QUALITY AUDIT REPORT

GREEN, ENERGY AND ENVIRONMENTAL AUDIT

Sathyabama Institute of Science and Technology

Chennai, Tamil Nadu-600119

Prepared by,

WasmanPro Environmental Solutions LLP

June 2021-May 2022

EXECUTIVE SUMMARY

"The environment is where we all meet and where we all have a mutual interest, it is the one thing that all of us share." The Earth is our environment to protect and garden to tend to, so all humans have a profound responsibility to protect Mother Natures' resources in its perpetuity.

A Nation's growth starts from its educational institutions, where the ecology is taught as a prime factor of development associated with environment. A clean and healthy environment aids effective learning and provides a conductive learning environment. Educational institutions now a day are becoming more sensitive to environmental factors and best practices are being introduced making them eco-friendly. To transform the institute as Environmentally Sustainable, promotion of the Green, Energy and Environmental Audits in terms of energy savings, recycle of waste, water reduction, water harvesting and analyses environmental practices within and outside of the campus are done.

Green, Energy and Environmental auditing is a process whereby an organization's environmental performance is rated from its environmental policies and objectives. As a part of such practice, internal Green, Energy and Environmental Audit is a key performance indicator to evaluate the sustainability of the institute.

Green, Energy and Environmental Audit can be a useful tool for an institute to determine how and where the energy and water resources are used the most; the institution can then consider how to implement changes to make it environmentally sustainable. These audits also acts as a tool to analyze the type and volume of waste being generated, to determine the quantum of waste that can be diverted to recycling project and to arrive at the best waste minimization strategy that can be adopted.

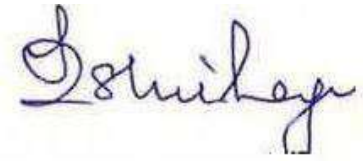
These audits promote environmental awareness, better understanding of environmental impact in the campus among staff and students. Green Audit is a process of systematic identification, quantification, recording, reporting and analysis of components of environmental diversity of institute. .Environmental and energy auditing promotes financial savings through reduction of resource use. It gives an opportunity for the development of ownership, personal and social responsibility for the students and teachers. If self- enquiry is a natural and necessary outgrowth

of a quality education, it could also be stated that institutional self-enquiry is a natural and necessary outgrowth of a quality educational institution. Thus it is imperative that the institution evaluates its own contributions toward a sustainable future. As environmental sustainability is becoming an increasingly important issue for the nation, the role of higher educational institutions in relation to environmental sustainability is more imperative.

In Sathyabama Institute of Science and Technology, the audit process involved walk through inspections, initial interviews with management to clarify policies, activities, records and the co-operation of staff and students in the implementation of mitigation measures. This was followed by staff and student interviews, collection of data through the questionnaire, review of records, observation of practices and observable outcomes. In addition, the approach ensured that the management and staff are active participants in the Green, Energy and Environmental Auditing process in the institute.

The baseline data prepared for the Sathyabama Institute of Science and Technology will be a useful tool for campus greening, resource management, planning of future projects for such audit purpose, and a document for implementation of sustainable development of the institute. Existing data will allow the institution to compare its programs and operations with those of peer institutions, identify areas in need of improvement, and prioritize the implementation of future projects. It is expected that the management will be committed to implement the Green, Energy and Environmental Audit recommendations.

Wasmanpro Environmental Solutions LLP



Chairman

Sathyabama Institute of Science and Technology-Internal Audit Team

Management Representative	**Dr.DawnS S** Professor(Research) Centre for Waste Management Centre of Excellence for Energy Research
Members	**Dr.Vinita Vishwakarma** Professor (Research) Centre for Nanoscience and Nanotechnology **Dr.S.Barani** Professor Department of Electronics and Communication Engineering School of Electrical and Electronics Engineering **Dr.S.Poorna pushpakala** Associate Professor Department of Electronics and Communication Engineering School of Electrical and Electronics Engineering **Dr.S.Sathish** Associate Professor and Head Department of Chemical Engineering **Dr.D.Prabu** Associate Professor Department of Chemical Engineering **Dr.Arun J** Assistant Professor (Research) Centre for Waste Management **Dr.N.Nirmala** Assistant Professor (Research) Centre for Waste Management **Dr.P.Priyadhrasini** Assistant Professor (Research) Centre forWaste Management **Mr.A.Santhosh** Project Coordinator (STI-Hub) Centre for Waste Management **Ms.A.Bhuvaneswari** Project Assistant (STI-Hub), Centre forWaste Management **Mr.J.Jayakanth** Project Assistant (STI-Hub) ,Centre for Waste Management.

Wasmanpro Environmental Solutions LLP - External Audit Team

Wasmanpro Representative	**Dr.K.Karthikeyan** Chairman Certified Lead Auditor - Environmental Management Systems ISO 14000 and OSHAS 18000 Wasmanpro Environmental Solutions LLP
Members	**Er.G.Sathiamoorthi** Vice-Chairman, M/s WasmanPro Environmental Solutions LLP **Er. M.Omprakash** CEO., Chief Executive Officer M/s WasmanPro Environmental Solutions LLP **Er.R.Praveen kumar** COO., Chief Operating Officer M/s WasmanPro Environmental Solutions LLP **Er. Dhinesh Kumar** Technical Director, M/s. WasmanPro Environmental Solutions LLP **Er.P.Gajendran,** Senior Environmental & Instrumentation Engineer, M/s WasmanPro Environmental Solutions LLP **Er. Ann Christy Jose** Senior Environmental & Instrumentation Engineer, M/s WasmanPro Environmental Solutions LLP **Mr.K.Gowtham** Environmental Health & Safety Specialist M/s WasmanPro Environmental Solutions LLP **Er.Sabarinathan Jayaperumal** Environmental Engineer M/s. WasmanPro Environmental Solutions LLP

LEAD AUDITOR CRTIFICATE

CHLEHS/INDIA-031-/33

Confederation of Indian Industry

NABET

Environmental, Occupational Health & Safety Management Systems Auditor/Lead Auditor Training Course (As Per ISO 14001:2004 & OHSAS 18001:2007)

This is to certify that

Dr. K Karthikeyan

has successfully completed the

Environmental, Occupational Health & Safety Management Systems Auditor/Lead Auditor Training Course

organised by
Confederation of Indian Industry
Centre of Excellence for Sustainable Development

held at **Chennai**

from ***3rd February 2014*** *to* ***7th February 2014***

"Course Accredited With NABET"
(National Accreditation Board for Education and Training)
Accreditation No : LEHS 1315 10
"For Auditor Registration purposes this certificate is valid for Three years from the initial certification date"

Seema Arora
Executive Director
CII-ITC Centre of Excellence for Sustainable Development

AUDIT CERTIFICATE

wasmanproglobal2020@gmail.com
www.wasmanpro.in

WasmanPro
Environmental Solutions

13-07-2022

This is to certify that

SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY

Jeppiaar Nagar, Rajiv Gandhi Road, Sholinganallur, Chennai,
Tamil Nadu-600119, India

has been assessed by us for the Environmental and Energy Audit
conducted during June 2021 to May 2022
The environmental protection initiatives of the Institution has been assessed based on the field observation and details submitted was found to be satisfactory.

The efforts taken by the Institution in the area of energy conservation, waste management and environment protection is highly commendable

WASMANPRO ENVIRONMENTAL SOLUTIONS LLP

CHAIRMAN

No.5,B.M Complex, 3rd Floor,45th Street, Thillaiganga Nagar,
Nanganallur, Chennai - 600061

TABLE OF CONTENTS

CHAPTER 1 26
INTRODUCTION 26
1.1 About Sathyabama Institute of Science and Technology 26
1.2 About WasmanPro Environmental Solutions LLP 27
1.2.1 Core Environmental Compliance & Remediation Services 28
CHAPTER 2 29
2.1 Introduction 29
2.2 Methodology for Environmental and Energy Auditing 29
2.3 Benefits of the Green, Energy and Environmental Auditing 32
2.4 Scope and Goals of Green, Energy and Environmental Auditing 33
2.5 Pre-Audit Stage 35
2.6 Audit Stage 36
2.7 Post Audit Stage 36
2.8 Follow-up Action and Plans 37
2.9 Environmental Education 37
CHAPTER 3 39
GREEN AUDIT 39
3.1 Introduction 39
3.2 Key Methodologies adopted for Green Audit 40
3.3 Green Audit-Survey/Questionnaire 40
3.4 Green Audit- Key Findings 42
3.5 Green Audit-Evaluations and Recommendations 43
3.5.1 Consolidation of Green Audit Findings-Evaluation 44
3.5.2 Recommendation 47
3.6 Green Audit Conclusion 48
CHAPTER 4 59
ENERGY AUDIT 59
4.1 Introduction 59
4.2 Key Methodology adopted for Energy Audit 59
4.3 Energy Audit Survey/Questionnaire 60
4.4 Energy Audit-Key Findings 62
4.4.1 List of Instruments Used 62

4.4.2 Energy System Evaluation-Lighting System 65
4.4.2 Fan System 72
4.4.3 Air Conditioning System 75
4.4.4 Pumping System Evaluation 76
4.4.5 Generator System Evaluation 77
4.4.6 Transformers Evaluation 78
4.4.7 Solar System an Evaluation 79
4.4.8 Summary of Major Utilities 79
4.5 Energy Audit – Evaluations and Recommendations 80
4.5.1 Consolidation of Energy Audit Findings-Evaluation 81
4.5.2 Recommendations 85
4.6 Energy Audit Conclusion 85
CHAPTER 5 92
ENVIRONMENTAL AUDIT 92
5.1 WATER AUDIT 92
5.1.1 Introduction 92
5.1.2 Key Methodology adopted for Water Audit 93
5.1.3 Water Audit Survey/Questionnaire 94
5.1.4 Water Audit-Key Findings 96
5.1.4.1 Wastewater Treatment Unit Details 103
5.1.5 Water Audit – Evaluations and Recommendations 106
5.1.5.1 Consolidation of Water Audit Findings-Evaluation 107
5.1.5.2 Recommendations 111
5.2 WASTE AUDIT 113
5.2.1 Introduction 113
5.2.2 Solid Waste 113
5.2.2.1 Key Methodology adopted for Solid Waste Audit 114
5.2.2.2 Solid Waste Survey 115
5.2.2.3 Solid Waste Audit-Key Findings 116
5.2.3 Solid Waste Audit-Evaluations and Recommendations 127
5.2.3.1 Consolidation of Solid Waste Audit Findings - Evaluation 128
5.2.3.2 Recommendations 137
5.2.4 Biomedical Waste Audit 146

5.2.4.1 Key Methodology adopted for Biomedical Waste Audit 147
5.2.4.2 Bio Medical Waste Audit-Survey/Questionnaire 147
5.2.4.3 Biomedical Waste Audit-Key Findings 148
5.2.4.4 Biomedical Waste Audit-Evaluations and Recommendations 152
5.2.4.5 Consolidation of Biomedical Waste Audit Findings-Evaluation 154
5.2.4.6 Recommendations 157
5.2.5 E -Waste Audit 160
5.2.5.1 Key Methodology adopted for E-Waste Audit 160
5.2.5.2 E-Waste Audit-Survey/Questionnaire 161
5.2.5.3 E-Waste Audit- Key Findings 161
5.2.5.4 E-waste Audit- Evaluations and Recommendations 163
5.2.5.5 Consolidation of E-Waste Audit Findings - Evaluation 164
5.2.5.6 Recommendations 166
5.3 CARBON FOOTPRINT 167
5.3.1 Key Methodologies adopted for Carbon Footprint Audit 168
5.3.2 Carbon Footprint Audit-Survey/Questionnaire 169
5.3.3 Carbon Footprint Auditing-Key Findings 170
5.3.4 Transportation 170
5.3.5 Electricity 171
5.3.6 LPG and Natural Gas 171
5.3.7 Carbon Footprint Analysis 171
5.3.6 Carbon Footprint Audit-Evaluations and Recommendations 174
5.3.7 Consolidation of Carbon Footprint Audit Findings-Evaluation 175
5.3.8 Recommendations 178
5.4 Environmental Audit Conclusion 181
ANNEXURES 187

LIST OF TABLES

Table 1: Name list of Campus Trees 42

Table 2: List of Indoor Gardening plants....55

Table 3: Tabulation of Campus Connected Load (KW) 63

Table 4: Major Utilities at Satyabama Institution of Science and Technology 64

Table 5: List of lighting load....65

Table 6: Performance assessment of lighting system with Lux Measurement 69

Table 7: Standard lux level in different areas 71

Table 8: Fans installed at the facility 72

Table 9: Detailed performance assessment of few Air-Conditioners....75

Table 10: Pumps location....76

Table 11: Generator with Capacity 77

Table 12: Transformer Ratings....78

Table 13: Various solar devices installed in the Institute 79

Table 14: Major Utilities at Sathyabama Institute....79

Table 15: Source of Water for the Institution 96

Table 16: Water Storage Structure in the Campus 97

Table 17: Distribution Tanks in the Campus....97

Table 18: Location of Raw Water Distribution Tanks in Campus 97

Table 19: Various points of Usage of Water 98

Table 20: RO Plant Water Output Details....99

Table 21: Water Cooler Details 99

Table 22: Various Points of Water Wastage....100

Table 23: Details of Water Treatment System 100

Table 24: Characteristics of Raw Sewage....103

Table 25: Size of Unit Operations of Sewage Treatment Plant 105

Table 26: Paper Waste Generated in The Campus (2021-22) 117

Table 27: Other Type of Food -Container Waste Generated (21-22) 118

Table 28: Plastic Waste Generated in the Campus (21-22) 119

Table 29: Metal Waste Generated in the Campus (21-22) 120

Table 30: Organic Waste Generated in the Campus (21-22) Organic Waste Generated in the Campus (21-22) 121

Table 31: Other Type of Waste Generated in the Campus (21-22) 121

Table 32: Glass Waste Generated in the Campus (21-22) 122

Table 33: Hazardous Waste Generated in the Campus (21-22) 123

Table 34: Various Waste Generated in the Campus (2020-21) 123

Table 35: Glass Waste Generated in the Campus (21-22) 124

Table 36: Hazardous Waste Generated in the Campus (21-22) 125

Table 37: Various Waste Generated in the Campus (2020-21) 125

Table 38: Generation of waste (infectious and non-infectious) in different departments of Sathyabama Dental College and Hospital. 149

Table 39: Quantity of Bio-Medical waste generated 2021-22 151

Table 40: Quantity of Bio-Medical waste generated 2021-22 151

Table 41: Various Pollutants present in E-Waste generated in the Campus 162

Table 42: Emission Inventory 172

Table 43: Details for Carbon Foot Print Auditing 173

LIST OF FIGURES

Figure 1: Sathyabama Institute of Science and Technology 26

Figure 2: Layout Plan of the campus 27

Figure 3: Audit Stages 31

Figure 4: Sathyabama Officials and WasmanPro Officials during Pre-Audit Stage Meeting held on 20thOctober 2021 35

Figure 5: Green coverage 50

Figure 6: Ariel view of roof top gardening 50

Figure 7: Ariel view of roof top gardening 50

Figure 8: Watering the plants using recycled water 50

Figure 9: Watering the plants using recycled water 51

Figure 10: Aerial view of marshy land 51

Figure 11: Campus Green Pathway 51

Figure 12: Campus Garden 51

Figure 13: Campus Garden 52

Figure 14: Campus Green Pathway 52

Figure 15: Coconut tree 52

Figure 16: Banana tree 53

Figure 17: Campus Green Pathway 53

Figure 18: Campus Greenery 54

Figure 19: Pie Chart on Load Distribution 64

Figure 20: Solar Panels on waiting shed 88

Figure 21: Rooftop Solar Panel 88

Figure 22: Solar Inverter with controller 88

Figure 23: Solar powered walk way.....89
Figure 24: Solar Panel at campus.....89
Figure 25: Solar system with Service box.....89
Figure 26: Solar cells on roof top.....89
Figure 27: Solar-wind hybrid system.....90
Figure 28: Large area Pervoskite Solar Cells.....90
Figure 29: Windmill in the campus.....90
Figure 30: Transformer.....90
Figure 31: D.G Set.....91
Figure 32: Power house Control Panels.....91
Figure 33: Water Foot Print of the Institute in the Year 2021-2022.....101
Figure 34: Major Water Utilization Points at the Institute in the Year 2021-2022.....102
Figure 35 : Water usage Points at the Institute in the Year 2021-2022.....102
Figure 36 : Flow diagram of the treatment process in the STP.....104
Figure 37: STP overview.....111
Figure 38: Water treatment unit.....111
Figure 39: Site inspection at STP.....112
Figure 40: Water transporting tanker.....112
Figure 41 :Lead auditor inspecting the blowers.....112
Figure 42: Panel room.....112
Figure 43: Composition of Paper Waste 2021-22.....129
Figure 44: Composition of Biogas (21-22).....130
Figure 45: Composition of Plastic Waste (21-22).....131
Figure 46: Composition of Metal Waste (21-22).....132
Figure 47: Solid Waste composition of the Institute 21-22.....133

Figure 48: Solid waste composition of the Institute21-22 134
Figure 49: Solid waste composition of the Institute21-22 134
Figure 50:Mat made from Textile waste 138
Figure 51:Decorative item from plastic water bottles 138
Figure 52: Decorative item from plastic caps 138
Figure 53: Eco friendly soap from waste cooking oil 139
Figure 54:Biodiesel from kitchen waste 139
Figure 55:Waste leaf collected for disposal 139
Figure 56:Organic pots made from food wastes 140
Figure 57:Generator run on biodiesel 140
Figure 58:Automatic smart waste segregator 140
Figure 59:Source segregation at the Campus 140
Figure 60: Waste dumping bins 141
Figure 61: Waste dumping bins 141
Figure 62: Waste dumping bins 141
Figure 63: Disposal of Collected Waste 141
Figure 64: E-Waste dumping 142
Figure 65: Plywood Waste dumping area 142
Figure 66: Common Washbasin at campus 142
Figure 67: 1Ton/day Biogas plant Installed and Commissioned at Sathyabama Institute of Science and Technology, Chennai 143
Figure 68: Biogas Digester and Slurry collection Tank 144
Figure 69: Feeding Food Waste Into Crusher 144
Figure 70: H2S Scrubber 144
Figure 71: Flame Arrestor 144

Figure 72: Booster Pump 145
Figure 73: Burner Lit by Biogas 145
Figure 74: Biogas Storage Balloon 145
Figure 75: Types of Biomedical Waste Generated from Various Department in the Hospital...150
Figure 76: Quantity of BMW generated in the Institute 2021-22 151
Figure 77: Quantity of BMW generated in the Institute 2020-21 152
Figure 78: Scores provided for various aspects of BMW management at hospital 156
Figure 79:Colour coded dustbins.....158
Figure 80:Poster in the hospital corridor for raising awareness 158
Figure 81:Color coded bags 158
Figure 82:Audit at Dental College and Hospital 158
Figure 83: Equipments' of Hospital.....158
Figure 84: Doctors with PPE for attending Covid patients 158
Figure 85: Covid wastes- masks and gloves 159
Figure 86:Neat and Clean Hospital Floor 159
Figure 87:Change bins Color coded bags 159
Figure 88: Standard daily CO2 emitted by different emission inventories at the Institute 172
Figure 89: Percentage of CO2 emission.....176
Figure 90:Bus in the campus.....179
Figure 91:Four wheeles in the campus.....179
Figure 92:Biodiesel(12%) run bus 180
Figure 93:Two wheelers in the campus 180

CHAPTER 1

INTRODUCTION

1.1 About Sathyabama Institute of Science and Technology

Sathyabama Institute of Science and Technology is one of India's premier Academic and Research Universities that offers multi-disciplinary academic programmes in various fields of Engineering, Science, Technology, Law, Dental Science, Pharmacy, Nursing, and Management. The Institution is established under Sec.3 of UGC Act, 1956 and is been accredited with 'A' Grade by the National Accreditation and Assessment Council. This glorious Institution is functioning under the dynamic leadership of Dr.Mariazeena Johnson, Chancellor, Dr. Marie Johnson, President, Ms. Maria Bernadette Tamilarasi Johnson, Vice President. 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.

Figure 1: Sathyabama Institute of Science and Technology

Figure 2: Layout Plan of the campus

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 regulatory consent and compliance support that 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 programs
- Implementing phased compliance and cleanup strategies

1.2.1 Core Environmental Compliance & Remediation Services

WasmanPro helps clients in adopting advanced environmental sustainability, maintain environmental compliance, and reduce environmental risk and cleanup sites by providing a 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.

.

CHAPTER 2

2.1 Introduction

Green auditing is the process of identifying and determining whether institutions practices are eco-friendly and sustainable. Traditionally, we are good and efficient users of natural resources. Energy and Environmental Audit forms a part of the resource management process. Although they are individual events, the real value of these Audits is the fact that they are carried out, at defined intervals, and their results can illustrate improvement or change over time. Eco-campus concept mainly focuses on the efficient use of energy and water; minimization of waste generation, pollution and to attain economic efficiency. All these indicators are assessed in process of "Green, Energy and Environmental Audit of educational institute".

Eco-campus mainly focuses on the reduction of contribution to emissions, procures a cost effective and secure supply of energy, encourages and enhances energy use conservation, promotes personal action, reduce the institute's energy and water consumption, reduce wastes to landfill, and integrate environmental considerations into all contracts and services considered to have significant environmental impacts. Target areas included in this auditing are water, energy, waste, green campus and carbon footprint.

2.2 Methodology for Environmental and Energy Auditing

The purpose of the audit was to ensure that the practices adopted by the institution are in accordance with the Environmental Policy suggested by NAAC. The methodology includes: preparation and filling up of questionnaire, physical inspection of the campus, observation and review of the document, interviewing responsible persons and data analysis, measurements and recommendations.

The methodology adopted for this audit was a step by step process comprising of:

1. **Data Collection** – In preliminary data collection phase, exhaustive data collection was performed using different tools such as observation, conducting surveys, distributing questionnaires, communicating with responsible persons and measurements.

Following steps were taken for data collection:

- The team went to whole campus for collect data on Green Auditing.
- Green Auditing details about total campus area, area under green coverage, and area under Marshy land were collected.
- The team went to each department, Library, canteen, hostels, research centers etc.
- Data about the general information was collected by observation and interview.
- The power consumption of appliances was recorded by taking an average value in some case.
- For Waste auditing details about types of waste generated, mode of disposal were collected.
- For Water auditing details about source of water for the institution, various uses of water, mode of disposal of waste water were collected.
- For Energy auditing details about source of power for the institution, major points of power usage, generation of power from non-conventional source etc were collected.
- For Carbon Foot Print auditing details about source of emission of greenhouse gases, details about major Carbon Foot Print reduction strategy etc were collected.
- For Green Auditing details about total campus area, area under green coverage, area under Marshy land etc were collected.
- Five categories of questionnaires were distributed among the students and staff for data collection.

1. **Data Analysis** - Detailed analysis of data collected was done.

The calculation area under green cover, the methods used to maintain the green cover, the frequency of watering and manuring. The efforts taken by the Institution to increase the Green cover. The various types of plants, trees, shrubs seen in the campus. Noting down the details of these species and marking presence of any indigenous species. Any medicinal plant seen around the campus

It also includes calculation of energy consumption, analysis of latest electricity bill of the campus, understanding the tariff plan, analysis of various water usage and wastage

points, analysis of water recycling and reusing methods implemented in the campus, analysis of types of waste being generated, studying various waste management strategy adopted in the campus, analyzing various Carbon Foot Print strategy being implemented in the campus.

2. Recommendation/Suggestions– On the basis of results of data analysis and observations, various suggestions that the University can implement were recommended.

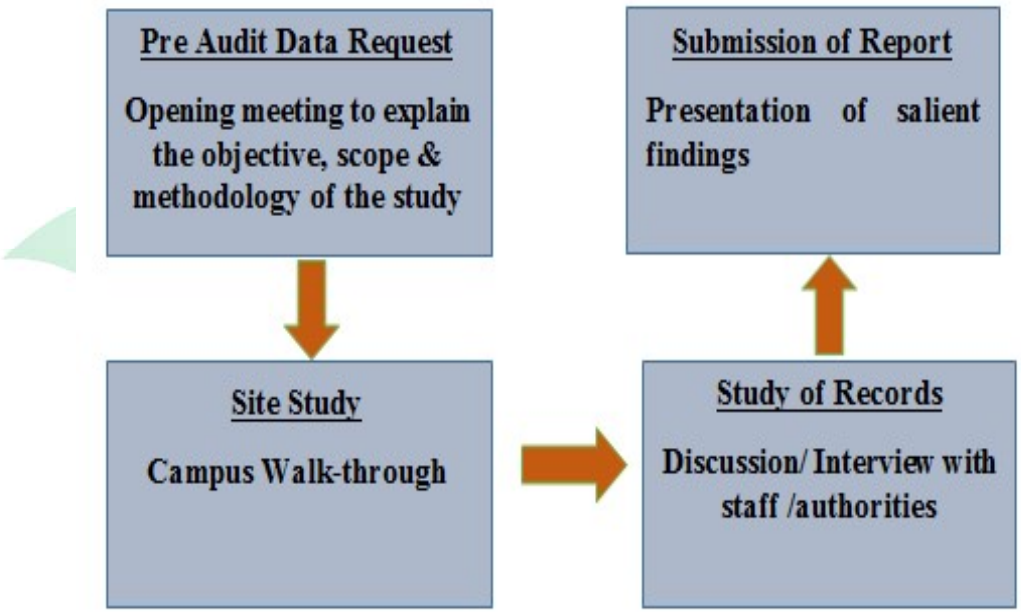


Figure 3: Audit Stages

2.3 Benefits of the Green, Energy and Environmental Auditing

- ✓ It would help to protect the environment in and around the campus.
- ✓ More efficient resource management
- ✓ To provide basis for improved sustainability
- ✓ To create a green campus
- ✓ To enable waste management through reduction of waste generation, E-Waste management, solid-waste management and wastewater recycling
- ✓ To create plastic free campus and evolve health consciousness among the stakeholders
- ✓ 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 Institute and its environment
- ✓ Developing environmental ethics and value systems in youngsters.
- ✓ Environmental and energy auditing should become a valuable tool in the management and monitoring of environmental and sustainable development programs of the institute.

2.4 Scope and Goals of Green, Energy and Environmental Auditing

A clean and healthy environment aids effective learning and provides a conducive learning environment. There are various efforts around the world to address environmental issues. Green, Energy and Environmental Audit is the most efficient and ecological way to manage environmental problems.

The environment has become a major consideration for any decision-making for the development of any organizations. There is growing recognition that environmental issues are associated with almost all activities of an organization. An effective way of addressing environmental issues in an organization is by conducting systematic Green audit. A green audit can be considered as an internal examination conducted by an Institution with reference to its own environmental operations as a means of assessing its environmental compliance and performance

Environmental and Energy auditing is used as a tool to investigate, understand, identify effects of various activities on the environment against set criteria or standards. These are used to help improve existing activities, with the aim of reducing the adverse effects of these activities on the environment. It is necessary to conduct these audits in the institution because students become aware of the Environment, advantages it offers, thereby become the warriors to save the planet. Thus, such quality audits become necessary at the institution level.

A very simple indigenized system has been devised to monitor the environmental performance of Sathyabama Institute of Science and Technology. It comes with a series of questions to be answered on a regular basis. This innovative scheme is user friendly and totally voluntary. The aim of this is to help the institution, identify their weak areas, project their best practices and to set examples for the community, and to educate the young learners. Environmental and Energy Auditing is done in three phases

Phase I - Pre Audit Stage

Phase II - Audit Stage

Phase III - Post Audit Stage

1. Pre Audit Stage
    - Plan and organize
    - Walk through audit
    - Macro data collection
    - First hand observation and assessment
    - Issue questionnaire for each department
2. Audit Stage
    - Primary data gathering
    - Analysis of energy use, water use, waste generation
    - Analysis of Annual Energy Bill, Water Bill, GHG Emission
    - Analysis of energy consumption pattern, water usage pattern
    - Identification of resource conservation opportunities
    - Select most promising techniques
    - Cost benefit analysis
3. Post Audit Stage
    - Implementation of ideas
    - Follow up and periodic review

2.5 Pre-Audit Stage

A pre-audit meeting provides an opportunity to reinforce the scope and objectives of the audit and to discuss on the practicalities associated with the audit. This meeting is an important prerequisite for the Green, Energy and Environmental Audit because it is the first opportunity to meet the expert and deal with any concerns.

The pre-audit meeting was conducted successfully at Sathyabama Institute of Science and Technology, Chennai on 20thOctober 2021and necessary documents were collected directly from the institution before the initiation of the audit processes. The audit protocol and audit plan were handed over at this meeting and actual planning of audit processes was discussed. The WasmanPro team worked under the leadership of the lead auditor (Dr. K. Karthikeyan), to ensure completion within the brief and scope of the audit.

Figure 4: Sathyabama Officials and WasmanPro Officials during Pre-Audit Stage Meeting held on 20thOctober 2021

2.6 Audit Stage

In Sathyabama institute of Science and Technology, Chennai Environmental and Energy Auditing was coordinated with WasmanPro Environmental Solutions LLP. The entire exercise was conducted by involving different student groups, teaching and non-teaching staff. The Green, Energy and Environmental Auditing began with the team conducting walk through inspections of all the different facilities at the institute, determining the different types of appliances and utilities (lights, taps, toilets, fridges, etc.) as well as measuring the usage per item (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 students were interviewed to get details of usage, frequency or general characteristics of certain appliances. Data collection was done in the sectors such as Water use, Energy, Waste, Green coverage and Carbon footprint. University records and documents were verified several times to clarify the data received through survey and discussions.

The methodology adopted for this audit was a step by step process comprising of:

- Involvement of Student Clubs and Forums
- Site inspection
- Interviews
- Review of Policies
- Review of Documents and Records

2.7 Post Audit Stage

The base of any Green, Energy and Environmental Auditing is that its findings are supported by documents and verifiable information. The audit process seeks, on a sampled basis, to track past actions, activities, events, and procedures to ensure that they are carried out according to systems requirements and in the correct manner. The real value of Environmental and Energy Auditing is when they are carried out at defined intervals, and their results and recommendations can bring improvement or change over time. Although Environmental and Energy Auditing are carried out using policies, procedures, documented systems and objectives as a test, there is always an element of subjectivity in an audit.

The essence of any audit is to find out how well the organization, departments and equipment are performing keeping the environmental sustainability in mind. Each of the three components is crucial in ensuring that the organization's environmental performance meets the goals set in its green policy. The individual functioning and the success of integration will all play a role in the degree of success or failure of the organization's environmental performance.

2.8 Follow-up Action and Plans

Green, Energy and Environmental Audits are exercises which generate considerable quantities of valuable information. The time and effort and cost involved in this exercise is often considerable and in order to be able to justify this expenditure, it is important to ensure that the findings and recommendations of the audit are considered at the correct level within the organization and that action plans and implementation programs result from the findings.

Audit follow up is part of the wider process of continuous improvement. Without follow-up, the audit becomes an isolated event which soon becomes forgotten in the pressures of organizational priorities and the passing of time.

2.9 Environmental Education

The following environmental education program may be implemented in the institute before the next Environmental auditing:-

- Training programs to be given in solid waste management, liquid waste management, water management and conservation, energy management, E-Waste management, Biomedical Waste Management, pollution monitoring methods, rainwater harvesting methods, artificial ground water recharge methods, Plastic Waste Management.
- Increase the number of display boards for awareness such as – save water, save electricity, now a stage of food/water, no smoking, switch off light and fan after use, plastic free campus etc.
- Paste more brochure to create awareness about disposal of waste to color coded bags
- Increase the awareness about segregation of waste at source itself- dry waste, wet waste, non-biodegradable waste, hazardous waste.
- Encourage to reuse Electronic Products rather than discarding

- Encourage students to give the damaged electronic product to the manufacturer while buying new product
- Set up model rain water harvesting system, rain water pits, for providing proper training to the students- even encourage them to transfer this knowledge from lab to land thereby benefitting the local people.
- Conduct exhibition of recyclable waste products and demonstration how it can be reused.

CHAPTER 3

GREEN AUDIT

3.1 Introduction

Green auditing is the process of identifying and determining whether institutions practices are eco-friendly and sustainable.

The green audit aims to analyse environmental practices within and outside the university campuses, which will have an impact on the eco-friendly atmosphere. Green audit can be defined as systematic identification, quantification, recording, reporting and analysis of components of university environment. Green Audit was initiated at Sathyabama Institute of Science and Technology with the motive of inspecting the effort within the institutions whose exercises can cause threat to the health of inhabitants and the environment. Through the green audit, a direction as how to improve the structure of environment and there are include several factors that have determined the growth of carried out the green audit. Achieving an Eco-friendly Green Campus is long term commitment to continuous environmental improvement from the campus community.

Green campus makes a point to account for sustainable living when designing and operating their buildings. Trees in a campus yard improve air quality and can reduce temperatures with their cool shade. In one year, a single mature tree will absorb up to 48 pounds of carbon dioxide from the atmosphere, and release it as oxygen.

Trees on our campus impact our mental health as well; studies have shown that trees greatly reduce stress, which is a huge deal considering that many students are under some amount of stress.In this note, every educational Institution must conduct green audit as a form of self-assessment to reflect the role the Institution has been playing in mitigating the environmental impacts caused by its various activities.

3.2 Key Methodologies adopted for Green Audit

1. A walk through survey of the entire campus was done to observe the total area under green coverage, presence of marshy land, ponds and to identify various types of trees and plants.
2. The base line data was collected by conducting interviews and discussions with the students and staff.
3. Walk through survey and base line data collection was done to note down the area under green cover
4. The Botanical names of the trees were identified a listed during the Onsite audit.
5. Presence of any nature club in the Institute and its activities were enquired among the students.
6. Documentation of efforts pertaining environmental management plan done within the campus for increasing a green cover
7. Based on the findings, the total Green Coverage area in the campus was calculated and recommendations were given for better green management practices.

3.3 Green Audit-Survey/Questionnaire

1. Is there a garden in the Institution? Area?
2. Do students spend time in the garden?
3. List the plants in the garden, with approx. numbers of each species.
4. List the species planted by the students, with numbers.
5. Whether scientific names of the trees are displayed in the campus?
6. Is there any plantation in the campus? If yes specify area and type of plantation.
7. Is there any vegetable garden in the Institution? If yes how much area?
8. Is there any medicinal garden in the Institution? If yes how much area?

9. What are the vegetables cultivated in the vegetable garden? (Mention the quantity of harvest in each season)
10. How much water is used in the vegetable garden and other gardens? (Mention the source and quantity of water used).
11. Whether recycled water is used for gardening?
12. Whether organic farming is done in the Institution? How?
13. Is there any composting pit in the Institute? If yes what is being done with the compost generated?
14. Is there any student market in the Institute?
15. Give the number and names of the medicinal plants in the Institution campus.
16. Any threatened plant species planted/conserved?
17. Is there a nature club in the Institute? If yes what are their activities?
18. Is there any arboretum in the Institution? If yes details of the trees planted.
19. Is there any fruit yielding plant in the Institution? If yes details of the trees planted.
20. Is there any grove in the Institution? If yes details of the trees planted.
21. Is there any irrigation system in the Institution?
22. What is the type of vegetation in the surrounding area of the Institution?
23. What are the nature awareness programs conducted in the campus?
24. What is the involvement of students in the green cover maintenance?
25. What is the total area of the campus under tree cover? Or under tree canopy?
26. Share the IDEAS for further improvement of green cover.

3.4 Green Audit- Key Findings

The Sathyabama Institution of Science and Technology has a huge area under green cover. The approximate area under green cover is 39500sqft. The Institution has a marshy land area of 5120 sq.m and this is home to many water birds and migratory birds.

The campus has many grown up tress like and shrubs which provides a good sun protection and brings coolness in the campus.

The Institution along with its nature club is taking efforts toincrease the green cover by encouragingpractices terrace farming, planting of saplings, roof top gardening, vegetable gardening etc.

The various tree/plant/shrub species observed in the campus are listed below.

