GREEN AUDIT REPORT

ST. MICHAELS COLLEGE
CHERTHALA

Executed by

OTTOTRACTIONS
Energy - Engineering - Environment

2024

Digitally signed by SURESH BABU B V
DN: c=IN, o=PERSONAL, pseudonym=4bf2cfce3869471fa42e25d96b103bf2, 2.5.4.20=25d8b344eceac8d4d825bcb320ae4ce19c838fed7a5ffbac643a6505ef9dc2e5, postalCode=695006, st=Kerala, serialNumber=57fd01e799360df7e11d7deee61d667daf7b59aefeb701eebba13e2ddfb03b3d, cn=SURESH BABU B V
Date: 2024.01.30 12:35:59 +05'30'

OTTOTRACTIONS
Energy - Engineering - Environment
aea@ottotractions.com, otenergy@gmail.com
www.ottotractions.com
ISO 9001-2015 & ISO 14001-2015 Certified

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

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

ISO 9001 : 2015 Certified (22DQJE85) ISO 14001:2015 Certified (22DEJE84)

GREEN AUDIT REPORT

ST. MICHAEL'S COLLEGE

CHERTHALA

OTTOTRACTIONS
Energy-Engineering-Environment

Green Audit Report
St. Michael’s College, Cherthala
Report No: EA 1112/GA
2024-Januray

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. Michael’s College, 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.

B V Suresh Babu
Accredited Energy Auditor
AEA 33, Bureau of Energy Efficiency
Government of India

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

Contents

1

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 All Saints College, Trivandrum, 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. MICHAEL'S COLLEGE, CHERTHALA

St. Michael's College, Cherthala essentially epitomizes the lofty pedagogical mission of the Diocese of Alappuzha which has been devoting long years to the grooming of erudite citizens for the nation by imparting value-based education materialised through the selfless service of committed and dedicated group of visionaries. The college is situated on the highway, 18 kms north of Alappuzha town, silhouetted against the captivatingly verdant scenery. The sprawling campus of the college with its solemn and serene air is a magnificent sight to behold from the national highway – NH 66. However, the grandeur duly adorns the prime institute under the Diocese of Alappuzha. As the well-deserved outcome of the determined effort of the stalwarts of the Diocese, a long-treasured dream found its realization in this citadel of knowledge which took its birth on 19 June 1967. The construction of the infrastructure began in the middle of July 1964 itself and the foundation stone was blessed by His Excellency Bishop Michael Arattukulam and was laid by the then Vicar General Msgr. Silverious Jackson. Pledging its loyalty and coalescence, the community joined this noble endeavour quite enthusiastically by setting apart their 'Kettuthengu' to give their mite towards the construction of the college. The pace of progress in its development was duly accelerated by the proper guidance of Msgr. Joseph Thekkepalackal and the institution was initially named as 'St. Michael's Institute'. The college chapel that was built opposite to the college in 1973 later grew into a fullfledged parish church.

Occupancy Details

Particulars	2018-19	2019-20	2020-21	2021-22	2022-23
Total Students	1121	1098	1137	1179	1177
Staffs	58	58	53	58	60
Total Occupancy of the college	1179	1156	1190	1237	1237

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.

The Audit Team

1. Er. B V Suresh Babu, Accredited Energy Auditor, BEE
2. Dr. C.K Peethambaran, Agricultural Expert,(Flora)
3. Dr. P N Krishnan, Consultant (Agro Informatics)
4. Dr. E K Eswaran, Consultant (Fauna)
5. Er. B Zachariah, Chief Consultant

<table>
<tr><th colspan="8">BASELINE DATA SHEET FOR GREEN AUDIT</th></tr>
<tr><td>1</td><td>Name of the Organisation</td><td colspan="6">St. Michael's College, Cherthala</td></tr>
<tr><td>2</td><td>Address (include telephone, fax & e-mail)</td><td colspan="6">St. Michael's College, Cherthala,
Mayithara P.O, Alappuzha Dt. PIN: 688539
Phone: 0478 2822387, 2810387(Principal)
Email: michaelscherthala@gmail.com</td></tr>
<tr><td>3</td><td>Year of Establishment</td><td colspan="6">1967</td></tr>
<tr><td>4</td><td>Name of building and Total No. of Electrical Connections/building</td><td colspan="6">St. Michael's College (8)</td></tr>
<tr><td>5</td><td>Total Number of Students</td><td>Boys</td><td>-</td><td>Girls</td><td>-</td><td>Total</td><td>1177</td></tr>
<tr><td>6</td><td>Total Number of Staff</td><td colspan="6">60</td></tr>
<tr><td>7</td><td>Total Occupancy</td><td colspan="6">1237</td></tr>
<tr><td>8</td><td>Total area of green cover</td><td colspan="6">60%</td></tr>
<tr><td>9</td><td>Type of Electrical Connection</td><td>HT</td><td>0</td><td>LT</td><td colspan="3">8</td></tr>
<tr><td>10</td><td>Total Connected Load (kW)</td><td colspan="6">-</td></tr>
<tr><td>11</td><td>Average Maximum Demand (KVA)</td><td colspan="6">-</td></tr>
<tr><td>12</td><td>Total built up area of the building (M^2)</td><td colspan="6">9600</td></tr>
<tr><td>13</td><td>Number of Buildings</td><td colspan="6">3</td></tr>
<tr><td>14</td><td>Average system Power Factor</td><td colspan="6">-</td></tr>
<tr><td>15</td><td>Details of capacitors connected</td><td colspan="6">Nil</td></tr>
<tr><td rowspan="2">16</td><td rowspan="2">Transformer Details (Nos., kVA, Voltage ratio)</td><td>TR 1</td><td colspan="5"></td></tr>
<tr><td>0</td><td colspan="5"></td></tr>
<tr><td rowspan="2">17</td><td rowspan="2">DG Set Details (kVA)</td><td>DG1</td><td>DG2</td><td>DG3</td><td>DG4</td><td>DG5</td><td>Remarks</td></tr>
<tr><td>62.5</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">18</td><td rowspan="4">Details of motors</td><td colspan="2">Rating</td><td colspan="2">Nos.</td><td colspan="2">Remarks</td></tr>
<tr><td colspan="2">5 to 10</td><td colspan="2">3</td><td colspan="2"></td></tr>
<tr><td colspan="2">10 to 50</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">Above 50</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>19</td><td>Brief write-up about the firm and the energy/environmental conservation activities already undertaken.</td><td colspan="6">Installed Solar power plant and Solar street lights, Installed biogas plant, Energy conservation projects and Rain water harvesting</td></tr>
<tr><td rowspan="2">20</td><td rowspan="2">Contact Person & Telephone number</td><td colspan="6">Dr. Manoj Parameswaran</td></tr>
<tr><td colspan="6">9400562122</td></tr>
</table>

2
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 1237 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 4948 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

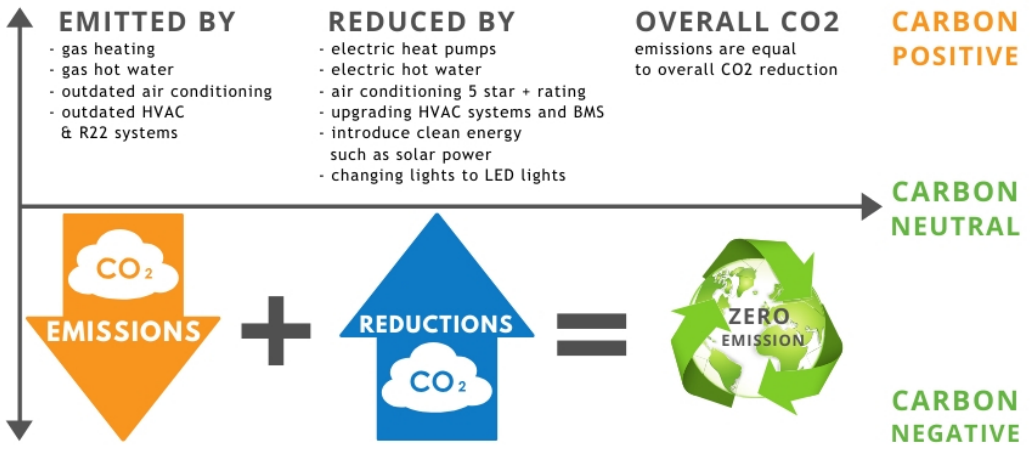
The approach to calculating carbon footprints is continually evolving, emerging as a pivotal tool for greenhouse gas management. In the current study, we are actively engaged in estimating carbon emission data from the campus, categorizing it into four distinct and crucial dimensions. This methodology 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 Sequestration

Carbon sequestration is a crucial process that involves the extended storage of atmospheric carbon dioxide, primarily facilitated by trees. Through the natural mechanism of photosynthesis, trees extract carbon dioxide from the air and retain the carbon within various components such as leaves, branches, stems, bark, and roots.

To quantify the carbon sequestered by a tree, various methods can be employed. In this particular study, a volumetric approach is adopted, encompassing a comprehensive calculation process comprised of five distinct steps:

Determining the Total Weight of the Tree: This initial step involves assessing the overall weight of the tree, encompassing all its components.

Determining the Dry Weight of the Tree: The dry weight of the tree is ascertained, excluding any moisture content. This provides a more accurate measure of the tree's structural mass.

Determining the Weight of Carbon in the Tree: By conducting specific analyses, the weight of carbon contained within the tree is determined, offering insights into the carbon content of different tree components.

Determining the Weight of CO_2 Sequestered in the Tree: Building on the carbon weight, this step involves calculating the equivalent weight of carbon dioxide sequestered by the tree.

Determining the Weight of CO_2 Sequestered in the Tree Per Year: This final process involves extrapolating the annual carbon sequestration capacity of the tree, providing a dynamic perspective on its contribution to mitigating atmospheric carbon dioxide levels over time.

The utilization of this volumetric approach and the detailed calculations contribute to a more nuanced understanding of the carbon sequestration potential of individual trees. These findings offer valuable insights for environmental management and sustainable practices, enabling informed decision-making for promoting and preserving carbon sequestration in ecosystems. The subsequent section provides an in-depth exploration of the calculations and results derived from this study.

