- There are different plant species available in the garden.

Hitendranath Barua Science and Culture Park

Boys Hostel

Tea Garden

Campus Path Way

Girls Hostel

Guest House

Rangghar

Department of Chemistry

Centre for Management Studies

Department of Physics

Lakshminath Bezbaroa Library

Botanical Garden

A small dense forest under department of Life Sciences

There is a dense forest inside the campus under the department of life sciences. Various work is conducted in this forest under the department. Basically, the forest is a workshop for the students of life sciences department.



2. GREEN AUDIT METHODOLOGY

2.1 Pre-Audit Stage

A pre-audit meeting provided an opportunity to reinforce the scope and objectives of the audit and pre-audit discussions were held on the basis of green initiatives taken and the current scenario of the University campus. This meeting is an important prerequisite for the green audit because it is the first opportunity to understand the concerns. It was conducted with the concerned authorities of the University regarding initiatives taken by the University and also about the previously conducted audit by the University. The meeting was an opportunity to gather the information that the audit team can study before arriving on the site. The audit protocol and audit plan were handed over at this meeting and discussed in advance. After successfully conducting the pre-audit meeting, the necessary documents were collected directly from the concerned authorities before commencing the audit processes. The actual planning of audit processes was discussed in the pre-audit meeting. An Audit team was also selected in this meeting with the help of staff and the University management.

2.2 Management Commitment

The Management of the University has shown a commitment towards green auditing during the pre-audit meeting. They were ready to encourage all green activities. It was decided to promote all activities that are environmentally friendly such as awareness programs on the environment, campus farming, plantation of more trees on the campus, etc., after the green auditing. The management of the University was willing to formulate policies based on a green auditing report.

2.3 Objectives of the study

A clean and healthy environment is very important for effective learning as it provides a conducive learning environment. There are various efforts available to address environmental education issues. Green Audit is the most efficient and ecological way to manage environmental problems. It is a kind of professional care that is the responsibility of each individual who is part of economic, financial, social, environmental factors. It is necessary to conduct a green audit on a University campus because students become aware of the green audit, its advantages to saving the planet and they become social and responsible citizens of our country. Thus Green audit becomes necessary at the university level. The broad objectives are as follows.

- Diagnosing the environmental problems to eliminate them.

- Environmental education through a systematic environmental management approach.
- Improving environmental standards.
- Benchmarking for environmental protection initiatives.
- Efficient utilization of resources.
- Financial savings through a reduction in resource use.
- Curriculum enrichment through practical experience.
- Development of ownership, personal and social responsibility for the University and its environment.
- Developing environmental ethics and value systems in young people.
- Providing certain recommendations based on environmental audit reports.
- Ensuring compliance, not only with laws, regulations, and standards but also with company policies and the requirements of an Environmental Management System (EMS) standard.
- Enabling environmental problems and risks to be anticipated.
- To demonstrate that University is aware of its impact upon the environment.

2.4 Audit Stage

Green Audit was done with the help of co-associates involving different student groups, teaching and non-teaching staffs. The green audit commenced with the teams visiting different facilities at the University, to identify different types of appliances and utilities as well as measuring their utility (Watts indicated on the appliance or measuring water from a tap) and identifying the relevant consumption patterns (such as how often an appliance is used) and their impacts. The staff and learners were interviewed to get details of usage, frequency, or general characteristics of certain appliances. Data collection was done in the sectors such as Energy, Waste, Green Area, Carbon footprint, and Water use. University records and documents were verified to validate the data received through surveys and discussions.

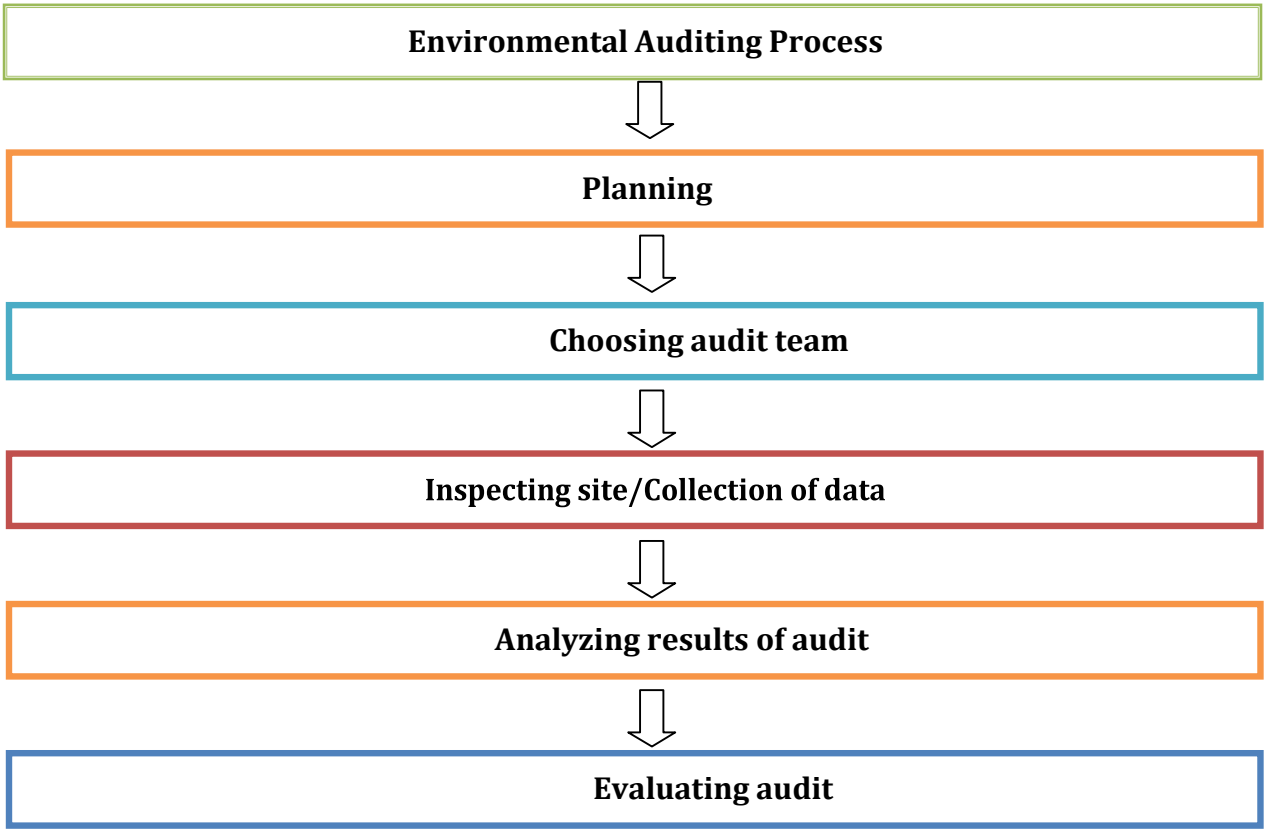
2.5 Methodology

The Management of the University has shown a commitment towards green auditing during the pre-audit meeting. They were ready to encourage all green activities. It was decided to promote all activities that are environmentally friendly such as awareness programs on the environment, campus farming, planting more trees on the campus, etc., after the green auditing. The management of the University was willing to formulate policies based on a green auditing report. In order to perform green audits, the methodology included different tools such as preparation of questionnaires, physical inspection of the campus, observation, and review of the documentation, interviewing key persons, and data analysis, measurements, and recommendations. The study covered the following areas to summarize the present status of environmental management on the campus:

- Energy Management
- Water Management
- Waste Management
- Environment Management

Methodology – Step by Step

The audit process was carried out in three phases. At first, all the secondary data required for the study was collected from various sources, like concerned departments such as engineering cell, Internal Quality Assurance Cell, Department of Physics, etc. A broad reference work was carried out to clear the idea of green auditing. Different case studies and methodologies were studied and the following methodology was adopted for the present audit. The methodology of the present study is based on onsite visits, personal observations, and questionnaires survey tools. Initially, based on data requirements, sets of questionnaires were prepared. The surveyors then visited all the departments of the university and the questionnaires were filled. The generated data is subsequently gathered and used for further analysis. From the outcome of the overall study, a final report is prepared.



2.5.1 Survey by Questionnaire

Baseline data for green audit report preparation was collected by questionnaire survey method. Questionnaires were prepared to conduct the green audit in the university campus based on the guidelines, rules, acts, and formats prepared by the Ministry of Environment, Forest and Climate Change, New Delhi, Central Pollution Control Board, and other statutory organizations. Most of the guidelines and formats are based on broad aspects and some of the issues or formats were not applicable for the University campus. Therefore, using these guidelines and formats, combinations, modifications, and restructuring were done and sets of questionnaires were prepared for solid waste, energy, water, hazardous waste, and e-waste data.

All the questionnaires consists of a group of modules. The first module is related to the general information of the concerned department, which comprises of the name of the department, month and year, the total number of students and employees, visitors of the department, average working days and office timings, etc. The next module is related to the present consumption of resources like water, energy, or the handling of solid and hazardous waste. Maintaining records of the handling of solid and hazardous waste is much important in green audits. There are possibilities of loss of resources like

water, energy due to improper maintenance, and assessment of this kind of probability is necessary for the green audit. One separate module is based on the questions related to this aspect. Another module is related to maintaining records, like records of disposal of solid waste, records of solid waste recovery, etc. For better convenience of the surveyor, some statistics like basic energy consumption characteristics for electrical equipment, etc. were provided with the questionnaires.

2.5.2 Onsite visit and observations

Dibrugarh University has a vast built-up area comprising various departments under various academic buildings, teachers and staff quarters, many facilities including Academic Buildings, Guest House, Health Centre, Council hall, Auditorium, other facilities and separate men's and women's hostels. All these amenities have different kinds of infrastructure as per their requirement. All these buildings were visited by the surveyors and the present condition is checked with the help of the questionnaires. Personal observations were made during the onsite visit. All the amenities were clubbed in, as per their similarities and differences, which makes the survey and further analysis easier. For the data compilation purpose, the University Departments and support services were clubbed into Three Types of Buildings and given names as academic buildings, Facilities Buildings, and Hostel Buildings. The details of the Buildings are as follows:

Sr. No.	Name of the Buildings
1.	Academic Buildings
2.	Facilities Buildings
3.	Hostel Buildings

After the collection of secondary data, the reviews related to each environmental factor were taken by the green audit team. The data were tabulated, analyzed and graphs were prepared. Depending upon the observations and data collected, interpretations were made. The lacunas and good practices were documented. The Environmental Management Plan (EMP) was prepared for the next academic year in order to have better environmental sensitization. Finally, all the information was compiled in the form of the Green Audit Report.

2.5.3 Data analysis and final report preparation

Proper analysis and presentation of data is a vital element. In the case of a green audit, the filled questionnaires of the survey from each group were tabulated as per their modules, in Excel spreadsheets. The tabulated data is then used for further analysis. For a better understanding of the results and to avoid complications, averages, and percentages of the tables were calculated. A graphical representation of these results was prepared to have a quick look at the present scenario. Interpretation of the overall outcomes was made after incorporating all the primary and secondary data, references, and interrelations within. Final report preparation was done using this interpretation.

3. WATER & WASTE WATER AUDIT

Water is a precious natural national resource available with a fixed quantum. The availability of water is decreasing due to the increasing population of the nation; as per capita availability of utilized water is going down. Due to the ever-rising standard of living of people, industrialization, urbanization, demand for freshwater is increasing day by day. The unabated discharge of industrial effluent in the available water bodies is reducing the quality of these ample sources of water continuously. Hence, the national mission on water conservation was declared by the Honorable Prime Minister Narendra Modi as 'Jal Shakti Abhiyan' and appealed to all citizens to collectively address the problem of water shortage, by conserving every drop of water and suggesting conducting water audits for all sectors of water use. Water audit can be defined as a qualitative and quantitative analysis of water consumption to identify means of reducing, reusing, and recycling water. Water Audit is nothing but an effective measure for minimizing losses, optimizing various uses, and thus enabling considerable conservation of water in the irrigation sector, domestic, power, and industrial sectors. A water audit is a technique or method which makes it possible to identify ways of conserving water by determining any inefficiency in the system of water distribution. The measurement of water losses due to different uses in the system or any utility is essential to implement water conservation measures in such an establishment.

3.1 Importance of Water Audit

- Systematic process
- May yield some surprising results
- Easier to work on solutions when the problems are identified.
- Attracting mechanism can be put into place.
- It is observed that a number of factors like climate, culture, food habits, work and working conditions, level and type of development, and physiology determine the requirement of water. The community which has a population between 20,000 to 1, 00,000 requires 100 to 150 liters per person (capita) per day. The communities with a population over 1, 00,000 require 150 to 200 liters per person (capita) per day. As per the standards provided by WHO Regional Office for Southeast Asia Schools require 2 liters of water per student for drinking purposes; 10-15 liters per student for Water-flush toilets. Administration requires (Staff Accommodation not included) 50 liters per person per day.

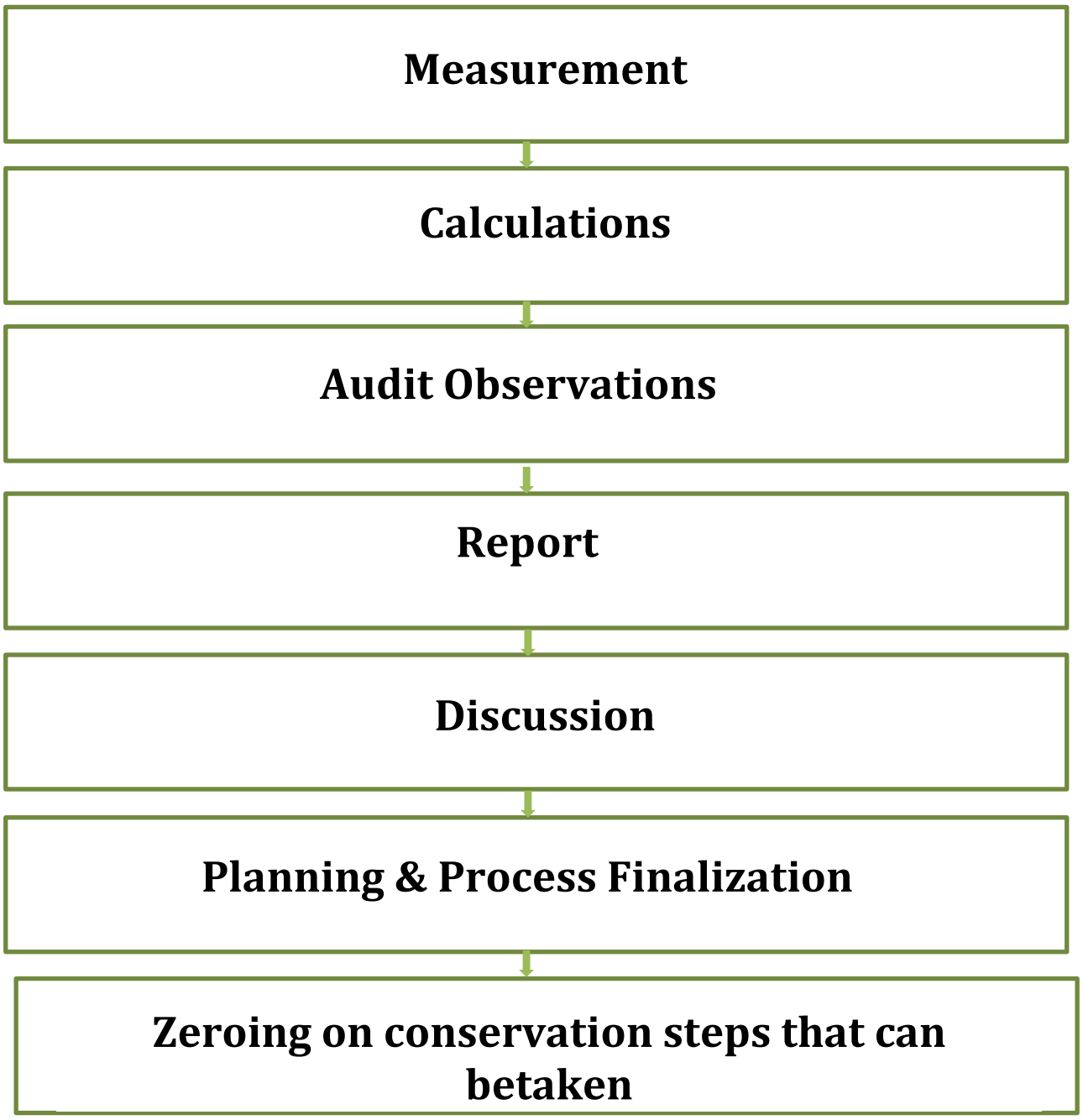
3.2 Water Audit

Water usage can be defined as water used for all activities which are carried out on campus from different water sources. This includes usage in all residential halls, academic buildings, on-campus, and on-grounds. Wastewater is referred to as the water which is transported off the campus. The wastewater includes sewerage, residence water used in cooking, showering, clothes washing as well as wastewater from chemical and biological laboratories which ultimately go down in the sink or drainage system.

University water resources

The major resource for the water in the university is a self-reliant water boring system installed on the campus. There are Ground Water Tube wells installed on the campus with 11x1.5 HP and 4x10 HP, 3x2 HP, 1x3.5 HP, 2x7.5 HP, 1x2.5 HP, 2x3 HP, 4x1 HP, 3x0.5 HP which operate to fill the 2 overhead tanks and various individual tanks on other buildings. To fulfill the need for the supply of the campus, overhead storage tanks are available with capacity (1x 10000 Litres and 1x 20000 Litres). Total Water Resource Capacity of the University is 403385 litres.

Total consumption of the campus is approx. 720 kilo litres per day. Hence total approx. 160 Litres per day per head is used for Bathroom, Toilet, Garden, Urinals, Shower, Drinking, and Laboratories etc.



Water Audit Methodology & Steps

3.3 Sustainable Water Practices Watershed Management Practices

Dibrugarh University has ample amount of water as the ground water is sufficiently available because of high amount of rainfall in the area. Therefore, there are no water conservation and water management practices like rainwater harvesting systems are available.

Observation:

1. Water in the university is directly drained without any treatment or recycling.
2. No water conservation/management practices.

