GREEN AUDIT REPORT

ST JOSEPH'S COLLEGE OF PHARMACY

CHERTHALA

Executed by

OTTOTRACTIONS

Energy - Engineering - Environment

2024

Accredited Energy Auditor:AEA-33
Bureau of Energy Efficiency
Government of India.

Empanelled Energy Auditor:EMCEEA-0211F
EMC (Energy Management Centre-Kerala

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GREEN AUDIT REPORT

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Energy-Engineering-Environment

Green Audit Report
St. Joseph's College of Pharmacy, Cherthala
Report No: EA 1143/GA
2024

Audit Team

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About OTTOTRACTIONS

OTTOTRACTIONS, established in 2005, is a distinguished organization with a proven track record and extensive expertise in the fields of energy, engineering, and environmental services. As the first Accredited Energy Auditor from Kerala, OTTOTRACTIONS specializes in conducting Mandatory Energy Audits in Designated Consumers, in accordance with the Energy Conservation Act-2001.Acknowledging its outstanding contributions, the Government of Kerala has recognized and commended OTTOTRACTIONS. In 2009, the organization was honored with the prestigious "The Kerala State Energy Conservation Award" for its exemplary performance as an Energy Auditor. OTTOTRACTIONS takes pride in its commitment to quality, holding ISO 9001-2015, ISO 17020-2012, and ISO 14001-2015 certifications. These certifications underscore the organization's dedication to delivering high-quality services in energy, engineering, and environmental sectors.

Acknowledgment

We had the privilege of collaborating with the administration and staff of St. Joseph's College of Pharmacy, Cherthala and we express our gratitude for their invaluable assistance, which played a crucial role in the timely completion of the audit and the preparation of this report.

In heartfelt appreciation, we recognize the diligent efforts and commitments of all individuals involved in contributing to the production of this report. Their unwavering support has been instrumental in bringing this project to fruition.

Furthermore, we extend our thanks to the dedicated audit team for their unwavering support throughout the audit process. Their bona-fide efforts have significantly contributed to the successful execution of the audit.

A special acknowledgment goes to our consultants, engineers, and backup staff for their unwavering dedication, which has been pivotal in ensuring the quality and accuracy of this report. We appreciate their tireless efforts in making this collaboration a success.

Thank you.

OTTOTRACTIONS ★ ACCREDITED ENERGY AUDITOR, BEE, GoI, AEA-33 ★

B V Suresh Babu
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Preface

Throughout the annals of history, educational institutions have consistently played a pivotal role in addressing the pressing challenges of their times, guiding societal progress and shaping the intellectual landscape. In contemporary times, a global movement has taken root within these institutions, championing sustainability and aspiring to achieve recognition as carbon-neutral schools. A watershed moment in this global endeavor unfolded in 2018 when the state of Kerala in India emerged as a pioneer in establishing 15 carbon-neutral schools, employing innovative strategies that set a new standard for environmental consciousness.

Concurrently, local self-governments, exemplified by the proactive engagement of the Meenangadi Grama Panchayath, embraced the "Carbon Neutral Meenangadi" project. This initiative reflects a concerted effort to actively pursue carbon-neutral status, with Ottotractions standing as a key knowledge partner, providing invaluable insights and expertise.

Furthermore, Ottotractions has demonstrated unwavering support for the "Carbon Neutral Kattakkada" project, a transformative initiative within a legislative assembly constituency in Kerala. The project ambitiously strives to achieve net-zero status for all public establishments, aligning itself with the prestigious BEE's Shunya or Shunya Plus rating. Notably, even major entities such as Indian Railways are committed to achieving net-zero status for their non-traction buildings soon. These collective endeavors signify a broader trend in our country towards sustainability—a movement that not only deserves recognition but also serves as a model worthy of emulation.

However, it is crucial to acknowledge the challenges inherent in the pursuit of carbon neutrality. While the concept is commendable, it does not guarantee permanent carbon capture, and the implementation can incur significant costs. Despite these challenges, the movement underscores the substantial role that educational institutions can play as catalysts for positive change, influencing not only the present but also shaping the future trajectory of sustainable practices.

The transformative potential of any academic institution, regardless of its geographical location—whether nestled in a remote village or situated in an urban setting—is indeed significant. By assuming leadership roles within their communities, educational institutions can actively champion and influence the widespread adoption of carbon-neutral living practices, setting an example for others to follow.

To effectively address the major contributors to carbon emissions—Energy, Transportation, and Waste—coordinated efforts for reduction are paramount. Initiatives targeting these sectors may range from low-cost behavioral changes to high-cost technological investments. Proper education of students on the concept of carbon-neutral campuses and the methods to achieve it is essential in facilitating these transformative changes, fostering a culture of environmental responsibility.

In India, the momentum behind carbon-neutral campuses is steadily gaining traction. The implementation of Green Audits in campuses involves a comprehensive assessment of greenhouse gas emissions and carbon sequestration from relevant sources. The recommendations derived from these assessments are strategically designed to diminish the carbon footprint and guide campuses towards becoming carbon-neutral environments, exemplifying a commitment to sustainable practices that resonate on a global scale.

B Zachariah
Director
OTTOTRACTIONS

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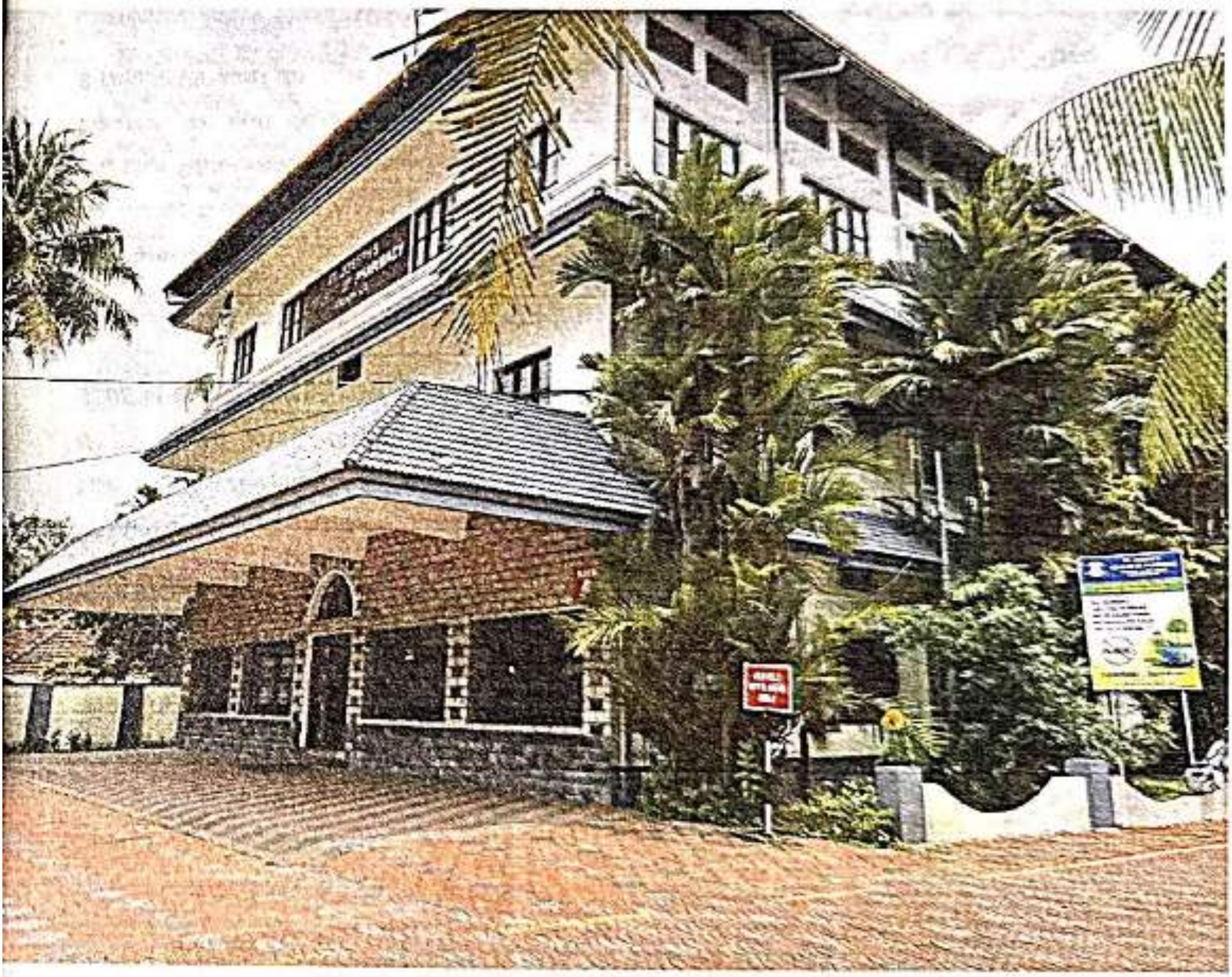
Introduction

