No: 202303039861

Certification & Inspection
ISO/IEC 17020: 2012

ROHS

035-CB-EMS
ISO 9001 : 2015 Certified (22DQJE85)
ISO 14001:2015 Certified (22DEJE84)

OTTOTRACTIONS
Energy-Engineering-Environment

Green Audit Certificate

This is to certify that the Sree Narayana College, Chengannur has conducted "Green Audit " to assess the Carbon foot print, Green initiatives, Waste management, Water management, Energy management , Environment awareness activities etc.

The data collection has been carried out diligently and truthfully.

All reasonable professional skill, care and diligence had been taken in preparing the green audit report and the contents thereof are a true representation of the facts; Adequate training provided to personnel involved in daily operations after implementation of recommendations;

and the college has submitted necessary data and credentials for verification. The green audit for the year 2020-23 has been carried out in accordance with the various rules and regulations in India.

The efforts taken by the management, faculty and the students towards environment and sustainability are highly appreciated.

Dated this 3rd day of March 2023.

OTTOTRACTIONS AEA- 0033 EMPANELED ACCREDITED ENERGY AUDITOR, BEE

SURESH BABU B V
ACCREDITED ENERGY AUDITOR
AEA-33, BUREAUOF ENERGY EFFICIENCY
GOVERNMENT OF INDIA

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www.ottotractions.com

GREEN AUDIT REPORT

SREE NARAYA COLLEGE, CHENGANNUR

Executed by

OTTOTRACTIONS
Energy - Engineering - Environment

2023

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

SREE NARAYANA COLLEGE

CHENGANNUR

OTTOTRACTIONS
Energy-Engineering-Environment

Green Audit Report

Sree Narayana College,Chengannur

Report No: EA 986

2021-22

About OTTOTRACTIONS

OTTOTRACTIONS established in 2005, is an organization with proven track record and knowledge in the field of energy, engineering, and environmental services. They are the first Accredited Energy Auditor from Kerala for conducting Mandatory Energy Audits in Designated Consumers as per Energy Conservation Act-2001. Government of Kerala recognized and appreciated OTTOTRACTIONS by presenting its prestigious "The Kerala State Energy Conservation Award 2009" for the best performance as an Energy Auditor. Ottotractions is an ISO 9001-2015 and ISO 14001-2015 Certified organization, which ensures the quality of its services.

Acknowledgment

We were privileged to work together with the administration and staff of Sree Narayana College, Chengannur for their timely help extended to complete the audit and bringing out this report.

With gratitude, we acknowledge the diligent effort and commitments of all those who have helped to bring out this report.

We also take this opportunity to thank the bona-fide efforts of audit team for unstinted support in carrying out this audit.

We thank our consultants, engineers and backup staff for their dedication to bring this report.

Thank you.

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

Preface

Educational institutions always had an important leadership role in society in demonstrating types of changes that used to occur with respect to the prime issues of the time. All around the world, educational institutions are taking steps to declare themselves the next carbon neutral school as a part of the global trend of becoming sustainable. In 2007, Victoria University School of Architecture and Design declared themselves the first carbon neutral campus in the world through the purchase of carbon credits. This concept is not a sustainable model as it does not guarantee the capture of carbon forever and also it is expensive.

The potential for any academic institution- (may be a school in a remote village or a university in an urban setting) - to become the driver for change is huge. Its role of practicing leadership in its community can be utilized to encourage and influence carbon neutral living.

The biggest factors that contribute towards emission are Energy, Transportation and Waste. Any reduction in the carbon emission by the above sectors, starts with the behavioral changes (Low cost) and/or technological investments (High cost). In order to make these changes, the students are to be educated properly on the concept of carbon neutral campuses and methods to reduce it.

In India, the concept of carbon neutral campuses is gaining momentum. Green Audit in Campuses measures the amount of Green House Gases (GHG) emissions produced as a result of its operations through an accounting like inventory of all the sources of GHGs and carbon sequestration in the school campus. Based on this, the total carbon footprint is estimated. Measures are recommended to bring down the carbon footprint of the campus and to make it a carbon neutral campus.

B. Zachariah
Director, OTTOTRACTIONS

Contents

OTTOTRACTIONS
Energy Engineering Environment

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Introduction

Background

All across the developed countries, educational institutions are now moving to a sustainable future by becoming carbon neutral and greener spaces. They are taking responsibility for their environmental impact and are working to neutralize those effects. To become carbon neutral, institutions are working to reduce their emissions of greenhouse gases, cut their use of energy, use energy efficient equipment, use more renewable energy, plant and protect green cover and emphasize the importance of sustainable energy sources. Institutions that have committed to becoming carbon neutral have recognized the threat of global warming and are therefore committing to reverse the trend. Studies on this line has not struck roots in most of the developing countries-especially among students.

The Sustainable Development Goals (SDGs), launched by the United Nations in 2015, are an excellent vehicle for driving this change. They represent an action plan for the planet and society to thrive by 2030. The SDGs provide a window of opportunity for creating multidimensional operational approaches for climate change adaptation. They address poverty, hunger and climate change, among other issues central to human progress and sustainable development, such as gender equality, clean water and sanitation, and responsible consumption and production.