Step 1: Determine the total green weight of the tree

The green weight is the weight of the tree when it is alive. First, you have to calculate the green weight of the above-ground weight as follows:

W above-ground= 0.25 D2 H (for trees with D<11)

W above-ground= 0.15 D2 H (for trees with D>11)

W above-ground= Above-ground weight in pounds

D = Diameter of the trunk in inches

H = Height of the tree in feet

The root system weight is about 20% of the above-ground weight. Therefore, to determine the total green weight of the tree, multiply the above-ground weight by 1.2:

$W_{\text{total green weight}} = 1.2 * W_{\text{above-ground}}$

Step 2: Determine the dry weight of the tree

The average tree is 72.5% dry matter and 27.5% moisture. Therefore, to determine the dry weight of the tree, multiply the total green weight of the tree by 72.5%.

$W_{\text{dry weight}} = 0.725 * W_{\text{total green weight}}$

Step 3: Determine the weight of carbon in the tree

The average carbon content is generally 50% of the tree's dry weight total volume. Therefore, in determining the weight of carbon in the tree, multiply the dry weight of the tree by 50%.

$W_{\text{carbon}} = 0.5 * W_{\text{dry weight}}$

Step 4: Determine the weight of carbon dioxide sequestered in the tree

CO_2 has one molecule of Carbon and 2 molecules of Oxygen. The atomic weight of Carbon is 12 (u) and the atomic weight of Oxygen is 16 (u). The weight of CO_2 in trees is determined by the ratio of CO_2 to C is 44/12 = 3.67. Therefore, to determine the weight of carbon dioxide sequestered in the tree, multiply the weight of carbon in the tree by 3.67. $W_{carbon\text{-}dioxide} = 3.67 * W_{carbon}$

3

RESULTS AND DISCUSSIONS

Carbon Footprint Estimation

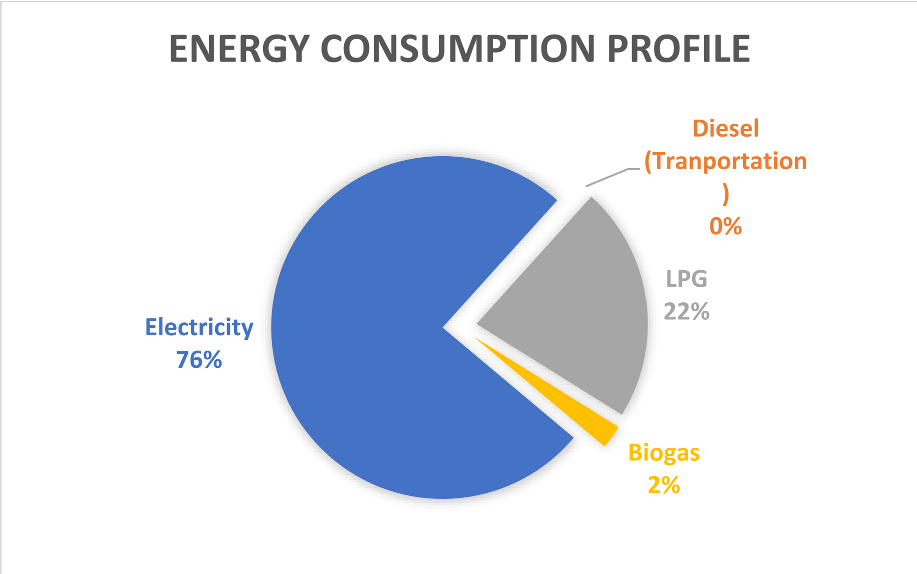
In accordance with the carbon footprint estimation methodology outlined in the preceding chapter, this section provides a comprehensive breakdown of the carbon emissions associated with this campus, specifically attributed to energy consumption, transportation, and waste generation.

3.1. Energy Consumption

Base Line Energy Data						
St. Michael's College, Cherthala						
		2018-19	2019-20	2020-21	2021-22	2022-23
1	Electricity KSEB (kWh)	66248	26728	15106	29229	31831
2	Electricity DG (kWh)	2297	2904	1480	1232	3129
3	Electricity Solar, Off grid (kWh)	12775	25550	25550	25550	25550
5	Electricity Grid Tied (kWh)	0	0	0	0	0
4	Electricity (KSEB + DG + Off grid) kWh	81320	55182	42136	56011	60510
6	Diesel for Transportation (L)	0.0	0.0	0.0	0.0	0.0
7	LPG (kg)	1121.00	1102.00	304.00	1216.00	1273.00
8	Biogas generated/year (m3)	0	0	0	0	330.00

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 off-grid, These systems are designed to generate, store, and use their own electricity, making them suitable for locations where grid power is unavailable or unreliable.

Off-grid SPV refers to a type of solar power system that is not connected to the electrical grid. Unlike grid-tied solar systems, which feed excess electricity back into the grid and draw power from it when needed, off-grid SPV systems operate independently. Electricity bills often include charges related to being connected to the grid, regardless of the amount of electricity consume. In some cases, off-grid systems are designed to produce more electricity than is needed, especially during sunny days. This excess energy can be stored in batteries or used to power other applications. If your system generates more electricity than you consume over a billing period, you may end up with a surplus of energy credits.



The campus has distinct thermal energy requirements, particularly in the areas of transportation, laboratories, and canteens. These requirements are met through a combination of Liquefied Petroleum Gas (LPG), Diesel, and Biogas.

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	2018-19	2019-20	2020-21	2021-22	2022-23
1	Electricity	69934852	47456228	36237202	48169365	52038574
2	Diesel (Transportation)	0	0	0	0	0
3	LPG	13452000	13224000	3648000	14592000	15276000
4	Biogas	0	0	0	0	1540000
Total		83386852	60680228	39885202	62761365	68854574

Laboratories, known for their diverse and specialized equipment, predominantly rely on LPG for their thermal energy requirements. LPG, being a versatile and clean-burning fuel, is well-suited for the precise and controlled conditions essential in laboratory settings.

The canteens on the campus employ a dual approach, utilizing both LPG and Biogas to meet their thermal energy demands. Biogas, a renewable energy source, is generated on-site through a biogas plant installed within the campus premises. This sustainable practice not only contributes to the reduction of greenhouse gas emissions but also showcases the campus's commitment to integrating environmentally friendly energy solutions.

In summary, the campus strategically sources thermal energy from LPG, Diesel, and Biogas, tailoring each energy type to meet the specific needs of transportation, laboratories, and canteens. 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 Eight LT Connections, the details are given below.

Electricity Connection Details		
St. Michael's College, Cherthala		
1	Name of the Consumer	St. Michael's College, Cherthala
2	Tariff	LT-6A/Ndom
3	Consumer Numbers	1155209003214, 1155200018399, 1155208020126, 1155207021332, 1155201018481
4	Connected Load Total (kW)	-
5	Annual Electricity Consumption (kWh)	31831

Electricity Bill Analysis

Annual Electricity Consumption (kWh)					
Consumer No	**2018-19**	**2019-20**	**2020-21**	**2021-22**	**2022-23**
1155209003214	38424	15502	8761	16953	18462
1155200018399	1987	802	453	877	955
1155208020126	5962	2406	1360	2631	2865
1155207021332	662	267	151	292	318
1155201018481	19212	7751	4381	8476	9231
TOTAL	66248	26728	15106	29229	31831

3.1.2. Solar Power Plant

The campus has implemented a 20-kilowatt peak (kWp) off grid solar power plant on its rooftop, demonstrating a commitment to harnessing sustainable energy sources. This solar power system is not integrated with the electrical grid, ensuring a reliable and environmentally friendly contribution to the campus's energy needs.

The solar power plant's electricity generation details are as follows:

Capacity: The installed solar power plant has a capacity of 20 kWp, signifying its peak power output under standard conditions.

Battery Bank: Off-grid systems require energy storage in the form of batteries to store excess electricity generated during sunny periods. Batteries store energy for use during periods when there is little or no sunlight, such as at night or during cloudy days.

Inverter: The inverter converts the DC electricity stored in the batteries into alternating current (AC), which is used to power standard household appliances and devices. Some off-grid systems also include inverters with built-in chargers to support generator charging.

Backup Generator: In certain off-grid setups, a backup generator may be included to provide additional power during extended periods of low sunlight or high electricity demand. This generator can be used to recharge the battery bank.

Monitoring Systems: Off-grid solar systems may include monitoring systems that allow users to track energy production, battery status, and overall system performance. This helps users manage their energy usage and ensure the system is functioning optimally.

Solar Power Plant Off Grid						
Location	**Capacity (kWp)**	**2018-19**	**2019-20**	**2020-21**	**2021-22**	**2022-23**
		Annual generation (kWh)				
Roof Top	10	12775	12775	12775	12775	12775
	10	0	12775	12775	12775	12775
Total	20	12775	25550	25550	25550	25550

By installing and effectively utilizing this off grid solar power plant, the campus not only enhances its energy resilience but also actively participates in the global movement towards cleaner and greener energy alternatives.

3.1.3. Diesel Generators

The campus is equipped with a diesel generator, boasting capacities of a 62.5 kVA, respectively. These generators are strategically connected to both the Main Building and annex 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
18-19	766	2296.5	75019
19-20	968	2903.7	94855
20-21	493	1480.4	48360
21-22	411	1231.7	40235
22-23	1043	3128.5	102199

3.2. Thermal Energy

The thermal energy needs for buses, laboratories, and cooking on the campus are fulfilled through the utilization of Diesel, Liquefied Petroleum Gas (LPG), and Biogas. Further details regarding each fuel source are elaborated below.

Thermal Fuel Consumption					
St. Michael's College, Cherthala					
	2018-19	2019-20	2020-21	2021-22	2022-23
Annual LPG consumption in kg	1121.0	1102.0	304.0	1216.0	1273.0
Annual Diesel consumption in L	0	0	0	0	0
Annual Biogas consumption in kg	0	0	0	0	330.00

3.2.1. Diesel for Transportation

No buses are operating from the campus for its transportation need.

3.2.2. LPG for Laboratory and Cooking

LPG is utilized in laboratories for scientific purposes and for cooking in the canteen.

LPG Consumption Details					
Particulars	2018-19	2019-20	2020-21	2021-22	2022-23
No Cylinders in Canteen	22	20	10	19	21
No Cylinders in Hostel	35	36	5	43	44
No Cylinders in Lab	2	2	1	2	2
Canteen/Lab LPG Consumption in kg	1121	1102	304	1216	1273
Total in kg	1121	1102	304	1216	1273

3.2.3. Biogas for Cooking

Biogas is used for cooking Purposes. On the campus, a $2m^3$ biogas system is installed.