Recommendations:

1. Waste Water Filtration Tank to be installed as enormous amount of water is available.
2. Rain water-harvesting system to be implemented.
3. Filling of Water tank should be done during off peak time to save energy & Electricity Bill Cost.
4. Use of BEE star rated Energy Efficient Pumps in place of old & inefficient Pumps.
5. Water efficient plumbing fixtures can be used in toilets etc.

4. ENERGY AUDIT

Energy is one of the major inputs for the economic development of any country. The fundamental goal of energy management is to produce goods and provide services with minimal cost and least environmental effect. Also, it can be said as "the strategy of adjusting and optimizing energy, using system and procedure so as to reduce energy requirements per unit of output while holding constant or reducing total costs producing the output from these systems". The energy audit is key to a systematic approach for decision-making in the area of energy management. It attempts to balance the total energy inputs with its use and assist to identify all the energy streams in a facility.

4.1 Energy Audit

Energy resources utilized by all the departments, support services, and the administrative buildings of Dibrugarh University, include Electricity, Solar Roof Top Systems, and Diesel Generators installed on the campus.

4.1.1 Energy Audit Objectives

Primary

- The first objective is to acquire and analyze data and find the necessary consumption pattern of these facilities.
- The second objective is to calculate the wastage pattern based on the results of the first objective.
- The final objective is to determine and implement solutions that are acceptable and feasible.

Secondary

- This would be our first exposure to this field hence experience gain would be vital.
- This project will precede many follow up projects and hence helps to gain technical and management exposure required for future energy projects.
- It is sure to help create a repertoire of vital contacts hence will develop interaction with alumni, faculty and students.

4.2 Sources of Energy

Dibrugarh University, Assam withdraws Energy from Followings:

a. Electricity from APDCL

b. High Speed Diesel (High Speed Diesel used as a fuel for Diesel Generator which is run whenever power supply is not available and for transportation)

c. Solar Energy (not functioning during audit)

The Following are the Major consumers of electricity in the facility

- Lightning
- Air Conditioner
- Fans
- Computers
- Other Lab Equipment
- Bore well pumps

Indirect Benefits of Energy Audit

Every time the Energy Audit is carried out it rekindles the interest in Energy Conservation as an important function. Energy Auditors sharing their experience and knowledge with the Plant Personnel helps in fueling the innovative ideas for further action of reduction in Specific Power consumption (SPC). Any loose connections or heating of cables come to timely vision. For an external agency due to unbiased vision, few points for Energy Conservation may be visible each time they perform the audit and this would help in achieving further saving. Inform any irregularities in Energy meter HT connections for rectification.

Executive Summary

EXECUTIVE SUMMARY
Dibrugarh University

SN.	*Energy saving measures*	*Investment Rs.lakh.*	*Electricity Savings (kWh)*	*Cost saving /year (Rs. Lakh)*	*Payback Period (Year)*
		1	**2**	4	5
A	**INVESTMENT**				
1	Reduction of Contract Demand 428 KVA to 300 KVA to reduce the unnecessary demand charges for Consumer No. 210000001305	Nil		1.99	Immediate
2	Reduction of Contract Demand 287 KVA to 150 KVA to reduce the unnecessary demand charges for Consumer No. 210000001069	Nil		2.13	Immediate
3	Reduction of Contract Demand 453 KVA to 250 KVA to reduce the unnecessary demand charges for Consumer No. 210000001306	Nil		3.16	Immediate
4	Reduction of Contract Demand 210 KVA to 130 KVA to reduce the unnecessary demand charges for Consumer No. 210000000468	Nil		1.24	Immediate
5	Reduction of Contract Demand 688 KVA to 450 KVA to reduce the unnecessary demand charges for Consumer No. 210000000467	Nil		3.71	Immediate
6	Replacement of 100 W ceiling fans with energy efficient BLDC fan, in phase wise manner.	91.00	531440.00	34.27	2.66
	Total	**91.00**	**0.00**	**46.5**	**1.96**

4.3 Electricity Billing (transformer wise)

Electricity Bill Summary for the year 2021-2022 are as follows.

4.3.1 Energy Consumption details for Consumer number: 210000001305

Table 4.3.1 Energy Consumption details for Consumer number: 210000001305

ELECTRICITY CONSUMPTION DETAILS for Year 2021-2022						
BILL MONTH	Consumption Unit (kWh)	Contract demand (kVA)	Actual demand (kVA)	Bill amount (Rs.)	Power Factor	Unit Cost (In Rs./KW)
Apr-21	37333.36	428	138	310462	0.98	6.45
May-21	38447.89	428	118	319931	0.98	6.45
Jun-21	45810.68	428	145.5	367875	0.985	6.45
Jul-21	50973.5	428	162	410279	0.985	6.45
Aug-21	52162.24	428	143.5	412811	0.987	6.45
Sep-21	59574.97	428	155.5	467279	0.985	6.45
Oct-21	48158.07	428	132.5	385693	0.98	6.45
Nov-21	39818.5	428	141.5	327292	0.98	6.45
Dec-21	47064.4	428	132.5	383191	0.98	6.45
Jan-22	47573.65	428	132.5	329713	0.98	6.45
Feb-22	49869.64	428	128	391522	0.989	6.45
Mar-22	40728.36	428	133.5	335375	0.98	6.45
Total	**557515.26**	**-**	**-**	**4441423**	**-**	**-**
Average	**46459.605**	**428**	**138.58**	**370118.6**	**0.9826**	**6.45**
Max	**59574.97**	**428**	**155.5**	**467279**	**0.989**	**6.45**
Min	**37333.36**	**428**	**118**	**310462**	**0.98**	**6.45**

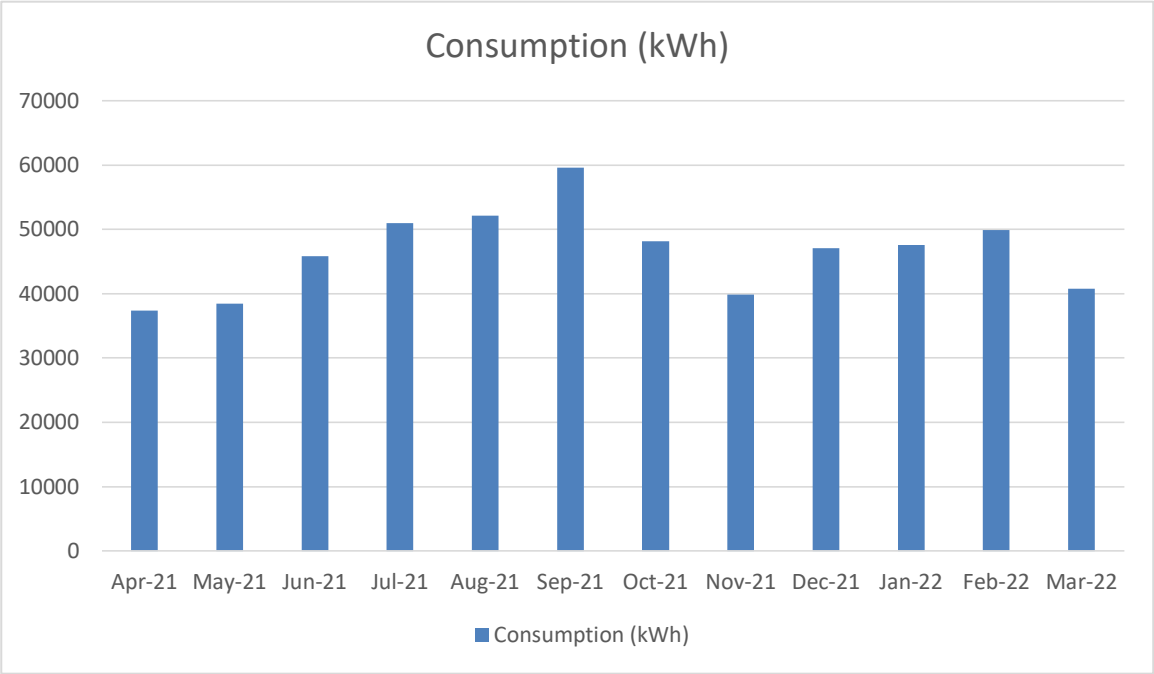
Observation:

The recorded actual demand is in the range of 118 KVA to 155.5 KVA whereas the Maximum Contract Demand is 428 KVA. It is recommended to reduce contract demand till the regular functioning (i.e., full occupancy) of the University.

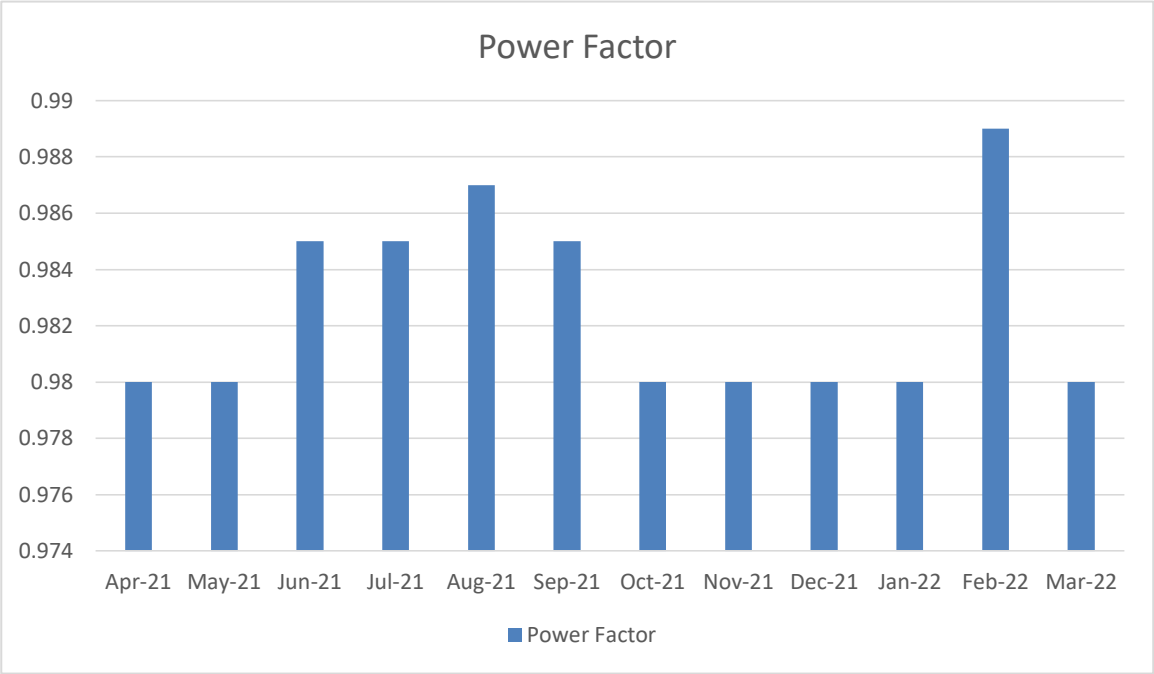
Recommendation

1. It is Recommend to reduce the contract demand from 428 KVA to 300 KVA to reduce the unnecessary demand charges

Graphical Representation of Consumption Unit (kWh)



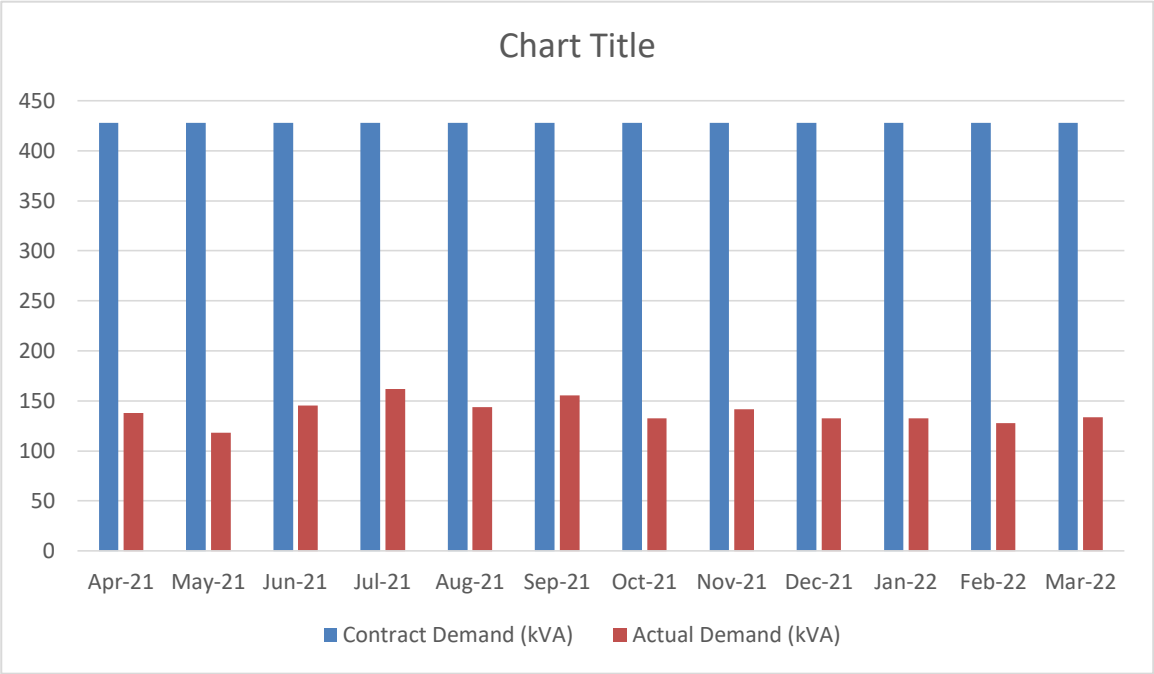
Graphical Representation of Power Factor



Observation

The average Power factor recorded for the year of 2021-22 is 0.982 which is satisfactory.

Graphical Representation of Contract Demand & Actual Demand



Energy Saving Potential

S.No	Particular	UOM	
1	Existing Demand	KVA	428
2	Recommended Reduced Demand	KVA	300
3	Fixed Charges per KVA	Rupees/KVA	130
4	Annual Cost Saving	Rupees	199680
5	Payback Period		Immediate

4.3.2 Energy Consumption details for Consumer number: 210000001069

Table 4.3.2 Energy Consumption details for Consumer number: 210000001069

ELECTRICITY CONSUMPTION DETAILS for Year 2021-2022						
BILL MONTH	Consumption Unit (kWh)	Contract demand (kVA)	Actual demand (kVA)	Bill amount (Rs.)	Power Factor	Unit Cost (In Rs./KW)
Apr-21	16223.25	287	55	116807	0.98	7.2
May-21	12867.4	287	31.5	152561	0.95	7.2
Jun-21	11907	287	32	143517	0.96	7.2
Jul-21	12277.44	287	32	150254	0.94	7.2
Aug-21	15332.1	287	54.6	171194	0.968	7.2
Sep-21	17056.9	287	54.6	185015	0.968	7.2
Oct-21	12697.3	287	42	151275	0.97	7.2
Nov-21	17450.3	287	40.65	185577	0.97	7.2
Dec-21	18703.3	287	44.2	199462	0.958	7.2
Jan-22	14355	287	53.85	120300	0.94	7.2
Feb-22	17790.3	287	59	184428	0.93	7.2
Mar-22	17275.5	287	50.6	185886	0.91	7.2
Total	**183935.79**	**-**	**-**	**1946276**	**-**	**-**
Average	**15327.9825**	**287**	**45.833**	**162189.7**	**0.9537**	**7.2**
Max	**18703.3**	**287**	**59**	**199462**	**0.98**	**7.2**
Min	**11907**	**287**	**31.5**	**116807**	**0.91**	**7.2**

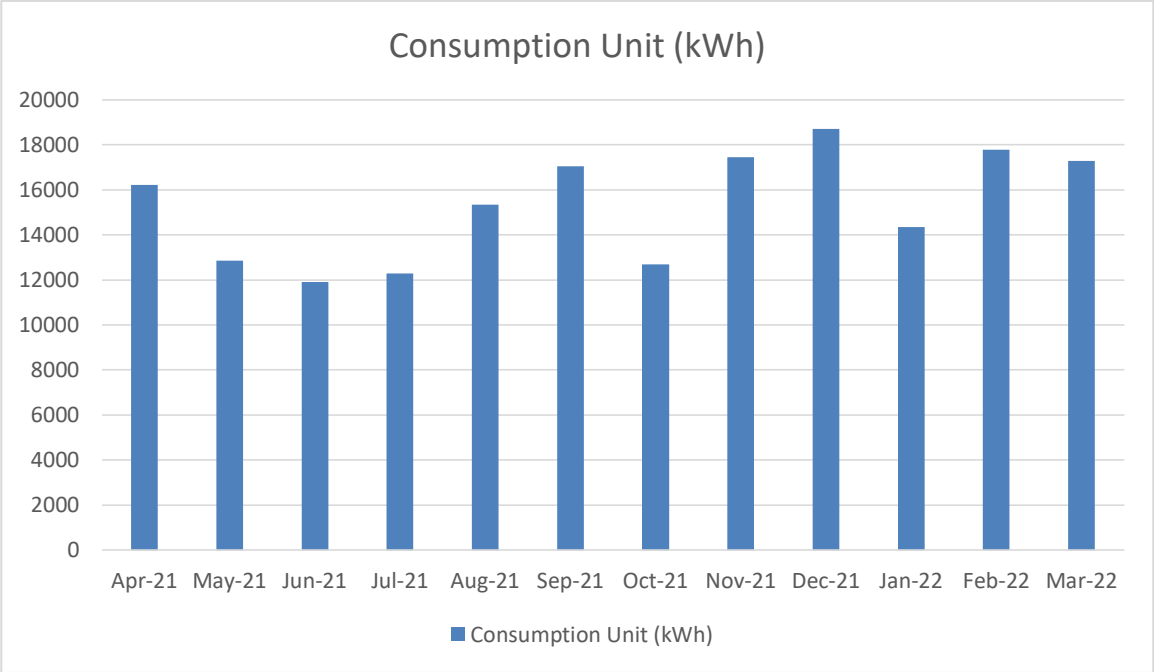
Observation:

The recorded actual demand is in the range of 31.5 KVA to 59 KVA whereas the Maximum Contract Demand is 287 KVA. This is due to the non-occupancy of students due to covid-19 crises period. It is recommended to reduce contract demand till the regular functioning (i.e., full occupancy) of the University.