The Green Audit of college aims to assist campus to reduce their carbon footprint and educate tomorrow's leaders about strategies for carbon mitigation using their campus as a model. Also, this audit covers institutes responses towards SDGs by covering SDG 3,6,7,11,13,15. The green audit also aims to educate students and teachers on the concept of carbon footprint and to enable the students to collect data pertaining to the carbon emissions and carbon sequestration in their campus and to calculate the specific carbon footprint of the campus.

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 major objectives of the audit are:

- To make aware students and teachers on the concept of carbon footprint.
- To calculate the specific carbon footprint of the campus and classify it as carbon negative, neutral or positive.
- To create carbon mitigation plans to reduce their footprint based on the data generated.

SREE NARAYANA COLLEGE, CHENGANNUR

Sree Narayana College, Chengannur is a major centre for higher education offering educational opportunities to the rural community. The College is named after the great saint and social reformer Sree Narayana Gurudev. It stands as a monument that reminds us of the great doctrines of the Guru. The basic objective of the institution is to provide education to the marginalised section of the society. The college started functioning in 1981, and is a young growing college offering five under graduate courses and three post graduate courses. The college is situated in a beautiful place 6kms away from Chengannur. The college endeavours to mould a community of students committed to the pursuit of truth and moral excellence upholding the high ideals of Sree Narayana Guru, our patron. It was His Holiness Narayana Guru's call

to seek “Liberation through Education” which inspired the distinguished citizens of this backward area to start a new college. We aim at building up a humane and socially committed fraternity of young men and women through education. The motto of the college is “Enlightenment through Education”. The college stands for academic excellence as well as development of the skill and character of students based on the Holy Guru’s perspectives on humanism, secularism and universal brotherhood.

Occupancy Details			
Particulars	2020-21	2021-22	2022-23
Total Students	549	534	326
Staffs	33	31	31
Total Occupancy of the college	582	565	357

For calculating per capita carbon emission estimation, only the student strength is taken into account.

Form-A											
BASELINE DATA SHEET FOR GREEN AUDIT											
1	Name of the Organisation	Sree Narayana College, Chengannur									
2	Address (include telephone, fax & e-mail)	Sree Narayana College Chengannur Neduvaramcode PO, Cheriyanad, Chengannur- 689508									
3	Year of Establishment	1981									
4	Name of building and Total No. of Electrical Connections/building	Block A, Block B, Block C and Library Block									
5	Total Number of Students	Boys		Girls		Total	326				
6	Total Number of Staff	31									
7	Total Occupancy	357									
8	Total area of green cover (hectare)	2.20									
9	Type of Electrical Connection	HT	0	LT	3						
10	Total Connected Load (kW)	24									
11	Average Maximum Demand (KVA)	-									
12	Total built up area of the building (M^2)	2855									
13	Number of Buildings	6									
14	Average system Power Factor	0.95									
15	Details of capacitors connected	0									
16	Transformer Details (Nos., kVA, Voltage ratio)	TR 1	315								
17	DG Set Details (kVA,)	DG1	DG2	DG3	DG4	DG5	Remarks				
		0									
18	Details of motors	Rating		Nos.		Remarks					
		5 to 10		0							
		10 to 50									
		Above 50									
19	Brief write-up about the firm and the energy/environmental conservation activities already undertaken.	1kWp Solar power plant is installed, Bhoomithrasena club, Water conservation activities, Energy conservation activities,Biogasplant installed									
20	Contact Person & Telephone number	Dr. Anju K S									
		9447187800									

2
METHODOLOGY

2.1. Sensitisation

Low Carbon campus initiatives are successful when everyone in the campus is engaged including students, teachers and staff. A team of students, teachers and staff were formed to participate in the audit. A sensitisation among students and teachers on the concept of carbon footprint was conducted.

During the audit the students and staffs were sensitised on the project and trained to be a part of the data collection team. This helped in conducting the survey in a participatory mode so that the awareness will penetrate to the grass root level. During the data collection field visit it was stressed that the team will spread these ideas to their homes and friends. This will help in a horizontal and vertical spread of the message to a wider group. It is assumed that through 357 occupants of this campuses will reach same number of households. This message will spread to at least 1428 individuals approximately.

2.2 Estimation of carbon footprint

A carbon footprint is the amount of greenhouse gases—primarily carbon dioxide—released into the atmosphere by a particular human activity. A carbon footprint can be a broad measure or be applied to the actions of an individual, a family, an event, an organization, or even entire nation. It is usually measured as tons of CO_2 emitted per year, a number that can be supplemented by tons of CO_2-equivalent gases, including methane, nitrous oxide, and other greenhouse gases.