Biogas Consumption				
	m3	kcal/m3	Daily production kCal	Annual production (kCal)
Biogas plant 1	2	3500	7000	1540000
				1540000

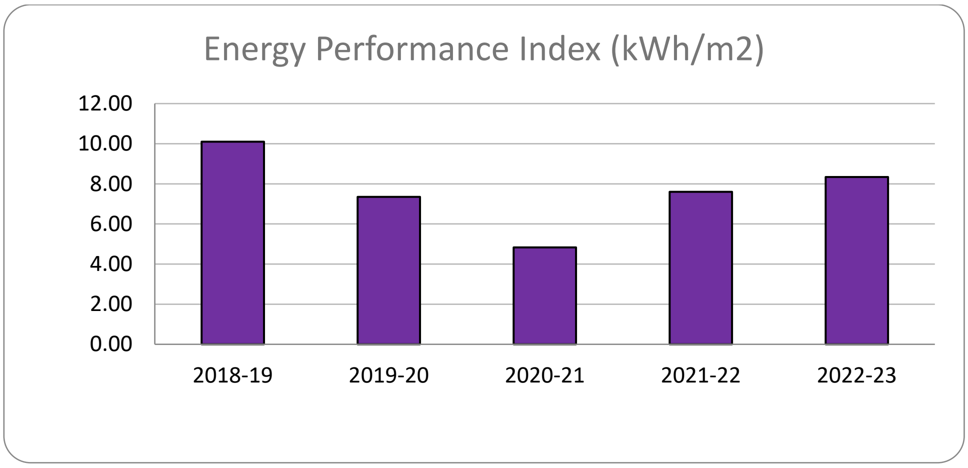
3.3. Energy Performance Index

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. Michael's College, Cherthala						
Energy Performance Index (EPI)						
Sl No	Particulars	2018-19	2019-20	2020-21	2021-22	2022-23
1	Total building area (m^2)	9600	9600	9600	9600	9600
2	Annual Energy Consumption (kCal)	83386852	60680228	39885202	62761365	68854574
3	Annual Energy Consumption (kWh)	96961	70558	46378	72978	80063
4	Total Energy in Toe	8.34	6.07	3.99	6.28	6.89
5	Energy Performance Index kWh/m^2	10.10	7.35	4.83	7.60	8.34



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.

Degradable Waste Generation					
St. Michael's College, Cherthala					
Particulers	2018-19	2019-20	2020-21	2021-22	2022-23
Total Occupancy	1179	1156	1190	1237	1237
Waste generated in kg /day	23.58	23.12	23.8	24.74	24.74
Waste generated in kg /Yr	5187.6	5086.4	5236	5442.8	5442.8

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. The institute employs vermicomposting as a sustainable method to manage organic waste, converting it into valuable compost suitable for campus landscaping or agricultural activities.

Solid non degradable Waste Generation					
St. Michael's College, Cherthala					
Particulers	2018-19	2019-20	2020-21	2021-22	2022-23
Total Occupancy	1179	1156	1190	1237	1237
Waste paper generated in kg /day	0.2358	0.2312	0.238	0.2474	0.2474
Waste plastic generated in kg /day	0.3537	0.3468	0.357	0.3711	0.3711
Waste paper generated in kg /Yr	51.88	50.86	52.36	54.43	54.43
Waste plastic generated in kg /Yr	77.81	76.30	78.54	81.64	81.64

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 (2022-23)

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/m^3
Petrol	0.0031	tCo2e/kg
Food Waste	0.00063	tCo2e/kg
Paper Waste	0.00056	tCo2e/kg

Carbon Foot Print 2022-23

Carbon Foot Print											
Sl. No.	Particulars	2018-19	tCO2e	2019-20	tCO2e	2020-21	tCO2e	2021-22	tCO2e	2022-23	tCO2e
1	Electricity (kWh)	81320	66.68	55182	45.25	42136	34.55	56011	45.93	60510	49.62
2	Diesel (L)	0.00	0.00	0	0.00	0	0.00	0	0.00	0.00	0.00
3	LPG (kg)	0.00	0.00	1102	1.65	304	0.46	1216	1.82	1273.00	1.91
4	Biogas (m3)	0.00	0.00	0	0.00	0	0.00	0	0.00	330.00	0.462
5	Degradable Waste in kg/yr.	5187.6	3.27	5086.4	3.20	5236.0	3.30	5442.8	3.43	5442.8	3.43
6	Paper Waste in kg/yr	51.88	0.03	50.86	0.03	52.36	0.03	54.43	0.03	54.43	0.03
Total Carbon Foot Print tCO2e/yr			69.98		50.13		38.34		51.21		55.45

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	2018-19	2019-20	2020-21	2021-22	2022-23
Total No of Trees	462	462	462	462	462
Carbon sequestrated by trees in the campus (tCO2e)	8.44	8.71	8.98	9.25	9.54

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

List of Trees in Campus

List of trees in campus		
Sl.No	Name of Trees	Number
1	Indian almond	1
2	Palm tree	1
3	Foxtail palm	1
4	Indian almond	3
5	Persian silk tree	5
6	gooseberry	1
7	Cashew tree	1
8	Jungle jack	1
9	pala	1
10	teak	19
11	River tarmarind	3
12	Jungle jack	2
13	perumaram	1
14	Neem	1
15	Mango tree	3
16	Jack fruit tree	8
17	Mango tree	9
18	Cashew tree	1
19	Foxtail palm	1
20	Paradise tree	2
21	Bread fruit tree	2
22	karaka	1
23	pomelo	1
24	pomelo	1
25	Neem	1
26	Bay leaf tree	1
27	guava	1

28	Sugar apple	1
29	Allinaranga	1
30	allinaranga	1
31	Jungle jack	1
32	Jungle jack	1
33	avocado	1
34	pathal	1
35	karaka	1
36	Bread fruit tree	1
37	Bread fruit tree	1
38	chembakam	1
39	Gooseberry	1
40	Lemon	1
41	Jaathi	1
42	Mahagony	1
43	karuva	1
44	Persian silk tree	1
45	Persian silk tree	1
46	njaval	1
47	Bauhinia	1
48	Golden shower tree	1
49	gooseberry	1
50	Mango tree	1
51	Mango tree	1
52	Pala indigo plant	1
53	Indian almond tree	1
54	Teak	1
55	Indian almond tree	1
56	Cashew tree	1
57	lagerstroemia	1
58	Falso ashoka	1
59	False ashoka	1
60	False ashoka	1
61	False ashoka	1
62	araucaria	1
63	Aracucaria	1
64	aracucaria	1
65	False ashoka	1
66	Golden shower tree	1
67	Mahagony	1
68	lagerstroemia	1
69	Lagerstroemia	1

70	lagerstroemia	1
71	Araucaria	1
72	araucaria	1
73	Goose berry	1
74	Bauhinia	1
75	Cashew	1
76	kadamba	1
77	Alstonia	1
78	alstonia	1
79	Cashew	1
80	Jungle jack	1
81	Cashew	1
82	Cashew	1
83	Cashew	1
84	Cashew	90
85	Acacia	1
86	Jungle jack	1
87	Persian silk tree	1
88	Persian silk tree	1
89	Persian silk tree	1
90	Cashew	18
91	Acacia	21
92	Jungle jack	3
93	Veli pathal	1
94	Veli pathal	1
95	Acacia	99
96	Bauhinia	4
97	Mango tree	2
98	mahagony	7
99	lagerstroemia	1
100	lagerstroemia	1
101	Jack fruit tree	1
102	Gooseberry	1
103	gooseberry	1
104	Divi divi	1
105	gulmohar	1
106	gulmohar	1
107	acacia	1
108	Persian silk tree	1
109	Persian silk tree	1
110	cashew	1
111	Paradise tree	1

112	Persian silk tree	1
113	Persian silk tree	1
114	Persian	1
115	Guava	6
116	Acacia	1
117	acacia	1
118	Polyalthia longifolia	1
119	Lagerstroemia	1
120	Araucaria heterophylla	1
121	Araucaria heterophylla	1
122	cashew	1
123	Kalasham tree	29
124	Annona muricata	1
125	Annona reticulata	1
126	Artocarpus altilis	1
127	Averrhoa bilimbi	1
128	Averrhoa carambola	1
129	Bambusa bambos	1
130	Carica papaya	1
131	Elaeis guineensis	1
132	Corynocarpus laevigatus	1
133	Ficus benghalensis	1
134	Ficus benjamina	1
135	Ficus elastica	1
136	Ficus exasperate	1
137	Ficus racemose	1
138	Ficus religiosa	1
139	Ficus tictoria	1
140	Flacourtia montana	1
141	Homalium ceylanicum	1
142	Hydnocarpus pentandrus	1
143	Lagerstroemia speciosa	1
Total		462

Carbon Balancing (2022-23)

Various carbon emitting activities such as consumption of energy, transportation and waste generation leads to the total emission of **55.45tCO_2e** per year by the campus. The total carbon sequestration by trees in the campus compound is **9.45tCO_2e**. Thus, the current carbon footprint of the campus will be the difference of total carbon emission and total carbon sequestration/mitigation. The following table shows the carbon footprint level:

Mittigation Through Renewable Energy											
Sl No	Source	2018-19	tCO2e	2019-20	tCO2e	2020-21	tCO2e	2021-22	tCO2e	2022-23	tCO2e
1	Electricity Consumption kWh /Yr (Solar)	12775	10.48	25550	20.95	25550	20.95	25550	20.95	25550	20.95
2	Biogas Consumption in kg/yr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	330.00	0.46
Total tCO2e			10.48		20.95		20.95		20.95		21.41

Specific CO2 Footprint

Amount of Carbon to be mitigated for Low Carbon Campus						
Sl No	Particulars	2018-19	2019-20	2020-21	2021-22	2022-23
1	Total carbon emission tCO2e	69.98	50.13	38.34	51.21	55.45
2	Total carbon sequestration tCO2e	8.44	8.71	8.98	9.25	9.54
3	Amount of carbon mitigated through renewable energy tCO2e	10.48	20.95	20.95	20.95	21.41
4	To be mitigated tCO2e	51.06	20.48	8.41	21.01	24.50
5	Total No of Students	1179	1156	1190	1237	1237
6	Specific Carbon Footprint kg CO2e/Student/Yr	43.31	17.71	7.07	16.98	19.80

The total specific carbon footprint is estimated as **19.80** kg of CO_2e per student for the year 2022-23.