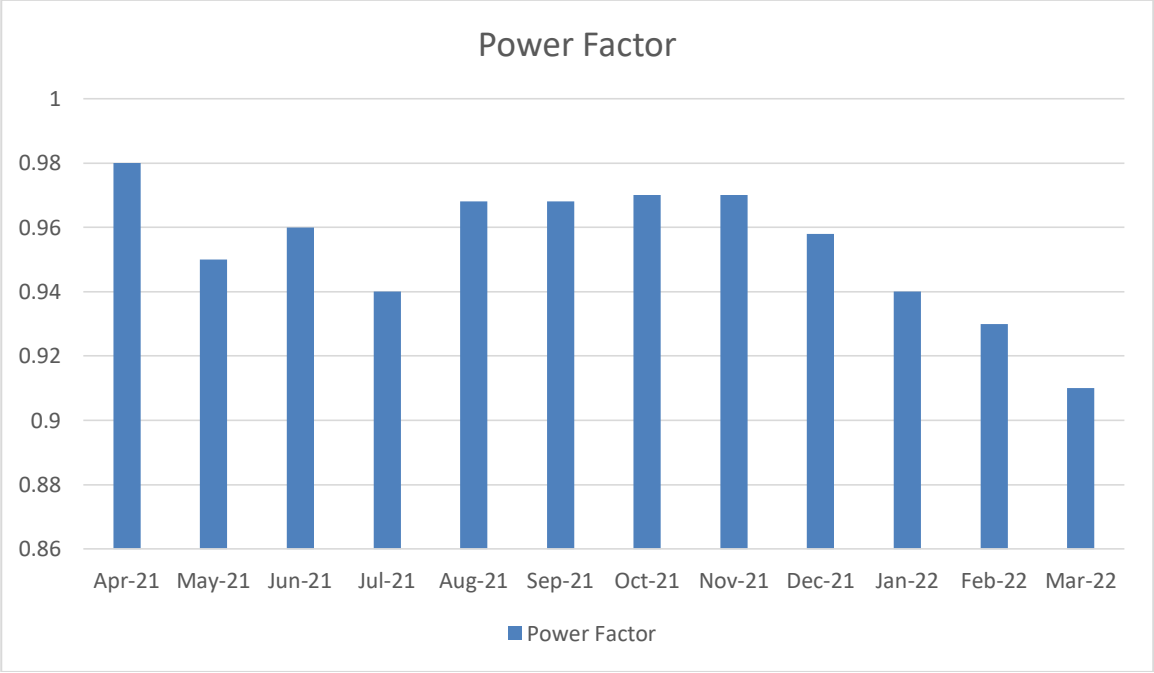
Recommendation

1. It is Recommend to reduce the contract demand from 287 KVA to 150 KVA to reduce the unnecessary demand charges

Graphical Representation of Consumption Unit (kWh)



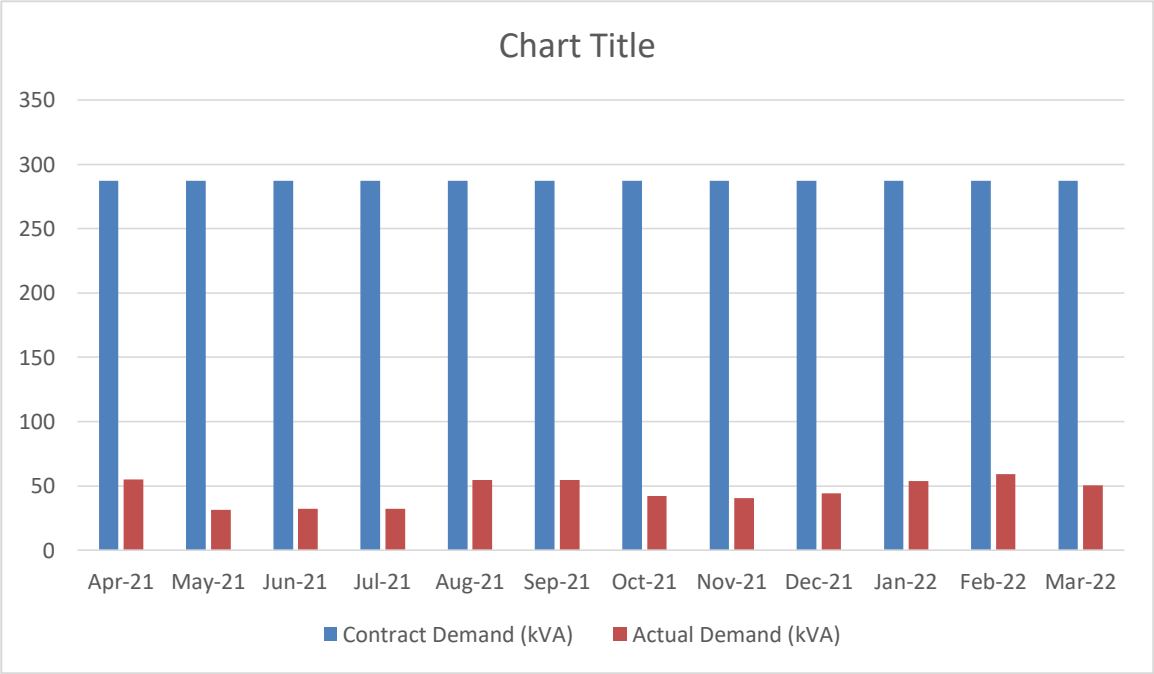
Graphical Representation of Power Factor



Observation:

The average Power factor recorded for the year of 2021-22 is 0.953 which is satisfactory.

Graphical Representation of Contract demand and Actual demand



Energy Saving Potential

S.No	Particular	UOM	
1	Existing Demand	KVA	287
2	Recommended Reduced Demand	KVA	150
3	Fixed Charges per KVA	Rupees/KVA	130
4	Annual Cost Saving	Rupees	213720
5	Payback Period		Immediate

4.3.3 Energy Consumption details for Consumer number: 210000001306

Table 4.3.3 Energy Consumption details for Consumer number: 210000001306

ELECTRICITY CONSUMPTION DETAILS for Year 2021-2022						
BILL MONTH	Consumption Unit (kWh)	Contract demand (kVA)	Actual demand (kVA)	Bill amount (Rs.)	Power Factor	Unit Cost (In Rs./KW)
Apr-21	30424.05	453	92.5	196235.12	0.99	6.45
May-21	18527.49	453	69.5	188498	0.97	6.45
Jun-21	20653.72	453	85.5	200865	0.978	6.45
Jul-21	24264.55	453	102	230365	0.98	6.45
Aug-21	27438.88	453	96	252261	0.985	6.45
Sep-21	33052.26	453	112	288567	0.99	6.45
Oct-21	29321.16	453	97.5	261598	0.987	6.45
Nov-21	33789.46	453	87	289827	0.99	6.45
Dec-21	34249.04	453	87	299315	0.96	6.45
Jan-22	34829.2	453	87	243877	0.96	6.45
Feb-22	21863.8	453	96.5	204994	0.986	6.45
Mar-22	39934.9	453	96.5	333479	0.99	6.45
Total	**348348.51**	**-**	**-**	**2989881**	**-**	**-**
Average	**29029.0425**	**453**	**92.417**	**249156.8**	**0.9805**	**6.45**
Max	**39934.9**	**453**	**112**	**333479**	**0.99**	**6.45**
Min	**18527.49**	**453**	**69.5**	**188498**	**0.96**	**6.45**

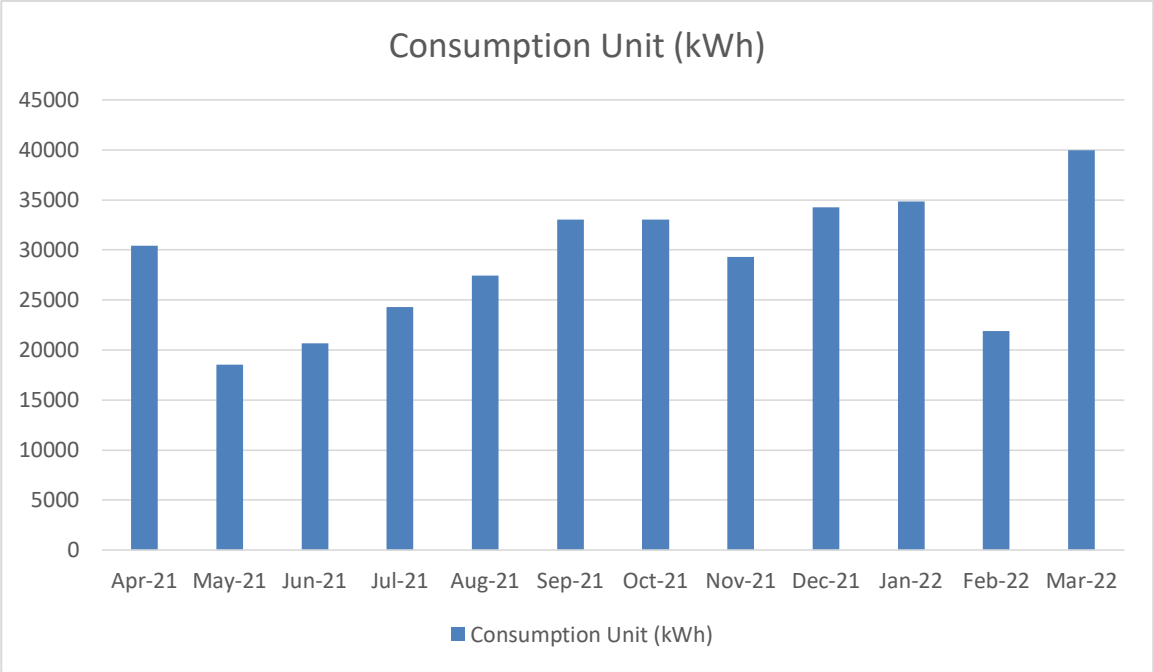
Observation:

The recorded actual demand is in the range of 69.5 KVA to 112 KVA whereas the Maximum Contract Demand is 453 KVA. This is due to the non-occupancy of students because of the covid-19 crises. It is recommended to reduce contract demand till the regular functioning (i.e., full occupancy) of the University.

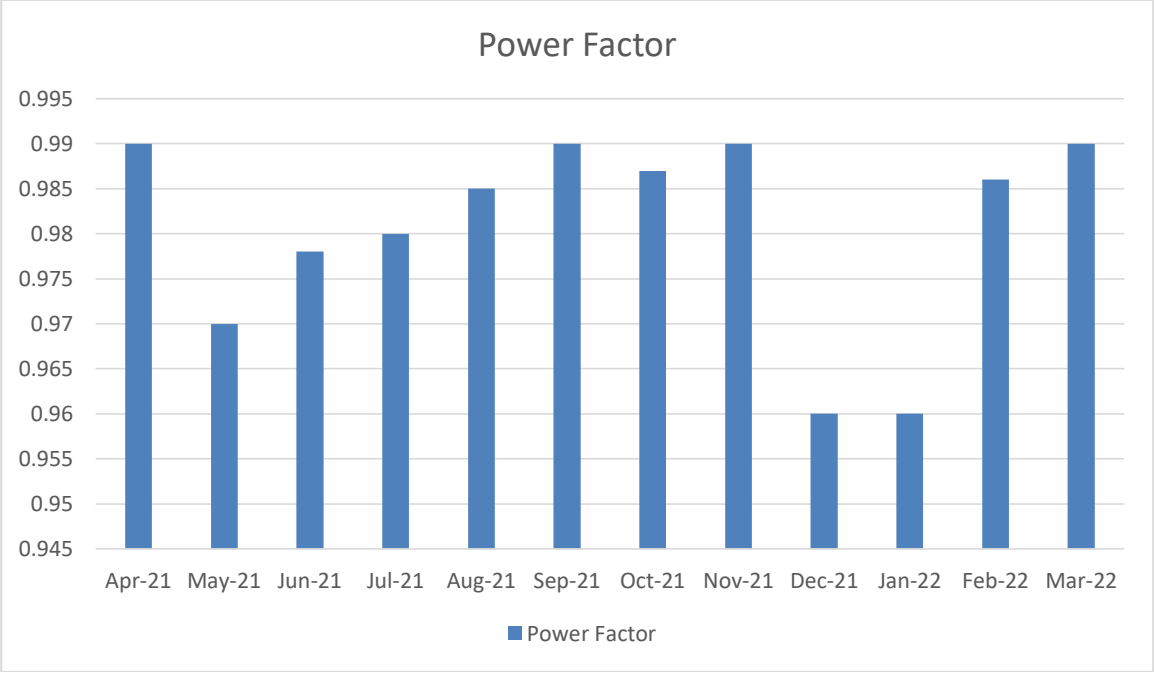
Recommendation

1. It is Recommend to reduce the contract demand from 453 KVA to 250 KVA to reduce the unnecessary demand charges

Graphical Representation of Consumption Unit (kWh)



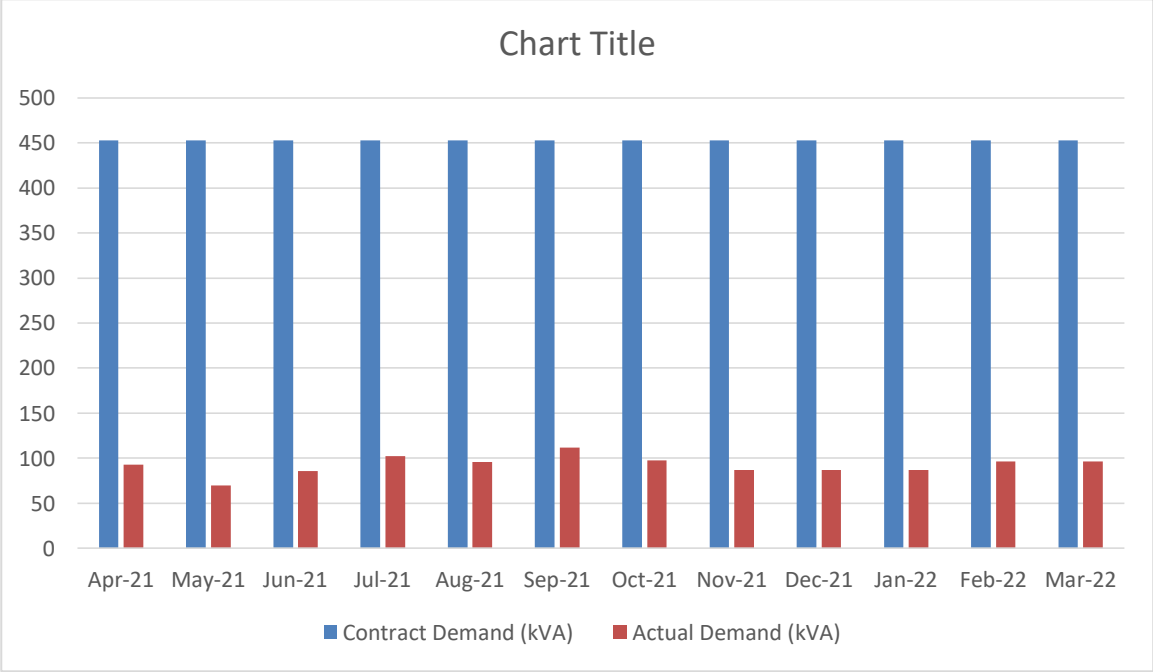
Graphical Representation of Power Factor



Observation:

The average Power factor recorded for the year of 2021-22 is 0.98 which is satisfactory.

Graphical Representation of Contract Demand & Actual Demand



Energy Saving Potential

S.No	Particular	UOM	
1	Existing Demand	KVA	453
2	Recommended Reduced Demand	KVA	250
3	Fixed Charges per KVA	Rupees/KVA	130
4	Annual Cost Saving	Rupees	316680
5	Payback Period		Immediate

Table 4.3.4 Energy Consumption details for Consumer number: 210000000468

ELECTRICITY CONSUMPTION DETAILS for Year 2021-2022						
BILL MONTH	Consumption Unit (kWh)	Contract demand (kVA)	Actual demand (kVA)	Bill amount (Rs.)	Power Factor	Unit Cost (In Rs./KW)
Apr-21	15949.71	210	58.8	102875.63	0.989	6.45
May-21	9421.12	210	28.2	93158	0.97	6.45
Jun-21	9962.39	210	35.4	95877	0.98	6.45
Jul-21	10394.52	210	32.1	101189	0.978	6.45
Aug-21	12207.45	210	40.2	113525	0.98	6.45
Sep-21	14746.42	210	49.5	129958	0.985	6.45
Oct-21	16166.5	210	54.9	138841	0.987	6.45
Nov-21	17813.56	210	76.5	149048	0.978	6.45
Dec-21	19802.55	210	71.1	165700	0.977	6.45
Jan-22	16342.56	210	71.4	76191	0.977	6.45
Feb-22	19377.69	210	79.5	157749	0.98	6.45
Mar-22	20260.88	210	65.1	166571	0.986	6.45
Total	**182445.35**	**-**	**-**	**1490683**	**-**	**-**
Average	**15203.7792**	**210**	**55.225**	**124223.6**	**0.9806**	**6.45**
Max	**20260.88**	**210**	**79.5**	**166571**	**0.989**	**6.45**
Min	**9421.12**	**210**	**28.2**	**76191**	**0.97**	**6.45**

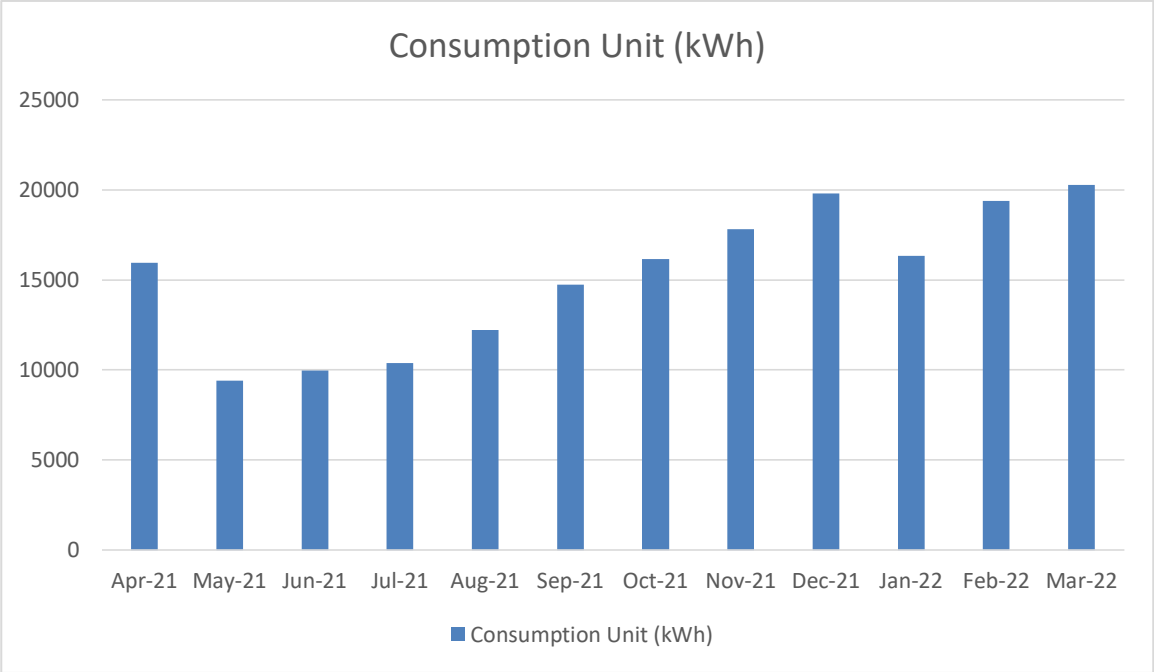
Observation:

The recorded actual demand is in the range of 28.2 KVA to 79.5 KVA whereas the Maximum Contract Demand is 210.59 KVA. This is due to the non-occupancy of students because of the covid-19 crises. It is recommended to reduce contract demand till the regular functioning (i.e., full occupancy) of the University.

