GREEN AUDIT REPORT

MAHATMA GANDHI COLLEGE

THIRUVANANTHAPURAM

Executed by

OTTOTRACTIONS
Energy - Engineering - Environment

2023

OTTOTRACTIONS
Energy - Engineering - Environment

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Bureau of Energy Efficiency
Government of India.

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

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

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GREEN AUDIT REPORT

MAHATMA GANDHI COLLEGE

TRIVANDRUM

OTTOTRACTIONS
Energy-Engineering-Environment

Green Audit Report
Mahatma Gandhi College, Trivandrum
Report No: EA 1093/GA
2023

About OTTOTRACTIONS

OTTOTRACTIONS established in 2005, is an organization with proven track record and knowledge in the field of energy, engineering, and environmental services. They are the first Accredited Energy Auditor from Kerala for conducting Mandatory Energy Audits in Designated Consumers as per Energy Conservation Act-2001. Government of Kerala recognized and appreciated OTTOTRACTIONS by presenting its prestigious "The Kerala State Energy Conservation Award 2009" for the best performance as an Energy Auditor. Ottotractions is an ISO 9001-2015, ISO 17020-2012 and ISO 14001-2015 Certified organization, which ensures the quality of its services.

Acknowledgment

We were privileged to work together with the administration and staff of Mahatma Gandhi College, Trivandrum. We are grateful to them for the timely help extended to complete the audit and bringing out this report.

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

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

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

Thank you.

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

Preface

Educational institutions always had an important leadership role in society in demonstrating types of changes that used to occur with respect to the prime issues of the time. All around the world, educational institutions are taking steps to declare themselves the next carbon neutral campus 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 campus 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 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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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 **Mahatma Gandhi College, Trivandrum** 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 3,6,7,11,3,15. 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.

MAHATMA GANDHI COLLEGE

Founded by the Nair Service Society in 1948, Mahatma Gandhi College, Thiruvananthapuram, is a premier educational institution where quality education is given new dimensions. It is one of the largest and oldest institutions of higher education in the capital city of the state of Kerala run by the largest educational agency of Kerala, the Nair Service Society.

Mahatma Gandhi College functions with the objective of providing value added quality education to all, with special emphasis on the economically poor sections of the society, upholding the motto "Sa Vidya Ya Vimukthaye". It has 13 UG, 10 PG and 8 research programmes in the faculties of basic science, humanities and social sciences with more than 2500 students pursuing their studies in various disciplines.

Mahatma Gandhi College has been accredited by NAAC at 'A' level in the first phase which was retained in the second phase of accreditation as well. University Grants commission bestowed the college with the status of CPE (College with Potential for Excellence) and awarded an assistance of Rupees One crore for the development of infrastructure and the conduct of various programs in the first phase. The college underwent its third phase of accreditation in 2018 and was awarded B+ grade with a CGPA of 2.73. The institution was selected for the award of three FIST (Fund for Improvement of Science and Technology Infrastructure in Universities and Higher Educational Institutions) programmes of the DST (Department of Science and Technology, Government of India). In 2018, the college bagged the 68th position in NIRF ranking by MHRD, Government of India, under Colleges category. A RUSA fund of Two Crores was also awarded to the college for infrastructure development in 2018

Occupancy Details					
Particulars	2018-19	2019-20	2020-21	2021-22	2022-23
Total Students	2275	2300	2301	2262	2214
Staffs	120	120	120	120	120
Total Occupancy of the college	2395	2420	2421	2382	2334

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

BASELINE DATA SHEET FOR GREEN AUDIT											
1	Name of the Organisation	Mahatma Gandhi College, Trivandrum									
2	Address (include telephone, fax & e-mail)	Mahatma Gandhi College Kesavadasapuram, Pattom. PO., Trivandrum - 695 004, Kerala, India Phone: +91 471 211 4465									
3	Year of Establishment	1948									
4	Name of building and Total No. of Electrical Connections/building	MG College (4)									
5	Total Number of Students	Boys	-	Girls	-	Total	2214				
6	Total Number of Staff	120									
7	Total Occupancy	2334									
8	Total area of green cover	50%									
9	Type of Electrical Connection	HT	0	LT	4						
10	Total Connected Load (kW)	190									
11	Average Maximum Demand (KVA)	-									
12	Total built up area of the building (M^2)	10000									
13	Number of Buildings	3									
14	Average system Power Factor	0.99									
15	Details of capacitors connected	Nil									
16	Transformer Details (Nos., kVA, Voltage ratio)	TR 1									
		0									
17	DG Set Details (kVA)	DG1	DG2	DG3	DG4	DG5	Remarks				
		10	3								
18	Details of motors	Rating		Nos.		Remarks					
		5 to 10									
		10 to 50		3							
		Above 50									
19	Brief write-up about the firm and the energy/environmental conservation activities already undertaken.	Installed Solar Street Lights and 1kWp Solar power plant, Installed biogas plant, Energy conservation projects and Rain water harvesting									
20	Contact Person & Telephone number	Principal									
		04712114465									

