GREEN AUDIT REPORT

GURUDEV ARTS & SCIENCE COLLEGE

PAYYANUR

2021

Executed by

OTTOTRACTIONS
Energy-Engineering-Environment

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Report No: EA 807

2021-September

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.

Acknowledgment

We were privileged to work together with the administration and staff of GURUDEV COLLEGE OF ARTS & SCIENCE for their timely help extended to complete the audit and bringing out this report.

We thank the management of Mar Ivanios College for entrusting Ottotractions to conduct the audits in all its mentee institutes as part of its Paramarsh Scheme.

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

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

1

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 Gurudev Arts & Science College, Payyanur aims to assist campus to reduce their carbon footprint and educate tomorrow's leaders about strategies for carbon mitigation using their campus asa 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.

Gurudev Arts & Science College

Gurudev Arts & Science College was established in the year 2002 at Mathil, and is affiliated to Kannur University. It is one of the most Reputed Catholic Colleges managed by Corporate Educational Agency of the Catholic Diocese of Sulthan Bathery, Wayanad. His Excellency Most. Rev. Dr. Joseph Mar Thomas is the Manager and Patron of this college.

Started with two UG courses, the glory of Gurudev Arts and Science College reaches hither to with 12 UG courses and 4 PG courses by securing enthralling victories and progress in both curricular and co-curricular fields throughout its journey. Now it imparts the silver light of knowledge to more than thousands of students who belong mainly to the rural areas of Kannur, Kasargod and other Districts and thereby fulfills the higher education dreams of thousands of people and became an integral part in the overall development of these areas.

Excellence in educational performance and ethics in social norm shave marked the wonderful reputation of our institution. The college marches forward with enhanced vigour and vitility upholding the motto 'Lighted to Lighten'.

Gurudev Arts and Science College was established in the year 2002. It was founded by Gurudev Educational and Charitable Trust' Mr. M.V.Purushothaman was the founder chairman. The college has a humble beginning only with two UG courses. After the initial year of functioning at Payyanur in Safa Marva Tower, the college shifted to its own building atop the scene hill whirl, in the middle of Mathil town in 2003. More UG courses started and the college became one of the top most colleges affiliated to Kannur University within a short span of time.

Occupancy Details			
Particulars	2018-19	2019-20	2020-21
Total Students	1298	1298	1298
Staffs	77	77	77
Total Occupancy of the college	1375	1375	1375

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 Organization	GURUDEV COLLEGE OF ARTS & SCIENCE					
2	Address (include telephone, fax & e-mail)	Gurudev Arts & Science College, P. O. Mathil, Payyanur, Kannur, Kerala-670307					
2	Year of Establishment	2002					
3	Name of building and total No. of Electrical Connections/building	College (1), Hostel (1)					
4	Total Number of Students	Boys	-	Girls	-	Total	1298
5	Total Number of Staff	77					
6	Total Occupancy	1375					
7	Total area of green cover (m2)	1011.71					
8	Type of Electrical Connection	HT	0	LT	2		
9	Contract Demand (KVA) /Connection	NA					
10	Average Maximum Demand (KVA)	NA					

11	Total built up area of the building (M2)	2165					
12	Number of Buildings	2					
13	Average system Power Factor	NA					
14	Details of capacitors connected	NA					
15	Transformer Details (Nos., kVA, Voltage ratio)	TR 1	TR 2	TR 3	TR 4	TR 5	TR 6
		NA	-	-	-	-	-
15	DG Set Details (kVA,)	DG1	DG2	DG3	DG4	DG5	Remarks
		25	-	-	-	-	-
16	Details of motors	Rating		Nos.		Remarks	
		5 to 10		NA		NA	
		10 to 50		NA		NA	
		Above 50		NA		NA	
17	Brief write-up about the firm and the energy/environmental conservation activities already undertaken.	LED Lighting, Tree Plantation, Awareness Programs, 20kWe Solar Power Plant					
18	Contact Person & Telephone number	Dr .K.T.Raveendran, Principal					
		9447491201					

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 visited 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 1375 occupants of this campuses will reach same number of households. This message will spread to at least 5500 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).