Table 1: Name list of Campus Trees

S.No	Tamil Names	Botanical Names
1	Pungai	*Millettiapinnata*
2	Neem	*Azadirachtaindica*
3	Thoongumoonjimaram	*Samaneasaman*
4	Like coconut-	*Cocosnucifera*
5	Idly poo	*Ixoracoccinea*
6	Savukku	*Casuarinaequisetifolia*
7	Badam	*Terminaliacatappa*
8	Hibiscus	*Hibiscus rosa-sinensis*
9	Jasmine/mullai	---
10	Coconut	*Cocosnucifera*
11	Australian babul plant	*Acacia auriculiformis*
12	Ashokamaram	*Saracaasoca*
13	Munkil	*Bambusoideae*
14	kagitha poo	*– Bougainvillea*

15	Tamanumaram	*Calophylluminophyllum*
16	Mayilkondraimaram	*Delonixregia*
17	Koyyamaram	*Psidiumguajava*
18	Kondraimaram	*Cassia fistula*
19	Elumiccai	*Citrus × limon*
20	Mhaliammaram	*Mimusopselengi*
21	Veppammaram	*Azadirachtaindica*
22	Badammaram -	*Terminaliacatappa*
23	Pungaimaram -	*Millettiapinnata*
24	Thoongumoonjimaram -	*Samaneasaman*
25	Perunkondraimaram -	*peltophorum-pterocarpum*

3.5 Green Audit-Evaluations and Recommendations

The environment where we live within is of utmost concern since it is directly related to the survival. Keeping it healthy is the responsibility of each and every individual. The green auditing of university campus enables to assess if measures taken by university are sufficient to make the campus environment friendly

During the audit, various trees and plant species were observed, and area under green coverage was analyzed to ensure that the campus conform to green standards. The audit was done to ensure that the practices followed in the campus are in accordance with the Green Policy recommended by NAAC. All the efforts to increase the green coverage within the campus was documented.

During the audit all measures and actions taken by the authorities for protection and conservation of the environment in and around the campus were carefully observed.

Green audit was extensively done for the Sathyabama Institute of Science and Technology and the audit findings are as follows:

Best Practices Observed in the Institution –Green Campus Management

- Planting and caring of trees in and around the campus
- Various plantation drives involving the students were held in the campus
- Institution is maintaining Marshy Land in its natural form, there by helping in Ground Water Recharge and even act as a habitat for the birds nearby.
- Eco-club developed an eco-farm in the Institution campus, for growing vegetables using organic fertilizers.
- Terrace garden was inaugurated at the Chemical Engineering Department
- Eco club along with Rotaract club of Sathyabama Institute arranged for a 100sq.ft.terrace garden in Administration building, International Research Centre, ECEB lock, CSE Block, 14th classroom Block, Biotechnology Department and Chemical Engineering Department.
- Fifth phase of terrace gardening incorporated 'PET-bottle-watering method'
- Various seminar were conducted to give awareness about various gardening practices
- With the coordination of staffs and students at the Institution, students were demonstrated the scientific methodology for preparation of Bio Manure and organic pots
- Workshops were conducted to generate awareness regarding Vermi Composting practices, Carbon Credits and for generating Wealth out of Waste (WOW).
- Workshop on seed balls, a permaculture technique for growing seeds in an easy and effective way was conducted.

3.5.1 Consolidation of Green Audit Findings-Evaluation

The Green audit was conducted in Sathyabama Institute of Science and Technology in three stages: pre-audit, an on-site audit and post-audit follow-up.

In the Preliminary audit, a walk through the entire institution was carried out to see the green cover, the area of marshy land seen in the campus.

Discussion with the administrative officers, staff in-charge of gardening section were held to find out the maintenance drive practiced within the campus like frequency of grass cutting and trimming, frequency of dry leaves collection, frequency of watering, frequency of manuring, the type of manure used etc.

During pre audit stage efforts were made to gather information on environment protection drive and nature conservation activities done by its nature club.

During the audit the information regarding the types of trees seen around the campus, their numbers, presence of any endangered species, any horticulture plantation in the campus was collected.

During on-site walk though survey presence of various species of plants and trees were noted along with their scientific name.

During the on-site audit, the watering points were examined to see if there is water efficiency while watering the plants.

During on site audit, careful observation was done to see if any drip irrigation or springer irrigation is followed in the campus.

Discussion with the staff in-charge of water division was held during on-site audit to gauge their knowledge on water efficient irrigation, mulching and vertical farming followed in the institution.

During On-Site audit, walk through survey was done to the Compost pit within the campus to which dry leaves and other compostable matters are channeled for making compost. The quality of compost was also analysed to assess its suitability for use as fertilizer to kitchen garden and other plants seen in the campus.

Green audit was conducted in the Campus to analyze whether the concept of sustainable environment practice is adhered to while undertaking various construction and expansion activities in the campus.

The audit was done to suggest methods and practices that can be followed for environmental protection.

During the Green Audit green practices followed by the Institution was identification and documentation of the same was carried out. The strength and weakness of the current green practices was analysed to suggest a solution for a sustainable campus

During the audit continuous identification and assessment of environmental risk & issues was carried out.

All the current practices, which can impact the environment was noted down to suggest a way ahead to this problem. During the audit goal, vision, and mission for Green practices in campus was set up taking the authorities into confidence.

During Green Audit it was observed that the Institution has green cover of 39,500sq.ft and Marshy Land of 5,120 m2 area.

The green cover in the campus gives a cooling effect to the campus and act as sunblock. The green cover also helps in absorption of pollutant and nullifying the GHG emitted in the campus.

The Institution has a huge Marshy Land having an area of 5,120 sq.mt. This marshy land is present adjacent to the main entry of the campus. This marshy land is home to many water birds and migratory birds. The Marshy land offers drinking water to birds and small animals in and around the campus. This also helps in maintaining the water table in and around the campus area. This Marshy land also acts as a natural rain harvesting structure.

The campus has several plant, tree and shrubs species including medicinal plants like neem all these together contribute to aesthetics and overall greening of the campus.

The Institution taking up various efforts to increase the area under green cover by conducting various plantation drives involving the students. The administration is promoting activities like kitchen gardening, vegetable farming etc.

Institution is also promoting terrace gardening by motivating the students to do gardening on the roofs of various building.

The Institution has an active Eco-Club that conducts various plantation drive, awareness programmes, seminars etc. The Institution is also conducting various seminars and workshops to give awareness about Vermi-Composting, seed balls, preparation of Bio-Manure, making of Organic pots.

The Institution has its own composting pits to which dried leaves, leaves sweeping and plant cutting are diverted. These are then subject to composting and the organic compost is used as manure for the plants, trees and Kitchen garden in the campus.

The Institution is also taking great effort to ensure knowledge transfer to the people of the villages that the Institution has adopted. This clearly displays the Institutions endeavour to exercise leadership in addressing the fundamental problems of resource exploitation, by reversing the trends of environment degradation, and in promoting sustainability and to become stewards of Mother Nature.

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

3.5.2 Recommendation

- Form a Green Monitoring Forum. The priority of this forum is to exchange ideas about latest developments happening around the world with respect to maintaining a sustainable environment and implement the most feasible idea. The Green Monitoring Forum may consist of members from teaching staffs, non-teaching staffs, and students and if possible include some local interested people.
- Install Vermicomposting facility, the output of which can be used as manure for plantation purpose.
- Promote Indoor Gardening-Indoor plants are commonly used for their aesthetics benefits but they also have vital role reducing airborne pollution. The right choice of plants can be an excellent way of improving indoor air quality and general health. List of indoor plants are shown below.
- Prepare and maintain a Green Book of the campus where details of all the plants and trees available in the campus must be recorded along with their counts, so that any variations in the same can be evaluated periodically and necessary actions can be taken.

3.6 Green Audit Conclusion

An environmental audit for an Educational Institution is a systematic examination to assess a company's environmental responsibility. It aims to identify environmental compliance, verify environmental responsibility implementation gaps whether they meet stated objectives, along with related corrective actions. Environmental Audits play a significant role in tracking the sustainability of an Institution. An Environmental and Green audit helps an educational Institution to be accountable in their daily activities by examining their practices and determining what measures need to be taken to become a more Sustainable Educational Institute. The Educationists all over the world believes that it is important for Institutions to go green not only from the point of view of protecting the environment but also from teaching the youth the importance of maintaining ecological balance and ensuring sustainable development. Environmental and Energy audit provides an opportunity to create a clean and healthy environment in the campus.

Green audit was conducted as a process of examination of the green coverage area in the campus. It was conducted in the Campus to analyze whether the concept of sustainable environment practice is adhered to while undertaking the daily practices in the campus including various construction and expansion activities.

During Green Audit it was observed that the Institution has green cover of 39,500sq.ft and Marshy Land of 5,120 m2 area. The green cover in the campus gives a cooling effect to the campus and act as sunblock. The green cover also helps in absorption of pollutant and nullifying the GHG emitted in the campus. The marshy land is home to many water birds and migratory birds. The Marshy land offers drinking water to birds and small animals in and around the campus. This also helps in maintaining the water table in and around the campus area. This Marshy land acts as a natural rain harvesting structure.

The campus has several species of plants and trees including medicinal plant like Neem. Several efforts are taken by the administration to increase the green cover by terrace farming, planting of saplings, roof top gardening, vegetable gardening, kitchen Gardening etc. The dry leaves, leaf trimming and other compostable waste are diverted to six compost pits seen in the Campus premises and the compost generated is used as organic fertilizer for the plants grown in the

campus. This is classic example of leading a green and sustainable life in the campus adhering the R3-reduce, recycle, reuse principles. The rain water harvested in the rain water harvesting pits are used to water the plants in the campus. The treated effluent water is also reused for gardening purpose.

The Institution is also taking great effort to ensure knowledge transfer to the people of the villages that the Institution has adopted by frequently conducting knowledge exchange session on how to live Sustainability in the present time.

These shows the amount of importance the Satyabhama Institute of Science and Technology is giving in a Sustainable manner by maintaining a clean and healthy environment in and around the campus and decreasing the environmental impact from its daily activities. These efforts can be taken as major step taken towards preserving the degrading environment and maintaining a balance between growth and development

Satyabhama Institute of Science and Technology is setting an example for other Educational Institutions to follow on how to ensure Sustainability in a Campus with so many young population.

The Environmental Audit conducted in Satyabhama Institute of Science and Technology, endorse the commitment of the Institution towards the environment with a greater involvement, action plans towards maintaining Sustainability at every stage by the management and teaching professionals and the student community

All these show the Institution's commitment towards its environmental and social responsibility and its commitment towards protecting the earth's resources in its perpetuity. This Green audit conducted is not only significant for the Institution, but also for the other Institutions to emulate and adopt as a model and therefore contribute in this endeavour of sustainable environment for all.

Photos of Campus Green Coverage

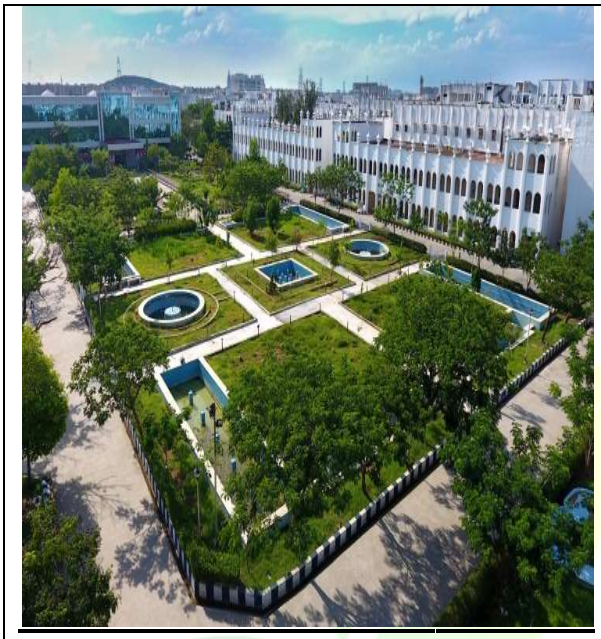


Figure 5: Green coverage

Figure 6: Ariel view of roof top gardening

Figure 7: Ariel view of roof top gardening

Figure 8: Watering the plants using recycled water

Figure 9: Watering the plants using recycled water

Figure 10: Aerial view of marshy land

Figure 11: **Campus Green Pathway**

Figure 12: **Campus Garden**

Figure 13: **Campus Garden**

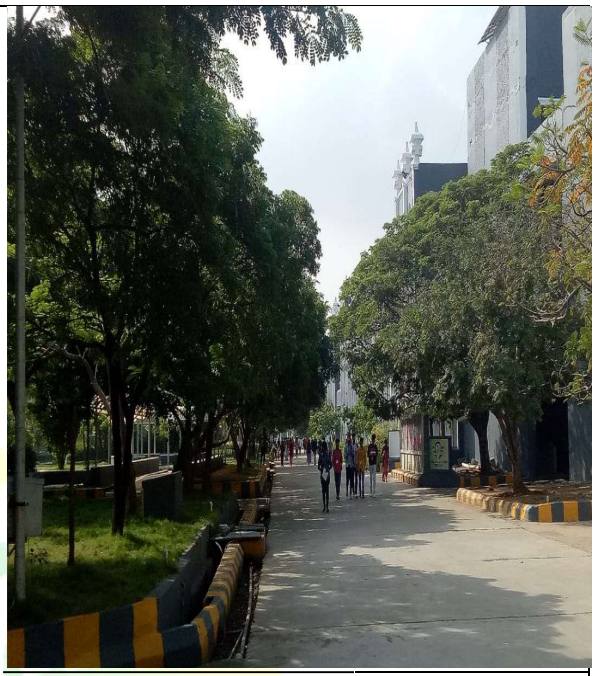
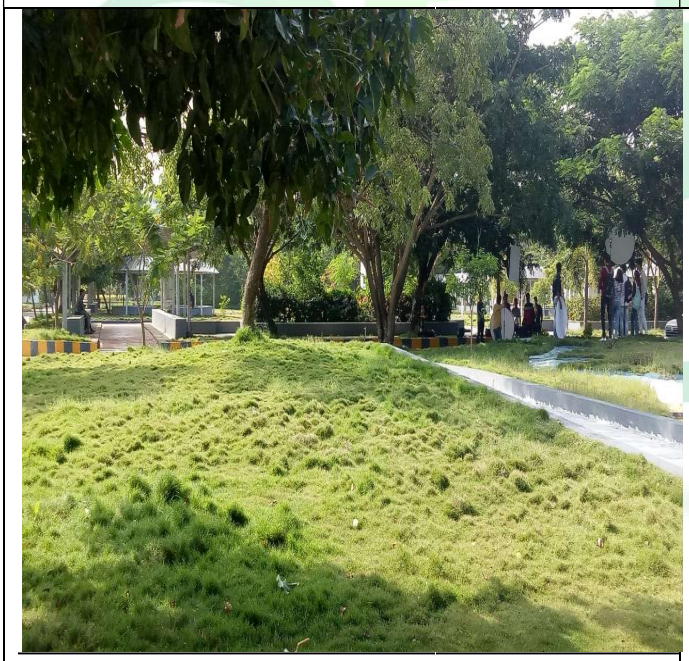


Figure 14: **Campus Green Pathway**

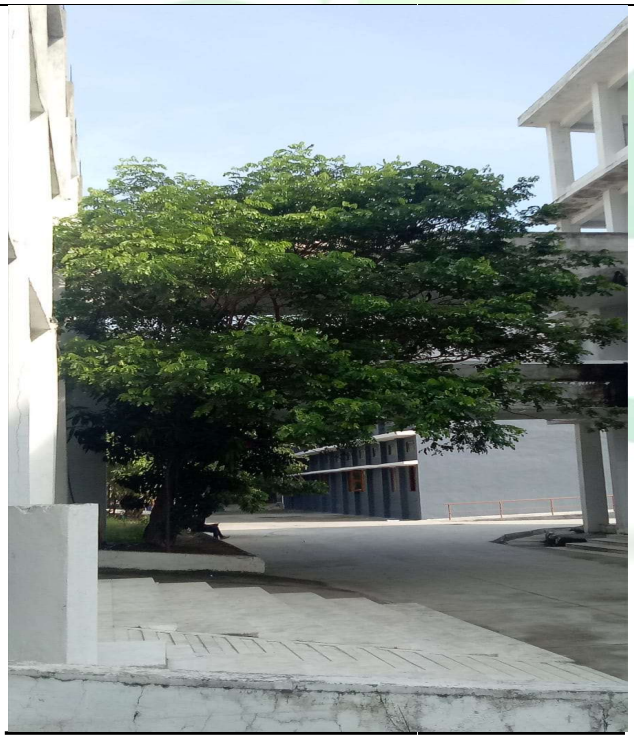


Campus Garden

Figure 15: **Coconut tree**

Figure 16: **Banana tree**

Campus Tree



Campus Tree

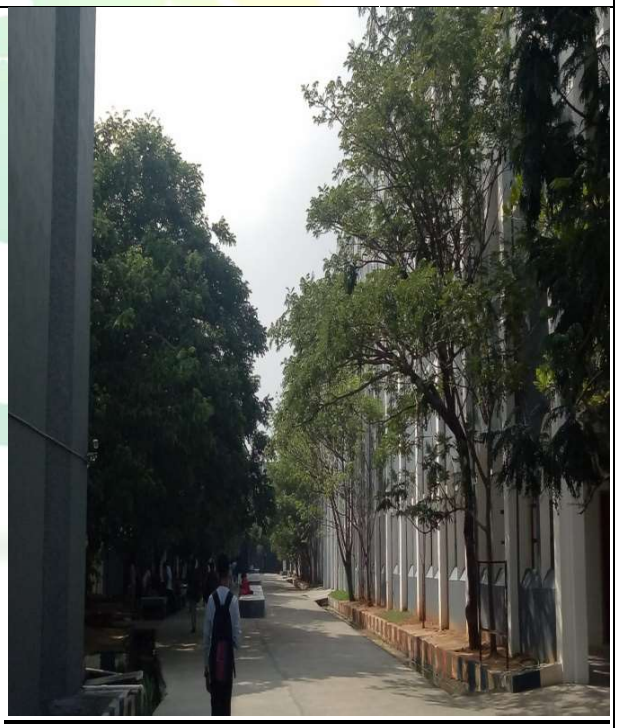


Figure 17: **Campus Green Pathway**

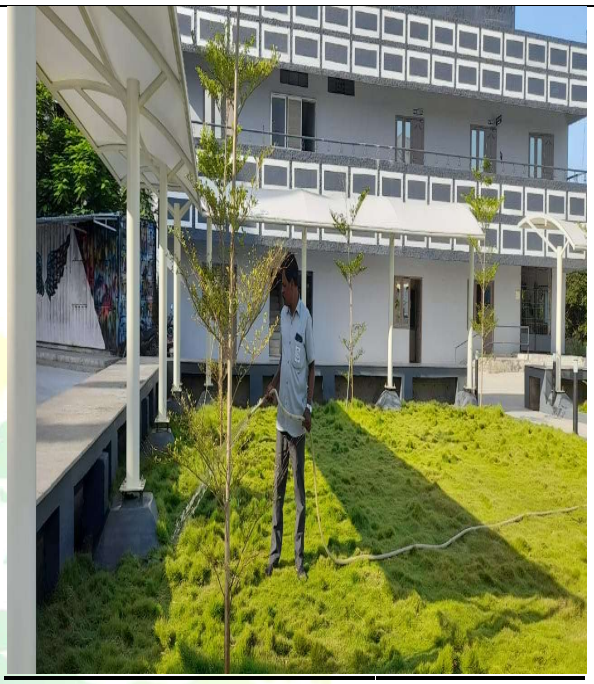


Figure 18: **Campus Greenery**

Table 2: List of Indoor Gardening plants

Indoor plants are commonly used for their aesthetic benefits but they also play a vital role in reducing airborne pollution. The right choice of plants can be an excellent way in improving indoor air quality and general health. Local landscape contractor can be contacted for supply and rotation of these plants.

Plants	Name	VOC it removes	Indoor source of VOC's	Plant care
	**Aloe Vera**	Formaldehyde, Trichloroethylene and Benzene	Chemical based cleaners and paints	Easy to grow with enough sunlight
	**Bamboo Plant**	Formaldehyde, Trichloroethylene and Benzene	Paints, Plastics, Wood products etc.	Thrives under low light conditions as well as easy to maintain
	**Chinese Evergreen**	Benzene	Paints	Low maintenance plant that prefers low light conditions.
	**English Ivy**	Formaldehyde, Benzene, Air borne fecal matter particles	Wood, Paper products, Air borne faecal – matter particles from pests	Easy to maintain

Plants	Name	VOC it removes	Indoor source of VOC's	Plant care
	**Janet Craig**	Formaldehyde, Benzene and Trichloroethylene	Paints, Plastics, Wood products etc.	Medium to low light tolerant plant. Requires little water for growth.
	**Golden Pothos or Devils Ivy**	Formaldehyde, Cleanses air	Exhaust fumes, carpeting materials, panelling and furniture products made with particle board	Extremely easy to maintain under low to bright light conditions. Fast growing and grows well under Fluorescent light.
	**Mass Cane**	Formaldehyde, benzene and trichloroethylene	Paints, Plastics, Wood products etc.	Medium to low light tolerant plant. Requires little water for growth.
	**Snake plant**	Formaldehyde and trichloroethylene	cooking fuels, wood products, facial tissues, personal care	Drought resistant and Tolerates a variety Of light

Plants	Name	VOC it removes	Indoor source of VOC's	Plant care
			products and waxed papers	conditions. Hard to damage or kill.
	**Peace Lily**	Formaldehyde, benzene and trichloroethylene	Paints, Plastics, Wood products etc.	Relatively easy to maintain. Survives in low light conditions.
	**Red-edged Dracaena**	Formaldehyde and trichloroethylene	cooking fuels, wood products, facial tissues, personal care products and waxed papers	Drought resistant and Tolerates a variety of light conditions. Hard to damage or kill.
	**Spider Plant**	Formaldehyde, benzene, carbon monoxide and xylene	cooking fuels, wood products, Printing	Easy to maintain under medium to bright light condition.

Plants	Name	VOC it removes	Indoor source of VOC's	Plant care
	**Parlor Palm**	Purifies indoor air	-	Easy to maintain

CHAPTER 4

ENERGY AUDIT

4.1 Introduction

Energy, particularly electrical energy is crucial to human sustenance and development. Due to the increasing demand for electrical energy, day by day the gap between the demand and supply is widening. The only achievable way to handle this crisis is the efficient utilization of available electrical energy and making use of the renewable source of energy to supplement the energy requirement. Efficient utilization of electrical energy is only possible by persistently monitoring and controlling the use of electricity by conducting energy audits.

Energy audit in Satyabhama 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 equipments 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.

4.2 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 were studies and evaluation of operational efficiency of these equipments from the energy conservation point of view was 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. The walk through survey and base line data collection was carried out between October

2021 and May 2022

6. Analysis of past records were done to find the historical usage for base line data collection purpose
7. 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.
9. Brainstorming was done to find any chance of upgrading the existing system to improve energy efficiency.

4.3 Energy Audit Survey/Questionnaire

1. List the ways of energy usage in the Institution. (Electricity, electric stove, kettle, microwave, LPG, Petrol, diesel and others).
2. The amount spent for petrol/diesel for the past one year?
3. Are there any energy saving methods employed in the Institution? If yes, please specify.
4. How much money does the Institution spend on energy such as electricity, gas, firewood, etc. in a month?
5. How many CFL bulbs have been installed? Mention hours of usage (Hours used/day for how many days in a month)
6. Energy used by each bulb per month? Forexample-60watt bulb x 4hours x number of bulbs
7. How many LED bulbs are used in the Institution? Mention hours of usage (Hours used/day for how many days in a month)
8. Energy used by each bulb per month? (KWh).
9. How many incandescent (tungsten) bulbs have been installed? Mention hours of usage (Hours used/day for how many days in a month)
10. How many fans are installed in the Institution? Mention hours of usage (Hours used/day for how many days in a month)
11. Energy used by each fan per month?(kWh)
12. How many air conditioners are installed in the Institution? Mention hours of usage (Hours used/day, for how many days in a month)
13. Energy used by each air conditioner per month? (KWh).
14. How much electrical equipment including weighing balance is installed the Institution? Mention the use (Hours used/day for how many days in a month)
15. Energy used by each electrical equipment per month? (KWh).

16. How many computers are there in the Institution? Mention hours of usage (Hours used/day for how many days in a month)
17. Energy used by each computer per month?(kWh)
18. How many photocopiers are installed by the Institution? Mention hours of usage (Hours used/day for how many days in a month).
19. How many cooling apparatus have been installed in the Institution? Mention hours of usage (Hours used/day for how many days in a month)
20. Energy used by each cooling apparatus per month? Mention hours of usage (Hours used/day for how many days in a month)
21. Energy used by each photocopier per month? Mention hours of usage (Hours used/day for how many days in a month)
22. How many inverters have been installed? Mention hours of usage (Hours used/day for how many days in a month)
23. Energy used by each inverter per month?(kWh)
24. 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)
25. Energy used by each equipment per month?(kWh)
26. 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).
27. Energy used by each heater per month?(kWh)
28. No of streetlights in the Institution?
29. Energy used by each streetlight per month?(kWh)
30. No of TV in the Institution and hostels?
31. Energy used by each TV per month?(kWh)
32. 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)
33. Any alternative energy sources/non-conventional energy sources employed/installed in the Institution? (photovoltaic cells for solar energy, windmill, energy efficient stoves, etc.,)
34. Do you run switch off drills at Institution?
35. Are the computers and other equipment put on power-saving mode?
36. Does the machinery (TV, AC, Computer, weighing balance, printers, etc.) run on standby

mode most of the time? If yes, how many hours?

37. What are the energy conservation methods adapted by the Institution?
38. How many boards are displayed for energy saving awareness?
39. How much ash is collected after burning fire wood per day in the canteen?

4.4 Energy Audit-Key Findings

4.4.1 List of Instruments Used

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

WasmanPro Energy audit team visited the campus premises and collected a detailed list of all electrical equipment and appliances used in the campus.

Team visited various locations/ departments in the campus like-

- Conference hall
- Library
- Laboratory
- Sports Room
- Staff Room
- Computer Room
- Canteen
- Prayer Hall
- Common Corridor and Hall Way
- Walk Ways the campus
- Kitchen
- Various Departments
- Hostel
- Pump House
- Water Treatment Units

Audit Findings

The major energy consuming equipment installed in Satyabhama Institute of Science and Technology are- Lighting fixtures, Air conditioning system, Ceiling & Exhaust Fan, Pumps Refrigerators, laboratory equipment etc

Table 3: Tabulation of Campus Connected Load (KW)

Sl.No.	Connected Load	Major Usage Area	Connected Load(%)
1	Lighting System	Hostel, Classroom, Admin Block, Labs, Canteen, Out Door, Stadium, Corridor, Study Hall, Prayer Room etc	19.01%
2	Fan System	Hostel, Classroom, Admin Block, Labs, Canteen, Out Door, Stadium, Corridor, Study Hall, Prayer Room etc	17%
3	Air Conditioning System	Hostel, Classroom, Admin Block, Labs, Study Hall, Prayer Room etc	35.18%
5	Other Appliances	Computer, Printer,Xerox Machine, Gym Laboratory Equipments, RO Plant etc	23.82%

Pie Chart on Load Distribution

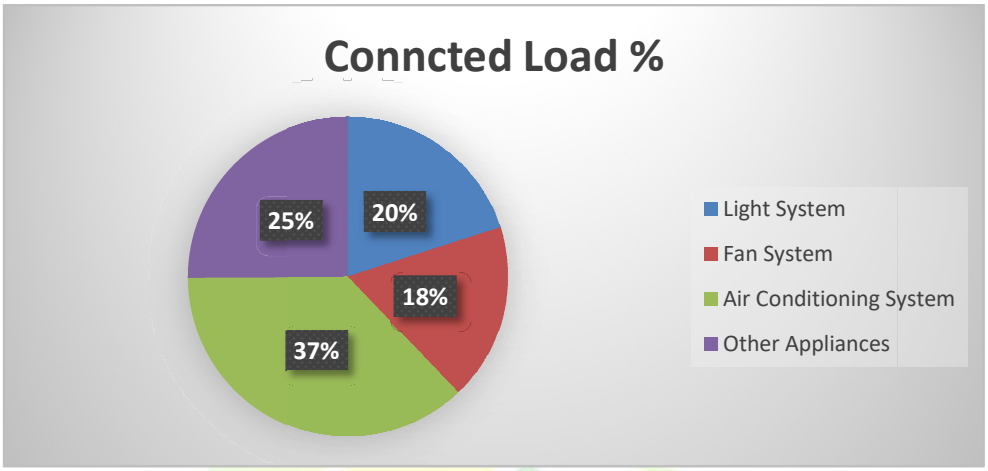


Figure 19: Pie Chart on Load Distribution

During the Energy audit, the connected load of the entire Campus was analyzed. Based on the analysis it was found that AC units put maximum load nearly 35 %. Light and Fan system consumes 19 % and 17 % of power purchased by the Institute. The other Miscellaneous equipment's like Computer, Printer, Xerox Machine, Gym Laboratory Equipment's, RO Plant, heater and other equipment's and appliances used in the campus exerts a load of 23.82 %.This miscellaneous equipment's puts the second highest load on the system.

Table 4: Major Utilities at Satyabama Institution of Science and Technology

S.NO	Particular	Quantity
1	Lighting System	5371
2	Fan	2571
3	Air Conditioner	10 plus
4	Core 2 Duo/Core i3(Board/Process/Ram,HDD/SMPS)	252
5	Core i5(Board/Process/Ram/HDD/SMPA)	13

S.NO	Particular	Quantity
6	TFT Monitor	165
7	CRT Monitor	6
8	Keyboard	160
9	Server	6
10	UPS	10
11	Apple AIO	5
11	DG Set	8

4.4.2 Energy System Evaluation-Lighting System

The Satyabhama 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 findings of audit are tabulated below.

Table 5: List of lighting load

Area	Equipment	Rating(W)	Quantity	Total load (in kWh per day)
Block No.1	Tube Light	40	156	49.92
Block No.2	Tube Light	40	34	10.88
Block No.3	Tube Light	40	37	11.84
Block No.4	Tube Light	40	37	11.84
Block No.5	Tube Light	40	35	11.2
Block No.6	Tube Light	40	29	9.28
Block No.7	Tube Light	40	35	11.2

Area	Equipment	Rating(W)	Quantity	Total load (in kWh per day)
Block No.8	Tube Light	40	35	11.2
Block No.10	Tube Light	40	156	49.92
Block No. 11	Tube Light	40	136	43.52
Block No.12	Tube Light	40	156	49.92
Block No.14	Tube Light	40	156	49.92
Block No.15	Tube Light	40	156	49.92
Block No.16	Tube Light	40	156	49.92
Block No.18	Tube Light	40	156	49.92
Dr.MGRillam(Boys hostel)	Tube Light	40	320	153.6
Dr.Gopalakrishananillam (boys hostel)	Tube light	40	320	153.6
3rd year hostel(Boys hostel)	Tube light	40	203	97.44
Panimalarhostel(Ladies hostel)	Tube light	22	203	53.59
Janakiammalhostel(Ladies hostel)	Tube light	40	156	74.88
Janakiammal hostel-I(Ladies hostel)	Tube light	40	156	74.88
Janakiammal hostel-II(Ladies hostel)	Tube light	40	200	96
Janakiammal hostel-III(Ladies hostel)	Tube light	40	206	98.88

Area	Equipment	Rating(W)	Quantity	Total load (in kWh per day)
Administrative office	Tube light	40	156	49.92
Old office	Tube light	40	31	9.92
Ladies mess	Tube light	40	250	80
PG mess	Tube light	40	22	7.04
Boys mess	Tube light	40	250	80
CSC block	Tube light	40	80	25.6
ECE block	Tube light	40	80	25.6
E&C AND E&I block	Tube light	40	30	9.6
EEE block	Tube light	40	55	17.6
Machine shop	Tube light	40	30	9.6
CAD lab	Tube light	40	20	6.4
Production lab	Tube light	40	50	16
Welding lab	Tube light	40	60	19.2
Civil block	Tube light	40	97	31.04
Bio-tech block	Tube light	40	130	41.6
M.sc block	Tube light	40	30	9.6
ETC block	Tube light	40	90	28.8
Thermal lab	Tube light	40	30	9.6
Mech & production	Tube light	40	30	9.6
Aeronautical lab	Tube light	40	156	49.92
B.Arch.	Tube light	40	156	49.92

Area	Equipment	Rating(W)	Quantity	Total load (in kWh per day)
Nano-tech block	Tube light	40	60	19.2
Auditorium	Tube light	40	156	12.48
Transport shed	Tube light	40	10	3.2
Library	Tube light	40	30	9.6
Play ground	Tube light	120	22	21.12
Sewage & drainage	Tube light	40	2	0.64
Dobi room	Tube light	40	4	1.28
Street light	Tube light	120	20	28.8
			Total	**1956.15**

The Institution has tube light installed at various locations like Class room,hostels, common areas, laboratories, administrative building etc. The details of the lighting system is tabulated in the above given table. There are nearly 5371 light fitting installed at various locations. Most of these have a power rating of 40W. The total load exerted by the lighting system in the Campus is 1956 KW per day. The luminous intensity was also taken into consideration and details of the same are tabulated below.

Table 6: Performance assessment of lighting system with Lux Measurement

S.No	Location	Wattage	Type of Fitting CFL/LED/Tube light	No. of Fittings	Avg. LUX
1	Library hall	1572	LED	44	155
2	Library hall Ground floor (student sitting area)	3960	LED	15	115
3	Library 2nd Floor (HR discussion panel)	180	LED	10	64
4	Interview panel room	220	LED	1	219
5	Auditorium	30	LED	1	186
6	Janakiamal Hostel	36	LED	2	85
7	St Mother tresaillum	72	LED	2	47
8	Mother of Roseryillum	80	LED	2	48
9	Immaculate Marry illum	44	LED	2	85
10	Gopal Krishnan illum	44	LED	2	189
11	MGR illum	72	LED	2	66
12	Col Dr Jeppiarillum	72	LED	2	72

S.No	Location	Wattage	Type of Fitting CFL/LED/Tube light	No. of Fittings	Avg. LUX
13	Class Room Block 15	240	LED	6	60
14	Class Room Block 18	320	LED	8	85
15	Class Room Block 8 (Room 9)	108	LED	6	95
16	Hostels	50	LED	7	48
17	Toilets	50	LED	6	48
18	Common Corridor	40	LED	8	40

Table 7: 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

4.4.2 Fan System

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

Table 8: Fans installed at the facility

Area	Equipment	Rating(W)	Quantity	Total load (in kWH per day)
Block No.1	Fan	80	65	41.6
Block No.2	Fan	80	38	24.32
Block No.3	Fan	80	36	23.04
Block No.4	Fan	80	36	23.04
Block No.5	Fan	80	37	23.68
Block No.6	Fan	80	28	17.92
Block No.7	Fan	80	45	28.8
Block No.8	Fan	80	43	27.52
Block No.10	Fan	80	65	41.6
Block No. 11	Fan	80	65	41.6
Block No.12	Fan	80	55	35.2
Block No.14	Fan	80	55	35.2
Block No.15	Fan	80	65	41.6
Block No.16	Fan	80	65	41.6
Block No.18	Fan	80	65	41.6
Dr.MGRillam(Boys	Fan	80	180	172.8

Area	Equipment	Rating(W)	Quantity	Total load (in kWH per day)
hostel)				
Dr.Gopalakrishanan illam (boys hostel)	Fan	80	180	172.8
3rd year hostel(Boys hostel)	Fan	80	155	148.8
Panimalar hostel(Ladies hostel)	Fan	80	155	148.8
Janakiammal hostel(Ladies hostel)	Fan	80	65	62.4
Janakiammal hostel-I(Ladies hostel)	Fan	80	50	48
Janakiammal hostel-II(Ladies hostel)	Fan	80	150	144
Janakiammal hostel-III(Ladies hostel)	Fan	80	150	144
Administrative office	Fan	80	8	5.12
Old office	Fan	80	12	7.68
Ladies mess	Fan	80	140	89.6
PG mess	Fan	80	13	8.32
Boys mess	Fan	80	140	89.6
EEE block	Fan	80	24	15.36
Machine shop	Fan	80	30	19.2
Production lab	Fan	80	20	12.8
Welding lab	Fan	80	10	6.4

Area	Equipment	Rating(W)	Quantity	Total load (in kWH per day)
Civil block	Fan	80	10	6.4
Bio-tech block	Fan	80	30	19.2
M.sc block	Fan	80	18	11.52
ETC block	Fan	80	20	12.8
Thermal lab	Fan	80	20	12.8
Aeronautical lab	Fan	80	65	41.6
B.Arch.	Fan	80	65	41.6
Nano-tech block	Fan	80	30	19.2
Auditorium	Fan	80	50	8
Transport shed	Fan	80	4	2.56
Library	Fan	80	12	7.68
Sewage & drainage	Fan	80	1	0.64
Dobi room	Fan	80	1	0.64

In the institution there is nearly 2571 fan system with power rating ranging from 80 W installed in various departments, hostels, common room, guest room, canteen.There are exhaust fans in Kitchen, toilets, laboratory etc. The ceiling fan constitutes the highest number among all other fans and details of the same are shown above. The Institution has just three pedestal fan.The fan systems in together put a load of 1968.64 KWh.

