Sathyabama Institute of Science and Technology

Green Audit & Energy Audit

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Centre for Waste Management

Audited by

WasmanPro Environmental Solutions LLP

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EXECUTIVE SUMMARY

"The environment is where we all meet and where we all have a mutual interest; it is the one thing we all share." The Earth, our shared environment, is a resource we must collectively protect and nurture. Humanity has a profound responsibility to safeguard nature's resources, ensuring their preservation for future generations.

National growth begins within educational institutions. Academic leaders play a pivotal role in mobilizing internal and external resources, fostering sustainable resource use, and supporting knowledge that ensures minimal environmental impact. A key area in sustainable development is energy usage, particularly electrical energy, which is essential for human progress and well-being. With demand for electrical energy rising steadily, the gap between supply and demand is widening. Addressing this challenge requires both the efficient use of available electrical energy and the adoption of renewable sources to supplement demand. Energy efficiency can only be achieved through continuous monitoring, control, and regular energy audits.

An energy audit within an educational institution involves gathering primary and secondary data, conducting walkthrough inspections, surveying building and equipment energy flows, and analyzing methods for conservation. This process aims to identify ways to reduce energy input without compromising institutional output. At Sathyabama Institute of Science and Technology, the audit process included walkthrough inspections, discussions with management on policies and records, and engagement with staff and students to implement recommended mitigation measures. The process incorporated interviews, data collection through questionnaires, record reviews, and observation of campus practices.

The baseline data collected for Sathyabama Institute of Science and Technology will serve as a valuable resource for campus greening, resource management, and the planning of future sustainability initiatives. It provides a foundation for comparing operations with peer institutions, identifying improvement areas, and prioritizing future projects. With management's commitment to implementing audit recommendations, the institution can advance towards sustainable development, benefiting both the campus community and the environment.

CHAPTER 1

1. INTRODUCTION

1.1. About Sathyabama Institute of Science and Technology

Sathyabama is a prestigious institution which excels in the fields of Engineering, Science and Technology for more than three successful decades. It offers multi-disciplinary academic programmes in various fields of Engineering, Science, Technology, law, Dental Science, Pharmacy, Nursing, Management, Arts and Science and Allied Health Sciences. It is established under Sec.3 of UGC Act, 1956 and is been Accredited with 'A++' Grade by the National Accreditation and Assessment council. The Institution persistently seeks and adopts innovative methods to improve the quality of higher education and is responsive to the changes taking place in the field of education on a global scale. The Institution has a team of dynamic and outstanding faculty, innovative pedagogical practices, state of the art infrastructure and world class Research Facilities. This glorious Institution is functioning under the dynamic leadership of Dr. Mariazeena Johnson, Chancellor, Dr. Marie Johnson, President, Mr. J. Arul Selvan Vice President, Ms. Maria Bernadette Tamilarasi, Vice President and Ms. Maria Catherin Jayapriya Vice President.

Sathyabama has a good presence in rankings and ratings at National and International level. The Institution has been ranked in 51st position by the National Institutional Ranking Framework (NIRF), Government of India among the Universities in India for the year 2023 and ranked one among the top 100 Universities for eight consecutive years. Sathyabama is ranked among the Top 5 Institutions in the Country for Innovation by ATAL ranking of Institution for Innovation Achievements, Govt. of India. Times Higher Education and QS has ranked Sathyabama among the top Institutions worldwide. Sathyabama Institute of Science & Technology has alliances with leading Universities and research establishments at National and International Level. It is a research-intensive University with world class laboratories and research facilities and is involved in research in the emerging areas of Science and Technology. Sathyabama has undertaken various sponsored and collaborative R&D projects funded by National and International Organizations. Sathyabama has written a special page in the history of space research on 22nd June 2016 with the launch of "SATHYABAMASAT" in association with ISRO. Sathyabama has emerged as a leading Institution and achieved excellence in higher education to international standards owing to its research and academic excellence.

Figure 1: Campus View of Sathyabama Institute of Science and Technology

Figure 2: Layout Plan of the Sathyabama campus

1.1.1. Vision of the Institute

Sathyabama Institute of Science and Technology envision being a leading multidisciplinary Institute, producing world class talents to address global challenges.

1.1.2. Mission of the Institution

- To attain excellence in Education and Research through effective collaboration with Industries and other International/National organisations
- To consistently remain an attractive ecosystem for students and employees, a hub of innovation for researchers and an incubating platform for entrepreneurs
- To create an inclusive environment that caters to all forms of diversity
- To engage in outreach and community development activities, creating an impact on the society

1.1.3. Objectives of the Institution

The Institution endeavours to prepare its student for fulfilling careers by enabling them to realize their full potential and by inculcating in them the spirit of intellectual enquiry, independent thinking, self-reliance, leadership, co-operation, expression of cultural talents and service to society.

1.1.4. Core Values of the Institution

Sathyabama Institute of Science and Technology is committed in practices that are fair, honest and objective in dealing with students, faculty members and other stake holders, which fosters a climate of ethical conduct, respect, responsibility and trust. Sathyabama Institute of Science and Technology believes in stakeholder partnership for holistic Institutional development and to promote a healthier working atmosphere with the following core values.

- **Integrity:** We emphasise on high ethical standards in our actions and are committed in being transparent, responsible and accountable.
- **Nobility:** We inculcate ethical values parallel to the curriculum enrichment to the student community, so that they outstand amongst their peers irrespective of the environment in which they are placed.

- **Sustainability:** We develop, practise and emphasize protocols in academics and research enabling ourselves to be competitive, ensuring environmental and social sustainability.
- **Partnership and Collaboration:** We encourage academic and research partnerships with organisations and Universities at National and International level. We value and applaud the relationships we have with our partners.
- **Inclusion and Diversity:** We are committed to facilitate diverse student and Faculty culture and encourage multi-cultural learning in the University. We provide opportunity to work, learn and embrace the diversity of every individual irrespective of race, gender, religion, nationality, age, social background, physical ability and mental competence.
- **Responsibility**: We believe in Education for all. We take pride in owning responsibility and commitment towards society by supporting the education of students from rural, economically backward communities, differently abled and acid attack victims with full Financial Assistance.
- **Excellence:** We focus on excelling in all our academic and research activities, ensure best academic quality in our programmes, encourage innovations and receptive to the ever-changing needs of our stake holders.

1.2. About WasmanPro Environmental Solutions LLP

WasmanPro has in-depth understanding and practical experience with Environmental and Energy Audit, Green Practices, Environmental Policies, Regulatory Programs, and Remediation Strategies. The firm offers comprehensive regulator address a full spectrum of air, water, wastewater and hazardous waste issues, regulations, and policies. Drawing up on the collective experience of the team, it has developed technically sound and cost-effective strategies to achieve environmental compliance. The development and implementation of these strategies have led to:

- Faster Consent Management Services
- Reducing waste streams
- Improving mechanisms to track consent conditions
- Executing effective monitoring
- Implementing phased compliance and clean up strategies

1.2.1 Core Environmental Compliance & Remediation Services

WasmanPro helps clients in adopting advanced environmental sustainability, maintain environmental compliance, and reduce environmental diverse set of core services including:

- Environmental Compliance
- Air Emission Inventories and Reporting
- Air Quality and Clean Air Act Compliance
- Environmental Due Diligence
- Environmental Impact Assessment
- Site Investigation and Feasibility Studies
- EHS Audits & Training
- Environmental Management System and Compliance Auditing
- Environmental Monitoring
- Ground water and Sub surface Investigations
- Green Audit
- Soil Management Plans
- Hazardous and Solid Waste Management Plans
- Remedial Design and Monitoring
- Brown field Cleanup
- Pollution Prevention Plans
- Environmental, Health and Safety Plans
- Hydro geological studies

M/S WasmanPro Environmental Solutions LLP has also undertaken several Environmental and Energy Audits as per NAAC requirements.

