GREEN AUDIT REPORT

BISHOP MOORE COLLEGE

MAVELIKARA

2021

OTTOTRACTIONS
Energy-Engineering-Environment

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Bishop Moore College, Mavelikara

Report No: EA 798

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 Bishop Moore College, Mavelikkara 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 team OTTOTRACTIONS 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

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Introduction

1.1 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 **Bishop Moore College, Mavelikara** 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.

Bishop Moore College, Mavelikara

Bishop Moore College had its genesis in the imagination of Bishop M.M. John, the then Bishop of the C.S.I. Madhya Kerala Diocese. When the Government of Kerala announced its decision to start new junior colleges in 1964, Bishop M. M. John saw it as an opportunity to fulfill the urgent need for a quality educational institution in this part of the world. Thus Bishop Moore College took concrete shape and he christened it in honour of the late Rt. Rev. Edward Alfred Livingstone Moore, the fourth Anglican Bishop of the Diocese of Travancore- Cochin. Rev. K.C. Mathew was appointed Principal.

society, especially the most downtrodden. They aimed at shaping the citizens imbued with a patriotic outlook for the nation providing equal opportunities for all irrespective of religion, caste, class or gender.The College began at Kallumala, Mavelikara in the Alappuzha District of Kerala as a Junior College offering two years Pre-Degree Course in 1964 and has since then grown to an institution that offers several Under Graduate, Post Graduate Courses and Research facilities. The College has been able to do justice and attain the vision and mission of its founding fathers.

Instilled with a secular outlook, the founding fathers of the College had the singular aim of ameliorating the lot of the

The College has 12 departments, 4 PG programmes 10 UG programmes. The college is located in 6 hectares of land spanning with a total built up area 10400 m^2.

Occupancy Details			
Particulars	2018-19	2019-20	2020-21
Total Students	1418	1417	1456
Staffs	85	84	87
Total Occupancy of the college	1503	1501	1543

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

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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 1500 occupants of this campuses will reach same number of households. This message will spread to at least 6000 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).

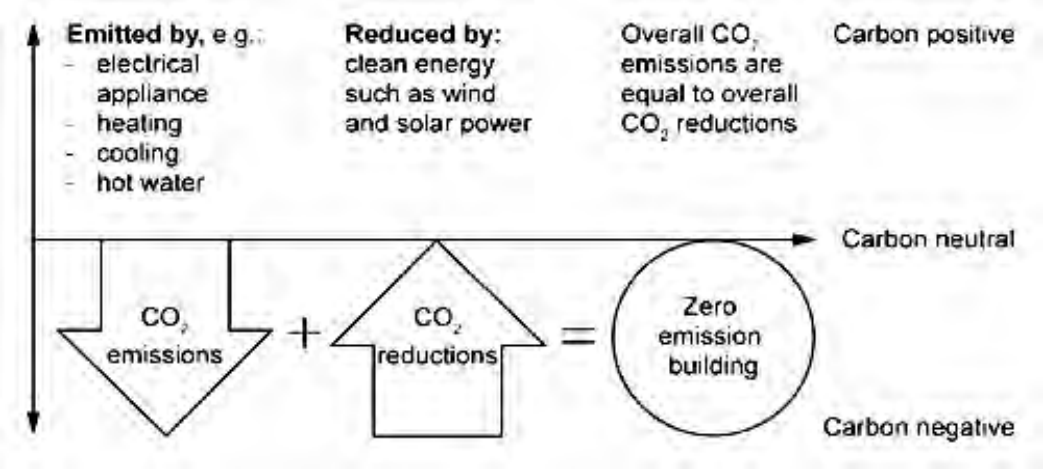
Global Warming Potentials (IPCC Second Assessment Report)					
Species	Chemical formula	Lifetime (years)	Global Warming		
			20 years	100 years	500 years
Carbon dioxide	CO2	variable §	1	1	1
Methane *	CH4	12±3	56	21	6.5
Nitrous oxide	N2O	120	280	310	170
HFC-23	CHF3	264	9100	11700	9800
HFC-32	CH2F2	5.6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

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.

