GREEN AUDIT REPORT

MAR IVANIOS COLLEGE OF ARTS & SCIENCE

MAVELIKARA

2021

Executed by

OTTOTRACTIONS
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GREEN AUDIT REPORT

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Green Audit Report

Mar Ivanios College of Arts and Science

Report No: EA 871

2021-December

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 MAR IVANIOS 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

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Certification

This is to certify that

The data collection has been carried out diligently and truthfully;

All data monitoring devices are in good working condition and have been calibrated or certified by approved agencies authorised and no tampering of such devices has occurred;

All reasonable professional skill, care and diligence had been taken in preparing the energy 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 green audit for the year 2020-21 has been carried out in accordance with the various rules and regulations in India.

This Certificate is issued to Mar Ivanios College of Arts and Science , Mavelikara on their request.

Dated this 10th day of December 2021.

SURESH BABU B V
ACCREDITED ENERGY AUDITOR (AEA 33)
BUREAU OF ENERGY EFFICIENCY, GOVT OF INDIA

OTTOTRACTIONS * EMPANELED ACCREDITED ENERGY AUDITOR, BEE * AEA- 0033

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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 Mar Ivanios Arts & Science 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.

Mar Ivanios College of Arts & Science

Mar Ivanios College of Arts and Science, Mavelikara is a project of the Malankara Catholic Diocese of Mavelikara, established in 2015, under the patronage of His Grace most .Rev. Dr. Joshua Mar Ignathios, the metropolitan of the Diocese and CBCI 1st Vice-President.

Mar Ivanios College of Arts & Science, Mavelikara affiliated to the University of Kerala offer PG & UG degree courses in M.com Finance and accounting, B.A.English Language and Literature, B.A.Economics, B.com Finance, B.com Tax procedure and practice, B.com Tourism and Travel Management. The college is located very close to Mavelikara Railway station and Mavelikara Town. The college has the best infrastructure, a well equipped computer lab, a language lab, a digital library with internet facilities and audio visual room. A hygienic cafeteria also functions in the campus. Students are encouraged to participate in extra curricular activities like sports and games, training programmes, seminars, debates, quiz competitions etc. Periodical evaluation of students through internal assesments and class tests help them to face the university examinations.

The college is run under the able leadership of Fr.Thomas Puthenparampil, the director and Prof.Dr.K.C.Mathai, the principal .The faculty is the best of its kind.

On the whole Mar Ivanios College of Arts and Science Mavelikara, envisions the moulding of an intellectually empowered, ethically fortified and socially committed civil society.

Occupancy Details					
Particulars	2016-17	2017-18	2018-19	2019-20	2020-21
Total Students	268	416	438	475	517
Teaching Staff	17	19	22	22	27
Non-Teaching Staff	13	13	13	13	13
Total Occupancy of the college	298	448	473	510	557

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	Mar Ivanios College of Arts and Science									
2	Address (include telephone, fax & e-mail)	Mar Ivanios College of Arts and Science , Kallumala P O , Mavelikara, Pin: 690110 , ph -0479 2344601									
2	Year of Establishment	2015									
3	Name of building and total No. of Electrical Connections/building	Mar Ivanios College of Arts and Science (2)									
4	Total Number of Students	Boys	-	Girls	-	Total	475				
5	Total Number of Staff	35									
6	Total Occupancy	510									
7	Total area of green cover (Acre)	5.7 Acre									
8	Type of Electrical Connection	HT	-	LT	LT-6F/Three						
9	Contract Demand (KVA) /Connection	NA									
10	Average Maximum Demand (KVA)	NA									
11	Total built up area of the building (M^2)	2440									
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	NA	NA	NA	NA	NA				
15	DG Set Details (kVA,)	DG1	DG2	DG3	DG4	DG5	Remarks				
		20	NA	NA	NA	NA	NA				
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.	Installed solar power plant, Well recharging, Tree plantation,									
18	Contact Person & Telephone number	Prof. Dr. K C Mathai									
		9061202814									

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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 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 510 occupants of this campuses will reach same number of households. This message will spread to at least 2040 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.