4

Carbon Mitigation Plans

In the academic year 2022-2023, the per-student carbon dioxide emission for the campus was measured at **55.45** 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. Michael's College, Cherthala						
Greenhouse Gas Mitigation through Major Energy Efficiency Projects						
Sl No	Projects proposed	Energy saved (Yearly)		Sustainability (Years)	First year ton of CO2 mitigated	Expected Tons of CO2 mitigated through out life cycle
		(kWh)	MWh	Years		
1	Energy Saving in Lighting by replacing existing 3 No's T8 (40W) Lamps to 18W LED Tube	63	0.06	10	0.05	0.46
2	Energy Saving in Lighting by replacing existing 6 No's T12 (55W) Lamps to 18W LED Tube	159	0.16	10	0.12	1.16
3	Energy Saving by replacing existing 147 No's in-efficient ceiling fans with Energy Efficient Five star fans	2766	2.77	10	2.02	20.19
Total		**2989**	**3**	**10**	**2.18**	**21.82**

OTTOTRACTIONS- ENERGY AUDIT						
St. Michael's College, Cherthala						
Greenhouse Gas Mitigation through Renewable Energy Projects						
Sl No	Projects	Energy saved (Yearly)		Sustainability (Years)	First year ton of CO2 mitigated	Expected Tons of CO2 mitigated through out life cycle
		(kWh)	MWh	Years		
1	Installation of 25kWp Solar Power Plant	34219	34.22	25	24.98	624.49

OTTOTRACTIONS- ENERGY AUDIT	
Energy Saving Proposal	
Energy Saving in Lighting by replacing existing 3 No's T8 (40W) Lamps to 18W LED Tube	
Existing Scenario	
3 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	3
Total load (kW)	0.12
Annual Energy Consumption (kWh)	115
Expected Annual Energy saving for replacing all fittings (kWh)	63
Cost of Power	6.30
Annual saving in Lakhs Rs (1st year)	0.00
Investment required for complete replacements [@Rs 300 per fittings](Lakhs Rs)	0.01
Simple Pay Back (in Months)	27.06

OTTOTRACTIONS- ENERGY AUDIT	
Energy Saving Proposal	
Energy Saving in Lighting by replacing existing 6 No's T12 (55W) Lamps to 18W LED Tube	
Existing Scenario	
6 numbers of T12(55 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 T12 may be replaced to LED Tube of 18W in phased manner and the savings will be of 67% (inclusive of improved light output and reduced energy consumption)	
Financial Analysis	
Annual working hours (hr)	2400
No of fittings	6
Total load (kW)	0.33
Annual Energy Consumption (kWh)	238
Expected Annual Energy saving for replacing all fittings (kWh)	159
Cost of Power	6.30
Annual saving in Lakhs Rs (1st year)	0.01
Investment required for complete replacements [@Rs 300 per fittings](Lakhs Rs)	0.02
Simple Pay Back (in Months)	21.54

OTTOTRACTIONS- ENERGY AUDIT	
Energy Saving Proposal	
Energy Saving by replacing existing 147 No's in-efficient ceiling fans with Energy Efficient Five star fans	
Existing Scenario	
There are 147 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	147
Total load (kW)	10.29
Annual Energy Consumption (kWh)	9878
Expected Annual Energy saving, for total replacement(kWh)	2766
Cost of Power (Rs)	6.30
Annual saving in Lakhs Rs (1st year)	0.17
Investment required for a total replacement (Lakhs Rs)[@3000 Rs per Fan with 50W at full speed]	4.41
Simple Pay Back (in Months)	303.69

Energy Saving Proposal	
Installation of 25kWp Solar Power Plant	
Existing Scenario	
There is a good potential of solar power electricity generation. The availability of sunlight is very high. There are some canopies available in the proposed site, but by having proper trimming of trees this may be avoided. If the SPVs are place in the roof top it will help improving RTTV (Roof Thermal Transmit Value) of the building.	
Proposed System	
It is proposed to have a Solar Power Plant of 25 kW at the beginning stage. The state and central government is pushing and giving good assistance to the installation. It can be installed as an internal grid connected system which is much cheaper than off grid system. Now days the technology provides trouble free grid interactive and connected system. The installation will provide 25yrs trouble free generation with only 20% efficiency loss at the 25th year.	
Financial Analysis	
Proposed Solar installed Capacity (kW)	25
Total average kWh per day expected (3.5kWh/day average)	93.75
Total annual Generating Capacity (kWh)	34219
Cost of energy generated annually Lakhs Rs	4.55
Investment required (INR lakh)(Approx)	13.75
Simple Pay Back (in Months)	36.26
Life cycle in Yrs	25
Total Saving in Life Cycle (Approx) RS lakh	113.78

Executive Summary					
Consolidated Cost Benefit Analysis of Energy Efficiency Improvement Projects					
St. Michael's College, Cherthala					
Sl No	Projects	Investment	Cost saving	SPB	Energy saved
		(Lakhs Rs)	(Rs)/Yr	Months	kWh/Yr
1	Energy Saving in Lighting by replacing existing 3 No's T8 (40W) Lamps to 18W LED Tube	0.01	0.004	27.06	63
2	Energy Saving in Lighting by replacing existing 6 No's T12 (55W) Lamps to 18W LED Tube	0.02	0.01	21.54	159
3	Energy Saving by replacing existing 147 No's in-efficient ceiling fans with Energy Efficient Five star fans	4.41	0.17	303.69	2766
4	Installation of 25kWp Solar Power Plant	13.75	4.551	36.26	34219
	Total	**18.19**	**4.74**	**97.14**	**37207**
(The saving are projected as per the assumed operation time observed based in the discussions with the plant officials. The data of saving percentages are taken from BEE guide books and field measurements.)					

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	55.45
2	Carbon Sequrested tCO2e/yr	9.54
3	Carbon mitigated by Renewable Energy tCO2e/yr (Installed)	21.41
4	Carbon mitigated by Renewable Energy tCO2e/yr (Proposed)	24.98
5	Carbon mitigated by Energy Efficiency (Proposed) tCO2e/yr	2.18
6	Effective Carbon footprint tCO2e/yr	-2.66
7	Total No of Students	1177
8	Specific Carbon Footprint kg CO2e/Student/Yr	-2.26

From this study it was found that carbon footprint of the campus to be **-2.26**kgCO_2e/ Student/ Year in place of current footprint i.e., **47.11** kgCO_2e/ student/ Year. To achieve this, an investment of **18.19Lakhs Rs** is required through energy efficiency and renewable energy projects proposed. It will be around **1545 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	4.44
2	Cost of implementation in Renewable Energy Lakhs Rs	13.75
3	Total Lakhs Rs	18.19
4	Total number of students	1177
5	Cost per student to make the campus carbon negative Rs/ Student	1545

REFERENCES

Reports and Books

- Towards campus climate neutrality: Simon Fraser University's carbon footprint (2007), Simon Fraser University, Bokowski, G., White, D., Pacifico, A., Talbot, S., DuBelko, A., Phipps, A.
- The bare necessities: How much household carbon do we really need? Ecological Economics (2010), 69, 1794–1804, Druckman, A., & Jackson, T.
- Home Energy Audit Manual (2017), Ottotractions & EMC Kerala, No.ES 26, Pp.114
- Screening of 37 Industrial PSUs in Kerala for Carbon Emission Reduction and CDM Benefits, (2011), Ottotractions & Directorate of Environment & climate Change, Kerala, No. ES-8, Pp.157

Website

- http://www.moef.nic.in/downloads/public-information/Report_INCCA.pdf
- https://ghgprotocol.org/sites/default/files/standards_supporting/Ch5_GHGP_Tech
- https://www.sciencedirect.com/science/article/pii/S0921344915301245
- http://www.kgs.ku.edu/Midcarb/sequestration.shtml
- http://www.sustainabilityoutlook.in/content/5-things-consider-you-plan-rooftop-pv-plant
- https://www.nrs.fs.fed.us/pubs/jrnl/2002/ne_2002_nowak_002.pdf
- https://www.ipcc-nggip.iges.or.jp/EFDB/find_ef.php
- https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2018
- https://www.carbonfootprint.com/factors.aspx
- http://cea.nic.in/reports/others/thermal/tpece/cdm_co2/user_guide_ver10.pdf
- https://beeindia.gov.in/sites/default/files/guidebook-Campus.pdf
- https://www.elgas.com.au/blog/389-lpg-conversions-kg-litres-mj-kwh-and-m3
- http://www.sustainabilityoutlook.in/content/5-things-consider-you-plan-rooftop-pv-plant
- https://www.nrcan.gc.ca/energy/efficiency/transportation/20996
- https://www.americangeosciences.org/critical-issues/faq/how-does-recycling-save energy

6

TECHNICAL SUPPLEMENT

St. Michael's College, Cherthala															
Sl.No	Locations		Lights						Fans				IT		AC
			LED-T	LED - 40W	LED-sq(40W)	LED B	T8	T12	CF	WF	PF	EF	Projector	PC	1.5 TR
1	First floor	Top						2							
2		Manager Room	2			4			2						1
3		Lab	10						6						
4		IQAC	10						4						2
5		Seminar Hall				14									6
6		Conference Room	6												2
7		Class x 4	12						16						
8		Zoology Lab	5						4						
9		English Department	3						3						
10		Botany Lab						4	8						
11		Office	4						4		1			4	
12		Auditorium	2	5					19						
13		Canteen	2		5				6						
14		Class x 6	12						12						
15		Class x 4	16						24				4		
16	Ground Floor	Chemistry Department							3	1					
17		Lab			10					1		4			
18		Class x 8	24						24						
19		Fitness Centre	2			3	2		5					13	
20		Physics Department	2						3						
21		Ecnomics Department	3						4					2	

22		Riffle Club	5			35				4					1
23		Library	13				1			4				4	2
Total			**133**	**5**	**15**	**56**	**3**	**6**	**147**	**10**	**1**	**4**	**4**	**23**	**14**