2

METHODOLOGY

2.1. Sensitisation

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

During the audit the students and staffs were sensitised on the project and trained to be a part of the data collection team. This helped in conducting the survey in a participatory mode so that the awareness will penetrate to the grass root level. During the data collection field visit it was stressed that the team will spread these ideas to their homes and friends. This will help in a horizontal and vertical spread of the message to a wider group. It is assumed that through 2334 occupants of these campuses will reach same number of households. This message will spread to at least 9340 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

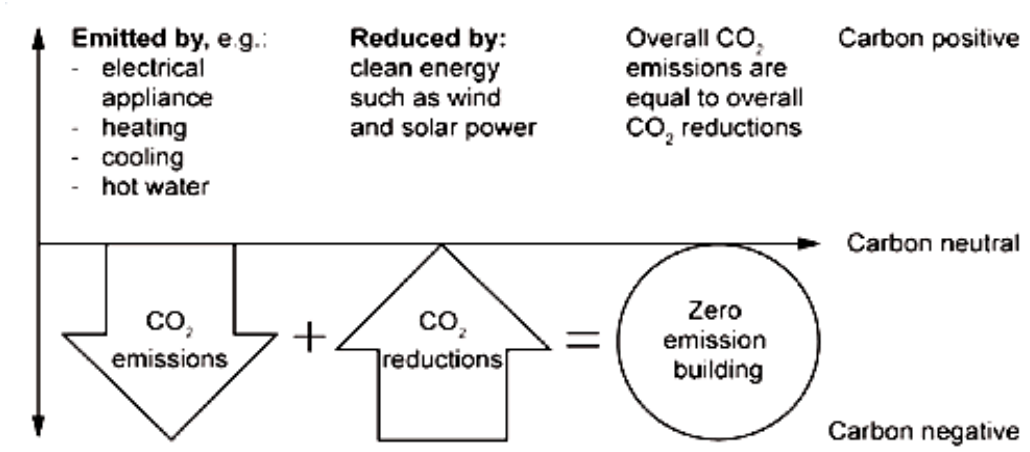
warming impacts of different gases. Specifically, it is a measure of how much energy the emissions of one ton of a gas will absorb over a given period of time, relative to the emissions of one ton of carbon dioxide (CO_2).

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

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 below.

Step 1: Determine the total green weight of the tree

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

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

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

W above-ground= Above-ground weight in pounds

D = Diameter of the trunk in inches

H = Height of the tree in feet

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

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

Step 2: Determine the dry weight of the tree

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

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

Step 3: Determine the weight of carbon in the tree

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

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

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

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

3

RESULTS AND DISCUSSIONS

3.1 CARBON FOOTPRINT ESTIMATION

3.1.1 ENERGY

a. Electricity

Electricity is purchased from KSEB under 4 LT Connections, the details are given below.

Electricity Connection Details		
Mahatma Gandhi College, Trivandrum		
1	Name of the Consumer	Mahatma Gandhi College, Trivandrum
2	Tariff	LT-6A/Ndom
3	Consumer Numbers	1145162001339, 1145165001338 1145163001351, 1145165001349
4	Connected Load Total (kW)	190
5	Annual Electricity Consumption (kWh)	51135