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RESULTS AND DISCUSSIONS

3.1 CARBON FOOTPRINT ESTIMATION

3.1.1 ENERGY

a. Electricity

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

Electricity Connection Details		
BISHOP MOORE COLLEGE		
1	Name of the Consumer	BISHOP MOORE COLLEGE Mavelikara, Alapuzha
2	Tariff	LT 6A Ndom(3)
3	Consumer Numbers	1155225001338,115522901274, 1155228010598
5	Connected Load Total	90
6	Annual Electricity Consumption (kWh)	46300

Electricity Bill Analysis (from 2018 to 2021)

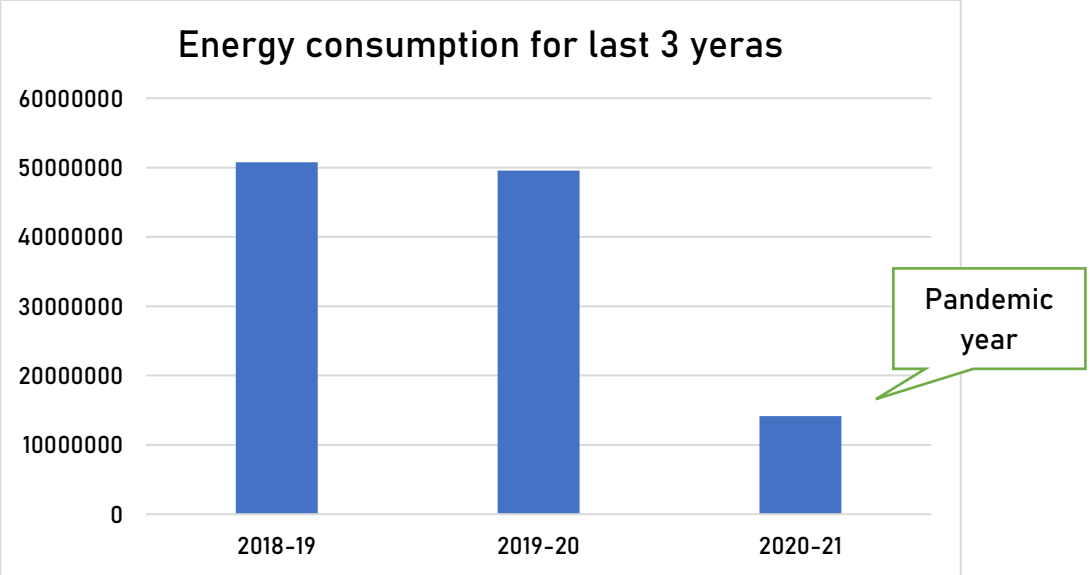
LT Consumer details

LT Consumer No's		kWh/Yr		
		18-19	19-20	20-21
1	**1338**	35388	34154	9024
2	**2974**	8892	8300	3354
3	**10598**	3915	3846	1586
Total		**48195**	**46300**	**13964**