Form 5										
Sl. No	Name of tree	Circumference	Stem diameter (cm)	Height of trees (m)	Total weight of tree (Kg)	Weight of carbon in the tree* (tCO2e)	No.of similar trees	Total carbon sequestrated (tCO2e)	Carbon Sequestrated by each species	Average age (years)
1	Indian almond	57	18.14	1.5	20.50	0.008	1	0.010	0.01	14
2	Palm tree	63	20.05	2	33.39	0.013	1	0.016	0.02	14
3	Foxtail palm	86	27.37	1.7	52.89	0.021	1	0.025	0.03	14
4	Indian almond	55	17.51	1.5	19.09	0.008	1	0.009	0.01	14
5	Indian almond	25	7.96	2	5.26	0.002	1	0.003	0.00	14
6	Indian almond	38	12.10	1.7	10.33	0.004	1	0.005	0.00	14
7	Persian silk tree	232	73.85	1.5	339.64	0.135	1	0.163	0.16	14
8	Persian silk tree	179	56.98	2	269.58	0.107	1	0.129	0.13	14
9	Persian silk tree	157	49.97	1.7	176.28	0.070	1	0.084	0.08	14
10	Persian silk tree	146	46.47	1.5	134.51	0.054	1	0.064	0.06	14
11	Persian silk	344	109.50	2	995.64	0.397	1	0.476	0.48	14

	tree									
12	gooseberry	93	29.60	1.7	61.85	0.025	1	0.030	0.03	14
13	Cashew tree	41	13.05	1.5	10.61	0.004	1	0.005	0.01	15
14	Jungle jack	24	7.64	2	4.85	0.002	1	0.002	0.00	16
15	pala	48	15.28	1.7	16.48	0.007	1	0.008	0.01	17
16	teak	66	21.01	2	36.65	0.015	1	0.018	0.02	18
17	teak	29	9.23	2	7.08	0.003	1	0.003	0.00	19
18	teak	50	15.92	2	21.03	0.008	1	0.010	0.01	20
19	teak	64	20.37	1.5	25.85	0.010	1	0.012	0.01	21
20	teak	49	15.60	2	20.20	0.008	1	0.010	0.01	22
21	teak	85	27.06	1.7	51.67	0.021	1	0.025	0.02	23
22	teak	86	27.37	1.5	46.67	0.019	1	0.022	0.02	24
23	teak	95	30.24	2	75.93	0.030	1	0.036	0.04	25
24	teak	91	28.97	1.7	59.22	0.024	1	0.028	0.03	26
25	teak	87	27.69	2	63.68	0.025	1	0.030	0.03	27
26	teak	66	21.01	2	36.65	0.015	1	0.018	0.02	28
27	teak	88	28.01	2	65.16	0.026	1	0.031	0.03	29
28	teak	114	36.29	2	109.34	0.044	1	0.052	0.05	30
29	teak	95	30.24	2	75.93	0.030	1	0.036	0.04	31
30	teak	97	30.88	2	79.16	0.032	1	0.038	0.04	32
31	teak	69	21.96	2	40.06	0.016	1	0.019	0.02	33
32	teak	73	23.24	2	44.84	0.018	1	0.021	0.02	34
33	teak	80	25.46	2	53.85	0.021	1	0.026	0.03	35
34	Teak	97	30.88	2	79.16	0.032	1	0.038	0.04	36
35	River tarmarind	40	12.73	2	13.46	0.005	1	0.006	0.01	37
36	River tarmarind	40	12.73	1.5	10.10	0.004	1	0.005	0.00	38
37	River	40	12.73	2	13.46	0.005	1	0.006	0.01	39

	tarmarind									
38	Jungle jack	47	14.96	1.7	15.80	0.006	1	0.008	0.01	40
39	Jungle jack	42	13.37	1.5	11.13	0.004	1	0.005	0.01	41
40	perumaram	44	14.01	2	16.29	0.006	1	0.008	0.01	42
41	Neem	110	35.01	1.5	76.35	0.030	1	0.037	0.04	43
42	Mango tree	67	21.33	2	37.77	0.015	1	0.018	0.02	44
43	Mango tree	118	37.56	1.7	99.58	0.040	1	0.048	0.05	45
44	Mango tree	90	28.65	1.5	51.11	0.020	1	0.024	0.02	46
45	Jack fruit tree	79	25.15	2	52.51	0.021	1	0.025	0.03	47
46	Jack fruit tree	87	27.69	1.7	54.13	0.022	1	0.026	0.03	48
47	Jack fruit tree	72	22.92	1.5	32.71	0.013	1	0.016	0.02	49
48	Jack fruit tree	54	17.19	2	24.53	0.010	1	0.012	0.01	50
49	Mango tree	54	17.19	1.7	20.85	0.008	1	0.010	0.01	51
50	Cashew tree	101	32.15	1.5	64.37	0.026	1	0.031	0.03	52
51	Foxtail palm	50	15.92	2	21.03	0.008	1	0.010	0.01	53
52	Paradise tree	38	12.10	1.7	10.33	0.004	1	0.005	0.00	54
53	Paradise tree	40	12.73	2	13.46	0.005	1	0.006	0.01	55
54	Bread fruit tree	50	15.92	2	21.03	0.008	1	0.010	0.01	56
55	Bread fruit tree	31	9.87	2	8.09	0.003	1	0.004	0.00	57
56	karaka	64	20.37	2	34.46	0.014	1	0.016	0.02	58
57	pomelo	81	25.78	2	55.20	0.022	1	0.026	0.03	59
58	pomelo	80	25.46	2	53.85	0.021	1	0.026	0.03	60
59	Jack fruit tree	90	28.65	2	68.15	0.027	1	0.033	0.03	61
60	Jack fruit tree	90	28.65	2	68.15	0.027	1	0.033	0.03	62
61	Jack fruit tree	77	24.51	2	49.88	0.020	1	0.024	0.02	63
62	Jack fruit tree	111	35.33	1.5	77.75	0.031	1	0.037	0.04	64
63	Mango tree	107	34.06	2	96.33	0.038	1	0.046	0.05	65
64	Mango tree	65	20.69	1.7	30.22	0.012	1	0.014	0.01	66
65	Mango tree	137	43.61	1.5	118.44	0.047	1	0.057	0.06	67

66	Mango tree	174	55.39	2	254.73	0.102	1	0.122	0.12	68
67	Mango tree	129	41.06	1.7	119.01	0.047	1	0.057	0.06	69
68	Mango tree	152	48.38	2	194.39	0.078	1	0.093	0.09	70
69	Mango tree	153	48.70	2	196.96	0.079	1	0.094	0.09	71
70	Mango tree	151	48.06	2	191.84	0.076	1	0.092	0.09	72
71	Neem	124	39.47	2	129.37	0.052	1	0.062	0.06	73
72	Bay leaf tree	40	12.73	2	13.46	0.005	1	0.006	0.01	74
73	guava	40	12.73	2	13.46	0.005	1	0.006	0.01	75
74	Sugar apple	35	11.14	2	10.31	0.004	1	0.005	0.00	76
75	Allinaranga	40	12.73	2	13.46	0.005	1	0.006	0.01	77
76	allinaranga	60	19.10	2	30.29	0.012	1	0.014	0.01	78
77	Jungle jack	120	38.20	1.5	90.87	0.036	1	0.043	0.04	79
78	Jungle jack	78	24.83	2	51.19	0.020	1	0.024	0.02	80
79	avocado	78	24.83	1.7	43.51	0.017	1	0.021	0.02	81
80	pathal	41	13.05	1.5	10.61	0.004	1	0.005	0.01	82
81	karaka	22	7.00	2	4.07	0.002	1	0.002	0.00	83
82	Bread fruit tree	144	45.84	1.7	148.30	0.059	1	0.071	0.07	84
83	Bread fruit tree	128	40.74	2	137.85	0.055	1	0.066	0.07	85
84	chembakam	51	16.23	2	21.88	0.009	1	0.010	0.01	86
85	Gooseberry	56	17.83	2	26.39	0.011	1	0.013	0.01	87
86	Lemon	35	11.14	2	10.31	0.004	1	0.005	0.00	88
87	Jaathi	28	8.91	2	6.60	0.003	1	0.003	0.00	89
88	Mahagony	204	64.94	2	350.14	0.140	1	0.168	0.17	90
89	karuva	150	47.75	2	189.31	0.075	1	0.091	0.09	91
90	Persian silk tree	339	107.91	2	966.91	0.386	1	0.463	0.46	92
91	Persian silk tree	410	130.51	2	1414.34	0.564	1	0.677	0.68	93
92	njaval	90	28.65	2	68.15	0.027	1	0.033	0.03	94

93	Bauhinia	45	14.32	2	17.04	0.007	1	0.008	0.01	95
94	Golden shower tree	42	13.37	2	14.84	0.006	1	0.007	0.01	96
95	gooseberry	16	5.09	1.5	1.62	0.001	1	0.001	0.00	97
96	Mango tree	27	8.59	2	6.13	0.002	1	0.003	0.00	98
97	Mango tree	18	5.73	1.7	2.32	0.001	1	0.001	0.00	99
98	Pala indigo plant	71	22.60	1.5	31.81	0.013	1	0.015	0.02	100
99	Indian almond tree	25	7.96	2	5.26	0.002	1	0.003	0.00	101
100	Teak	46	14.64	1.7	15.13	0.006	1	0.007	0.01	102
101	Indian almond tree	23	7.32	2	4.45	0.002	1	0.002	0.00	103
102	acacia	87	27.69	2	63.68	0.025	1	0.030	0.03	104
103	acacia	47	14.96	2	18.59	0.007	1	0.009	0.01	105
104	Cashew tree	63	20.05	2	33.39	0.013	1	0.016	0.02	106
105	Cashew tree	40	12.73	2	13.46	0.005	1	0.006	0.01	107
106	Cashew tree	38	12.10	2	12.15	0.005	1	0.006	0.01	108
107	lagerstroemia	60	19.10	2	30.29	0.012	1	0.014	0.01	109
108	Falso ashoka	113	35.97	2	107.43	0.043	1	0.051	0.05	110
109	False ashoka	101	32.15	2	85.83	0.034	1	0.041	0.04	111
110	False ashoka	108	34.38	2	98.14	0.039	1	0.047	0.05	112
111	False ashoka	105	33.42	2	92.76	0.037	1	0.044	0.04	113
112	araucaria	44	14.01	2	16.29	0.006	1	0.008	0.01	114
113	Aracucaria	65	20.69	2	35.55	0.014	1	0.017	0.02	115
114	aracucaria	20	6.37	1.5	2.52	0.001	1	0.001	0.00	116
115	False ashoka	99	31.51	2	82.46	0.033	1	0.039	0.04	117
116	Golden shower tree	26	8.28	1.7	4.83	0.002	1	0.002	0.00	118
117	Mahagony	48	15.28	1.5	14.54	0.006	1	0.007	0.01	119