4.4.3 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. Due to large number of ACs installed, auditors did the study on sample basis.

Table 9: Detailed performance assessment of few Air-Conditioners

S.NO	Location	Rated Capacity in (TR)	Type	Compressed Load (in kW)
1	Auditorium AC unit 1	11.5	Ducted	10.85
2	Auditorium AC unit 1	11.5	Ducted	11.06
3	Auditorium AC unit 1	11.5	Ducted	10.97
4	Auditorium AC unit 1	8.5	Ducted	8.89
5	Auditorium AC unit 1	8.5	Ducted	8.93
6	Library Auditorium	2	Split	2.45
7	Library Auditorium	2	Split	2.2

The institution has many A/C units installed in various locations across the institution. Majority of these Air Conditioning systems are of Duct A/C type and only few are window A/C. Duct A/C consumes less power and more efficient than window A/C. So installation of Duct A/C instead of Window A/C is an appreciable step taken by the institution towards power saving.

4.4.4 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.

Table 10: Pumps location

Sl.No.	Location	Number of Pump	HP of Pumps
1	Pumps to Overhead tanks	9	5
2	Ladies Hostel	25	5
3	Rain Water Pump	7	5HP, 2 HP,1HP
4	Sewage Water Pump	2	5HP
5	Boys Hostel	3	5HP
6	Mess	4	5HP

4.4.5 Generator System Evaluation

Table 11: Generator with Capacity

SI.NO.	COMPONENT		CAPACITY (KVA)
1	D.G		500
2	D.G		500
3	D.G		625
4	D.G		700
8	D.G		400
6	D.G		300
7	D.G		320
8	D.G		630

There are nearly 8 Diesel generator set in the Institute. Only 4 are fully functional which operates for 4-6 hrs per day based on the demand and power requirement. 4 DG sets are made to function occasionally for 2 hrs per day when the demand is higher or when there is shortage in power supply or when there is a power cut. 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 consume90litres 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.

4.4.6 Transformers Evaluation

Table 12: Transformer Ratings

S.NO	Transformer	Transformer Rating (in kVA)
1	Transformer	1000
2	Transformer	1000
3	Transformer	630

Details of Other Type Equipment

S. No	Description	No of Units
1	Core 2 Duo/Core i3(Board/Process/Ram,HDD/SMPS)	252
2	Core i5(Board/Process/Ram/HDD/SMPA)	13
3	TFT Monitor	165
4	CRT Monitor	6
5	Keyboard	160
6	Server	6
7	UPS	10
8	Apple AIO	5
9	Empty Cabinet	160

4.4.7 Solar System an Evaluation

Table 13: 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	10 KW
Ceria based SOFC	0.3 W

The University 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.

4.4.8 Summary of Major Utilities

Table 14: Major Utilities at Sathyabama Institute

S.NO	Particular	Quantity	Rating
1.	Transformer	3	1000kVA × 2 630kVA× 1
2.	Capacitor Bank	4	100 kVA × 4
3.	Diesel Generators	8	725 kVA × 1 625 kVA × 1 500 kVA × 3 185 kVA × 1
4.	Single phase load (lights, fan, power sockets, etc.)	Multiple	Total 440kW
5.	Electric Motor	Multiple	Total 526 HP
6.	Power Load in facility	Multiple	Total 570 kW
7.	Power Load for UPS	Multiple	Total 669 kVA

4.5 Energy Audit – Evaluations and Recommendations

An Energy audit of an Educational Institution is a process for the collection of primary and secondary data, conducting walk-through inspection, building and equipment survey and analysis of energy flow into a building and Testing equipment in the labs, utilities, analysis of methods for energy conservation in a building, and arrive at methods to reduce the amount of energy input into the building without affecting the output of the building. Energy Audit was used as the key to decision-making in the area of energy management in the Institution.

The audit was carried out in Satyabhama Institute of Science and Technology with an aim to identify various energy usage points and to quantify the usage, to balance the input with the usage, and to arrive at practical steps for the conservation of energy.

Energy audit was extensively done for the Sathyabama Institute of Science and Technology and the Audit findings are as follows:

Best Practices Observed in the Institution - Energy Management

- Periodic maintenance of electrical/electronic equipmentis 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.

4.5.1 Consolidation of Energy Audit Findings-Evaluation

The audit conducted by WasmanPro Environmental Solutions LLP involved data collection for various electrical & thermal utilities, holding meeting with concerned departmental officials & managers, carrying out various field measurements, performance analysis and loss analysis covering all major energy-consuming sections of Sathyabama Institute of Science and Technology, to assess losses mainly in energy consuming utility areas and to arrive at the potential for energy savings.

The Energy audit was conducted in Sathyabama Institute of Science and Technology in three stages: pre-audit, on-site audit and post-audit follow-up.

During pre audit stage efforts were made to gather information on the source of power supply to the Campus, any alternate power supply sources like solar cells/panels, solar -wind hybrid system. Efforts were also made to find out whether the Institution has implemented any energy conservation techniques.

During the on-site audit, careful observation of supply to distribution to final utility point was done to see if there is any Transmission and Distribution loss any wastage or theft. During the

Onsite audit the energy efficiency of various equipment's, and fixtures like fan, light , AC were analyzed.

Discussion with the staff in chargeof electricity division was held during on-site audit to gather information including about the solar panels, its efficiency, its power generation capacity etc.

During On-Site audit, walk through survey was done to examine the building layout, transformer location, DG set locations, major utility points etc

During the Post Audit Stage, the data collected and identified were analysed to find the how the energy is managed throughout the institution from supply point to the consumption point. Various observations noted down were taken into consideration during the analysis stage.

Detailed analysis of data collected was done. It included calculation of energy consumption, analysis of the latest electricity bill of the campus, understanding the tariff plan, analysis of various power saving methods implemented in the campus, analysis of any clean or green source of energy in the campus to substitute the conventional source of power.

On the basis of results of data analysis and observations, various suggestions that the Institution can implement were recommended.

Based on the above observation and analysis it was found that the main source of power is the electricity purchased from Tamil Nadu Electricity Board. The power purchased during the year 2021-22 was very high when compared to the 2020-21. As during 2020-21, the Institution was only partially functioning due to Covid-Pandemic.

The Institution is taking major efforts to decrease the dependence on conventional power, as conventional power leads to emission of GHG to the atmosphere leading to global warming. So to contribute towards Paris Agreement and NDC of our nation, the Institute is rapidly increasing its renewable power production capacity.

The administration of Satyabhama Institute of Science and Technology has promoted the use of solar panels on rooftops, waiting sheds, and other free open areas to generate power. This power is used to light the campus street lights and to run geysers in the hostel. This a highly

commendable step as lot of power wastage happens in the hostel as many students are careless regarding the usage of geysers and leading to power wastage. The Institution is using solar power to run the solar water heaters and geysers in the Hospital and to meet other hot water requirements at the Hospital leading to substantial savings of power.

The Institution has also taken an effort to power its laboratory using the Solar-Wind Hybrid system. The Institution has installed various types of solar cells like thin film solar cells, Si-based solar cell panels, Perovskite Solar Cells, Hetrojunction Oxide solar cells. These solar units all together generate 141 W per annum. Efforts have been taken to scale up these initiatives.

The Institution had installed World's Largest Solar Steam Cooking System with 110 concentrator dishes to power the Institution's mess. This solar powered kitchen consumes less power and time than conventional LPG powered kitchen. By replacing LPG with solar dishes the Institution was able to save nearly Rs 25 lakhs per annum.

The administration has started the initiative of replacing 2571 Conventional Fans (80W) with BLDC (30 watts)fans. BLDC fans are much more efficient than conventional fans. BLDC fans consume a lesser amount of energy, without compromising much on air delivery. BLDC stands for brush-less direct-current motor, a special type of motor which has a permanent magnet instead of electromagnets found in a conventional induction motor. The 5-star rated BLDC ceiling fans consumes 25-40 watts of energy, which is about 40-70% less than the regular old fans. Also BLDC motor has important advantages over induction motor like low electricity consumption, lesser noise generation, improved reliability and better lifespan.Based on audit observation, we would like insist the administration to complete the process of replacement of all the regular fans with BLDC fans.

The Institution has already replaced Conventional single-star AC with five-star AC, this could save nearly 2KWper day. 3 Star Split A/C has energy efficiency ratio in the range of 3.50-3.399, while a 5 Star Split A/C has energy efficiency ratio 4.50. While the energy efficiency ratio of 3 Star Window A/C is 2.9-3.09 and that of 5 Star Window A/C is 3.3.This dataconveys the message that Split A/C is much better than Window A/C and 5 Star Split A/C is more energy

efficient than 3 Star Window A/C, 3 Star Split & 5 Star Window A/C. This clearly shows the benefit the Institution has already acquired by replacing the conventional AC with Duct type AC.

Smart motion sensors have been installed in various areas of the administrative building, which automatically switch off the light when there is no movement and turn on the light when it detects any motion. By installation of smart sensors, the total load in corridors, main building could be reduced considerably. This initiative had to be stopped in between owing to the pandemic.

The Institution had replaced its 5371 Conventional FTLs with LED Tube lights leading to saving of nearly 97 KW per day. By replacing CFL lights with LED Light, the Institution was able to save nearly 15W per light. LED are expensive than CFL and tube lights, but LEDs come with a life span of 10-15 years (depending on the number of hours of usage per day); consume up to 50% less power than CFLs and 80% lesser than incandescent. Thus the savings in the electricity bills and operational costs result in a quick payback of the comparatively higher product price.

The Institution took initiatives to replace the CRT Monitors with LCD Monitors, leading to saving of nearly 270 W per monitor.

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 administration has started taking efforts to use an all-in-one printer/scanner/copier instead of three separate power-consuming devices. This process is not yet completed but an ongoing effort.

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. The Institute has signed MoUs with various Foreign Institutes to collaborate on research activities in the field of clean energy.

The Electrical audit of the Institution shows efforts are being taken up to reduce non-renewable energy consumption and thereby reducing the GHG emission to the atmosphere, by focusing

more on renewable sources of energy like solar , solar-wind hybrid . It can be concluded that the Institution is taking a great effort in energy conservation and management.

Based on the above finding few recommendations that the Institution can follow are:

4.5.2 Recommendations

- 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.

4.6 Energy Audit Conclusion

Energy is a primary and most universal measure of all kind of work by human being and nature. It is one of the real contributions to the economic development of any nation. On account of the developing nation, the energy sector shows acceptance up to a significant level to expand energy requirements based on colossal investments to meet them.

Under the mandate of The Energy Conservation Act 2001, the Bureau of Energy Efficiency and Government of India are implementing various programmes to initiate energy conservation movement in the country. Energy Auditing is most vital part of the energy conservation strategy. In order to improve the efficiency of the Energy consuming system, energy auditing is the first necessary action to be taken by the concerned institution. For proper Energy auditing and energy accounting, parameters need to be monitored on regular basis.

An energy audit of an Educational Institute is an inspection and analysis of energy input to the campus, energy flows with the campus through several building with the objective of understanding the energy efficiency and analysing the major usage points and to assess and transmission distribution loss.

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 Energy audit was conducted in Sathyabama Institute of Science and Technology in three stages: pre-audit, on-site audit and post-audit follow-up.

Based on the above observation and analysis it was found that the main source of power is the electricity purchased from Tamil Nadu Electricity Board. The power purchased during the year 2021-22 was very high when compared to the 2020-21.

The Institution is taking major efforts to decrease the dependence on conventional power, as the conventional power leads to emission of GHG to the atmosphere leading to global warming.

The administration of Satyabhama Institute of Science and Technology has promoted the use of solar panels on rooftops to generate solar power for lighting the campus,running geysers in the hostel and hospital. The Institution has installed various types of solar cells like thin film solar cells, Si-based solar cell panels, Perovskite Solar Cells, Hetrojunction Oxide solar cells. These solar units all together generate 141 W per annum. Efforts have been taken to scale up these initiatives.

The Institution has also taken an effort to power its laboratory using the Solar-Wind Hybrid system.

The Institution had installed World's Largest Solar Steam Cooking System with 110 concentrator dishes to power the Institution mess. This solar powered kitchen consumes less power and time than conventional LPG powered kitchen.

Light and Fan system consumes 19 % and 17 % of power purchased by the Institute. The administration has started the initiative of replacing 2571 Conventional Fans (80W) with BLDC (30 watts)fans. BLDC fans are much more efficient than conventional fans. BLDC fans consume a lesser amount of energy, without compromising much on the air delivery. The 5-star rated

BLDC ceiling fans consumes 25-40 watts of energy, which is about 40-70% less than the regular old fans.

The Institution had replaced its 5371 Conventional FTLs with LED Tube lights leading to saving of nearly 97 KW per day. By replacing CFL lights with LED Light, the Institution was able to save nearly 15W per light leading less power consumption meaning less GHG emission. These efforts taken by the administrative authority is laudable as they are always striving to contribute towards a safe and a better world.

The other Miscellaneous equipment's like Computer, Printer, Xerox Machine, Gym Laboratory Equipment's, RO Plant, heater and other equipment's and appliances used in the campus exerts a load of 23.82 %.These miscellaneous equipment's puts the second highest load on the system.To reduce this load the Institution has already initiatives to replace the CRT Monitors with LCD Monitors, leading to saving of nearly 270 W per monitor.

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 infact 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 SDG goals.

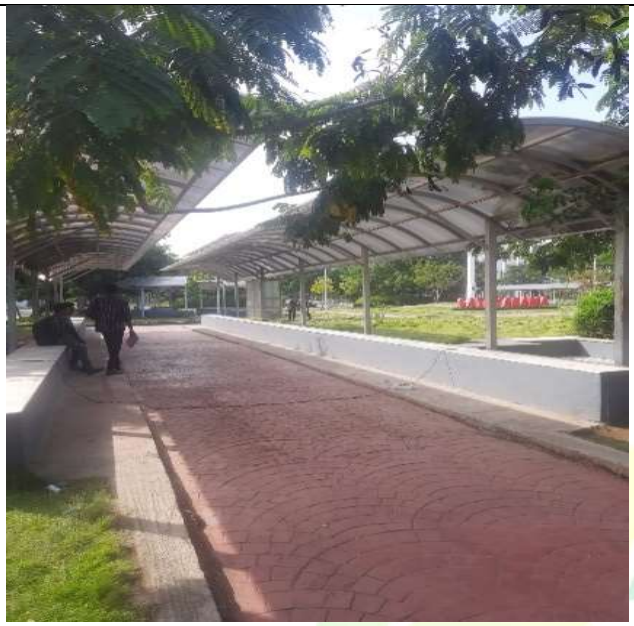


Figure 20: Solar Panels on waiting shed

Figure 21: Rooftop Solar Panel

Figure 22: Solar Inverter with controller

Figure 23: Solar powered walk way

Figure 24: Solar Panel at campus

Figure 25: Solar system with Service box

Figure 26: Solar cells on roof top

Figure 27: Solar-wind hybrid system

Figure 28: Large area Pervoskite Solar Cells

Figure 29: Windmill in the campus

Figure 30: Transformer

Figure 31: D.G Set

Figure 32: Power house Control Panels

CHAPTER 5

ENVIRONMENTAL AUDIT

5.1 WATER AUDIT

5.1.1 Introduction

Water is an essential precondition for life, and according to the UN it is a human right to have access to clean water. However, in India millions of people are living without direct access to safe water and based on the rapid population growth coupled with the fact that the water reserve is finite, it will be a very valuable and scarce resource within only a few years. In this light, there is an urgent need for decision makers to act in order to improve the conditions for effective use and supply of water.

Water auditing is a mechanism for conserving water, a comprehensive water audit gives a detailed profile of the distribution system and water users, thereby facilitating easier and effective management of the resources with improved reliability.

Water Audit is a tool to quantify the total intake water in an Institution, to analyze its various uses, to observe wastage/ leakage, to examine waste water treatment methods and to suggest water conservation techniques. It is thus an effective tool for realistic understanding and assessment of the present performance level and efficiency of usage of water at various points in the institutions, helps in rectification of faults and helps to arrive at a relevant method that can be adopted and implemented in an Institution to balance the demand and supply of water. It is therefore essential that any environmentally responsible Institution conducts a water audit and examines its water use practices.

5.1.2 Key Methodology adopted for Water Audit

a. Base Line data were collected by walk through survey and by conducting interactions with concerned staff and authorities.

b. Walk through survey was done, at various locations of buildings to understand the nature of water uses,to identify the type of water fixtures, and various systems installed in the building.

c. A walk through survey of the entire facility was conducted for measuring the water usage at various points based on flow rates. Survey was done to identify defective fixtures and to spot water leakage/ wastage points.

d. The walk through survey and interacting with the staff and other concerned authorities were conducted a different intervals spanning between October 2021 and May 2022

e. Discussion was held with the administrative officers, pump operators, ETP/STP staff, housekeeping staff, kitchen employees, students, staffs on the various water usage done by them during the day and the related treatment aspects.

f. Collection of records of water pumped to the overhead and underground tanks and average running hours of all pumps etc. was done to estimate actual supply and to quantify the total water intake by the Institute.

g. The amount of water sent to water treatment unit and the quantity of water recycled and reused was also analyzed.

h. Past records were also analyzed to get historic water usage data for baseline study purpose and to have a companion of past years and present years water footprint.

i. Based on the findings, calculation was done on overall water usage in the campus and methods for reducing the water footprint were suggested.

5.1.3 Water Audit Survey/Questionnaire

1. List various sources of water in your Institute.
2. How many wells are there in your Institute?
3. What is the depth of each well?
4. What is the present depth of water in each well?
5. No. of motors used for pumping water from each well?
6. What is the total horsepower of each motor?
7. Does the Institute buy water from outside sources?
8. Is the institute located in water stressed area or water scarce area?
9. Quantity of water stored in overhead water tank?(in liters)
10. Quantity of water pumped every day?(in liters)
11. List out various uses of water
12. List productive and unproductive usage of water seen in the Institute
13. No. of water coolers. Amount of water used per day?(in liters)
14. No. of water taps. Amount of water used per day?
15. No. of bath rooms in staff rooms, common area, hostels. Amount of water used per day?
16. No. of toilet, urinals. Amount of water used per day?
17. No. of water taps in the canteen. Amount of water used per day?
18. Amount of water used per day for gardening.
19. No. of water taps in laboratories. Amount of water used per day in each lab?
20. Total use of water in each hostel?
21. Is there any water used for agricultural purposes?
22. How many water fountains are there?
23. How often is the garden watered?

24. Quantity of water used to watering the ground?
25. Quantity of water used for bus cleaning?(liters per day)
26. Amount of water for other uses?(items not mentioned above)
27. At the end of the period, compile a table to show how many liters of water have been used in the Institute for each purpose
28. If there is water wastage, specify why.
29. How many of the taps are leaky? Amount of water lost per day?
30. Are there signs reminding people to turn off the water?
31. How many water fountains are leaky?
32. How can the wastage be prevented/stopped?
33. Locate the point of entry of water and point of exit of waste water in the Institute.
34. Where does waste water come from?
35. Where does the waste water go?
36. What are the uses of waste water in your Institute?
37. Is there any treatment for waste water?
38. What happens to the water used in labs? Whether it gets mixed with ground water?
39. Is there any treatment for the lab water?
40. Whether green chemistry methods are practiced in labs?
41. Write down four ways that could reduce the amount of water used in the Institute.
42. Record water use from the Institute water meter for six months.
43. Bimonthly water charges paid to water connections if any,
44. Is there any water conservation plan in the Institute?
45. Does your Institute harvest rainwater?
46. If yes, how many rain water harvesting units are there?(Approx .amount)

47. Is there any water less toilets?

48. Is drip irrigation used to water plants outside?

49. Area under green coverage.

50. Is there any water management plan in the Institute?

51. Are there any water saving techniques followed in your Institute? What are they?

52. List out key opportunities for water consumption reduction, reuse & recycle.

5.1.4 Water Audit-Key Findings

Water audit was performed by WasmanPro Environmental Solutions and the main water usage points in the campus were noted to be for cooking, drinking, gardening, cleaning,toilet and bathroom usages, hostel uses,washing, laboratory uses, canteen uses, office uses, floor cleaning, etc.

Table 15: Source of Water for the Institution

Number of Tankers	25 tanker lorries per day with 10,000litrescapacity
Number of bore wells	Nil
Number of ponds	Nil
Number of Open Wells	6(water was taken from 6 open wells)

Table 16: Water Storage Structure in the Campus

Number of Raw Water Tank	7
Number of water tanks for storage	9
Number of Distribution Tanks (for fresh water)	26
Number of Fire Water Storage Tank	5
Number of Treated Water Tank	3 (50,000 ltrs.)
Number of Treated water Distribution Tanks	4
Number of Rain Water Collection Tank	6 (5000 L)

Table 17: Distribution Tanks in the Campus

Capacity of Distribution Tanks	Number of Tanks
25,000 L	19
20000 L	14
10000 L	7
5000 L	10
1000 L	5

Table 18: Location of Raw Water Distribution Tanks in Campus

Location of Distribution Tank
Old CoE office
Mess
Ladies Hostel
Dental Block
Admn block
Advanced New Research block
ETC lab
Gents Hostel

Library
IRC
B.Arch Block
Dental Block
JPR Research Park
Advanced New Research Block

Table 19: Various points of Usage of Water

RO Plant40000 L Capacity	2 tanks (20000 L each)
Number of Urinals and Toilets	688,1525
Number of water less urinals	Nil
Number of bathrooms	1000
Number of water taps	1735
Water taps in laboratories	164
Number of Washbasin	400
Water pumps–Nos. HP each	6 (10HP)

Table 20: RO Plant Water Output Details

Parameter	Result
pH	7.4
Turbidity	1 NTU
TDS	83 mg/L

Table 21: Water Cooler Details

SL.NO	Location	Nos.
1	Block (Research)	6
2	Block (admin)	6
3	Block (hospital)	12
4	Block (academics)	9
5	Block (dental)	8
6	Hostel	5
7	Hostel	4
8	Work shop 3& 4	2
9	Library	8
10	Ladies Hostel	7
11	Mess	11
12	Canteen	Nil
	Grand Total	78

Table 22: Various Points of Water Wastage

Number of Leaky Taps	Nil
Number of leaky pipes	Nil
Number of Urinals	Nil
Number of Leaky Tanks	Nil
Overflow water Wastage	Max 7-8 mts overflow-immediate switch off followed
Any Evaporation Loss from Storage Tanks	No Evaporation Loss as the Storage Tanks are completely covered

Table 23: Details of Water Treatment System

No. of water treatment system in place	1
Total Quantity of Water being treated	952 KLD
Total Quantity of Water Reused	750 KLD

Overall Utilization of water in the Institute

The water consumption by the Institution for the year 2021-22was audited by WasmanPro Environmental Solutions. The audit was conducted in various time periods spanning from October 2021 to May 2022 to get a clear picture of water consumption of the institute and the measures taken by it to reduce the wastage and decrease the water footprint

The STP unit was also audited at several occasions to check its functionality the quality of treated water. It was found that the Institution has been using treated water from the STP for gardening and flushing which are one of the major water usage points in the educational Institution. Nearly 40 lpcd is used for flushing in an educational Institution, this requirement is met by the treated water.

The fresh water take is used for purposes like drinking, cooking, cleaning, bathing, laboratory use etc. So the water footprint of the Sathyabama Institute of Technology is considerable less due to presence of an efficient water treatment unit and Rain water harvesting facility.

So the intake water of 1191KLD per day seems adequate.

Total fresh water consumption in the Institution = 1191KLD

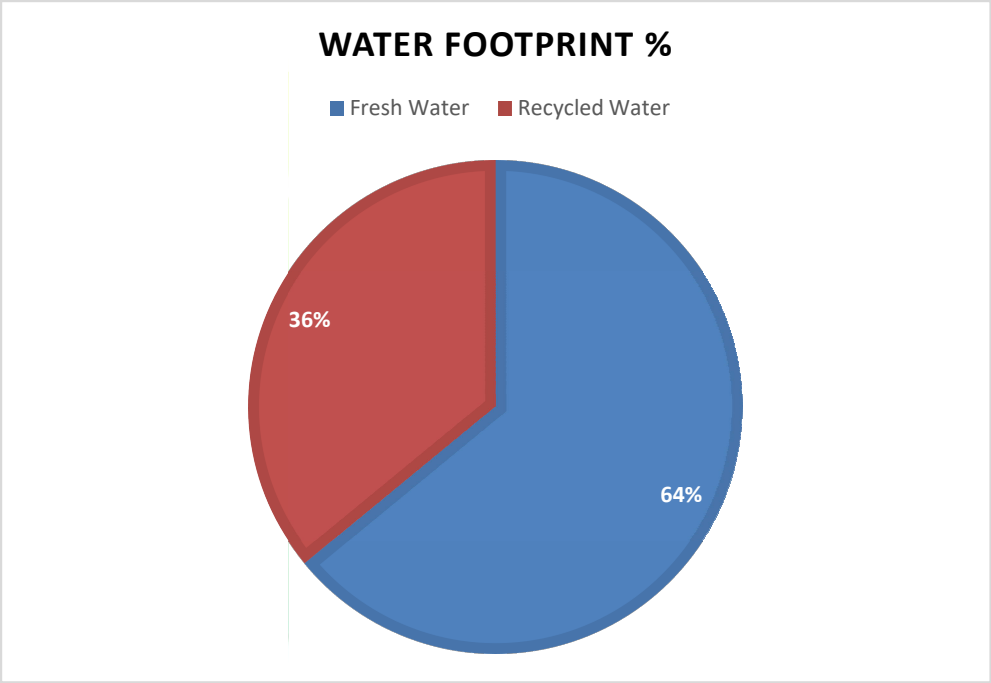


Figure 33: Water Foot Print of the Institute in the Year 2021-2022

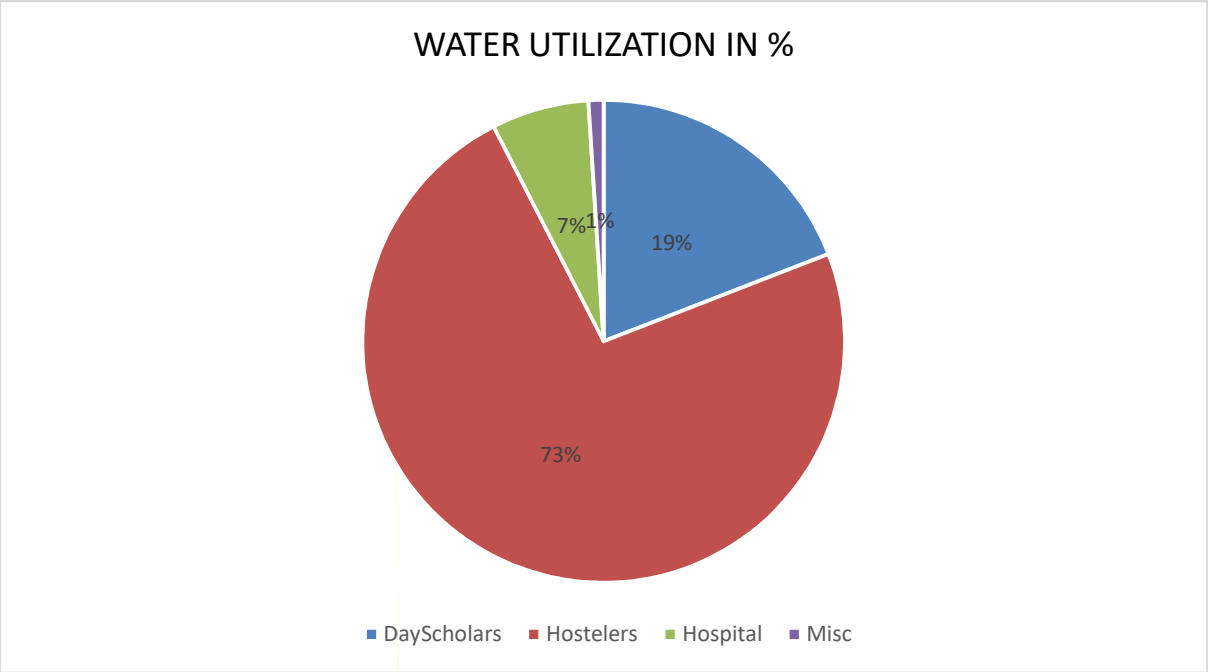


Figure 34: Major Water Utilization Points at the Institute in the Year 2021-2022

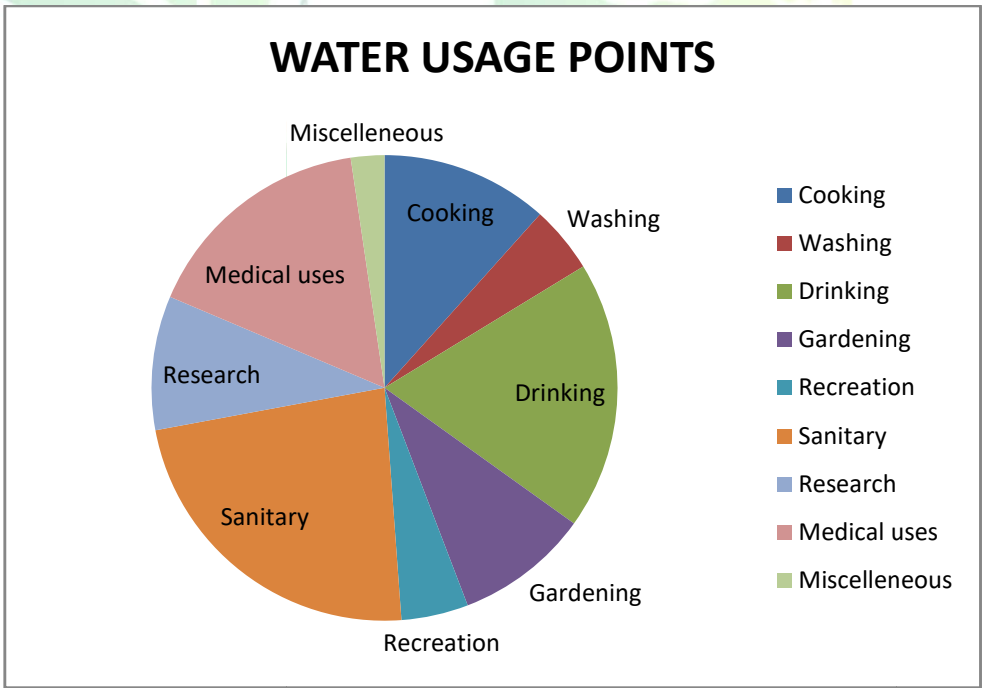


Figure 35 : Water usage Points at the Institute in the Year 2021-2022

5.1.4.1 Wastewater Treatment Unit Details

Sewage Treatment Plant at Sathyabama Institute Campus

(Capacity of 1.5 Million Liters per Day)	
Input flow to STP	953 KLD
STP designed for	1500 KLD

Table 24: Characteristics of Raw Sewage

Sl. No.	Parameters	Inlet character	Units
1.	Flow	41	m^3/day
2.	pH	8.0	-
3.	BOD_3	430	mg/l
4.	COD	670	mg/l
5.	TSS	360	Ppm

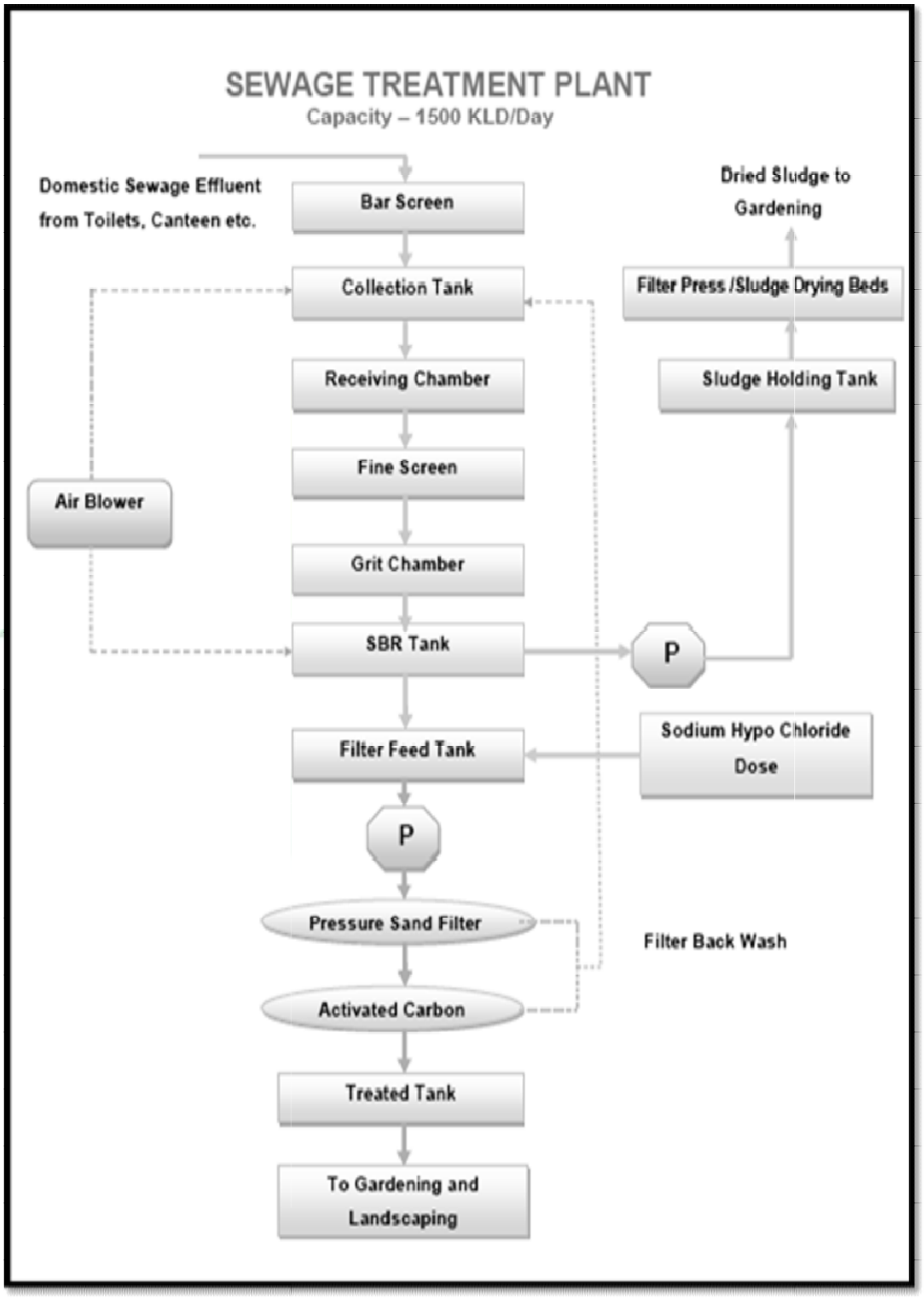


Figure 36 : Flow diagram of the treatment process in the STP

Table 25: Size of Unit Operations of Sewage Treatment Plant

SI.No.	Description of unit operation of STP	Size/Capacity (M)	Liquid Volume (KL)	Free Board Volume (KL)
1	Bar Screen	2.5 × 1.5 × 1.0M (TD)	-	3.75
2	Raw Sewage Sump	15.0 × 12.0 × 4.0M (LD) + 1.0M (FB)	720	180
3	Receiving Chamber	2.5 × 1.5 × 0.7M (TD)	-	2.6
4	Fine Screen Channel	4.0 × 0.525 × 0.8M (TD)	-	1.7
5	Grid Chamber Manual	4.5 × 2.5 × 1.5M (LD) + 0.5M (FB)	16.875	5.625
6	SBR Basins – I	15.0 × 6.0 × 4.5M (LD) + 1.0M (FB)	405	90
7	SBR Basins – II	15.0 × 6.0 × 4.5M (LD) + 1.0M (FB)	405	90
8	Clarified Water Tank	15.0 × 12.0 × 2.8M (LD) + 2.2M (FB)	504	396
9	Treated Tank	15.0 × 12.0 × 4.5M (LD) + 0.5M (FB)	810	90
10	Sludge Sump	4.0 × 4.0 × 3.5M (LD) + 0.5M (FB)	56	8
11	Sludge Drying Beds (4 Nos)	3.0 × 3.0 × 1.5M (TD)	28.8	25.2

5.1.5 Water Audit – Evaluations and Recommendations

A water audit was conducted by WasmanPro at Sathyabama Institute of Science and Technology. The entire water usage of the Institution was analysed during the audit process. The audited included all aspects of water consumption right from the start, the point where water enters the premises and conducted up to the point where the waste water was sent to the treatment unit and its recycling and reuse at various points in the Institution. All aspects of usewascritically examined. The audit analysed the quantity/volume of water being used, wastage if any, leakages existing, excess use etc.