1.2.2. WasmanPro Team

M/S WasmanPro Environmental Solutions LLP is spearheaded by Dr. K. Karthikeyan, a certified Lead Auditor for ISO 14001, sha 18001 certified by CII-NABET certification program.

Dr. Karthikeyan was former Member Secretary of TNPCB and has vast experience in the field of Environmental Impact Assessment (EIA), Marine Impact Assessment (MIA), Solid Waste Management (SWM), Environmental and Social Management Framework (ESMF), Disaster Management Plan (DMP), Risk Assessment, Water and Wastewater treatment, Training of Engineers. The Company is also lead by senior retired professionals like G. Sathiamoorthi, Former Engineering Director Chennai Metropolitan Water Supply and Sewerage Board

(CMWSSB), V. Ganesan, Former Member State Environmental Impact Assessment Authority, Government of India, K.M.M. Annamalai, with more than 35 years of experience in EPC Project Management in various private sector companies, T.S. Murli with rich experience in various project executions and project management in several private sector companies. WasmanPro has talented & committed employees as engineers and scientists across multiple sectors.

1.2.3 Internal Audit Team

The audit is conducted by members of the Centre for Waste Management with due support and association from the faculty members of various teaching and non-teaching departments of the institution.

Following members are associated in the Audit

Centre for Waste Management
Dr.Dawn S S
Dr.J.Arun
Dr.Nirmala N
Dr.P.Priyadharsini
Dr.M.Sivasakthi
Dr.R.Sathish Kumar
Mr.A.Santhosh
Mr.J.Jeyakanth
Ms.A.Bhuvaneswari

Department of Chemical Engineering
Dr.S.Sathish
Dr. A.Annam Renita
Dr.Prabhu D
Dr.D.Venkatesan

Department of Electronics and Communication
Dr.S.Barani
Dr.S.Poornapushpakala
Dr.M.Subramoniom

Chapter 2

GREEN AUDIT

1. Introduction

The process of finding and evaluating an institution's eco-friendly and sustainable practices is known as "green auditing."

The objective of the green audit is to examine environmental practices both on and off institution campuses, as this will influence the environment-friendly environment. The term "green audit" refers to the methodical identification, measurement, documentation, reporting, and analysis of elements that make up the institution environment. At Sathyabama Institute of Science and Technology, the Green Audit was started with the intention of examining the activities conducted by the institutions that may pose a risk to the environment and public health.

A direction for enhancing the environmental structure is provided by the green audit, and the audit's expansion has been influenced by several causes. The campus community must make a sustained commitment to ongoing environmental improvement to create an eco-friendly green campus. Green campuses make it a point to incorporate sustainable living into the planning and management of their structures. In a campus yard, trees provide soothing shade that lowers temperatures and enhances the quality of the air. A single mature tree can take in and release up to 48 pounds of carbon dioxide from the atmosphere in a single year.

The presence of trees on our campus has a positive effect on our mental health as well. Research has shown that trees significantly lower stress, which is important because many students experience some level of stress. To reflect the role the institution has been playing in reducing the impacts generated by its varied activities, every educational institution is required by law to undertake green audits.

2. Key methodologies adopted for green audit

1) On-site survey for assessment of green coverage with the involvement of students and staff.
2) Identification of marshy areas/ miniature ponds within campus to spot the greenery surrounding it.

3) Recording the plants and trees available and categorizing the same based on species with identification of botanical names.
4) Identification of various strategies adopted in maintaining the green coverage as an initiative of the Institution's Environmental Management Plan.
5) Provision of recommendations for improvisation in the green coverage considering management practices based on the survey findings, including an assessment of the total green coverage area on campus.

3. Green Audit-Survey/Questionnaire

The following questionnaire was used as the basis to study the institution's green coverage

- Does the institution have a garden, and if so, what is its size?
- How much time do students typically spend in the garden?
- Provide a list of plants in the garden, along with approximate quantities for each species.
- Detail the species planted by students, including the respective quantities.
- Are the scientific names of the trees displayed on the campus?
- Are there any plantations on the campus? If so, specify the type and area.
- Is there a vegetable garden in the institution, and if yes, what is its size?
- Is there a medicinal garden in the institution, and if yes, what is its size?
- Specify the vegetables cultivated in the vegetable garden and provide the quantity harvested in each season.
- Detail the water usage in the vegetable garden, including the quantity of water utilized.
- Is recycled water employed for gardening?
- Is organic farming practiced in the institution?
- Does the institution have a composting pit or any other mechanism for composting the organic waste generated?
- Is there a student market on the campus?
- Enumerate the number and names of medicinal plants in the institution.
- Are any threatened plant species planted or conserved?
- Does the institution have a nature club?
- Is there an arboretum on the campus?
- Are there fruit-yielding plants in the institution?
- Does the institution have a grove?

- Is there an irrigation system in place?
- Describe the type of vegetation in the surrounding area of the institution.
- Provide details about nature awareness programs conducted on campus.
- How are students involved in the management of green cover?
- What is the total area of the campus covered by trees or under tree canopy?
- Share ideas for further improving the green cover on campus:

4. Green Audit- Key Findings

- **List of plants/trees in the garden**

  The plants depicted below with scientific names displayed are available in the campus green coverage.

- **Species planted by students, including the respective quantities**

  Students were involved in planting the following during eco club camps and club activities including environment day celebrations, NSS activities etc.,

S.No	Botanical Names	No. of plants
1	*Acacia auriculiformis*	15
2	*Saraca asoca*	25
3	*Bambusa arundinacea*	30
4	*Bougainvillea*	25
5	*Millettia pinnata*	15
6	*Terminaliacatappa*	20
7	*Hibiscus rosa-sinensis*	35
8	*Citrus limon*	15
9	*Jasminum officinale*	25

- **Vegetables cultivated**

  Microgreens, raw banana, tomatoes, chillies, lemon

- **Water usage for gardening**

  50 KLD to 60 KLD of treated water is being used

- **Recycled water usage**

  The treated water from the sewage treatment plant apart from utilized in hostel flushes is also being used for gardening

- **Organic farming practices**

Chemical based fertilizers have been eliminated and have been replaced with bio-composts. Focus has been given on soil health and composting.

- **Mechanism for composting the organic waste generated**

  Accelerated Composting is practised in the STI Hub project operating site, where the vegetable wastes are composted using a microbial consortium that reduces the composting period from 45 days to 14 days. This not only increases compost productivity but creates venue increased quantity of vegetable waste processing

- **Student market in campus:**

  Sales has been initiated in campus and off campus with the involvement of project students and staff associated with Science Technology and Innovation Hub and Agri Hub established by the Investigators of the institution operating DST-SEED funded projects though their Startups Poobas Pvt. Ltd for the sales of Hydroponics cultivated microgreens and sprouts; BiGlySo Pvt. Ltd for the sales of Accelerated Bio-compost to popularize the indigenous products promoting green coverage.

- **Medicinal plants in the institution:**

  A green house is being maintained to study the medicinal and aromatic plants and how they can be utilized for health and environmental benefits

- **Fruit-yielding plants in the institution**

  Coconut and banana are cultivated in the campus

- **Irrigation system implemented:**

  Drip irrigation is installed in various locations to nourish the green coverage

- **Types of vegetation in the surrounding area of the institution:**

  Paddy is majorly cultivated along with vegetables including brinjal, radish, snake gourd.

- **Green Coverage awareness programs conducted on campus:**

  Awareness programmes are conducted frequently during Seminar sessions of the various departments with the involvement of faculty related with the Eco Club to create an impact on the students on maintaining the green coverage in the institution. Role of plants in air and water remediation, how green coverage contributes in Carbon reductions, effects of composting from environmental and plant health insights were addressed during the awareness programme.