118	lagerstroemia	40	12.73	2	13.46	0.005	1	0.006	0.01	120
119	Lagerstroemia	68	21.65	1.7	33.07	0.013	1	0.016	0.02	121
120	lagerstroemia	62	19.74	2	32.34	0.013	1	0.015	0.02	122
121	Araucaria	85	27.06	1.7	51.67	0.021	1	0.025	0.02	123
122	araucaria	64	20.37	2	34.46	0.014	1	0.016	0.02	124
123	Goose berry	60	19.10	2	30.29	0.012	1	0.014	0.01	125
124	acacia	92	29.28	2	71.21	0.028	1	0.034	0.03	126
125	acacia	55	17.51	1.5	19.09	0.008	1	0.009	0.01	127
126	acacia	57	18.14	2	27.34	0.011	1	0.013	0.01	128
127	acacia	38	12.10	1.7	10.33	0.004	1	0.005	0.00	129
128	acacia	44.5	14.16	1.5	12.50	0.005	1	0.006	0.01	130
129	acacia	78	24.83	2	51.19	0.020	1	0.024	0.02	131
130	acacia	63	20.05	1.7	28.38	0.011	1	0.014	0.01	132
131	acacia	46.5	14.80	1.7	15.46	0.006	1	0.007	0.01	133
132	acacia	57.5	18.30	1.5	20.86	0.008	1	0.010	0.01	134
133	acacia	35	11.14	2	10.31	0.004	1	0.005	0.00	135
134	Bauhinia	60	19.10	1.7	25.75	0.010	1	0.012	0.01	136
135	Cashew	70	22.28	2	41.23	0.016	1	0.020	0.02	137
136	kadamba	25	7.96	2	5.26	0.002	1	0.003	0.00	138
137	Alstonia	151	48.06	2	191.84	0.076	1	0.092	0.09	139
138	alstonia	93	29.60	2	72.77	0.029	1	0.035	0.03	140
139	Cashew	89	28.33	1.5	49.98	0.020	1	0.024	0.02	141
140	Jungle jack	43	13.69	2	15.56	0.006	1	0.007	0.01	142
141	Cashew	68	21.65	1.7	33.07	0.013	1	0.016	0.02	143
142	Cashew	74	23.55	1.5	34.56	0.014	1	0.017	0.02	144
143	Cashew	44	14.01	2	16.29	0.006	1	0.008	0.01	145
144	Cashew	82	26.10	1.7	48.09	0.019	1	0.023	0.02	146
145	Acacia	56	17.83	2	26.39	0.011	1	0.013	0.01	147
146	Jungle jack	52	16.55	2	22.75	0.009	1	0.011	0.01	148

OTTOTRACTIONS
Energy-Engineering-Environment

147	Persian silk tree	180	57.30	2	272.60	0.109	1	0.130	0.13	149
148	Persian silk tree	87	27.69	1.5	47.76	0.019	1	0.023	0.02	150
149	Persian silk tree	100	31.83	2	84.14	0.034	1	0.040	0.04	151
150	Cashew	40	12.73	1.7	11.44	0.005	1	0.005	0.01	152
151	Acacia	32	10.19	1.5	6.46	0.003	1	0.003	0.00	153
152	Acacia	28	8.91	2	6.60	0.003	1	0.003	0.00	154
153	Acacia	30	9.55	1.7	6.44	0.003	1	0.003	0.00	155
154	Acacia	41	13.05	2	14.14	0.006	1	0.007	0.01	156
155	Acacia	17	5.41	2	2.43	0.001	1	0.001	0.00	157
156	Acacia	33	10.50	2	9.16	0.004	1	0.004	0.00	158
157	Acacia	19	6.05	2	3.04	0.001	1	0.001	0.00	159
158	Acacia	62	19.74	1.5	24.26	0.010	1	0.012	0.01	160
159	Acacia	31	9.87	2	8.09	0.003	1	0.004	0.00	161
160	cashew	31	9.87	1.7	6.87	0.003	1	0.003	0.00	162
161	cashew	76	24.19	1.5	36.45	0.015	1	0.017	0.02	163
162	cashew	80	25.46	2	53.85	0.021	1	0.026	0.03	164
163	cashew	91	28.97	1.7	59.22	0.024	1	0.028	0.03	165
164	Jungle jack	28	8.91	1	3.30	0.001	1	0.002	0.00	166
165	Jungle jack	76	24.19	1.7	41.31	0.016	1	0.020	0.02	167
166	Jungle jack	72	22.92	1.5	32.71	0.013	1	0.016	0.02	168
167	Veli pathal	34	10.82	2	9.73	0.004	1	0.005	0.00	169
168	Veli pathal	29	9.23	1.7	6.01	0.002	1	0.003	0.00	170
169	Acacia	75	23.87	2	47.33	0.019	1	0.023	0.02	171
170	Acacia	26	8.28	2	5.69	0.002	1	0.003	0.00	172
171	Acacia	39	12.41	1.5	9.60	0.004	1	0.005	0.00	173
172	Acacia	50	15.92	2	21.03	0.008	1	0.010	0.01	174

173	Acacia	40	12.73	1.7	11.44	0.005	1	0.005	0.01	175
174	Acacia	50	15.92	1	10.52	0.004	1	0.005	0.01	176
175	Acacia	40	12.73	1.7	11.44	0.005	1	0.005	0.01	177
176	Acacia	62	19.74	1.5	24.26	0.010	1	0.012	0.01	178
177	Acacia	32	10.19	1.5	6.46	0.003	1	0.003	0.00	179
178	Acacia	49	15.60	2	20.20	0.008	1	0.010	0.01	180
179	Acacia	42	13.37	1.7	12.62	0.005	1	0.006	0.01	181
180	Acacia	37	11.78	1	5.76	0.002	1	0.003	0.00	182
181	Cashew	31	9.87	1.7	6.87	0.003	1	0.003	0.00	183
182	Cashew	20	6.37	1.5	2.52	0.001	1	0.001	0.00	184
183	Cashew	32	10.19	2	8.62	0.003	1	0.004	0.00	185
184	Cashew	52	16.55	2	22.75	0.009	1	0.011	0.01	186
185	Cashew	45	14.32	2	17.04	0.007	1	0.008	0.01	187
186	Cashew	33	10.50	1.5	6.87	0.003	1	0.003	0.00	188
187	Cashew	61	19.42	2	31.31	0.012	1	0.015	0.01	189
188	Cashew	33	10.50	1.7	7.79	0.003	1	0.004	0.00	190
189	Cashew	42	13.37	1	7.42	0.003	1	0.004	0.00	191
190	Cashew	47	14.96	1.7	15.80	0.006	1	0.008	0.01	192
191	Cashew	48	15.28	1.5	14.54	0.006	1	0.007	0.01	193
192	Cashew	41	13.05	2	14.14	0.006	1	0.007	0.01	194
193	Cashew	36	11.46	1	5.45	0.002	1	0.003	0.00	195
194	Acacia	85	27.06	1.7	51.67	0.021	1	0.025	0.02	196
195	Acacia	32	10.19	1.5	6.46	0.003	1	0.003	0.00	197
196	Acacia	25	7.96	2	5.26	0.002	1	0.003	0.00	198
197	Acacia	15	4.77	2	1.89	0.001	1	0.001	0.00	199
198	Acacia	47	14.96	2	18.59	0.007	1	0.009	0.01	200
199	Acacia	37	11.78	2	11.52	0.005	1	0.006	0.01	201
200	Acacia	67	21.33	1.5	28.33	0.011	1	0.014	0.01	202
201	Acacia	87	27.69	2	63.68	0.025	1	0.030	0.03	203

202	Acacia	36	11.46	1.7	9.27	0.004	1	0.004	0.00	204
203	Acacia	48	15.28	1	9.69	0.004	1	0.005	0.00	205
204	cashew	24	7.64	1.7	4.12	0.002	1	0.002	0.00	206
205	cashew	43	13.69	1.5	11.67	0.005	1	0.006	0.01	207
206	cashew	36	11.46	2	10.90	0.004	1	0.005	0.01	208
207	cashew	42	13.37	1.5	11.13	0.004	1	0.005	0.01	209
208	cashew	75	23.87	2	47.33	0.019	1	0.023	0.02	210
209	cashew	32	10.19	1.7	7.32	0.003	1	0.004	0.00	211
210	cashew	20	6.37	1	1.68	0.001	1	0.001	0.00	212
211	cashew	22	7.00	1.7	3.46	0.001	1	0.002	0.00	213
212	cashew	38	12.10	1.5	9.11	0.004	1	0.004	0.00	214
213	cashew	72	22.92	1.5	32.71	0.013	1	0.016	0.02	215
214	cashew	66	21.01	2	36.65	0.015	1	0.018	0.02	216
215	cashew	44	14.01	1.7	13.85	0.006	1	0.007	0.01	217
216	cashew	55	17.51	1	12.73	0.005	1	0.006	0.01	218
217	cashew	68	21.65	1.7	33.07	0.013	1	0.016	0.02	219
218	cashew	42	13.37	1.5	11.13	0.004	1	0.005	0.01	220
219	acacia	91	28.97	2	69.67	0.028	1	0.033	0.03	221
220	acacia	71	22.60	1.7	36.05	0.014	1	0.017	0.02	222
221	acacia	54	17.19	1	12.27	0.005	1	0.006	0.01	223
222	acacia	49	15.60	1.5	15.15	0.006	1	0.007	0.01	224
223	acacia	184	58.57	2	284.85	0.114	1	0.136	0.14	225
224	acacia	31	9.87	1.5	6.06	0.002	1	0.003	0.00	226
225	Cashew	39	12.41	2	12.80	0.005	1	0.006	0.01	227
226	Cashew	39	12.41	1.7	10.88	0.004	1	0.005	0.01	228
227	Cashew	25	7.96	1	2.63	0.001	1	0.001	0.00	229
228	Cashew	34	10.82	1.7	8.27	0.003	1	0.004	0.00	230
229	Cashew	27	8.59	1.5	4.60	0.002	1	0.002	0.00	231
230	Cashew	34	10.82	2	9.73	0.004	1	0.005	0.00	232