The audit was even conducted to analyse the existing best practices implemented at the Institution and to suggest ways to improve water use efficiency and reduce usage and wastage.

Water audit was extensively done for the SathyabamaInstitute of Science and Technology and the Audit findings are as follows.

Best Practices Observed in the Institution -Water Management

- Treatment of waste water using STP of capacity 1500 KLD per day and reusing the treated water for gardening and flushing
- Rainwater harvesting in tanks 5000 L capacity using Rooftop Rain water harvesting structures and rain water harvesting pits.
- Institution has own RO unit catering to drinking water requirement of the entire campus
- Ledgers were maintained in various departments and hostels where students could make entry about leaky taps/ water wastage when-ever it comes to their notice
- Institution is conducting periodic awareness camp for own students as well as for the members of the adopted village about water conservation, Sanitation and Hygiene
- Institution also conducted Water Audit training for its students in July 2021 to create more awareness among them
- Posters were displayed at various locations urging students to conserve water

5.1.5.1 Consolidation of Water Audit Findings-Evaluation

The Water audit was conducted in Sathyabama Institute of Science and Technology in three stages: pre-audit, an on-site audit and post-audit follow-up.

In the Preliminary audit, a walk through the entire institution was carried out to understand the nature of water uses, to identify the major water usage points, to note the best practices implemented at the institution for reducing the water footprint.

Discussion with the administrative officers, staff in-charge of water division, housekeeping and kitchen employees were held to note down water usage throughout the day.

Discussions with the administrative department including the electrician, staff in-charge of water division was done to gather information about the raw water intake, pumping frequency and to identify the capacity of storage and distribution tank.

During preaudit stage efforts were made to gather information on source of raw water intake,presence of alternative source of water during summer season,any water meters and sub-meters installed in the campus, any existing water conservation techniques followed in the Institution.

During the on-site audit, the raw water pumping stations, storage and distribution tanks were visited. The onsite water treatment units were visited to observe its efficiency of operation. The water samples were collected and tested to find the quality of effluent water input to treatment system and to find the quality of treated output water of STP.

Discussion with the staff in-charge of water division was held during on-site audit to gather site specific information including: water supply records to determine current water use and water costs; size of the facility; and the population occupying the facility during various shifts of operation, details about pumping station, total water storage capacity in entire educational campus etc.

During On-Site audit, walk through survey was done to examine building layout, to identifying any water leakage from water pumping station to conveyance points to water usage points, disposal point, recycling and reuse locations.

During the Post Audit Stage the data collected and identified were analysed to find the how the water is managed throughout the institution from raw-water intake to reuse and recycling. Various observation noted down were taken into consideration during the analysis stage.

While analyzing the source of input water, it was observed that the main source of raw water for the campus is supplied by tanker lorries nearly 25 tanker lorries of 10,000 L capacity. Rest of the water is taken from 6 Open wells located at Kaaranai nearly 2 km away from the Institution. The raw water from these open wells is conveyed to the institution by Pipeline and motor.

Analysis shows that 36 % of water demand which is majorly used for flushing & gardening is met by recycled water and only 64 % of water is brought by the Institution. This 36 % less dependence of raw water is an appreciable step, as it leads to reduced pressure on fresh water source taken by the Institution

The water usage at different location of the institution were analyzed based on the audit data collected. The water usage in the campus were divided into 3 categories for ease of calculation- Water used by day-scholars including students and staffs (including non-teaching) at the college, water used at the hostel, water used at the hospital facility present inside the campus.

It was found that 73% of water used in the hostel, 19 % is used in the campus by the daily goers and 7% is used in the hospital and 1% for other Miscellaneous activities like Cooking purpose etc.

The main water consumption for the day-scholars including students and staffs teaching & non-teaching is for toilet use (flushing). The water for the purpose is met by the recycled water coming the Institutions own STP facility. Only the rest of water needed for hand washing and drinking is to be met by the fresh water intake.

The per capita water consumption for the Hostlers is around 135 Lpcd, of this a major portion of water consumption is for toilet usage which is met by the recycled water coming from the

Institutions own STP facility. The fresh water needed for cooking, bathing, washing, laundry, cleaning etc are provided by the fresh water taken by the Institutions from various sources like Open wells, water tankers etc.

The water needed for the Hospital facility for drinking, cleaning, laundry, canteen etc is met by the fresh water bought by the institution. Water for toilet use in the hospital is once again the treated water coming from the institutions own STP facility.

Based on the pie charts shown in the analysis section it can be seen that the maximum water load exerted in the Institution is by the Sanitary purpose. Next major water demand is exerted by the Medical facility present within the Institution. Water demand is high in the medical facility as extra care should be taken to maintain the sanitation hygiene in the Hospital. Rest of the load is by the cooking and drinking and followed laundry. Institution has huge green facility which needs frequent watering and maintenance, so gardening also exerts water demand. Rest of water demand is exerted by various laboratories present across various department in the Campus.

The other miscellaneous water usage points observed in the Institution was for Campus canteen-cooking and cleaning, laboratory usage, bus cleaning etc, for this fresh water was provided.

It was also observed that the campus has storm water drainage channels that collects the storm water and diverts it to rain water harvesting pits. The Institution has also made facilities for roof top rain water harvesting structures and rain water harvesting pits which is highly appreciable. The campus has six rain water harvesting tanks of 5000 L capacity. The rain water collected is diverted to gardening purpose and even used to substitute the raw water intake once sufficient quantity has been collected.

It was noted that the Institution has own RO unit catering to drinking water requirement of the entire campus. During the year 20-21, all the RO units were not fully utilized as the Institution was only partially working due to Covid pandemic. But in the year 21-22 all RO units were fully operational.

Careful observation was done by the audit team to find any water wastage points. But the team couldn't find any water leakage as the leaky taps are repaired whenever such leaks came to the

notice of the authority. This is made possible by the Institutes water maintenance division who are working round the clock to ensure there is no leakage. The students also played a major role as they were vigilant to report any leaky taps whenever it came to their notice. The frequent water awareness drive conducted by the authorities too played a major role as students were aware of the importance of water conservation and refrained from water wastage. There was no leakage from the overhead tank as the pumps were switched off the moment it got filled as the alarm attached to the overhead tank makes a prompt noise

The campus has an STP of 1.5 MLD capacity to treat the waste water which is then diverted to gardening and flushing. This STP in the campus helped the institution in reducing their water footprint by 36 %, leading the huge cost saving. The treated water was recycled and reused for flushing the toilets and gardening. The left-over water was used for ground water recharge by the artificial recharge water facility built in the campus. This ensured that the level of water table in and around the Institution periphery was maintained and prevented from drastic fall.

A comparison was made compared to present year and last year's water intake. But an accurate comparison is difficult due to the fact that the institution was only partially functioning last year due to Corona-Virus. So in the academic year 20-21, only staff (teaching and non-teaching staff) came to the college and they were asked to bring own food and water due to Coroviruspandemic. The canteen was only partially functioning and the RO plants too were not fully operational. Hence in the academic year 20-21 the water intake by the institution was very less only 42 KLD and the rest of water requirement for toilet use was met by recycled water. But in the year 21-22, the overall water demand is quite high as the Institution was fully functional including the canteen and mess. So as the Institution had to cater to drinking water, food, laundry which were not there in the year 2020-21.

It can be concluded that the Institution has been taking a great effort to decrease the water footprint by relying on the recycled waste water and water harvested during the rainy season. Hence it can be said that the Institution is taking the right steps towards water management and is on the path towards achieving Zero Liquid Discharge which is highly commendable.

The Institution is also involved in conducting periodic awareness camp for own students as well as for the members of the adopted village about water conservation, Sanitation and Hygiene and is planning to conduct water audit training for its students.

Based on the above findings, few recommendations that the Institution can follow are suggested in the following section.

5.1.5.2 Recommendations

- Replace conventional flush system with latest dual model flush system to conserve water- as at present the toilet commodes have 10 liter flush which can be replaced with 3/6 liters or 2/4 liters dual flush cisterns. This can reduce water use by around 30-40%.
- Installation of water meter to analyze water consumption.

Figure 37: STP overview

Figure 38: Water treatment unit

Figure 39: Site inspection at STP

Figure 40: Water transporting tanker

Figure 41 :Lead auditor inspecting the blowers

Figure 42: Panel room

5.2 WASTE AUDIT

5.2.1 Introduction

Solid wastes arise from human and animal activities that are normally discarded as useless or unwanted. Solid wastes are defined as the organic and inorganic waste materials produced by various activities of the society and which have lost their value to the first user. Waste is a continually growing problem at global, regional as well as at local levels.

A waste audit is a formal, structured process used to quantify the amount and types of wastes being generated by the campus of Sathyabama Institute Of Science and Technology. The information obtained from the waste audit will help identify current waste practices being followed in the Institution and how it can be improved by devising a better waste management strategy.

In an Educational Institutions like Sathyabama Institute of Science and Technology the major types of waste found are, cardboard, paper, plastics, tetra packs, metal can, bottles, food packages ,kitchen waste, E-Waste, Glass/Plastic waste which goes into the garbage as Solid waste. The waste generated in the campus can be classified as biodegradable, non biodegradable, combustible, dry and inert based on their characteristics. The waste audit was conducted at Sathyabama Institute of Science and Technology with an aim to help set a baseline and create benchmarks year after year to gauge progress and to set targets and analyse the progress and effectiveness of the waste management and recycling programs implemented at the Institute.

5.2.2 Solid Waste

Solid waste is the unwanted or useless solid materials generated by activities of students, staffs and other personnel in the Campus. This waste often includes wasted material resources that could otherwise be channelized into better service through recycling and reuse.

A solid waste audit was performed by WasmanPro Environmental Solutions with an aim to identify the type of waste generated in the campus, the composition of waste, to identify the major source of waste generation in the campus. The audit was also done to observe the current

waste management strategy followed in the campus and its adherence to R7 process of waste management.

The audit process followed by WasmanPro included monitoring the collection, transport, processing, recycling and disposal process followed in the Institute. The process were thoroughly analysed to figure out the shortcomings and to devise a better strategy for waste management to be implemented in the campus.

5.2.2.1 Key Methodology adopted for Solid Waste Audit

1. 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
2. A walk-through survey of the entire facility was conducted to identify various waste generation points and to estimate the quantity of waste generated.
3. The walk-through survey and base line data collection was carried out between 29th - 31st March 2021
4. Based on the observation, the major category of waste generated in the campus, its composition, quantity was noted
5. The current waste management practices followed in the campus along with the recycling and disposal practices were observed
6. The progress made by the Institution with regards to waste management compared to previous year was analyzed
7. The best practices implemented in the institution with respect to solid waste management were studied
8. Suitable recommendations were suggested for adhering to 3R s (reduce, reuse, recycle) principles of waste management strategy.

5.2.2.2 Solid Waste Survey

1. Does the Institution generate any waste? If so, what are they? How much quantity? Number/weight.
   - ❖ Paper Waste
   - ❖ Plastic Waste
   - ❖ Metal Waste
   - ❖ Glass Waste
   - ❖ Organic Waste
   - ❖ Bio-Medical Waste
   - ❖ E- Waste
   - ❖ Hazardous Solid Waste
   - ❖ Others(Specify)
2. What is the approximate quantity of waste generated per day?(In Kilograms)
3. Why waste is a problem?
4. Whether waste is polluting ground/surface water? How?
5. Whether waste is polluting the air around the campus?
6. Is there any waste treatment system in the Institution? Methods
   - ❖ Composting
   - ❖ Recycling
   - ❖ Reusing
   - ❖ Others(specify)
7. How many separate boxes do you think you would need to put into a classroom tostart a waste segregation and recycling campaign?
8. What should be the use for each box?(Develop a color code with reasons)
9. Do you use recycled paper in Institution?
10. Is there any waste wealth program implemented in the Institution?
11. How would you spread the message of recycling to others in the community? Have you taken any initiatives? If yes, please specify.

12. Is there any zero garbage policy followed in the Institution? (Reduce, Recycle, Reuse, Refuse)

13. What is the total strength of students, teachers and Non- teaching staff in the Institution?

14. Which of the following are found near the Institution?

- ❖ Municipal dump yard/Garbage heap
- ❖ Sewer line/stagnant water/Open drainage
- ❖ Presence of Bus station/Railway station/Industry
- ❖ Market/shopping complex/public halls

5.2.2.3 Solid Waste Audit-Key Findings

During the audit the waste generated in the campus was analyzed under different section namely.

- ❖ Paper Waste Generated
- ❖ Plastic Waste Generated
- ❖ Metal Waste Generated
- ❖ Glass Waste Generated
- ❖ Organic Waste Generated
- ❖ Hazardous Waste Generated
- ❖ Other Misc Waste Generated

The Biomedical and E-Waste Generated are audited in separate section within this chapter of waste audit.

Table 26: Paper Waste Generated in The Campus (2021-22)

SI.NO.	Type of Paper Waste	Generation Daily (kgs)	Generation Weekly (kgs)	Generation Monthly (kgs)	Mode of Disposal
1	Newspaper and Magazines	12	60	240	Sold to local waste collector in return of recycled paper
3	Card Board	20	100	400	Sold to local waste collector in return of recycled paper
4	Box Board	50	250	1000	Sold to local waste collector in return of recycled paper
5	Mixed Papers	0	0	0	Nil
6	Molded Pulp	0	0	0	Nil
7	Kraft Paper	10	50	200	Sold to local waste collector in return of recycled paper
8	Coffee Cups	74.72	373.6	1494.4	Sold to local waste collector in return of recycled paper

- During the audit it was found that several types of paper waste were generated in the campus
  - Paper Waste like Newspaper, Magazines,
  - Card Board, Box Board, Kraft Paper
  - Coffee Cups

Newspaper, Magazines are disposed by selling it to the vendor in exchange of recycled papers, while other paper waste were sold to vendor who then recycles it.

Table 27: Other Type of Food -Container Waste Generated (21-22)

SI.NO.	Type of Waste	Generation Daily (no)	Generation Weekly (no)	Generation Monthly (no)	Mode of Disposal
1	Poly Coat Containers	300	1500	6000	Disposed into municipal waste
2	Aseptic Containers	10	50	200	Disposed into municipal waste

During the audit it was found that the Campus generated a high amount of Poly coat containers and Aseptic Containers due to fast food culture of Gen Z students who forms 90% of population of the campus.

Poly coat cartons or containers are generally used for juice and milk packaging. These are made up of “polycoat”, a lightweight, high-grade paperboard sandwiched between two thin layers of polyethylene film (and sometimes a foil laminate). This generally comes in Tetra Paks, and difficult to recycle in the campus so its disposed as municipal waste.

Aseptic cartons or drink boxes are made up of paper, an aluminum lining, and a plastic coating, and are often reported as part of a wider “aseptic and gable top packaging” category and it is disposed as municipal waste.

Table 28: Plastic Waste Generated in the Campus (21-22)

Sl.No.	Type of Waste	Daily Generation (kgs or no)	Weekly (No)	Monthly(no)	Mode of Disposal
1	PET Soft Drink Bottle	500 no	2500	10000	Sold to local waste collector
2	HDPE	Nil	Nil	Nil	Nil
3	PVC	20 kg	100	400	Sold to local waste collector
4	LDPE Recyclable Film	Nil	Nil	Nil	Nil
5	Poly Propyelene	Nil	Nil	Nil	Nil
6	Thermocoal	Nil	Nil	17 kg	100kg is generated in 6month Sold to local waste collector
7	Rigid Plastics	Nil	Nil	Nil	Nil
8	Plastics Strapping	Nil	Nil	Nil	Nil

It was found that the plastic waste was generated in the campus as PET Soft Drink Bottle and PVC and Thermocoal. Nearly 500 PET Soft Drink Bottle was generated per day due to huge student population in the campus. Nearly 20 kg of PVC waste and 100 kg of Thermocoal waste is generated in six months within the campus. These wastes are disposed along with the Municipal waste.

Table 29: Metal Waste Generated in the Campus (21-22)

Sl.No	Type of Waste	Daily (no or kg)	Weekly (no)	Monthly(no)	Mode of Disposal
1	Aluminium Cans	**nil**	**nil**	**nil**	**nil**
2	Aluminium Foils	nil	nil	nil	nil
3	Aerosol Cans	nil	nil	nil	nil
4	Steel Cans	50 no	250 no	1000 no	oil cans sold to the seller who reprocesses it
5	Scrap Metal /Steel waste	13kg	65kg	260kg	Plate,bucket,kitchen scrap etc sold to the reseller to buy other utilises

Metal Waste Generated in the Campus included Steel cans in which oil is purchased and scrap metals from old worn-out steel buckets, plates, and other kitchen utilities. These metal waste excluding the oil can is swapped with the reseller to purchase new goods in place of old worn-out utilities. The oil can is given to the recycler who reprocess it at his facility.

Table 30: Organic Waste Generated in the Campus (21-22) Organic Waste Generated in the Campus (21-22)

SI.NO.	Type of Waste	Daily (kgs)	Weekly (kgs)	Monthly (kgs)	Mode of Disposal
1	Food Waste	1500	7500	30000	-Food and Other Organic waste is channelled to the Biogas plant to generate Biogas to run the kitchen stove -Dry leaves and other compostibles are diverted to the Compost pit
2	Tissue	0	0	0	
3	Beverage Liquids		0	0	
4	Compostable	55	275	1100	
5	Dry Leaves	120	600	2400	
	Total Organic	1675	8375	33500	

The food waste and other organic waste like vegetable peel, fruit waste and other such items are channeled to the Biogas plant for generation of biogas which is then used in the kitchen canteen to run the burners for cooking purpose. The Dry leaves collected is directed to the compost plant present in the campus. The campus six composting pits and the compost generated from the dry leaves and other compostable items are used as manure.

Table 31: Other Type of Waste Generated in the Campus (21-22)

Sl.No.	Type of Waste	Daily (kgs)	Weekly (kgs)	Monthly (kgs)	Mode of Disposal
1	Textile	3	15	60	Some cotton waste used for mat making and other will disposed as municipal waste
2	Latex Gloves	2	10	40	Disposed as municipal waste
3	Water Bottles	15	75	300	Disposed as municipal waste
4	Sanitary Napkins	5	25	100	Disposed as municipal waste
5	Milk packets	5	25	100	Return to milk supplier

Other types of waste generated in the campus includes Textile waste which is reused in the form of cotton or recycled to make door mats. Nearly 5 kg of Sanitary Napkin waste is generated per day which is given away to corporation who then incinerates it at the appropriate location. On an average,waste in the form of latex gloves 2 kg/day waste is generated and it is given away to corporation who then sends it to the recycling facility. The milk packets so generated are washed and returned it to the milk supplier who then send it to the recycle facility of the milk production firm.

Table 32: Glass Waste Generated in the Campus (21-22)

SI.NO.	Type of Waste	Daily (kgs)	Weekly (kgs)	Monthly(kgs)	Mode of Disposal
1	Glass Clear/ Coloured	2.5	12.5	50	Disposed as municipal waste
2	Chemical bottles, laboratory bottle waste Glass	2	10	40	Disposed as municipal waste

The glass waste generated in the campus includes the empty glass bottles generated in the laboratory including the bottles used to store chemicals. Even the broken glass equipment's in the laboratory falls under this category. The glass from broken window was also included in this waste categorization.

Table 33: Hazardous Waste Generated in the Campus (21-22)

SI.NO.	Type of Waste	Monthly(No/kg/l)	Remarks
1	Batteries(No.)	**16 no**	**100 Batteries are replaced every 6 months**
2	Toner Catridges (No.)	**25no**	25 tonners monthly
3	Hand Sanitizer (litres)	**10 L**	10litres monthly
4	Chemicals in Lab (kgs)	**30 kg**	

Th hazardous waste generated in the campus was audited and it was found that the 100 batteries are replaced every six months and 25 tonner catridge is removed as waste every month

Table 34: Various Waste Generated in the Campus (2020-21)

Type of Waste	Quantity	Disposal Mechanism adopted
Paper Waste , tea cups, tetra packs, juice bottles	Collected in bin of 4.5 * 3.5*3.5 - 6 such bins get filled in three days	1) Of the total waste collected 1-3% is recycled through recyclers who take recyclable papers and return A4 sheets in return of 50% lesser weight 2) Other wastes are being collected by Corporation vehicles once in three days; which can be accounted as one bin.

Other types of waste generated in the campus includes Textile waste which is reused in the form of cotton or recycled to make door mats. Nearly 5 kg of Sanitary Napkin waste is generated per day which is given away to corporation who then incinerates it at the appropriate location. On an average,waste in the form of latex gloves 2 kg/day waste is generated and it is given away to corporation who then sends it to the recycling facility. The milk packets so generated are washed and returned it to the milk supplier who then send it to the recycle facility of the milk production firm.

Table 35: Glass Waste Generated in the Campus (21-22)

SI.NO.	Type of Waste	Daily (kgs)	Weekly (kgs)	Monthly(kgs)	Mode of Disposal
1	Glass Clear/ Coloured	2.5	12.5	50	Disposed as municipal waste
2	Chemical bottles, laboratory bottle waste Glass	2	10	40	Disposed as municipal waste

The glass waste generated in the campus includes the empty glass bottles generated in the laboratory including the bottles used to store chemicals. Even the broken glass equipment's in the laboratory falls under this category. The glass from broken window was also included in this waste categorization.

Table 36: Hazardous Waste Generated in the Campus (21-22)

SI.NO.	Type of Waste	Monthly(No/kg/l)	Remarks
1	Batteries(No.)	**16 no**	**100 Batteries are replaced every 6 months**
2	Toner Catridges (No.)	**25no**	25 tonners monthly
3	Hand Sanitizer (litres)	**10 L**	10litres monthly
4	Chemicals in Lab (kgs)	**30 kg**	

Th hazardous waste generated in the campus was audited and it was found that the 100 batteries are replaced every six months and 25 tonner catridge is removed as waste every month

Table 37: Various Waste Generated in the Campus (2020-21)

Type of Waste	Quantity	Disposal Mechanism adopted
Paper Waste , tea cups, tetra packs, juice bottles	Collected in bin of 4.5 * 3.5*3.5 - 6 such bins get filled in three days	1) Of the total waste collected 1-3% is recycled through recyclers who take recyclable papers and return A4 sheets in return of 50% lesser weight 2) Other wastes are being collected by Corporation vehicles once in three days; which can be accounted as one bin.

Type of Waste	Quantity	Disposal Mechanism adopted
Plastic Waste	Major quantum is diverted to architecture department for sustainable building research	Remaining wastes were given away to corporation along with paper waste
Metal Waste: Steel chairs, scrap cupboards, racks	In 2020-2021 Metal racks-3 Steel cupboards-20, Plastic chairs :50 Wooden tables : 50 Wooden racks :30	Metal waste generated was disposed by selling to Scrap dealers
Food Waste including vegetable/fruit peels, waste food	100 to 150 kg per day	Food waste was diverted to pig farms as feed for pigs

5.2.3 Solid Waste Audit-Evaluations and Recommendations

Solid wastes generated in the Institution comprised of both organic and inorganic waste materials produced by various activities in the Institution.

The waste audit was done by WasmanPro to determine the amount and types of waste produced by Sathyabama Institute of Science and Technology.

Waste audit was extensively done for the Sathyabama Institute of Science and Technology and the Audit findings are as follows:

Best Practices Observed in the Institution –Solid Waste Management

- Segregation of waste at the source was done-such Segregation was carried out in each and every building in the campus
- Disposal of waste into color coded bins
- Recycling of Paper Waste
- Diversion of Plastic Waste to architecture department for sustainable building research
- Diversion of Food Waste including vegetable/fruit peels, waste food to Biogas plant as feed, to generate biogas which is in turn used to run the kitchen burners. This biogas plant is able to generate sufficient biogas so as to replace 3 LPG cylinder per day. This form of organic waste management is one of most preferred form of disposal of food waste management
- Technology Development for conversion of food waste to organic pots
- Technology Development for conversion of used up ornamental flowers to Incense Sticks
- Technology development for conversion of organic waste into electricity
- Technology Development for production of organic sanitary pads
- Smart Compost development from solid waste
- Generation of Biodiesel from Waste Cooking Oil to Run Biodiesel powered buses
- Technology Development for Generation of Bio diesel from Waste Cooking Oil to run the pump sets for farmers
- Production of Eco Friendly soap from waste cooking oil
- Students prepared paper bags and distributed to various shops in exchange for plastic bags to create awareness on the detrimental effects of plastic bags.

- Students made an eco-market by making products out of recycled waste products.
- Eco club students conducted a workshops on making useful things from waste pet bottles, paper, glass, cardboards, ice cream sticks etc.
- Students cultivated Mushrooms and Ladies finger in waste pet bottles
- Girl students were exclusively called upon to make value added and fashionable products from waste scraps, and those were shelved for sale.

5.2.3.1 Consolidation of Solid Waste Audit Findings - Evaluation

In the Preliminary audit, a walk survey through the entire institution was carried out to understand the nature of waste generated, to identify the major waste generation points, to note the best practices implemented at the institution for reducing the waste.

Discussion with the administrative officers, staff in-charge of, housekeeping and kitchen employees were held to note down quantity and type of waste generated in a day.

During preaudit stage efforts were made to gather information on on-site source segregation and disposal methods followed in the campus.

During On-Site audit, a through survey was done to examine the major waste generation points like canteen, hostel mess, dining area, laboratory and to examine the segregation strategy followed in the Institution.

During the Post Audit Stage, the data collected and identified were analysed to type of waste generated, quantity of waste etc. Various observation noted down were taken into consideration during the analysis stage.

The data compiled during the audit shows that 460 kg of paper waste is generated in week in Sathyabama Institute of Science and Technology. The paper waste generated in the campus is a mix of coffee cups, Box Board, Card Board, Kraft Paper, News paper and Magazine etc.

Composition of Paper Waste 2021-22

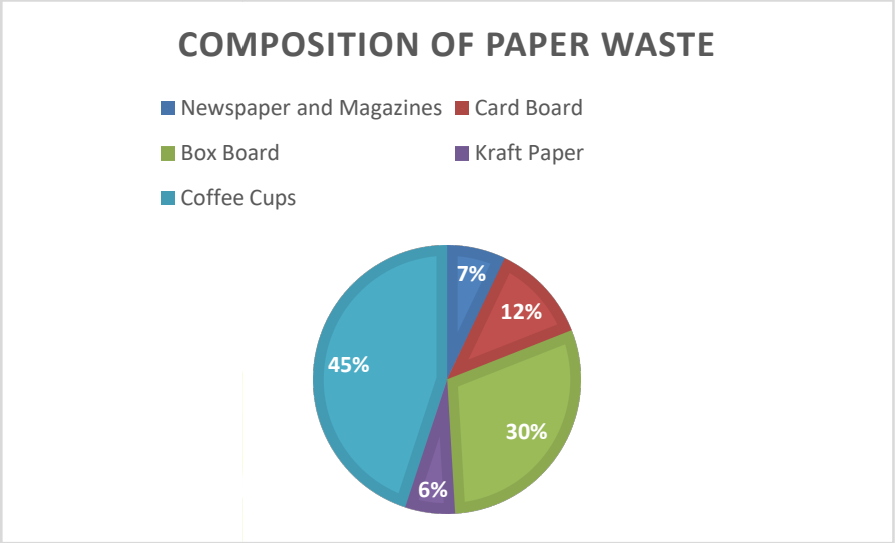


Figure 43: Composition of Paper Waste 2021-22

The coffee cups (paper cups) forms the major portion of paper waste it constitutes around 44% of paper waste generated in the campus. The second largest fraction of paper waste is that of Box Board which is of 29 %. The Card Board and Newspapaer and Magazine waste accounts for 12 % and 8% respectively. The Kraft paper constitutes the lowest percentage 6%.

The paper waste generated in the campus were disposed by selling it to vendor in exchange of recycled papers, rest was given away to municipality along with other general solid waste.100 % of paper waste is undergoing recycling or reuse at the recycling facility of the vendor. No paper waste is disposed off unmindfully or reaches the landfill.

Composition of Biogas (21-22)

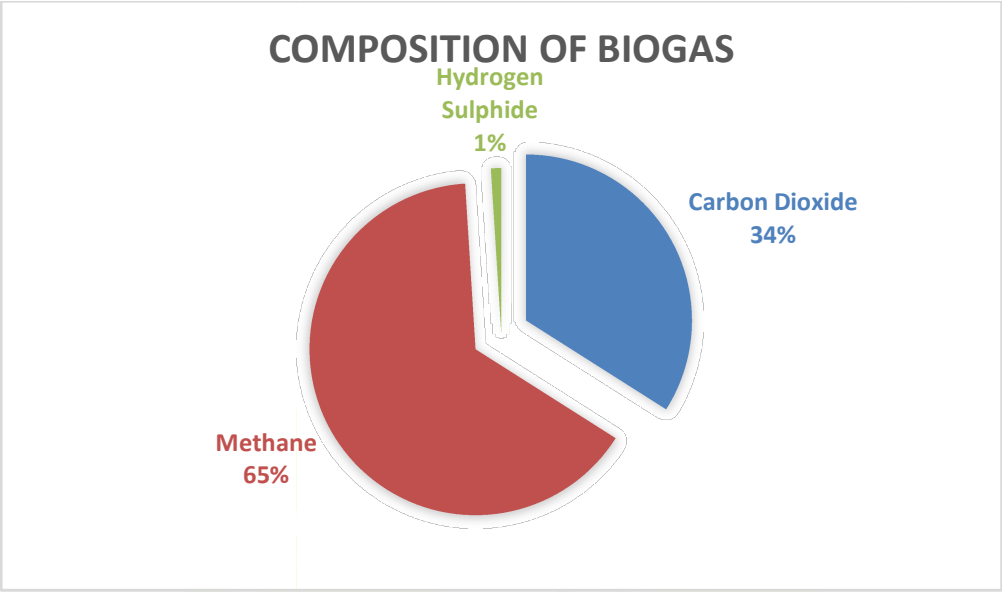


Figure 44: Composition of Biogas (21-22)

It was found that the organic waste forms the largest component in the solid waste stream. Majority of organic waste accounted by the food waste generated within the campus.

Nearly 1500kg of food waste is generated in the Campus which forms 89% of total organic waste. The food waste includes the leftover food cooked for the Students and Staffs in the campus, vegetable peel, fruit waste etc.

Other miscellaneous compostable waste forms 3.2% of organic waste. Dry leaves forms 7.1 % of organic waste. Most of the organic waste is fed to the Biogas plant to generate Biogas. The Biogas, a mixture consisting of approximately 60 percent methane (CH4) and 40 percent carbon dioxide is generated. The Biogas so generated is channelled to the Kitchen. The Kitchen stoves get ignited by the cooking gas from food waste. Nearly three commercial cylinders have been replaced per day by the Biogas generated in the Campus.

The Dry leaves and other Compostable substances were diverted to 6 compost pits within the campus and the matured compost is used as manure for its Kitchen garden.

Composition of Plastic Waste (21-22)

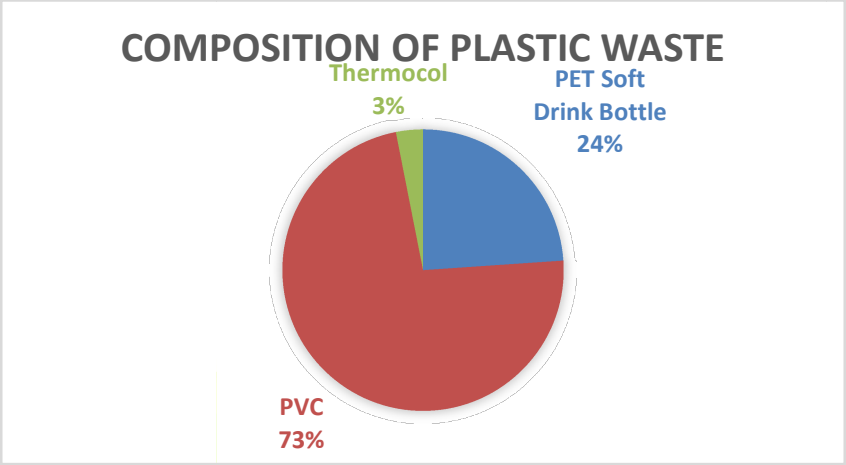


Figure 45: Composition of Plastic Waste (21-22)

The data compiled during the Plastic waste audit shows that PVC waste generated in the campus forms the major portion of plastic waste which is 73%. PET Soft Drink Bottles forms the second largest portion of plastic waste and forms 23 %. Nearly 500 PET Soft Drink Bottles are generated in the campus in one day. No rigid plastic or Plastic strapping was seen in the campus. The campus generated 100 kg of Thermocol waste in six months' time period. This Thermocol is generated due to unboxing of new batteries, cartridges and other miscellaneous things used in the campus. This plastic waste generated in the campus falls under the category of non-biodegradable waste. The creative way of disposal is, its reuse by recycling or use it for other waste to energy generation practices or using it for road pavement. This plastic waste is disposed by giving it to the vendor, who further handles it in a responsible manner.

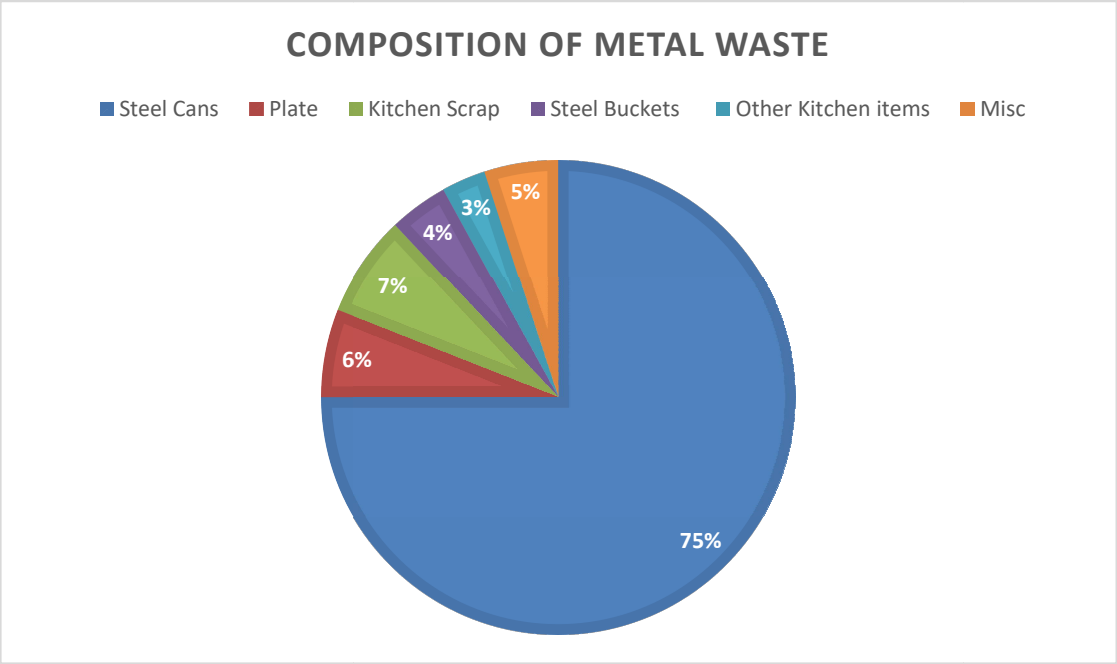


Figure 46: Composition of Metal Waste (21-22)

The audit data compiled shows that 252 kg of metal waste is generated per week in the Institution. Data collected show that 75 % of this waste is due to the oil cans brought by the Institution for the cooking purpose. Nearly 50 Oil cans are generated per day in the campus. Scrap metals accounts for 25 % of total metal waste generated in the campus.