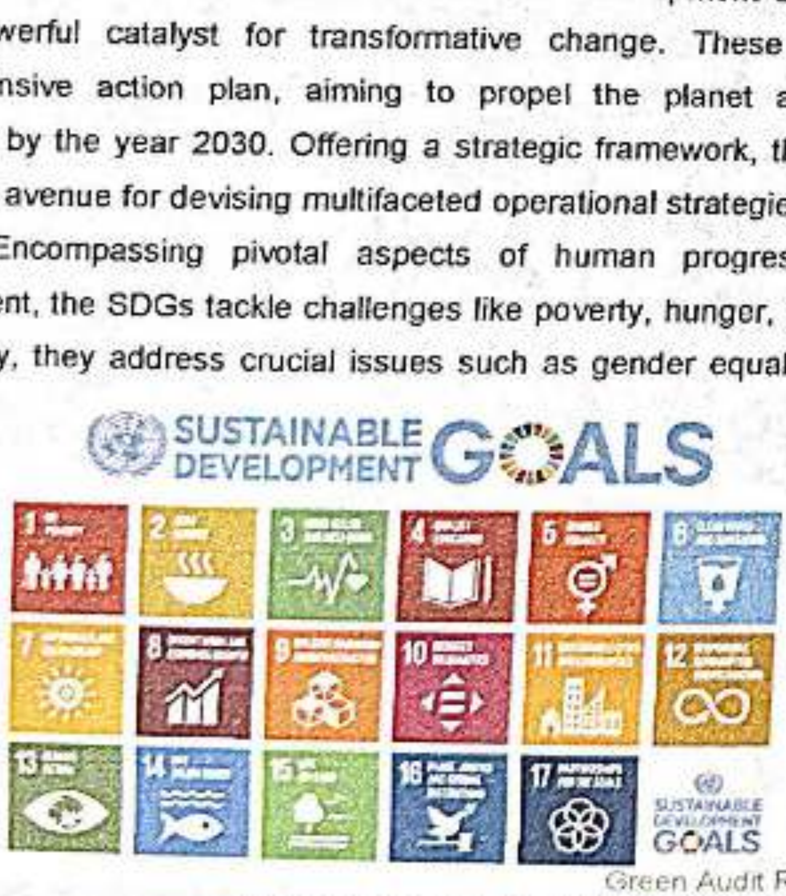


Background

In developed nations, educational institutions are actively embracing a sustainable future by transforming into carbon-neutral and environmentally conscious spaces. Recognizing their environmental impact, these institutions are taking proactive measures to mitigate and neutralize their effects. The journey toward carbon neutrality involves a multifaceted approach, including efforts to reduce greenhouse gas emissions, minimize energy consumption, adopt energy-efficient technologies, increase the utilization of renewable energy sources, implement green cover initiatives, and emphasize the significance of sustainable energy practices.

Institutions that have committed to achieving carbon neutrality are demonstrating a heightened awareness of the threat posed by global warming and are making deliberate efforts to reverse this concerning trend. However, it's noteworthy that the propagation of such initiatives has not yet taken root in many developing countries, particularly among students. The need for extensive studies and awareness campaigns in these regions is evident to foster a broader understanding and commitment to sustainable practices.

The United Nations introduced the Sustainable Development Goals (SDGs) in 2015 as a powerful catalyst for transformative change. These goals serve as a comprehensive action plan, aiming to propel the planet and society towards prosperity by the year 2030. Offering a strategic framework, the SDGs present an opportune avenue for devising multifaceted operational strategies to adapt to climate change. Encompassing pivotal aspects of human progress and sustainable development, the SDGs tackle challenges like poverty, hunger, and climate change. Additionally, they address crucial issues such as gender equality, access to clean



water and sanitation, and the promotion of responsible consumption and production.

The Green Audit conducted at St. Joseph's College of Pharmacy, is geared towards aiding the campus in minimizing its carbon footprint. The overarching goal is to educate the future leaders about effective strategies for carbon mitigation, utilizing the campus as a tangible model for sustainable practices. This comprehensive audit not only addresses carbon reduction but also evaluates the institute's responses to Sustainable Development Goals (SDGs), specifically targeting SDG 3, 6, 7, 9, 11, 13, and 15.

Furthermore, the Green Audit serves as an educational tool for both students and teachers. It aims to familiarize them with the concept of carbon footprint and empowers students to gather relevant data on carbon emissions and sequestration within their campus. The ultimate objective is to equip students with the skills needed to calculate the specific carbon footprint of the campus, fostering a deeper understanding of environmental impact and sustainability. The project also suggests plans to make the campus carbon neutral or even carbon negative by implementing carbon mitigation strategies in areas such as,

a. Energy
b. Transportation
c. Waste minimisation
d. Carbon Sequestration etc.

The primary goals of the audit include:

- Raising awareness among students and teachers about the concept of carbon footprint and sustainability.
- Estimate the specific carbon footprint of the campus and categorizing it as either carbon negative, neutral, or positive.
- Developing carbon mitigation plans informed by the generated data to systematically reduce the campus's carbon footprint.

ST. JOSEPH'S COLLEGE OF PHARMACY

St. Joseph's College of Pharmacy, started in 2004, is one of the pioneers in the field of Pharmacy education in Kerala. The College Campus (Dharmagiri) spreads over five acres of land amidst the panoramic beauty of the back waters at Cherthala, in close proximity to Kumarakom, the renowned National Aquatic Bird Sanctuary and global tourist spot. The College is a unit of Nirmala Province of the Medical Sisters of St. Joseph (MSJ Dharmagiri), Aluva, Kerala, India. The Medical Sisters of St. Joseph is a Christian congregation dedicated to St. Joseph, started in 1944 by the Servant of God, Rev. Msgr. Joseph. C. Panjikaran.

Presently, the College offers B.Pharm , M.Pharm in three specializations (Pharmaceutics, Pharmaceutical Chemistry , Pharmacology) and Doctor of Pharmacy (Pharm. D - Six Years). St. Joseph's College of Pharmacy is approved by the Govt. of Kerala, Pharmacy Council of India, and affiliated with Kerala University of Health Sciences. It is accredited with KUHS-Quality Assurance System (QAS) and is pursuing additional accreditations. The College is an approved research (Ph.D) centre by the Kerala University of Health Sciences. Since its inception, the College has achieved numerous accomplishments, with many University ranks in B.Pharm, M.Pharm and Pharm.D programs. The College and its management aim to impart modern, quality education to the students and their overall development.

Occupancy Details	
Particulars	2023-24
Total Students	413
Staffs	63
Total Occupancy of the college	476

To determine per capita carbon emissions, the calculation exclusively considers the student population. The campus actively engages in routine green audits to meticulously track the impact of its practices on sustainability. This proactive approach aims to instil a sense of responsibility among students, fostering a community of future champions committed to sustainable living practices.

The overarching ethos is one of reciprocal care, emphasizing that by nurturing nature, nature reciprocates.

The institution is dedicated to implementing the recommendations derived from the green audit reports, striving to adopt sustainable practices that align with environmental best practices. Additionally, the campus encourages innovative in-house activities, serving as a model that can be replicated by peer groups. These initiatives reflect a commitment to continuous improvement and the dissemination of sustainable practices within and beyond the campus community.

It is noteworthy that all the images of flowers and plants featured in this report are the result of collective efforts by students and faculty who actively planted and preserved them. This hands-on involvement underscores the campus's commitment to not only theoretical sustainability but also the tangible cultivation of a greener and more eco-conscious environment, symbolizing a harmonious coexistence between the institution and nature.