The baseline data of energy consumption for the last 3 year is given below.,

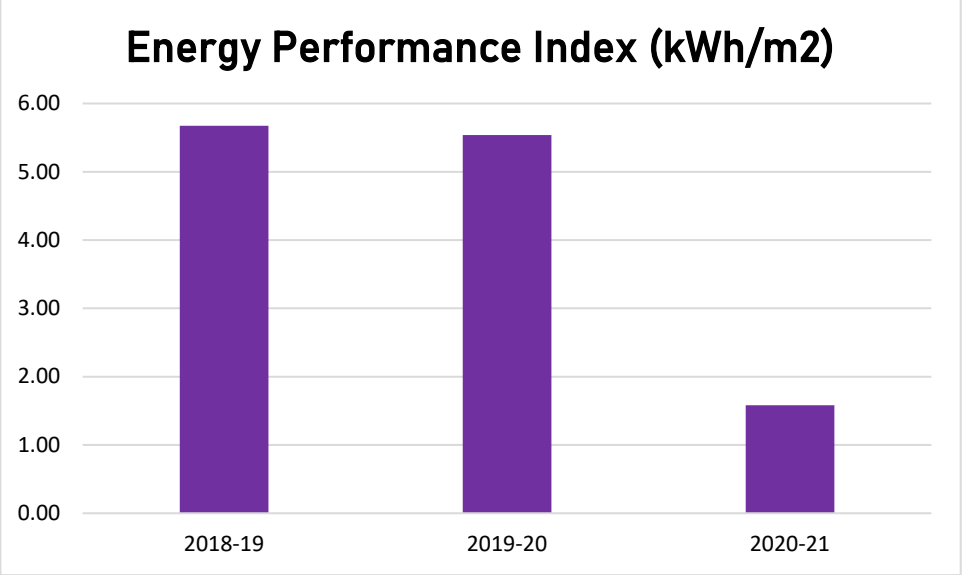
Base Line Energy Data				
BISHOP MOORE COLLEGE				
		2018-19	2019-20	2020-21
1	Electricity KSEB (kWh)	48195.00	46300.00	13964.00
2	Electricity Solar - Off grid (kWh)	0.00	0.00	0.00
3	Electricity (KSEB + Off grid) kWh	48195.00	46300.00	13964.00
4	Electricity Grid Tied (kWh)	0.00	0.00	0.00
5	Diesel (L)	169.00	275.00	61.00
6	LPG (kg)	627.00	570.00	124.00
7	Biogas (kg)	-	-	-

Energy Consumption Profile				
Sl No	Fuel	2018-19	2019-20	2020-21
		(kCal)		
1	Electricity	41447700	39818000	12009040
2	Diesel	1774500	2887500	640500
3	LPG	7524000	6840000	1488000
4	Biogas	-	-	-
Total		50746200	49545500	14137540



Specific Energy Consumption

OTTOTRACTIONS- ENERGY AUDIT				
BISHOP MOORE COLLEGE				
Energy Performance Index (EPI)				
Sl No	Particulars	2018-19	2019-20	2020-21
1	Total building area (m²)	10400	10400	10400
2	Annual Energy Consumption (kCal)	50746200	49545500	14137540
3	Annual Energy Consumption (kWh)	59007.2	57611.0	16439
4	Total Energy in Toe	5.07	4.95	1.41
5	Specific Energy Consumption kWh/m²	5.67	5.54	1.58



In 2020-21 the energy consumption was less due to lock down based on covid 19 pandemic.

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

BISHOP MOORE COLLEGE			
	2018-19	2019-20	2020-21
Waste generated in kg /day	28.9	32.6	8.9
Waste generated in kg /Yr	3814.8	4303.2	1174.8

Non-Degradable waste

Solid non degradable Waste Generation

BISHOP MOORE COLLEGE			
	2018-19	2019-20	2020-21
Waste paper generated in kg /day	1.11	1.25	0.58
Waste plastic generated in kg /day	0.4295	0.48095	0.1954
Waste paper generated in kg /Yr	146.52	165	76.56
Waste plastic generated in kg /Yr	56.69	63.49	25.79

3.4. Transportation

There is no vehicles operated from college

Carbon Emission Profile (2020-21)

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 2018-19

Carbon Foot Print

Sl. No.	Particulars	2018-19	tCO2e
1	Electricity (kWh)	48195	39.52
2	Diesel (L)	169.00	0.54
3	LPG (kg)	4180.00	6.27
4	Biogas (m3)	-	-
5	Degradable Waste in kg/yr.	3814.80	2.40
6	Paper Waste in kg/yr	146.52	0.08
7	Plastic Waste in kg/yr	56.69	0.02
Total Carbon Foot Print tCO2e/yr			48.84