Electricity Bill Analysis

Electricity Bill Details (2022-23)						
Name of the Consumer			**Mahatma Gandhi College, Trivandrum**			
Connected Load (kW)			**178**	Consumer no	**1145162001339**	
Tariff		**LT-6A/Ndom**		Section	**Kesavadasapuram**	
Month	kWh	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Total amount to be paid (Rs)
Apr	4035	9500	26792	2679	35	39007
May	2571	9500	17071	1707	35	28314
Jun	2296	9500	15245	1525	35	26305
Jul	3498	9500	23227	2323	35	35084
Aug	2995	9500	19887	1989	35	31410
Sep	2736	9500	18167	1817	35	29519
Oct	3078	9500	20438	2044	35	32017
Nov	3346	9500	22217	2222	35	33974
Dec	3681	9500	24442	2444	35	36421
Jan	2957	9500	19634	1963	35	31133
Feb	3299	9500	21905	2191	35	33631
Mar	3237	9500	21494	2149	35	33178

Electricity Bill Details (2021-22)						
Name of the Consumer			**Mahatma Gandhi College, Trivandrum**			
Connected Load (kW)			**178**	Consumer no	**1145162001339**	
Tariff		**LT-6A/Ndom**		Section	**Kesavadasapuram**	
Month	kWh	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Total amount to be paid (Rs)
Apr	2944	9500	19548	1955	35	31038
May	1805	9500	11985	1199	35	22719
Jun	1805	9500	11985	1199	35	22719
Jul	1390	9500	9230	923	35	19688
Aug	2414	9500	16029	1603	35	27167
Sep	1894	9500	12576	1258	35	23369
Oct	2394	9500	15896	1590	35	27021
Nov	2678	9500	17782	1778	35	29095
Dec	2942	9500	19535	1953	35	31023
Jan	2784	9500	18486	1849	35	29869
Feb	2970	9500	19721	1972	35	31228
Mar	2820	9500	18725	1872	35	30132

Electricity Bill Details (2020-21)						
Name of the Consumer			**Mahatma Gandhi College, Trivandrum**			
Connected Load (kW)			**178**	Consumer no	**1145162001339**	
Tariff		**LT-6A/Ndom**		Section	**Kesavadasapuram**	
Month	kWh	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Total amount to be paid (Rs)
Apr	1493	9500	9914	991	35	20440
May	1493	9500	9914	991	35	20440
Jun	788	9500	5232	523	35	15291
Jul	1854	9500	12311	1231	35	23077
Aug	1023	9500	6793	679	35	17007
Sep	1107	9500	7350	735	35	17621
Oct	1387	9500	9210	921	35	19666
Nov	1611	9500	10697	1070	35	21302
Dec	1808	9500	12005	1201	35	22741
Jan	1679	9500	11149	1115	35	21798
Feb	3017	9500	20033	2003	35	31571
Mar	3400	9500	22576	2258	35	34369

Electricity Bill Details (2019-20)						
Name of the Consumer			**Mahatma Gandhi College, Trivandrum**			
Connected Load (kW)			**178**	Consumer no	**1145162001339**	
Tariff		**LT-6A/Ndom**		Section	**Kesavadasapuram**	
Month	kWh	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Total amount to be paid (Rs)
Apr	4124	9500	27383	2738	35	39657
May	2739	9500	18187	1819	35	29541
Jun	3445	9500	22875	2287	35	34697
Jul	3581	9500	23778	2378	35	35691
Aug	3039	9500	20179	2018	35	31732
Sep	3724	9500	24727	2473	35	36735
Oct	2181	9500	14482	1448	35	25465
Nov	3326	9500	22085	2208	35	33828
Dec	3701	9500	24575	2457	35	36567
Jan	2723	9500	18081	1808	35	29424
Feb	3261	9500	21653	2165	35	33353
Mar	3744	9500	24860	2486	35	36881

Electricity Bill Details (2018-19)						
Name of the Consumer			**Mahatma Gandhi College, Trivandrum**			
Connected Load (kW)			**178**	Consumer no	**1145162001339**	
Tariff		**LT-6A/Ndom**		Section	**Kesavadasapuram**	
Month	kWh	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Total amount to be paid (Rs)
Apr	3800	9500	25232	2523	35	37290
May	6700	9500	44488	4449	35	58472
Jun	6100	9500	40504	4050	35	54089
Jul	4252	9500	28233	2823	35	40592
Aug	5968	9500	39628	3963	35	53125
Sep	4590	9500	30478	3048	35	43060
Oct	6194	9500	41128	4113	35	54776
Nov	7107	9500	47190	4719	35	61445
Dec	6959	9500	46208	4621	35	60364
Jan	5158	9500	34249	3425	35	47209
Feb	4976	9500	33041	3304	35	45880
Mar	3693	9500	24522	2452	35	36509