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Form-A							
BASELINE DATA SHEET FOR GREEN AUDIT							
1	Name of the Organization	St. Joseph's College of Pharmacy					
2	Address (include telephone, fax & e-mail)	Dharmagiri College Campus Naipunnya Road, Cherthala Alappuzha, Kerala, India Pin - 688 524					
2	Year of Establishment	1944					
3	Name of building and Total No. of Electrical Connections/building	St. Joseph's College of Pharmacy (7)					
4	Total Number of Students	Boys	-	Girls	-	Total	413
5	Total Number of Staff	63					
6	Total Occupancy	476					
7	Total area of green cover	60%					
8	Type of Electrical Connection	HT	0	LT	7		
9	Total Connected Load (kW)	85					
11	Total built up area of the building (M^2)	7964					
12	Number of Buildings	7					
13	Average system Power Factor	0.98					
14	Details of capacitors connected	-					
15	Transformer Details (Nos., kVA, Voltage ratio)	TR 1	TR 2				
		-	-				
16	DG Set Details (kVA)	DG1	DG2	DG3	DG4	DG5	Remarks
		62.5	-				
17	Details of motors	Rating		Nos.		Remarks	
		5 to 10		2			
18	Brief write-up about the firm and the energy/environmental conservation activities already undertaken.	Installed Solar power plant, Bhoomithrasena club, Energy conservation projects, Rain water harvesting, Installed biogas plants					
19	Contact Person, Telephone number & Email	Dr.Sr.Daisy.P.A					
		(+91) 478-2182138					
		principal@sjpharmacycollege.org					

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METHODOLOGY

2.1. Sensitisation

The effectiveness of Low Carbon campus initiatives hinges on the collective engagement of every member within the campus community, encompassing students, teachers, and staff alike. To facilitate this inclusive approach, a dedicated team consisting of students, teachers, and staff was formed to actively participate in the audit process. Recognizing the importance of awareness and understanding, a comprehensive sensitization program was conducted among both students and teachers to familiarize them with the concept of carbon footprint.

This collaborative effort underscores the commitment to a holistic involvement in sustainable practices, where each stakeholder within the campus plays a pivotal role. By fostering awareness and education on carbon footprint, the campus community is not only informed but also empowered to contribute meaningfully to the collective goal of reducing carbon impact. The formation of a dedicated team signifies a shared responsibility, ensuring that the Low Carbon initiatives are not only successful but also ingrained in the collective consciousness of the entire campus.

As part of the audit process, a concerted effort was made to sensitize both students and staff members about the project, equipping them with the necessary training to actively contribute to the data collection team. This strategic approach aimed to conduct the survey in a participatory mode, ensuring that awareness permeates to the grassroots level within the campus community.

During the field visits for data collection, a key emphasis was placed on the team's role in disseminating these ideas to their homes and friends. This intentional outreach strategy was designed to facilitate a horizontal and vertical spread of the message, reaching a broader audience. It is anticipated that the approximately 476 occupants of these campuses will, in turn, extend the message to an equivalent number of households, resulting in the potential dissemination of this important message to around 1904 individuals.

This approach not only enhances the reach of the project but also transforms it into a community-wide endeavour, emphasizing the importance of individual participants acting as ambassadors for sustainable practices in both their immediate and extended social circles.

2.2 Estimation of carbon footprint

A carbon footprint serves as a quantifiable metric, measuring the volume of greenhouse gases—predominantly carbon dioxide—emitted into the atmosphere due to a specific human activity. This metric can encompass a broad range, from individual actions to the collective impact of families, events, organizations, or entire nations. Typically expressed as tons of CO_2 released annually, this figure can also be complemented by tons of CO_2-equivalent gases. These equivalents include methane, nitrous oxide, and other greenhouse gases that contribute to the overall impact on climate change.

The concept of Global Warming Potential (GWP) further refines our understanding of the environmental impact of different gases. GWP is a quantitative measure of how much heat a particular greenhouse gas traps in the atmosphere within a defined time horizon, relative to the heat-trapping capacity of carbon dioxide. This metric was developed to facilitate comparisons of the global warming impacts associated with various gases.

More specifically, GWP represents the amount of energy that the emissions from one ton of a particular gas will absorb over a specified timeframe, relative to the emissions from one ton of carbon dioxide (CO_2). By utilizing GWP, we can better grasp the relative contributions of different gases to the greenhouse effect, allowing for a more comprehensive assessment of their environmental consequences. In essence, GWP serves as a crucial tool for understanding the nuanced and varied impacts of diverse greenhouse gases on global warming.

Global Warming Potentials (IPCC Second Assessment Report)					
Species	Chemical formula	Lifetime (years)	Global Warming		
			20 years	100 years	500 years
Carbon dioxide	CO2	variable §	1	1	1
Methane *	CH4	12±3	56	21	6.5
Nitrous oxide	N2O	120	280	310	170
HFC-23	CHF3	264	9100	11700	9800
HFC-32	CH2F2	5.6	2100	650	200
HFC-41	CH3F	3.7	490	150	45
HFC-43-10mee	C5H2F10	17.1	3000	1300	400
HFC-125	C2HF5	32.6	4600	2800	920
HFC-134	C2H2F4	10.6	2900	1000	310
HFC-134a	CH2FCF3	14.6	3400	1300	420
HFC-152a	C2H4F2	1.5	460	140	42
HFC-143	C2H3F3	3.8	1000	300	94
HFC-143a	C2H3F3	48.3	5000	3800	1400
HFC-227ea	C3HF7	36.5	4300	2900	950
HFC-236fa	C3H2F6	209	5100	6300	4700
HFC-245ca	C3H3F5	6.6	1800	560	170
Sulphur hexafluoride	SF6	3200	16300	23900	34900
Perfluoromethane	CF4	50000	4400	6500	10000
Perfluoroethane	C2F6	10000	6200	9200	14000
Perfluoropropane	C3F8	2600	4800	7000	10100
Perfluorobutane	C4F10	2600	4800	7000	10100
Perfluorocyclobutane	c-C4F8	3200	6000	8700	12700
Perfluoropentane	C5F12	4100	5100	7500	11000
Perfluorohexane	C6F14	3200	5000	7400	10700

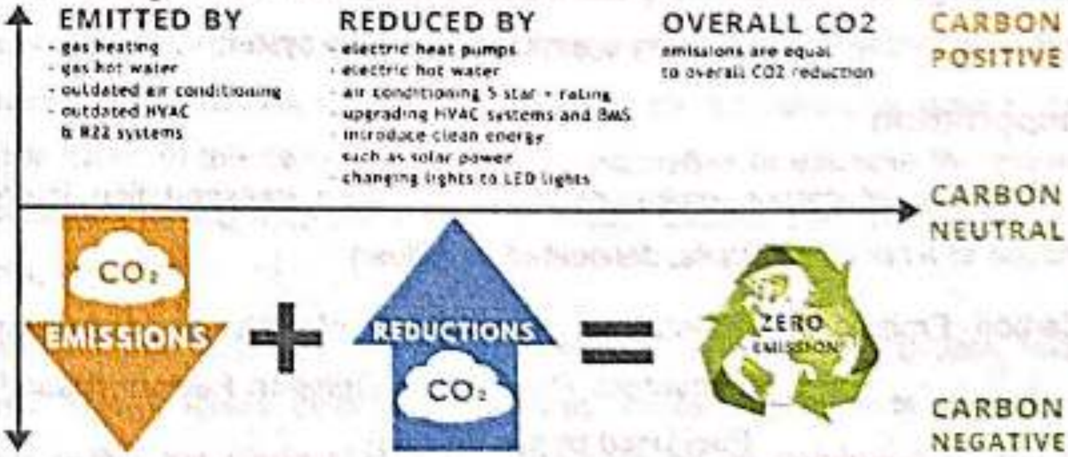
The approach to calculating carbon footprints is continually evolving, emerging as a pivotal tool for greenhouse gas management. In the current study, we are actively engaged in estimating carbon emission data from the campus, categorizing it into four distinct and crucial dimensions. This methodology not only allows us to quantify our environmental impact but also contributes to the broader understanding of greenhouse gas management, paving the way for more effective and targeted sustainability strategies.

By adopting a comprehensive approach to categorizing carbon emissions, we aim to delve deeper into the intricacies of our campus's environmental footprint. This evolving methodology is reflective of our commitment to staying at the forefront of sustainable practices, contributing to the ongoing discourse on effective greenhouse gas management within academic institutions. As we refine our understanding and measurement of carbon footprints, we position ourselves to make informed decisions that align with our environmental stewardship goals.

1. Energy
2. Transportation
3. Waste minimisation
4. Carbon Sequestration

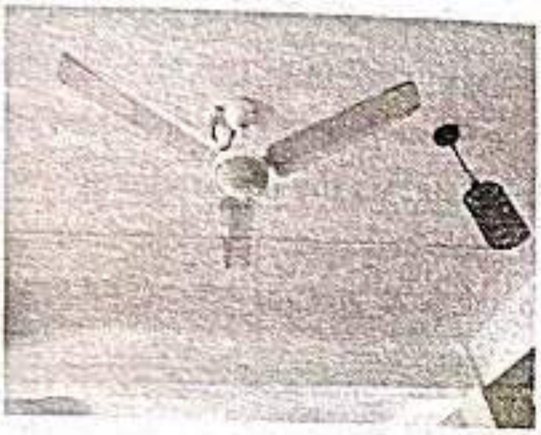
Carbon neutrality entails attaining a state of equilibrium in greenhouse gas (GHG) emissions by offsetting the amount of carbon released into the atmosphere through human activities with an equivalent amount sequestered in carbon sinks. This holistic approach is imperative for curbing the rise in atmospheric concentrations of GHGs stemming from diverse socio-economic, developmental, and lifestyle activities. The goal is to employ biological or natural processes to counteract the emissions, aligning with sustainable practices.