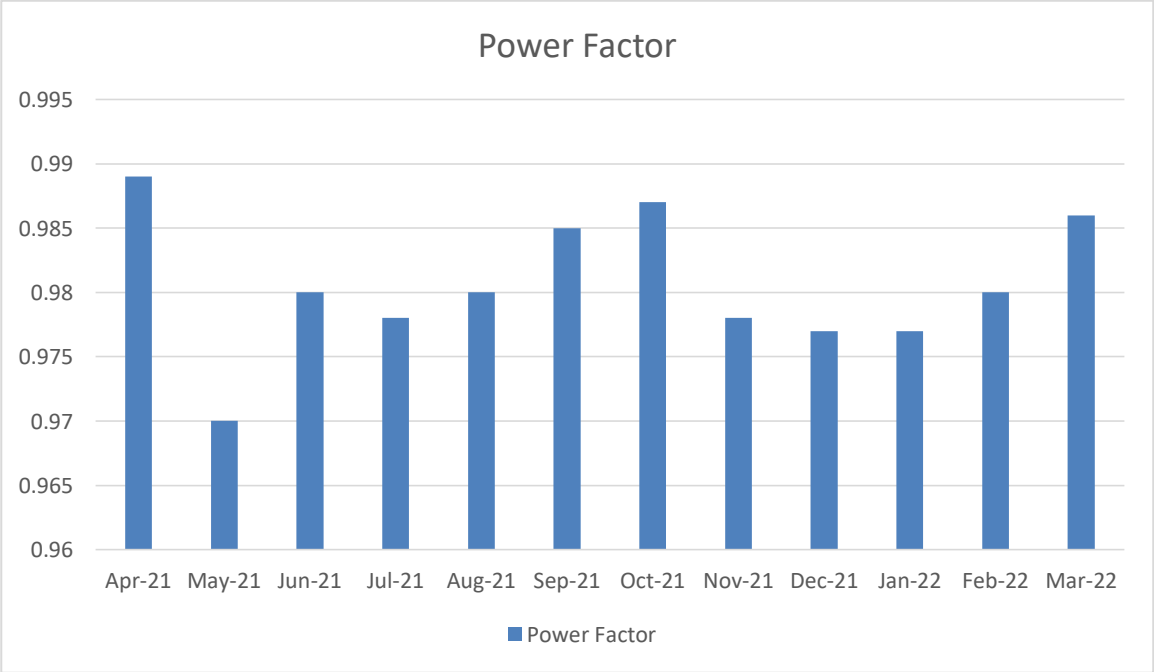
Recommendation

1. It is Recommend to reduce the contract demand from 210 KVA to 130 KVA to reduce the unnecessary demand charges

Graphical Representation of Consumption Unit (kWh)



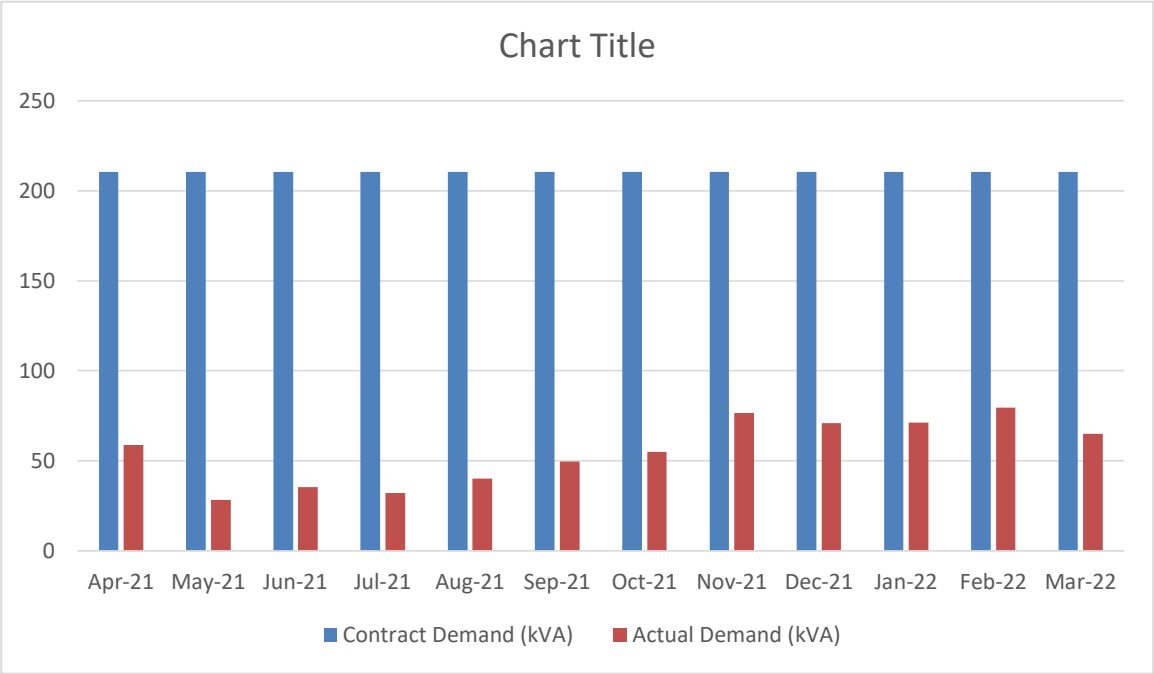
Graphical Representation of Power Factor



Observation:

The average Power factor recorded for the year of 2021-22 is 0.98 which is satisfactory.

Graphical Representation of Contract Demand & Actual Demand



Energy Saving Potential

S.No	Particular	UOM	
1	Existing Demand	KVA	210
2	Recommended Reduced Demand	KVA	130
3	Fixed Charges per KVA	Rupees/KVA	130
4	Annual Cost Saving	Rupees	124800
5	Payback Period		Immediate

4.3.5 Energy Consumption details for Consumer number: 210000000467

ELECTRICITY CONSUMPTION DETAILS for Year 2021-2022						
BILL MONTH	Consumption Unit (kWh)	Contract demand (kVA)	Actual demand (kVA)	Bill amount (Rs.)	Power Factor	Unit Cost (In Rs./KW)
Apr-21	38906.7	688	187	250948.21	0.975	6.45
May-21	32653.6	688	138	316860	0.96	6.45
Jun-21	35721	688	178	334546	0.96	6.45
Jul-21	46432.4	688	208	415195	0.969	6.45
Aug-21	53456.7	688	226	463901	0.97	6.45
Sep-21	64854.2	688	263	538717	0.98	6.45
Oct-21	56395	688	264	477654	0.98	6.45
Nov-21	52477	688	181	448026	0.98	6.45
Dec-21	53815.6	688	169	466892	0.979	6.45
Jan-22	41865.6	688	150	379248	0.97	6.45
Feb-22	45075.9	688	150	295341	0.97	6.45
Mar-22	59131.2	688	213	496179	0.976	6.45
Total	**580784.9**	**-**	**-**	**4883507**	**-**	**-**
Average	**48398.7417**	**688**	**193.92**	**406958.9**	**0.9724**	**6.45**
Max	**64854.2**	**688**	**264**	**538717**	**0.98**	**6.45**
Min	**32653.6**	**688**	**138**	**250948.2**	**0.96**	**6.45**

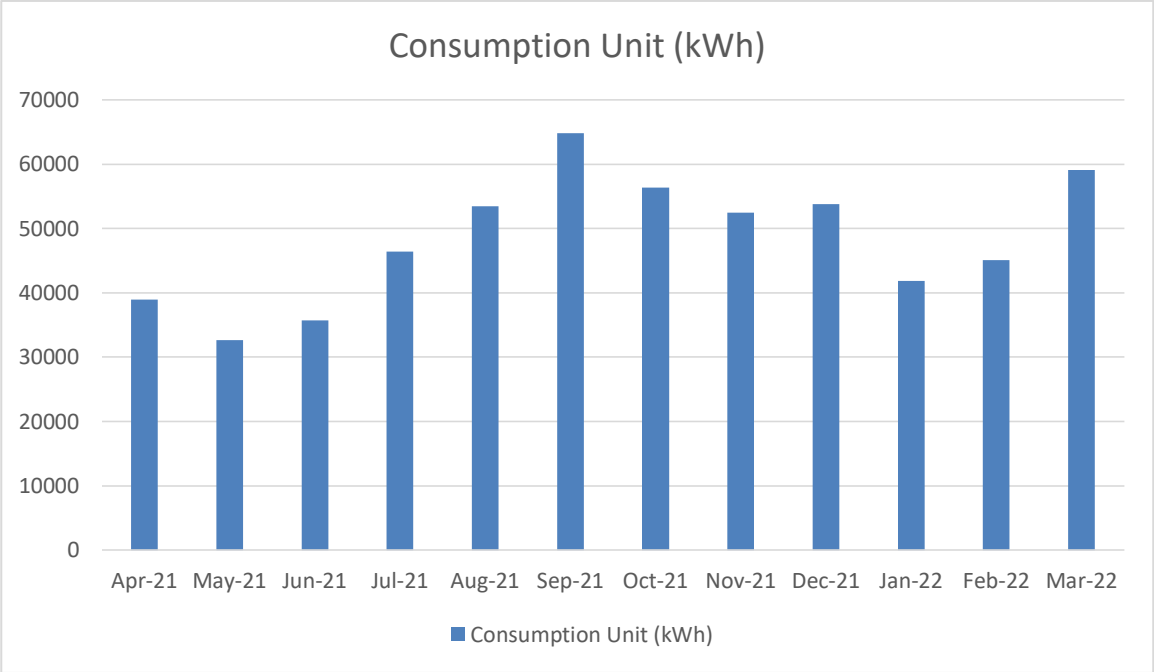
Observation

The recorded actual demand is in the range of 138 KVA to 264 KVA whereas the Maximum Contract Demand is 688 KVA. This is due to the non-occupancy of students because of the covid-19 crises. It is recommended to reduce contract demand till the regular functioning (i.e., full occupancy) of the University.

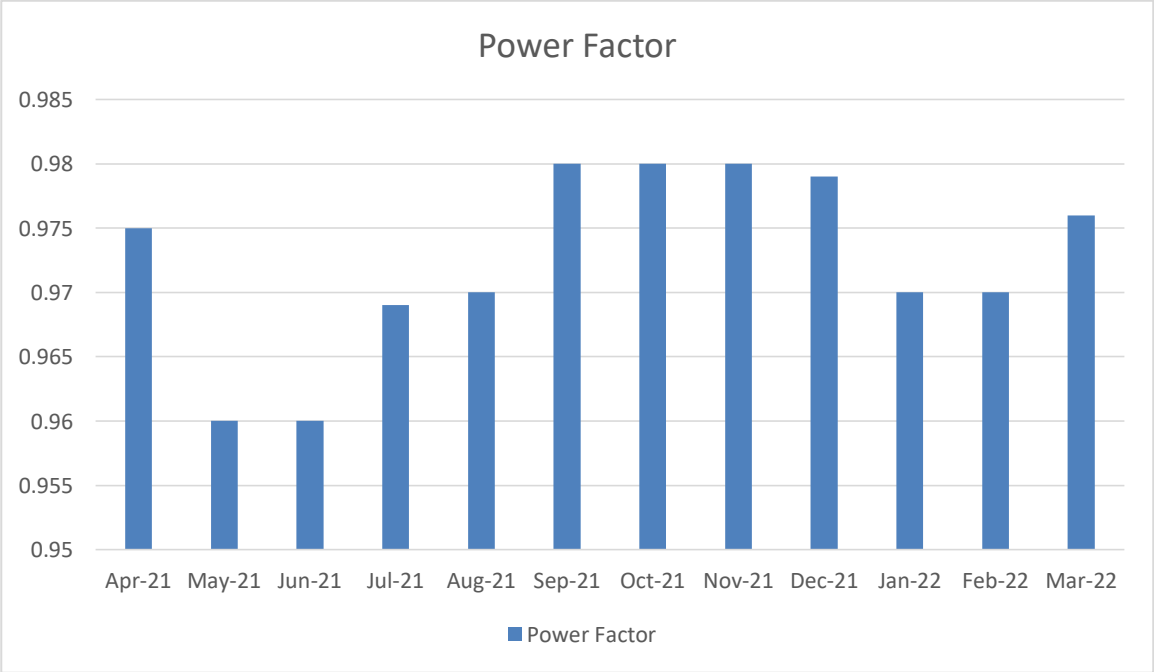
Recommendation

1. It is Recommend to reduce the contract demand from 688 KVA to 450 KVA to reduce the unnecessary demand charges

Graphical Representation of Consumption Unit (kWh)



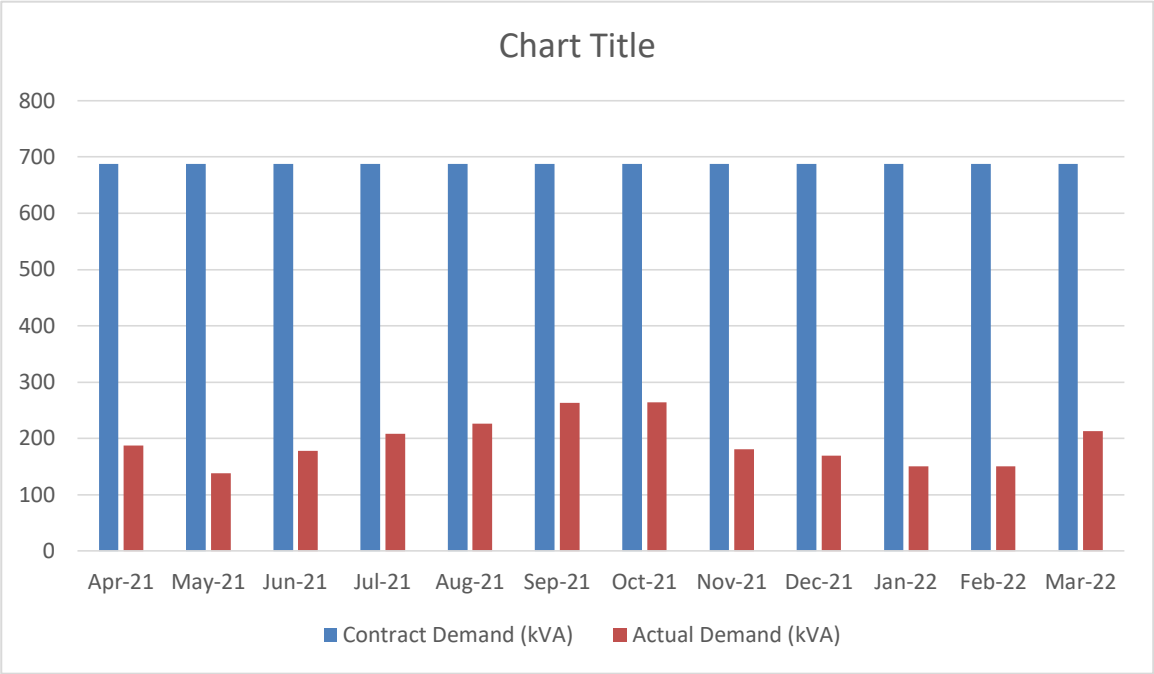
Graphical Representation of Power Factor



Observation:

The average Power factor recorded for the year of 2021-22 is 0.972 which is satisfactory.