Carbon Foot Print 2019-20

Carbon Foot Print

Sl. No.	Particulars	2019-20	tCO2e
1	Electricity (kWh)	46300	37.97
2	Diesel (L)	275	0.88
3	LPG (kg)	4389	6.584
4	Biogas (m3)	-	-
5	Degradable Waste in kg/yr.	4303.2	2.711
6	Paper Waste in kg/yr	165	0.092
7	Plastic Waste in kg/yr	63.485	0.022
Total Carbon Foot Print tCO2e/yr			48.25

Carbon Foot Print 2020-21

Carbon Foot Print

Sl. No.	Particulars	2020-21	tCO2e
1	Electricity (kWh)	13964	11.45
2	Diesel (L)	1743.5	5.579
3	LPG (kg)	61	0.092
4	Biogas (m3)	-	-
5	Degradable Waste in kg/yr.	1174.8	0.74
6	Paper Waste in kg/yr	76.56	0.043
7	Plastic Waste in kg/yr	25.793	0.009
Total Carbon Foot Print tCO2e/yr			17.91

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	156	184	203
Carbon sequestrated by trees in the campus (tCO2e)	28.16	36.23	40.47

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'.

Form 5										
Sl. No	Name of tree (Botanical name)	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	Acacia auriculiformis Benth.	80	25.46	4	107.70	0.14	3	0.429	0.143	9
2	Albizia saman (Jacq.) Merr.	98	31.19	2	80.81	0.11	1	0.107	0.107	6
3	Amherstia nobilis Wall.	87	27.69	2	63.68	0.08	1	0.085	0.085	7
4	Artocarpus heterophyllus Lam.	120	38.20	3	181.74	0.24	7	1.691	0.242	4
5	Artocarpus hirsutus Lam.	97	30.88	5	197.91	0.26	5	1.315	0.263	8
6	Azadirachta indica A.Juss.	59	18.78	4	58.58	0.08	1	0.078	0.078	7
9	Bridelia retusa (L.) A.Juss.	30	9.55	4	15.14	0.02	3	0.060	0.020	7
10	Caesalpinia coriaria (Jacq.) Willd.	24	7.64	2	4.85	0.01	1	0.006	0.006	7
11	Caesalpinia sappan L.	84	26.74	2	59.37	0.08	1	0.079	0.079	9
12	Carallia brachiata (Lour.) Merr.	20	6.37	4	6.73	0.01	5	0.045	0.009	12
13	Caryota urens L.	98	31.19	3	121.21	0.16	4	0.644	0.161	12
14	Cassia fistula L.	85	27.06	6	182.37	0.24	7	1.697	0.242	7
15	Casuarina equisetifolia L.	110	35.01	7	356.32	0.47	4	1.894	0.474	12
16	Chrysophyllum cainito L.	86	27.37	2	62.23	0.08	1	0.083	0.083	10
17	Cochlospermum religiosum (L.) Alston	161	51.25	4	436.18	0.58	1	0.580	0.580	14
18	Cocos nucifera L.	117	37.24	3	172.76	0.23	5	1.148	0.230	8
19	Couroupita guianensis Aubl.	195	62.07	4	639.86	0.85	3	2.551	0.850	6
20	Dalbergia latifolia Roxb.	126	40.11	5	333.94	0.44	7	3.107	0.444	6