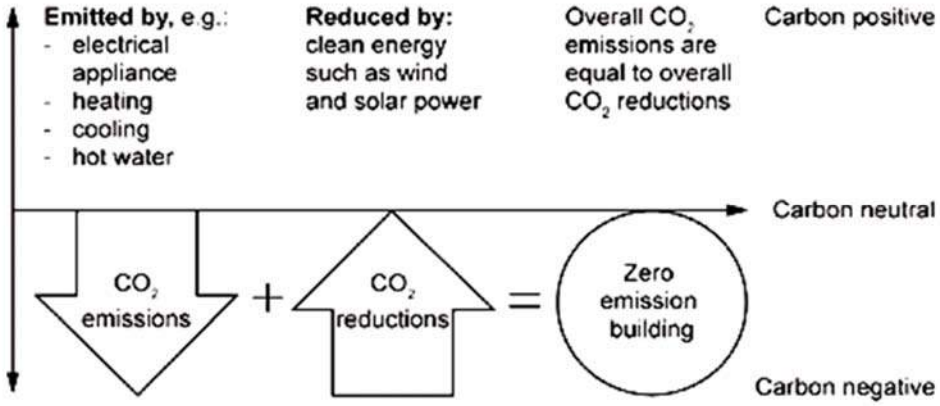
Global Warming Potentials (IPCC Second Assessment Report)					
Species	Chemical formula	Lifetime (years)	Global Warming		
			20 years	100 years	500 years
Carbon dioxide	CO2	variable §	1	1	1
Methane *	CH4	12±3	56	21	6.5
Nitrous oxide	N2O	120	280	310	170
HFC-23	CHF3	264	9100	11700	9800
HFC-32	CH2F2	5.6	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 are 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, 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

There is no vehicles operates from campus for its logistics.

Carbon emission from transportations 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)

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 in the technical supplements of this document.

3
RESULTS ANDDISCUSSIONS

3.1 CARBON FOOTPRINT ESTIMATION

3.1.1 ENERGY

a. Electricity

Electricity is purchased from KSEB under 2 LT Connections, the details are given below.

Electricity Connection Details		
GURUDEV COLLEGE OF ARTS & SCIENCE		
1	Name of the Consumer	GURUDEV COLLEGE OF ARTS & SCIENCE Payyannur, Kannur
2	Tariff	LT 6F 3Phase
3	Consumer Numbers	1166502012194, 1166505017896
5	Connected Load Total	49
6	Annual Electricity Consumption (kWh)	63994

Electricity Bill Analysis (from 2016 to 2020)

Consumer number			1166502012194		
Electricity Bill Details (2019-20)					
Month	Amount	Fixed charge	Energy Consumption	Duty	Energy charge
Apr	24171	6020	1815	1815	16336
May	16345	6020	1033	1033	9293
Jun	19648	6020	1363	1363	12265
Jul	20016	6020	1400	1400	12596
Aug	26785	6020	2077	2077	18689
Sep	21261	6020	1524	1524	13717
Oct	21894	6020	1587	1587	14287
Nov	22922	6020	1690	1690	15212
Dec	28432	6020	2241	2241	20171
Jan	21373	6020	1535	1535	13818
Feb	32065	6020	2605	2605	23441
Mar	28568	6020	2255	2255	20293

Consumer number			1166502012194		
Electricity Bill Details (2017-18)					
Month	Amount	Fixed charge	Energy Consumption	Duty	Energy charge
Apr	21699	6020	1568	1568	14111
May	11462	6020	544	544	4898
Jun	8428	6020	241	241	2167
Jul	18020	6020	1200	1200	10800
Aug	18624	6020	1260	1260	11344
Sep	20887	6020	1487	1487	13380
Oct	17154	6020	1113	1113	10021
Nov	17303	6020	1128	1128	10155
Dec	18135	6020	1212	1212	10904
Jan	15808	6020	979	979	8809
Feb	19956	6020	1394	1394	12542
Mar	22659	6020	1664	1664	14975