  Awareness on Alternate farming techniques- Hydroponics for the cultivation of Cash yielding crops including horticultural harvests like tomatoes, chillies, cucumber,

spinach, greens, turmeric ; Cultivation of Medicinal plants and their applications were consistently given to the students, staff and other stake holders associated with the institution

- **Students' involvement in the management of green coverage:**
  Student volunteers in the Eco Club and project students involved in composting related research pursued in the School of Bio and Chemical Engineering, Centre for Waste Management have been assigned specific areas in the campus to monitor the growth of the plants and capture the patterns with effect of seasonal variations, watering, manure addition etc.,
- **Total area of the campus covered by trees or under tree canopy**
  The Sathyabama Institute of Science and Technology boasts an expansive green cover, encompassing approximately 39,500 square feet. Within the institution, there is a marshy land area spanning 5,120 square meters, serving as a habitat for numerous bird species, including migratory birds.
- **Ideas for further improving the green cover on campus**
  Scope for organizing indoor air remediating plants that can remove Volatile Organic Compounds.

Acacia auriculiformis

Cocos nucifera

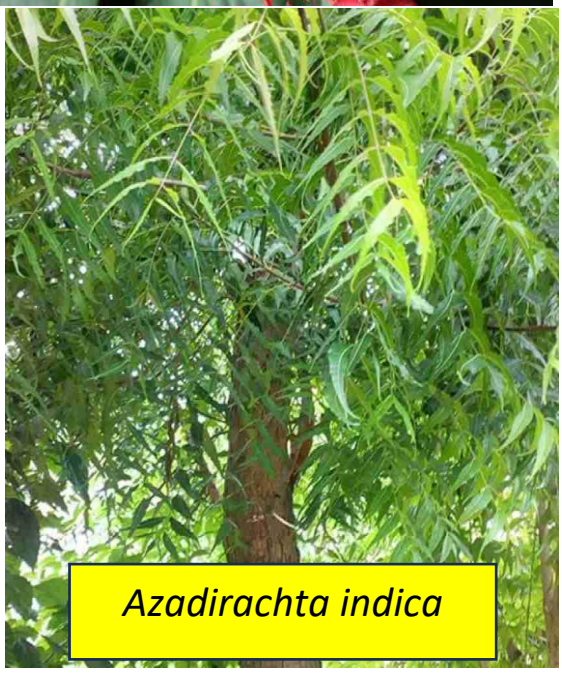
Bambusa arundinacea

Saraca asoca

Bougainvillea

Ixora coccinea

Millettia pinnata



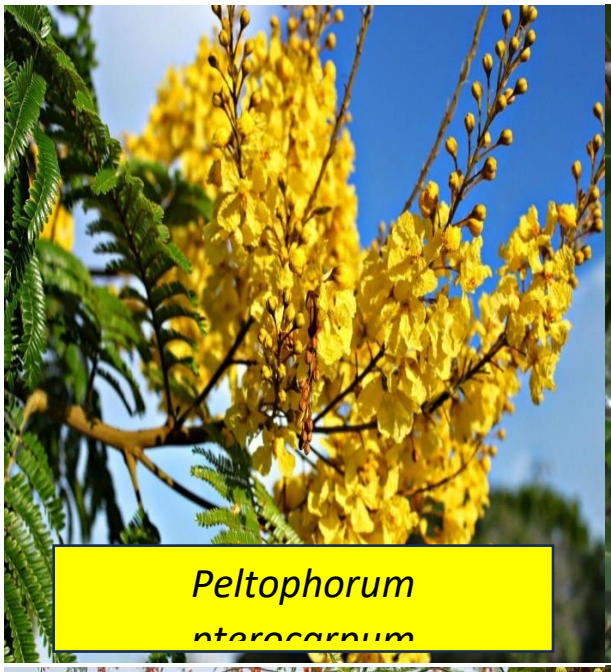
Azadirachta indica

Samanea saman

Casuarina equisetifolia

Terminalia catappa

Hibiscus rosa-sinensis

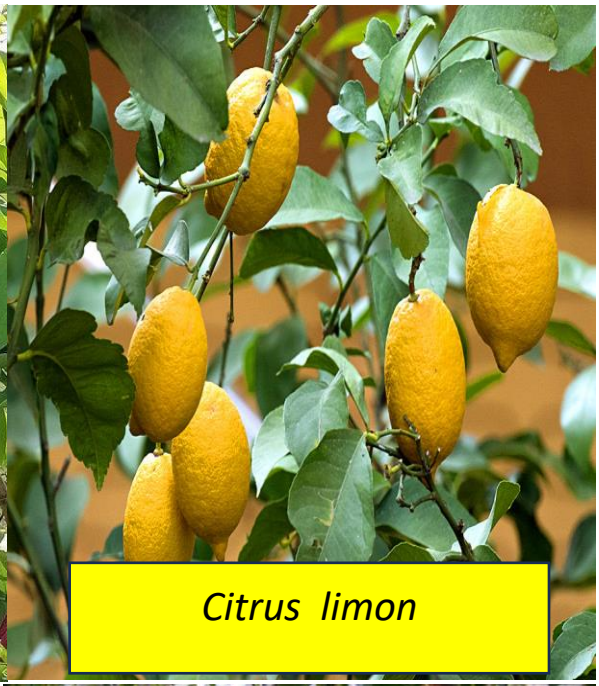


Peltophorum pterocarpum

Calophyllumino phyllum

Delonix regia

Psidiumgua java



5. Green Audit-Evaluations and Recommendations

The well-being of the environment in which we reside is of paramount importance as it directly impacts our survival. It is the responsibility of every individual to contribute to its health. The audit of the university campus aims to determine whether the measures implemented by the university are adequate to create an environmentally friendly campus.

Throughout the audit, a comprehensive assessment of various trees and plant species was conducted, and the extent of green coverage was analyzed to ensure compliance with

established green standards. The audit was carried out to verify that the campus practices align with the recommended Green Policy , and all endeavours to enhance green coverage within the campus were meticulously documented.

The audit involved a thorough examination of the measures and actions taken by the authorities to protect and conserve the environment in and around the campus.

A comprehensive green audit was conducted for Sathyabama, and the findings are outlined as follows:

Best Practices Observed in the Institution- Green campus management

- The campus organized several plantations drives actively involving students.
- The institution preserves a natural Marshy Land, serving as a groundwater recharge area and providing a habitat for local birds.
- The Eco-club successfully developed eco-organic fertilizers, Centre for Waste Management has developed a Accelerated Bio compost derived from vegetable waste
- A terrace garden was inaugurated at the Chemical Engineering Department.
- The Eco-club, in collaboration with the Rotaract Club of Sathyabama, established for a 100 sq.ft.terrace gardens in various locations, including the Administration building, International Research Centre, ECEB 14th classroom Block, Biotechnology Department, and Chemical Engineering Department.
- The fifth phase of terrace gardening incorporated the use of PET materials.
- Numerous seminars were conducted to raise awareness about various gardening practices.
- Staff and students collaborated to implement scientific methodologies for the preparation of Bio Manure and organic pots.
- Workshops were organized to promote awareness about Vermi Composting practices, Carbon Credits, and the generation of wealth through Waste (WOW).
- A workshop on seed balls, a permaculture technique for easy and effective seed growth, was conducted.

5.1 Consolidation of Green Audit Findings- Evaluation

The Green audit at Sathyabama Institute of Science and Technology comprised three stages: pre-audit, on-site audit, and post-audit. During the Preliminary audit, a comprehensive

walkthrough of the entire institution was conducted, encompassing the assessment of the marshy land area within the campus.

Discussion with administrative officers and staff included an examination of campus maintenance practices such as grass cutting, trimming frequency, dry leaves collection frequency, watering frequency, and the type of manure used.

During the pre-audit stage, efforts were made to gather information on nature conservation activities conducted by the institution's nature club.

Information gathered during the audit included details on tree types and numbers, the presence of endangered species, and any horticulture plantations on campus. On-site walk-through surveys documented the presence of various plant species, including their scientific names.