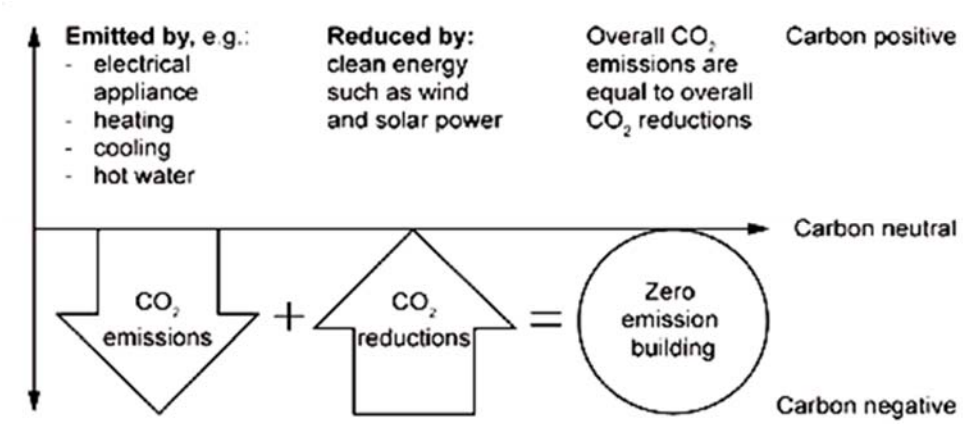
Global Warming Potential (GWP) is a measure of how much heat a greenhouse gas traps in the atmosphere up to a specific time horizon, relative to carbon dioxide. The Global Warming Potential (GWP) was developed to allow comparisons of the global warming impacts of different gases. Specifically, it is a measure of how much energy the emissions of one ton of a gas will absorb over a given period of time, relative to the emissions of one ton of carbon dioxide (CO_2).

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 methodology for carbon footprint calculations is still evolving and it is emerging as an important tool for green house management. In the present study carbon emission data from the campus is estimated under four categories viz.

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

Carbon neutrality refers to achieving net zero GHG emission by balancing the measured amount of carbon released into atmosphere due to human activities, with an equal amount sequestrated in carbon sinks. It is crucial to restrict atmospheric concentrations of GHGs released from various socio-economic, developmental and life style activities using biological or natural processes. It is recognized that addressing climate change is not as simple as switching to renewable energy or offsetting GHG emissions. Rather, providing an opportunity for innovation in new developmental activities for viable and effective approach to address the problem.



Energy

In the campus carbon emission from energy consumption is categorised under two headings viz. energy from Electrical and Thermal. Energy used for transportation is calculated under transportation sector.

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 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

Carbon emission from transportation to be calculated by using the following formula:

Carbon Emission = Number of each type of vehicles × Avg. fuel consumed per year ×Emission factors (based on the fuel used by the vehicle)

Only vehicles operate from the campus will take in to the account of transportation. The private vehicles are not considered for accounting carbon foot print. As private vehicle footprint will be in the account for personal footprint.

Waste Minimisation

The waste generated from the campus is also responsible for the greenhouse gas emission. So, in order to calculate the total carbon foot print of the campus it is necessary to estimate the greenhouse gas emission from the waste generated in the campus by the activity of the students, teachers and staffs.

The calculation of the waste generated has been conducted by keeping measuring buckets for collecting the waste generated in a day. This waste so generated was calculated by weighing it.

Carbon Sequestration

Carbon sequestration is the process involved in the long-term storage of atmospheric carbon dioxide. Trees remove carbon dioxide from the atmosphere through the natural process of photosynthesis and store the carbon in their leaves, branches, stems, bark, and roots

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

Detailed calculations and results are given below.

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. $W_{\text{carbon-dioxide}} = 3.67 * W_{\text{carbon}}$

3

RESULTS AND DISCUSSIONS

3.1 CARBON FOOTPRINT ESTIMATION

3.1.1 ENERGY

a. Electricity

Electricity is purchased from KSEB under 3 LT-6F Ndom Connections, the details are given below.

Electricity Connection Details		
Sree Narayana College, Chengannur		
1	Name of the Consumer	Sree Narayana College, Chengannur Chenganoor
2	Tariff	LT 6B Ndom
3	Consumer Number	1155331020552, 1155332001350, 1155372011780
5	Connected Load Total (kW)	24
6	Annual Electricity Consumption (kWh)	16257

Electricity Bill Analysis (from 2020 to 2023)

1155372011780								
2022-23			2021-22			2020-21		
Month	kWh	Amount	Month	kWh	Amount	Month	kWh	Amount
May-22	941	7495	May-21	518	4844	May-20	900	7319
Jul-22	706	5969	Jul-21	697	5966	Jul-20	839	6857
Sep-22	731	6179	Sep-21	633	5564	Sep-20	466	4518
Nov-22	1492	12526	Nov-21	813	6693	Nov-20	679	5854
Jan-23	917	7566	Jan-22	941	7495	Jan-21	929	7421
Feb-23	964	7866	Feb-22	706	5969	Feb-21	779	6481