The scrap metals are formed by several miscellaneous items such as old worn-out steel buckets, plates, and other kitchen utilities, old broken metal chairs and table and even cupboard. These metal waste excluding the oil can is swapped with the reseller to purchcase new goods in place of old worn-out utilities. The oil can is given to the recycler who reprocess it at his facility.

The audit show that nearly 90 kg of Glass Waste is generated in the campus in a month. This glass waste includes, colored glass, clear class, broken window glass, empty glass chemical storage bottles seen in the laboratory, broken glass equipment's from laboratory and other miscellaneous items.

According to the audit data Hazardous waste generated in the campus includes Chemicals used in the laboratory, Hand Sanitizer etc. Nearly 30 kg of Chemicals used in the laboratory end up as waste in a month.

The data compiled during the audit shows that 60 kg of textile waste is generated in the campus in a month. A total of 40 kg of waste is accounted by the latex gloves and 25kg by Sanitary Napkins. The Sanitary Napkins are covered appropriately and handed over to municipal waste collectors. These Sanitary Napkins are disposed by the Incineration method. The textile waste generated is reused and some-time recycled to make usable door mats. The latex Gloves are also handed over to the municipal waste collectors for further disposal.

A Comparison of 2020 -21 and 2021-22 Solid waste data

Biodegradable and Non Biodegradable Waste (21-22)

The entire waste generated by Sathyabama Institute of Science and Technology can be put into two broad categories-Biodegradable and Non-Biodegradable.

Solid waste composition of the Institute 21-22

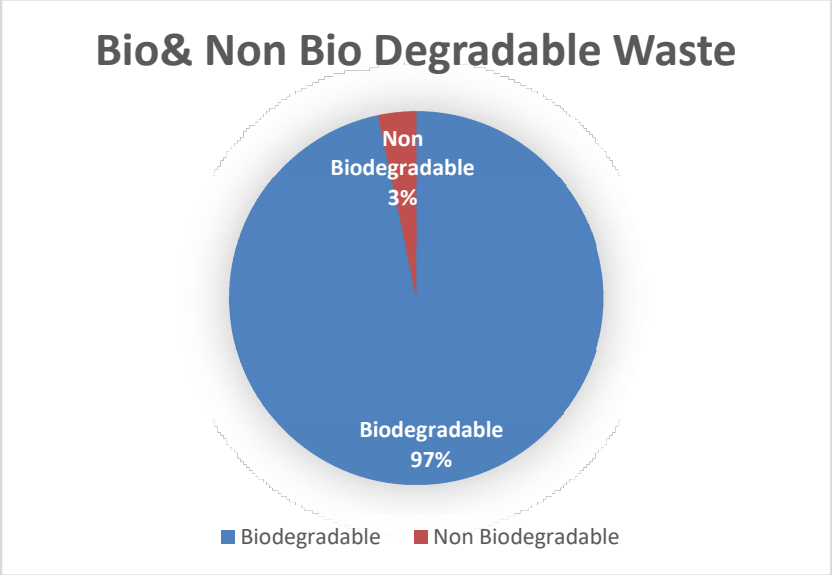


Figure 47: Solid Waste composition of the Institute 21-22

During the audit 21-22, it was observed that nearly 97% of waste generated at the campus falls under Biodegradable category and just 3 % falls under Non-Biodegradable category. This itself is a good sign as most of the Biodegradable matters are either given to Biogas plant or appropriate recycle facility. Most of the Non-Biodegradable waste are given to recycle facility.

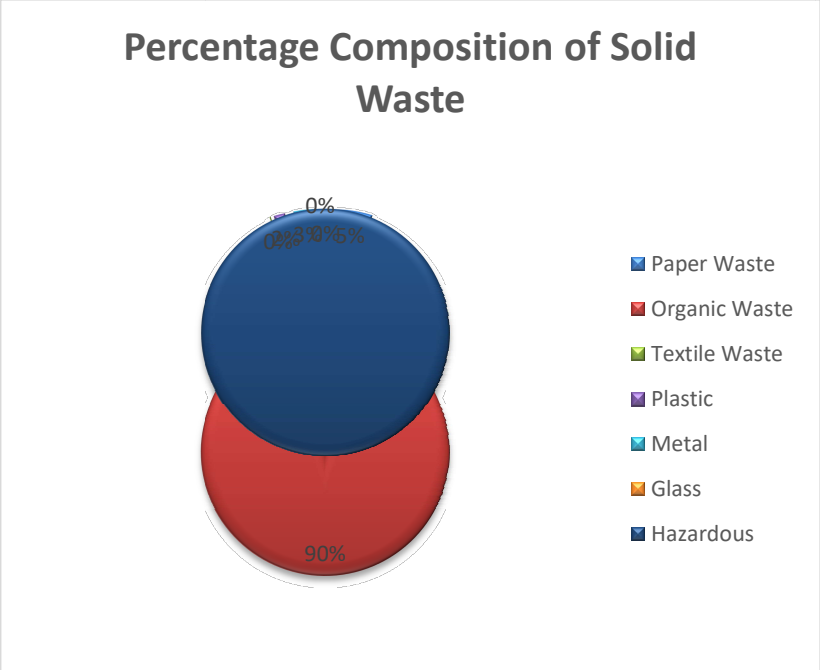


Figure 48: Solid waste composition of the Institute21-22

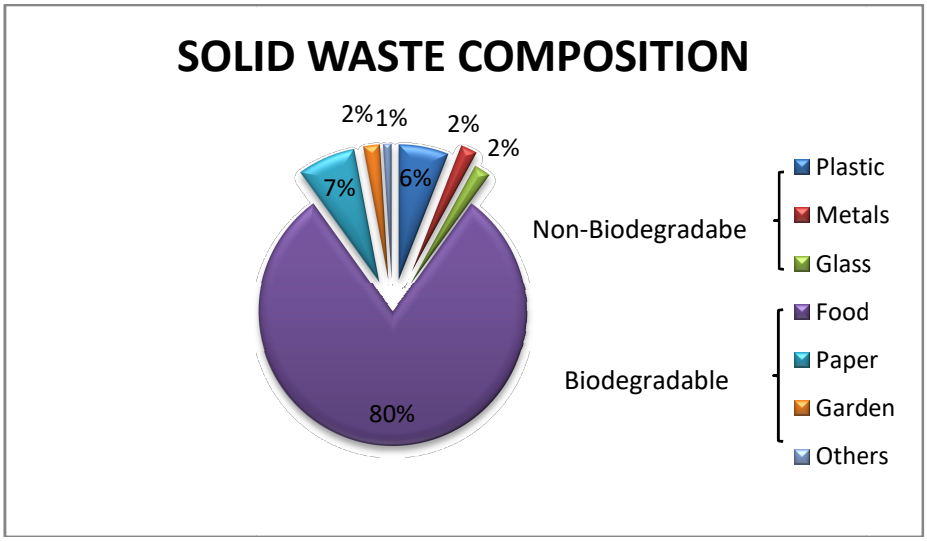


Figure 49: Solid waste composition of the Institute21-22

The data compiled during the audit included quantity and composition information. It was found that the largest component in the solid waste stream is compostable materials – making up to 97% in the year 21-22 and 90 % during the year 2020-21.

The break-up of the composition of the biodegradable waste generated shows that food waste represents the largest proportion and is around 89%in the year 21-22 and 80% during the year 2020-21. The difference of in percentage is due to the fact that during 20-21 the Institute was functioning only partially on account of Corona Virus Outbreak. Canteen was also functioning just to meet the demand of very few students and staff.

The second largest fraction of biodegradable waste is mixed paper waste accounting to nearly 5% in the year 21-22 and 7%during the year 2020-21. This data shows that the Institution has taken up efforts to go digital and have taken efforts to reduce the paper work in the Campus. They are encouraging students to go digital rather than the conventional way of learning using hard print. The assignments were shifted to online mode of presentation and submission. Due to these efforts the Institution was able to bring down the paper consumption by 2% in the year 21-22 compared to previous year.

The garden and other organic waste (other than food waste) accounts to 7% and 3% in the year 21-22 and 2% and 1% during the year 2020-21of total biodegradable waste, respectively. The increase in garden waste is due to the fact that in 21-22, the Institute is fully functional and great care is taken regarding waste grass trimming, removal of dry leaves etc. While in the year 20-21, as the institute was only partially working, cutting and trimming and other garden maintenance activities were done occasionally and not on a daily basis. In the year 21-22, the percentage of organic waste (other than food waste) is also slightly high, the amount of kitchen waste has increased as the Canteen became fully operational which was not the case in 2020-21.

Of the total waste generated in the campus, Composite plastic represents 1.5 % in the year 21-22 and 6% during the year 2020-21. There is 4.5% decrease in the amount of plastic waste generated in the campus. The Institute was able to bring such a drastic reduction due to the "Plastic Free Campus" drive lead by the administrative authorities of the Institution. Awareness drives were conducted at various occasions to give awareness to the students on the importance

of cutting down the plastic waste.

Metaland glass wastes constituted2% and 0.22% of non-biodegradable wastes, respectively during the year 21-22. Where as Metaland glass wastes constituted2% and 2.2% of non-biodegradable wastes, respectively in the year 20-21.These waste are formed due to the old worn out broken metal chairs, table, cupboard, plates, buckets. Kitchen utilities etc. The glass is generated by the laboratory that uses glass bottles to store chemicals, broken windows, broken glass and even broken glass equipment's used in the laboratory.

Food waste formed the largest portion of solid waste generated in the campus. The food waste category consisted primarily of leftover cafeteria waste.

In the year 2020-2021, the Food waste generated at the cafeteria was given to the pig farms on a daily basis. But in the 2021-22, the food waste generated was channeled to biogas plant and the biogas generated is fed to the canteen stoves. This gas is used to ignite stove and was able to replace three commercial cylinders per day.

Paper and cardboard represented a large percentage of the solid waste generated in Institution. This can be justified as this is a general trend seen across all the academic Institution. The mixed paper waste was composed of office paper, newspaper, cardboard paper, white paper, paper plates etc. These were sold to a recycler who recycled these paper waste and A4 sheets were given to the Institution in return.

The composite plastic waste generated was diverted to Architecture department for sustainable building research activities and few left out waste was given away to Corporation. Few plastic bottles, plastic covers, cans, broken glass wares, tins were recycled for planting saplings and also to create decorative items to be displayed in the campus. The Institution is also developing technology for conversion of food waste to organic pots, for generation of electricity from organic waste, for smart Compost development from solid waste. Metal waste generated in the campus is sold to scrap dealers who further recycles and reuses it for various purposes. So metal recycling is happening, this represents a significant volume of material diverted from landfill.

Few key operational staff was interviewed to obtain further insight into new technologies

developed by them to covert waste to useful products. It was noted that the Institution developed a trans-esterification process to generate biodiesel out of waste cooking oil. These biodiesel generated was blended with conventional fuel to run buses and generators. The Institution has also developed technology for development of Incense Sticks from waste ornamental/ ritual flowers and also developed the technology for production of organic sanitary pads. This knowledge was imparted to rural women of the villages adopted by Sathyabama Institute. This provided a means of livelihood for these rural women. This initiative was recognized by the Government under Unnat Bharat Abhiyan Scheme.

The current waste management strategies implemented by the Institution were fully evaluated during the audit process. It can be concluded that the Institution has well-established solid waste reduction, management and recycling programs and the Institution is highly successful in executing waste reduction and recycling strategies. There seems to be a balance between quantum of waste being generated in the campus and the quantum being recycled, reused and disposed. The solid waste data illustrates that overall quantum of the waste generated in the year2020-21 was lesser than the previous year as the Institution was only partly functional due to Covid-pandemic.

In order to further its progress towards waste minimization few recommendations are given below:

5.2.3.2 Recommendations

- Install Composting plant to compost organic waste like coffee mud, tea waste, vegetable cuttings, dried leaves generated in the campus that can't be diverted to pig farm. The energy so generated can be diverted to power the kitchen and the compost generated can be used as a fertilizer. This can further reduce the dependence on conventional power and artificial fertilizer.
- Aim to achieve zero garbage policy which refers to producing, consuming, reusing and recycling products without throwing anything away.

Encourage students and staff to donate used good like clothes, electronic items, booksand frequently conduct such donation camps.

Figure 50:Mat made from Textile waste

Figure 51:Decorative item from plastic water bottles

Figure 52: Decorative item from plastic caps

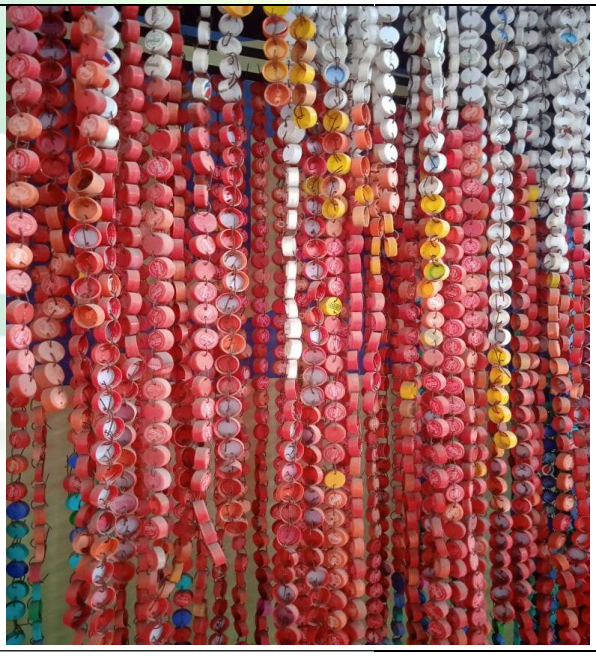


Figure 53: Eco friendly soap from waste cooking oil

Figure 54:Biodiesel from kitchen waste

Figure 55:Waste leaf collected for disposal

Figure 56:Organic pots made from food wastes

Figure 57:Generator run on biodiesel

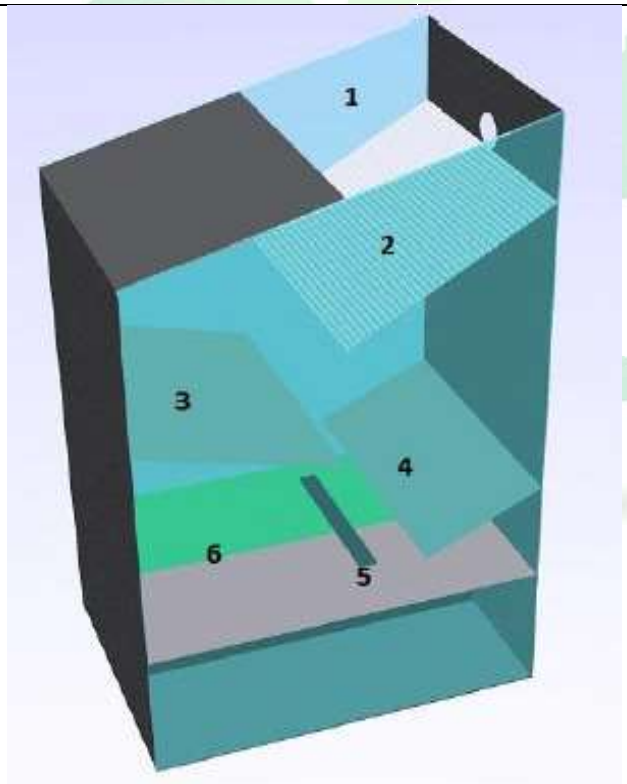


Figure 58:Automatic smart waste segregator

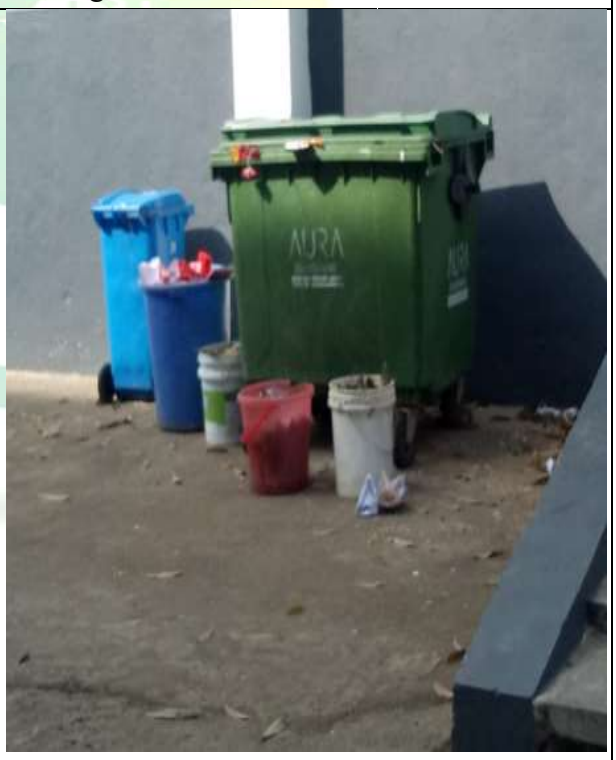


Figure 59:Source segregation at the Campus

Figure 60: Waste dumping bins

Figure 61: Waste dumping bins

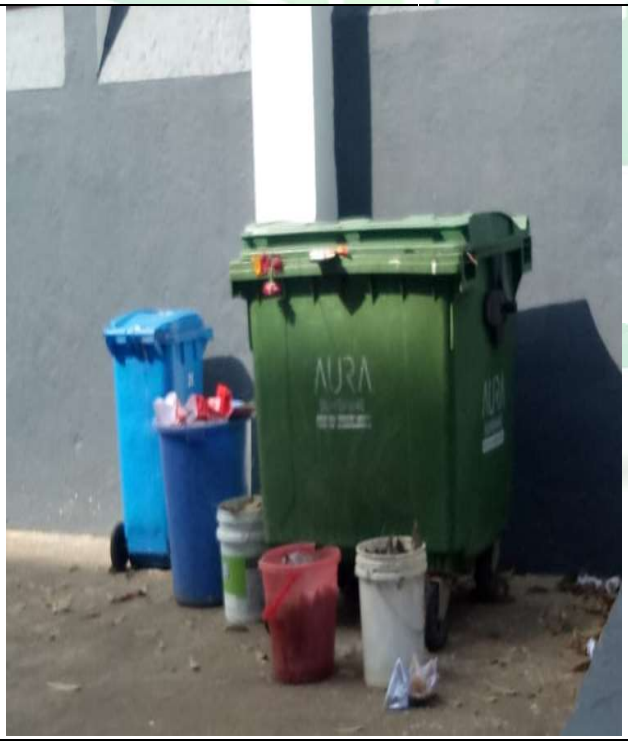


Figure 62: Waste dumping bins

Figure 63: Disposal of Collected Waste

Figure 64: E-Waste dumping

Figure 65: Plywood Waste dumping area

Figure 66: Common Washbasin at campus

Figure 67: 1Ton/day Biogas plant Installed and Commissioned at Sathyabama Institute of Science and Technology, Chennai

Figure 68: Biogas Digester and Slurry collection Tank

Figure 69: Feeding Food Waste Into Crusher

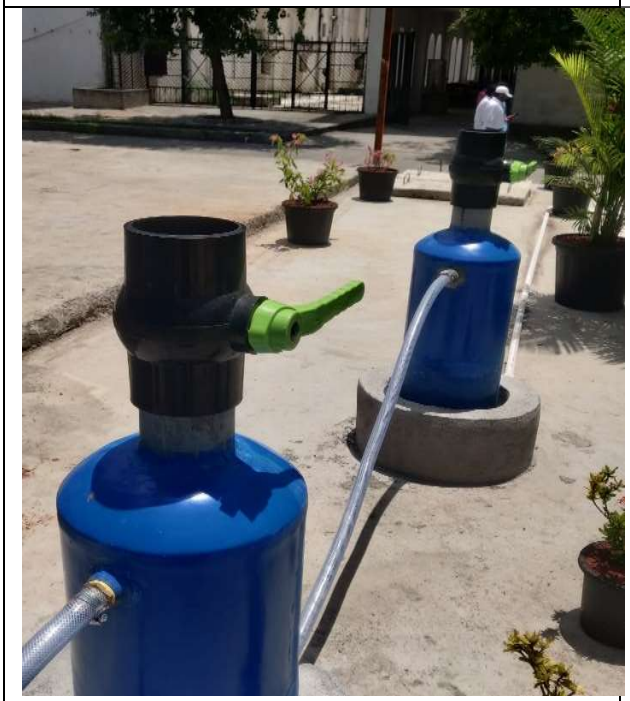


Figure 70: H2S Scrubber

Figure 71: Flame Arrestor

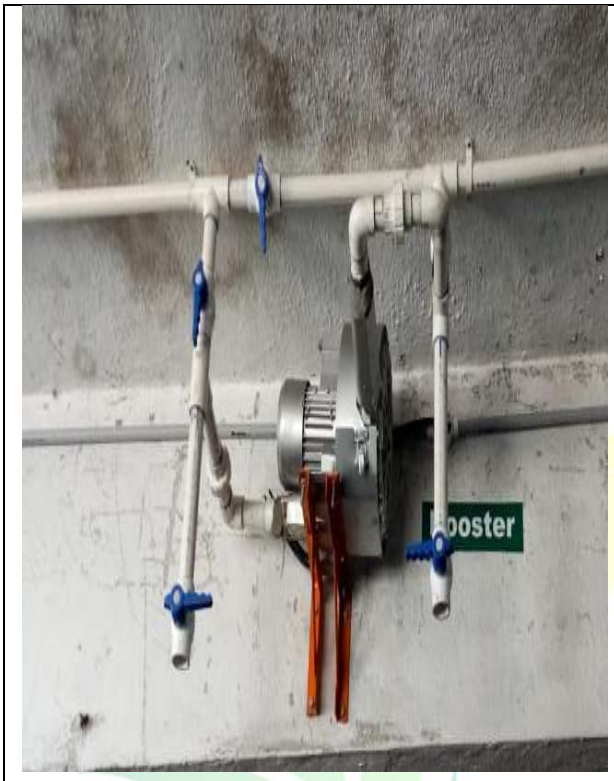


Figure 72: Booster Pump

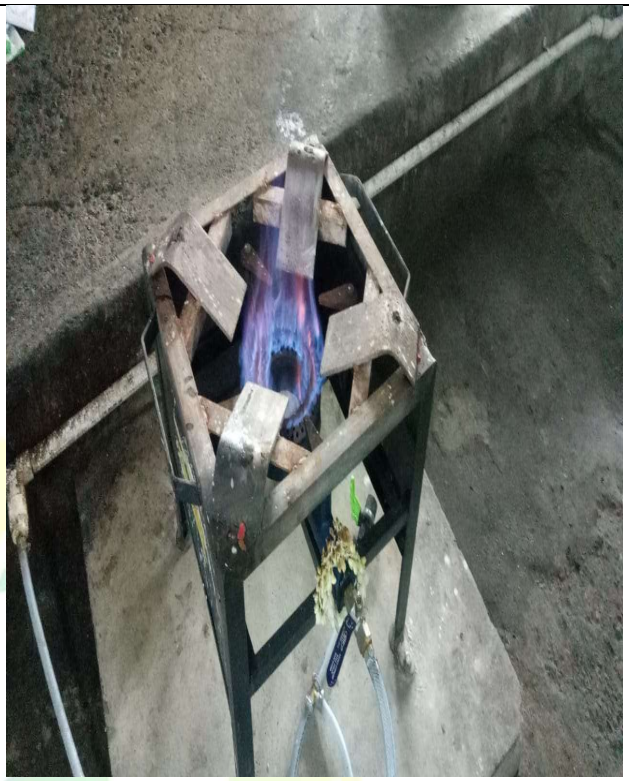


Figure 73: Burner Lit by Biogas

Figure 74: Biogas Storage Balloon

5.2.4 Biomedical Waste Audit

Biomedical waste is any waste which is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities pertaining thereto or in the production or testing of biological.

Healthcare generates large amounts of waste, harming both environmental and human health if not managed properly. Biomedical Waste audits are the standard method for measuring and characterizing waste. This is a systematic review of healthcare waste audits, to analyse the handling of biomedical waste, its disposal and further treatment.

Proper management of Biomedical waste (BMW) generated in a healthcare facility of Sathyabama Institute of Science and Technology is one of the most important responsibilities of the institution.

The Biomedical waste audit was conducted at Sathyabama Institute of Science and Technology. The audit included site visit and inspection of various departments in the hospitals, the patient ward, pathological laboratory etc to see the handling of biomedical waste, how it is categorized according to colour code and how sharps, used cotton swabs, masks, and other hospital wastes are handled by the hospital authorities. The process of segregation, collection, storage and transport of biomedical waste followed in the hospital was carefully analyzed. The audit was also conducted to check the awareness level of doctors and the paramedical staff while handling Biomedical waste.

5.2.4.1 Key Methodology adopted for Biomedical Waste Audit

1. Base Line data were collected by conducting online interaction with the house keeping authority and staff also by conducting interviews among the doctors and nurses in the hospital.
2. A walk through survey was done for assessing the knowledge of doctors and paramedical staff regarding biomedical waste handling and management.
3. A walk through survey was done for observing the real time practices of the biomedical waste management in the various departments of Dental College and Hospital and to formulate details of Biomedical waste (infectious and non-infectious) being generated.
4. The walk through survey and base line data collection was done on several occasions between Oct 2021 and May 2022.
5. During each site visit the log book for entry was verified to see if proper entry was made regarding the waste handling
6. Observation was done during the Onsite audit to study the implementation of Biomedical Waste Management rules 2016 in its hospital premises.
7. Based on the observation and surveys, analysis was done to see whether Biomedical Waste Management Rules were followed and suitable recommendations were also suggested.
8. Interaction with Doctors, nurses, housekeeping staff was done to check the awareness level of doctors and the paramedical staff while handling Biomedical waste

5.2.4.2 Bio Medical Waste Audit-Survey/Questionnaire

1. Whether Bio medical waste are segregated at source and put in color coded bags as per Schedule I of BMW RULE 2016? Is Color coding practiced?
2. Whether Performa of the label used on container/bag?
3. How much waste is generated per day/week/month/year?
4. Whether the Standard for treatment and disposal of waste is been followed?
5. Whether there is any mixing of general waste with bio-medical waste?
6. Is there adequate awareness on biomedical waste segregation, disposal, effect and

management amongst the doctors and the paramedical staff?

7. Whether the workers involved in the biomedical waste handling were provided with gloves, face mask and head cap?
8. Is there Pre-treatment of the laboratory waste, microbiological waste, blood samples, and blood bags through disinfection or sterilization on-site in the manner as prescribed by WHO or NACO ?
9. Whether the liquid waste generated from health care facilities pretreated before mixing with other wastewater?
10. Whether training to all its health care workers and others, involved in handling of biomedical waste at the time of induction and thereafter at least once every year?
11. Whether Regular checkup of Healthcare workers are conducted?
12. Whether health care workers and others, involved in handling of bio-medical waste are given immunization for protection against diseases that are likely to be transmitted by handling of bio-medical waste?

5.2.4.3 Biomedical Waste Audit-Key Findings

Sathyabama Dental College and Hospital established in 2009 is an autonomous Institution affiliated to Sathyabama Institute of Science and Technology, Chennai, Tamil Nadu, India. The Institution has gained an unsavory reputation and has been accredited by the National Assessment and Accreditation Council (NAAC) with 'A' grade.

Sathyabama Dental College and Hospital has 18 functioning departments and has its own pharmacy. The total numbers of patients coming to have treatment under OP is 450,inpatient 80. The hospital has capacity of 1000 beds these function under the supervision of 60-90 doctors and 20-35 paramedical staff.

Sathyabama Dental College and Hospital is using color coded bins for all types of Bio Medical Wastes being generated.

GJ Multiclave (India) Pvt. Ltd. Adyar, Chennai is the authorized recycler who collects the biomedical waste being generated in the Institution for further treatment and disposal.

Table 38: Generation of waste (infectious and non-infectious) in different departments of Sathyabama Dental College and Hospital.

Source of BMW	Types Of Waste Generated	No Of Person Involved In Waste Handling
Department of oral maxillofacial pathology	Sharps, body fluids, Discarded medicine	>5
Department of public health dentistry	Gloves, mask, washed water	+2
Department of oral medicine and Radiology	Gloves ,mask, instrument pouches	3
Department of oral maxillofacial surgery	Sharps, outdated Medicine	2
Department of prosthodontics and implantology	Plaster of paris, Alginate	4
Department of Pedodontics	Cotton, gloves, needles, bandages	2
Department of Conservative dentistry and endodontic	Soiled cotton, needles, syringes, amalgam	4
Casualty	Sharps, plastics container , anatomical organs	2

Types of Biomedical Waste Generated from Various Department in the Hospital

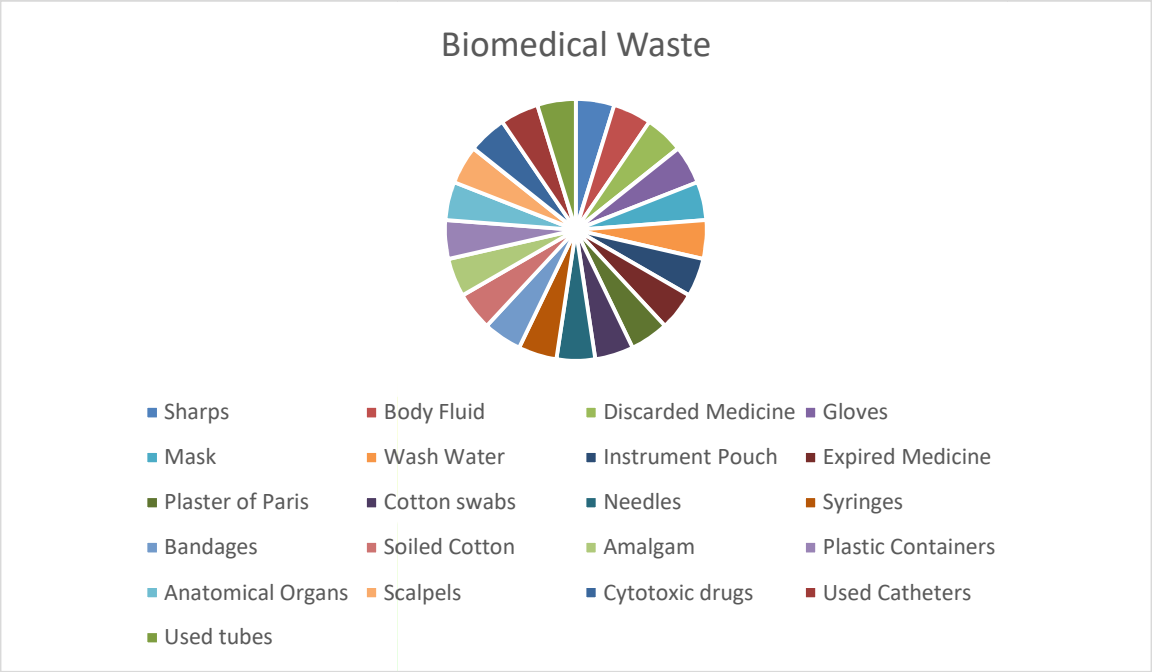


Figure 75: Types of Biomedical Waste Generated from Various Department in the Hospital

Colour Coding of Biomedical Waste

- **Yellow-**Human &Animal Anatomical Waste, Discarded Chemicals, Chemical Waste, Lab Waste
- **Red-** Contaminated Waste (Recyclable) – Wastes generated from disposable items such as tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes (syringe without needle)
- **Blue**-Broken or discarded and contaminated glass vials including medicine vials and ampoules
- **White**-Needles, syringes with fixed needles, needles from needle tip cutter or burner, scalpels, blades.

Table 39: Quantity of Bio-Medical waste generated 2021-22

Red			Yellow			Blue		
Avg/ day	Avg/ Week	Avg/ month	Avg/ day	Avg/ week	Avg/ Month	Avg/ Day	Avg/ week	Avg/ Month
3	15	60	2.333	11.66667	46.667	1.3333	6.667	26.6667

Table 40: Quantity of Bio-Medical waste generated 2021-22

Red			Yellow			Blue		
Avg/ day	Avg/ Week	Avg/ month	Avg/ day	Avg/ week	Avg/ Month	Avg/ Day	Avg/ week	Avg/ Month
3.25	22.75	97.5	2	14	60	0.5	3.5	15

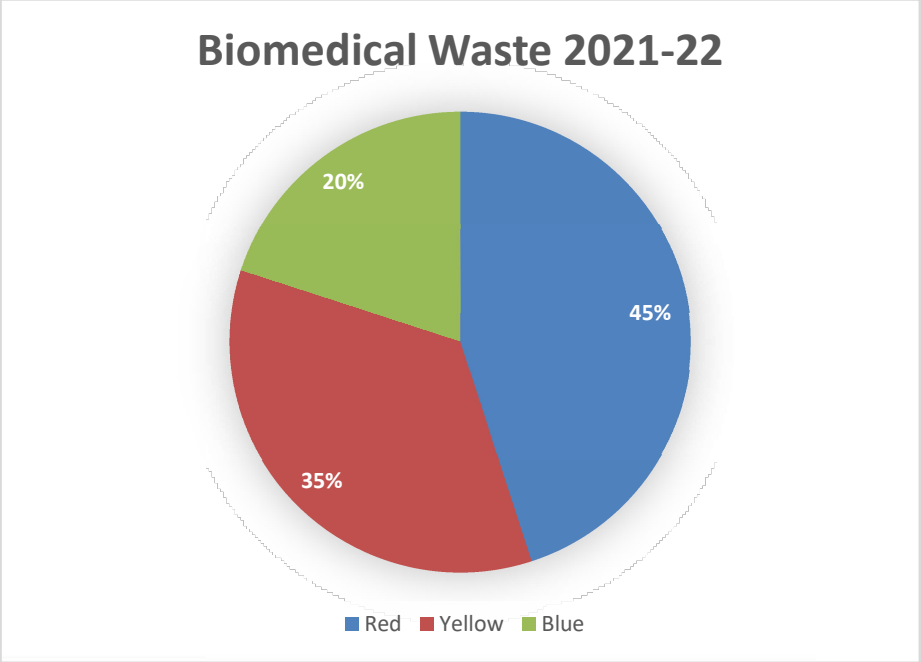


Figure 76: Quantity of BMW generated in the Institute 2021-22

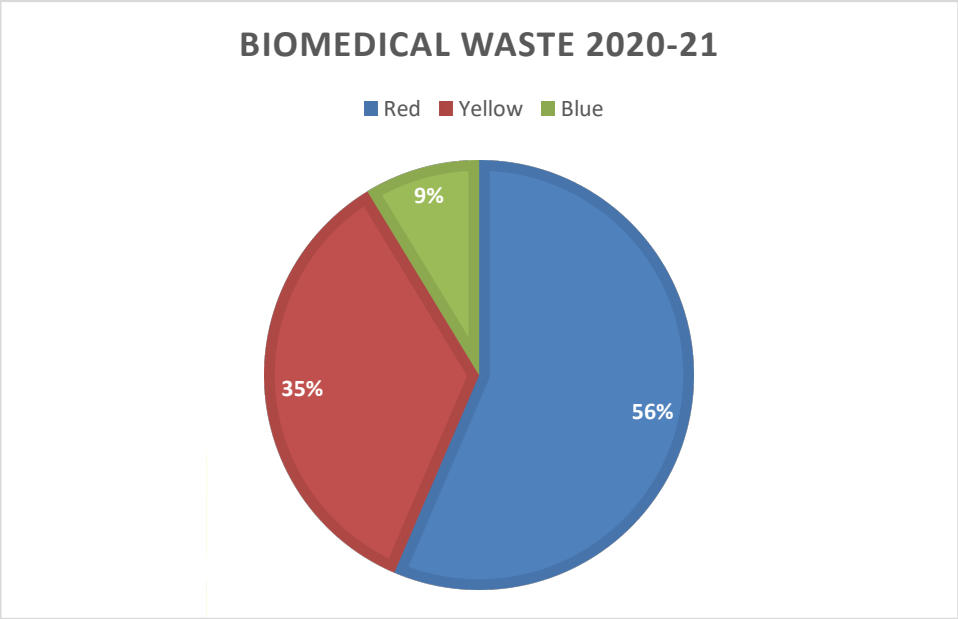


Figure 77: Quantity of BMW generated in the Institute 2020-21

5.2.4.4 Biomedical Waste Audit-Evaluations and Recommendations

Biomedical wastes generated from Dental College and Hospital are potentially hazardous, toxic and highly infectious because of their high potential for disease transmission.