Consumer number			1166502012194		
Electricity Bill Details (2016-17)					
Month	Amount	Fixed charge	Energy Consumption	Duty	Energy charge
Apr	19833	6020	1381	1381	12432
May	13798	6020	778	778	7000
Jun	18476	6020	1246	1246	11210
Jul	15835	6020	982	982	8834
Aug	15986	6020	997	997	8969
Sep	14880	6020	886	886	7974
Oct	15567	6020	955	955	8592
Nov	14244	6020	822	822	7402
Dec	14584	6020	856	856	7708
Jan	13680	6020	766	766	6894
Feb	18105	6020	1209	1209	10877
Mar	16672	6020	1065	1065	9587

b. Diesel

Diesel Consumption Details		
2017-18	Total in L	cost
August 03	120	9000
August 07	120	9000
August 08	120	9000
September 25	68	5104
January 09	64	4830

Diesel Consumption Details		
2019-20	Total in L	cost
April 06	47	4214
July 20	47	4230
August 19	46	4179
September 20	134	12022
October 22	15	1380
October 28	16	1400
February 19	47	4204
February 28	47	4189

Diesel Consumption Details		
Year	Total in L	cost
2017-18	591	44294
2019-20	398	35818
2020-21	45	3825

c. LPG

LPG Consumption Details				
	2017-18	2018-19	2019-20	2020-21
No Cylinders In Hostel	48	45	48	12
Hostel LPG Consumption in kg	912	855	912	228
No of cylinders in college	17	17	20	2
College LPG Consumption in kg	323	323	380	38
Total in kg	1235	1178	1292	266

Base Line Energy Data				
GURUDEV COLLEGE OF ARTS & SCIENCE				
		2018-19	2019-20	2020-21
1	Electricity KSEB (kWh)	52662	63994	8400
2	Electricity Solar - Off grid (kWh)	0.00	0.00	0.00
3	Electricity (KSEB + Off grid) kWh	52662	63994	8400
4	Electricity Grid Tied (kWh)	0.00	0.00	0.00
5	Diesel (L)	590.59	397.98	45.00
6	LPG (kg)	1178.00	1292.00	266.00
7	Biogas (kg)	0.00	0.00	0.00

Energy Consumption Profile				
Sl No	Fuel	2018-19	2019-20	2020-21
		(kCal)		
1	Electricity	45289320	55034418	7224000
2	Diesel	6201160	4178767	472500
3	LPG	14136000	15504000	3192000
4	Biogas	-	-	-
Total		65626480	74717185	10888500

Thermal Fuel Consumption			
GURUDEV COLLEGE OF ARTS & SCIENCE			
	2018-19	2019-20	2020-21
Annual LPG consumption in kg	1178	1292	266
Annual Diesel consumption in L	590.59	397.98	45.00
Annual petrol consumption in L	0.0	0.0	0
Annual Biogas consumption in m3	-	-	-

Specific Energy Consumption

OTTOTRACTIONS- ENERGY AUDIT				
GURUDEV COLLEGE OF ARTS & SCIENCE				
Energy Performance Index (EPI)				
Sl No	Particulars	2018-19	2019-20	2020-21
1	Total building area (m^2)	2165	2165	2165
2	Annual Energy Consumption (kCal)	33634480	74717185	10888500
3	Annual Energy Consumption (kWh)	39109.9	86880.4	12661.047
4	Total Energy in Toe	3.36	7.47	1.09
5	Specific Energy Consumption kWh/m^2	18.06	40.13	5.85

In 2020-21 the energy consumption was less due to lock down based on covid 19 pandemic. So the specific energy consumption in 2019-20 may be taken as benchmark.