The on-site audit assessed the efficiency of watering points, examined the implementation of drip irrigation, and engaged in discussions with the water division staff regarding water-efficient irrigation, mulching, and vertical farming practices.

Observations during the on-site audit focused on identifying areas where dry leaves and compostable matter were channelled for composting. The quality of the compost was analysed for its suitability as fertilizer for other plants on campus.

The Green Audit addressed environmental practices during construction and expansion activities, aiming to suggest methods for environmental protection. The documentation of green practices analyzed their strength and proposed solutions for a sustainable campus.

During Green Audit it was observed that the e Institution has green cover of 39,500sq.ft and Marshy Land of 5,120 m^2 area.

Continuous identification and assessment of environmental risks and issues were carried out during the audit, with a proactive approach to addressing potential problems.

The audit revealed a Marshy Land covering an area of 5,120 sq.mt, providing a cooling effect, acting as a sunblock, and aiding in pollutant absorption and greenhouse gas nullification. This marshy land also serves as a habitat for water birds and migratory species, contributing to the campus's overall ecological balance.

The institution has diverse plant, tree, and shrub species, enhancing the aesthetics and greenery of the campus. Various initiatives, including plantation drives involving students, kitchen

gardening, and vegetable farming, are actively promoted. Terrace gardening is also encouraged, motivating students to garden on the roofs of various buildings.

The institution actively engages in eco-friendly programs and seminars to raise awareness. It educates about practices such as Vermi-Composting, seed ball creation, and the preparation of bio-organic pots.

Composting pits within the institution receive dried leaves, swept leaves, and plant cuttings. These materials undergo composting, and the resulting organic compost is utilized as manure for plants, trees, and the kitchen garden on campus.

The institution is dedicated to knowledge transfer initiatives for the communities in the adopted villages. This commitment reflects leadership in addressing the foundational challenges of reversing environmental degradation trends and fostering sustainability as stewards of Mother Nature.

Based on the above finding few recommendations that the institution can follow are-

5.2 Recommendation

- Establish a Green Monitoring Forum to stay updated on the latest global developments related to environmental conservation and implement the most viable ideas. The forum will comprise members from the teaching staff and include local individuals with a keen interest in environmental matters.
- Implement a Vermicomposting facility to produce organic manure for plantation purposes.
- Advocate for Indoor Gardening, emphasizing its crucial role in reducing airborne pollution. The careful selection of plants can significantly enhance indoor air quality and overall health. A curated list of suitable plants is provided below.
- Develop and maintain a Green Inventory, where all the green resources available on the campus are documented. This inventory should be regularly assessed, and necessary actions can be taken based on the evaluation.
- These initiatives aim to create a proactive and informed community dedicated to preserving the environment and fostering sustainable practices.

6. Green Audit Conclusion

Conducting an environmental audit for an educational institution involves a systematic examination to assess the institution's environmental responsibility. The primary goal is to identify environmental compliance, pinpoint gaps in the implementation of environmental responsibility, and assess whether the institution is meeting its stated objectives, along with proposing relevant corrective actions. Environmental audits play a pivotal role in monitoring the sustainability practices of an educational institution, helping it be accountable and take necessary measures to become more environmentally sustainable.

Educators worldwide emphasize the importance of institutions going green not only for environmental protection but also for imparting the significance of maintaining ecological balance and ensuring sustainable development to the youth. Environmental and energy audits offer an opportunity to create a clean and healthy environment within the campus.

A green audit, specifically conducted to examine the green coverage area in the campus, assessed whether sustainable environmental practices were adhered to in various daily activities, including construction and expansion. The audit revealed that the institution has a green cover spanning 39,500 sq.ft and a marshy land area of 5,120m^2. The green cover provides a cooling effect, acts as a sunblock, absorbs pollutants, and neutralizes greenhouse gas emissions in the campus. The marshy land serves as a habitat for various birds, offering drinking water to wildlife and maintaining the water table in the surrounding area. Additionally, it acts as a natural rain harvesting structure.

The campus surrounded by diverse plant and tree species, including medicinal plants like Neem. Administration-led initiatives, such as terrace farming, planting saplings, rooftop gardening, vegetable gardening, and kitchen gardening, aim to increase the green cover. The institution follows the principles of "R3" – reduce, recycle, reuse – by diverting dry leaves, leaf trimmings, and other compostable waste to compost pits. The compost generated is used as organic fertilizer, showcasing a commitment to sustainability.

Rainwater harvested in rainwater harvesting pits is utilized to water the plants, and treated effluent water is reused for gardening purposes. The institution actively engages in knowledge transfer to nearby villages on sustainable living practices. These efforts exemplify the institution's commitment to maintaining a clean and healthy environment, reducing environmental impact, and preserving Earth's resources.

Sathyabama Institute of Science and Technology sets an exemplary standard for other educational institutions by demonstrating how to ensure a sustainable population. The environmental audit conducted reinforces the institution's commitment to the environment, with active involvement, action plans, and sustainable practices at every level – from management and teaching professionals to the student community.

This commitment not only fulfils the institution's environmental and social responsibility but also contributes to the broader goal of protecting Earth's resources for future generations. The conducted green audit serves as a significant model for other institutions to emulate and adopt, fostering a collective effort toward a sustainable environment for all.

Indoor Gardening plants Recommended

Certainly, indoor plants are not only valued for their aesthetic appeal but also for their crucial role in mitigating airborne pollution. Selecting the appropriate plants can be a highly effective method for enhancing indoor air quality and overall well-being. There are many chemicals infusing into the indoor air environment because of the usage of toilet and floor washes that cause health problems like headaches, respiratory problems, anemia, marrow disease, and kidney. Hence natural remedies are highly sort. Indoor plants become a recommended solution. This can be achieved by reaching out to a local landscape contractor for the procurement and regular rotation of these plants, ensuring a continuous improvement in air quality within your indoor space. The awareness among students can be created and they can be encouraged to promote cultivation of indoor plants. Following are the advantageous features that encourages cultivation of the indoor plants

- Low maintenance plants that prefer low light conditions.
- Requires little water for growth
- Fast growing and grows well even under Fluorescent light.
- Drought resistant
- Hard to damage or kill.

Details of plants that have been already chosen and cultivated in the institution campus are detailed below.

ALOE VERA

Common name : Aloe vera

Botanical name : *Aloe barbadense*

Environment benefits : Removes formaldehyde, trichloroethylene

Health benefits : A medicinal plant promotes weight loss, diabetes and hepatitis

BAMBOO PLANTS

Common name: Bamboo plant

Botanical name: *Bambusa vulgaris*

Environment benefits: Removes volatile organic carbon in Formaldehyde, Benzene, Air borne faecal matter particles

Health benefits: Can reduce your risk of heart disease This can help people on low-carb diets get the vitamins and minerals they need.

ENLISH IVY

Common name: English ivy

Botanical name: *Hedera helix*

Environment benefits: This removed volatile organic carbon in Formaldehyde, Benzene, Air borne faecal matter particles

Health benefits: improve respiratory issues and antioxidant properties and help treat in asthma, bronchitis

PEACE LILY

Common name: Peace lily

Botanical name: *Spathiphyllum wallisii*

Environment benefits: Removes formaldehyde, trichloroethylene and household carcinogens

Health benefits: helps filter the indoor air, increase the levels of humidity, helps inmates breathe better

DAISY PLANTS

Common name: Daisy plant

Botanical name: *Gerbera daisy*

Environment benefits: Removes formaldehyde trichloroethylene and benzene

Health benefits: People use wild daisy for bleeding, cough, bronchitis and wounds

CHINESE EVERGREEN

Common name: Chinese evergreen

Botanical name: *Aglaonema sp*

Environment benefits: This removes formaldehyde, trichloroethylene and benzene

Health benefits: Emits high oxygen purifies indoor air

DRAGON TREE

Common name: Dragon tree

Botanical name: *Dracaena marginata*

Environment benefits: Reduces formaldehyde, trichloroethylene, benzene , toluene from air