1155331020552							
2022-23		**2021-22**			**2020-21**		
Date	**kWh**	**Date**	**kWh**	**Amount**	**Date**	**kWh**	**Amount**
May-22	1197	May-21	250	1467	May-20	184	1469
Jul-22	776	Jul-21	250	2728	Jul-20	183	1467
Sep-22	775	Sep-21	679	1909	Sep-20	139	1108
Nov-22	1466	Nov-21	1075	5701	Nov-20	111	1904
Jan-23	2014	Jan-22	1197	3740	Jan-21	567	4926
Feb-23	1902	Feb-22	776	1909	Feb-21	250	1467

1155332001350							
2022-23		2021-22			2020-21		
Month	kWh	Month	kWh	Amount	Month	kWh	Amount
May-22	554	May-21	111	1968	May-20	165	1771
Jul-22	378	Jul-21	160	2116	Jul-20	90	2079
Sep-22	405	Sep-21	331	1640	Sep-20	120	3151
Nov-22	350	Nov-21	521	1829	Nov-20	153	4342
Jan-23	414	Jan-22	275	2036	Jan-21	323	2800
Feb-23	275	Feb-22	414	3101	Feb-21	112	3671

Annual Electricity Consumption (kWh)					**Connected Load**
Sl.No	**Consumer No**	2020-21	2021-22	2022-23	
1	1155331020552	1434	4227	8130	5
2	1155332001350	963	1812	2376	7.5
3	1155372011780	4592	4308	5751	11
Total		**6989**	**10347**	**16257**	**24**

b. Diesel & LPG

The campus doesn't have any consumption of diesel and LPG

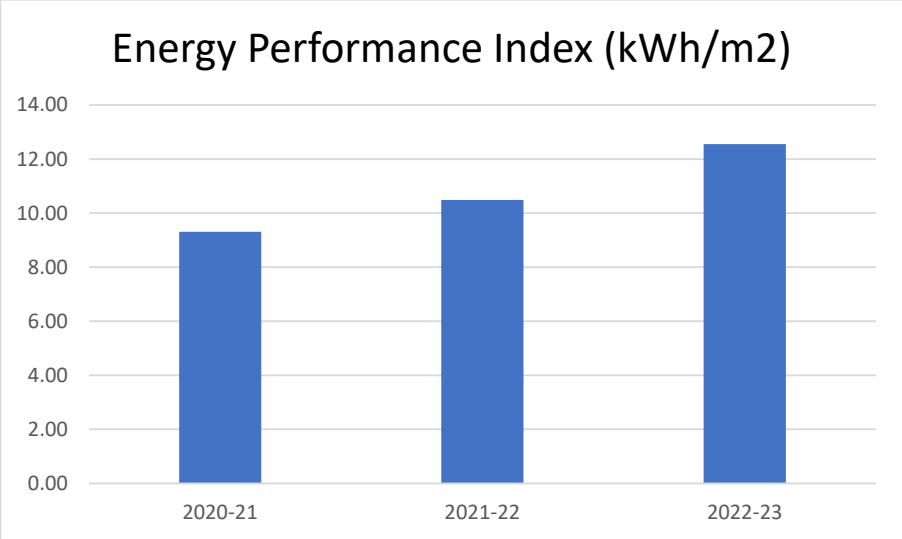
Sree Narayana College, Chengannur				
		2020-21	2021-22	2022-23
1	Electricity KSEB (kWh)	6988.5	10347	16257
2	Electricity Solar Consumption (kWh)	1278	1278	1278
3	Electricity (KSEB + Solar) kWh	8266	11625	17535
4	Electricity Solar Export (kWh)	0	0	0
5	Diesel (L)	0.00	0.00	0.00
6	LPG (kg)	0	0	0
7	Biogas (m^3)	3500.00	3500.00	3500.00

Energy Consumption Profile							
Sl No	Fuel	2020-21		2021-22		2022-23	
		kCal	kWh	kCal	kWh	kCal	kWh
1	Electricity	7108760	8266	9997070	11625	15079670	17535
2	Diesel	0	0	0	0	0	0
3	LPG	0	0	0	0	0	0
4	Biogas	15750000	18314	15750000	18314	15750000	18314
Total		22858760	26580	25747070	29938	30829670	35848

Thermal Fuel Consumption Sree Narayana College, Chengannur			
	2020-21	2021-22	2022-23
Annual LPG consumption in kg	0	0	0
Annual Diesel consumption in L	0	0	0
Annual petrol consumption in L	0	0	0
Annual Biogas consumption in m3	3500	3500	3500

Specific Energy Consumption

OTTOTRACTIONS- ENERGY AUDIT Sree Narayana College, Chengannur Energy Performance Index (EPI)				
Sl No	Particulars	2020-21	2021-22	2022-23
1	Total building area (m²)	2855	2855	2855
2	Annual Energy Consumption (kCal)	22858760	25747070	30829670
3	Annual Energy Consumption (kWh)	26580	29938	35848
4	Total Energy in Toe	2.29	2.57	3.08
5	Specific Energy Consumption kWh/m²	9.31	10.49	12.56



3.3. Waste Generation total

The major concern of waste management will be focused on the solid waste produced by the campus. Solid wastes produced in the campus are mainly of three types, food waste, paper waste, and plastic waste. Food wastes produced in the campus are mainly by two means. The vegetable wastes produced in the kitchen during the food preparation. The food waste produced by the students and staffs of the campus after the consumption of meals.