Recognizing the complexity of addressing climate change, carbon neutrality goes beyond the simplistic solutions of solely transitioning to renewable energy or offsetting GHG emissions. Instead, it serves as a catalyst for fostering innovation in new developmental activities. This approach aims to provide a viable and effective means of addressing the multifaceted challenges posed by climate change. By encouraging innovative thinking and sustainable practices, carbon neutrality serves as a strategic and comprehensive response to the environmental issues associated with human activities.



Energy

On the campus, carbon emissions resulting from energy consumption are classified into two distinct categories: namely, energy derived from Electrical sources and Thermal sources. The evaluation of energy utilized for transportation purposes falls within the purview of the transportation sector. This systematic categorization enables a more detailed understanding and assessment of the campus's carbon footprint, providing valuable insights for sustainable energy management and environmental conservation efforts.



A detailed energy audit is conducted to understand the energy consumption of the campus. Information on total connected loads, their duration of usage and documents like electricity bills are evaluated. Connected loads are calculated by conducting a survey on electrical equipment on each location. Duration of usage was found out by surveying the users. The survey of equipment was conducted in a participatory mode.

The fuel consumption for cooking, like LPG, was studied by analysing the annual fuel bills and usage schedules during the study. Discussions were carried out with the concerned individuals who actually operate the cooking system.

Transportation

The calculation of carbon emissions stemming from transportation involves the application of a specific formula, delineated as follows:

Carbon Emission = Number of Each Type of Vehicles × Average Fuel Consumed Per Year × Emission Factors (Based on the Fuel Used by the Vehicle)

This formula encapsulates a multifaceted approach to assess the environmental impact of transportation. The "Number of Each Type of Vehicles" accounts for the diversity in the vehicle fleet, acknowledging variations in emission profiles across different types. The "Average Fuel Consumed Per Year" parameter reflects the aggregate fuel consumption, providing a comprehensive view of the overall energy usage within the transportation sector. The "Emission Factors," tailored to the specific fuel utilized by each vehicle, introduce a nuanced dimension to the calculation by considering the varying environmental impact associated with different fuel types.

This methodological framework enables a thorough and precise evaluation of carbon emissions, facilitating a data-driven understanding of the environmental footprint attributed to transportation activities. It serves as a valuable tool for sustainability initiatives, allowing for targeted interventions and informed decision-making to mitigate the ecological impact of transportation.

Waste Minimisation

The waste produced within the campus plays a significant role in contributing to greenhouse gas emissions. Consequently, to comprehensively gauge the total carbon footprint of the campus, it becomes imperative to estimate the greenhouse gas emissions arising from the waste generated through the activities of students, teachers, and staff.

To ascertain the volume of waste generated, a systematic approach has been adopted. This involves strategically placing measuring buckets across various locations within the campus to collect the daily waste generated by the diverse community of students, teachers, and staff. Subsequently, the collected waste is meticulously weighed to quantify its mass accurately.

This meticulous measurement and weighing process provides a quantitative foundation for assessing the environmental impact associated with the waste generated on campus. By accounting for the diverse sources and activities that contribute to this waste stream, the calculation of greenhouse gas emissions becomes more nuanced and reflective of the campus's overall sustainability performance. This data-driven approach is pivotal in formulating targeted strategies for waste reduction, recycling initiatives, and ultimately mitigating the ecological impact of campus activities.

Carbon Footprint Estimation

The process by which trees remove carbon from the atmosphere is called carbon sequestration. The amount or weight of carbon accumulated by a tree is called carbon storage (Nowak et al., 2012). Carbon Sequestration is closely related to the greenhouse emission reduction order imposed by Kyoto Protocol established in 2004. There are two basic methods of carbon sequestration viz. direct and indirect. The direct method is implemented by immediately binding carbon components at the sources of its formation- before it enters the atmosphere in specially designated Landfills. The indirect method of sequestration involves using plants that bind carbon dioxide in photosynthesis. During the present study, only carbon sequestration by plants was estimated. Hence, it does not, therefore, account for carbon in dead wood- whether standing or fallen. Similarly, the minimum diameter of a measurable tree was 7cm and the smallest stem was defined as either a sapling or seedlings.

Similarly, carbon sequestered by grasses was not taken into account while measuring the carbon sequestration potential of plants.

Seedlings:	A living stem less than 15cm tall
Saplings:	A living stem greater than 15cm tall and with a diameter at bust height (DBH approximately -1.3m above the ground level), less than 7cm
Tree:	A living stem greater than 7cm at D BH

Study Area

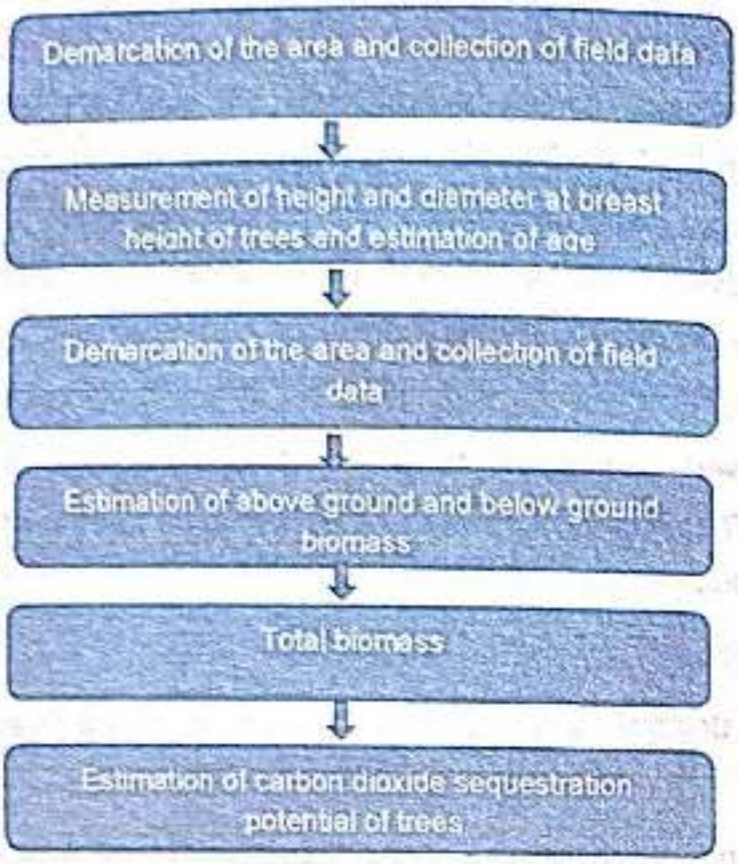
The present work was carried out at the St. Joseph's College of Pharmacy, Alappuzha District. The campus is spread over with different trees in and around it. The survey was conducted during May 2024

Determining the carbon content of trees

As the first step in determining the total carbon content of the trees the entire campus

The biomass of plants comprises all woody stems, branches, leaves and root systems. Biomass of trees can be calculated in two ways-destructive sampling and non-destructive sampling. In the present study, the non-destructive technique suggested by Jenkins et al (2011) of the Forest Research Agency of the Forest Commission was used to calculate the carbon content of trees. This involved the following steps: -

Fig 1 Carbon dioxide potential of trees



Estimating trunk biomass

To calculate the volume of the tree trunk the circumference of the tree trunk at chest height (approximately 1.3m from ground level) was measured using a measuring tape

Estimating the height of trees

The height of the tree was calculated by "the STICK method. For this, a stick and a measuring tape were used. The length of the stick was of the same length as the person's arm. The stick was held pointing straight up, at 90 degrees to the outstretched, straight arm. Carefully walk backwards until the top of the tree lines up with the top of the stick and that point is marked. The distance between the marked point and the tree is roughly equivalent to the height of the tree (Fig). From these values volume of the tree trunk was calculated using the formula

$V=\pi r^2 h$

where:

V is the volume,

π is a mathematical constant (approximately 3.14159),

r is the radius of the tree at chest height

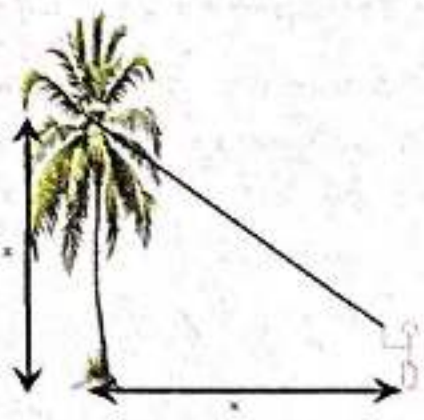
h is the height of the tree

Biomass = Volume X Nominal Specific Gravity

For estimating the Nominal Specific Gravity of a tree trunk the constant suggested by Jenkin et al (2011) was used.