GERBERA DAISY

Common name: Gerbera daisy

Botanical name: *Gerbera jamesonii*

Environment benefits: This removes volatile organic carbon in formaldehyde trichloroethylene

Health benefits: helps relieve stress and anxiety very well, they are excellent oxygen producers

PHILODENDRON

Common name: Philodendron

Botanical name: *Philodendron coradatum or selloum*

Environment benefits: Removes formaldehydes especially higher concentrations

Health benefits: Philodendrons release oxygen, helps increase oxygen levels

SNAKE PLANT

Common name: Snake plant

Botanical name: *Sansevieria trifasciata*

Environment benefits: Absorbs toxins such as nitrogen oxides & formaldehyde

Health benefits: This removes toxic pollutants and effective against allergies

Campus Green Coverage

Chapter 3

ENERGY AUDIT

1. Introduction

Energy demand and reserving of Energy sources for the future has necessitated wise utilization of energy, which primarily begins with evaluating the ways in which energy is available for use, consumed and wasted. The effective way to understand these is to perform Energy Audit. Like previous years the energy audit was pursued in Sathyabama Institute of Science and Technology through the process of

1.1.Collection of primary and secondary data that includes the following

- How many CFL bulbs have been installed? Mention hours of usage (Hours used/day for how many days in a month)
- Energy used by each bulb per month? Forexample-60watt bulb x 4hours x number of bulbs
- How many LED bulbs are used in the Institution? Mention hours of usage (Hours used/day for how many days in a month)
- Energy used by each bulb per month? (KWh).
- How many incandescent (tungsten) bulbs have been installed? Mention hours of usage (Hours used/day for how many days in a month)
- How many fans are installed in the Institution? Mention hours of usage (Hours used/day for how many days in a month)
- Energy used by each fan per month?(kWh)
- How many air conditioners are installed in the Institution? Mention hours of usage (Hours used/day, for how many days in a month)
- Energy used by each air conditioner per month? (KWh).
- How much electrical equipment including weighing balance is installed the Institution? Mention the use (Hours used/day for how many days in a month)
- Energy used by each electrical equipment per month? (KWh).
- How many computers are there in the Institution? Mention hours of usage (Hours used/day for how many days in a month)
- Energy used by each computer per month?(kWh)

- How many photocopiers are installed by the Institution? Mention hours of usage (Hours used/day for how many days in a month).
- How many cooling apparatus have been installed in the Institution? Mention hours of usage (Hours used/day for how many days in a month)
- Energy used by each cooling apparatus per month? Mention hours of usage (Hours used/day for how many days in a month)
- Energy used by each photocopier per month? Mention hours of usage (Hours used/day for how many days in a month)
- How many inverters have been installed? Mention hours of usage (Hours used/day for how many days in a month)
- Energy used by each inverter per month? (kWh)
- How many electrical equipment are used in different labs of the Institution? Mention hours
- of usage (Hours used/day for how many days in a month)
- Energy used by each equipment per month? (kWh)
- How many heaters are used in the canteen of the Institution? Mention hours of usage (Hours used/day for how many days in a month).
- Energy used by each heater per month? (kWh)
- No of streetlights in the Institution?
- Energy used by each streetlight per month? (kWh)
- No of TV in the Institution and hostels?
- Energy used by each TV per month?(kWh)
- Any other item that uses energy (Please write the energy used per month) Mention hours of usage (Hours used/day for how many days in a month)

1.2.Conduct of walk-through surveys and interviews with relevant departments in the institution to understand the following

- Any alternative energy sources/non-conventional energy sources employed/installed in the Institution? (photovoltaic cells for solar energy, windmill, energy efficient stoves, etc.,)
- Frequency of conduct of switch off drills at Institution
- Operation of computers and other equipment on power-saving mode

- Operation time of gadgets (TV, AC, Computer, weighing balance, printers, etc.) on standby mode
- Energy conservation methods adapted by the Institution
- Availability of display boards and sign boards for are displayed for creating energy saving awareness
- Quantity of ash collected after burning fire wood per day in the canteen

1.3.Team visited various locations/ departments in the campus like-

- All blocks including administration block, research centres, departments, laboratories etc.,
- Conference halls
- Auditoriums
- Stadium
- Library
- Sports Room
- Staff Room
- Computer Room
- Canteen
- Prayer Hall
- Common Corridor and Hall Way
- Walkways in the campus
- Kitchen
- Hostels
- Pump House
- Water Treatment Units
- Hospital
- Dental College Campus

2. Key Methodology adopted for Energy Audit

1.The Energy audit was performed to understand where energy is used and which areas are worth focusing on the most.

2.During the audit, all major energy consumption equipment operational efficiency of these equipments done.

3. Base Line data were collected by distributing online questionnaire through Google form to the students and staff and also by conducting interviews among the staff.

4.A walk through survey of the entire facility was conducted for first hand observation and assessment of current level operation and practices.

5. Analysis of past records were done to find the historical usage for base line data collection purpose .

6.Faulty equipment's or equipments having defects were noted down 8. Based on the above findings, the base line data collected were analyzed along with annual Energy bill and analysis of major energy consumption pattern was carried out.

7. Brainstorming was done to find any chance of upgrading the existing system to improve energy efficiency.

2.1. Energy Audit-Key Findings

Following instruments were used to collect data related to energy audit:

- 3-phase power analyzer
- Lux meter
- Power Clamp meter
- Hygrometer
- Anemometer
- Measuring tape
- Ultra-sonic flow meter

The major utilities seen at Sathyabama Institute of Science and Technology are elaborated below:

- Computers and related infrastructure
- Machineries in Laboratories in the departments of Mechanical Engineering, Chemical Engineering, Civil Engineering and Electrical Engineering
- Sophisticated Analytical Instruments in the Research Laboratories
- Air Conditioners
- Refrigerators
- Freezers
- Cooling Systems
- Lighting fixtures
- Ceiling/Standing Fans

- Exhaust fans
- Pumps
- Compressors
- Owens
- Incinerators

Table 1 Major Utilities at Sathyabama Institute of Science and Technology

S.NO	Particular	Quantity
1	Lighting System	13618
2	Fan	12580
3	Air Conditioner	1000 plus
4	Core 2 Duo/Core i3(Board/Process/Ram,HDD/SMPS)	352
5	Core i5(Board/Process/Ram/HDD/SMPA)	43
6	TFT Monitor	5165
7	CRT Monitor	60
8	Keyboard	5165
9	Server	60
10	UPS	100 plus
11	Apple AIO	50 plus
12	DG Set	15 plus

3. Energy System Evaluation

3.1.Lighting System

The Sathyabama Institute of Science and Technology has high lighting load of various type of indoor and outdoor lighting fixture installed at various locations in the campus. The load utilization for light fixtures were estimated based on the number of lights installed in the campus and their wattage. The time of operation was also taken into account while calculating

the total electrical load estimated for burning of lights. The Standard lux level as given in table below was also understood and used for reference

Table 2 Standard lux level in different areas

Activity	Illumination (lux, lumen/$m^{2)}$
Public areas with dark surrounding	20-50
Simple orientation for short visits	50-100
Working areas where visual tasks are only occasionally performed	100-150
Warehouse, Homes, Theatres, Archives	150
Easy Office work, Classes	250
Normal Office work, PC work, Study library, Groceries, Show room, Laboratories	500
Supermarkets, Mechanical workshops, Office landscapes	750
Normal Drawing work, very detailed mechanical works	1000
Detailed Drawing work, very detailed mechanical works	1500-2000
Performance of visual tasks of low contract and very small size for prolonged periods of time	2000-5000
Performance of visual tasks of low contract and very small size for prolonged periods of time	2000-5000
Performance of very prolonged and exacting visuals tasks	5000-10000
Performance of very special visual tasks of extremely low contract and small size	10000-20000

3.2.Fan System

Fans have been installed at various locations like classrooms, hostel room, study areas, canteen, office room, laboratory, offices etc. Various types of fan system like conventional ceiling fan, wall fans and exhaust fans are installed at various location in the campus.