231	Cashew	24	7.64	1.7	4.12	0.002	1	0.002	0.00	233
232	Cashew	34	10.82	1.5	7.29	0.003	1	0.003	0.00	234
233	Cashew	46	14.64	2	17.80	0.007	1	0.009	0.01	235
234	Cashew	57	18.14	2	27.34	0.011	1	0.013	0.01	236
235	Cashew	31	9.87	1.7	6.87	0.003	1	0.003	0.00	237
236	Cashew	50	15.92	1.5	15.78	0.006	1	0.008	0.01	238
237	Cashew	40	12.73	2	13.46	0.005	1	0.006	0.01	239
238	Cashew	31	9.87	1.7	6.87	0.003	1	0.003	0.00	240
239	Acacia	69	21.96	1.5	30.04	0.012	1	0.014	0.01	241
240	Acacia	69	21.96	1.5	30.04	0.012	1	0.014	0.01	242
241	Acacia	69	21.96	2	40.06	0.016	1	0.019	0.02	243
242	Acacia	22	7.00	2	4.07	0.002	1	0.002	0.00	244
243	Acacia	27	8.59	1.7	5.21	0.002	1	0.002	0.00	245
244	Acacia	31	9.87	1.5	6.06	0.002	1	0.003	0.00	246
245	Acacia	19	6.05	2	3.04	0.001	1	0.001	0.00	247
246	Acacia	65	20.69	1.7	30.22	0.012	1	0.014	0.01	248
247	Acacia	55	17.51	1.5	19.09	0.008	1	0.009	0.01	249
248	Acacia	41	13.05	2	14.14	0.006	1	0.007	0.01	250
249	Acacia	27	8.59	2	6.13	0.002	1	0.003	0.00	251
250	Acacia	54	17.19	1.7	20.85	0.008	1	0.010	0.01	252
251	Acacia	35	11.14	1.5	7.73	0.003	1	0.004	0.00	253
252	Acacia	40	12.73	2	13.46	0.005	1	0.006	0.01	254
253	Acacia	84	26.74	1.7	50.46	0.020	1	0.024	0.02	255
254	Acacia	85	27.06	2	60.79	0.024	1	0.029	0.03	256
255	Acacia	49	15.60	1.5	15.15	0.006	1	0.007	0.01	257
256	Acacia	37	11.78	2	11.52	0.005	1	0.006	0.01	258
257	Acacia	36	11.46	2	10.90	0.004	1	0.005	0.01	259
258	Acacia	46	14.64	1.7	15.13	0.006	1	0.007	0.01	260
259	Acacia	57	18.14	1.5	20.50	0.008	1	0.010	0.01	261

260	Acacia	50	15.92	2	21.03	0.008	1	0.010	0.01	262
261	Acacia	41	13.05	1.7	12.02	0.005	1	0.006	0.01	263
262	Acacia	40	12.73	2	13.46	0.005	1	0.006	0.01	264
263	Acacia	31	9.87	2	8.09	0.003	1	0.004	0.00	265
264	Acacia	41	13.05	1.5	10.61	0.004	1	0.005	0.01	266
265	Acacia	63	20.05	2	33.39	0.013	1	0.016	0.02	267
266	Bauhinia	30	9.55	2	7.57	0.003	1	0.004	0.00	268
267	bauhinia	48	15.28	1.7	16.48	0.007	1	0.008	0.01	269
268	bauhinia	54	17.19	1.5	18.40	0.007	1	0.009	0.01	270
269	Bauhinia	50	15.92	2	21.03	0.008	1	0.010	0.01	271
270	Mango tree	63	20.05	1.7	28.38	0.011	1	0.014	0.01	272
271	Mango tree	31	9.87	2	8.09	0.003	1	0.004	0.00	273
272	cashew	62	19.74	1.5	24.26	0.010	1	0.012	0.01	274
273	cashew	36	11.46	2	10.90	0.004	1	0.005	0.01	275
274	cashew	84	26.74	2	59.37	0.024	1	0.028	0.03	276
275	cashew	58	18.46	1.7	24.06	0.010	1	0.012	0.01	277
276	cashew	54	17.19	1.5	18.40	0.007	1	0.009	0.01	278
277	cashew	54	17.19	2	24.53	0.010	1	0.012	0.01	279
278	cashew	52	16.55	1.5	17.06	0.007	1	0.008	0.01	280
279	mahagony	75	23.87	2	47.33	0.019	1	0.023	0.02	281
280	mahagony	70	22.28	2	41.23	0.016	1	0.020	0.02	282
281	mahagony	70	22.28	1.7	35.04	0.014	1	0.017	0.02	283
282	mahagony	70	22.28	1.5	30.92	0.012	1	0.015	0.01	284
283	mahagony	70	22.28	2	41.23	0.016	1	0.020	0.02	285
284	mahagony	57	18.14	1.7	23.24	0.009	1	0.011	0.01	286
285	mahagony	43	13.69	2	15.56	0.006	1	0.007	0.01	287
286	lagerstroemia	42	13.37	1.7	12.62	0.005	1	0.006	0.01	288
287	lagerstroemia	50	15.92	1.5	15.78	0.006	1	0.008	0.01	289
288	Jack fruit tree	43	13.69	2	15.56	0.006	1	0.007	0.01	290

289	Gooseberry	57	18.14	1.7	23.24	0.009	1	0.011	0.01	291
290	gooseberry	32	10.19	1.5	6.46	0.003	1	0.003	0.00	292
291	Divi divi	33	10.50	2	9.16	0.004	1	0.004	0.00	293
292	acacia	75	23.87	1.7	40.23	0.016	1	0.019	0.02	294
293	Acacia	55	17.51	1.7	21.63	0.009	1	0.010	0.01	295
294	Acacia	65	20.69	1.5	26.66	0.011	1	0.013	0.01	296
295	Acacia	90	28.65	2	68.15	0.027	1	0.033	0.03	297
296	Acacia	83	26.42	1.7	49.27	0.020	1	0.024	0.02	298
297	Acacia	82	26.10	1.5	42.43	0.017	1	0.020	0.02	299
298	Acacia	55	17.51	2	25.45	0.010	1	0.012	0.01	300
299	Acacia	53	16.87	1.7	20.09	0.008	1	0.010	0.01	301
300	Acacia	54	17.19	1.7	20.85	0.008	1	0.010	0.01	302
301	Acacia	32	10.19	1.5	6.46	0.003	1	0.003	0.00	303
302	Acacia	60	19.10	2	30.29	0.012	1	0.014	0.01	304
303	Acacia	27	8.59	1.7	5.21	0.002	1	0.002	0.00	305
304	Acacia	20	6.37	1.5	2.52	0.001	1	0.001	0.00	306
305	Acacia	19	6.05	1.7	2.58	0.001	1	0.001	0.00	307
306	Acacia	25	7.96	1.5	3.94	0.002	1	0.002	0.00	308
307	Acacia	26	8.28	1.7	4.83	0.002	1	0.002	0.00	309
308	Acacia	23	7.32	1.5	3.34	0.001	1	0.002	0.00	310
309	Acacia	60	19.10	2	30.29	0.012	1	0.014	0.01	311
310	Acacia	119	37.88	1.7	101.27	0.040	1	0.048	0.05	312
311	Acacia	100	31.83	1.5	63.10	0.025	1	0.030	0.03	313
312	Acacia	85	27.06	2	60.79	0.024	1	0.029	0.03	314
313	Acacia	145	46.15	1.7	150.36	0.060	1	0.072	0.07	315
314	gulmohar	67	21.33	1.5	28.33	0.011	1	0.014	0.01	316
315	gulmohar	145	46.15	2	176.90	0.071	1	0.085	0.08	317
316	acacia	116	36.92	1.7	96.23	0.038	1	0.046	0.05	318
317	cashew	55	17.51	1.5	19.09	0.008	1	0.009	0.01	319

OTTOTRACTIONS
Energy-Engineering-Environment

318	cashew	42	13.37	1.6	11.87	0.005	1	0.006	0.01	320
319	cashew	50	15.92	1	10.52	0.004	1	0.005	0.01	321
320	cashew	36	11.46	1.7	9.27	0.004	1	0.004	0.00	322
321	cashew	44	14.01	1.7	13.85	0.006	1	0.007	0.01	323
322	cashew	50	15.92	1.5	15.78	0.006	1	0.008	0.01	324
323	cashew	52	16.55	1.6	18.20	0.007	1	0.009	0.01	325
324	cashew	52	16.55	1	11.38	0.005	1	0.005	0.01	326
325	cashew	62	19.74	1.7	27.49	0.011	1	0.013	0.01	327
326	cashew	55	17.51	1.4	17.82	0.007	1	0.009	0.01	328
327	cashew	24	7.64	1.8	4.36	0.002	1	0.002	0.00	329
328	cashew	42	13.37	1.4	10.39	0.004	1	0.005	0.00	330
329	cashew	55	17.51	1.8	22.91	0.009	1	0.011	0.01	331
330	cashew	62	19.74	2	32.34	0.013	1	0.015	0.02	332
331	cashew	50	15.92	2	21.03	0.008	1	0.010	0.01	333
332	cashew	66	21.01	2	36.65	0.015	1	0.018	0.02	334
333	cashew	45	14.32	1.7	14.48	0.006	1	0.007	0.01	335
334	cashew	63	20.05	1.7	28.38	0.011	1	0.014	0.01	336
335	cashew	55	17.51	1.5	19.09	0.008	1	0.009	0.01	337
336	cashew	55	17.51	1.6	20.36	0.008	1	0.010	0.01	338
337	cashew	29	9.23	1	3.54	0.001	1	0.002	0.00	339
338	cashew	55	17.51	1.7	21.63	0.009	1	0.010	0.01	340
339	cashew	21	6.68	1.4	2.60	0.001	1	0.001	0.00	341
340	Acacia	52	16.55	1.8	20.48	0.008	1	0.010	0.01	342
341	Acacia	26	8.28	1.7	4.83	0.002	1	0.002	0.00	343
342	Acacia	75	23.87	1.7	40.23	0.016	1	0.019	0.02	344
343	Acacia	66	21.01	1.5	27.49	0.011	1	0.013	0.01	345
344	Acacia	57	18.14	1.6	21.87	0.009	1	0.010	0.01	346
345	Acacia	72	22.92	1	21.81	0.009	1	0.010	0.01	347
346	Acacia	69	21.96	1.7	34.05	0.014	1	0.016	0.02	348