Graphical Representation of Contract Demand & Actual Demand



Energy Saving Potential

S.No	Particular	UOM	
1	Existing Demand	KVA	688
2	Recommended Reduced Demand	KVA	450
3	Fixed Charges per KVA	Rupees/KVA	130
4	Annual Cost Saving	Rupees	371280
5	Payback Period		Immediate

4.3.6 Energy Consumption details for Consumer No: 210010060033

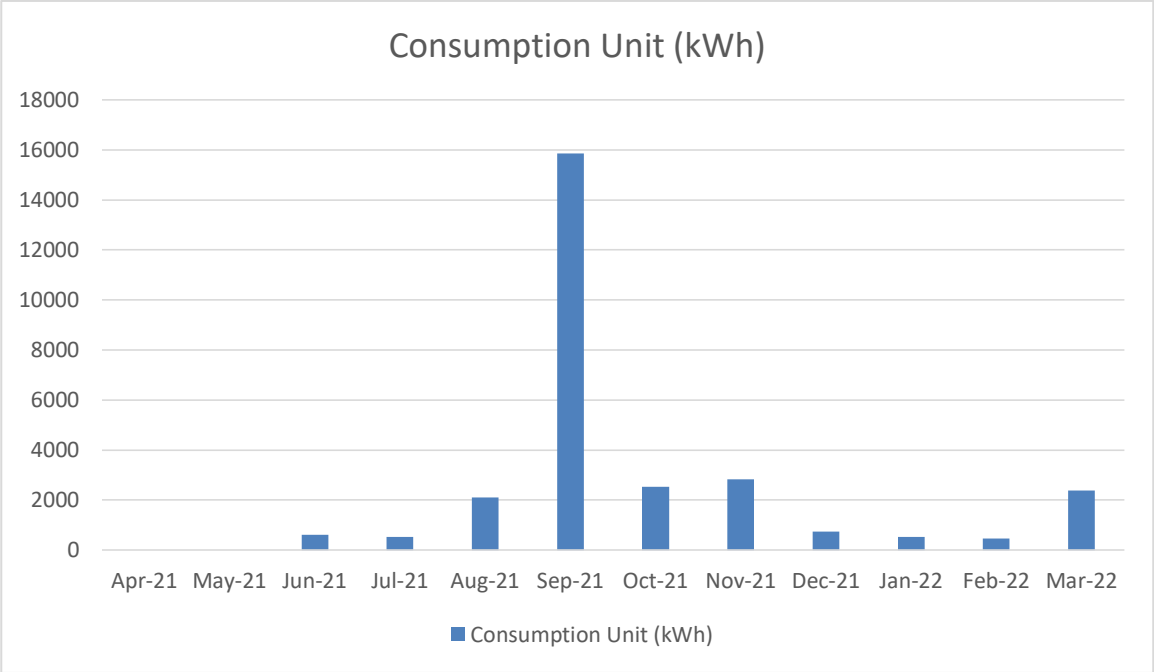
Table 4.3.6 Energy Consumption details for Consumer No: 210010060033

ELECTRICITY CONSUMPTION DETAILS for Year 2021-2022						
BILL MONTH	**Consumption Unit (kWh)**	**Contract demand (kVA)**	**Actual demand (kVA)**	**Bill amount (Rs.)**	**Power Factor**	**Unit Cost (In Rs./KW)**
Apr-21	-	-	-	-	-	-
May-21	-	-	-	-	-	-
Jun-21	618	247	485.64	14664	0.81	6.45
Jul-21	526.35	247	6.15	37927	0.63	6.45
Aug-21	2096.28	247	119.1	48559	0.77	6.45
Sep-21	15851.7	247	135.3	141337	0.82	6.45
Oct-21	2523.06	247	119.34	51450	0.78	6.45
Nov-21	2819.25	247	123.78	52399	0.797	6.45
Dec-21	729.3	247	9.63	40086	0.75	6.45
Jan-22	514.83	247	1.8	37849	0.57	6.45
Feb-22	468.27	247	1.23	34208	0.58	6.45
Mar-22	2377.44	247	118.89	50463	0.809	6.45
Total	**28524.48**	**-**	**-**	**508942**	**-**	**-**
Average	**2852.448**	**247**	**112.09**	**50894.2**	**0.7316**	**6.45**
Max	**2819.25**	**247**	**485.64**	**141337**	**0.82**	**6.45**
Min	**618**	**247**	**1.23**	**14664**	**0.57**	**6.45**

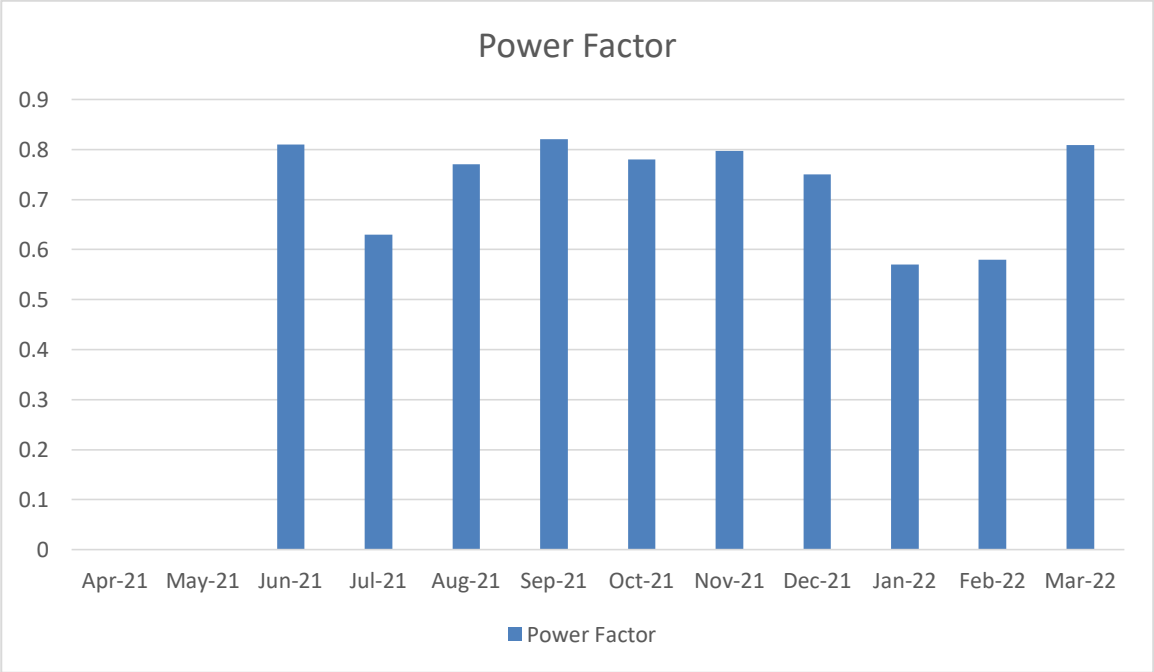
Observation:

The recorded actual demand is in the range of 1.23 KVA to 485.64 KVA whereas the Maximum Contract Demand is 247 KVA. This is due to the non-occupancy of students because of the covid-19 crises. It is recommended to reduce contract demand till the regular functioning (i.e., full occupancy) of the University.

Graphical Representation of Consumption Unit (kWh)



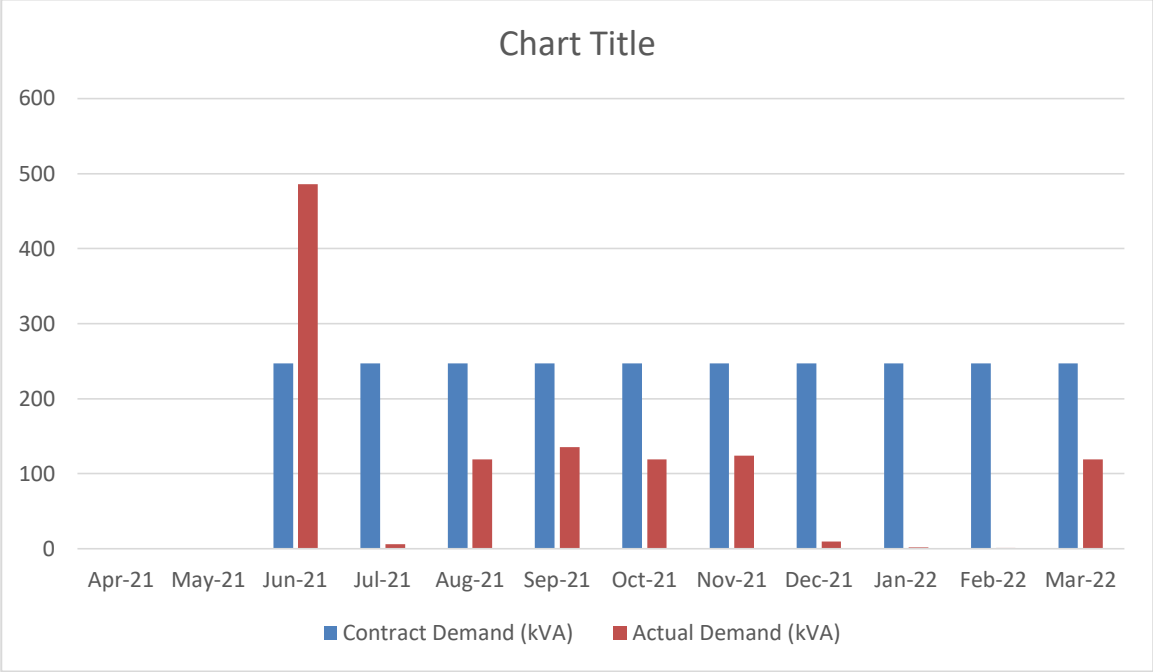
Graphical Representation of Power Factor



Observation:

The average Power factor recorded for the year of 2021-22 is 0.731 which needs to be improved. It is recommended to install an Automatic Power Factor Correction instrument (APFC) in the premises to maintain the Power factor.

Graphical Representation of Contract Demand & Actual Demand



Observation:

It is observed that the recorded demand is below the actual demand by 54.61 %, Overall margin is less than 46% which is due to the non-availability of students at university because of covid-19.

4.4 Lighting System

Lighting is an essential service in all industries, Universities, Hospitals, Malls, etc. Innovation and continuous improvement in the field of lighting, have given rise to tremendous energy-saving opportunities in this area. Lighting is an area, which provides a major scope to achieve energy efficiency at the design stage, by incorporation of modern energy-efficient lamps, luminaries, and gears, apart from good operational practices.

Basic Terms in Lighting System and Features

Lamps

Lamp is equipment, which produces light. The most commonly used lamps are described briefly as follows:

Incandescent lamps

Incandescent lamps produce light by means of a filament heated to incandescence by the flow of electric current through it. The principal parts of an incandescent lamp, also known as GLS (General Lighting Service) lamp include the filament, the bulb, the fill gas and the cap.

Reflector lamps

Reflector lamps are basically incandescent, provided with a high quality internal mirror, which follows exactly the parabolic shape of the lamp. The reflector is resistant to corrosion, thus making the lamp maintenance free and output efficient.

Gas discharge lamps

The light from a gas discharge lamp is produced by the excitation of gas contained in either a tubular or elliptical outer bulb. The most commonly used discharge lamps are as follows:

Fluorescent Tube lamps (FTL)

Compact Fluorescent Lamps (CFL)

Mercury Vapour Lamps

Sodium Vapour Lamps

Metal Halide Lamps

4.4.1 Energy Saving Strategy

Introduction of Light-emitting-diode or LED in place of Conventional Lighting Sources

A light transmitting diode (LED) is a semiconductor light source. LED's are utilized as marker lights as a part of numerous gadgets, and are progressively utilized for lighting. Early LED's emitted low power red light, however current adaptations are accessible over the unmistakable, ultraviolet and infrared wavelengths, with high splendor. The LED is focused around the semiconductor diode. At the point when a diode is forward predisposition (exchanged on), electrons can recombine with gaps inside the gadget, discharging vitality as photons. This impact is called electroluminescence and the color of the light (comparing to the vitality of the photon) is dictated by the vitality hole of the semiconductor. LED's present numerous focal points over radiant light sources including easier vitality utilization, longer lifetime, enhanced heartiness, more modest size, quicker exchanging, and more stupendous sturdiness and dependability. Notwithstanding, they are moderately unmanageable and require more exact current and hotness administration than customary light sources. Current LED items for general lighting are more unreasonable to purchase than fluorescent light wellsprings of equivalent yield.

Advantages of LED Lighting System -

- LEDs have an extremely long lifespan relative to every other lighting technology (including LPS and fluorescent lights but especially compared to incandescent lights). New LEDs can last 50,000 to 100,000 hours or more. The typical lifespan for an incandescent bulb, by comparison, is 1-5% as long at best (roughly 1,200 hours).
- LEDs are extremely energy efficient relative to every other commercially available lighting technology. There are several reasons for this including the fact that they waste very little energy in the form of infrared radiation (heat), and they emit light directionally (over 180 degrees versus 360 degrees which means there are far fewer losses from the need to redirect or reflect light).
- Very high light quality
- Very low maintenance costs and hassle

Automatic Control of Street Lights

Automatic control of street lights is designed to turn on and turn of street lights automatically. This project checks the amount of light. If light is 80 percent available, it automatically turn off street lights. But if amount of light is less than 80 percent, this project will automatically turn on street lights. one can also adjust it according to its requirement. Light sensor is used to detect intensity of light. Microcontroller is used interfaced with light sensor to sense amount of light available. Control signal is generated with the

help of microcontroller after analyzing amount of light. Control signal generated by microcontroller is used to turn on transistor which in turn energize the relay coil and relay turn on the street light.

Daylight utilization

Daylight is of extraordinary impact on energy savings. The measures made in this respect especially include investment costs and almost no future costs, compared with other measures (daylight is for free). Daylight can be controlled by use of venetian blinds, roller blinds, marquises, redirecting, and special glazing and so on, in existing buildings. The options how to increase daylight utilization are also installation of skylights into a ceiling structure, installation of light guides, regular window cleaning, painting the walls, change in a space geometry and a space utilization purpose.

Lighting system maintenance

The regular maintenance is very important for the efficiency of the lighting system. Therefore, the maintenance must be carried out in regular intervals. A correctly scheduled maintenance plan helps to maintain the illumination, reduce investment and operational costs and operate the system safely. The plan of maintenance is to include.

- Interval of maintenance execution.
- Description of activities performed within the framework of a regular maintenance.
- Description of activities performed within the framework of extraordinary maintenance (service action).
- Way of luminaries and surfaces cleaning.

Solar Lighting System

Solar street lighting system is ideal for street lighting in remote villages. The system is provided with battery storage backup sufficient to operate the light for 10-11 hours daily. The system is provided with automatic ON/OFF time switch for dusk to dawn operation and overcharge / deep discharge prevention cut-off with LED indicators.

The SPV modules are reported to have a service life of 15-20 years. Tubular Batteries provided with the solar street lighting system require lower maintenance; have longer life and give better performance.

4.5 Inventory Details

The audit team has done the Inventory with Wattage analysis of the different types of lighting installed and the other electrical equipment across the campus. The below table shows the electrical equipment install at the University.

Table 4.5: Inventory details of lights Building wise

S. No.	Name of the Building	LED Tube light of 20 W	Ceiling light of 15 W	LED Lights of 9 W	Total Load (in KW)
1	Department of Anthropology	40			**0.8**
2	Department of Applied Geology	90			**1.8**
3	Department of Assamese	55			**1.1**
4	Department of Chemistry	189			**3.78**
5	Department of Commerce	45			**0.9**
6	Department of Economics	45			**0.9**
7	Department of English	30			**0.6**
8	Department of History	30			**0.6**
9	Department of Life Sciences	180			**3.6**
10	Department of Mathematics	60			**1.2**
11	Department of Petroleum Technology	80			**1.6**
12	Department of Pharmaceutical Sciences	245			**4.9**
13	Department of Physics	89			**1.78**
14	Centre for Atmospheric Studies	39			**0.78**
15	Department of Political Science	30			**0.6**
16	Department of Sociology	45			**0.9**
17	Department of Statistics	60			**1.2**
18	Centre for Computer Science and Applications	95			**1.9**
19	Centre for Management Studies	98			**1.96**
20	Centre for Social Works Studies	20			**0.4**
21	Centre for Studies in Biotechnology and Bioinformatics	53			**1.06**
22	Centre for Studies in DUIET	417			**8.34**
23	Centre for Studies in Geography	30			**0.6**
24	Centre for Studies in	8			**0.16**

	Languages				
25	Centre for Studies in Philosophy	16			**0.32**
26	Centre for Studies in Physical Education and Sports	25			**0.5**
27	Centre for Tea and Agro Studies	35			**0.7**
28	Dr. Bhupen Hazarika Centre for Studies in Performing Arts		150		**2.25**
29	SWS	20			**0.4**
30	DODL	120			**2.4**
31	Jyomati Chatri Nivas	55		301	**3.809**
32	Aideo Handique Chatri Nivas	51		217	**2.973**
33	Pushpalata Das Chatri Nivas	20		352	**3.568**
34	Nalinibala Devi Chatri Nivas	107		190	**3.85**
35	Swarnalata Baruah Chatri Nivas	111		176	**3.804**
36	Padmakumari Gohain Women's Hostel	29		496	**5.044**
	Total	**2662**	**150**	**1732**	**71.078**

Observation:

1. Most of the lights in the university are LEDs.
2. Streetlights in the University are also LED.
3. Overall lightning of university is good.

Recommendation:

1. General maintenance should be done regularly.
2. Solar powered streetlights to be installed.
3. It is Recommend to Install **Astronomical Switch** with timer in all the streetlights.
4. Use of occupancy sensors in auditorium and halls.
5.

Note: It is stated that Astronomical Switch lightings can give up to 3-5 % savings on Lighting Power Consumption.

4.6 Ceiling Fans

Ceiling Fan is the major part which consumes electricity and however, it is very useful in household, universities, offices, etc. Hence, Innovation and continuous improvement in the field of fans, have given rise to tremendous energy-saving opportunities in this area. The fan is an area, which provides a major scope to achieve energy efficiency at the design stage, by incorporation of modern energy-efficient Fans, BLDC Fans, smart Fans, apart from good operational practices.

Inventory details of Fans Building wise

S. No.	Name of the Building	Ceiling Fan of 100 W	Total Load (in KW)
1	Department of Anthropology	35	**3.5**
2	Department of Applied Geology	80	**8**
3	Department of Assamese	35	**3.5**
4	Department of Chemistry	100	**10**
5	Department of Commerce	25	**2.5**
6	Department of Economics	25	**2.5**
7	Department of Education	110	**11**
8	Department of English	25	**2.5**
9	Department of History	25	**2.5**
10	Department of Life Sciences	125	**12.5**
11	Department of Mathematics	50	**5**
12	Department of Petroleum Technology	50	**5**
13	Department of Pharmaceutical Sciences	187	**18.7**
14	Department of Physics	34	**3.4**
15	Centre for Atmospheric Studies	34	**3.4**
16	Department of Political Science	25	**2.5**
17	Department of Sociology	25	**2.5**
18	Department of Statistics	50	**5**
19	Centre for Computer Science and Applications	85	**8.5**
20	Centre for Management Studies	80	**8**
21	Centre for Social Works Studies	10	**1**
22	Centre for Studies in Biotechnology and Bioinformatics	42	**4.2**
23	Centre for Studies in DUIET	312	**31.2**
24	Centre for Studies in Geography	25	**2.5**
25	Centre for Studies in Languages	6	**0.6**
26	Centre for Studies in Philosophy	6	**0.6**
27	Centre for Studies in Physical Education and Sports	15	**1.5**

28	Centre for Tea and Agro Studies	20	**2**
29	Dr. Bhupen Hazarika Centre for Studies in Performing Arts	100	**10**
30	SWS	14	**1.4**
31	DODL	85	**8.5**
32	Jyomati Chatri Nivas	148	**14.8**
33	Aideo Handique Chatri Nivas	111	**11.1**
34	Pushpalata Das Chatri Nivas	173	**17.3**
35	Nalinibala Devi Chatri Nivas	96	**9.6**
36	Swarnalata Baruah Chatri Nivas	77	**7.7**
37	Padmakumari Gohain Women's Hostel	155	**15.5**
	Total	**2600**	**260**

Observation:

1. There are 2600 number of 100 Watt fan which consumes 260 kW of electricity.
2. It is observed that fans installed at university are old & conventional which needs to be replace by BLDC (Brushless Direct Current) Fans.