21	Gmelina arborea Roxb.	159	50.61	6	638.12	0.85	4	3.392	0.848	7
22	Livistona chinensis (Jacq.) R.Br. ex Mart.	112	35.65	6	316.62	0.42	8	3.366	0.421	8
23	Magnolia champaca (L.) Baill. ex Pierre	121	38.52	7	431.15	0.57	2	1.146	0.573	9
24	Mangifera indica L.	40	12.73	6	40.39	0.05	3	0.161	0.054	9
25	Mesua ferrea L.	14	4.46	6	4.95	0.01	1	0.007	0.007	10
26	Mimusops elengi L.	28	8.91	1	3.30	0.00	4	0.018	0.004	9
27	Monoon longifolium (Sonn.) B Cue.R.M.	72	22.92	5	109.04	0.14	21	3.043	0.145	8
28	Peltophorum pterocarpum (DC.) K. Heyne	86	27.37	5	155.57	0.21	14	2.895	0.207	10
29	Phyllanthus emblica L.	116	36.92	1	56.61	0.08	3	0.226	0.075	8
30	Pongamia pinnata (L) Pierre	60	19.10	3	45.43	0.06	6	0.362	0.060	14
31	Psidium guajava L.	28	8.91	1	3.30	0.00	2	0.009	0.004	14
32	Pterocarpus santalinus L. f.	104	33.10	4	182.00	0.24	2	0.484	0.242	15
33	Ravenala madagascariensis Sonn.	87	27.69	6	191.05	0.25	1	0.254	0.254	16
34	Roystonea regia (Kunth) O.F.Cook	45	14.32	6	51.11	0.07	16	1.087	0.068	16
35	Saraca asoca (Roxb.) Willd.	108	34.38	6	294.41	0.39	2	0.783	0.391	14
36	Spathodea campanulata P.Beauv.	96	30.56	2	77.54	0.10	7	0.721	0.103	14
37	Swietenia mahagoni (L.) Jacq.	76	24.19	6	145.79	0.19	16	3.100	0.194	16
38	Syzygium cumini (L.) Skeels	118	37.56	2	117.15	0.16	4	0.623	0.156	14
39	Tectona grandis L. f.	72	22.92	3	65.42	0.09	20	1.739	0.087	8
40	Terminalia arjuna (Roxb. ex DC.) Wight & Arn.	128	40.74	4	275.70	0.37	2	0.733	0.366	8
41	Vateria indica L.	114	36.29	2	109.34	0.15	5	0.727	0.145	8
						Total	203	40.47	8.50	
Details of the trees having diameter more than 15cm and having heights above 150cm from ground level is taken for the study										

CARBON FOOTPRINT OF THE CAMPUS (2020-21)

Various carbon emitting activities such as consumption of energy, transportation and waste generation leads to the total emission of **17.91 tCO_2e** per year by the campus. The total carbon sequestration by trees in the campus compound is **40.47 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 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	48.84	48.25	17.91
2	Total carbon sequestration tCO2e	28.16	36.23	40.47
3	Amount of carbon mitigated through renewable energy tCO2e	0.00	0.00	0.00
4	To be mitigated tCO2e	20.68	12.02	-22.56
5	Total No of Students	1418	1417	1456
6	Specific Carbon Footprint kg CO2e/Student/Yr	14.58	8.49	-15.50

Specific Carbon Footprint kg CO2e/Student/Yr	
2018-19	14.58
2019-20	8.49
2020-21	-15.50

The total specific carbon emission is estimated as **-15.50** kg of CO_2e per student for the year 2020-21.

4

Carbon Mitigation Plans

The total emission of the carbon dioxide per student is **-15.50** kg per year. 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 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						
BISHOP MOORE COLLEGE						
Greenhouse Gas Mitigation through Major Energy Efficiency Projects						
Sl No	Projects	Energy saved(Yearly)		Sustainability (Years)	First year ton of CO_2	of CO_2 mitigated through out
		(kWh)	MWh	Years		
1	Energy Saving in Lighting by replacing existing 160 No's T8 (40W) Lamps to 18W LED Tube	2534	2.53	10	1.85	18.50
2	Energy Saving in Lighting by replacing existing 57 No's T12 (55W) Lamps to 18W LED Tube	1512	1.51	10	1.10	11.04
3	Energy Saving by replacing existing 137No's in-efficent ceiling fans with Energy Efficient Five star fans	6905	6.90	10	5.04	50.41
Total		10952	11	10	8	80

OTTOTRACTIONS- ENERGY AUDIT						
BISHOP MOORE COLLEGE						
Greenhouse Gas Mitigation through Renewable Energy Projects						
Sl No	Projects	Energy saved(Yearly)		Sustainability (Years)	First year ton of CO_2	of CO_2 mitigated through out
		(kWh)	MWh	Years		
1	Installation of 50kWp Solar Power Plant	63875	63.88	25	46.63	1165.72