347	Acacia	71	22.60	1.4	29.69	0.012	1	0.014	0.01	349
348	Acacia	53	16.87	1.8	21.27	0.008	1	0.010	0.01	350
349	Acacia	63	20.05	1.4	23.38	0.009	1	0.011	0.01	351
350	Acacia	59	18.78	1.8	26.36	0.011	1	0.013	0.01	352
351	Acacia	70	22.28	2	41.23	0.016	1	0.020	0.02	353
352	cashew	64	20.37	2	34.46	0.014	1	0.016	0.02	354
353	Persian silk tree	70	22.28	1.7	35.04	0.014	1	0.017	0.02	355
354	Persian silk tree	203	64.62	1.7	294.71	0.118	1	0.141	0.14	356
355	cashew	43	13.69	1.5	11.67	0.005	1	0.006	0.01	357
356	Cashew	44	14.01	1.6	13.03	0.005	1	0.006	0.01	358
357	Cashew	36	11.46	1	5.45	0.002	1	0.003	0.00	359
358	Cashew	48	15.28	1.7	16.48	0.007	1	0.008	0.01	360
359	Cashew	50	15.92	1.4	14.72	0.006	1	0.007	0.01	361
360	Cashew	47	14.96	1.8	16.73	0.007	1	0.008	0.01	362
361	Cashew	46	14.64	1.4	12.46	0.005	1	0.006	0.01	363
362	Cashew	36	11.46	1.8	9.81	0.004	1	0.005	0.00	364
363	Cashew	39	12.41	2	12.80	0.005	1	0.006	0.01	365
364	Cashew	39	12.41	1.7	10.88	0.004	1	0.005	0.01	366
365	Cashew	34	10.82	1.7	8.27	0.003	1	0.004	0.00	367
366	Cashew	48	15.28	1.5	14.54	0.006	1	0.007	0.01	368
367	Cashew	39	12.41	1.6	10.24	0.004	1	0.005	0.00	369
368	Cashew	43	13.69	1	7.78	0.003	1	0.004	0.00	370
369	Cashew	48	15.28	1.7	16.48	0.007	1	0.008	0.01	371
370	Cashew	47	14.96	1.4	13.01	0.005	1	0.006	0.01	372
371	Cashew	27	8.59	1.8	5.52	0.002	1	0.003	0.00	373
372	Cashew	55	17.51	1.4	17.82	0.007	1	0.009	0.01	374
373	Cashew	34	10.82	1.8	8.75	0.003	1	0.004	0.00	375

374	Cashew	55	17.51	2	25.45	0.010	1	0.012	0.01	376
375	Cashew	49	15.60	1.7	17.17	0.007	1	0.008	0.01	377
376	Cashew	43	13.69	1.7	13.22	0.005	1	0.006	0.01	378
377	Cashew	34	10.82	1.5	7.29	0.003	1	0.003	0.00	379
378	Cashew	24	7.64	1.6	3.88	0.002	1	0.002	0.00	380
379	Cashew	37	11.78	1	5.76	0.002	1	0.003	0.00	381
380	Cashew	70	22.28	1.7	35.04	0.014	1	0.017	0.02	382
381	Cashew	45	14.32	1.7	14.48	0.006	1	0.007	0.01	383
382	Cashew	48	15.28	1.5	14.54	0.006	1	0.007	0.01	384
383	Cashew	52	16.55	1.6	18.20	0.007	1	0.009	0.01	385
384	Cashew	45	14.32	1	8.52	0.003	1	0.004	0.00	386
385	Paradise tree	53	16.87	1.7	20.09	0.008	1	0.010	0.01	387
386	Guava	24	7.64	1.4	3.39	0.001	1	0.002	0.00	388
387	guava	29	9.23	1.7	6.01	0.002	1	0.003	0.00	389
388	Guava	24	7.64	1.7	4.12	0.002	1	0.002	0.00	390
389	Guava	22	7.00	1.5	3.05	0.001	1	0.001	0.00	391
390	Guava	23	7.32	1.6	3.56	0.001	1	0.002	0.00	392
391	Persian silk tree	172	54.75	1	124.46	0.050	1	0.060	0.06	393
392	Persian silk tree	279	88.81	1.7	556.69	0.222	1	0.266	0.27	394
393	Persian	292	92.95	1.4	502.17	0.200	1	0.240	0.24	395
394	Guava	148	47.11	1.7	156.65	0.062	1	0.075	0.07	396
395	guava	163	51.88	1.7	190.01	0.076	1	0.091	0.09	397
396	Acacia	188	59.84	1.7	252.77	0.101	1	0.121	0.12	398
397	acacia	134	42.65	1.7	128.41	0.051	1	0.061	0.06	399
398	Polyalthia longifolia	115	36.61	1.5	83.45	0.033	1	0.040	0.04	400
399	Lagerstroemia	57	18.14	1.6	21.87	0.009	1	0.010	0.01	401

400	Araucaria heterophylla	59	18.78	1	14.64	0.006	1	0.007	0.01	402
401	Araucaria heterophylla	74	23.55	1.7	39.16	0.016	1	0.019	0.02	403
402	cashew	75	23.87	1.7	40.23	0.016	1	0.019	0.02	404
403	Kalasham tree	55	17.51	1.7	21.63	0.009	1	0.010	0.01	405
404	Kalasham tree	22	7.00	1.5	3.05	0.001	1	0.001	0.00	406
405	Kalasham tree	53	16.87	1.6	18.91	0.008	1	0.009	0.01	407
406	Kalasham tree	46	14.64	1	8.90	0.004	1	0.004	0.00	408
407	Kalasham tree	59	18.78	1.7	24.89	0.010	1	0.012	0.01	409
408	Kalasham tree	58	18.46	1.4	19.81	0.008	1	0.009	0.01	410
409	Kalasham tree	24	7.64	1.8	4.36	0.002	1	0.002	0.00	411
410	Kalasham tree	94	29.92	1.4	52.04	0.021	1	0.025	0.02	412
411	Kalasham tree	44	14.01	1.8	14.66	0.006	1	0.007	0.01	413
412	Kalasham tree	58	18.46	1.8	25.47	0.010	1	0.012	0.01	414
413	Kalasham tree	38	12.10	1.7	10.33	0.004	1	0.005	0.00	415
414	Kalasham tree	46	14.64	1.7	15.13	0.006	1	0.007	0.01	416
415	Kalasham tree	68	21.65	1.5	29.18	0.012	1	0.014	0.01	417
416	Kalasham tree	42	13.37	1.6	11.87	0.005	1	0.006	0.01	418
417	Kalasham tree	28	8.91	1	3.30	0.001	1	0.002	0.00	419
418	Kalasham tree	49	15.60	1.7	17.17	0.007	1	0.008	0.01	420
419	Kalasham tree	72	22.92	1.4	30.53	0.012	1	0.015	0.01	421
420	Kalasham tree	21	6.68	1.8	3.34	0.001	1	0.002	0.00	422
421	Kalasham tree	50	15.92	1.4	14.72	0.006	1	0.007	0.01	423
422	Kalasham tree	24	7.64	1.8	4.36	0.002	1	0.002	0.00	424
423	Kalasham tree	26	8.28	2	5.69	0.002	1	0.003	0.00	425
424	Kalasham tree	31	9.87	2	8.09	0.003	1	0.004	0.00	426
425	Kalasham tree	76	24.19	2	48.60	0.019	1	0.023	0.02	427
426	Kalasham tree	37	11.78	2	11.52	0.005	1	0.006	0.01	428

427	Kalasham tree	28	8.91	2	6.60	0.003	1	0.003	0.00	429
428	Kalasham tree	46	14.64	2	17.80	0.007	1	0.009	0.01	430
429	Kalasham tree	25	7.96	2	5.26	0.002	1	0.003	0.00	431
430	Kalasham tree	27	8.59	1.7	5.21	0.002	1	0.002	0.00	432
431	Kalasham tree	72	22.92	1.7	37.07	0.015	1	0.018	0.02	433
432	Kalasham tree	41	13.05	1.5	10.61	0.004	1	0.005	0.01	434
433	Acacia	92	29.28	1.6	56.97	0.023	1	0.027	0.03	435
434	Acacia	55	17.51	1	12.73	0.005	1	0.006	0.01	436
435	Acacia	57	18.14	1.7	23.24	0.009	1	0.011	0.01	437
436	Acacia	38.5	12.25	1.4	8.73	0.003	1	0.004	0.00	438
437	Acacia	44.5	14.16	1.8	15.00	0.006	1	0.007	0.01	439
438	Acacia	78	24.83	1.4	35.83	0.014	1	0.017	0.02	440
439	Acacia	63	20.05	1.8	30.05	0.012	1	0.014	0.01	441
440	Acacia	46.5	14.80	1.7	15.46	0.006	1	0.007	0.01	442
441	Acacia	57.5	18.30	1.4	19.47	0.008	1	0.009	0.01	443
442	Acacia	55	17.51	1.8	22.91	0.009	1	0.011	0.01	444
443	Annona muricata	18	5.73	1.4	1.91	0.001	1	0.001	0.00	445
444	Annona reticulata	42	13.37	1.8	13.36	0.005	1	0.006	0.01	446
445	Artocarpus altilis	56	17.83	2	26.39	0.011	1	0.013	0.01	447
446	Averrhoa bilimbi	44	14.01	2	16.29	0.006	1	0.008	0.01	448
447	Averrhoa carambola	33	10.50	1.8	8.25	0.003	1	0.004	0.00	449
448	Bambusa bambos	45	14.32	1.4	11.93	0.005	1	0.006	0.01	450
449	Carica papaya	30	9.55	1.8	6.82	0.003	1	0.003	0.00	451
450	Elaeis	98	31.19	1.4	56.56	0.023	1	0.027	0.03	452

	guineensis									
451	Corynocarpus laevigatus	50	15.92	1.8	18.93	0.008	1	0.009	0.01	453
452	Ficus benghalensis	29	9.23	2	7.08	0.003	1	0.003	0.00	454
453	Ficus benjamina	38	12.10	2	12.15	0.005	1	0.006	0.01	455
454	Ficus elastica	32	10.19	1.7	7.32	0.003	1	0.004	0.00	456
455	Ficus exasperate	28	8.91	1.7	5.61	0.002	1	0.003	0.00	457
456	Ficus racemose	32	10.19	1.5	6.46	0.003	1	0.003	0.00	458
457	Ficus religiosa	30	9.55	1.6	6.06	0.002	1	0.003	0.00	459
458	Ficus tictoria	24	7.64	1	2.42	0.001	1	0.001	0.00	460
459	Flacourtia montana	26	8.28	1.7	4.83	0.002	1	0.002	0.00	461
460	Homalium ceylanicum	27	8.59	1.4	4.29	0.002	1	0.002	0.00	462
461	Hydnocarpus pentandrus	53	16.87	1.8	21.27	0.008	1	0.010	0.01	463
462	Lagerstroemia speciosa	60	19.10	1.4	21.20	0.008	1	0.010	0.01	464
						Total	462	9.54	9.54	234
Details of the trees having diameter more than 15cm and having heights above 150cm from ground level is taken for the study										