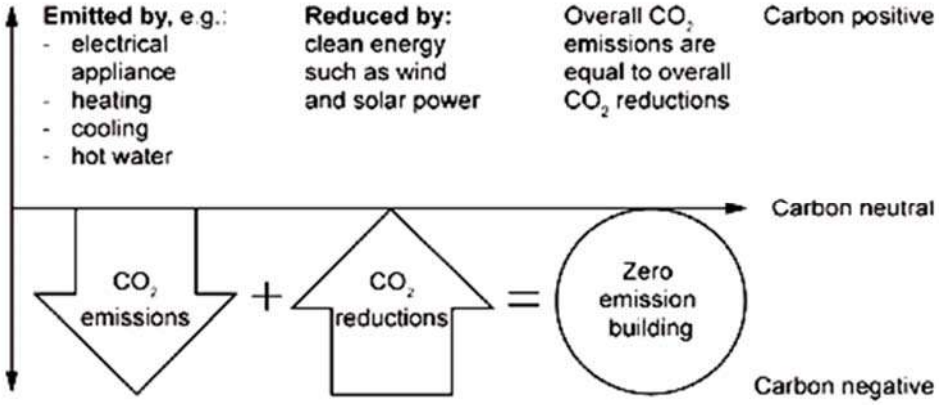
Global Warming Potential (GWP) is a measure of how much heat a greenhouse gas traps in the atmosphere up to a specific time horizon, relative to carbon dioxide. The Global Warming Potential (GWP) was developed to allow comparisons of the global warming impacts of different gases. Specifically, it is 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 are three 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.

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RESULTS AND DISCUSSIONS

3.1 CARBON FOOTPRINT ESTIMATION

3.1.1 ENERGY

a. Electricity

Electricity is purchased from KSEB under 1 LT Connections, the details are given below.

Electricity Connection Details		
Mar Ivanios College of Arts and Science		
1	Name of the Consumer	Mar Ivanios College of Arts and Science Kallumala
2	Tariff	LT-6F/Three
3	Consumer Numbers	1155229026811 , 1155226026331
5	Connected Load (kW)	43.4
6	Annual Electricity Consumption (kWh)	15488

Electricity Bill Analysis (from 2016 to 2021)

Electricity Bill 2016-17						
Date	Amount	Fixed Charge	Energy Charge	Duty	Meter Rent	Consumption(Kwh)
Apr-18	10606	6120	4023.9	447.1	15	503.0
May-18						
Jun-18	10702	6120	4110.3	456.7	15	513.8
Jul-18						
Aug-18	28020	6120	19696.5	2188.5	15	2462.1
Sep-18						
Oct-18	26770	6120	18571.5	2063.5	15	2321.4
Nov-18						
Dec-18	13943	6120	7027.2	780.8	15	878.4
Jan-19						
Feb-19	13846	6120	6939.9	771.1	15	867.5
Mar-19						

Electricity Bill 2017-18						
Date	Cost	Fixed Charge	Energy Charge	Duty	Meter Rent	Consumption(Kwh)
Apr-19	13793	4200	8620.2	957.8	15	1077.5
May-19						
Jun-19	10548	4200	5699.7	633.3	15	712.5
Jul-19	31294	4200	24371.1	2707.9	15	3046.4
Aug-19						
Sep-19						
Oct-19	42569	4200	34518.6	3835.4	15	4314.8
Nov-19	16270	4200	10849.5	1205.5	15	1356.2
Dec-19	13760	4200	8590.5	954.5	15	1073.8
Jan-20	23360	4200	17230.5	1914.5	15	2153.8
Feb-20						
Mar-20	18573	4200	12922.2	1435.8	15	1615.3

Electricity Bill 2018-19						
Date	Amount	Fixed Charge	Energy Charge	Duty	Meter Rent	Consumption(Kwh)
Apr-18	15263	4200	9943.2	1104.8	15	1242.9
May-18	16460	4200	11020.5	1224.5	15	1377.6
Jun-18	7800	4200	3226.5	358.5	15	403.3
Jul-18	10589	4200	5736.6	637.4	15	717.1
Aug-18	12788	4200	7715.7	857.3	15	964.5
Sep-18	8850	4200	4171.5	463.5	15	521.4
Oct-18	14896	4200	9612.9	1068.1	15	1201.6
Nov-18	13647	4200	8488.8	943.2	15	1061.1
Dec-18	13847	4200	8668.8	963.2	15	1083.6
Jan-19	11910	4200	6925.5	769.5	15	865.7
Feb-19	12878	4200	7796.7	866.3	15	974.6
Mar-19	13665	4200	8505	945	15	1063.1