OTTOTRACTIONS- ENERGY AUDIT	
Energy Saving Proposal Code EA 798.01	
Energy Saving in Lighting by replacing existing 160 No's T8 (40W) Lamps to 18W LED Tube	
Existing Scenario	
160 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	160
Total load (kW)	6.40
Annual Energy Consumption (kWh)	4608
Expected Annual Energy saving for replacing all fittings (kWh)	2534
Cost of Power	7.90
Annual saving in Lakhs Rs (1st year)	0.20
Investment required for complete replacements [@Rs 250 per fittings](Lakhs Rs)	0.40
Simple Pay Back (in Months)	23.97

OTTOTRACTIONS- ENERGY AUDIT	
Energy Saving Proposal Code EA 798.02	
Energy Saving in Lighting by replacing existing 57 No's T12 (55W) Lamps to 18W LED Tube	
Existing Scenario	
86 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	57
Total load (kW)	3.14
Annual Energy Consumption (kWh)	2257
Expected Annual Energy saving for replacing all fittings (kWh)	1512
Cost of Power	7.90
Annual saving in Lakhs Rs (1st year)	0.12
Investment required for complete replacements [@Rs 250 per fittings](Lakhs Rs)	0.14
Simple Pay Back (in Months)	14.31

OTTOTRACTIONS- ENERGY AUDIT	
Energy Saving Proposal Code 798.03	
Energy Saving by replacing existing 137No's in-efficient ceiling fans with Energy Efficient Five star fans	
Existing Scenario	
There are 137 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	137
Total load (kW)	9.59
Annual Energy Consumption (kWh)	23016.00
Expected Annual Energy saving, for total replacement(kWh)	6904.80
Cost of Power (Rs)	7.90
Annual saving in Lakhs Rs (1st year)	0.55
Investment required for a total replacement (Lakhs Rs)[@1500 Rs per Fan with 50W at full speed]	2.06
Simple Pay Back (in Months)	45.21

Energy Saving Proposal Code 798.04	
Installation of 50kWp 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 50kW 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)	50
Total average kWh per day expected (3.5kWh/day average)	175.00
Total annual Generating Capacity (kWh)	63875
Cost of energy generated annually Lakhs Rs	5.28
Investment required (INR lakh)(Approx)	37.50
Simple Pay Back (in Months)	85.29
Life cycle in Yrs	25
Total Saving in Life Cycle (Approx) RS lakh	131.90

Executive Summary					
Consolidated Cost Benefit Analysis of Energy Efficiency Improvement Projects					
BISHOP MOORE COLLEGE					
Sl No	Projects	Investment	Cost saving	SPB	Energy saved
		(Lakhs Rs)	(Rs)/Yr	Months	kWh/Yr
1	Energy Saving in Lighting by replacing existing 160 No's T8 (40W) Lamps to 18W LED Tube	0.40	0.200	23.97	2534
2	Energy Saving in Lighting by replacing existing 57 No's T12 (55W) Lamps to 18W LED Tube	0.14	0.119	14.31	1512
3	Energy Saving by replacing existing 137No's in-efficent ceiling fans with Energy Efficient Five star fans	2.06	0.545	45.21	6905
4	Installation of 50kWp Solar Power Plant	37.50	5.28	85.29	63875
	Total	40.10	6.14	78.35	74827
(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.)					

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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	17.91
2	Carbon Sequrested tCO2e/yr	40.47
3	Carbon mitigated by Renewable Energy tCO2e/yr	0.00
4	Carbon mitigated by Energy Efficiency (Proposed) tCO2e/yr	7.99
5	Effective Carbon footprint tCO2e/yr	-30.56
6	Total No of Students	1456.00
7	Specific Carbon Footprint kg CO2e/Student/Yr	-20.99

From this study it was found that carbon footprint of the campus to be **-20.99** $kgCO_2e$/ Student/ Year in place of current footprint i.e., **-15.50** $kgCO_2e$/ student/ Year. This will be achieved after implementing energy efficiency projects.