Degradable Waste

Degradable Waste Generation			
Sree Narayana College, Chengannur			
	2020-21	2021-22	2022-23
Total Occupancy	582	565	357
Waste generated in kg /day	11.64	11.3	7.14
Waste generated in kg /Yr	1396.8	1356	856.8

Non-Degradable waste

Solid non degradable Waste Generation			
Sree Narayana College, Chengannur			
	2020-21	2021-22	2021-22
Total Occupancy	582	565	357
Waste paper generated in kg /day	0.1164	0.113	0.0714
Waste plastic generated in kg /day	0.1746	0.1695	0.1071
Waste paper generated in kg /Yr	13.968	13.56	8.568
Waste plastic generated in kg /Yr	20.95	20.34	12.85

3.4. Transportation

There are no vehicles operates from college for its logistics.

Carbon Emission Profile (2021-22)

Carbon emissions in the campus due to the day-to-day activities are calculated and is discussed below. The emission factors considered for estimation and its units are given.

Emission Factors		
Item	Factor	Unit
Electricity	0.00082	tCo_2e/kWh
LPG	0.0015	tCo_2e/kg
Diesel	0.0032	tCo_2e/kg
Petrol	0.0031	tCo_2e/kg
Food Waste	0.00063	tCo_2e/kg
Paper Waste	0.00056	tCo_2e/kg
Plastic Waste	0.00034	tCo_2e/kg

Carbon Foot Print 2020-23

Carbon Foot Print							
Sl. No.	Particulars	2020-21	tCO2e	2021-22	tCO2e	2022-23	tCO2e
1	Electricity (kWh)	8266	6.78	11625	9.53209	17535	14.38
2	Diesel (L)	0	0	0	0	0	0.00
3	LPG (kg)	0	0	0	0	0	0.00
4	Biogas (M3)	3500	5	3500	5	3500	4.90
5	Degradable Waste in kg/yr.	1396.80	0.88	1356.00	0.85	856.80	0.54
6	Paper Waste in kg/yr	13.968	0.0078	13.56	0.0076	8.57	0.005
7	Plastic Waste in kg/yr	20.95	0.0071	20.34	0.0069	12.85	0.00
Total Carbon Foot Print tCO2e/yr			12.57		15.3009		19.83

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			
Parculers	2020-21	2021-22	2022-23
Carbon sequestrated by trees in the campus (tCO2e)	0.96	1.02	1.13

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 3.18. 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 sequestrated by each species of trees in the campus compound is given in the technical supplement.

CARBON FOOTPRINT OF THE CAMPUS (2022-23)

Various carbon emitting activities such as consumption of energy, transportation and waste generation leads to the total emission of **19.83 tCO_2e** per year by the campus. The total carbon sequestration by trees in the campus compound is **1.13 tCO_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 of 2021-22.

Specific CO2 Footprint

Amount of Carbon to be mitigated for Low Carbon Campus				
Sl No	Particulars	2020-21	2021-22	2022-23
1	Total carbon emission tCO2e	12.57	15.30	19.83
2	Total carbon sequestration tCO2e	0.96	1.02	1.13
3	Amount of carbon mitigated through renewable energy tCO2e	5.95	5.95	5.95
4	To be mitigated tCO2e	5.66	8.33	12.75
5	Total No of Students	549	534	326
6	Specific Carbon Footprint kg CO2e/Student/Yr	10.31	15.60	39.10

The total specific carbon emission is estimated as **39.10** kg of CO_2e per student for the year 2022-23.

4

Carbon Mitigation Plans

The total emission of the carbon dioxide per student is **39.10** kg per year (2022-2023). Emission reduction plans were prepared to bring the existing per capita carbon footprint to zero or below so as to bring the campus a carbon neutral or carbon negative campus.

This can be achieved in many ways but, every alternate plan must be in such a way that, it must fulfill the actual purpose of each activity that is considered.

Here, three major methods are taken in to account as the plans for reducing the carbon emission of the campus.

- Resource optimisation
- Energy efficiency
- Renewable energy

RESOURCE OPTIMISATION

The effective use of resources can limit its unnecessary wastage. Optimal usage of the resources (such as fuels) can save the fuel and can also reduce the carbon emission due to its consumption. This technique can be effectively implemented in the ’transportation’ and ‘waste’ sectors of the campus.

WASTE MINIMISATION

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.

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.

ENERGY EFFICIENCY

Energy efficiency is the practice of reducing the energy requirements while achieving the required energy output. Energy efficiency can be effectively implemented in all the sectors of the campus.