3.3. Air Conditioning System

Air-Conditioners are used to maintain comfort in working environment. People working in offices require a certain ambient condition to be comfortable to perform the task. Here at Sathyabama Institute, packaged type AC units are used. The units used are as follows:

Split – High wall

Split – Cassette

Duct type

The units used are of different capacities, depending on the space and number of people occupying that space.

3.4.Pumping System Evaluation

Pumps are installed at various locations to pump the raw water to the various storage and distribution structures across the campus. Pumps are also used to pump recycled water from the treated water tank to overhead tank that gives supply to all the toilet facilities in the campus.

3.5.Generator Evaluation

There are nearly 20 Diesel generator set in the Institute. Some DG sets consume 60 liters of diesel for one hour of operation and few even consume 120 liters per hour of operation. So based on the analysis it can be said that these DG sets consume 90litres per hour on average. But measures are taken by the Institution to reduce the dependence on DG set by increasing the dependence of Solar Power generation within the campus. Also initiatives are taken to operate the DG sets with Waste Cooking Oil derived Biodiesel which is indigeneously produced from the Biodiesel Pilot Plant housed in the institution in the Centre for Waste Management. The capacity of the plant is 50 L. In a week 1000 L waste cooking oil is converted to biodiesel. The Generator fuel requirement is met by the biodiesel produced.

Fig.1 Biodiesel Plant in Campus

Apart from the in house requirement biodiesel is also given away to farmers for operating their pumpsets in the institution adopted villages.

3.6.Solar System Evaluation

The Institution has solar power generation system with solar cells and panels installed at various locations. Solar panels installed at location like roof top, open areas, sheds etc. The power generated from these solar panels are used to power the campus open area lights, corridor light and even to boil water for kitchen and bathing purpose.

Table 3 Various solar devices installed in the Institute

Devices	**Power output**
Hetero junction oxide solar cells (lab scale)	3 W
Thin film solar cells (lab scale)	10 W
Perovskite solar cells (lab scale)	0.1 W
Si based solar cell panels **(housed in Centre for Advanced Studies)**	50 KW
Ceria based SOFC	0.3 W

On validating the various utilities the following has been summarized

Th electrical load for the various utilities housed in the institution is estimated and given in the table below

Table 4 Electrical Utility in the institution

S.NO	Particular	Quantity	Rating
1	Lighting System	13618	800 kVA
2	Fan	12580	502 kVA
3	Air Conditioner	1000 plus	1120 kVA
4	Core 2 Duo/Core i3(Board/Process/Ram,HDD/SMPS)	352	175 to 325 kVA
5	Core i5(Board/Process/Ram/HDD/SMPA)	43	
6	TFT Monitor	5165	
7	CRT Monitor	60	
8	Keyboard	5165	
9	Server	60	
11	Apple AIO	50 plus	
12	DG Set	20	1175 kVA 875 kVA 900 kVA 555 kVA
14	Electric Motors	6 20	50hP 10hP
15	Single phase load (lights, fan, power sockets, etc.)	Multiple	820 kVA
6.	Power Load in facility	Multiple	955 kVA
7.	Power Load for UPS	Multiple	620 kVA

4. Best Practices Observed in the Institution - Energy Management

- Periodic maintenance of electrical/electronic equipment is done to optimize the power usage.
- Usage of Star rated Electric/Electronic Appliances
- Air conditioners are set at optimum temperature with fans on to conserve energy
- Use of Solar -Wind Hybrid system to power laboratory
- Use of Solar Lamps to light the Walkways
- Use of Solar power to Run the Kitchen
- Energy saving through the replacement of incandescent bulbs, CFL lamps and tube lights to LED light
- Since 2014 Earth Hour has been organized in the Sathyabama Institute of Science and Technology to create awareness among the upcoming generation that electricity is being wasted and we all have the sole responsibility to conserve it.
- To enhance awareness among students about energy efficiency and energy conservation various training and seminars were conducted at Sathyabama Institute of Science and Technology.
- Installation of Motion sensors in various areas of the main campus building to conserve electricity-as it turns on the connected lighting system when it detects motion, and turns off the light when there is no motion.
- The generators was run with 12% biodiesel blend to reduce the dependence on conventional power
- The Centre of Excellence for Energy Research of developed various types of solar cells and fuel cells like heterojunction solar cells, perovskite based solar cells, intermediate temperature solid oxide fuel cell, oxide and nitride-based super-capacitors for energy production and storage.
- Centre of Excellence for Energy Research is conducting research on the production of hydrogen using titanium oxide as photo catalyst for water splitting
- The Institute also has signed MoUs with Foreign Institutes to collaborate on research activities in the field of clean energy.

5. Research Collaborations

1. University of Hyogo, Japan – ***Perovskite Solar Cells.***
2. Indian Institute of Madras, Chennai, India - ***Storage applications***.
3. CSIR-Central Electrochemical Research Institute (CSIR-CECRI) - ***Sensor and Storage applications.***
4. Technological Development Unit (UDT), University of Concepcion, Coronel Industrial Park, Coronel, Chile - ***Water splitting applications.***
5. Institute of Natural Science and Mathematics, Ural Federal University, Yekaterinburg 620002, Russia - ***Development of new magnetic materials.***
6. King Saud University, Kingdom of Saudi Arabia – ***Photocatalytic Applications.***
7. National Dong Hwa University, Taiwan- ***Solid oxide Fuel Cells*** **te against the** developing research solutions and innovative technology• delivering behaviour change through instilling low-carbon values and habits in our students.

6. Status on the Clean Energy Programme at our Institute:

6.1.Establishment of Centre of Excellence for Energy

Recognising the importance of the clean energy as one of the primary sustainable development goals, **Sathyabama Institute of Science and Technology** has been focussing its R&D efforts in developing and demonstrating new energy materials and lab scale modules for the sustainable energy production and storage technologies such as solar photovoltaics, solid oxide fuel cells, super capacitors and photocatalysis. The institute has established "**The Centre of Excellence for Energy Research (CEER)** funded by the Ministry of Human Resource Development (MHRD), Govt. of India under the scheme of Centre of Excellence in the Frontier Areas of Science and Technology (FAST). It was inaugurated by His Excellency Dr. A. P. J. ABDUL KALAM, Former President of India on December 9th, 2014 in the august presence of Col. Dr. JEPPIAAR, Founder and Chancellor of the Sathyabama Institute of Science and Technology.

6.2. Aim and Objectives

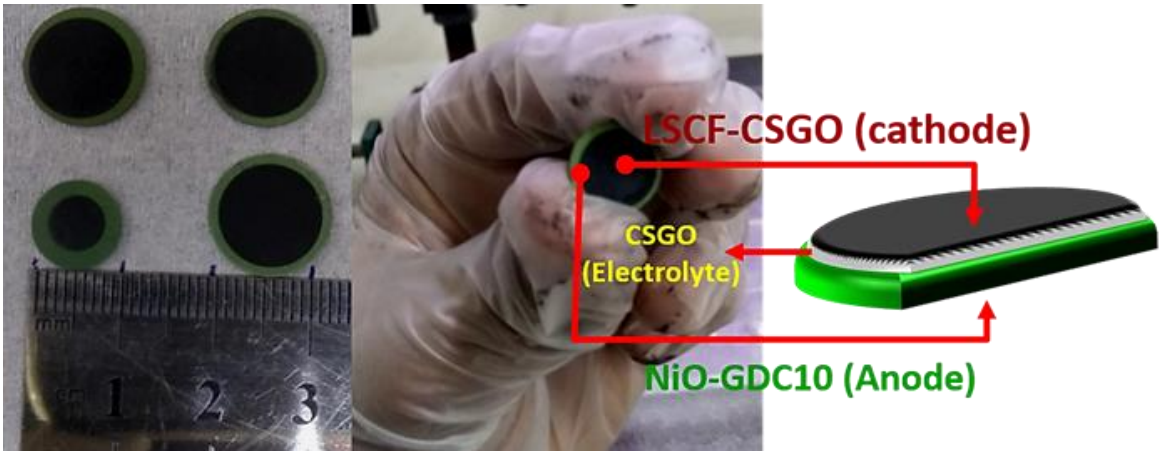
The main objectives of this Centre of Excellence is to promote education, training, research and developmental programmes in the novel and newly emerging areas of energy research and to develop cost effective, efficient and sustainable technologies for the energy needs of the nation. The Centre also aims to enhance the quality and quantity of basic and applied research programs. The Centre organizes workshops/conferences for students, researchers, academic staff, and scientists in India to further strengthen their expertise in the areas of energy research, to accelerate the India's human development index and to provide energy security.