Recommendation:

1. It is recommended to replace all the 100 W ceiling fans with energy efficient BLDC fan, in phase wise manner.

Replacement of Normal Ceiling Fan of 100 W with 30 W BLDC Fan		
Particulars		**Units**
Total Number of 100 Watt Ceiling Fan	2600	Number
Measured Watt	100	Watts
Total Watts	260000	Watts
Proposed watt after replacement	30	Watts
Total Watt After Replacement	78000	Watts
Operating Hours in a day	8	Hours
Estimated Energy Saving after Replacement Annual kWh	531440	kWh
Per Unit Cost as Per APDCL Bill	6.45	Rs
Estimated Cost Saving Per Year	34.27	Rs. Lacs
Cost of Per Fan	3500	Rs
Total Investment Cost	91	Rs. Lacs
Payback	**2.65**	**Year**

BLDC Fan

A BLDC Fan is a DC motor a magnet synchronous electric motor that is driven by electrical energy (DC) electricity and it accomplishes an electronically controlled commutation system (commutation is the process of manufacturing motility force in the motor by dynamical part currents through it at appropriate times) rather than an automatically commutation system. BLDC motors also are referred to as tetragon magnet motors that are positioned around the mechanical device. The electronics contain a driving algorithm that drives the BLDC motor could be an electric motor that keeps running on the provision of electric power. In this motor, there's the straight relationship amongst current and torsion moreover within the between voltage and rate of BLDC motor. This straight relationship is that the main reason that the BLDC motor offers wonderful leads to the routine ceiling fans. BLDC Fans consume low power.

BLDC fan takes in AC voltage and internally converts it into DC victimization SMPS. DC voltage as input that is reborn victimization the heartbeat breadth Modulation Techniques to regulate the excitation of the coils to come up with the motion in a prescribed fashion. we've projected AN electronic management for the PWM generation and motion detection and management through the "hall effect" sensors that square measure embedded within the BLDC Motor. there's additionally some way to use the "back emf" generated by the excitation on the "third leg" of the motor for conniving the relative position for the motion management. This sensor less or back electromotive force methodology, whereas it reduces the value of the motor, has bound challenges and disadvantages and isn't being thought of here for the actual application.

Comparison of BLDC Fans & Ceiling Fan

Speed of Fans (RPM)	BLDC Fans (watts)	Ordinary Fans (Watts)
140	3.8	13
210	7.7	24
270	13.8	30
310	22.7	40
370	35.8	55
410	40	80

4.7 Air Conditioner Details

S. No.	Name of the Building	Air Conditioner of 1.5 Ton (1500 W)	Air Conditioner of 2 Ton (1800 W)	Air Conditioner of 2 Ton (1900 W)	Central AC of 5 KW	Central AC of 11 KW	Total Load (in KW)
1	DUIET Core Building	24					36
2	Electronics and Communication Engineering (DUIET)	8					12
3	Computer Engineering Department (DUIET)	19					28.5
4	Mechanical Engineering Department (DUIET)	1					1.5
5	Department of Pharmaceutical Sciences	23					34.5
6	Animal house of Phar. SU Department	6					9
7	Department of Petroleum Technology	9					13.5
8	Department of Education	2					3
9	Department of Life Sciences	13					19.5
10	Centre for Studies in Biotechnology and Bioinformatics	16					24
11	Directorate of open and distance learning	6					9
12	Centre for Juridical Studies	2					3
13	Centre for Tea	6					9

	and Agro Studies						
14	Department of Applied Geology	8					12
15	Centre for Atmospheric Studies	7					10.5
16	Department of Physics	13					19.5
17	Department of Chemistry	12					18
18	Department of Anthropology	4					6
19	Centre for Computer Science and Applications	11					16.5
20	Centre for Studies in Applied Psychology & Mass Communicatio n	10					15
21	Department of Mathematics	1					1.5
22	Department of Statistics	2					3
23	Centre for Women's Studies	2					3
24	Centre for Management Studies	9					13.5
25	Department of Commerce	1					1.5
26	Department of Economics	3					4.5
27	Building of Sri Anirudhadeva	6					9
28	Centre for Studies in Languages	2					3
29	Department of English	1					1.5
30	Centre for Studies in Geography	1					1.5
31	Department of Sociology	3					4.5

32	Centre for Social Works Studies	2					3
33	V.C. office building & CDC office	16					24
34	New Administrative office building and Punjab National Bank	10	4				22.2
35	Indira Miri Conference Hall	1	10		6		49.5
36	Department of Assamese	1					1.5
37	Department of History	6					9
38	Administrative Building	11		4			24.1
39	Dean Office building	8					12
40	LNB Library	10					15
41	Vishranta Guest House	47					70.5
42	Dr. Bhupen Hazarika Centre for Studies in Performing Arts	1					1.5
43	Gyan Malini Radio Centre	6					9
44	USIC	6					9
45	Rangghar Auditorium	2				8	91
46	P & C Branch	1					1.5
	Total	**359**	**14**	**4**	**6**	**8**	**689.3**

Observations:

1. In some places ACs are old and conventional.

Recommendations:

1. It is recommended to replace the conventional ACs with five-star invertor AC, in phase wise manner.

4.8 Transformer Load Profile

The Table below shows the Load Profile of Transformer.

Dibrugarh University Transformer									
DATE OF MEASUREMENT - 16.08.2022 & 17.08.2022									
SN.	**Name of the drive**	**Drive Status**	**Design**	**Measured Parameters**			**Calculated Parameters**		
	Equipment Name		**Transformer Rating KVA**	**Avg. Voltage (V)**	**Avg. Current (A)**	**PF**	**Calculated kVA**	**Calculated Values (KW)**	**Loading (%)**
1	Transformer Near Boys Hostel	LT	250.00	407.50	40.20	0.98	28.37	27.81	**11.35**
2	Old Transformer Control Room	LT	500.00	396.61	190.71	0.97	131.00	127.07	**26.20**
3	New Transformer Control Room	LT	500.00	399.94	138.83	0.97	96.17	93.28	**19.23**
4	Transformer Near Girls Hostel	LT	500.00	407.36	128.58	0.83	90.72	75.30	**18.14**
5	Transformer Engineering Department	LT	315.00	406.67	20.70	0.93	14.58	13.56	**4.63**
6	Transformer Rangghar	LT	250.00	392.10	15.20	0.90	10.32	9.29	**4.13**

Observations:

1. Above table is based on recording of loading for one hour each.
2. Loading percentage of all transformers were very less because of non-availability of students because of semester break.

4.8.1 Assessment of Transformers

Assessment of Transformer of Consumer No. 210000001305

BILL MONTH	Consumption Unit (kWh)	Transformer Rating (kVA)	Hours	Power Factor	Average kVA	% Loading
Apr-21	37333.36	500	696	0.98	54.73	10.947
May-21	38447.89	500	736	0.98	53.31	10.661
Jun-21	45810.68	500	688	0.985	67.60	13.520
Jul-21	50973.5	500	709	0.985	72.99	14.598
Aug-21	52162.24	500	719	0.987	73.50	14.701
Sep-21	59574.97	500	702	0.985	86.16	17.231
Oct-21	48158.07	500	726	0.98	67.69	13.537
Nov-21	39818.5	500	708	0.98	57.39	11.478
Dec-21	47064.4	500	728	0.98	65.97	13.194
Jan-22	47573.65	500	744	0.98	65.25	13.050
Feb-22	49869.64	500	667	0.989	75.60	15.120
Mar-22	40728.36	500	663	0.98	62.68	12.537
Annual	**557515.26**	**500**	**8486**	**0.983**	**66.863**	**13.373**
Average	**46459.605**	**500**	**707.17**	**0.983**	**66.863**	**13.373**

Observation:

1. Average loading for the transformer is 66.863 kVA.
2. The average percentage loading for the session 2021-22 is 13.37%

Assessment of Transformer of Consumer No. 210000001069

BILL MONTH	Consumption Unit (kWh)	Transformer Rating (kVA)	Hours	Power Factor	Average kVA	% Loading
Apr-21	16223.25	315	695	0.98	23.82	7.562
May-21	12867.4	315	735	0.95	18.43	5.850
Jun-21	11907	315	693	0.96	17.90	5.682
Jul-21	12277.44	315	744	0.94	17.56	5.573
Aug-21	15332.1	315	744	0.968	21.29	6.758
Sep-21	17056.9	315	720	0.968	24.47	7.769
Oct-21	12697.3	315	744	0.97	17.59	5.585
Nov-21	17450.3	315	720	0.97	24.99	7.932
Dec-21	18703.3	315	744	0.958	26.24	8.330
Jan-22	14355	315	744	0.94	20.53	6.516
Feb-22	17790.3	315	672	0.93	28.47	9.037
Mar-22	17275.5	315	744	0.91	25.52	8.100
Annual	**183935.79**	**315**	**8699**	**0.954**	**22.172**	**7.039**
Average	**15327.9825**	**315**	**724.92**	**0.954**	**22.172**	**7.039**

Observations:

1. Average loading for the transformer is 22.172 kVA.
2. The average percentage loading for the session 2021-22 is 7.039%.

Assessment of Transformer of Consumer No. 210000001306

BILL MONTH	Consumption Unit (kWh)	Transformer Rating (kVA)	Hours	Power Factor	Average kVA	% Loading
Apr-21	30424.05	500	696	0.99	44.15	8.83
May-21	18527.49	500	736	0.97	25.95	5.19
Jun-21	20653.72	500	688	0.978	30.70	6.14
Jul-21	24264.55	500	709	0.98	34.92	6.98
Aug-21	27438.88	500	719	0.985	38.74	7.75
Sep-21	33052.26	500	702	0.99	47.56	9.51
Oct-21	29321.16	500	726	0.987	40.92	8.18
Nov-21	33789.46	500	708	0.99	48.21	9.64
Dec-21	34249.04	500	744	0.96	47.95	9.59
Jan-22	34829.2	500	744	0.96	48.76	9.75
Feb-22	21863.8	500	672	0.986	33.00	6.60
Mar-22	39934.9	500	710	0.99	56.81	11.36
Annual	**348348.51**	**500**	**8554**	**0.9805**	**41.5334**	**8.31**
Average	**29029.0425**	**500**	**712.83**	**0.9805**	**41.5334**	**8.31**

Observations:

1. Average loading for the transformer is 41.533 kVA.
2. The average percentage loading for the session 2021-22 is 8.31%.

Assessment of Transformer of Consumer No. 210000000468

BILL MONTH	Consumption Unit (kWh)	Transformer Rating (kVA)	Hours	Power Factor	Average kVA	% Loading
Apr-21	15949.71	250	696	0.989	23.17	9.268
May-21	9421.12	250	736	0.97	13.20	5.279
Jun-21	9962.39	250	688	0.98	14.78	5.910
Jul-21	10394.52	250	709	0.978	14.99	5.996
Aug-21	12207.45	250	719	0.98	17.32	6.930
Sep-21	14746.42	250	700	0.985	21.39	8.555
Oct-21	16166.5	250	721	0.987	22.72	9.087
Nov-21	17813.56	250	708	0.978	25.73	10.291
Dec-21	19802.55	250	728	0.977	27.84	11.137
Jan-22	16342.56	250	734	0.977	22.79	9.116
Feb-22	19377.69	250	667	0.98	29.64	11.858
Mar-22	20260.88	250	735	0.986	27.96	11.183
Annual	**182445.35**	**250**	**8541**	**0.981**	**21.784**	**8.714**
Average	**15203.77917**	**250**	**711.75**	**0.981**	**21.784**	**8.714**

Observation:

1. Average loading for the transformer is 21.784 kVA.
2. The average percentage loading for the session 2021-22 is 8.714%.

Assessment of Transformer of Consumer No. 210000000467

BILL MONTH	Consumption Unit (kWh)	Transformer Rating (kVA)	Hours	Power Factor	Average kVA	% Loading
Apr-21	38906.7	500	695	0.975	57.42	11.483
May-21	32653.6	500	735	0.96	46.28	9.256
Jun-21	35721	500	690	0.96	53.93	10.785
Jul-21	46432.4	500	713	0.969	67.21	13.441
Aug-21	53456.7	500	721	0.97	76.44	15.287
Sep-21	64854.2	500	700	0.98	94.54	18.908
Oct-21	56395	500	725	0.98	79.37	15.875
Nov-21	52477	500	707	0.98	75.74	15.148
Dec-21	53815.6	500	728	0.979	75.51	15.102
Jan-22	41865.6	500	734	0.97	58.80	11.760
Feb-22	45075.9	500	667	0.97	69.67	13.934
Mar-22	59131.2	500	732	0.976	82.77	16.553
Annual	**580784.9**	**500**	**8547**	**0.972**	**69.909**	**13.982**
Average	**48398.74167**	**500**	**712.25**	**0.972**	**69.879**	**13.976**

Observation:

1. Average loading for the transformer is 69.909 kVA.
2. The average percentage loading for the session 2021-22 is 13.98%.

Assessment of Transformer of Consumer No. 210010060033

BILL MONTH	Consumption Unit (kWh)	Transformer Rating (kVA)	Hours	Power Factor	Avr. kVA	% Loading
Apr-21	-	-	-	-	-	-
May-21	-	-	-	-	-	-
Jun-21	618	250	48	0.81	15.90	6.358
Jul-21	526.35	250	744	0.63	1.12	0.449
Aug-21	2096.28	250	744	0.77	3.66	1.464
Sep-21	15851.7	250	720	0.82	26.85	10.740
Oct-21	2523.06	250	744	0.78	4.35	1.739
Nov-21	2819.25	250	720	0.797	4.91	1.965
Dec-21	729.3	250	744	0.75	1.31	0.523
Jan-22	514.83	250	744	0.57	1.21	0.486
Feb-22	468.27	250	672	0.58	1.20	0.481
Mar-22	2377.44	250	744	0.809	3.95	1.580
Annual	**28524.48**	**250**	**6624**	**0.732**	**5.886**	**2.354**
Average	**2852.448**	**250**	**662.4**	**0.732**	**5.886**	**2.354**

Observation:

1. Average loading for the transformer is 5.886 kVA.
2. The average percentage loading for the session 2021-22 is 2.354%.

Recording of Electrical Parameters of Transformer

Damaged Power Cable Found in panel of Incomer Transformer

4.9 Power Quality

Power Quality & Harmonics

Equipment based on frequency conversion techniques generates harmonics. With the increased use of such equipment, harmonics- related problems have been enhanced. The harmonic currents generated by different types of loads travel back to the source. While traveling back to the source, they generate harmonic voltages, following simple Ohm's Law. Harmonic voltages, which appear on the system bus, are harmful to other equipment connected to the same bus. In general, sensitive electronic equipment connected to this bus will be affected. The Harmonics Level on the HT side of the Transformers was measured, details of which is as under: -

Particulars	TR
Voltage Harmonics(VTHD)	
"R"Phase	1.9
"Y"Phase	1.85
"B"Phase	1.8
Current Harmonics(ATHD)	
"R"Phase	11.55
"Y"Phase	10.4
"B"Phase	10.05

- Maximum Individual Frequency Voltage Harmonic: 3%
- Total Harmonic Distortion of the Voltage: 5%

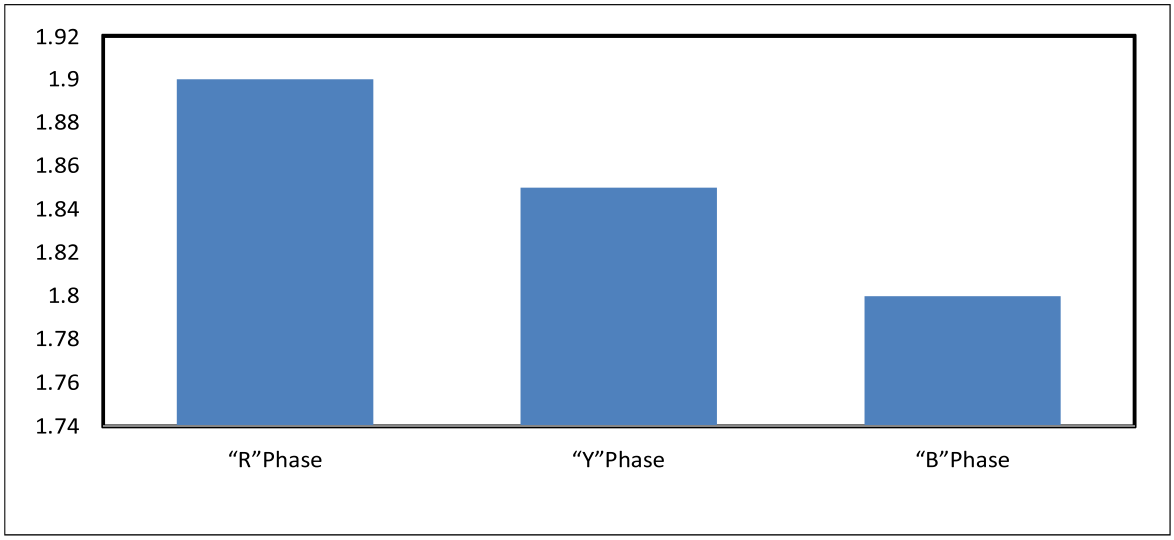
harmonic current limitations

Maximum Harmonic Current Distortion in Percent of IL
120 Volt through 69 KV
Individual Harmonic Order (Odd Harmonics)

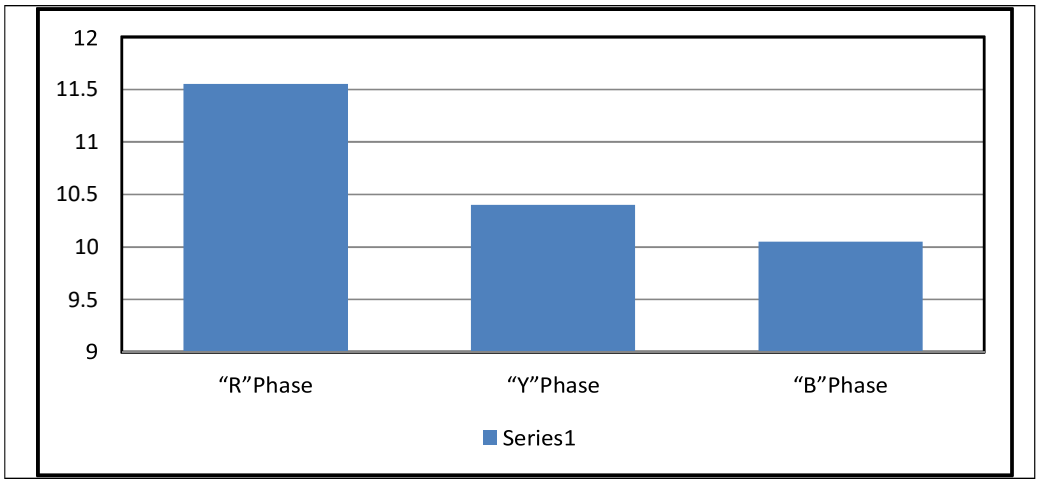
ISC/IL	h<11	11<h<17	17<h<23	23<h<35	35<h	TDD
<20*	4.0	2.0	1.5	0.6	0.3	5.0
20<50	7.0	3.5	2.5	1.0	0.5	8.0
50<100	10.0	4.5	4.0	1.5	0.7	12.0
100<1000	12.0	5.5	5.0	2.0	1.0	15.0
>1000	15.0	7.0	6.0	2.5	1.4	20.0

Even harmonics are limited to 25% of the odd harmonic limits
TDD refers to Total Demand Distortion based on the average demand current at the fundamental frequency and measured at the PCC (Point of Common Coupling).
*All power generation equipment is limited to these values of current distortion regardless of ISC/ IL value.
ISC = Maximum short-circuit current at PCC.
IL = Maximum demand load current (fundamental) at the PCC.
h = Harmonic number.