- For broad-leaved trees Nominal Specific Gravity = 0.53
- For conifers Nominal Specific Gravity = 0.39

Stick method of measuring the tree



Estimating root biomass

Tree's root systems produce large quantities of biomass underground. Quantification of root biomass is difficult. Hence, in the present study factor of 0.3 of the above-ground

biomasses was used to estimate below-ground biomass as suggested by Shadman et al (2022).

Estimation of carbon content based on the biomass of the whole tree

Biomass of the whole tree was calculated using the formula:

- Biomass of the whole tree= Trunk Biomass + Root Biomass

On average a tree consists of 72.5% dry matter and 27.5% moisture content. To calculate the total dry weight the total biomass was multiplied by 72.5. Since carbon occupies nearly 50% of total dry weight the total carbon content of the tree was calculated multiplying total dry weight by 0.5.

After estimating the total carbon content of the tree the carbon dioxide equivalent sequestration of the tree was calculated as given below;

The atomic weight of carbon = 12

The atomic weight of oxygen = 16

The weight of carbon dioxide in a tree = 44 (16 X2 + 12) /12 =3.67

Thus, one tonne of carbon stored in the tree represents the removal of 44/12 or 3.67 tonnes of Carbon from the atmosphere and the release of 2.67 tonnes of oxygen back into the atmosphere.

The weight of carbon dioxide Sequestered in a tree = Total carbon X 3.67

The above value represents the total carbon dioxide sequestered by a tree during the entire life span of the tree. To ascertain the annual or yearly rate of carbon dioxide sequestered the value was divided by the age of the tree.

3 RESULTS AND DISCUSSIONS

College campuses are test beds for environmental change. The initiatives that are emerging at the college are models for the larger society. Since many of the students of the college are joining hands with the administrators to streamline operations of the college the campus becomes part of the solution for solving the problem of global warming. To this end, the college started a comprehensive plan to make the campus carbon neutral. Carbon neutral means contributing no net greenhouse gases to the atmosphere either by not generating them or by offsetting them through the process of greening the campus. All the activities including energy consumption and waste management have their equivalent carbon emission and they positively contribute to the carbon footprint of the campus. Even though there are many natural sequestration processes involved in the campus the major one continues to be the one where carbon di oxide is sequestered by the plants in the campus.

Distribution of Trees in the Campus

St. Joseph's College of Pharmacy covers an area of 5 ha. Even though all plants with chlorophyll contribute to sequestration of carbon, in the present study only trees having a diameter of more than 7 cm at chest height (1.3 m above ground level) were included in carbon sequestration calculations.

The most dominant species on the campus are *Mangifera indicana, swetiena mahagoni* and *cocos nucifera*. This species are commonly seen in this area as it can survive drought conditions, requires very little maintenance and can thrive in a range of soil types. The exact age of the tree is not known to the staff of the college. This tree has the maximum diameter at breast height. The exact age of most the trees is not known as those trees were on the campus even before the land was acquired for starting the college. Hence, approximate age of the tree was taken based on the size, shape and discussion with local people.

Carbon sequestration Potential

Carbon stored in a tree is directly proportional to its biomass, increasing its diameter, height, and canopy spread (McPherson 1998). The amount of carbon sequestration depends on the growth characteristics of the tree species, the condition for growth where the tree is planted and the density of the tree's wood (Jana et al., 2010). The total carbon sequestered by all the trees in a year is 2.43 ton.

Oxygen released by the trees on the campus

In general, one kg of carbon stored in the tree represents the removal of 44/12 or 3.67 Kg of Carbon from the atmosphere and the release of 2.67 Kg of oxygen back into the atmosphere. The total carbon stored by trees on the campus is 2.43. Hence, the quantity of oxygen released by the trees of St. Joseph's College of Pharmacy Campus is 6.48 kg per year.

Constraints

- Carbon sequestration value computation involves a lot of variables like the girth of the plant, per year increment, soil type, vegetation type, damage to the plant due to human interference
- The amount of carbon dioxide sequestered by shrubs, small trees and grasses have not been taken into account during the study.
- The indirect method of carbon sequestration in the campus was not taken into account while estimating the carbon sequestration ability of the campus.
- Carbon sequestration rates fluctuate seasonally and annually. Assessments should account for these variations over time. This was not considered in the present study
- Since the actual age of the trees is not known an approximation is done while calculating the carbon dioxide sequestered annually.
- Much of the vegetation in the college is still young and needs to be given more time to mature further and have more potential for carbon stock storage in its terrestrial carbon pools.
- Trees near buildings, roads, or utilities have restricted root space, affecting their growth and carbon sequestration.

Recommendations and suggestions

- As this is the first time the carbon footprint of the campus is estimated, whether the college has shown development over the previous years or not cannot be estimated.
- A tree register of the campus is to be maintained of all the trees with diameter more than 7 cm. They are to be properly numbered so that it will be possible to study the growth pattern of the trees during subsequent years and to calculate their carbon sequestration ability.

To ensure the improvement is further achieved, the major focus areas may include:

- Optimize resource usage through enhanced efficiency in processes and controls
- Avoid wastage through the use of technology and human-controlled processes
- Work towards water neutral campus
- Transition/expansion of clean energy sources with the aim of achieving 100% green power
- Undertake "Zero Cost" Improvement projects with the participation of Students, Faculty & Non-teaching staff
- Usage of new & energy-efficient technologies to reduce energy consumption
- Increase green cover by planting of trees with high carbon sequestration index
- Engage stake holders within the campus and from nearby society through increased
- participation in structured events like Earth-day, Environment-day, Safety weeks, etc.
- Ensure effective management of Integrated Management System
- Adopt, deploy and achieve certification to water efficiency management system ISO
- Ensure energy optimization and conduct of regular energy audit
- Encourage and promote paperless documentation for official communication and
- academic activities like online submission of assignments / providing notes
- Sub-metering to identify high consumption areas of electricity to be able to drive
- specific optimization initiatives

- Review the possible impact of key events towards GHG emissions (example: Increased

Carbon Footprint Estimation

In accordance with the carbon footprint estimation methodology outlined in the preceding chapter, this section provides a comprehensive breakdown of the carbon emissions associated with this campus, specifically attributed to energy consumption, transportation, and waste generation.

3.1. Energy Consumption

Base Line Energy Data		
St. Joseph's College of Pharmacy		
		2023-24
1	Electricity KSEB (kWh)	33499
2	Electricity DG (kWh)	672
3	Electricity Solar, Off grid (kWh)	108588
4	Electricity (KSEB + DG + Off grid) kWh	142759
5	Electricity Solar Grid Tied (kWh)	70263
6	Diesel (L)	7914.0
7	LPG (kg)	532.00
8	Biogas generated/year (kg)	1320

The campus relies on both electricity and thermal energy to facilitate its day-to-day operations. Electricity is sourced from four distinct sources: the Kerala State Electricity Board (KSEBL), Solar Photovoltaic (SPV) system, and one Diesel Generators (DGs). The campus utilizes DGs in instances of grid failure to ensure a continuous power supply. Notably, the SPV system is grid-tied, meaning that in the event of a grid failure, its electricity generation ceases.

The 140 kWp SPV system generates surplus power that surpasses the campus's current electricity requirements. Consequently, the excess energy is exported into the grid (KSEB), leading to a reduction in payment on the next electricity bill for the campus. Therefore, the total electricity consumption comprises the sum of the billed electricity, the variance between total solar generation and solar export, and the electricity generated through DG sets. This dynamic system ensures a balanced and efficient approach to meeting the campus's energy needs while incorporating renewable sources and minimizing reliance on grid power during normal operation.

The campus has distinct thermal energy requirements, particularly in the areas of transportation. This requirement is met through Diesel.

Transportation demands are primarily addressed through the utilization of Diesel, specifically in the buses that serve the campus. This choice aligns with the efficiency and energy density characteristics of Diesel fuel, making it suitable for meeting the vehicular thermal energy needs.