The Centre is established in the International Research Centre (IRC) with facilities such as Raman Spectroscopy (Renishaw inVia Reflex Raman spectrometer), DEKTAK profilometer from (Bruker, USA), Potentiostat,- Galvanaostat with Impedance Analyser (Biologic, France), Hall Effect measurement system (Ecopia, South Korea), Raman Spectroscopy (Renishaw, United Kingdom), UV-Visible Spectroscopy (Jasco Analytical Instruments), 50L Biodiesel Pilot plant (Malnad Extraction Industries Bangalore, India), and Gas chromatography (YL Instrument South Korea). The major research laboratories established are Photovoltaics, Surface Physics, Energy Materials, Materials Chemistry, Materials Processing and Bio fuels.

6.3.Activities for the Promotion of Clean Energy

The Institute engages itself in several clean energy production and storage related projects in order to reduce the carbon emission. It renders the necessary support to cater to the needs of the Government bodies such as MHRD, ISRO etc. (please see Table 1). The scientists and research scholars are deeply involved in the development of heterojunction solar cells, perovskite based solar cells, intermediate temperature solid oxide fuel cell, oxide and nitride-based supercapacitors for energy production and storage. They have fabricated lab scale devices with advanced materials and have planned to upgrade the power capacity of the devices in future (please see the Table 2). Research is also in progress in the production of hydrogen using titanium oxide as photocatalyst for water splitting.

The Institute also has installed solar panels within the campus for creating awareness among student community. It is continuously making great progress in by publishing high quality manuscripts on clean energy in high impact International Journals. Because of the excellent contact through Faculty and Student Exchange Programme with reputed foreign institutes, our researchers have contributed significantly to update the clean energy programme and our Institute also has signed MoUs with Foreign Institutes who work on clean energy .Our Institute pays keen attention to organize Workshops, National and International Conferences on energy production and storage .



Noteworthy Waste to Energy Initiatives in the Institution

7. Biofuel Research and Implementation of Technologies

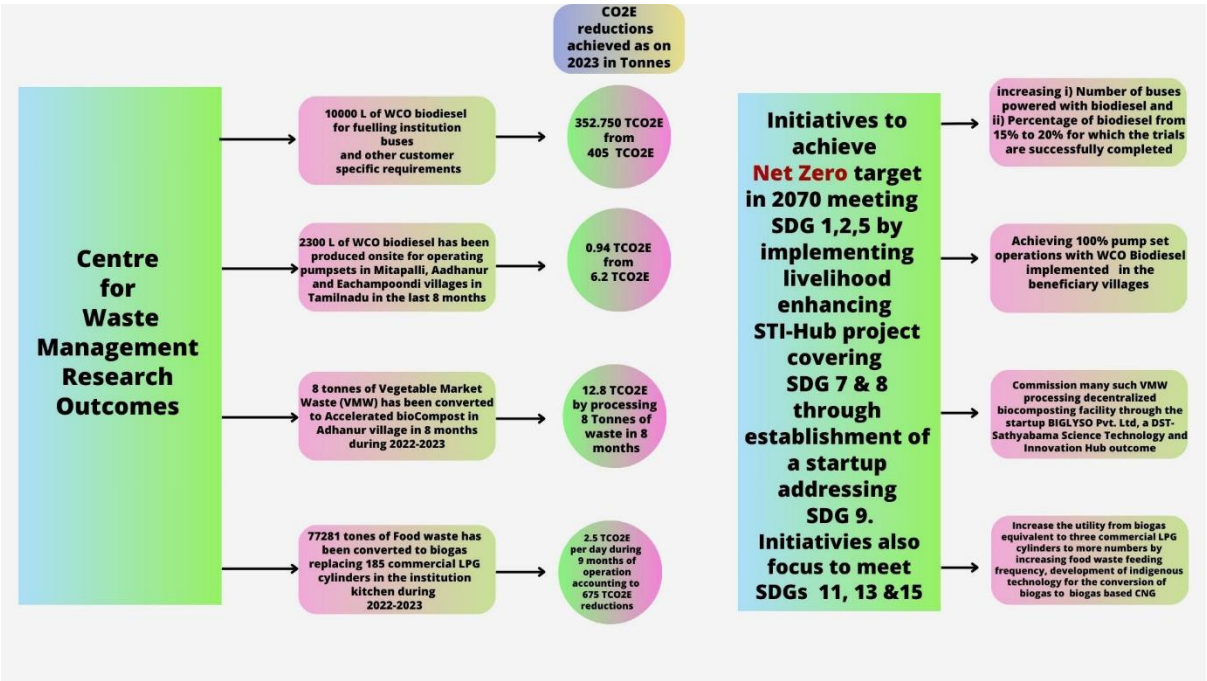
Centre for Waste Management, Centre of Excellence for Energy Research (Bioenergy) has been involved in bioenergy/biofuel research since 2014 with waste as a substrate for energy production. Climate Change remains a threat and Renewable energy sources including solar and wind energy have contributed to the global energy demand. While this energy gap is attempted to be filled, reduction of greenhouse gas emissions by the conversion of industry and urban waste to energy are simultaneously getting popularized to reach the Net Zero target by 2050 globally and by 2070 in India. In line with this the research pursued in the Centre for

Waste Management completely focusses on diversion of organic waste (both liquid and solid) more specifically waste cooking oil to biodiesel; agro waste to biochar for nutrient supplementation; vegetable market waste for accelerated biocompost; food waste to biogas; ritual waste to incense sticks. These initiatives have contributed to circular economy and reduction of CO2E (Carbon dioxide emissions represented as Tonnes CO2E). The Centre has contributed in achieving CO2E reductions as detailed below through its research initiatives.
The biodiesel produced in the institution premises is used regularly for operating five of the institution buses in blends with diesel on a regular basis, while the produced in the project site is sold for genset, pumpset and heavy vehicles' (lorries) fueling. Sathyabama is looking forward to integrate the source to enhance the biodiesel production rate.

7.1. ***Algal Oil to Biodiesel:*** Third generation sources are also proven as a sustainable raw material for the production of biodiesel. A team in the institution is extensively working on the algae cultivation and extraction facility for the separation of the lipid from the algal biomass for biodiesel production. A study has been demonstrated to prove the effective use of algae based biodiesel in colder conditions owing to its excellent cold flow properties, a technique which has been patented and published by the scientific team.

7.2. ***Agro-waste to Bioethanol:*** A team has studied different agro-wastes combinations for the cellulose improvement in the biomass adopting various pretreatment techniques. Soon a Pilot Scale fermentation facility to produce bioethanol with membrane distillation technology for high purity bioethanol recovery will be established.

7.3. ***Agro-waste biochar for briquette applications:*** Not all agro waste are found suitable for bioethanol production. Agricultural waste are so heterogeneous and plentiful that they can be diverted for numerous applications. Hydrothermal Reactors have been set up to study the conversion rate of different biomass into biochar and subsequently valuated. On the basis of the calorific value of the char obtained developments are initiated in briquetting of the agro-waste based biochar as a replacement to solid fuels (coal) in specific energy/power sectors.