Improper disposal of the biomedical waste poses a serious threat to the environment and human health. The waste produced in the course of healthcare activities carries a higher potential for infection and injury than any other type of waste.

Audit was done to see if biomedical wastes are managed with at most importance in an environmentally sound manner.

This audit was conducted with the aim to assess the level of awareness of biomedical waste management among all staff and personnel in the hospital. The Audit was done to analyze the whether a proper segregation, storage, handling, and disposal was carried out in the Dental college adhering to Biomedical Waste Management rule 2016.

Biomedical Waste audit was extensively done for the Sathyabama Institute of Science and Technology and the Audit findings are as follows:

Best Practices Observed in the Institution –Biomedical Waste Management

- Biomedical waste are segregated at source and put in color coded bags
- Compliance with the BMW Management Rules, 2016
- Sealing of the color-coded bags before giving it to Common Biomedical Waste treatment facility for treatment processing and disposal
- Adequate awareness level amongst the doctors and the paramedical staff on biomedical waste segregation, disposal and management exist.
- Records of the Biomedical waste generation is maintained
- The Institution has its own General hospital and Dental Hospital that offers free of cost medical treatment to its students, staff and their family members
- General Hospital and Dental College of Sathyabama University conducted vaccination camps, blood donation camps, and dental camps.
- General hospital and Dental Hospital offer medical treatment to nearby community at a very reasonable rate.
- Mobile health monitoring facility is run by the Institution and conducts regular health checkup for the members of its adopted villages.
- Psychological counseling is offered on a regular basis to its students to reduce the stress of students and to help them not to fall into depression
- Medical camps are held regularly in the college campus as well as in the adopted villages and the schools
- The Institution has signed MoU with various Universities and Hospitals to strengthen research partnership and to collaborate in various researches
- The Hospital conducted Corona- vaccination drive in two phases which was open to local people
- The Institution provided both the doses of Corona-vaccination to its staffs to ensure their safety
- The institution is maintaining separate bins for the collection of infectious waste and Covid-related waste.

5.2.4.5 Consolidation of Biomedical Waste Audit Findings-Evaluation

Sathyabama Institute of Science and Technology has its own Dental College and Hospital with 18 functioning departments and own pharmacy. This Dental College and Hospital are the main source of Biomedical Waste Generation.

The average quantity of biomedical waste generated is 200kg/month in the year 2021-22. During the year 2021-22 the average quantity of biomedical waste generated was 185 kg/month.

During the audit the segregation, collection, storage and transport of biomedical waste was carefully examined. It was noted that the authorities are taking good care regarding its source segregation. Colour coded bins are provided for the Hospital by the authority, the waste generated were discarded into the bags based on the colour code.

The house keeping staffs were very much aware of the Biomedical Waste management rules and they were very prudent regarding sealing of the bags and handing it over the authorised BMW waste handler.

Log Book was maintained and entry was made every single day about the quantity of waste generated based on the colour code. The Bill regarding BMW waste handling was also carefully preserved by the hospital administration and was provide for verification for the audit team.

During the audit it was seen that cleanliness was given at most importance in the Hospital and Dental Care facility. The colour coded foot operated bins with lid were provided in each room and common area of the Hospital facility and Dental College. Markings and posters were also seen near to waste bins and other areas to create awareness among the general public and patients visiting the hospital.

It was noticed that the Doctors, Paramedical staffs, and even the House-keeping section were fully aware of BMW rules 2016 and it was followed by them during handling of BMW Waste. The BMW register was well maintained and updated on a regular basis by the hospital authority.

On analysis it was found that Redbag having wastes generated from disposable items such as tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes (syringe without needle) accounted for 45% of BMW in 2021-22

The Yellow bag constituting of Human &Animal Anatomical Waste, Discarded Chemicals, Chemical Waste, Lab Waste accounted for 35 %.

Blue bag constituting Broken or discarded and contaminated glass vials including medicine vials and ampoules formed 20 % during the year 2021-22.

In the year 2020-21the red bag consisting of the wastes generated from disposable items such as tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes (syringe without needle) accounted for accounted for 56 % of BMW,

Yellow bag constituting of Human &Animal Anatomical Waste, Discarded Chemicals, Chemical Waste, Lab Waste accounted - formed 35% of BMW and Blue bag constituting Broken or discarded and contaminated glass vials including medicine vials and ampoules formed 8.6% of BMW.

It is not clear how the hospital administration is manging the sharps like Needles, syringes with fixed needles, needles from needle tip cutter or burner, scalpels, blades.As these were not reported in the log book.

During the audit a survey was done by distributing google form and through interview of staff, Doctors, Housekeeping section. Based on the survey scoring was done for various sections. Details of this is given below

Score for availability of colour coded bins and proper segregation of waste was 97% which was satisfactory. This shows that this aspect of waste management is appropriately addressed.

Segregation score in white category bag is relatively less as compared to other categories which indicates that still more focus has to be laid down regarding proper segregation of sharps. The entry regarding the management of sharps was missing in the log book.

Score for 'Cleanliness of waste storage area' was 95.3%. The person handling BMW had proper PPE, masks, gloves and bags were labelled with duly filled up information and stickers, so score for this section was significantly high around 97.6%. PPE were made available to waste handlers as well as they were adequately trained regarding importance of using PPE as they

were at greater risk of acquiring infections especially during Covid times. So this section scored around 98.3%.

Induction training program on BMW management and immunisation are done regularly for the healthcare workers as specified under BMW rules 2016. As a result score for these parameters are excellent. The Doctors and the staffs in the Hospital and Dental College are well aware of the safe handling and disposal methods of Biomedical Waste. Score for level of awareness among Doctors and staffs were 96.9%.Biomedical Waste so generated was handed over to authorized handler at periodic intervals as mentioned in the BMW Management Rules, 2016 for further treatment and disposal. Hence the overall mean percentage score for BMW management in Dental College and Hospital was 97.02%.

Figure 78: Scores provided for various aspects of BMW management at hospital

Based on the above finding few recommendations that the Institution can follow are

5.2.4.6 Recommendations

- ❖ Phase-out the use of chlorinated plastic bags, gloves, and blood bags as soon as possible (as per BMW Management Rules, 2016)
- ❖ Pre-treatment of the laboratory waste, microbiological waste, blood samples, and blood bags through disinfection or sterilization n-site in the manner as prescribed by WHO or NACO needs to be done
- ❖ Treatment of liquid waste generated from health care facilities due to use of chemicals in production of biological and used or discarded disinfectants, discarded Formalin, infected secretions, aspirated body fluids, liquid from laboratories and floor washings, cleaning, housekeeping and disinfecting activities etc. shall be pretreated before mixing with another wastewater.
- ❖ Maintain separate bins for the collection of infectious waste and Covid-related waste
- ❖ BMW register should be maintained and updated on day to day basis
- ❖ In case of a major accident, report the same along with the remedial action taken and make it available during inspection.

Figure 79:Colour coded dustbins

Figure 80:Poster in the hospital corridor for raising awareness

Figure 81:Color coded bags

Figure 82:Audit at Dental College and Hospital

Figure 83: Equipments' of Hospital

Figure 84: Doctors with PPE for attending Covid patients

Figure 85: Covid wastes- masks and gloves

Figure 86:Neat and Clean Hospital Floor

Figure 87:Change bins Color coded bags

5.2.5 E -Waste Audit

E-Waste can generally be defined as any electrical powered appliance that has reached its end-of-life. Electronic waste or E-waste is generated when electronic and electrical equipment become unfit for their originally intended use or have crossed the expiry date.

The existing practices of E-waste management in India suffer from quite a few disadvantages like appropriate inventory, unhealthy conditions of informal recycling, inadequate legislation, poor awareness, dumping of E-Waste. These results in toxic materials entering the waste stream causing adverse effects on the environment and human health and wasting recoverable valuable by-products.

E-waste consists of toxic elements such as Lead, Mercury, Cadmium, Chromium etc. The unscientific disposal of E-Waste can generate a threat to the environment as well as to human health. Due to the presence of these toxic substances in E-Waste, recycling and disposal of E-Waste becomes an important issue.

The audit attempts to analyse the level of awareness about E-Waste generation, storage, disposal, environmental and health concerns among the members of the Institution.

5.2.5.1 Key Methodology adopted for E-Waste Audit

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

A walkthrough survey was done for assessing the types of E-Waste being generated, for quantification of E-waste Generated, for analyzing the existing E-waste Management Strategy in the Institution, for analyzing whether Extended Produce Responsibility is being followed in the Institution.

Walk through survey and base line data collection was done between Oct 21 and May 22

Based on the observation and surveys, analysis was done to see whether E-Waste Management Rules were followed and suitable recommendations were also suggested

5.2.5.2 E-Waste Audit-Survey/Questionnaire

What the Institution does with electronic/electrical products that are no longer in use?

What the Institution does with broken electronic/electrical products?

How many electronic/electrical products does the Institution purchase a year?

On average, how many electronic/electrical products does the Institution choose to repair in a year?

Awareness about E-waste Laws among the students?

Awareness about what happens to E-waste if not recycled through proper channels?

What is the approximate quantity of E-waste generated per day?

Whether E-waste generated by them is channelized through authorized producer or dismantler or recycler?

Whether records of e-waste generated are maintained in Form-2?

Whether end-of-life electrical and electronic equipment are admixed with e-waste containing radioactive material?

Whether the annual returns are filed in Form-3, to the concerned State Pollution Control Board?

5.2.5.3 E-Waste Audit- Key Findings

Sathyabama Institute being an educational Institution will fall under the category of Bulk Consumer as per E-Waste Management Rules 2016.

Main source of E- Waste in the campus includes used Electric/ Electronic equipments like Laptops, PC, desktops, monitors, circuit boards, old mobile phones, printers, scanners, damaged electrical/electronic equipment's used in the laboratories etc.

Nearly one tonne of E-Waste is being generated in an year in the Institution which is sold to the recycler and generating a revenue of 3 lakhs per annum

M/S Earth Sense Recycle Pvt. Limited, Chennai is the authorized recycler who collects the E-waste being generated in the Institution for further dismantling, recycling and disposal

Name & Address of authorized collection centre /dismantler/recycler / refurbisher who collects E- waste from the Institution is --M/S Earth Sense Recycle Pvt. Limited, Thenmelpakkam Village, Chengalpattu, Chennai

Major type of E-Waste generated in the campus are batteries- nearly 2400 to 2500 batteries are are used in the UPS units across the Institute. These batteries are refilled frequently. Old batteries are exchanged upon replacement of new batteries.

Other e-waste generated in the campus includes A/C, Laptops, Desktops, Tab, Old Phones, Damaged Laboratory Equipments, Switch Boards and Circuits, Printer and Scanner Scraps, Tubes and Bulbs, etc.

Earlier 500 new systems were bought in a year and nearly 200 old systems were getting repaired.

Extended producer responsibility is been followed for equipments like batteries and UPS.

Table 41: Various Pollutants present in E-Waste generated in the Campus

Pollutant	**Occurrence**
Arsenic	LEDs (light emitting diodes), solar cells
Lithium	Mobile telephones, Photographic equipments, video equipments, batteries
Mercury	batteries in clocks and pocket calculators, switches, LCDs
Nickel	batteries,semiconductors
PCBs (poly chlorinated biphenyls)	Transformers, capacitors
Selenium	photo copiers, fax machines

Silver	Capacitors, Switches (contacts) batteries, resistors
Zinc	disposable and rechargeable batteries,
Cadmium	computer batteries, monitor
Lead	Lead reachable batteries, solar, transistors, LEDs, thermo electrical elements, circuit boards

5.2.5.4 E-waste Audit- Evaluations and Recommendations

During the audit it was noted that Computers, servers, mainframes, monitors, compact discs (CDs), printers, scanners, copiers, calculators, fax machines, battery cells, cellular phones, TVs, iPods, medical apparatus, refrigerators, and air conditioners are the general type of E-Waste generated in the campus of Sathyabama Institute of Science and Technology.

Recycling is the key to reduce the e-Waste. Recycling has environmental benefits at every stage in the life cycle of an electronic product-from the raw material from which it is made to its final method of disposal. Apart from reducing greenhouse gas emissions, which contribute to global warming, recycling also reduces air and water pollution associated with making new products from raw materials. The Institution is well aware of this fact and has entered into an agreement with a recycler to recycle the E-Waste generated in the campus. E-Waste is generated from various Department/Schools especially electric and electronics department, Mechanical department, IT department, Administrative Building. Institution is generating nearly one tonne of E-Waste in a year which is sold to the recycler and generating revenue of nearly 3Lakhs from it.

E-Waste audit was extensively done for the Sathyabama Institute of Science and Technology and the audit findings are as follows.

Best Practices Observed in the Institution -E-Waste Management

Effort to utilize the Extended Producer Responsibility

Use of reusable resources in all possible areas

E-Waste generated is channelized through authorized recycler for treatment, dismantling and disposal

Compliance with the E-Waste Management Rules 2016

Adequate efforts put in to ensure that no damage is caused to the environment during storage and transportation of the E-Waste

The Institution signed MoU with VANS CHEMISTRY PVT. Ltd., an E-Waste Management Company for teaching students the safe dismantling of E-Waste. Also there is a proposal to establish a dismantling facility in the Institution for knowledge transfer.

The Institution along with VANS CHEMISTRY PVT .Ltd. are planning to jointly develop a technology in handling the hazardouse-waste by translating the preliminary work done on recovery of Mercury from Compact Fluorescent Lamps part from establishing an E-Waste Collection hub.

Institution is conducting periodic awareness programs for safe dismantling of E-Waste.

5.2.5.5 Consolidation of E-Waste Audit Findings - Evaluation

Main source of E- Waste in the campus includes used Electric and Electronic equipments like Laptops, PC, desktops, monitors, circuit boards, old mobile phones, printers, scanners, damaged electronic equipment's used in the laboratories etc.

Recycling is the key to reduce the e-Waste as it reduces the load for fresh raw material and also leads to reduction in greenhouse gas emissions recycling also reduces air and water pollution associated with making new products from raw materials.

The Institution is well aware of this fact and has entered into an agreement with a recycler to recycle the E-Waste generated in the campus.Institution is generating nearly one tonne of E-Waste in a year which is sold to the recycler and generating revenue of nearly 5 Lakhs from it. The recycler is in turn utilizing the unwanted or obsolete materials generated out of the E-Waste as industrial feedstock. This arrangement as a whole is helping to reduce the burden of E-Waste generated by the Institution.

The Institution has also signed MoU with VANS CHEMISTRY PVT. Ltd., an E-Waste Management Company for teaching students the safe dismantling of E-Waste. Thereis a proposal to establish a dismantling facility in the Institution for knowledge transfer. It can be concluded that the Institution is taking adequate efforts while handling the E-Waste especially while collection, storage, transportation and disposal of E-Waste.

It was observed that the Institution themselves are paying a key role in E-Waste Management. It is appropriate steps to implement with Extended Producer Responsibility (EPR) by having a tie-up with the electric/ electronic supplier. The batteries and UPS are taken back by the vendor once it reaches its end of life.

The Institution also takes into the aspect of Design for Environment (DfE) where in it tries to purchase that product that have maximum energy efficiency and minimum impact on environment during the whole product life cycle.

Sathyabama Institute of Science and Technology is also trying to implement Reduce, Reuse, Recycle (3Rs), technology platform for linking a circular economy aiming correct disposal their e-waste, with increased reuse and recycling rates, and adopt sustainable consumer habits.

The records of E-waste generated were well maintained as per Form-2 and the records were produced for scrutiny during the audit. The E-waste storage area have water proof roofing and impermeable surface to prevent water from entering the temporary E-Waste storage area before disposal. The Institution hands over the E-Waste to recycler one in every six months, till then it is temporarily stored in a storage area within the campus.

It can be concluded that the Institution is taking all possible steps to ensure that all steps are taken to manage the E-waste according to E-Waste management rules and also to protect the health and environment against any adverse effects.

Based on the above finding few recommendations that the Institution can follow are

5.2.5.6 Recommendations

- Maintain a record of collection, sale, transfer and storage of wastes and make these record available for inspection
- The E-waste storage area shall have separate containers for storage of batteries, capacitors containing PCBs (Poly Chlorinated Biphenyls) or PCTs (Poly Chlorinated Terphenyls)

5.3 CARBON FOOTPRINT

The carbon footprint is a parameter that represents the total emissions of CO2 and other greenhouse gases (GHG), expressed in mass of CO2 equivalent, caused directly or indirectly by a product, organization, service or event throughout its life cycle. The carbon footprint is important to try to quantify the main emission sources and to have a complete picture of the impact of an organization on climate change. It is also the first step to carry out a plan to reduce GHG emissions. The carbon footprint of an organization intends to quantify the GHG emissions implied by the activity flows of an interconnected entity or group of entities, which may be under its responsibility or on which it depends, over a period of one year with an expressed result in tonnes of CO2 equivalent (CO2 e).

The Carbon Footprint Audit and Disclosure for an educational institution helps to understand and identify its key emission sources and helps to focus on adopting mitigation measures for carbon emission reduction.

The Carbon Foot Print Audit was done in Sathyabama Institute of Science and Technology is to account the carbon foot print of the campus by determining the net amount of greenhouse gas emitted from various activities in the campus so that the Institution can adopt better ways to reduce its carbon foot print. Computing Carbon Footprint will allow Sathyabama Institute of Science and Technology to position themselves favorably in tackling the future challenges associated with a changing climate. Adopting carbon reductions strategies at the campus will yield environmental benefits along aligning themselves with the NDC target and Paris Agreement.

Carbon FootPrint Analysis is divided into 3 Scopes

Scope 1: Direct GHG emissions from:

- Combustion of fuels in stationary sources-diesel used in electricity generators
- Combustion of fuels in stationary sources – LPG consumption in canteen and Chemistry laboratories
- Combustion of fuels in mobile sources- CNG used in owned vehicle (College Bus)
- Fugitive emissions from Refrigeration/air-conditioning equipment

Scope 2 Indirect emissions from:

- Purchased electricity

Scope 3 Other Indirect GHG emissions from:

- GHG emissions due to daily commuting of Teaching Staff, Non-Teaching Staff and Students to and from college GHG emissions due to paper consumption
- GHG emissions from garden waste generation, kitchen waste, plastic waste, E-Waste across the campus

5.3.1 Key Methodologies adopted for Carbon Footprint Audit

1. A walk through survey was conducted in the entire campus to observe various greenhouse gas emission points.
2. Base Line data was collected by distributing online questionnaire through Google form to the students and staff also by conducting interviews among staff.
3. Walk through survey and base line data collection was done between was done between Oct 21- May 22
4. Identify key emission sources of GHG at the campus
5. Based on the data collected, the Green House Gas Emission as CO2 Eq from the various sources was calculated.
6. Observation was done to see whether if the authorities have implemented any Carbon Footprint Reduction Strategy
7. Feasibility study on carbon reduction measures
8. Setting pragmatic carbon reduction targets
9. Recommendations were given for further Green House Gas Emission Reduction strategy.

5.3.2 Carbon Footprint Audit-Survey/Questionnaire

1. What is the total strength of students and teachers in the Institution?
2. Total Number of vehicles used by the stakeholders of the Institution. (per day)
3. No. of cycles used?
4. No. of two wheelers used (average distance travelled and quantity of fuel and amount used per day)
5. No. of cars used (average distance travelled and quantity of fuel and amount used per day)
6. No. persons using common (public) transportation (average distance travelled and quantity of fuel and amount used per day)
7. No. of persons using Institution conveyance by the students, non-teaching staff and teachers (average distance travelled and quantity of fuel and amount used per day)
8. Number of parent-teacher meetings in a year? Parents turned up(approx.)
9. Number of visitors with vehicles per day?
10. Number of generators used per day (hours). Give the amount of fuel used per day.
11. Number of LPG cylinders used in the canteen (Give the amount of fuel used per day and amount spent).
12. Quantity of kerosene used in the canteen/labs (Give the amount of fuel used per day and amount spent).
13. Amount of taxi/auto charges paid and the amount of fuel used per month for the transportation of vegetables and other materials to canteen.
14. Amount of taxi/auto charges paid per month for the transportation of office goods to the Institution.
15. Average amount of taxi/auto charges paid per month by the stakeholders of the Institution.
16. Use of any other fossil fuels in the Institution (Give the amount of fuel used per day and amount spent).
17. Suggest the methods to reduce the quantity of use of fuel used by the stakeholder's /students/ teachers / non-teaching staff of the Institution.

5.3.3 Carbon Footprint Auditing-Key Findings

Feasible emission inventories were selected to analyze the carbon footprint of the campus. The inventory survey was done for one academic year. The selected inventories are Human Factor, Transportation, Electricity, Solid Waste, Production and Consumption of Food, LPG & Natural Gas.

Data keepers are identified and the primary details were collected. Parameter wise and zone wise details were also collected. The received data were assembled and the missing gaps were recognized.

5.3.4 Transportation

Fossil fuels are used for transportation. The carbon dioxide emitted by different fuels is in different amounts. The engine of the vehicle burns fuel and creates a certain amount of CO_2, depending upon its fuel type, fuel consumption and the driving distances. One liter of petrol and diesel emits 2.3kg and 2.7kg of carbon dioxide, respectively. Travelling by car for1000km can produce about 150-200kg of carbon dioxide into the atmosphere. If a person travels by a bus for 1000km, generates 270 kg of CO_2 to his/her Carbon foot print. Worldwide, the fossil fuels used for transportation contribute over 13% of GHG emissions.

The transportation details for the Institution campus like the type of vehicle, No. of vehicles and the fuel used were collected. The carbon dioxide emitted from petrol is less compared to that of diesel. The Carbon footprint by the emission inventory transportation will be quite high.

It was noted that the Institution run buses with 15% biodiesel blends along with the diesel. The buses were reported to run smoothly with lesser emissions and noise and improved mileage on average of 5 to 7 km/L which was about 4 to 6 km/L with Diesel alone.

5.3.5 Electricity

Electricity is one emission inventory which contributes much to the Carbon footprint of the Institution. On an average, electricity sources emit 1.297lbs CO_2 per kWh i.e. 0.0005883 metric tons of CO_2 per kWh. The emission factor given by GRID 2010 version 1.1 for hydroelectricity is 6.8956 x10-4 metric tons CO_2/kWh. 50 grams of CO_2 is emitted from1 unit of solar power.

The details of the consumption of electricity and the use of generators in different zones were surveyed. If the number of classrooms and labs are more in a zone, consumption of electricity in that zone is more.

It was noted that the Institution uses a lot of Renewable power especially Solar and Solar-Wind Hybrid Model as a supplement to conventional power there by reducing emission of GHG to the atmosphere also contributing to the INDC commitment pledged by Government of India.

5.3.6 LPG and Natural Gas

The consumption of 1L of LPG can release 1.5kg of CO_2 to the atmosphere. Also, burning of wood (250kg) can add 33kg of CO_2 to the Carbon footprint. The consumption details of LPG and Natural Gas in canteen and hostels were surveyed. It was noted that the Institution uses the solar power to run the kitchens. It is Asia's largest solar powered Kitchen.

5.3.7 Carbon Footprint Analysis

Carbon footprint analysis can be done by suitably combining data collected with respective emission factor of the selected emission inventories. Table represents emission factors of the selected inventories.

Table 42: Emission Inventory

SI.No.	Emission Inventory	CO_2Emitted
1	Petrol	2.3 kg per liter
2	Diesel	2.7kgper liter
3	Electricity	0.05kgper kWh
4	LPG	1.5kgperkg

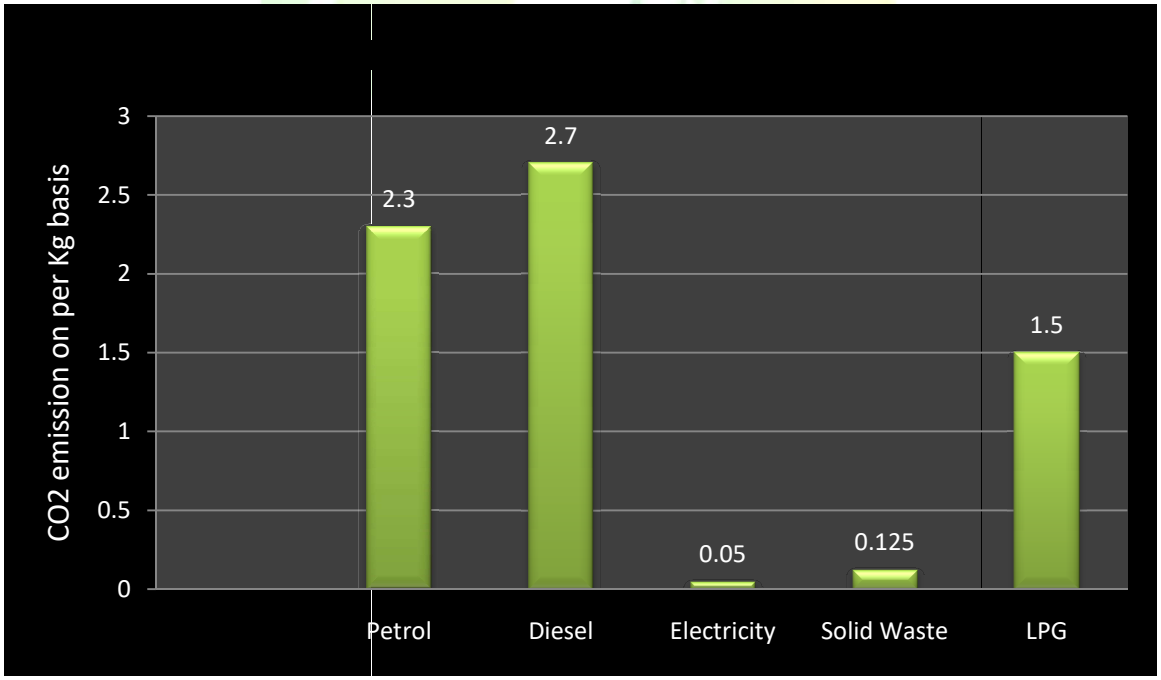


Figure 88: Standard daily CO2 emitted by different emission inventories at the Institute

Table 43: Details for Carbon Foot Print Auditing

Sl.No	Description	No of Vehicles	Qty of Net CO2 generated per week (Kg CO2 per week)	Qty of CO2 generated per month (Kg CO2 per month)	Qty of CO2 generated per year (Kg CO2 per year)
1	Buses (for transporting students and staff)	100	11485.71429	47857.14286	574285.7143
2	**Four wheelers for**				
	Transportation of Vegetables	1	64.32	268	3216
	Transportation of Goods	4	90.048	375.2	4502.4
	Car-Teachers travel	200	5544	23100	277200
	Car-Student Travel	100	2772	11550	138600
	Transportation of vegetables	1	19.296	80.4	964.8
	Transportation of milk	1	19.296	80.4	964.8
	Transportation of chicken & egg	1	25.728	107.2	1286.4
	Transportation of goods	1	19.296	80.4	964.8
	Waste Transportation	1	24.12	100.5	1206
3	Two wheelers	500	4158	17325	207900
4	No of people using Public transportation	400	7718.4	32160	385920
5	Number of visitors	75	4824	20100	241200
6	Generators used	8 but only 4 used for 6 hrs, rest used only for 2 hrs when in need	44766.72	186528	2238336
7	LPG cylinders	37			
8	Kerosene	nil	4995	20812.5	249750
	Total CO2 Emitted		81530.93	339712.24	4076546.91

Details of Total CO2 Emission from the Institution Campus is tabulated above. 4076.54691tonnes/ yr of CO2 is emitted in the Institute in the year 2021-22.

During the year 2020-21Total CO2 emitted from the whole campus was estimated to be 1741.63ton/year.

5.3.6 Carbon Footprint Audit-Evaluations and Recommendations

A carbon audit, sometimes referred to as a 'carbon footprint', is a means of measuring and recording the GHG emissions of an organization or building within a defined system boundary.

Climate change is one of the most important challenges facing mankind. Government is embarking upon a series of measures to reduce greenhouse gas (GHG) emissions. These include promoting use of cleaner energy and renewable energy, improving energy efficiency and energy conservation, encouraging greening and raising public awareness.

Measuring the total quantity of greenhouse gases being emitted by the Institution as a result of its daily activities is one of the best way to assess the Carbon Foot Print Institution. During the Carbon Foot Print audit at Sathyabama Institute of Science and Technology, analysis of various activities was quantified in the form of total greenhouse gases being emitted to the atmosphere. The main aim of this audit was to analyze and identify the main source of CO2 emission in the Institute and to point out intervention activities that can be done to reduce the emission and optimize the usage of resources.

Carbon Footprint audit was extensively done for the Sathyabama Institute of Science and Technology and the Audit findings are as follows:

Best Practices Observed in the Institution –Carbon Footprint Reduction

- Restriction of personal vehicle inside the campus enhancing reduction of carbon foot prints
- Use of battery-operated Vehicles to commute inside the campus
- Blending of Conventional fuel with biodiesel generated from Waste Cooking Oil thereby reducing the carbon footprint
- Use of Solar and Wind Hybrid system power the laboratory thereby reducing dependence on Conventional power
- Use of Solar Lamps to light the Walkways

- Use of Solar power to Run the Kitchen
- Use of Walkways to commute short distances
- Use of Biogas generated from food waste for running Kitchen Stoves
- Area under Green cover and Marshy Land in the Institution.

5.3.7 Consolidation of Carbon Footprint Audit Findings-Evaluation

As the first step in managing the impact of Sathyabama Institute of Science and Technology, onatmosphere due to greenhouse gas emissions, the carbon footprint was done.

Carbon Foot Print audit was done for analysis of various activities that lead to emission of total greenhouse gases to the atmosphere. The main aim of this audit was to analyze and identify the main source of CO2 emission in the Institute and to point out intervention activities that can be done to reduce the emission and optimize the usage of resources.

Carbon Footprint audit was extensively done for the Sathyabama Institute of Science and Technology and inventories selected for the audit were Transportation, Electricity, Diesel Generator, LPG, etc. Carbon Footprint audit took into account Carbon dioxide emitted on account of vehicles used for transportation of vegetables, chicken, egg, students and staff etc. The number of buses,cars, two wheelers used for used for coming to college, the kilometers covered by these vehicles, its milage, type of fuel used etc were taken into consideration to quantify the CO2 emitted by the Institute. The type of Vehicle used for carrying water to the Campus, for carrying out the waste out of the campus etc were also taken into consideration.

The audit was carried out in three phases namely, pre audit, post audit and audit analysis. The audit included steps Collection of data, finding the major CO2 emission activities and Estimation of CO2 following with suggestive measures for reduction.

During preaudit stage efforts were made to gather information on mode of transportation taken by students, staff; how vegetables, and other provisions for the canteen are transported, how the water is transported to the campus, how waste was transported out of the Campus.

During the on-site audit, efforts were made to the answer of the questions raised during preaudit. The exact details like the type of vehicle used, the fuel type used, the distance travelled by each vehicle, the milage of each vehicle, were noted down.

The onsite detailed observation was made on each activies performed that are emitting CO2 to the atmosphere.

During On-Site audit, interaction with students, staff and other authorities were done to gauge their knowledge on the GHG emission, its major contributors in the campus, its impact etc,

During the Post Audit Stage, the data collected and identified were analysed to quantify the total CO2 emitted by the Institute during the academic year 2021-22.

Survey responses, combined with utility data and emissions calculations, indicated that the average annual carbon footprint was a 4076.54691tonnes/ yr, whereas during the year 2020-21 it was 1741.63 tons of CO2 equivalent per annum. The main reason for this difference is due to the fact that during the academic year the Institution was only partially functioning due to outbreak of Covid Pandemic. Students were not coming and only limited staffs were coming to the Campus. Even the canteen was partially functioning, cooking to meet the requirement of very few, and the staffs were asked to carry own food and water. This lead to reduction in use of LPG cylinders. Even the number of trips taken by the Vehicle to transport vegetables and other provision was very limited. As the Canteen and mess was not fully functional the waste generated was very less. Overall, the Carbon foot print in the year 2020-21 was nominal.

During the analysis, it was observed that

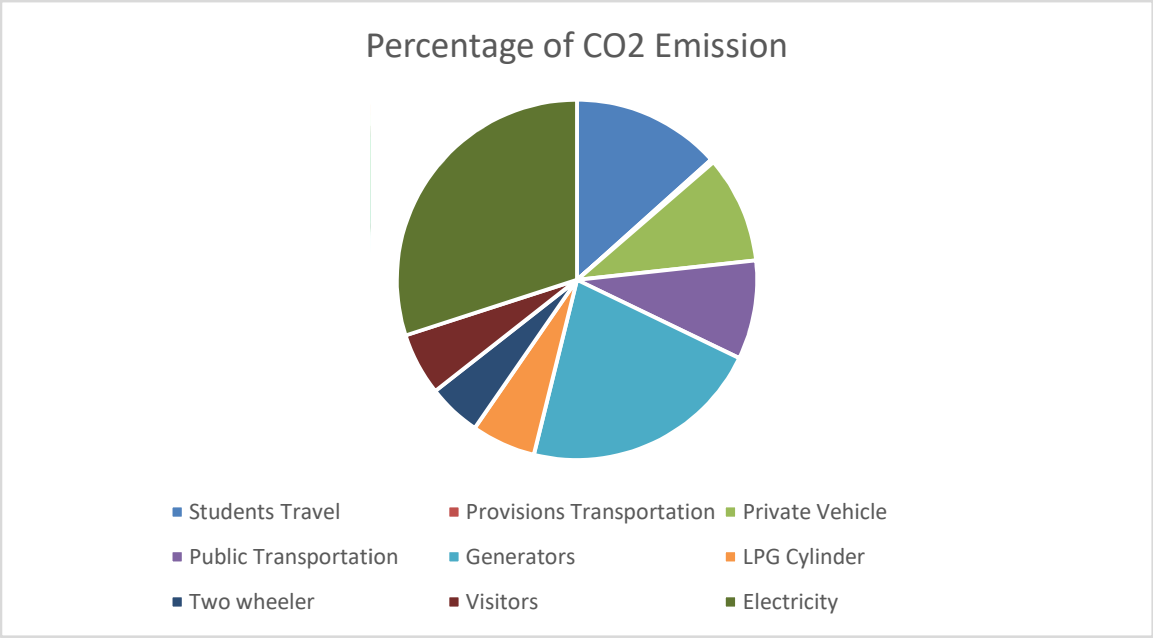


Figure 89: Percentage of CO2 emission

Major CO_2 emission was from Electricity with30%,this electricity is purchased from Tamil Nadu Electricity Board. But the Institute is taking efforts to reduce this CO2 emission by increasing its dependence on renewable source-solar. The institution has own solar power generation capacity and this solar power is used to run geysers, kitchen boilers, lighting the lamps etc. The Institution is using solar lamps to light the walk ways across the campus. Sathyabama has plans for to scale up in its solar capacity in the future to decrease the dependence on conventional source of power thereby decreasing the overall CO_2 emission.