FUELS FOR COOKING

The campus uses commercial LPG cylinders and biogas for its cooking purpose. The 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’

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						
Sree Narayana College, Chengannur						
Greenhouse Gas Mitigation through Major Energy Efficiency 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	Energy Saving in Lighting by replacing existing 21 No's T8 (40W) Lamps to 18W LED Tube	297	0.30	10	0.24	2.44
3	Energy Saving by replacing existing 80No's in-efficient ceiling fans with Energy Efficient Five star fans/BLDC Fans	2168	2.17	10	1.78	17.78
Total		**2465**	**2**	**20**	**2.02**	**20**

OTTOTRACTIONS- ENERGY AUDIT						
Sree Narayana College, Chengannur						
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 20 kWp Solar Power Plant	19163	19.16	25	15.71	392.83
	Total	19163	19	25	16	393

Executive Summary					
Consolidated Cost Benefit Analysis of Energy Efficiency Improvement Projects					
Sree Narayana College, Chengannur					
Sl No	Projects	Investment	Cost saving	SPB	Energy saved
		(Lakhs Rs)	(Lakhs Rs)/Yr	Months	kWh/Yr
1	Energy Saving in Lighting by replacing existing 21 No's T8 (40W) Lamps to 18W LED Tube	0.05	0.027	23.56	297
2	Energy Saving by replacing existing 80No's in-efficient ceiling fans with Energy Efficient Five star fans/BLDC Fans	2.00	0.180	133.36	2168
	Total	**2.05**	**0.21**	**78.46**	**2465**
(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	19.83
2	Carbon Sequestrated tCO2e/yr	1.13
3	Carbon mitigated by Renewable Energy tCO2e/yr (Installed)	5.95
3	Carbon mitigated by Renewable Energy tCO2e/yr (Proposed)	15.71
4	Carbon mitigated by Energy Efficiency (Proposed) tCO2e/yr	2.02
5	Effective Carbon footprint tCO2e/yr	-4.99
6	Total No of Students	326
7	Specific Carbon Footprint kg CO2e/Student/Yr	-15.30

From this study it was found that carbon footprint of the campus to be **–15.30** kgCO_2e/ Student/ Year in place of current footprint i.e., **60.82** kgCO_2e/ student/ Year. This will be achieved after implementing energy efficiency projects and implementation of 15kWp solar power plant. To achieve this an investment of **10.30 lakhs Rs** is required through energy efficiency and renewable energy projects proposed. It will be around **3160 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	2.05
2	Cost of implementation in Renewable Energy Lakhs Rs	8.25
3	Total Lakhs Rs	10.30
4	Total number of students	326
5	Cost per student to make the campus carbon negative Rs/ Student	3160

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
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OTTOTRACTIONS
Energy-Engineering-Environment

6

TECHNICAL SUPPLEMENT

Sree Narayana College, Chengannur													
Sl.No	Block	Location	T8	T12	CFL	LED B	LED T	CF	EF	Printer	Projector	PC	AC (1.5TR)
1	Block A	Class rooms*3					6	6					
2		Lab *2					4	4					
3		Physics Lab	4	1			2	7					
4		Physics Dept					1	1					
5		Principal	1			2		2					
6		Office					4	5		2		4	
7		Chemistry Dept.	1					2					
8		B Sc Chemistry Lab-1	1		2			1					
9		M Sc Chemistry Lab	3		1								
10		Chemistry Lab -2	4				2	1					
11	Library	Library	4	2				2					
12		Reading room					1	2					
13		Class rooms*2					4	4					
14		Class room-1					4	6					
15	Block B	Class room*2					4	4					
16	Block C	Class room*3					6	12					
17	Block D	Maths Dept.	2				2	2					
18		Economics Dept.	1				2	2					
19		Auditorium					2	6					
20	Hostel	Rooms *11					22	11					
TOTAL			21	3	3	2	66	80	0	2	0	4	0

KERALA STATE ELECTRICITY BOARD LIMITED

DEMAND CUM DISCONNECTION NOTICE

(As per Regulation 122 & 123 of Kerala Electricity Supply Code 2014)

Section	**[5533]-Electrical Section Chenganoor**	**Phone#**	0479-2452223	**Customer Care**	1912
Consumer#	**1155331020552**	Reg. Mob# **949xxxx517**		**Regular CC Bill**	**KSEBL GSTIN: 32AAECK2277NBZ1**

Name & Mailing Address

PRINCIPAL

SREE NARAYANA COLLEGE, NEDUVARAMKODU.P.O, CHE

NGANNUR

For redressing complaints/grievance approach the concerned CGRF

South: Chairperson,CGRF(South),KSEB Ltd, Vydythi Bhavanam,Kottarakkara-691506, Ph:0474-2060220

Central: Chairperson,CGRF(Central),KSEB Ltd, Power House Building Ernakulam-682018, Ph:0484-2394288

North: Chairperson,CGRF(North),KSEB Ltd,Gandhi Road,Kozhikode-32, Ph:0495-2367820

State Electricity Ombudsman, Pallikkavil Building,Mamangalam, Edappally, Kochi-682024 Ph:0484-2346488