7.4. ***Waste Cooking Oil to Biodiesel:*** The Centre has successfully taken initiatives to translate the research into implementation as the team has set a Pilot Scale Biodiesel Production facility that can handle 100 L of waste cooking oil if operated in two batches per day for the production of second-generation biodiesel with high brake thermal efficiency and lower emissions. Through the Science Technology and Innovation Hub established at Kattumannarkoil C,D block, Cuddalore District, with the support of Department of Science and Technology, Government of India, Sathyabama Institute of Science and Technology has succeeded in taking the lab outcomes to the society for livelihood enhancement. A pilot plant for biodiesel production ha also been house at the project site and about 250 beneficiaries have been trained to produce biodiesel. They have been trained in source/raw material collection, production, refining, product quality assessment, sales and marketing by the investigating team of the institution.

7.5. ***Food waste to Biogas :*** The institution has a 1 Tonne capacity anaerobic digestor that converts anaerobically the food waste generated into biogas. On an average about 500 to 700 kg of food waste converted daily and three commercial LPG cylinders are getting replaced. Sathyabama is looking for an expansion of this facility and the scientific team has been encouraged to involve committedly for the establishment of BioCNG in the institution.

8. Alternate Energy related Training Programmes Conducted

Centre of Excellence for Energy Research is involved in training and Capacity building and conducts series of training programmes in Biodiesel, Bioethanol and Biogas Production. In the last five years about 1000 students and 50 industry experts have been trained through the various programmes conducted.

Training Programs for scholars, School Students and researchers

Orientation Programmes conducted for students and faculty

9. Outreach Programmes

Centre for Waste Management, Centre of Excellence for Energy Research jointly with Centre for Aquaculture Sathyabama Institute of Science and Technology organized "An Awareness Programme on "Popularization of Biodiesel for Fueling Fishing Boats" commemorating World Biofuel Day on 10th August 2022 at Tsunami Quarters Karikkattukuppam Muttukadu. Dr. M.V. Rajeswari, Assistant Professor (Research), Centre for Aquaculture co-ordinated the program. 25 fishermen returning after fishing enthusiastically participated the programme. Dr. Dawn S.S ,Professor (Research) Centre for Waste Management, explained about the various

initiatives of the centre. The importance of biofuel and its role in Climate resilience was explained. Fishing boat fuel (Diesel) requirements per boat, frequency of fishing in a year and related information were gathered by the research team for further studies. The scheme of producing biodiesel from waste cooking oil and its benefits from environment, economy and efficiency points of view were explained. The participants were encouraged to fuel the boats with biodiesel in blends with diesel gradually from 1% - 10%. They showed keen interest and involvement in blending biodiesel with diesel and using the blends in their boats. The program ended with handing over of biodiesel to the fishermen as an encouragement to fuel their boats.


- **Centre for Waste Management, Sathyabama Institute of Science and Technology organized a "Waste Cooking Oil Collection Drive " commemorate National Safety Day on 4th March, elucidating Food Safety**. The Scientific team started the drive from the institution campus and covered the Sozhinganallur and Medavakkam stretch covering about 5 kms. The team approached Ponnusamy Hotel, Salem R R Briyani, Hotel Ramanaa's and Sundari Restaurant. The team highlighted their focus on collecting the waste cooking oil that is generated during the frying operations in their restaurant. The health impacts posed by the Waste Cooking Oil reuse for frying and cooking were explained and how they will be playing a major role in prevention of health hazards by giving the used cooking oil to the centre for waste management who are in turn using it to produce biodiesel. The environmental hazards of throwing away the waste cooking oil into sewer lines and on landfills were also explained creating an awareness on both food and environmental safety by diverting the much-generated waste cooking oil for biodiesel production. The drive was completed with an agreement from the hotels and restaurants a major portion of their waste cooking oil to Centre for Waste Management, Sathyabama Institute of Science and Technology. As a consequence of the drive, the centre will be getting waste cooking oil from the restaurants apart from the volume of waste cooking oil it has been receiving from the institution's mess that caters to the food needs of about ten thousand inmates on an average daily. This initiative was taken up to create an

additional awareness of how the waste cooking oil can alternately generate revenue by selling it away to organizations which hold a Repurpose Used Cooking Oil (RUCO) certification, who in turn will convert into Biodiesel.

10. Energy Management Policy Practised in the Institution

The overall goal of the energy efficiency and clean energy policy is to stimulate energy efficiency programmes to promote sustainable development in the university premises.

The main objectives of the affordable and clean energy policy are to:

- Improve energy security by making the most of current local energy sources,
- Utilization of solar and wind hybrid system power (Roof-top) the laboratory thereby reducing dependence on conventional power.
- Use of solar lamps to light the walkways and common utility areas such as Playground, Street lights in the campus, Building corridors, etc., in the night time.
- Utilize energy resources effectively by implementing cutting-edge technologies.
- Develop high purity, homogeneous and nanoscale materials for several photo-electrochemical applications such as chemical/gas sensors, energy storage, tribological, oxidation and corrosion resistant, water-splitting and photodetector applications.
- Establish a framework for the energy regulator to promote the supply of renewable energy
- Encourage the efficient use of renewable energy, and assess the levels of energy performance.
- Timer controlled devices (sensors) will be installed, in the classrooms, halls, administrative offices, restrooms, playground, street lights in the campus, building corridors, etc.,
- Restriction of personal vehicle inside the campus enhancing reduction of carbon foot prints and to meet zero-carbon campus.
- Use of battery-operated vehicles to commute inside the university premises

11. Provide guidelines for obtaining universal access to cost-effective energy.

o Conduct routine internal energy audits, energy management to find potentialfor energy conservation. Promote the faculty members as a certified energy audit.

o Encourage energy conservation awareness among diverse societal groups.

o Train the academics, non-teaching staff, students, and housekeeping staff to make the Institute a pioneer in energy conservation.

- Increase the utilization of renewable energy with the installation of a grid-interactive solar photovoltaic system on campus.
- Maintenance and replacement of other lights/lighting fixtures with LEDs on a regular basis
- Encourage students to complete undergraduate and graduate-level projects on energy management, energy optimization techniques, and renewable energy harvesting to raise awareness of energy use and its cost.

The Policy is reviewed on a regular basis.

12. Recommendations and Conclusions

- Use of Solar power to run the STP as it can lead to decrease in the overall power consumption.
- Utilize the full potential of built-up area in the campus by installing more number of solar rooftop panels- as it can reduce up to 20% of power consumption from substations
- Install more number of motion sensors especially in bathrooms to automatically turn off the lights when not in use.

Energy audit in Sathyabama Institute of Science and Technology was done through the process of collection of primary and secondary data, conducting walk through survey and inspection of building and equipment and analysis of energy flow into a building and Testing equipments in the labs, utilities, analysis of methods for energy conservation in a building to arrive at methods to reduce the amount of energy input into the building without affecting the output of the building.

The Institution has started observing a power-saving day every week where in the Institution is run on minimal power with not so important Equipment's/ Air Conditioners /Lights in switch off mode as step towards conservation / reduction of energy consumption. The Institution is also involved in various research activities focusing on developing cost effective, efficient and sustainable technologies for meeting the energy needs of the Institute.

Today energy conservation plays a very important role for energy conserving because energy consumption is increasing day by day but the natural resources are not increasing and also generation is not match with consumption. Sathyabama Institute of Science and Technology is well aware of this fact and is infect taking massive steps towards energy conservation and reducing the dependence on the conventional source of power.

So, by the audit it can be concluded that Sathyabama Institute of Science and Technology is moving towards the path of sustainable tomorrow by depending more on renewable power source and implementing energy efficiency in their daily routine thereby joining hands with world towards achieving the SDGs. It is worth mentioning as a concluding note that the Institution is ranked in bandwidth 101-200 in the Affordable and Clean Energy (SDG 07) category with all its initiatives and shows interest in reaching better rankings in future.