Electricity Bill 2019-20						
Date	Amount	Fixed Charge	Energy Charge	Duty	Meter Rent	Consumption(Kwh)
Apr-18	17336	4200	11808.9	1312.1	15	1476.1
May-18	11451	4200	6512.4	723.6	15	814.1
Jun-18	7614	4200	3059.1	339.9	15	382.4
Jul-18	6192	4200	1779.3	197.7	15	222.4
Aug-18	14630	4200	9373.5	1041.5	15	1171.7
Sep-18	15152	4200	9843.3	1093.7	15	1230.4
Oct-18	22809	4200	16734.6	1859.4	15	2091.8
Nov-18	14743	4200	9475.2	1052.8	15	1184.4
Dec-18	23866	4200	17685.9	1965.1	15	2210.7
Jan-19	12272	4200	7251.3	805.7	15	906.4
Feb-19	26496	4200	20052.9	2228.1	15	2506.6
Mar-19						

Electricity Bill 2020-21						
Date	Cost	Fixed Charge	Energy Charge	Duty	Meter Rent	Consumption(Kwh)
Apr-20		4200	-3793.5	-421.5	15	-474.2
May-20	35494	4200				
Jun-20	21494	4200				
Jul-20	13070	4200	7969.5	885.5	15	996.2
Aug-20						
Sep-20	17370	4200	11839.5	1315.5	15	1479.9
Oct-20						
Nov-20						
Dec-20	28792	4200	22119.3	2457.7	15	2764.9
Jan-21						
Feb-21	14423	4200				
Mar-21	37455	4200	29916	3324	15	3739.5

b. Diesel

Diesel Consumption Details		
Date	Litre(L)	Cost(Rs)
2016-17	2444	141738
2017-18	2715	173779
2018-19	2386	162260
2019-20	2727	193622
2020-21	1704	131240

c. LPG

LPG Consumption Details					
	2016-17	2017-18	2018-19	2019-20	2020-21
No Cylinders	7	8	8	12	4
LPG Consumption in kg	133	152	159.6	228	76

Base Line Energy Data						
Mar Ivanios College of Arts and Science						
		2016-17	2017-18	2018-19	2019-20	2020-21
1	Electricity KSEB (kWh)	15092	23025	11476	15488	12249
2	Electricity Solar - Off grid (kWh)	0.00	0.00	0.00	0.00	0.00
3	Electricity (KSEB + Off grid) kWh	15092	23025	11476	15488	12249
4	Electricity Grid Tied (kWh)	0.00	0.00	0.00	0.00	0.00
5	Diesel (L)	2444	2715	2386.18	2727	1704
6	Petrol(L)	1222.391	299.2754	3869.80	7105.95	2842.38
7	LPG (kg)	133	152	159.6	228	76
8	Biogas (kg)	0.00	0.00	0.00	0.00	0.00

Energy Consumption Profile						
Sl No	Fuel	2016-17	2017-18	2018-19	2019-20	2020-21
		(kCal)				
1	Electricity	12979400	19801871	9869758	13319414	10534264
2	Diesel	25659539	28510598	25054909	28634182	17896364
3	Petrol	13568536	3321957	42954750	78876095	31550438
4	LPG	1596000	1824000	1915200	2736000	912000
5	Biogas	-	-	-	-	-
Total (kCal)		53803474	53458426	79794617	123565691	60893066
Total (kWh)		62562.18	62160.96	92784.44	143681.04	70805.89

Thermal Fuel Consumption					
Mar Ivanios College of Arts and Science					
	2016-17	2017-18	2018-19	2019-20	2020-21
Annual LPG consumption in kg	133	152	159.6	228	76
Annual Diesel consumption in L	2444	2715	2386.18	2727.06	1704.42
Annual petrol consumption in L	1222.4	299.3	3869.8	7106.0	2842.38
Annual Biogas consumption in m3	-	-	-	-	-

Specific Energy Consumption

OTTOTRACTIONS- ENERGY AUDIT						
Mar Ivanios College of Arts and Science						
Energy Performance Index (EPI)						
Sl No	Particulars	2016-17	2017-18	2018-19	2019-20	2020-21
1	Total building area (m^2)	2440	2440	2440	2440	2440
2	Annual Energy Consumption (kCal)	53803474	53458426	79794617	123565691	60893066
3	Annual Energy Consumption (kWh)	62562.2	62161.0	92784.4	143681.0	70805.89
4	Total Energy in Toe	5.38	5.35	7.98	12.36	6.09
5	Specific Energy Consumption kWh/m^2	25.64	25.48	38.03	58.89	29.02

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

Degradable Waste Generation					
Mar Ivanios College of Arts and Science					
	2016-17	**2017-18**	2018-19	2019-20	2020-21
Total Occupancy	268	416	473	510	557
Waste generated in kg /day	5.36	8.32	9.46	12.75	4.456
Waste generated in kg /Yr	707.52	1098.24	1248.72	1683	588.192