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

Solid degradable Waste Generation			
GURUDEV COLLEGE OF ARTS & SCIENCE			
	2018-19	2019-20	2020-21
Total Occupancy	1375	1375	1375
Waste generated in kg /day	27.5	34.375	11
Waste generated in kg /Yr	3630	4537.5	1452

Non-Degradable waste

Solid non degradable Waste Generation			
GURUDEV COLLEGE OF ARTS & SCIENCE			
	2018-19	2019-20	2020-21
Total Occupancy	1375	1375	1375
Waste paper generated in kg /day	0.28	0.31	0.14
Waste plastic generated in kg /day	0.41	0.46	0.21
Waste paper generated in kg /Yr	60.50	67.22	30.25
Waste plastic generated in kg /Yr	90.75	100.83	45.38

3.4. Transportation

There is no buses operating from the college.

Carbon Emission Profile (2020-21)

Carbon emissions in the campus due to the day-to-day activities are calculated and are 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 2018-21

Carbon Foot Print							
Sl. No.	Particulars	2018-19	tCO2e	2019-20	tCO2e	2020-21	tCO2e
1	Electricity (kWh)	53262	43.67	63994	52.47	8400	6.89
2	Diesel (L)	590.59	1.89	397.98	1.27	45.00	0.14
3	LPG (kg)	1178.00	1.77	1292.00	1.94	266.00	0.40
4	Biogas (m3)	0.00	-	0.00	-	0.00	-
5	Degradable Waste in kg/yr.	3630.00	2.29	4537.50	2.86	1452.00	0.91
6	Paper Waste in kg/yr	60.50	0.03	67.22	0.04	30.25	0.02
7	Plastic Waste in kg/yr	90.75	0.03	100.83	0.03	45.38	0.02
Total Carbon Foot Print tCO2e/yr			49.68		**58.62**		8.38

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
Total number of trees	90	120	135
Carbon sequestrated by trees in the campus (tCO2e)	0	0.00	0.00

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 Table.3.19 Detailed calculation results are listed out in the tables provided in the technical supplements of 'Carbon sequestration'.

CARBON FOOTPRINT OF THE CAMPUS (2019-20)

Various carbon emitting activities such as consumption of energy, transportation and waste generation leads to the total emission of **58.62tCO$_2$e** per year by the campus. The total carbon sequestration by trees in the campus compound is **0.00 tCO$_2$e**.

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 2020-21.

Specific CO2 Footprint

Amount of Carbon to be mitigated for Low Carbon Campus				
Sl No	Particulars	2018-19	2019-20	2020-21
1	Total carbon emission tCO2e	49.68	58.62	8.38
2	Total carbon sequestration tCO2e	0.00	0.00	0.00
3	Amount of carbon mitigated through renewable energy tCO2e	0.00	0.00	0.00
4	To be mitigated tCO2e	49.68	58.62	8.38
5	Total No of Students	1298	1298	1298
6	Specific Carbon Footprint kg CO2e/Student/Yr	38.28	45.16	6.45

The total specific carbon emission is estimated as **58.62** kg of CO_2e per student for the year 2019-20 and **8.38**kg of CO_2e per student for the year 2020-21. (The reduction in CO2 foot print is due to the impact of pandemic year)

4

Carbon Mitigation Plans

The total emission of the carbon dioxide per student is **45.16** kg per year (2019-2020). 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 campusis 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 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'