(50kWp solar power plant)

and implementation of additional 15kWp solar power plant. To achieve this an investment of **26.22 lakhs Rs** is required through energy efficiency and renewable energy projects proposed. It will be around **966 Rs per student** to make the campus the carbon negative.

Cost to make the campus Carbon Negative (based on the 20-21 data)		
1	Cost of implementation in Energy Efficiency (Lakhs Rs)	9.72
2	Cost of implementation in Renewable Energy (Lakhs Rs)	16.50
3	Total Lakhs Rs	26.22
4	Total number of students	2714
5	Cost per student to make the campus carbon negative Rs/ Student	966.10

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TECHNICAL SUPPLEMENT

BISHOP MOORE COLLEGE										
Sl.No	Location	Lights				FAN		IT		
		T8	T12	CFL	LED B	CF	WF	PC	Printer	Scanner
1	Office	15				10		8	5	2
2	Msc chemistry Lab	8			4					
3	Bsc chemistry Lab	3	11	3	4					
4	Bottony Lab		14			3				
5	Physics Lab									
6	Zoology Lab	8				4				
7	Loibrary		16			6		11		
8	English Department		16			10				
9	Auditorium	18				32				
10	Class rooms*36	108				72				
Total		**160**	**57**	**3**	**8**	**137**	**0**	**19**	**5**	**2**

Electricity Bill Details (2019-20)										
Name of the Consumer				BISHOP MOORE COLLEGE						
Connected Load (kW)				36	Consumer number		1155225001338			
Tariff				LT-6A Ndom (Single Phase)	Section		Mavelkkara			
Month	Monthly Consumption (kWh)	Average consumption (kWh)	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Extra fixed charge (Rs)	Extra energy charge (Rs)	Adjustment (Rs)	Total amount to be paid (Rs)
Apr										
May	2228	3387	1750	14036	1403	17				17205
June	2761	3176	1750	17394	1739	17				20902
July										
Aug	3099	2676	2187	20040	2004	17				24250
Sep	2743	2906	2275	17830	1783	17				21863
Oct	2737	2900	2275	17791	1779	17				21863
Nov										
Dec										
Jan	2717	3280	2275	17661	1766	17				21720
Feb	3638	3277	2275	23647	2364	17				28305
Mar										

Electricity Bill Details (2019-20)										
Name of the Consumer				BISHOP MOORE COLLEGE						
Connected Load (kW)				18	Consumer number		115522901274			
Tariff				LT-6A Ndom (Single Phase)	Section		Mavelkkara			
Month	Monthly Consumption (kWh)	Average consumption (kWh)	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Extra fixed charge (Rs)	Extra energy charge (Rs)	Adjustment (Rs)	Total amount to be paid (Rs)
Apr										
May	630	754	900	3969	396	17				5284
June	506	709	900	3188	318	17				4425
July										
Aug	686	565	1125	4436	443	17				6023
Sep	633	583	1170	4114	411	17				5714
Oct	801	626	1170	5206	520	17				6915
Nov										
Dec										
Jan	836	790	1170	5434	543	17				7166
Feb	750	802	1170	4875	487	17				6551
Mar										

Electricity Bill Details (2019-20)										
Name of the Consumer				BISHOP MOORE COLLEGE						
Connected Load (kW)				2	Consumer number		1155228010598			
Tariff				LT-7A Ndom (Single Phase)	Section		Mavelkkara			
Month	Monthly Consumption (kWh)	Average consumption (kWh)	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Extra fixed charge (Rs)	Extra energy charge (Rs)	Adjustment (Rs)	Total amount to be paid (Rs)
Apr										
May	275	488	240	1842	184.2	14				2281
June										
July										
Aug										
Sep	366	458	280	2452		14				2992
Oct										
Nov										
Dec										
Jan										
Feb										
Mar										