The second largest contributor to CO2 Emission was by the Diesel Generator set 21.7%.There are 8 DG sets in the campus. They are run using diesel. Only 4 are used on a regular basis for 6 hrs per day based on the demand. The rest of the 4 generators are used only occasionally when there is a power shortage or when demand is higher on account of some function in the campus.

This year emission from food waste and solid waste was not considered as the food waste was diverted to the Biogas plant and the compostable solid waste was diverted to the compost pit. The Biogas so generated was used to ignite kitchen stove and the compost from the compost pit was used as organic manure. Both these Biogas plant and compost pit was designed that GHG or CO2 is not released to the atmosphere during the processing stage.

The third largest emission comes on account of students and staff commuting to and fro from campus. Satyabhama provides bus facility for this commuting purpose. There are nearly 100 buses and these buses are run by biodiesel blended fuel. Hence emission by these buses are comparatively less than the conventional buses.

The Institution is using battery operated vehicles to commute inside the campus and have restricted the use of personal vehicles

Cars used by students and faculty were separately considered and they account for 9.6% GHG emission. To reduce the emission from car, the Institution is promoting carpooling to reduce the overall number of vehicles used for commuting.

Use of LPG Cylinder accounts for 6 % GHG Emission. But the Institute has already implemented its Biogas unit where in the Biogas generated from food waste is used to run the

burner. With the initiative in place, the Institution was able to decrease the number of LPG cylinder use per day. Biogas was able to replace 3 cylinder per day, which is highly appreciable step. The LPG consumption was further reduced with the re-commissioning of Solar powered kitchen, for which efforts have been initiated

Two wheelers and Campus visitors contribute to 5.7% and 4.8 % of CO2 emission respectively. The authorities are mindful of this and taking steps to decrease the number of visitors per day and by giving permission only to selected few to use private vehicles.

Sathyabama Institute was able to bring down its physical paper consumption by going digital. It even encourages students to go digital rather than offline mode of submission.

The Institution is maintaining a good amount of green cover in terms of trees, plants and shrubs, and taking active steps to increase the green cover. This green cover will act as a sink to absorb CO2. And in the long run it might be able to nullify a great amount of CO_2 emission that is occurring in the campus.

All these are appreciable efforts put in by the Institution to reduce the overall carbon foot print by decreasing the dependence on conventional source of power and properly managing the waste being generated.

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

5.3.8 Recommendations

- Encourage to reduce dairy and meat intake- No Meat Mondays! Animal products make up 18% of greenhouse gas emissions. By replacing one or two of weekly meat and dairy meals to a vegetarian option, can help reduce emissions.
- Encourage use of Bicycles.

Figure 90:Bus in the campus

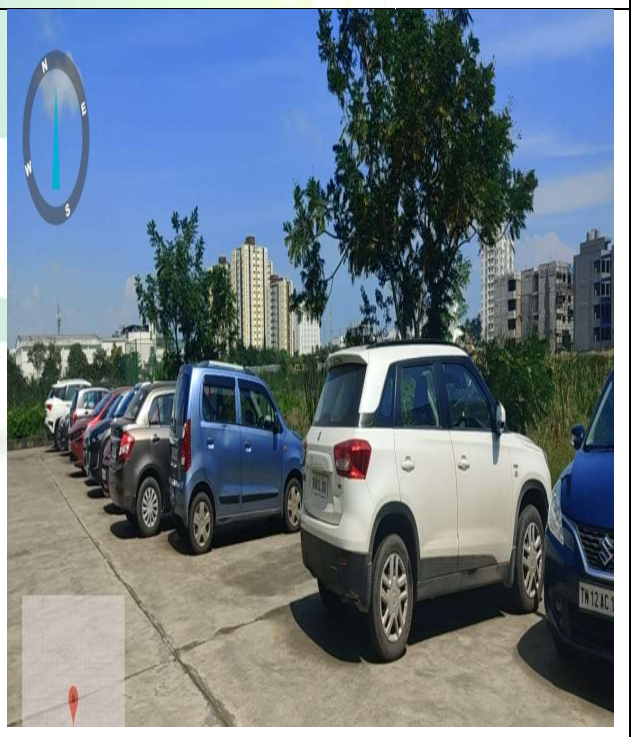


Figure 91:Four wheeles in the campus

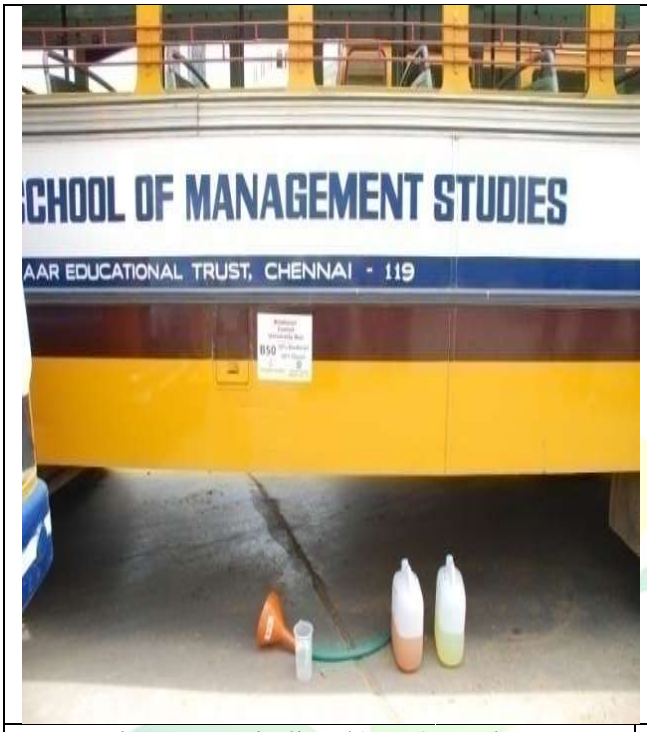


Figure 92:Biodiesel(12%) run bus

Figure 93:Two wheelers in the campus

5.4 Environmental Audit Conclusion

An environmental audit for an Educational Institution is a systematic examination to assess a company's environmental responsibility. It aims to identify environmental compliance, verify environmental responsibility implementation gaps whether they meet stated objectives, along with related corrective actions. Environmental Audits play a significant role in tracking the sustainability of an Institution. An Environmental and Green audit helps an educational Institution to be accountable in their daily activities by examining their practices and determining what measures need to be taken to become a more Sustainable Educational Institute. The Educationists all over the world believes that it is important for Institutions to go green not only from the point of view of protecting the environment but also from teaching the youth the importance of maintaining ecological balance and ensuring sustainable development. Environmental and Energy audit provides an opportunity to create a clean and healthy environment in the campus.

During the audit it was found that Sathyabama Institute of Science and Technology has done a significant work for scientific disposal and management of E-waste, Biomedical Waste, Solid Waste and generation of energy from the waste.

Based on the analysis section of water audit, it was seen that the maximum water load exerted in the Institution is by the Sanitary purpose. Next major water demand is exerted by the medical facility present within the Institution facility. Water demand is high in the medical facility as extra care should be taken to maintain the satiation hygiene in the Hospital. Rest of the load is by the cooking and drinking and followed laundry. Institution has huge green facility which needs frequent watering and maintenance, so gardening also exerts water demand. Rest of water demand is exerted by various laboratories present across various department in the Campus. On an average 64 % of water demand of the Institution is met by the Fresh water taken from open wells and tankers. 34 % of water demand is met by the recycled water from the STP. As 36 % is for flushing and gardening purpose for which the recycled water can fulfil the requirement. For rest of 64 % demand is for drinking, cooking, washing,laundry etc for which fresh water is needed.

The campus has an STP of 1.5 MLD capacity to treat the waste water which is then diverted to gardening and flushing. This STP in the campus helped the institution in reducing their water footprint by 36 %, leading the huge cost saving.

The Institution was able to reduce its water footprint by relying on the recycled waste water and water harvested during the rainy season. Hence it can be said that the Institution is taking the right steps towards water management and is on the path towards achieving Zero Liquid Discharge which is highly commendable.

The Institution is also involved in conducting periodic awareness camp for own students as well as for the members of the adopted village about water conservation, Sanitation and Hygiene and is planning to conduct water audit training for its students.

During the Solid waste audit 21-22, it was observed that nearly 97% of waste generated at the campus falls under Biodegradable category and just 3 % falls under Non-Biodegradable category.

The break-up of the composition of the biodegradable waste generated shows that food waste represents the largest proportion and is around 89%. In the previous year 2020-2021, the Food waste generated at the cafeteria was given to the pig farms on a daily basis. But in the 2021-22, the Sathyabama Institute of Science and Technology collaborated with WasmanPro Environmental Solutions and installed a biogas plant of 1 Ton capacity to treat the food waste generated in the campus. The biogas generated from the biogas plant is fed to the canteen stoves. This gas was used to ignite stove and was able to replace three commercial cylinders per day.With the Biogas the Institution was able to divert nearly 300 tons of Biodegradable waste from reaching the landfills.

This Biogas plant was able to prevent approximately 36,000 kgs of Greenhouse gases from entering the atmosphere including 14,400 kgs of methane as a Greenhouse gas 20 times worse than CO2 in terms of contributing to global warming.

More than 50tons of high-quality manure was produced by the Biogas plant and was provided to the marginal farmers helping them pivot from the clutches of chemical farming and adopt sustainable farming systems.

This Institutecaters to the food requirements of its staff, students and hostels hence has a huge cooking facility that generates on an average 750 liters of waste cooking oil on a weekly basis.

The Institute developed a profitable mechanism for recycling and reusing this Waste Cooking Oil. They have developed a trans-esterification process wherein the Waste Cooking Oil is recycled for the production of biodiesel. These Biodiesel are blended with normal fuel and used to run buses of the Institute.

15% biodiesel blendsare used for the running of Institutions buses. This will help in reduction of GHG as the biodiesel blended fuel emits less CO2 than the conventional fuel. The buses were reported to run smoothly with lesser emissions and noise and improved mileage on average of 5 to 7 km/l which was about 4 to 6 km /l with Diesel alone.

The Biodiesel powered buses in the Institution has lead the team to step further scale up their research on using the Biodiesel generated from Waste Cooking Oil to run agricultural pump sets. This initiative was successful and the farmers could operate the pump sets with Biodiesel

generated from Waste Cooking Oil. The farmers reported that the pump sets gave a good pickup with less noise during operation. This initiative will definitely boost the Climate Resilient agriculture in providing a Sustainable, Eco friendly fuel to the farmers Mittappalli village and promote them on the economic grounds with an alternative to the costlier crude based fuel and motivate them to contribute towards Greener India.

Paper and cardboard generated in Institution were sold to a recycler who recycled these paper waste and A4 sheets were given to the Institution in return.

Major quantum of plastic waste was diverted to architecture department for sustainable building research and few left out waste was given away to Corporation.

Few plastic bottles, plastic covers, cans, broken glass wares, tins were recycled for planting saplings and also to create decorative items to be displayed in the campus. The Institution is also developing technology for conversion of food waste to organic pots, for generation of electricity from organic waste, for smart Compost development from solid waste.

The current waste management strategies implemented by the Institution were fully evaluated during the audit process. It can be concluded that the Institution has well-established solid waste reduction, management and recycling programs and the Institution is highly successful in executing waste reduction and recycling strategies. There seems to be a balance between quantum of waste being generated in the campus and the quantum being recycled, reused and disposed.

During the Biomedical audit the segregation, collection, storage and transport of biomedical waste was carefully examined. It was noticed that the Doctors, Paramedical staffs, and even the House-keeping section were fully aware of BMW rules 2016 and followed it to the core during handling of BMW Waste. Colour coded bins are provided for the Hospital by the authority, the waste generated were discarded into the bags based on the colour code. It was noticed that the BMW register was well maintained and updated on a regular basis by the hospital authority.

Biomedical Waste so generated was handed over to authorized handler at periodic intervals as mentioned in the BMW Management Rules, 2016. The overall handling of the Hospital authority in handling the BMW Waste is satisfactory.

Recycling is the key to reduce the e-Waste. The Institution is well aware of this fact and has entered into an agreement with a recycler to recycle the E-Waste generated in the campus. The Institution is adhering to EPR while buying electric/electronic items. The batteries and UPS are taken back by the vendor once it reaches its end of life.

The Institution also takes into the aspect of Design for Environment (DfE) where in it tries to purchase that product that have maximum energy efficiency and minimum impact on environment during the whole product life cycle.

The Institution has also signed MoU with VANS CHEMISTRY PVT. Ltd., an E-Waste Management Company for teaching students the safe dismantling of E-Waste. There is a proposal to establish a dismantling facility in the Institution for knowledge transfer. It can be concluded that the Institution is taking adequate efforts while handling the E-Waste especially while collection, storage, transportation and disposal of E-Waste

The Carbon Footprint Audit and Disclosure for an educational institution helps to understand and identify its key emission sources and helps to focus on adopting mitigation measures for carbon emission reduction.

During the Carbon Foot Print audit at Sathyabama Institute of Science and Technology, analysis of various activities was quantified in the form of total greenhouse gases being emitted to the atmosphere.

The number of buses, cars, two wheelers used for used for coming to college, the kilometers covered by these vehicles, its milage, type of fuel used etc were taken into consideration to quantify the CO2 emitted by the Institute. The type of Vehicle used for carrying water to the Campus, for carrying out the waste out of the campus etc were also taken into consideration.

Utility data and emissions calculations, indicated that the average annual carbon footprint was a 4076.54691tonnes/ yr.

Major CO_2 emission was from Electricity with 30%,this electricity is purchased from Tamil Nadu Electricity Board. But the Institute is taking efforts to reduce this CO2 emission by increasing its dependence on renewable source-solar.

The Institution has installed many Solar Panels and Solar-Wind Hybrid system and the power generated is used for lightning of the walkway and laboratory. The Institute had Asia's largest kitchen run using Solar Power. Satyabhama has further plans for to scale up in its solar capacity in the future to decrease the dependence on conventional source of power thereby decreasing the overall CO_2 emission and contributing to the INDC commitment made by Government of India which is highly appreciable.

The second largest contributor to CO2 Emission was by the Diesel Generator set 21.7%. There are 8 DG sets in the campus. They are run using diesel.But the Institution is already working on a project to blend the diesel with the Biodiesel produced from waste cooking oil. This blending will be able to bring down the GHG emission compared to use of normal diesel.

This year emission from food waste and solid waste was not considered as the food waste was diverted to the Biogas plant and the compostable solid waste was diverted to the compost pit. The Biogas so generated was used to ignite kitchen stove and the compost from the compost pit was used as organic manure. Both these Biogas plant and compost pit was designed that GHG or CO2 is not released to the atmosphere during the processing stage.

The third largest emission comes on account of students and staff commuting to and fro from campus. Satyabhama provides bus facility for this commuting purpose. There are nearly 100 buses and these buses are run by biodiesel blended fuel. Hence emission by these buses are comparatively less than the conventional buses.

The Institution is using battery operated vehicles to commute inside the campus and have restricted the use of personal vehicles

Use of LPG Cylinder accounts for 6 % GHG Emission. But the Institute has already implemented its Biogas unit where in the Biogas generated from food waste is used to run the burner. With the initiative in place, the Institution was able to decrease the number of LPG cylinder use per day.

The Institution has green cover and Marshy Land. This will help in absorption of pollutant and nullifying the GHG emitted in the campus. The Institution is maintaining Marshy Land having an area of 5,120 m2 undisturbed. This will help in Ground Water Recharge and help in maintaining the ground water table in the nearby areas. It also acts as a habitat for the aquatic birds and a source of drinking water to small animals and birds in the nearby area. This Marshy land also acts as a natural rain harvesting structure.

The Institution has also developed several technologies to generate wealth out of waste and reduce dependence on conventional source of power. The Institution has also signed several MoUs with leading Universities all over the world and also with several companies in India for technological collaboration and for knowledge transfer. The Institution is also taking great effort to ensure knowledge transfer from lab to land. The Institution has adopted five villages and is empowering the villagers with the sustainable technology the Institution develops in its laboratories. This technical knowledge that the villagers have gained have helped them to become entrepreneurs'. All these show the Institution's commitment towards its environmental and social responsibility and its commitment towards protecting the earth's resources in its perpetuity.

During the Environmental Audit a scrutiny, was done on how Satyabhama Institute of Science and Technology is managing the its water and water related issues like reduction of raw water dependence, the treatment system followed in the campus, reuse of recycled water. The major source of solid waste generation, its composition, adherence to R3 during Solid waste management was scrutinised. Even the maintenance of green cover, its efforts taken by the Institution was analysed. Over all it can be concluded that Satyabhama Institute of Science and Technology is managing all its resources well with optimum utilization and is taking all possible efforts for reduction of wastage. It can be said that the Institution is handing its resources in a responsible way adhering to Sustainability aspects during all its decision making and implementation steps.This clearly displays the Institutions endeavour to exercise leadership in addressing the fundamental problems of resource exploitation, by reversing the trends of environment degradation, and in promoting sustainability and to become stewards of Mother Nature.

ANNEXURES

Electricity Bill (2021)

TamilNadu Generation and Distribution Corporation Ltd.

High Tension Bill (Provisional) for the Month of January 2021

TANGEDCO CIN No:U40109TN2009SGC073746 GST No:33AADCT4784E1ZC

HSN : 27160000 SAC : 996912

**** Electrical Energy & Distribution Services are exempted under GST ****

To:	SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY	Service No.	09909401 1060
	JEPPIAAR NAGAR,RAJIV GANDHI SALAI,OLD MAMALLAPURAM ROAD CHENNAI	Bill No.	H401 1060012111
		Date of Bill	03-Feb-21
		Due Date	09-Feb-21
	SHOLINGANALLUR - 2	Tariff App. / Bld.	HT IIB / HT IIB
	Sholinganallur		
	Kancheepuram - 600119	GST No :	111111111111111

Permitted MD :	2500 KVA	Transformer Loss :	0units/0KVA	Tr. CAP.	0 KVA

DETAILS	RATE	CONSUMPTION	AMOUNT (Rs.)
1. Industrial Consumption	6.35 per unit	69681	4,42,474.35
2. Peak Hour Consumption	1.27 per unit	0	0.00
3. Night Hour Consumption (5% Rebate)	0.3175 per unit	0 (-)	0.00(-)
4. Quarters Consumption	0 per unit	0	0.00
5. Commercial Consumption	8.05 per unit	24	120.00
6. Temp. Supply Consumption	12 per unit	70	840.00
7. Total Energy Charges			4,43,434.35
8. Demand Charges	350 per KVA	2250	7,87,500.00
9. Total Demand and Energy Charges			12,30,934.35
ADD			
10.For Non-Avsiling the supply at the Required Voltage 11 KV at 0.10 Rs.Amit			
11. Meter Rent(Including 9 %SGST&9 %CGST)			3,068.00
12. Belated Payment Surcharge for Govt service @0.5%			
13. Extra Levy for exceeding limits (Incl. 18% GST)			
a) Contracted Max. Dmd at	0 per KVA	0	0.00
14. Compensation Charges for low PF			0.00
15. Harmonics Compensation Charges (Incl. 18% GST)			0.00
16. Cross Subsidy Surcharge (Incl. 18% GST)			0.00
17. Electricity Tax			29,080.00
18. Adjustment Charges(Affecting) (Incl. 18% GST)			0.00
Rounding off			0.00
19. Assessment Amount			12,63,082.00
20. Adjustment Charges(Not Affecting) (Incl. 18% GST)			0.00
21. SD Refund amount / ASD amount if any			
22. Self Generation Tax			0.00
23. Self Generation Tax for Diesel Genset 0.10 /unit			0.00
Net Total			12,63,082.00
Less: Amount Deductable due to Court Case			0.00
Less: Amount Deductable due to Advance CC			0.00
Tax collected at source			12,631.00
Net Amount Payable			12,75,713.00

Rupees : Twelve Lakhs Seventy Five Thousand Seven Hundred and Thirteen Only

Amount Payable after due date & upto	24-Feb-21	12,85,063.00	(i.e 15 days Notice Period)

If the last day of the due date happens to be a holiday, the due date shall be extended till the next working day.

RTGS Payment should be made for the exact Bill Amount. Any Part/Excess/Short Amount will be rejected.

This Bill is subject to the Audit, Outcome of the Court Cases, etc., if any, before the appropriate forum.

E & OE

FOR DEPUTY FIN. CONTROLLER

TamilNadu Generation and Distribution Corporation Ltd.

High Tension Bill (Provisional) for the Month of February 2021

TANGEDCO CIN No:U40109TN2009SGC073746 GST No:33AADCT4784E1ZC

HSN : 27160000 SAC : 996912

**** Electrical Energy & Distribution Services are exempted under GST ****

To:	SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY	Service No.	099094011060
	JEPPIAAR NAGAR,RAJIV GANDHI SALAI,OLD MAMALLAPURAM ROAD CHENNAI	Bill No.	H4011060022111
		Date of Bill	03-Mar-21
		Due Date	09-Mar-21
	SHOLINGANALLUR - 2	Tariff App. / Bld.	HT IIB / HT IIB
	Sholinganallur		
	Kancheepuram - 600119	GST No :	11111111111111

Permitted MD :	2500 KVA	Transformer Loss :	0units/0KVA	Tr. CAP.	0 KVA

DETAILS	RATE	CONSUMPTION	AMOUNT (Rs.)
1. Industrial Consumption	6.35 per unit	118224	7,50,722.40
2. Peak Hour Consumption	1.27 per unit	0	0.00
3. Night Hour Consumption (5% Rebate)	0.3175 per unit	0 (-)	0.00(-)
4. Quarters Consumption	0 per unit	0	0.00
5. Commercial Consumption	8.05 per unit	173	1,392.65
6. Temp. Supply Consumption	12 per unit	678	8,136.00
7. Total Energy Charges			7,60,251.05
8. Demand Charges	350 per KVA	2250	7,87,500.00
9. Total Demand and Energy Charges			15,47,751.05
ADD			
10.For Non-Availing the supply at the Required Voltage 11 KV at 0.10 Rs./unit			
11. Meter Rent(Including 9 %SGST&9 %CGST)			3,068.00
12. Belated Payment Surcharge for Govt service @0.5%			
13. Extra Levy for exceeding limits (Incl. 18% GST)			
a) Contracted Max. Dmd at	0 per KVA	0	0.00
14. Compensation Charges for low PF			0.00
15. Harmonics Compensation Charges (Incl. 18% GST)			0.00
16. Cross Subsidy Surcharge (Incl. 18% GST)			0.00
17. Electricity Tax			45,853.00
18. Adjustment Charges(Affecting) (Incl. 18% GST)			0.00
Rounding off			0.00
19. Assessment Amount			15,96,672.00
20. Adjustment Charges(Not Affecting) (Incl. 18% GST)			0.00
21. SD Refund amount / ASD amount if any			
22. Self Generation Tax			0.00
23. Self Generation Tax for Diesel Genset 0.10 /unit			0.00
Net Total			15,96,672.00
Less: Amount Deductable due to Court Case			0.00
Less: Amount Deductable due to Advance CC			0.00
Tax collected at source			15,967.00
Net Amount Payable			16,12,639.00

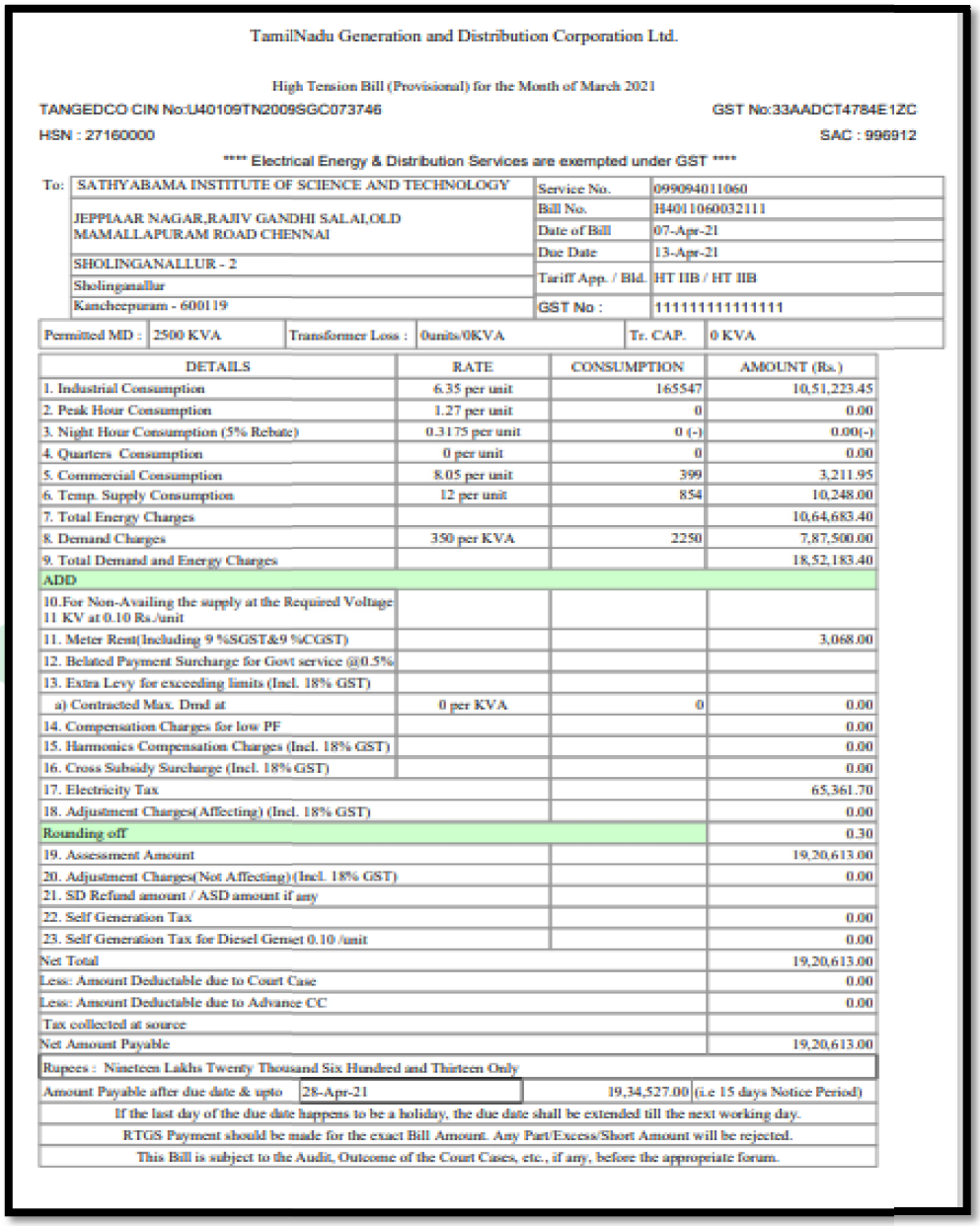
Rupees : Sixteen Lakhs Twelve Thousand Six Hundred and Thirty Nine Only

Amount Payable after due date & upto	24-Mar-21	16,24,390.00	(i.e 15 days Notice Period)

If the last day of the due date happens to be a holiday, the due date shall be extended till the next working day.

RTGS Payment should be made for the exact Bill Amount. Any Part/Excess/Short Amount will be rejected.

This Bill is subject to the Audit, Outcome of the Court Cases, etc., if any, before the appropriate forum.



TamilNadu Generation and Distribution Corporation Ltd.

High Tension Bill (Provisional) for the Month of March 2021

TANGEDCO CIN No:U40109TN2009SGC073746 GST No:33AADCT4784E1ZC

HSN : 27160000 SAC : 996912

**** Electrical Energy & Distribution Services are exempted under GST ****

To:			
SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY	Service No.	099094011060
JEPPIAAR NAGAR,RAJIV GANDHI SALAI,OLD MAMALLAPURAM ROAD CHENNAI	Bill No.	H401106032111
	Date of Bill	07-Apr-21
	Due Date	13-Apr-21
SHOLINGANALLUR - 2	Tariff App. / Bld.	HT IIB / HT IIB
Sholinganallur	GST No :	111111111111111
Kancheepuram - 600119		

Permitted MD :	2500 KVA	Transformer Loss :	0units/0KVA	Tr. CAP.	0 KVA

DETAILS	RATE	CONSUMPTION	AMOUNT (Rs.)
1. Industrial Consumption	6.35 per unit	165547	10,51,223.45
2. Peak Hour Consumption	1.27 per unit	0	0.00
3. Night Hour Consumption (5% Rebate)	0.3175 per unit	0 (-)	0.00(-)
4. Quarters Consumption	0 per unit	0	0.00
5. Commercial Consumption	8.05 per unit	399	3,211.95
6. Temp. Supply Consumption	12 per unit	854	10,248.00
7. Total Energy Charges			10,64,683.40
8. Demand Charges	350 per KVA	2250	7,87,500.00
9. Total Demand and Energy Charges			18,52,183.40
ADD			
10.For Non-Availing the supply at the Required Voltage 11 KV at 0.10 Rs./unit			
11. Meter Rent(Including 9 %SGST&9 %CGST)			3,068.00
12. Belated Payment Surcharge for Govt service @0.5%			
13. Extra Levy for exceeding limits (Incl. 18% GST)			
a) Contracted Max. Dmd at	0 per KVA	0	0.00
14. Compensation Charges for low PF			0.00
15. Harmonics Compensation Charges (Incl. 18% GST)			0.00
16. Cross Subsidy Surcharge (Incl. 18% GST)			0.00
17. Electricity Tax			65,361.70
18. Adjustment Charges(Affecting) (Incl. 18% GST)			0.00
Rounding off			0.30
19. Assessment Amount			19,20,613.00
20. Adjustment Charges(Not Affecting) (Incl. 18% GST)			0.00
21. SD Refund amount / ASD amount if any			
22. Self Generation Tax			0.00
23. Self Generation Tax for Diesel Genset 0.10 /unit			0.00
Net Total			19,20,613.00
Less: Amount Deductable due to Court Case			0.00
Less: Amount Deductable due to Advance CC			0.00
Tax collected at source			
Net Amount Payable			19,20,613.00

Rupees : Nineteen Lakhs Twenty Thousand Six Hundred and Thirteen Only

Amount Payable after due date & upto	28-Apr-21	19,34,527.00	(i.e 15 days Notice Period)

If the last day of the due date happens to be a holiday, the due date shall be extended till the next working day.

RTGS Payment should be made for the exact Bill Amount. Any Part/Excess/Short Amount will be rejected.

This Bill is subject to the Audit, Outcome of the Court Cases, etc., if any, before the appropriate forum.

Biomedical Waste Collection, Transportation, Treatment and Disposal Agreement with M/S G.J Multiclave (India) Pvt. Ltd.

भारतीय गैर न्यायिक

बीस रुपये

रु.20

भारत

Rs.20

TWENTY RUPEES

INDIA

INDIA NON JUDICIAL

தமிழ்நாடு तमिलनाडु TAMIL NADU

27 FEB 2020

7 SA 773893

V.BEDHARAJAN
Stamp Vendor
L.No: 12144/B1/96
Ekkattuthangal, Ch-32.
Mobile No: 9710019475

AGREEMENT

FOR COLLECTION, TRANSPORTATION, TREATMENT AND DISPOSAL OF BIOMEDICAL WASTES

This Agreement made and entered into at Chennai on this 1st October 2020 BETWEEN **M/s. G. J MULTICLAVE (INDIA) PVT. LTD,** incorporated under the Companies Act, 1956 having it's Registered Office at New No.37, Old No.20, Teachers Colony, Adyar, Chennai - 600 020 represented by its Manager, **Mr.P.SIVAKUMAR,** S/o. Sri.P.Paulduraí, hereinafter called the **FIRST PARTY.**

AND

SATHYABAMA DENTAL COLLEGE & HOSPITAL, Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai - 600 119, represented by its Chancellor, **Dr.MARIA ZEENA JOHNSON,** hereinafter called the **SECOND PARTY.**

For GJ Multiclave (India) Pvt. Ltd.

General Manager

CHANCELLOR
SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Jeppiaar Nagar, Rajiv Gandhi Salai,
Chennai – 600 119.

WHEREAS the **FIRST PARTY** has set up a Common Off-site Biomedical Waste Treatment Facility for Chennai in accordance with the standards prescribed in Biomedical Waste (Management & Handling) Rules, 2016 as amended to date for treatment and disposal of Biomedical Wastes generated by various Health Care Establishments in and around Chennai.

WHEREAS the **SECOND PARTY** is a Health Care Establishment, engaged in the service of providing various types of Health Care treatment facilities and generates Biomedical Wastes as defined under the Biomedical Waste (Management & Handling) Rules, 2016 in the course of such medical services to people.

WHEREAS the **SECOND PARTY** is enrolled with the **FIRST PARTY** for collection, transportation, treatment and final disposal by the **FIRST PARTY**, of such Biomedical Wastes generated in the **SECOND PARTY's** Health Care Facility.

WHEREAS now the **SECOND PARTY** enters into an Agreement with the **FIRST PARTY** as per the following terms and conditions:-

1. The **SECOND PARTY** declares that its bed strength operational is **100** Beds.

2. The **SECOND PARTY** will segregate the Biomedical Wastes as per Schedule II of the Biomedical Waste (Management & Handling) Rules, 2016 at the point of generation in its Health Care Facility and store such segregated Medical Wastes in designated Colour Coded Containers/Bags prior to collection, transportation, treatment and final disposal by the **FIRST PARTY**.

3. The **SECOND PARTY** shall also label the Bio-Medical Waste consumable bags and containers with the service providers name with BAR CODE according to Schedule III of Biomedical Waste (Management & Handling) Rules, 2016.

4. The **FIRST PARTY** shall collect the Biomedical Wastes from **SECOND PARTY** everyday at a specified time to suit the convenience of collection mechanism of the **FIRST PARTY** and the **SECOND PARTY** shall render all assistance to the **FIRST PARTY** in this regard.

5. The **SECOND PARTY** agrees to pay a Service Charge of **Rs.2000/- per month** for the waste collected by the **FIRST PARTY. In addition to the service charges, the SECOND PARTY has to pay any government taxes and levies as applicable on date to the FIRST PARTY** for the services rendered by the **FIRST PARTY.**

6. Both the parties agree that the rate of service charges mentioned in Clause 5 above will be in force for a period of 1 year from the date of this agreement and thereafter the rate shall be revised by mutual consent after deliberations with Indian Medical Association Nursing Home Board.

7. Notwithstanding the above, the **SECOND PARTY** agrees to consider an increase in the rate if and when there is an increase in the fuel tariff by more than 20% over the prevailing rate. **The prevailing rate now is Rs.77.49 per litre for diesel.**

8. The **SECOND PARTY** has paid an amount of **Rs.20000/-** interest free advance for the service charges payable by it. Such advance amount shall not be adjusted against the recurring service charges payable by **SECOND PARTY** to the **FIRST PARTY** and shall remain intact during the period of the agreement.

For GJ Multiclave (India) Pvt. Ltd.

General Manager

CHANCELLOR
SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Jeppiaar Nagar, Rajiv Gandhi Salai,
Chennai – 600 119.

9. The **FIRST PARTY** shall submit its bills towards Service Charges referred in Clause 5 above on a monthly basis to the **SECOND PARTY** at the end of each month and the SECOND PARTY shall pay the same before or on the 5th of the following months.

SECOND PARTY agrees to permit such authorised person/persons of the **FIRST PARTY** duly indicated in writing as and when the **FIRST PARTY** demands visual inspection of the segregated wastes stored in its premises before the same is collected by the **FIRST PARTY** from the said premises of the **SECOND PARTY**.

The **FIRST PARTY** agrees to provide Training on segregation of Biomedical Wastes to the **SECOND PARTY** Free of cost.

This agreement is subject to **force majeure** i.e. –

i. war invasion, mobilization, requisition or embargo;
ii. rebellion, revolution, insurrection or military or usurped power, or civil war;
iii. Government orders restrictions, riots, fire, epidemics, sabotage, act of God like earthquake, floods, accidents, breakdown of machinery or any other reasons whatsoever beyond the reasonable control of **FIRST PARTY**.