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						
GURUDEV COLLEGE OF ARTS & SCIENCE						
Greenhouse Gas Mitigation through Major Energy Efficiency Projects						
Sl No	Projects	gy sa ve d(Ye bili ty			ton of CO_2	mitig ated
		(kWh)	MWh	Years		
1	Energy Saving in Lighting by replacing existing 41 No's T8 Lamps to 20W LED Tube in Ground Floor	164	0.16	10	0.12	1.20
2	Energy Saving by replacing existing 54 No's in-efficient ceiling fans with Energy Efficient Five star fans in Ground Floor	2627	2.63	10	1.92	19.17
3	Energy Saving in Lighting by replacing existing 29 No's T8 Lamps to 20W LED Tube in First Floor	928	0.93	10	0.68	6.77
4	Energy Saving in Lighting by replacing existing 2 No's T12 (55W) Lamps to 18 W LED Tube in First Floor	177	0.18	10	0.13	1.29
5	Energy Saving in Lighting by replacing existing 4 No's CFL(15W) Lamps to 9W LED BULB in First Floor	58	0.06	10	0.04	0.42
6	Energy Saving by replacing existing 49 No's in-efficient ceiling fans with Energy Efficient Five star fans in First floor	2383	2.38	10	1.74	17.40
7	Energy Saving in Lighting by replacing existing 41 No's T8 Lamps to 20W LED Tube in Second Floor	164	0.16	10	0.12	1.20
8	Energy Saving by replacing existing 44 No's in-efficient ceiling fans with Energy Efficient Five star fans in Second Floor	2140	2.14	10	1.56	15.62
9	Energy Saving in Lighting by replacing existing 48 No's T8 Lamps to 20W LED Tube in Hostel	192	0.19	10	0.14	1.40
10	Energy Saving by replacing existing 48 No's in-efficient ceiling fans with Energy Efficient Five star fans in Second Floor	2335	2.33	10	1.70	17.04
Total		11167	11	10	8.15	82

OTTOTRACTIONS- ENERGY AUDIT						
GURUDEV COLLEGE OF ARTS & SCIENCE						
Greenhouse Gas Mitigation through Renewable Energy Projects						
Sl No	Projects	Energy saved(Yearly)		Sustainability (Years)	First year ton of CO_2 mitigated	of CO_2 mitigated throughout life
		(kWh)	MWh	Years		
1	Energy Generation from 20kWp Solar Power Plant installed in March 2021	27375	27.38	25	19.98	499.59
2	Energy Generation from 30kWp Solar Power Plant installed in March 2022	38325	38.33	25	27.98	727.41
3	Installation of 15m3 Biogas plant	22282	22.28	20	16.27	325.32

Executive Summary					
Consolidated Cost Benefit Analysis of Energy Efficiency Improvement Projects					
GURUDEV COLLEGE OF ARTS & SCIENCE					
Sl No	Projects	Investment	Cost saving	SPB	Energy saved
		(Lakhs Rs)	(Rs)/Yr	Months	kWh/Yr
1	Energy Saving in Lighting by replacing existing 41 No's T8 Lamps to 20W LED Tube in Ground Floor	0.12	0.040	37.11	164
2	Energy Saving by replacing existing 54 No's in-efficient ceiling fans with Energy Efficient Five star fans in Ground Floor	1.17	0.64	22.13	2627
3	Energy Saving in Lighting by replacing existing 29 No's T8 Lamps to 20W LED Tube in First Floor	0.09	0.23	4.64	928
4	Energy Saving in Lighting by replacing existing 2 No's T12 (55W) Lamps to 18 W LED Tube in First Floor	0.01	0.02	4.52	177
5	Energy Saving in Lighting by replacing existing 4 No's CFL(15W) Lamps to 9W LED BULB in First Floor	0.004	0.01	9.26	58

6	Energy Saving by replacing existing 49 No's in-efficient ceiling fans with Energy Efficient Five star fans in First floor	1.07	0.21	59.62	2383
7	Energy Saving in Lighting by replacing existing 41 No's T8 Lamps to 20W LED Tube in Second Floor	0.12	0.01	100.00	164
8	Energy Saving by replacing existing 44 No's in-efficient ceiling fans with Energy Efficient Five star fans in Second Floor	0.96	0.19	59.62	2140
9	Energy Saving in Lighting by replacing existing 48 No's T8 Lamps to 20W LED Tube in Hostel	0.14	0.02	100.00	192
10	Energy Saving by replacing existing 48 No's in-efficient ceiling fans with Energy Efficient Five star fans in Second Floor	1.04	0.21	59.62	2335
	Total	4.73	1.57	45.65	11167
(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.)					