Energy Consumption Profile		
Sl No	Fuel	2023-24
1	Electricity	122772310
2	Diesel	83097000
3	LPG	6384000
4	Biogas	4620000
	Total	216873310

In summary, the campus strategically sources thermal energy Diesel tailoring each energy type to meet the needs of transportation. This diversified approach reflects a thoughtful consideration of efficiency, cleanliness, and sustainability in addressing the campus's thermal energy requirements across various operational domains.

3.1.1. Electricity

Electricity is purchased from KSEB under Seven LT Connections, the details are given below.

Electricity Connection Details		
St. Joseph's College of Pharmacy		
1	Name of the Consumer	St. Joseph's College of Pharmacy
2	Tariff	LT 6B Ndom
3	Consumer Numbers	1155127001836 1155127020395 1155127024177 1155121023494 1155127001759 1155120024402 1155126023569
4	Contract Demand (kVA)	85
5	Annual Electricity Consumption (kWh)	33499

3.1.2. Diesel Generators

The campus is equipped with diesel generators, boasting capacities of 62.5kVA respectively. This generator is strategically connected to both the Main Building and other buildings, ready to activate seamlessly in the event of a power failure in the grid.

Electricity Generated through DGs			
Year	Generator in L	kWh /yr	cost in Rs
2023-24	224	672.0	21728

3.2. Thermal Energy

The campus meets its thermal energy needs for buses by using diesel. Additionally, biogas and LPG are utilized for cooking purposes. Further details about each fuel source are provided below.

Thermal Fuel Consumption	
St. Joseph's College of Pharmacy	
	2023-24
Annual LPG consumption in kg	532.00
Annual Diesel consumption in L	7914.0
Annual petrol consumption in L	0
Annual Biogas consumption in kg	1320.00

3.3. Energy Performance Index

The Energy Performance Index (EPI) serves as a key metric to gauge the energy efficiency of the campus. This index provides a quantitative measure that indicates how effectively and efficiently energy is utilized within the campus. Essentially, a lower EPI value signifies a more energy-efficient process, while a higher value suggests a less efficient utilization of energy resources.

To calculate the EPI, various factors related to energy consumption and total built-up area in m^2 is taken in to account. This includes assessing the energy inputs required to run the campus in one year. The goal is to minimize energy waste and optimize the overall efficiency of the process.

The EPI not only helps in identifying areas for improvement but also supports the development and implementation of strategies to enhance overall energy efficiency. In essence, the Energy Performance Index plays a crucial role in promoting sustainable and responsible energy management practices across various sectors.

OTTOTRACTIONS- ENERGY AUDIT		
St. Joseph's College of Pharmacy		
Energy Performance Index (EPI)		
Sl No	Particulars	2023-24
1	Total building area (m^2)	7964
2	Annual Energy Consumption (kCal)	216873310
3	Annual Energy Consumption (kWh)	252178
4	Total Energy in Toe	21.69
5	Specific Energy Consumption kWh/m^2	31.66

3.4. Waste Management

Waste management is a significant focus for the campus, with particular attention directed towards the solid waste generated within its premises. The solid waste stream on the campus predominantly consists of three main categories: food waste, paper waste, and plastic waste.

Food waste is a substantial component of the solid waste generated, originating from two primary sources. Firstly, within the campus kitchen, vegetable waste is generated during food preparation. This includes peels, trimmings, and other organic remnants produced during the cooking process. Secondly, after meals, both students and staff contribute to the generation of food waste. This can include leftover food, plate scrapings, and other consumable remnants.

Biogas Plant

Degradable Waste Generation	
St. Joseph's College of Pharmacy	
Particulars	2023-24
Total Occupancy	476
Waste generated in kg /day	9.52
Waste generated in kg /Yr	2094.4

Efficient management of food waste is crucial not only for environmental reasons but also for sustainability and hygiene. Implementation of strategies to minimize waste at its source, such as better portion control and meal planning, can significantly reduce the overall volume of food waste generated. Furthermore, composting can be explored as a sustainable solution for managing organic waste, converting it into valuable compost that can be used for campus landscaping or agricultural activities.

Solid non degradable Waste Generation	
St. Joseph's College of Pharmacy	
Particulars	2023-24
Total Occupancy	476
Waste paper generated in kg /day	0.0952
Waste plastic generated in kg /day	0.1428
Waste paper generated in kg /Yr	20.94
Waste plastic generated in kg /Yr	31.42

In addition to food waste, the campus grapples with paper waste and plastic waste. Paper waste may encompass used notebooks, printed materials, and packaging, while plastic waste includes items like bottles, containers, and packaging materials. A comprehensive waste management plan should address the proper disposal and recycling of these materials, promoting a circular economy where recyclable items are reprocessed and reintroduced into the production cycle.

By focusing on these specific waste streams, the campus can tailor its waste management strategies to effectively reduce, reuse, and recycle materials, contributing to a more sustainable and environmentally friendly campus environment. Education and awareness campaigns can also play a pivotal role in encouraging responsible waste disposal practices among the campus community, fostering a culture of environmental stewardship.

3.5. Carbon Emission Profile (2023-24)

The calculation of carbon emissions resulting from everyday activities on the campus is outlined and detailed below. The units and emission factors considered for the estimation are provided.

Emission Factors		
Item	Factor	Unit
Electricity	0.00082	tCo2e/kWh
Diesel	0.0032	tCo2e/kg
LPG	0.0015	tCo2e/kg
Biogas	0.0014	tCo2e/m³
Petrol	0.0031	tCo2e/kg
Food Waste	0.00063	tCo2e/kg
Paper Waste	0.00056	tCo2e/kg

Carbon Foot Print 2023-24

Carbon Foot Print			
Sl. No.	Particulars	2023-24	tCO2e
1	Electricity (kWh)	142759	117.06
2	Diesel (L)	7914	25.32
3	LPG (kg)	532	0.80
4	Biogas (kg)	1320.00	1.848
5	Degradable Waste in kg/yr.	2094.4	1.32
6	Paper Waste in kg/yr	20.94	0.01
Total Carbon Foot Print tCO2e/yr			146.36

3.5. Carbon Sequestration

All the activities including energy consumption and waste management have their equivalent carbon emission and they positively contribute to the carbon footprint of the campus. Carbon sequestration is the reverse process, at which the emitted carbon dioxide will get sequestrated according to the type of carbon sequestration employed. Even though there are many natural sequestration processes are involved in a campus, the major type of sequestration among them is the carbon sequestration by trees.

Carbon Sequestration	
Particulars	2023-24
Total No of Trees	354
Carbon sequestrated by trees in the campus (tCO2e)	**2.43**

Trees sequestrate carbon dioxide through the biochemical process of photosynthesis and it is stored as carbon in their trunk, branches, leaves and roots. The amount of carbon sequestrated by a tree can be calculated by different methods. In this study, the volumetric approach was taken into account, thus the details including CBH (Circumference at Breast Height), height, average age, and total number of the trees, are required. Details of the trees in the campus compound are given in the Table. Detailed table is included in the technical supplement.

Carbon sequestrated by a tree can be found out by using different methods. Since this study is employed the volumetric approach, the calculation consists of five processes.

- Determining the total weight of the tree
- Determining the dry weight of the tree
- Determining the weight of carbon in the tree
- Determining the weight of CO_2 sequestrated in the tree
- Determining the weight of CO_2 sequestrated in the tree per year

Carbon Balancing (2023-24)

Various carbon emitting activities such as consumption of energy, transportation and waste generation leads to the total emission of **146.36 tCO_2e** per year by the campus.

The total carbon sequestration by trees in the campus compound is **2.43tCO_2e**. Thus, the current carbon footprint of the campus will be the difference of total carbon emission and total carbon sequestration/mitigation.

Specific CO2 Footprint

Amount of Carbon to be mitigated for Low Carbon Campus		
Sl No	Particulars	2023-24
1	Total carbon emission tCO2e	146.36
2	Total carbon sequestration tCO2e	2.43
3	Amount of carbon mitigated through renewable energy tCO2e	148.51
4	To be mitigated tCO2e	-4.57
5	Total No of Students	413
6	Specific Carbon Footprint kg CO2e/Student/Yr	-11.06

The total specific carbon footprint is estimated as **-11.06** kg of CO_2e per student for the year 2023-24.

4

Carbon Mitigation Plans

In the academic year 2023-2024, the per-student carbon dioxide emission for the campus was measured at **146.36** kg CO_{2e} per year. In response to this carbon footprint, strategic emission reduction plans have been formulated with the ambitious goal of achieving a carbon-neutral or even carbon-negative status for the campus.