Bill#	**5533230108090**	**Bill Area**	A01/12	**DTR**	NEDUVARAMCODU FEDERAL BAN
Billing Period	**1/2023**[Bi-Monthly]	**Tariff/Phase**	LT-6B/Three	**Pole#**	PN/112/16
Bill Date	**12-01-2023**	**Due Date**	**23-01-2023**	**DC Date**	**07-02-2023**
Contract Demand	**(Nil)** VA [75% : 0KV, 130% : 0KV]	**Connected Load**	5040 Watts	**Security Deposit**	Rs.15684.00
Meter#	GIL0000S0004510092	**Average consumption(Monthly)**			
Meter Digits	6.2	**Power Unit/Zone**	**CUMULATIVE**		
Meter Type/Owner	TOD/KSEB	KWH	709		

Last Billed Rdg. Date	Prev. Rdg. Date	Prev. Meter Rdg. Status	Prst. Rdg. Date	Prst. Meter Rdg. Status
12-11-2022	**12-11-2022**	**Working**	**12-01-2023**	**Working**

Power Unit	Zone	Trading	Initial Reading(IR)	Final Reading(FR)	OMF	Units*
KWH	Cumulative	Import	9410.00	11312.00	1	1902

Remarks :

Last Paid Amount - Rs.16159.00

Last Payment Date - 07-02-2023

	Bill Details		**[INR] Amount(Rs.)**
a)	Fixed Charges	Fixed Charge[FC]	1080.00
		Sub Total	**1080.00**
b)	Energy Charges	Energy Charge[EC]	13599.30
		Sub Total	**13599.30**
c)	Other Charges	Electricity Duty[ED]	1359.93
		Meter Rent[MR]	30.00
		Sub Total	**1389.93**
d)	GST	MR-CGST	2.70
		MR-SGST	2.70
		Sub Total	**5.40**
e)	Round Off		0.37
f)	**Total Amt.(Bill#5533230108090)** *(a+b+c+d+e)*		**16075.00**
g)	Surcharge		84.00
h)	Reconnection Fee		0.00
i)	Interim Bills		0.00
j)	Arrears		0.00
k)	Less paid/adj.		-16159.00
l)	Less Advance		-0.00
	Net Payable*(f+g+h+i+j-k-l)*		**0.00**

Demand for 1/2023 is Rupees Sixteen Thousand and Seventy Five Only

E&OE ***Payment Options:*** *Cash,Cheque,DD,MO.* ***Online: www.kseb.in (Debit/Credit Cards,Net Banking)****. Other Platforms: BBPS,Friends,Akshaya,CSC,NACH*

Senior Superintendent

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KERALA STATE ELECTRICITY BOARD LIMITED

DEMAND CUM DISCONNECTION NOTICE

(As per Regulation 122 & 123 of Kerala Electricity Supply Code 2014)

Section	**[5533]-Electrical Section Chenganoor**	**Phone#**	0479-2452223	**Customer Care**	1912
Consumer#	**1155332001350**	Reg. Mob# **944xxxx311**		**Regular CC Bill**	**KSEBL GSTIN: 32AAECK2277NBZ1**

Name & Mailing Address

PRINCIPAL

S N COLLEGE, ALA, CHENGANNUR

For redressing complaints/grievance approach the concerned CGRF

South: Chairperson,CGRF(South),KSEB Ltd, Vydythi Bhavanam,Kottarakkara-691506, Ph:0474-2060220

Central: Chairperson,CGRF(Central),KSEB Ltd, Power House Building Ernakulam-682018, Ph:0484-2394288

North: Chairperson,CGRF(North),KSEB Ltd,Gandhi Road,Kozhikode-32, Ph:0495-2367820

State Electricity Ombudsman, Pallikkavil Building,Mamangalam, Edappally, Kochi-682024 Ph:0484-2346488

Bill#	**5533230108085**	**Bill Area**	A01/12	**DTR**	NEDUVARAMCODU FEDERAL BAN
Billing Period	**1/2023**[Bi-Monthly]	**Tariff/Phase**	LT-6A/Three	**Pole#**	PN/112/14
Bill Date	**12-01-2023**	**Due Date**	**23-01-2023**	**DC Date**	**07-02-2023**
Contract Demand	**(Nil)** VA [75% : 0KV, 130% : 0KV]	**Connected Load**	7500 Watts	**Security Deposit**	Rs.4248.00

Meter#	UEI5533M0000013668	**Average consumption(Monthly)**	
Meter Digits	5.1	**Power Unit/Zone**	**CUMULATIVE**
Meter Type/Owner	Static/KSEB	KWH	189

Last Billed Rdg. Date	**Prev. Rdg. Date**	**Prev. Meter Rdg. Status**	**Prst. Rdg. Date**	**Prst. Meter Rdg. Status**
12-11-2022	**12-11-2022**	**Working**	**12-01-2023**	**Working**

Power Unit	**Zone**	**Trading**	**Initial Reading(IR)**	**Final Reading(FR)**	**OMF**	**Units***
KWH	Cumulative	Import	30353.00	30907.00	1	554

Remarks :