6

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	58.62
2	Carbon Sequrested tCO2e/yr	0.00
3	Carbon mitigated by Renewable Energy tCO2e/yr (installed in 20-21)	19.98
4	Carbon mitigated by Renewable Energy tCO2e/yr (Solar plant Proposed)	27.98
5	Carbon mitigated by Renewable Energy (biogas plant) tCO2e/yr (Proposed)	7.67
6	Carbon mitigated by Energy Efficiency (proposed) tCO2e/yr	8.15
8	Effective Carbon footprint tCO2e/yr	-5.16
9	Total No of Students	1298.00
10	Specific Carbon Footprint kg CO2e/Student/Yr	-3.98

From this study it was found that carbon footprint of the campus to be **-3.98** $kgCO_2e$/ Student/ Year in place of current footprint i.e.,**58.62**$kgCO_2e$/ student/ Year. This will be achieved after implementing energy efficiency projects and implementation of 30kWp solar power plant. And to achieve this an investment of **27.23 lakhs Rs** is required through energy efficiency and renewable energy projects proposed. It will be around **2091.7Rs 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	4.73
2	Cost of implementation in Renewable Energy Lakhs Rs	23.70
3	Total Lakhs Rs	28.43
4	Total number of students	1298
5	Cost per student to make the campus carbon negative Rs/ Student	2190.2

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
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- https://www.sciencedirect.com/science/article/pii/S0921344915301245
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OTTOTRACTIONS
Energy-Engineering-Environment

6

TECHNICAL SUPPLEMENT

GURUDEV COLLEGE OF ARTS & SCIENCE													
Location		LIGHTS					FAN			IT			AC
		T8	T12	LED TUBE	LED SQUARE	LED BULB	CF	WF	EF	PC	Printer	Scanner	1.0
2ND	S12	2					3						
	S118 & S13	2					4						
	S14						2						
	S15					1	2						
	Dept of commerce & management	3					3						
	S11,S10,S9,S8,S7,S6,S1,S2,S3	18					27						
	Microbiology Lab	16					3						
Total		**41**	**0**	**0**	**0**	**1**	**44**	**0**	**0**	**0**	**0**	**0**	**0**
IST	Classroom 1-7	7					14						
	F3						3						
	Chemistry Dept+Lab	5							3				
	F2	1					2						
	F1	2					2						
	F7					1	2						
	F8			1			2						
	F9	2		2			4						
	F10	3					2						1
	F11 F12			2			4						
	F13							1					
	F19	2					2						
	F18	1					2						
	Physics Lab	6					6						
	F16		1				2						
	F17		1				2						

Total		29	2	5	0	1	49	1	3	0	0	0	1
GND	Computer Lab					4	5			18			
	G15 G14 G17 G13 G12	10					10						
	PG Lab, Chemistry	5							4				
	G9 G8 G7	3					6						
	G1 G2	2					4						
	Bio Chemistry Lab	13					5						
	Dept of English	1					1						
	Store	1					1						
	Library	6		4		8	9			1			
	Auditorium				12	3	13	2	4				
	Snehalaya Ladies hostel(32 rooms)	48					48						
Total		**89**	**0**	**4**	**12**	**15**	**102**	**2**	**8**	**19**	**0**	**0**	**0**

List of Trees in the Campus (above 15 cms growth)			
Sl No	Name	Botanical	Number
1	Mango	Mangifera indica L	6
2	Teak	Tectona grandis	2
3	Bottle palm	Roystonea regia	18
4	Coconut Palm	Cocos nucifera	73
5	Acacia	Acacia auriculiformis	34
6	Cashew nut	Anacardium occidentale)	2
7	Kanikonna	Cassia fistula	1
8	Persian silk tree	Albizia julibrissin	2
9	Amla tree	Phyllanthus emblica L	2