If any force majeure event outside the control of both parties arises during the currency of this agreement, which renders it impossible or unlawful for the **FIRST PARTY** to fulfil its agreement obligations, the **SECOND PARTY** shall not seek any remedy - legal or financial from the **FIRST PARTY**. However, the terms of this agreement shall be restored as far as both the parties are concerned, once the force majeure events cease to exit.

This Agreement shall be in force initially for valid upto 31st March 2022 and can be renewed thereafter for such period and on such terms and conditions as the parties mutually agree thereon.

If any dispute arises between the parties herein, or if any controversies or difference of opinion arises out of or in connection with the recitations of this agreement, the same shall be settled amicably. The jurisdiction shall be restricted to **CHENNAI ONLY**.

IN WITNESS WHEREOF the parties herein set out their hands on the day, date and place above written.

For GJ Multiclave (India) Pvt. Ltd.

General Manager

FIRST PARTY

SECOND PARTY

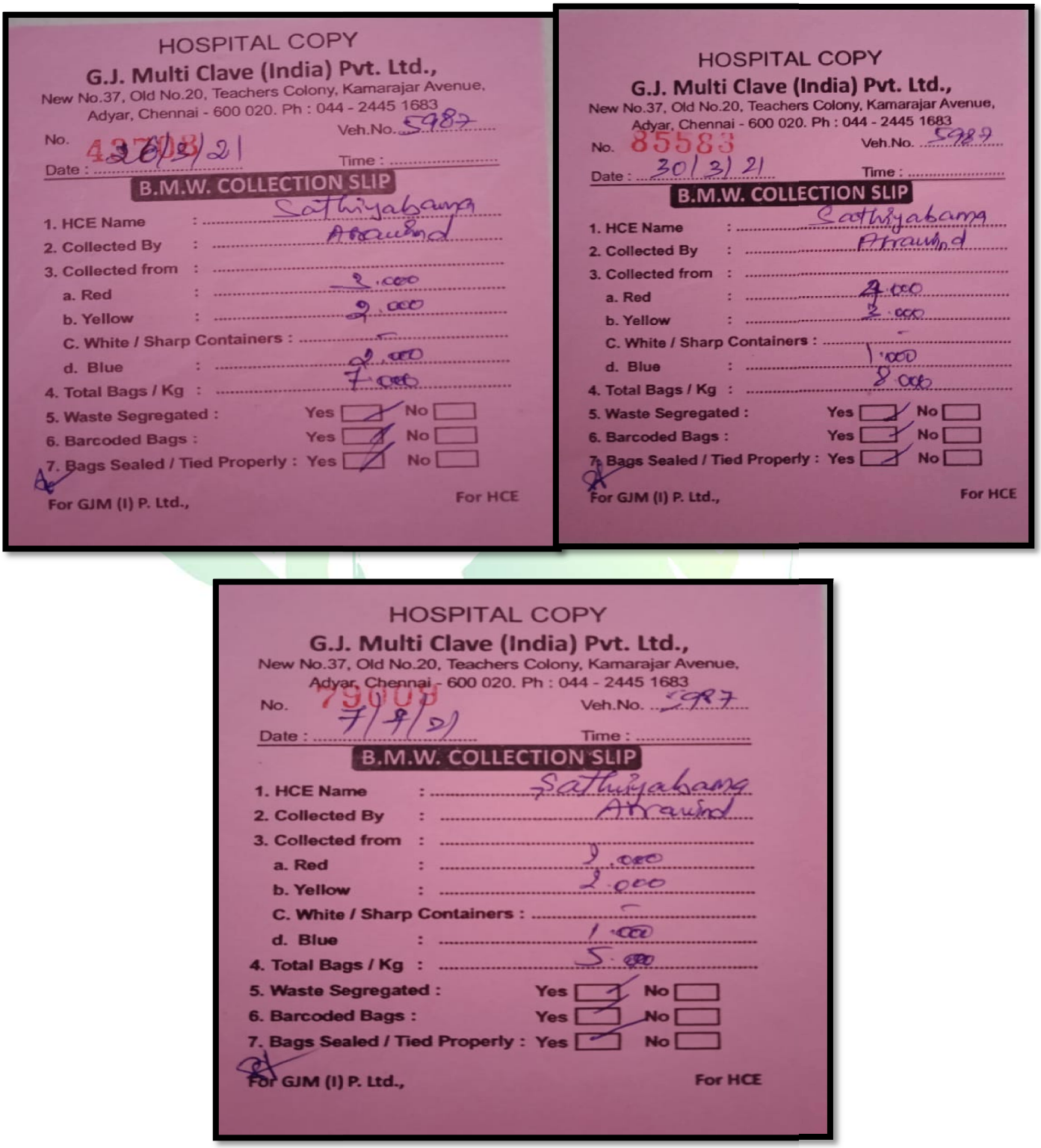
Dr. MARIA JEENA JOHNSON, B.E., MBA, M.Phil., Ph.D.
CHANCELLOR
SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Jeppiaar Nagar, Rajiv Gandhi Salai,
Chennai - 600 119.

WITNESSETH:

1. A. Jabastokar
37/20, Teachers Colony
Adyar, Chennai - 20

2. D.S.S. Rao
Flat #6, Kaveri Villa,
RL, Bharat Nagar I St.,
Choolaimedu, CH - 94

Biomedical Waste Collection Slip



HOSPITAL COPY

G.J. Multi Clave (India) Pvt. Ltd.,

New No.37, Old No.20, Teachers Colony, Kamarajar Avenue,
Adyar, Chennai - 600 020. Ph : 044 - 2445 1683

No. 42708 Veh.No. 5987

Date : 30/3/21 Time :

B.M.W. COLLECTION SLIP

1. HCE Name : Sathiyabama
2. Collected By : Aravind
3. Collected from :
   a. Red : 2.000
   b. Yellow : 2.000
   C. White / Sharp Containers : -
   d. Blue : 2.000
4. Total Bags / Kg : 7.000
5. Waste Segregated : Yes ✓ No
6. Barcoded Bags : Yes ✓ No
7. Bags Sealed / Tied Properly : Yes ✓ No

For GJM (I) P. Ltd., For HCE

HOSPITAL COPY

G.J. Multi Clave (India) Pvt. Ltd.,

New No.37, Old No.20, Teachers Colony, Kamarajar Avenue,
Adyar, Chennai - 600 020. Ph : 044 - 2445 1683

No. 85583 Veh.No. 5989

Date : 30/3/21 Time :

B.M.W. COLLECTION SLIP

1. HCE Name : Sathiyabama
2. Collected By : Aravind
3. Collected from :
   a. Red : 4.000
   b. Yellow : 3.000
   C. White / Sharp Containers : -
   d. Blue : 1.000
4. Total Bags / Kg : 8.000
5. Waste Segregated : Yes ✓ No
6. Barcoded Bags : Yes ✓ No
7. Bags Sealed / Tied Properly : Yes ✓ No

For GJM (I) P. Ltd., For HCE

HOSPITAL COPY

G.J. Multi Clave (India) Pvt. Ltd.,

New No.37, Old No.20, Teachers Colony, Kamarajar Avenue,
Adyar, Chennai - 600 020. Ph : 044 - 2445 1683

No. 79009 Veh.No. 5987

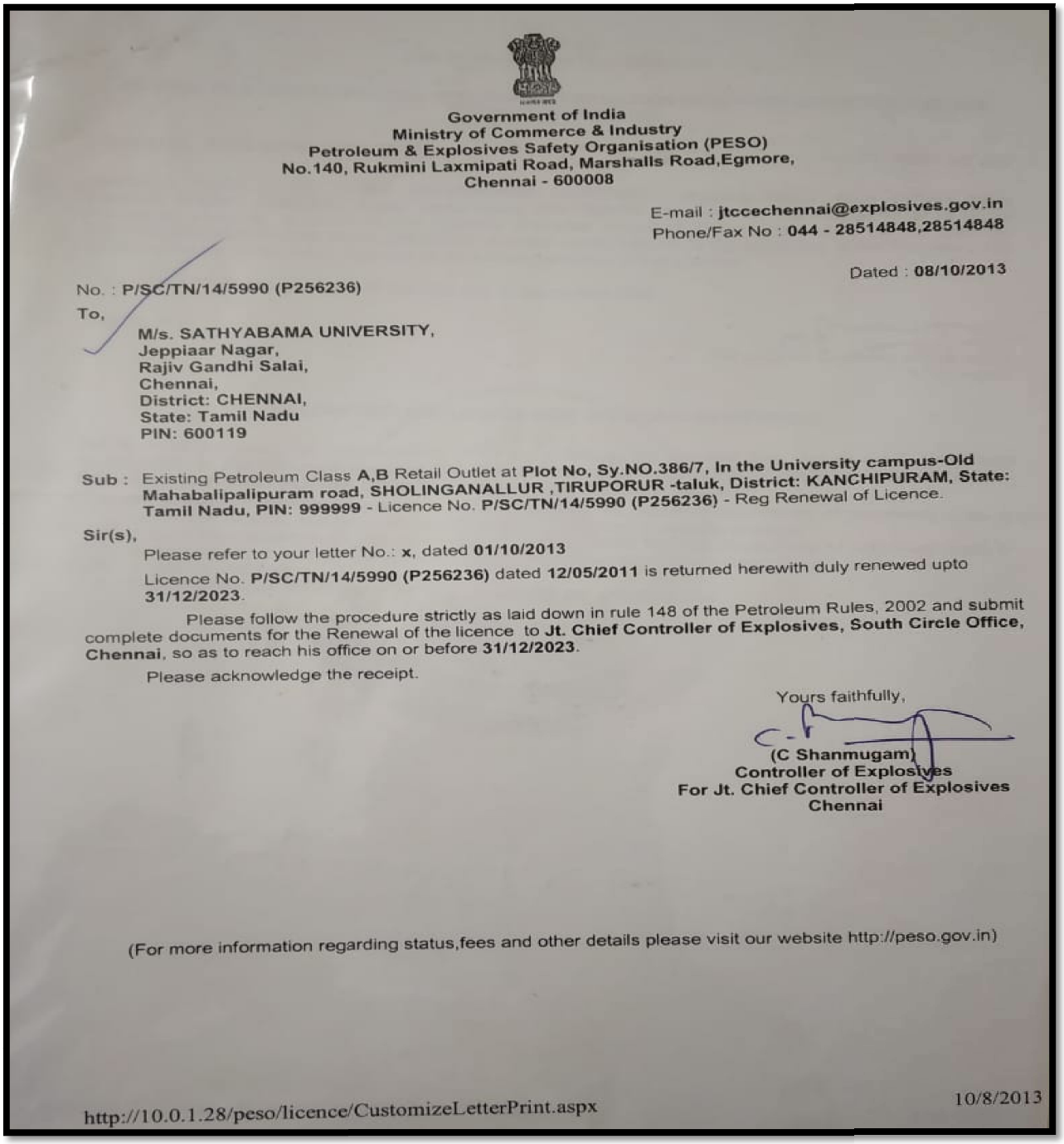
Date : 7/4/21 Time :

B.M.W. COLLECTION SLIP

1. HCE Name : Sathiyabama
2. Collected By : Aravind
3. Collected from :
   a. Red : 2.000
   b. Yellow : 2.000
   C. White / Sharp Containers : -
   d. Blue : 1.000
4. Total Bags / Kg : 5.000
5. Waste Segregated : Yes ✓ No
6. Barcoded Bags : Yes ✓ No
7. Bags Sealed / Tied Properly : Yes ✓ No

For GJM (I) P. Ltd., For HCE

Petroleum & Explosives Safety Organisation (PESO) Approval for Petrol Pump



Government of India
Ministry of Commerce & Industry
Petroleum & Explosives Safety Organisation (PESO)
No.140, Rukmini Laxmipati Road, Marshalls Road,Egmore,
Chennai - 600008

E-mail : jtccechennai@explosives.gov.in
Phone/Fax No : 044 - 28514848,28514848

Dated : 08/10/2013

No. : P/SC/TN/14/5990 (P256236)

To,

M/s. SATHYABAMA UNIVERSITY,
Jeppiaar Nagar,
Rajiv Gandhi Salai,
Chennai,
District: CHENNAI,
State: Tamil Nadu
PIN: 600119

Sub : Existing Petroleum Class A,B Retail Outlet at **Plot No, Sy.NO.386/7, In the University campus-Old Mahabalipalipuram road, SHOLINGANALLUR ,TIRUPORUR -taluk, District: KANCHIPURAM, State: Tamil Nadu, PIN: 999999** - Licence No. **P/SC/TN/14/5990 (P256236)** - Reg Renewal of Licence.

Sir(s),

Please refer to your letter No.: **x**, dated **01/10/2013**

Licence No. **P/SC/TN/14/5990 (P256236)** dated **12/05/2011** is returned herewith duly renewed upto **31/12/2023**.

Please follow the procedure strictly as laid down in rule 148 of the Petroleum Rules, 2002 and submit complete documents for the Renewal of the licence to **Jt. Chief Controller of Explosives, South Circle Office, Chennai**, so as to reach his office on or before **31/12/2023**.

Please acknowledge the receipt.

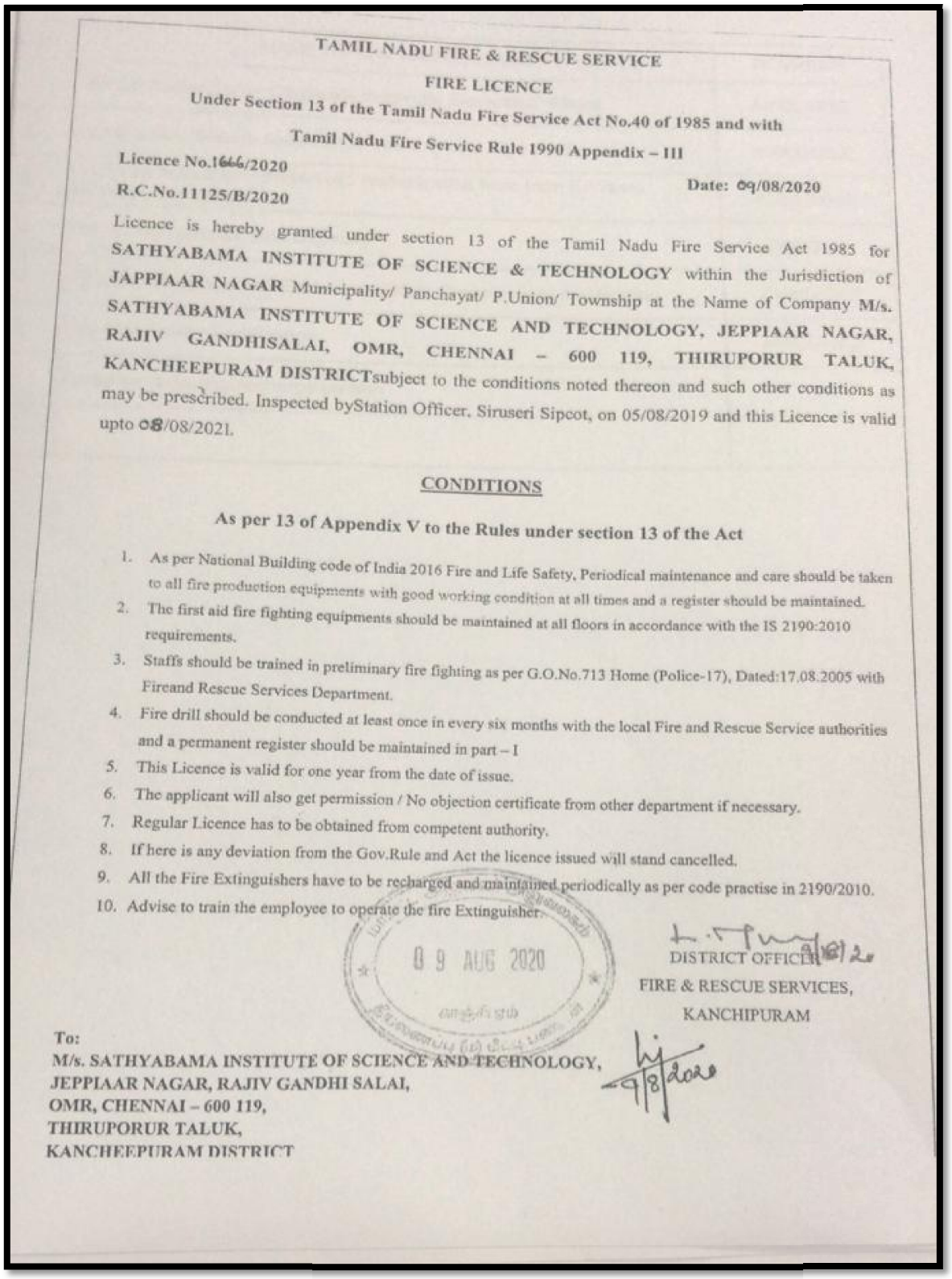
Yours faithfully,

(C Shanmugam)
Controller of Explosives
For Jt. Chief Controller of Explosives
Chennai

(For more information regarding status,fees and other details please visit our website http://peso.gov.in)

http://10.0.1.28/peso/licence/CustomizeLetterPrint.aspx 10/8/2013

FIRE LICENSE



TAMIL NADU FIRE & RESCUE SERVICE

FIRE LICENCE

Under Section 13 of the Tamil Nadu Fire Service Act No.40 of 1985 and with

Tamil Nadu Fire Service Rule 1990 Appendix – III

Licence No.1666/2020

Date: 09/08/2020

R.C.No.11125/B/2020

Licence is hereby granted under section 13 of the Tamil Nadu Fire Service Act 1985 for **SATHYABAMA INSTITUTE OF SCIENCE & TECHNOLOGY** within the Jurisdiction of **JAPPIAAR NAGAR** Municipality/ Panchayat/ P.Union/ Township at the Name of Company **M/s. SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY, JEPPIAAR NAGAR, RAJIV GANDHISALAI, OMR, CHENNAI – 600 119, THIRUPORUR TALUK, KANCHEEPURAM DISTRICT**subject to the conditions noted thereon and such other conditions as may be prescribed. Inspected byStation Officer, Siruseri Sipcot, on 05/08/2019 and this Licence is valid upto 08/08/2021.

CONDITIONS

As per 13 of Appendix V to the Rules under section 13 of the Act

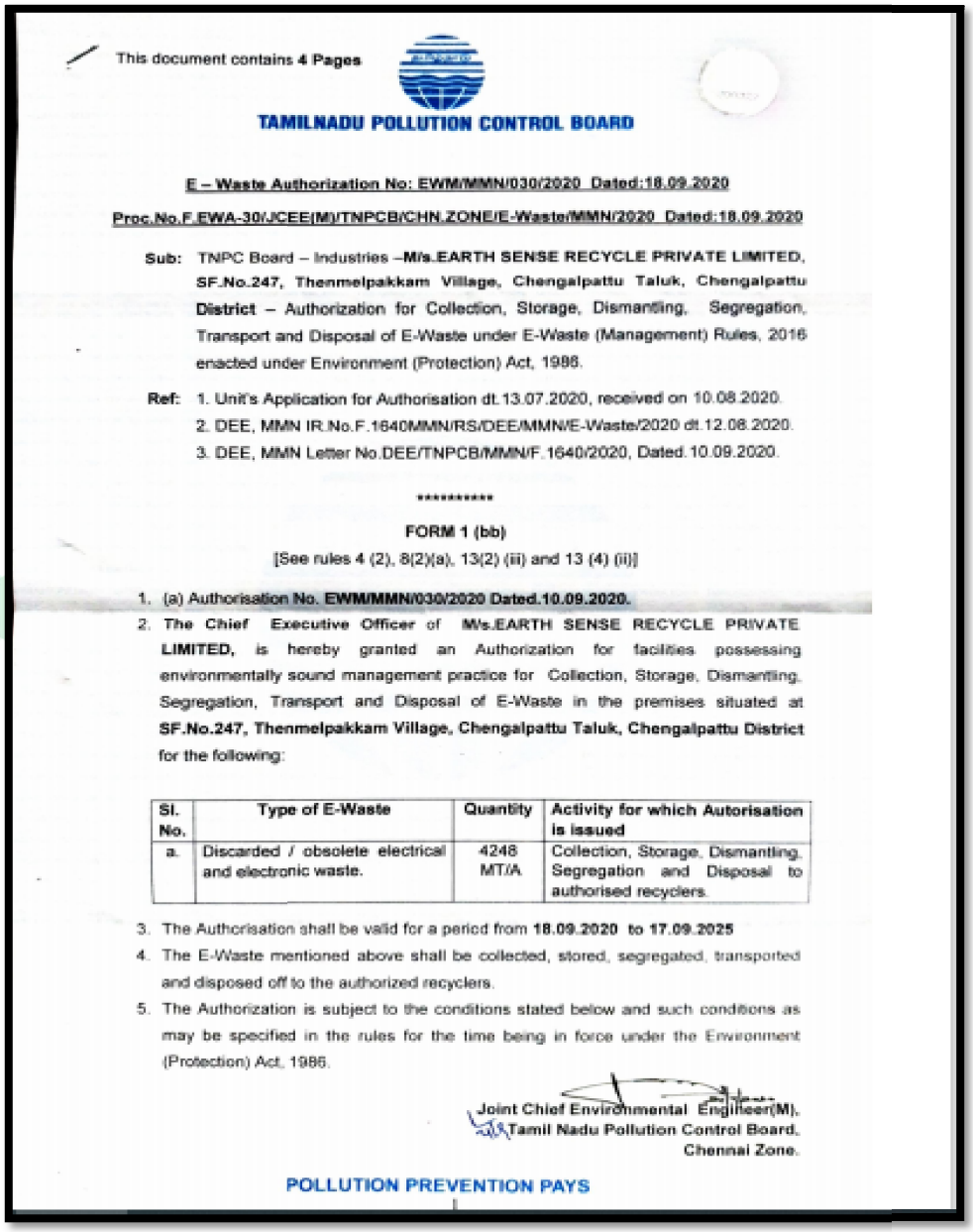
1. As per National Building code of India 2016 Fire and Life Safety, Periodical maintenance and care should be taken to all fire production equipments with good working condition at all times and a register should be maintained.
2. The first aid fire fighting equipments should be maintained at all floors in accordance with the IS 2190:2010 requirements.
3. Staffs should be trained in preliminary fire fighting as per G.O.No.713 Home (Police-17), Dated:17.08.2005 with Fireand Rescue Services Department.
4. Fire drill should be conducted at least once in every six months with the local Fire and Rescue Service authorities and a permanent register should be maintained in part – I
5. This Licence is valid for one year from the date of issue.
6. The applicant will also get permission / No objection certificate from other department if necessary.
7. Regular Licence has to be obtained from competent authority.
8. If here is any deviation from the Gov.Rule and Act the licence issued will stand cancelled.
9. All the Fire Extinguishers have to be recharged and maintained periodically as per code practise in 2190/2010.
10. Advise to train the employee to operate the fire Extinguisher.

09 AUG 2020

DISTRICT OFFICER
FIRE & RESCUE SERVICES,
KANCHIPURAM

To:
M/s. SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY,
JEPPIAAR NAGAR, RAJIV GANDHI SALAI,
OMR, CHENNAI – 600 119,
THIRUPORUR TALUK,
KANCHEEPURAM DISTRICT

E-WASTE AUTHORIZATION



This document contains 4 Pages

TAMILNADU POLLUTION CONTROL BOARD

E – Waste Authorization No: EWM/MMN/030/2020 Dated:18.09.2020

Proc.No.F.EWA-30/JCEE(M)/TNPCB/CHN.ZONE/E-Waste/MMN/2020 Dated:18.09.2020

Sub: TNPC Board – Industries –**M/s.EARTH SENSE RECYCLE PRIVATE LIMITED, SF.No.247, Thenmelpakkam Village, Chengalpattu Taluk, Chengalpattu District** – Authorization for Collection, Storage, Dismantling, Segregation, Transport and Disposal of E-Waste under E-Waste (Management) Rules, 2016 enacted under Environment (Protection) Act, 1986.

Ref: 1. Unit's Application for Authorisation dt.13.07.2020, received on 10.08.2020.
2. DEE, MMN IR.No.F.1640MMN/RS/DEE/MMN/E-Waste/2020 dt.12.08.2020.
3. DEE, MMN Letter No.DEE/TNPCB/MMN/F.1640/2020, Dated.10.09.2020.

****

FORM 1 (bb)

[See rules 4 (2), 8(2)(a), 13(2) (ii) and 13 (4) (ii)]

1. (a) Authorisation No. **EWM/MMN/030/2020 Dated.10.09.2020.**
2. **The Chief Executive Officer** of **M/s.EARTH SENSE RECYCLE PRIVATE LIMITED,** is hereby granted an Authorization for facilities possessing environmentally sound management practice for Collection, Storage, Dismantling, Segregation, Transport and Disposal of E-Waste in the premises situated at **SF.No.247, Thenmelpakkam Village, Chengalpattu Taluk, Chengalpattu District** for the following:

Sl. No.	Type of E-Waste	Quantity	Activity for which Autorisation is issued
a.	Discarded / obsolete electrical and electronic waste.	4248 MT/A	Collection, Storage, Dismantling, Segregation and Disposal to authorised recyclers.

3. The Authorisation shall be valid for a period from **18.09.2020 to 17.09.2025**
4. The E-Waste mentioned above shall be collected, stored, segregated, transported and disposed off to the authorized recyclers.
5. The Authorization is subject to the conditions stated below and such conditions as may be specified in the rules for the time being in force under the Environment (Protection) Act, 1986.

Joint Chief Environmental Engineer(M),
Tamil Nadu Pollution Control Board,
Chennai Zone.

POLLUTION PREVENTION PAYS

TNPCB - CONSENT TO OPERATE

TAMILNADU POLLUTION CONTROL BOARD

Category of the Industry :

RED

CONSENT ORDER NO. 20051323591184 DATED: 04/12/2020.

PROCEEDINGS NO.F.0384MMN/RS/DEE/TNPCB/MMN/W/2020 DATED: 04/12/2020

SUB: Tamil Nadu Pollution Control Board –CONSENT TO OPERATE – DIRECT -M/s. G.J MULTICLAVE(INDIA)PVT.LTD , S.F.No. 245&247, THENMELPAKKAM villageChengalpattu Taluk and Chengalpattu District - Consent for the operation of the plant and discharge of sewage and/or trade effluent under Section 25 of the Water (Prevention and Control of Pollution) Act, 1974 as amended in 1988 (Central Act 6 of 1974) – Issued- Reg.

Ref: 1. Proc.No. TNPCB/BMWM/31499/RS/ MMN/ W&A/2013 dated 17.09.2013
2. Proc.No. F.0384MMN/RS/DEE/TNPCB/MMN/W&A/2017 dated: 03/04/2017
3. Unit's Online Application No. 32359184 dated 03.09.2020
4. IR.No : F.0384MMN/RS/AEE/MMN/2020 dated 04/12/2020
5. Minutes of the 149th ZLCCC Meeting held on 24.11.2020 vide Item No.149-20

CONSENT TO OPERATE is hereby granted under Section 25 of the Water (Prevention and Control of Pollution) Act, 1974 as amended in 1988 (Central Act, 6 of 1974) (hereinafter referred to as "The Act") and the rules and orders made there under to

The Director,
M/s . G.J MULTICLAVE(INDIA)PVT.LTD
S.F No.245&247,
THENMELPAKKAM Village,
Chengalpattu Taluk,
Chengalpattu District.

Authorising the occupier to make discharge of sewage and /or trade effluent.

This is subject to the provisions of the Act, the rules and the orders made there under and the terms and conditions incorporated under the Special and General conditions stipulated in the Consent Order issued earlier and subject to the special conditions annexed.

This CONSENT is valid for the period ending March 31, 2023

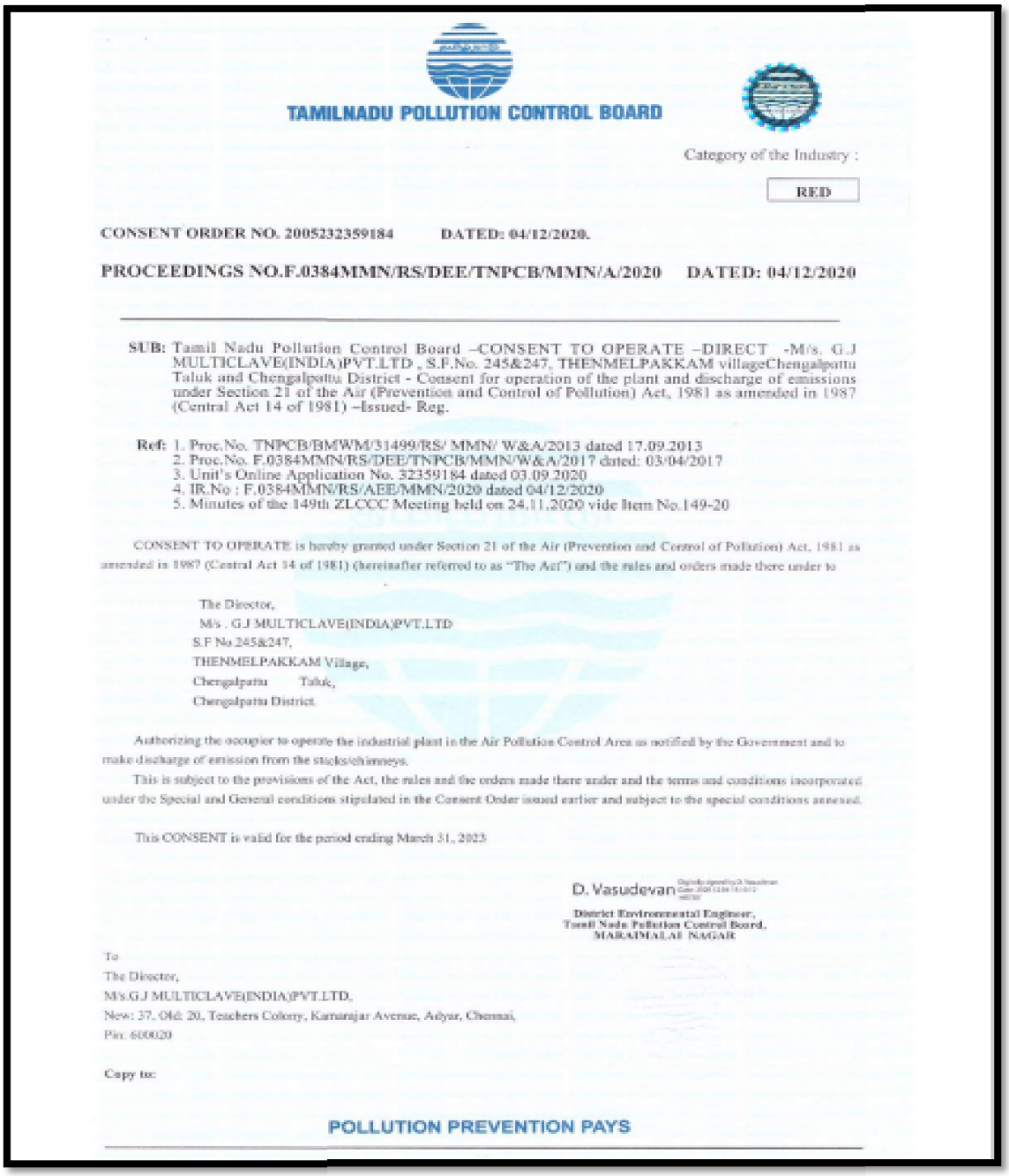
D. Vasudevan

District Environmental Engineer,
Tamil Nadu Pollution Control Board,
MARAIMALAI NAGAR

To
The Director,
M/s.G.J MULTICLAVE(INDIA)PVT.LTD,
New: 37, Old: 20, Teachers Colony, Kamarajar Avenue, Adyar, Chennai,
Pin: 600020

POLLUTION PREVENTION PAYS

1



TAMILNADU POLLUTION CONTROL BOARD

Category of the Industry :

RED

CONSENT ORDER NO. 20052323591184 DATED: 04/12/2020.

PROCEEDINGS NO.F.0384MMN/RS/DEE/TNPCB/MMN/A/2020 DATED: 04/12/2020

SUB: Tamil Nadu Pollution Control Board –CONSENT TO OPERATE –DIRECT -M/s. G.J MULTICLAVE(INDIA)PVT.LTD , S.F.No. 245&247, THENMELPAKKAM villageChengalpattu Taluk and Chengalpattu District - Consent for operation of the plant and discharge of emissions under Section 21 of the Air (Prevention and Control of Pollution) Act, 1981 as amended in 1987 (Central Act 14 of 1981) –Issued- Reg.

Ref: 1. Proc.No. TNPCB/BMWM/31499/RS/ MMN/ W&A/2013 dated 17.09.2013
2. Proc.No. F.0384MMN/RS/DEE/TNPCB/MMN/W&A/2017 dated: 03/04/2017
3. Unit's Online Application No. 32359184 dated 03.09.2020
4. IR.No : F.0384MMN/RS/AEE/MMN/2020 dated 04/12/2020
5. Minutes of the 149th ZLCCC Meeting held on 24.11.2020 vide Item No.149-20

CONSENT TO OPERATE is hereby granted under Section 21 of the Air (Prevention and Control of Pollution) Act, 1981 as amended in 1987 (Central Act 14 of 1981) (hereinafter referred to as "The Act") and the rules and orders made there under to

The Director,
M/s . G.J MULTICLAVE(INDIA)PVT.LTD
S.F No.245&247,
THENMELPAKKAM Village,
Chengalpattu Taluk,
Chengalpattu District.

Authorizing the occupier to operate the industrial plant in the Air Pollution Control Area as notified by the Government and to make discharge of emission from the stacks/chimneys.

This is subject to the provisions of the Act, the rules and the orders made there under and the terms and conditions incorporated under the Special and General conditions stipulated in the Consent Order issued earlier and subject to the special conditions annexed.

This CONSENT is valid for the period ending March 31, 2023

D. Vasudevan

District Environmental Engineer,
Tamil Nadu Pollution Control Board,
MARAIMALAI NAGAR

To
The Director,
M/s.G.J MULTICLAVE(INDIA)PVT.LTD,
New: 37, Old: 20, Teachers Colony, Kamarajar Avenue, Adyar, Chennai,
Pin: 600020

Copy to:

POLLUTION PREVENTION PAYS

Sewage Treatment Plant Test Report for Treated Sewage Sample (2020)

ECES
Eco Care Engineering Systems

TEST REPORT

Report No	: ECES/LAB/2019-20/067	Report Date	: 27.01.2020
Sample Description	: Treated Sewage sample	Received on	: 23.01.2020
Sample Collected from	:M/s.Sathyabama Institute of Science and Technology Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai - 119		
Sample Drawn by	: M/s. Eco Care Engineering Systems	Commenced on	: 23.01.2020
		Completed on	: 27.01.2020

S.No	Test Parameters	Protocol	Results	TNPCB Tolerance Limit for Sewage
1.	pH at 25° C	IS:3025 Part: 11-1983 (Reaff:2012)	7.85	5.5 - 9.0
2.	Total Suspended Solids	IS:3025 Part 17-1984 (Reaff:2012)	17 mg/l	30 mg/l
3.	Total Dissolved Solids	IS:3025 Part 16-1984 (Reaff:2012)	1012 mg/l	--
4.	BOD @ 27° C for 3 days	IS:3025 Part 44-1993 (Reaff:2014)	11 mg/l	20 mg/l
Note: BDL: Below Detection Limit, DL: Detection Limit.				

Note: This report relates only to the particular sample submitted for test. Any correction not attested shall invalidate this report. Retention period of tested sample is one month only. This report is strictly confidential. Its use for publicity, arbitration or as evidence in legal disputes is strictly forbidden.

Chemist

Eco Care Engineering Systems CHENNAI 600 016.

for Eco Care Engineering Systems

Authorized Signatory

No.10/25, Egambara Dabedhar Street, Alandur, Chennai - 600 016. Tel : 044-22311125 Telefax : 044-22311125 E-mail : ecocare.cp@gmail.com