Non-Degradable waste

Solid non degradable Waste Generation					
Mar Ivanios College of Arts and Science					
	2016-17	**2017-18**	2018-19	2019-20	2020-21
Total Occupancy	**268**	**416**	473	510	557
Waste paper generated in kg /day	0.05	0.08	0.09	0.11	0.06
Waste plastic generated in kg /day	0.08	0.12	0.14	0.17	0.08
Waste paper generated in kg /Yr	11.79	18.30	20.81	24.93	12.25
Waste plastic generated in kg /Yr	17.69	27.46	31.22	37.40	18.38

3.4. Transportation

There is two buses and a car 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	0.00079	tCo2e/kWh
Diesel	0.0032	tCo2e/kg
LPG	0.0015	tCo2e/kg
Biogas	0.0014	tCo2e/kg
Petrol	0.0031	tCo2e/kg
Food Waste	0.00063	tCo2e/kg
Paper Waste	0.00056	tCo2e/kg
Plastic Waste	0.00034	tCo2e/kg

Carbon Foot Print 2016-21

Carbon Foot Print											
Sl. No.	Particulars	2016-17	tCO2e	2017-18	tCO2e	2018-19	tCO2e	2019-20	tCO2e	2020-21	tCO2e
1	Electricity (kWh)	15092	11.92	23025	18.19	11476	9.07	15488	12.24	12249	9.68
2	Diesel (L)	2444	7.82	2715	8.69	2386	7.64	2386	7.64	1704	5.45
3	Petrol(L)	1222	3.79	299	0.93	3870	12.00	7106	22.03	2842	8.81
4	LPG (kg)	133.00	0.20	152.00	0.23	159.60	0.24	228.00	0.34	76.00	0.11
5	Biogas (m3)	0.00	-	0.00	-	0.00	-	0.00	-	0.00	-
6	Degradable Waste in kg/yr.	708	0.45	1098	0.69	1249	0.79	1683	1.06	588	0.37
7	Paper Waste in kg/yr	11.79	0.01	18.30	0.01	20.81	0.01	24.93	0.01	12.25	0.01
8	Plastic Waste in kg/yr	17.69	0.01	27.46	0.01	31.22	0.01	37.40	0.01	18.38	0.01
Total Carbon Foot Print tCO2e/yr			24.19		28.75		29.75		**43.33**		24.44

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 (Above 15 cm diameter)	0	0	0
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. 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. 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 **43.33tCO_2e** per year by the campus. The total carbon sequestration by trees in the campus compound is **0.00 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	2016-17	2017-18	2018-19	2019-20	2020-21
1	Total carbon emission tCO2e	24.19	28.75	29.75	43.33	24.44
2	Total carbon sequestration tCO2e	0	0	0.00	0.00	0.00
3	Amount of carbon mitigated through renewable energy tCO2e	0	0	0.00	0.00	0.00
4	To be mitigated tCO2e	24.19	28.75	29.75	43.33	24.44
5	Total No of Students	268	416	438	475	517
6	Specific Carbon Footprint kg CO2e/Student/Yr	90.26	69.10	67.92	91.22	47.27

The total specific carbon emission is estimated as **43.33** kg of CO_2e per student for the year 2019-20 and **24.44**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 **91.22** 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						
Mar Ivanios College of Arts and Science						
Greenhouse Gas Mitigation through Major Energy Efficiency Projects						
Sl No	Projects	Energy saved (Yearly)		Sustainability (Years)	First year ton of CO_2 mitigated	Expected Tons of CO_2 mitigated throughout life cycle
		(kWh)	MWh	Years		
1	Energy Saving in Lighting by replacing existing 78 No's T8 (40W) Lamps to 20 W LED Tube	582	0.58	10	0.46	4.60
2	Energy Saving in Lighting by replacing existing 7 No's CFL (20W) Lamps to 9 W LED Bulb	28	0.03	10	0.02	0.22
3	Energy Saving by replacing existing 171 No's in-efficient ceiling fans with Energy Efficient Five star fans	2308	2.31	10	1.82	18.23
Total		**2918**	**3**	**10**	**2.30**	**23**

OTTOTRACTIONS- ENERGY AUDIT						
Mar Ivanios College of Arts and Science						
Greenhouse Gas Mitigation through Renewable Energy Projects						
Sl No	Projects	Energy saved(Yearly)		Sustainability (Years)	First year ton of CO_2 mitigated	Expected Tons of CO_2 mitigated throughout life cycle
		(kWh)	MWh	Years		
1	Installation of 40kWp Solar Power Plant	**51100**	51.10	26	40.37	1049.59
2	Installation of 15Kg/day Biogas plant	**5647**	5.65	20	4.46	89.22