Graphical Representation of Voltage Harmonics (V THD) of Main Incomer



Graphical Representation of Voltage Harmonics (V THD) of Main Incomer



Observations & Suggestions

As detailed above, the voltage harmonics levels were around 1.8-1.9% and the levels of the current harmonics were 10.4-11.55%. The Overall harmonics are within limits. If the Harmonics level is on the higher side, then appropriate harmonic filters have to be installed in the system. Different technologies are available mitigating the harmonics from the system. These include Detuned or broadband harmonic filters: these filter banks are tuned to a frequency just below the predominant harmonic frequency. If the predominant

harmonic frequency is say, 5th, it is normal practice to tune the filters to 189 Hz, or 3.78th harmonic, in 50 Hz systems.

Active Harmonic Filters: these units are designed in such a manner that, they will inject harmonic frequencies in the system, which will be in anti-phase of the load harmonic frequencies. This will effectively free the source being loaded due to harmonics.

Major Causes of Harmonics

Devices that draw non-sinusoidal currents when a sinusoidal voltage is applied create harmonics. Frequently these are devices that convert AC to DC. Some of these devices are listed below:

- Electronic Switching Power Converters
- Computers, Uninterruptible power supplies (UPS), Solid-state rectifiers
- Electronic process control equipment, PLC's, etc.
- Electronic lighting ballasts, including light dimmer
- Reduced voltage motor controllers
- Arcing Devices
- Discharge lighting, e.g. Fluorescent, Sodium and Mercury vapor
- Transformers operating near saturation level
- Magnetic ballasts (Saturated Iron core)
- Induction heating equipment, Chokes, Motors, Appliances
- TV sets, air conditioners, washing machines, microwave ovens
- Fax machines, photocopiers, printers
- These devices use power electronics like SCRs, diodes, and thyristors, which are a growing percentage of the load in industrial power systems.

Many problems can arise from harmonic currents in a power system. Some problems are easy to detect; others exist and persist because harmonics are not suspected. Higher RMS current and voltage in the system are caused by harmonic currents, which can result in any of the problems listed below:

Blinking of Incandescent Lights	Transformer Saturation
Capacitor Failure	Harmonic Resonance
Circuit Breakers Tripping	Inductive Heating and Overload
Conductor Failure	Inductive Heating
Electronic Equipment Shutting down	Voltage Distortion
Flickering of Fluorescent Lights	Transformer Saturation
Fuses Blowing for No Apparent Reason	Inductive Heating and Overload
Motor Failures (overheating)	Voltage Drop
Electromagnetic Load Failures	Inductive Heating
Overheating of Metal Enclosures	Inductive Heating
Power Interference on Voice Communication	Harmonic Noise
Transformer Failures	Inductive Heating

4.10 Solar Power in University

There were two solar stations at university at –

1 Mechanical Workshop

2 Administrative Building

It is observed that during audit, both solar stations were not functioning and there were two issues reported, i.e., one of battery failure and one is of synchronization with grid.

Recommendations:

1. It is Recommended to Repair and Reuse the solar power system with synchronization with grid.

4.11 General Tips for Energy Conservation in Different Utilities Systems

4.11.1 Electricity

- Schedule your operations to maintain a high load factor
- Minimize maximum demand by tripping loads through a demand controller
- Use standby electric generation equipment for on-peak high load periods.
- Correct power factor to at least 0.99 under rated load conditions.
- Set transformer taps to optimum settings.
- Shut off unnecessary computers, printers, and copiers at night.

4.11.2 Motors

- Properly size to the load for optimum efficiency.
- (High efficiency motors offer of 4 - 5% higher efficiency than standard motors)
- Check alignment.
- Provide proper ventilation, (For every 10°C increase in motor operating temperature over recommended peak, the motor life is estimated to be halved)
- Check for under-voltage and over-voltage conditions.
- Balance the three-phase power supply.
- (An Imbalanced voltage can reduce 3 - 5% in motor input power)
- Demand efficiency restoration after motor rewinding.
- Use energy efficient motors instead of conventional wherever it is economical.

4.11.3 Fans

- Use smooth, well-rounded air inlet cones for fan air intakes.
- Avoid poor flow distribution at the fan inlet.
- Minimize fan inlet and outlet obstructions.
- Clean screens, filters, and fan blades regularly
- Use aero foil-shaped fan blades.

- Minimize fan speed.
- Use low-slip or flat belts.
- Check belt tension regularly.
- Eliminate variable pitch pulleys.
- Use variable speed drives for large variable fan loads.
- Use energy-efficient motors for continuous or near-continuous operation
- Eliminate leaks in ductwork.
- Minimize bends in ductwork
- Turn fans off when not needed

4.11.4 Pumps

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

4.11.5 Lighting

- Reduce excessive illumination levels to standard levels using switching, delamping, etc. (Know the electrical effects before doing delamping.)
- Aggressively control lighting with clock timers, delay timers, photocells, and/or occupancy sensors.

- Install efficient alternatives to incandescent lighting, mercury vapor lighting, etc.
- Efficiency (lumens/watt) of various technologies range from best to worst approximately as follows: low pressure sodium, high pressure sodium, metal halide, fluorescent, mercury vapor, incandescent.
- Select ballasts and lamps carefully with high power factor and long-term efficiency in mind.
- Upgrade obsolete fluorescent systems to Compact fluorescents and electronic ballasts
- Consider lowering the fixtures to enable using less of them.
- Consider day lighting, skylights, etc.
- Consider painting the walls a lighter color and using less lighting fixtures or lower wattages.
- Use task lighting and reduce background illumination.
- Re-evaluate exterior lighting strategy, type, and control. Control it aggressively.
- Change exit signs from incandescent to LED.

4.11.6 DG Sets

- Optimize loading
- Use waste heat to generate steam/hot water/power an absorption chiller or preheat process or utility feeds.
- Use jacket and head cooling water for process needs
- Clean air filters regularly
- Insulate exhaust pipes to reduce DG set room temperatures.

4.11.7 Water & Waste Water

- Recycle water, particularly for uses with less-critical quality requirements.
- Recycle water, especially if sewer costs are based on water consumption.
- Balance closed systems to minimize flow sand reduce pump power requirements.
- Eliminate once-through cooling with water.

- Use the least expensive type of water that will satisfy the requirement.
- Test for underground water leaks. (It's easy to do over a holiday shutdown.)
- Check water overflow pipes for proper operating level.
- Automate blowdown to minimize it.
- Provide proper tools for wash down- especially self-closing nozzles.
- Reduce flows at water sampling stations.
- Eliminate continuous overflow at water tanks.
- Promptly repair leaking toilets and faucets.
- Use water restrictors on faucets, showers, etc.
- Use self-closing type faucets in restrooms.

4.11.8 Energy Management Strategy

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

Set Up an Energy Monitoring and Reporting System

Successful energy management requires the establishment of a system to collect/ analyze and report the energy costs and consumption pattern. This will enable an overview of energy use and its related costs, as well as facilitating the identification of savings that might `otherwise not be detected. The system needs to record both historical and ongoing energy use, as well as cost information from billing data, and capable of producing summary reports on a regular basis. This information will provide the means by which trends can be analyzed and reviewed for corrective measures.

Implementation of Staff Awareness and Training Program

A key ingredient to the success of an energy management program is maintaining a high level of awareness among staff. This can be achieved through formal training, newsletters, posters and publications. It is important to communicate program plans and case studies that demonstrate savings, and to report results at least at 12-month intervals. Staff may need training from specialists on energy saving practices and equipment.

5. SOLID WASTE AUDIT

Solid waste is the unwanted or useless solid material generated from human activities in a residential, industrial, or commercial area. Solid waste management reduces or eliminates the adverse impact on the environment and human health. A number of processes are involved inefficiently managing waste for an organization. It is necessary to manage the solid waste properly to reduce the load on the waste management system. Solid waste generation and its management is a burning issue in current days. The rate of generation of solid waste is very high and yet we do not have adequate technology to manage the generated waste. Unscientific handling of solid waste can create threats to public health and environmental safety issues. Thus, it is necessary to manage solid waste properly to reduce the load on the waste management system. The purpose of this audit is to find out the quantity, volume, type, and current management practice of solid waste generation in the Dibrugarh University campus. This report will be helpful for further solid waste management and to go for green campus development.

5.1 Generation of solid waste in Dibrugarh University

Dibrugarh University campus solid waste data is collected from all the building areas and the same is directly handed over to the Municipalities Bin for further segregation and recycling purpose. There are different types of waste are recorded such as paper waste, plastic waste, construction waste, glass waste, etc. However biodegradable waste is recycled through the vermicomposting process previously, but now this process is not functioning. The wastes generated in the campus include

(i) kitchen wastes
(ii) wastes from construction sites
(iii) liquid waste (residential and eateries)
(iv) sewage and sludge
(v) biomedical waste
(vi) laboratory chemical wastes
(vii) plastic wastes
(viii) cans and bottles
(ix) damaged or spoiled laboratory glassware
(x) unused tools and machinery including battery
(xi) papers including packaging materials
(xii) electronics waste
(xiii) garden leaves and
(xiv) Sweeping litters, etc.

The University is committed to ensure that all forms of wastes generated are handled based on the RRRR (Reduce, Reuse, Recycle, Recover) principles by adopting appropriate source segregation protocols including safe disposal of bio, medical and hazardous wastes. There are studies from time to time to estimate the amount and nature of wastes, particularly solid waste which indicates the increasing trend of the volume. A preliminary survey reveals the domination of biodegradable components (volume basis) over the non-biodegradable counterparts on the campus. The students' hostels share the highest amount of solid waste mostly dominated by food/kitchen wastes (a substantial amount of papers, plastics, metals are also seen with waste also generated in hostels) followed by residential areas, eateries including shopping complex and offices including academic buildings, construction sites (occasionally), open areas including gardens and roads.

5.2 Waste Management

Biodegradable Waste Management – Vermicomposting Unit

University has taken initiative for Biodegradable Waste Management to compost using processes like Dry & Wet Waste Management. Vermicomposting technology relies upon the conjoint action of earthworms and microorganisms to rapidly transform varied types of solid wastes. Considering the simplicity and flexibility of the technology, a vermicomposting unit was established in January 2009 in the University under the supervision of the Horticulture Section. The primary objectives are to recycle biodegradable waste fractions in a sustainable manner and curtail the cost of purchasing the organic manure from the market for landscaping ventures. Presently, the unit is not running, but the unit was very profitable to the university when operated. So far, the ready-to-use vermicompost was produced entirely from garden waste (grass) and leaf litter of the campus.

Observation:

1. The Vermicompost unit was not running during the time of audit.

Recommendation:

1. It is recommended to restart the vermicompost unit as it is profitable to university as well as for nature.

Initiatives taken by the University for Waste Management

- Glass waste is generated from the laboratory mainly in the form of bottles; Many times, bottles are reused for storing other chemicals.
- The e-waste generated at Dibrugarh University is sent for recycling and reuse.
- Hazardous waste generated in a solid and liquid state during experiments in the laboratory are disposed properly.
- Biodegradable waste is a major solid waste generated on campus, which is further treated by vermicompost technology.
- University has banned single-use of plastic for any administrative as well as other purposes.

Recommendations

- Provision for the installation of garbage unit should be introduced where the multilevel segregation of various wastes such as paper, construction, glass, metal scrap, and food waste should be done. Further various waste recycling plans for different types of waste should be introduced.
- Provision for E-waste management should be introduced in the University Campus.
- Paper waste like answer sheets, old bills, and confidential reports should be sent for shredding, pulping, and recycling after completion of their preservation period.
- Recycling facilities should be introduced and should be supported by City Municipality and private suppliers, including glass, cans, white, colored, and brown paper, plastic bottles, batteries, print cartridges, cardboard, and furniture.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6. ENVIRONMENT QUALITY AUDIT

This includes the plants, greenery, and sustainability of the campus to ensure that the buildings conform to green standards. This also helps to ensure that the Environmental Policy is enacted, enforced, and reviewed using various environmental awareness programs.

6.1 Environment Quality Audit

To keep the greeneries in the campus, the University regularly maintains the gardens which are looked after by concerned staff under the guidance of higher authorities of the University. Activities organized to create greenery and its conservation at the university campus is as follows-

- Plantation of diversified species, Uses of medicinal plants, Identification of plants species
- Waste management plan and disposal facility
- Awareness of carbon consumption and carbon footprint program

Various departmental activities are being carried out every year such as: -

- Plantations and other Landscaping Activities
- Maintenance of Gardens and Landscape
- Maintenance of Plantations

There are three types of vegetation zones in the university campus, which are-

i) Monsoon Deciduous type.

ii) Evergreen type (Indo-Myanmar bio diversity)

iii) Evergreen and Coniferous type (East-Himalayan biodiversity)

The horticultural activities for landscaping and beautification of Dibrugarh University was started by constituting a Landscaping Committee in 1995. There were transformation and redeemed of certain natural vegetation patches for requisite infrastructure development to facilitate the emerging needs for the growth of the university. However, spaces for academic, administrative and recreational areas are delineated in harmony with the landscape to ensure an eco-friendly campus. Horticulture section of the University is looking after all the plantation and other landscaping activities within the University campus under the guidance of a Campus Horticultural Committee. This committee member develops strategies for

smooth execution of plantation, maintenance and overall protection of the landscape. Therefore, greenery of the large area in the campus is well maintained besides keeping remnants of the natural vegetation patches undisturbed. There are block plantation, plantations along roads side, garden space of departmental building premises, and along the residential compounds, while several tree species regenerated naturally and there are seasonal herbaceous plants that cover the whole natural landscapes. Several indigenous trees, shrubs and ornamental plants are carefully selected for the plantation to provide shelter for birds and to deliver a shaded walkway. Massive plantations and different landscaping/beautification activities have already been carried out in different parts of the University campus.

6.1.1 Plantations

Towards the sustainable land use practice, approximately 21,037 plant saplings of different species have been planted in various sites through routine and special plantation drives. This program helps in encouraging an eco-friendly environment that provides pure oxygen within the institute and awareness among villagers. The plantation program includes various types of indigenous species of ornamental and medicinal wild plant species. The plants have medicinal value, which faculty members of the Department of Environmental Science help students to identify with scientific names and give information about medicinal uses of the plants.

S. No.	Community	Total No. of Species
1	Evergreen	79
2	Semi Evergreen	6
3	Deciduous	35
4	Semi Deciduous	4
5	Coniferous/Alpine/Others	5
Total		**129**

6.1.2 Landscaping and Gardening Activities

In addition, to carry out different plantation programs, efforts were also made by the Horticulture Section, Dibrugarh University for beautification of different parts of the University campus by developing flower gardens and other landscaping activities such as the development of lawns, hedges, ornamental and avenue plantations, etc. From July'1997 to March'2021, landscaping and gardening work in most of the prime locations of the University campus like the front side of the Entrance gate, different Administrative and Academic buildings, Guest House, Central Library, Auditorium, Vice-Chancellor's residence, etc. and other amenity centers have been completed. In addition, two Citrus gardens (one near Subansiri Women Hostel and another at the western side of Academic Building-I) have also been developed within the University campus. Moreover, plantation of different types of orchids on the existing trees of different locations of the University campus has also been done for further beautification of the landscape.

Maintenance of Gardens and Landscape

In addition to new plantation drives and landscaping/beautification activities, all essential maintenance work (like lawn, hedge, existing plants /shrubs, growing of seasonal flowers) for previously developed flower and other gardens, as well as other locations of the University campus, is done regularly under the supervision of Horticulture Section.

Maintenance of Plantations

Apart from the maintenance of gardens, all previously planted trees (like roadside and other plantations) in different locations of the University campus are regularly nurtured by cleaning, fertilization, watering, etc.