To reach this environmental milestone, a thoughtful approach has been adopted, ensuring that each proposed plan aligns with the primary purpose of the corresponding activity. The emphasis is not just on emission reduction but on holistic sustainability that maintains the functionality and purpose of each campus activity.

The main avenues identified for reducing the campus carbon footprint are as follows:

Resource Optimization: This involves maximizing the efficiency of resource use, minimizing waste, and ensuring that every resource is utilized judiciously to minimize environmental impact.

Energy Efficiency: Enhancing energy efficiency across campus operations is a key strategy. This includes measures to optimize energy consumption, upgrade infrastructure for better energy performance, and implement technologies that reduce overall energy demand.

Renewable Energy: Embracing renewable energy sources is a pivotal aspect of the reduction plans. Transitioning towards renewable energy, such as solar or wind power, contributes significantly to decarbonizing the campus energy supply.

Waste Minimization: Optimal utilisation of paper and plastic stationaries can reduce the frequency of purchase of items. This can reduce the unnecessary wastage of money as well as the excess production of waste. In the case of food, proper food habits and housekeeping practices can optimise its usage.

Fuels for Cooking: The campus commercial LPG cylinders for its cooking purpose. The campus can install a biogas plant to treat food waste and the biogas thus generated can be used in kitchen. Installation of a solar water heater to rise the water temperature to a much higher level, then it has to consume only very less amount of thermal energy for preparing the same amount of food is another method. This can make a positive benefit to the campus by saving money, energy and can reduce the carbon emission of the campus due to thermal energy consumed for cooking.

Transportation: Energy efficiency of the transportation sector is mainly depended on the fuel efficiency of the vehicles used. Here mileage of the vehicle (kmpl - Kilometres per Litre) is calculated to assess the fuel efficiency of the vehicle.

Percentage of closeness is the ratio of actual mileage of the vehicle to its expected mileage. If the percentage of closeness of mileages of each vehicle is greater than that of its average, then the efficiency status of the vehicle is considered as 'Above average' and else, it is considered as 'Below average'.

Currently, the campus is taking an appreciable effort to reduce the unnecessary production of wastes. But the campus still has opportunities to reduce the generation of waste and can improve much more. Resource optimisation can be effectively implemented in all type of waste generated in the campus and the campus can expect about 50% reduction the total waste produced.

By incorporating these methods, the campus aims not only to reduce carbon emissions but to transform into a model of sustainable practices. The overarching objective is to create a campus environment where carbon neutrality is achieved or even surpassed, demonstrating a commitment to responsible and eco-friendly operations.

Carbon Mitigation Proposals

After analyzing the historical and measured data the following projects are proposed to make the campus carbon neutral. The projects are from energy efficiency and renewable energy. The further additions in the green cover increase will also give positive impact in the carbon mitigation.

OTTOTRACTIONS- ENERGY AUDIT						
St. Joseph's College of Pharmacy						
Greenhouse Gas Mitigation through Major Energy Efficiency Projects						
Sl No	Projects proposed	Energy saved (Yearly)		Sustainability (Years)	First year ton of CO_2 mitigated	Expected Tons of CO_2 mitigated *through out life cycle*
		(kWh)	MWh	Years		
1	Energy Saving in Lighting by replacing existing 50 No's T8 (40W) Lamps to 18W LED Tube	1320.00	1.32	10	0.96	9.6
2	Energy Saving by replacing existing 600 No's in-efficient ceiling fans with Energy Efficient Five star fans	21312	21.31	10	15.56	155.6
	Total	**22632**	**23**	**10**	**16.5**	**165.2**

OTTOTRACTIONS- ENERGY AUDIT	
Energy Saving Proposal	
Energy Saving in Lighting by replacing existing 50 No's T8 (40W) Lamps to 18W LED Tube	
Existing Scenario	
50 numbers of T8(40 W) lamps were identified during the energy audit field survey in the facility. During discussion with officers it is observed that the average utility of these fittings are of 30%.	
Proposed System	
The existing T8 may be replaced to LED Tube of 18W in phased manner and the savings will be of 55% (inclusive of improved light output and reduced energy consumption)	
Financial Analysis	
Annual working hours (hr)	2400
No of fittings	50
Total load (kW)	2.00
Annual Energy Consumption (kWh)	2400
Expected Annual Energy saving for replacing all fittings (kWh)	1320
Cost of Power	11.48
Annual saving in Lakhs Rs (1st year)	0.15
Investment required for complete replacements [@Rs 300 per fittings](Lakhs Rs)	0.15
Simple Pay Back (in Months)	11.88

OTTOTRACTIONS- ENERGY AUDIT	
Energy Saving Proposal	
Energy Saving by replacing existing 600 No's in-efficient ceiling fans with Energy Efficient Five star fans	
Existing Scenario	
There are 600 numbers of ceiling fans installed in the facility with minimum 8 hrs a day operation. All are conventional type and most of them are very old.	
Proposed System	
There is an energy saving opportunity in replace the existing fans with new five star labelled fans. The five star labelled fans give a savings up to 30% with higher service value (air delivery/watt).	
Financial Analysis	
Annual working hours (hrs)	2400
Total numbers of ordinary fans	600
Total load (kW)	48.00
Annual Energy Consumption (kWh)	57600
Expected Annual Energy saving, for total replacement(kWh)	21312
Cost of Power (Rs)	11.47
Annual saving in Lakhs Rs (1st year)	2.44
Investment required for a total replacement (Lakhs Rs) [@3000 Rs per Fan with 50W at full speed]	18.00
Simple Pay Back (in Months)	88.36

5 CONCLUSION

The carbon emission from different sectors namely, Energy, Transportation and wastes were calculated using standard procedures. Carbon sequestration by the trees present in the campus was also estimated. From these the total carbon footprint of the campus was arrived at.

Net Carbon Emission after implementing Energy Efficiency projects and Renewable Energy Projects Proposed		
1	Total Carbon Foot Print tCO2e/yr	146.36
2	Carbon Sequrested tCO2e/yr	2.43
3	Carbon mitigated by Renewable Energy tCO2e/yr (Installed)	148.51
4	Carbon mitigated by Renewable Energy tCO2e/yr (Proposed)	0.00
5	Carbon mitigated by Energy Efficiency (Proposed) tCO2e/yr	16.52
6	Effective Carbon footprint tCO2e/yr	-21.09
7	Total No of Students	413
8	Specific Carbon Footprint kg CO2e/Student/Yr	-51.06

From this study it was found that carbon footprint of the campus to be **-51.06** kgCO2e Student/ Year in place of current footprint i.e., **-11.08** kgCO2e/ student/ Year. To achieve this, an investment of **18.15 Lakhs Rs** is required through energy efficiency and renewable energy projects proposed. It will be around **4395 Rs per** student to make the campus the carbon negative.

Cost to make the campus Carbon Negative		
1	Cost of implementation in Energy Efficiency Lakhs Rs	18.15
2	Cost of implementation in Renewable Energy Lakhs Rs	0.00
3	Total Lakhs Rs	18.15
4	Total number of students	413
5	Cost per student to make the campus carbon negative Rs/ Student	4395

The campus has achieved carbon negativity by implementing a solar power plant and various energy efficiency projects. As a result, the carbon footprint is now on the negative side. However, there are still opportunities for further improvements in energy efficiency and conservation. These enhancements will help maintain the campus's carbon-negative status, even as additional infrastructure is added in the near future.