10	Castilla	Castilla elastica	3
11	Sindeva tree		3
12	Handy rubber tree	Hevea brasiliensis	2

Consumer number			1166502012194		
Electricity Bill Details (2019-20)					
Month	Ammount	Fixed charge	Energy Consumption	Duty	Energy charge
Apr	24171	6020	1815	1815	16336
May	16345	6020	1033	1033	9293
Jun	19648	6020	1363	1363	12265
Jul	20016	6020	1400	1400	12596
Aug	26785	6020	2077	2077	18689
Sep	21261	6020	1524	1524	13717
Oct	21894	6020	1587	1587	14287
Nov	22922	6020	1690	1690	15212
Dec	28432	6020	2241	2241	20171
Jan	21373	6020	1535	1535	13818
Feb	32065	6020	2605	2605	23441
Mar	28568	6020	2255	2255	20293

KERALA STATE ELECTRICITY BOARD LIMITED

DEMAND CUM DISCONNECTION NOTICE

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

Section	**[6650]-Electrical Section Vellur**	**Phone#**	0498-5202921	**Customer Care**	1912
Consumer#	**1166502012194**	Visit www.kseb.in for online payments.	**Regular CC Bill**	**KSEBL GSTIN: 32AAECK2277NBZ1**	

Name & Mailing Address

PRESIDENT

THE CO-OPERATIVE EDUCATIONAL SOCIETY

MATHIL

Reg. Mob# 9605980278

Reg. E-mail: (Nil)

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,Anchumana Temple Road, Edappally, Kochi-682024 Ph:0484-2346488

Bill#	**6650211101002**	**Bill Area**	M03/1	**DTR**	GURUDEV
Billing Period	**11/2021**[Monthly]	**Tariff/Phase**	LT-6F/Three	**Pole#**	TR30
Bill Date	**01-11-2021**	**Due Date**	**11-11-2021**	**DC Date**	**26-11-2021**
Contract Demand	**(Nil)** VA [75% : 0KV, 130% : 0KV]	**Connected Load**	42925 Watts	**Security Deposit**	Rs.32410.00

Meter#	L&TM66500002918758	**Average consumption(Monthly)**	
Meter Digits	8.1	**Power Unit/Zone**	**CUMULATIVE**
Meter Type/Owner	Static/KSEB	KWH	871

Prev. Available Rdg. Date	**Prev. Rdg. Date**	**Prev. Meter Rdg. Status**	**Prst. Rdg. Date**	**Prst. Meter Rdg. Status**
01-10-2021	**01-10-2021**	**Working**	**01-11-2021**	**Working**

Power Unit	**Zone**	**Trading**	**Initial Reading(IR)**	**Final Reading(FR)**	**OMF**	**Units**
KWH	Cumulative	Import	103704.00	104917.00	1	1213

Remarks :

Last Paid Amount - Rs.18105.00

Last Payment Date - 08-11-2021

Bill Details			**[INR] Amount(Rs.)**
a)	Fixed Charges	Fixed Charge[FC]	6020.00
		Sub Total	**6020.00**
b)	Energy Charges	Energy Charge[EC]	10917.00
		Sub Total	**10917.00**
c)	Other Charges	Electricity Duty[ED]	1091.70
		Meter Rent[MR]	15.00
		Sub Total	**1106.70**
d)	GST	MR-CGST	1.35
		MR-SGST	1.35
		Sub Total	**2.70**
e)	Round Off		-0.40
f)	**Total Amt.(Bill#6650211101002)** *(a+b+c+d+e)*		**18046.00**
g)	Surcharge		59.00
h)	Reconnection Fee		0.00
i)	Interim Bills		0.00
j)	Arrears		0.00
k)	Less paid/adj.		-18105.00
l)	Less Advance		-0.00
	Net Payable*(f+g+h+i+j-k-l)*		**0.00**

Demand for 11/2021 is Rupees Eighteen Thousand and Forty Six Only

E&OE

***Payment Options** : Cash,Money Order,Cheque,Demand Draft,Debit Cards,Net Banking,Digital Wallets,Any where,Friends,Akshaya,Apna CSC,NACH*

Senior Superintendent

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