House Plants

House plants do not just look good – they can make us feel good, too. Studies have shown that house plants-

- Boost our mood, productivity, concentration, and creativity
- Reduce our stress, fatigue, sore throats, and colds
- Help clean indoor air by absorbing toxins, increasing humidity & producing oxygen
- Add life to a sterile space, give privacy and reduce noise levels

Considering the different benefits of house plants, currently, about 950 House plant pots are placed in the interior space of different administrative offices and Academic buildings, Guest House, Library, Auditoriums, VC's residence etc. and other amenity centers for beautification, greenery, and purifying the air. Essential maintenance works of these house plants are carried out regularly under the supervision of the Horticulture Section, Dibrugarh University.

Campus Involvement

For sustainable use of resources and for the mission of "GO-GREEN" it is necessary that the students, faculty, and administration welcome it. Dibrugarh University is an environment that invites opportunities to better its community through campus organizations. The green initiative started on the campus many years ago. The University students are actively participating and solely concerned with the environment. These students under the guidance of faculties strive to create an environmentally friendly campus. Their purpose is to create awareness and eventually act on that awareness. University is also actively conducting environmental awareness programs on campus regularly.

Environmental Conservation Programme

University is very active in the practical education of the students with regard to environmental conservation. The University has arranged visits to their faculties to the Wildlife Institute of India (WII), Botanical Garden, Sanctuaries, Zoological Park Sacred grooves in order to educate their students. The University also took their students to different National Park in order to educate the students about in situ Conservation of Wildlife.

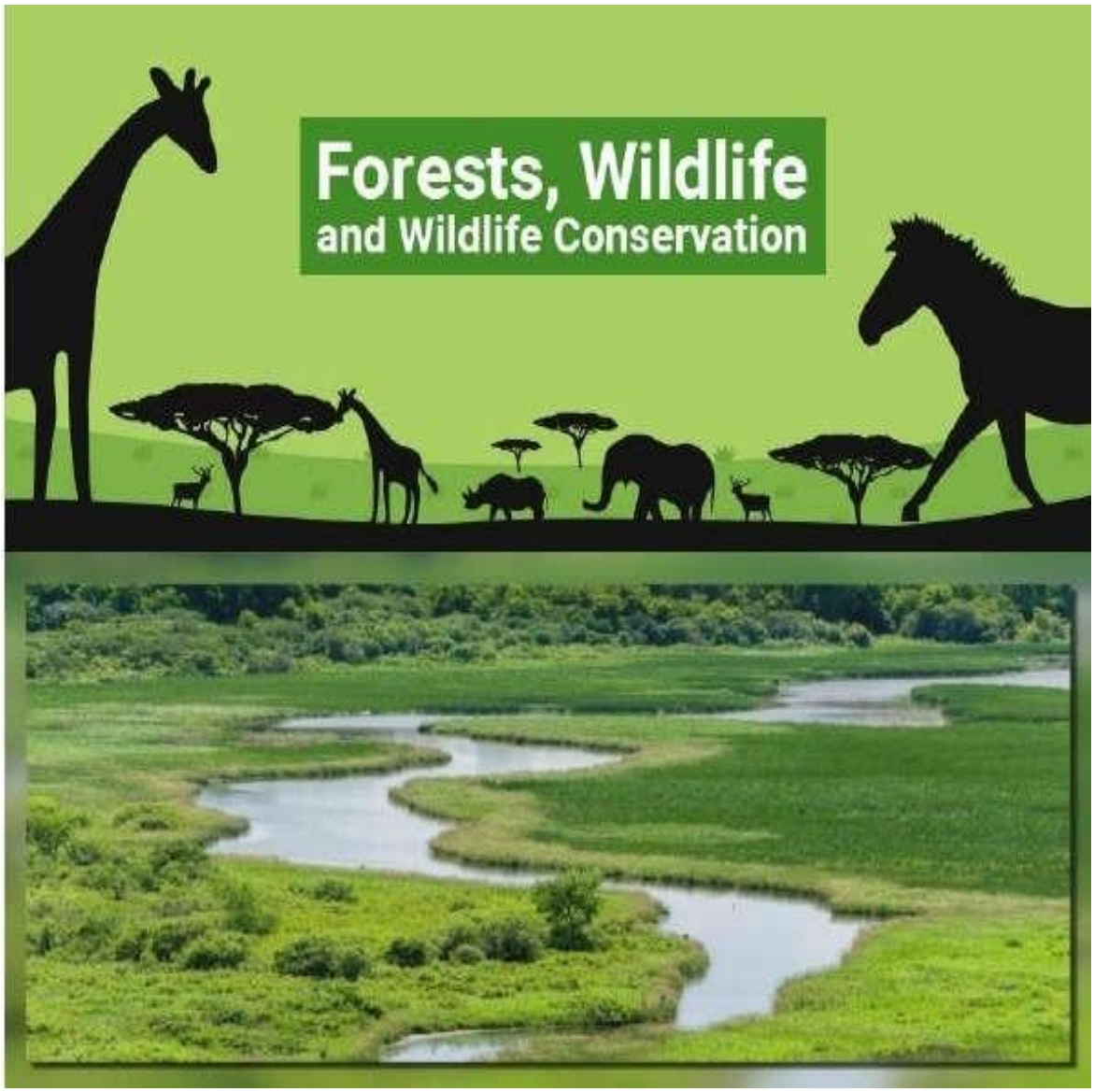
6.2 Ambient Air Quality in The Dibrugarh University

Sr. No	Parameters	Unit	Result	Requirement permissible limits as per NAAQS/CPCB	Test Method
1	Particulate Matter, PM10	µg/m³	88.9	100	IS:5182 (P-23): 2006
2	Particulate Matter, PM 2.5	µg/m³	50.2	60	SOP1/Ambient Air/01/010416
3	Sulphur Dioxide (as O2)	µg/m³	8.0	80	IS:5182 (P-2): 2006
4	Carbon Monoxide (as O)	mg/m³	0.930	04	IS:5182 (P-10): 1999
5	Oxide of Nitrogen (as O2)	µg/m³	20.3	80	IS:5182 (P-6): 2006

Central Pollution Control Board, New Delhi has set guidelines to monitor and analyze the air pollution quality parameters. The trees cover on the campus are the leading sources to absorb CO2 and release enough fresh O_2 across the University Campus. The result shows that Dibrugarh University Campus's air quality status is good as compared to other locations. It is identified that Dibrugarh University's campus is a green campus. University campus observed minimum air pollution as compared to other Ambient Air Pollution Centers located in different parts of the city.

Precautionary measures

- Avoid using diesel generators


Forests, Wildlife
and Wildlife Conservation

7. CARBON FOOTPRINTS

Carbon is the basis of life on mother Earth. It is absorbed by the plants through photosynthesis, consumed by animal species through the food, present in the form of carbon dioxide (CO_2) in the atmosphere, locked into the rocks like limestone, and compressed into the different fossil fuels such as coal and oil. As CO_2 levels in the atmosphere continue to increase, most climate designs or projects that the oceans of the world and trees will keep soaking up more than half of CO_2. The plants on land and in the sea, taken up carbon over many years increased the percentage discharged during decay, and this increased carbon became locked away as fossil fuels beneath the surface of the planet. At the beginning of the 21st century, we brought growing concern about global warming, climate change, food security, poverty, and population growth. In the 21st century, more carbon has been released into the atmosphere than that has been absorbed. CO2 is a principal component causing global warming. Atmospheric carbon dioxide levels have increased to 40 % from preindustrial levels to more than 390 parts per million CO2. On this background, it is a need of time to cover the research areas interrelated with climate change.

7.1 Carbon foot prints

In today's world, one of the biggest issues faced by all of us is global warming. Global warming refers to an increase in the average global temperature of mother Earth. The main cause of global warming is an increase in the concentration of greenhouse gases (GHGs) in the atmosphere due to anthropogenic activities and their level is determined with the help of global warming potential (GWP) and expressed as Carbon Footprint (CF). Carbon Footprint is another phenomenon used for GHGs or carbon dioxide emission in terms of CO2 equivalents. There are various definitions of carbon footprint are in literature. But the most recognized definition given by Wiedmann is *"the Carbon footprint is the measure of carbon dioxide emissions directly or indirectly caused by an activity or accumulated over the life stages of a product." In other words, "A carbon footprint is the total greenhouse gas (GHG) emissions caused directly and indirectly by an individual, organization, event or product."*

As Dibrugarh University is considered as an institutional organization, various energy resources like electricity, solar rooftop systems are used. It is necessary to calculate the carbon footprint of the University to upgrade the Clean Developmental Mechanism (CDM) in various processes. All the data from the various sources were collected from all the sectors where energy resources are used. The collected data is calculated by using standard emission factors.

Carbon emission from transport in the University

The university has conducted a survey for carbon emission by transport in the year 2020, from which it can be concluded that approximately 1547 two-wheelers, 596 four-wheelers arrive at the university on the working days and on holidays it gets reduced to 610 and 213 respectively. Below is the table which summarizes the carbon emission.

Table 7.1 vehicle pollutant from transportation on working days

Vehicle type	% of CO_2 from total vehicles	Hydrocarbon in PPM from total vehicles	Total
2-wheeler	3.5	6000×(661+886)	9282000
3-wheeler	3.5	6000×(8+17)	150000
4-wheeler	3	15000×(253+343)	894000
Total Hydrocarbon Emission in PPM			10326000

Table 7.2 vehicle pollutant from transportation on holidays

Vehicle type	% of CO_2 from total vehicles	Hydrocarbon in PPM from total vehicles	Total
2-wheeler	3.5	6000×610	3660000
3-wheeler	3.5	6000×17	102000
4-wheeler	3	15000×213	319500
Total Hydrocarbon Emission in PPM			4081500

Total vehicular carbon emission is- 23.98 tons/month

= 287.76 tons/year.

Efforts for Carbon Neutrality

Air pollution is a matter of serious concern on the campus owing to its urban location. Dibrugarh University as a responsible institution understands the importance of its carbon footprint and developed a plan to reduce greenhouse gas emissions in all its activities. Strictly ban on burning of dried leaves and waste paper in University.

Electricity carbon footprint

In the university, electricity is used for various purposes such as residential, office use, and laboratories. The total electricity used in the University liberates mass kg of CO_2 per year. The laboratory equipment consumes the highest electricity which emits a large amount of carbon CO_2 per year. The solar panels are installed on the roof of various buildings produce electricity from solar panels which further saves ample mass of CO_2 per year.

Paper footprint

The papers are used in the institution for various purposes like exam answer sheets, circulars, notices, office work, etc. The papers are responsible for the emission of CO_2. The University used a total used 1,765.17 reams of paper which emits 3.67 tons of CO_2. On the University campus, various departments follow paperless methods of communication to reduce the footprint by the use of papers. The various sections on the campus save 13, 48,914 papers per year i.e. 2,697 reams. The paperless work reduces approximately 5.61tons of CO2 approximately. A total of 2.80 tons of biomass is saved by paperless communication i.e. green computing.

The total footprint of the University

The total footprint is the addition of all the footprints and it is expressed as tons of CO_2 per year. The total footprint of Dibrugarh University is approx. more than 10,000 tons of CO_2 per year approximately. As the university is following the Clean Developmental Mechanism to reduce the emission of CO_2 and greenhouse emission by using solar panels for electricity generation and minimize the paperwork at the university reduces of 18.10 tons of CO_2 per year approximately.

Conclusion

India's CO2 emission is increased by an estimated 4.6 % in 2017, despite a turbulent year for its economy. The carbon footprint of the nation is measured per person; India's emissions are still very low – at only 1.8 tons of CO2 per capita which is much lower than the world average of 4.2 tons. But those emissions have been increasing steadily, with an average growth rate over the past decade of 6 %. The universities are the organizations which are having large areas which consume high quantities of electricity and LPG for many purposes. The Dibrugarh University Campus emits approx. 24,000 tons of CO2 per year approximately. The present Clean Development Mechanism (CDM) practices to reduce the 18.10 tons CO2 per year approximately.

Recommendations

- The food waste generated from university hostel mess, guest house, canteens, and staff quarters should be converted into biogas which can be further utilized for hostel kitchens.

- The solar battery-operated vehicles should be used on the campus to overcome the vehicle footprint.
- Green computing or E- work is helping the organization to reduce footprint very effectively.
- The solar energy-based street lamps on campus will reduce carbon footprint.
- The awareness should be made among the faculty, students, and other employees regarding Clean Development Mechanism (CDM) to reduce the consumption of electricity and natural resources.
- "Carbon Sequestration" survey should be conducted on the campus. Carbon sequestration is a process of converting atmospheric carbon i.e. CO_2 into other sinks of carbon such as vegetation, soil, ocean, etc. in various forms to mitigate global warming audit is one of the important clauses of the Kyoto Protocol.

Carbon Sequestration

While transforming ourselves from regional universities to global universities, the need of such universities to face the global future challenges and try to find out possible solutions for them. It is a social and environmental responsibility of Government Institutes, Universities, National and International Organizations to respond positively to various global issues at the local level and should collate the generated knowledge into the society. Global warming and climate change are current environmental issues that need to be addressed scientifically and efficiently. As Universities are provided with skillful human resources supported by analytical infrastructure, it is our duty to bring such ideas into practice.

8. GREEN INITIATIVES

University is located in the area which is one of the important wilder areas of Dibrugarh city with its precious biodiversity. It covers an area of about 500 acres. The major portion is covered with vegetation. The university aims to protect and conserve its biodiversity, fresh and clean ambiance through many initiatives. The university has taken the following green initiatives to protect and conserve nature.

Plantation and Nurturing Programme

Many plantation drives are taken by the University on its campus. Every year on 5th June i.e. World Environment Day, the University takes Plantation activity. Under 33 Crore tree plantation scheme of Government. University has taken many plantation drives. The Horticulture Section looks after tree plantation activities. The trees are watered by students of various Departments. They nurture these trees throughout the year. Students of various departments and students make the plantation and nurturing program successful. A total of 23 plant saplings of different species (like ornamental, fruit and medicinal plant, etc.) were planted in various sites of the University campus during this year's environment day program.

Green computing practice

Being an academic institution, papers are used for various purposes like exam answer sheets, circulars, notices, office work, document printing, and Xeroxing. Since the trees are cut for paper manufacturing, the sequestration of carbon is reduced increasing carbon footprint. To cut down the carbon footprint, the university administration and various departments follow paperless methods of communication by using emails, online forms submission, etc. The paperless work was helpful in reducing tons of CO2. The tons of biomass are saved by this green computing practice.

Solar Electricity Generation

The University has installed a 100KW (non-operating) capacity Solar Power Plant for electricity generation which produces electricity and sends it to the local grid which is helpful for an electricity bill reduction. Most of the buildings are constructed considering the need for Light and ventilation which reduces the use of electricity. The air conditioners are used only in essential conditions in the laboratories and offices to reduce electricity consumption.

Conferences and workshops on Environmental Sustainability

Dibrugarh University organizes Conferences and Workshops based on the theme of environmental sustainability.

9. CONCLUSIONS

Green Audit is one of the important tools to check the balance of natural resources and their judicial use. Green auditing is the process of identifying and determining whether institutional practices are eco-friendly and sustainable. It is a process of regular identification, quantification, documenting, reporting and monitoring of environmentally important components in a specified area. The main objective to carry out a green audit is to check the green practices followed by the university and to conduct a well-defined audit report to understand whether the university is on the track of sustainable development. After completing the audit procedure of the university for green practices, there are the following conclusions, recommendations, and Environmental Management Plan (EMP) which can be followed by the university in the future for keeping campus environment friendly.

- University takes efforts to dispose of majority of waste by proper methods. Green computing i.e. Online payment systems, online circulars, and examination procedures are helpful for reducing the use of papers and ultimately reducing carbon footprint.
- Reducing the use of one-time use plastic bottles, cups, folders, pens, bouquets, decorative items will be useful to solve the problem of plastic pollution to some extent.
- Biodegradable waste is used efficiently for composting and vermicomposting.
- Use of LED lamps and Tube Lights is to be encouraged.
- Toilets and bathrooms are consuming more water in the departments. The replacement of old taps can be beneficial for solving this issue
- The use of electric cars on the campus is a good initiative to save fuel.
- The overall ambient air quality on the campus is good while some air quality issues that may arise due to developmental activities on the campus should be addressed. The sound levels on the campus are good.
- Science departments are following the principles of Green Chemistry to reduce chemical waste.

Key Recommendations & Environment Management Plan (EMP)

Following are some of the key recommendations for improving the campus environment and to be considered as Environment Management Plan (EMP).

- An environmental policy document has to be prepared with all the recommendations and current practices carried by the university.
- A frequent visit should be conducted to ensure that the generated waste is measured, monitored, and recorded regularly and information should be made available to the administration.
- The university should develop internal procedures to ensure its compliance with environmental legislation and responsibility should be fixed to carry out it in practice.
- The solid waste should be reused or recycled at maximum possible places.
- Installation of sensor-based electrification items like fans, lights, etc. can save electricity
- Installation of solar panels and rainwater harvesting system to every terrace of the building will be useful in conserving the natural resources.
- Regular checkups and maintenance of pipes, overhead tanks, and plumbing systems should be done by the engineering section to reduce overflow, leakages, and corrosions.
- Science laboratories large amount of water goes waste during the process of making distilled water; the system should develop to reuse this water for other purposes. The solar distillation unit is installed at the earliest.
- No such processes or activities were observed at Dibrugarh University which can deteriorate the environmental quality.
- The University is in continuous efforts to spread the environmental awareness programs among staff and students.
- It was also observed that the said University is keeping the environmental quality at priority in every developmental stage.

DEVELOPMENT IS AN IMPORTANT ASPECT OF ANY ORGANIZATION, COLLEGE, OR UNIVERSITY. THIS DEVELOPMENT BY DIBRUGARH UNIVERSITY IS ALWAYS ACHIEVED AT THE EXPENSE OF ENVIRONMENTAL REHABILITATION.

WE ARE GLAD TO DECLARE THAT DIBRUGARH UNIVERSITY IS AN ENVIRONMENT-FRIENDLY UNIVERSITY ALONG WITH MANY GREEN DEVELOPMENT PROCESSES THAT ARE FAIRLY PRACTICED BY THE UNIVERSITY.