Executive Summary					
Consolidated Cost Benefit Analysis of Energy Efficiency Improvement Projects					
Mar Ivanios College of Arts and 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 78 No's T8 (40W) Lamps to 20 W LED Tube**	0.23	0.05	60.33	582
2	**Energy Saving in Lighting by replacing existing 7 No's CFL (20W) Lamps to 9 W LED Bulb**	0.01	0.00	34.04	28
3	**Energy Saving by replacing existing 171 No's in-efficient ceiling fans with Energy Efficient Five star fans**	4.28	0.18	277.83	2308
	Total	4.52	0.23	124.06	2917.67
(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.)					
Consolidated Cost Benefit Analysis of Renewable Energy Projects					
4	**Installation of 40kWp Solar Power Plant**	30.00	4.09	88.06	51100
5	**Installation of 15Kg/day Biogas plant**	0.2	0.26	9.39	5647

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	43.33
2	Carbon Sequestrated tCO2e/yr	0.00
3	Carbon mitigated by Renewable Energy tCO2e/yr (installed)	0.00
4	Carbon mitigated by Renewable Energy tCO2e/yr (Proposed) (Solar)	40.37
5	Carbon mitigated by Renewable Energy (Biogas Plant) (Proposed)	1.94
6	Carbon mitigated by Energy Efficiency (Proposed) tCO2e/yr	2.30
7	Effective Carbon footprint tCO2e/yr	-1.29
8	Total No of Students	475.00
9	Specific Carbon Footprint kg CO2e/Student/Yr	-2.71

From this study it was found that carbon footprint of the campus to be **-2.71** $kgCO_2e$/ Student/ Year in place of current footprint i.e., **43.33**$kgCO_2e$/ student/ Year. This will be achieved after implementing energy efficiency projects and implementation of 40kWp solar power plant. And to achieve this an investment of **34.72 lakhs Rs** is required through energy efficiency and renewable energy projects proposed. It will be around **7308.5Rs 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	4.52
2	Cost of implementation in Renewable Energy Lakhs Rs	30.20
3	Total Lakhs Rs	34.72
4	Total number of students	475
5	Cost per student to make the campus carbon negative Rs/ Student	7308.5

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.
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- 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

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OTTOTRACTIONS
Energy-Engineering-Environment

6

TECHNICAL SUPPLEMENT

Sl.No		Location	LIGHT				FAN	IT		AC
			T8	CFL	LED BULB	LED TUBE	CF	PC	Printer	1.5
1	Second Floor	Class 307				6	5			
2		308				6	5			
3		306				6	5			
4		304				6	5			
5		303				6	5			
6		302				6	5			
7		301				6	5			
8		Class 1				6	5			
9		Class 2				6	5			
10		Staff Room				5	4			
11		Department				4	4			
12		Yoga Corner				7	4			
13	First Floor	201	4				5			
14		202	4				5			
15		Department	6			1	4			
16		203	4				5			
17		IQ NC	4				4			

18		Office	4		1	2		4		
19		205	4				5			
20		Principal	3	1	1	2	4			1
21		207	1		1	1	5			
22		Computer Lab	9	4			6	45		
23		208	2	2	3	2	5			
24		106	4				5			
25		107	4				5			
26		108	4				5			
27		Library	4		3	3	2	1	1	
28		Department	1			1	5	3		
29	Ground Floor	104	2				2			
30		Seminar Hall	2			3	10			
31		**101**	4							
32		102	4							
33		103	4							
34		Canteen				2	5			
35	HOSTEL	27 Room				27	27			
		TOTAL	**78**	**7**	**9**	**114**	**171**	**53**	**1**	**1**

Electricity Bill 2019-20						
Date	Amount	Fixed Charge	Energy Charge	Duty	Meter Rent	Consumption (Kwh)
Apr-18	17336	4200	11808.9	1312.1	15	1476.1
May-18	11451	4200	6512.4	723.6	15	814.1
Jun-18	7614	4200	3059.1	339.9	15	382.4
Jul-18	6192	4200	1779.3	197.7	15	222.4
Aug-18	14630	4200	9373.5	1041.5	15	1171.7
Sep-18	15152	4200	9843.3	1093.7	15	1230.4
Oct-18	22809	4200	16734.6	1859.4	15	2091.8
Nov-18	14743	4200	9475.2	1052.8	15	1184.4
Dec-18	23866	4200	17685.9	1965.1	15	2210.7
Jan-19	12272	4200	7251.3	805.7	15	906.4
Feb-19	26496	4200	20052.9	2228.1	15	2506.6
Mar-19						

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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