Last Paid Amount - Rs.4690.00

Last Payment Date - 13-01-2023

Bill Details			**[INR] Amount(Rs.)**
a)	Fixed Charges	Fixed Charge[FC]	1120.00
		Sub Total	**1120.00**
b)	Energy Charges	Energy Charge[EC]	3213.20
		Sub Total	**3213.20**
c)	Other Charges	Electricity Duty[ED]	321.32
		Meter Rent[MR]	30.00
		Sub Total	**351.32**
d)	GST	MR-CGST	2.70
		MR-SGST	2.70
		Sub Total	**5.40**
e)	Round Off		0.08
f)	**Total Amt.(Bill#5533230108085)** *(a+b+c+d+e)*		**4690.00**
g)	Surcharge		0.00
h)	Reconnection Fee		0.00
i)	Interim Bills		0.00
j)	Arrears		0.00
k)	Less paid/adj.		-4690.00
l)	Less Advance		-0.00
	Net Payable*(f+g+h+i+j-k-l)*		**0.00**

Demand for 1/2023 is Rupees Four Thousand Six Hundred and Ninety Only

E&OE ***Payment Options:*** *Cash,Cheque,DD,MO.* ***Online: www.kseb.in (Debit/Credit Cards,Net Banking)****. Other Platforms: BBPS,Friends,Akshaya,CSC,NACH*

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KERALA STATE ELECTRICITY BOARD LIMITED

DEMAND CUM DISCONNECTION NOTICE

(As per Regulation 122 & 123 of Kerala Electricity Supply Code 2014)

Section	**[5537]-Electrical Section Kollakadavu**	**Phone#**	0479-2357251	**Customer Care**	1912
Consumer#	**1155372011780**	Reg. Mob# **944xxxx412**		**Regular CC Bill**	**KSEBL GSTIN: 32AAECK2277NBZ1**

Name & Mailing Address

PRASANNA M S

S N COLLEGE, CHERIYANADU

For redressing complaints/grievance approach the concerned CGRF

South: Chairperson,CGRF(South),KSEB Ltd, Vydythi Bhavanam,Kottarakkara-691506, Ph:0474-2060220

Central: Chairperson,CGRF(Central),KSEB Ltd, Power House Building Ernakulam-682018, Ph:0484-2394288

North: Chairperson,CGRF(North),KSEB Ltd,Gandhi Road,Kozhikode-32, Ph:0495-2367820

State Electricity Ombudsman, Pallikkavil Building,Mamangalam, Edappally, Kochi-682024 Ph:0484-2346488

Bill#	**5537230204056**	**Bill Area**	B01/7	**DTR**	AMBEDKAR COLONY
Billing Period	**2/2023**[Bi-Monthly]	**Tariff/Phase**	LT-6A/Three	**Pole#**	Unknown_55378
Bill Date	**07-02-2023**	**Due Date**	**17-02-2023**	**DC Date**	**06-03-2023**
Contract Demand	**(Nil)** VA [75% : 0KV, 130% : 0KV]	**Connected Load**	11275 Watts	**Security Deposit**	Rs.14724.00

Meter#	L&T020160015587913	**Average consumption(Monthly)**	
Meter Digits	6.2	**Power Unit/Zone**	**CUMULATIVE**
Meter Type/Owner	TOD/KSEB	KWH	562

Last Billed Rdg. Date	**Prev. Rdg. Date**	**Prev. Meter Rdg. Status**	**Prst. Rdg. Date**	**Prst. Meter Rdg. Status**
07-12-2022	**07-12-2022**	**Working**	**07-02-2023**	**Working**

Power Unit	**Zone**	**Trading**	**Initial Reading(IR)**	**Final Reading(FR)**	**OMF**	**Units***
KWH	Cumulative	Import	45131.00	46167.00	1	1036

Remarks :

Last Paid Amount - Rs.9360.00

Last Payment Date - 10-02-2023

	Bill Details		**[INR] Amount(Rs.)**
a)	Fixed Charges	Fixed Charge[FC]	1680.00
		Sub Total	**1680.00**
b)	Energy Charges	Energy Charge[EC]	6889.40
		Fuel Surcharge[FS]	10.88
		Sub Total	**6900.28**
c)	Other Charges	Electricity Duty[ED]	688.94
		Meter Rent[MR]	30.00
		Sub Total	**718.94**
d)	GST	MR-CGST	2.70
		MR-SGST	2.70
		Sub Total	**5.40**
e)	Round Off		0.38
f)	**Total Amt.(Bill#5537230204056)** *(a+b+c+d+e)*		**9305.00**
g)	Surcharge		47.00
h)	Reconnection Fee		0.00
i)	Interim Bills		0.00
j)	Arrears		0.00
k)	Less paid/adj.		-9352.00
l)	Less Advance		-8.00
	Net Payable*(f+g+h+i+j-k-l)*		**0.00**

Demand for 2/2023 is Rupees Nine Thousand Three Hundred and Five Only

E&OE ***Payment Options:*** *Cash,Cheque,DD,MO.* ***Online: www.kseb.in (Debit/Credit Cards,Net Banking)****. Other Platforms: BBPS,Friends,Akshaya,CSC,NACH*

Senior Superintendent

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