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OTTOTRACTIONS

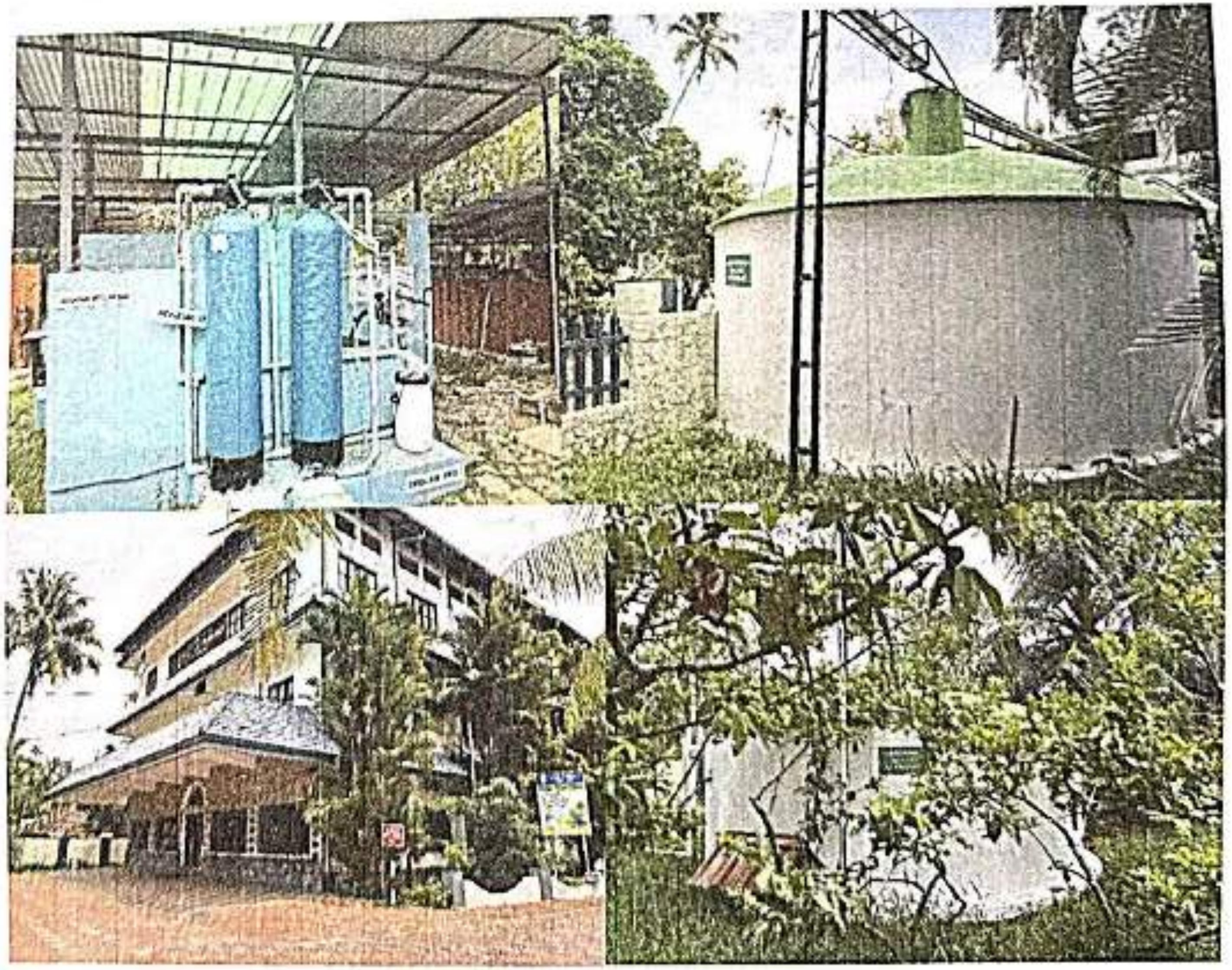
6

TECHNICAL SUPPLEMENT

Form 5

Sl No	Name of the tree	Circumference (cm)	Radius (cm)	Radius (m)	Height (m)	Trunk volume (m³)	Trunk Biomass (Ton)	Root biomass (Ton)	Total biomass (Ton)	Tree dry weight (Ton)	Carbon content of the tree (Ton)	Carbondioxide Sequestered (Ton)	No of Similar trees	Carbondioxide Sequestered (Ton) for all similar trees	Age of the tree (Years)	Carbon sequestered per year (Ton)
1	COCONUT TREE	28	4.58	0.04	2.49	0.01	0.01	0.00	0.01	0.01	0.00	0.01	95	1.40	2	0.70
2	JACK FRUIT TREE	35	5.57	0.06	1.90	0.02	0.01	0.01	0.02	0.01	0.01	0.02	2	0.04	5	0.01
3	SPANISH CHERRY (ILANJI)	34	5.41	0.05	3.96	0.54	0.02	0.01	0.03	0.02	0.01	0.04	2	0.08	5	0.02
4	MANGO TREE	29	4.62	0.05	4.58	0.03	0.01	0.01	0.02	0.02	0.01	0.03	29	0.88	3	0.29
5	TEAK	16	2.55	0.03	6.20	0.01	0.01	0.03	0.01	0.01	0.00	0.01	1	0.01	7	0.00
6	MAHOGANY TREE	30	4.78	0.05	5.30	0.04	0.02	0.01	0.03	0.01	0.01	0.04	50	2.52	7	0.36
7	PUNNA TREE (PUNNAMARAM)	18	2.87	0.03	7.50	0.02	0.01	0.01	0.02	0.01	0.01	0.02	1	0.02	8	0.00
8	ACACIA	12	1.91	0.02	3.66	0.08	0.00	0.00	0.00	0.00	0.00	0.01	31	0.16	3	0.05
9	INDIAN DATE (ETHAPPAZHAM)	23	3.66	0.04	3.10	0.01	0.01	0.00	0.01	0.01	0.00	0.01	1	0.01	2	0.01
10	ASHOKA TREE	69	10.99	0.11	6.50	0.25	0.13	0.08	0.21	0.15	0.08	0.28	1	0.28	8	0.03
11	GUAVA	35	5.57	0.06	3.29	0.33	0.02	0.01	0.03	0.02	0.01	0.04	30	1.98	12	0.59
12	INDIAN GOOSEBERRY	33	5.25	0.05	4.20	0.04	0.32	0.01	0.03	0.02	0.01	0.04	2	0.08	6	0.01
13	NEEM	21	3.34	0.03	3.10	0.01	0.01	0.00	0.01	0.01	0.00	0.01	1	0.01	8	0.00
14	LEMON	28	4.46	0.04	4.33	0.02	0.01	0.01	0.02	0.02	0.01	0.03	3	0.08	4	0.02
15	LARGE GARLIC PEAR TREE (NEERMATHALAM)	25	3.98	0.04	3.00	0.01	0.01	0.00	0.01	0.01	0.00	0.02	1	0.02	3	0.01
16	CHERRY WHITE ORCHID (MANDHARAM)	26	4.14	0.04	3.75	0.02	0.01	0.01	0.02	0.01	0.01	0.02	5	0.11	6	0.02
17	SPEAR TREE (SEETHU)	32	5.10	0.05	6.80	0.06	0.03	0.02	0.06	0.03	0.02	0.06	5	0.31	3	0.10
18	JAMUN (NJAVAL)	19	3.03	0.03	8.20	0.52	0.01	0.01	0.01	0.01	0.01	0.02	3	0.06	4	0.01
19	INDIAN ASH TREE (UDHI)	22	3.50	0.04	5.90	0.02	0.01	0.01	0.07	0.01	0.01	0.02	3	0.07	12	0.01
20	INDIAN ALMOND (THALLI MARAM)	27	4.30	0.04	6.20	0.04	0.52	0.01	0.03	0.02	0.01	0.04	2	0.08	8	0.01
21	BANYAN TREE (AALMARAM)	32	5.10	0.05	5.80	0.05	0.03	0.01	0.04	0.03	0.01	0.05	1	0.05	3	0.02
22	YELLOW PALM	32	5.10	0.05	3.96	0.03	0.02	0.01	0.03	0.02	0.01	0.04	37	1.32	3	0.44
23	RED PALM	33	5.25	0.05	3.80	0.33	0.02	0.01	0.03	0.02	0.01	0.04	21	0.78	5	0.15
24	BAMBOO PALM	22	3.50	0.04	4.80	0.02	0.01	0.01	0.02	0.01	0.01	0.02	10	0.20	4	0.05
25	MALABAR IRONWOOD (THAMBAKAM)	27	4.30	0.04	5.10	0.03	0.02	0.01	0.05	0.02	0.01	0.03	2	0.07	8	0.01
26	KODAMPULI (THAMARATHAMARAM)	31	4.84	0.05	5.10	0.04	0.02	0.01	0.03	0.02	0.01	0.04	1	0.04	14	0.00
27	MALABAR TAMARIND (KUDAMPULI)	18	2.87	0.33	3.96	0.01	0.56	0.00	0.01	0.01	0.00	0.01	2	0.02	14	0.00
28	INDIAN COFFEE PLUM (LUBY)	27	4.30	0.04	3.13	0.62	0.01	0.01	0.01	0.01	0.01	0.02	1	0.02	14	0.00
29	ARANJICHERUPUNNA	31	4.94	0.35	6.60	0.05	0.03	0.03	0.04	0.03	0.02	0.08	1	0.08	8	0.01
	Total					0.88	0.52	0.29	0.82	0.59	0.39	1.29	354	10	6	2.43

Details of the trees having diameter more than 15cm and having heights above 150cm from ground level is taken for the study



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