Electricity Bill Details (2022-23)						
Name of the Consumer			**Mahatma Gandhi College, Trivandrum**			
Connected Load (kW)			**2**	Consumer no	**1145165001338**	
Tariff		**LT-7A/Ndom**		Section	**Kesavadasapuram**	
Month	kWh	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Total amount to be paid (Rs)
Apr	247	120	1640	164	15	1939
Jun	288	120	1912	191	15	2239
Aug	399	120	2649	265	15	3049
Oct	276	120	1833	183	15	2151
Dec	254	120	1687	169	15	1990
Feb	221	120	1467	147	15	1749

Electricity Bill Details (2021-22)						
Name of the Consumer			**Mahatma Gandhi College, Trivandrum**			
Connected Load (kW)			**2**	Consumer no	**1145165001338**	
Tariff		**LT-7A/Ndom**		Section	**Kesavadasapuram**	
Month	kWh	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Total amount to be paid (Rs)
Apr	281	120	1866	187	15	2187
Jun	282	120	1872	187	15	2195
Aug	282	120	1872	187	15	2195
Oct	282	120	1872	187	15	2195
Dec	386	120	2563	256	15	2954
Feb	317	120	2105	210	15	2450

Electricity Bill Details (2020-21)						
Name of the Consumer			**Mahatma Gandhi College, Trivandrum**			
Connected Load (kW)			**2**	Consumer no	**1145165001338**	
Tariff		**LT-7A/Ndom**		Section	**Kesavadasapuram**	
Month	kWh	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Total amount to be paid (Rs)
Apr	190	120	1262	126	15	1523
Jun	189	120	1255	125	15	1515
Aug	179	120	1189	119	15	1442
Oct	240	120	1594	159	15	1888
Dec	281	120	1866	187	15	2187
Feb	282	120	1872	187	15	2195

Electricity Bill Details (2019-20)						
Name of the Consumer			**Mahatma Gandhi College, Trivandrum**			
Connected Load (kW)			**2**	Consumer no	**1145165001338**	
Tariff		**LT-7A/Ndom**		Section	**Kesavadasapuram**	
Month	kWh	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Total amount to be paid (Rs)
Apr	150	120	996	100	15	1231
Jun	150	120	996	100	15	1231
Aug	149	120	989	99	15	1223
Oct	724	120	4807	481	15	5423
Dec	723	120	4801	480	15	5416
Feb	308	120	2045	205	15	2385

Electricity Bill Details (2018-19)						
Name of the Consumer			**Mahatma Gandhi College, Trivandrum**			
Connected Load (kW)			**2**	Consumer no	**1145165001338**	
Tariff		**LT-7A/Ndom**		Section	**Kesavadasapuram**	
Month	kWh	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Total amount to be paid (Rs)
Apr	375	120	2490	249	15	2874
Jun	339	120	2251	225	15	2611
Aug	385	120	2556	256	15	2947
Oct	385	120	2556	256	15	2947
Dec	461	120	3061	306	15	3502
Feb	358	120	2377	238	15	2750

Electricity Bill Details (2022-23)						
Name of the Consumer			**Mahatma Gandhi College, Trivandrum**			
Connected Load (kW)			**2**	Consumer no	**1145163001351**	
Tariff		**LT-6A/Ndom**		Section	**Kesavadasapuram**	
Month	kWh	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Total amount to be paid (Rs)
Apr	225	120	1494	149	15	1778
Jun	224	120	1487	149	15	1771
Aug	228	120	1514	151	15	1800
Oct	228	120	1514	151	15	1800
Dec	228	120	1514	151	15	1800
Feb	228	120	1514	151	15	1800

Electricity Bill Details (2021-22)						
Name of the Consumer			**Mahatma Gandhi College, Trivandrum**			
Connected Load (kW)			**2**	Consumer no	**1145163001351**	
Tariff		**LT-6A/Ndom**		Section	**Kesavadasapuram**	
Month	kWh	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Total amount to be paid (Rs)
Apr	258	120	1713	171	15	2019
Jun	80	120	531	53	15	719
Aug	80	120	531	53	15	719
Oct	76	120	505	50	15	690
Dec	271	120	1799	180	15	2114
Feb	256	120	1700	170	15	2005

Electricity Bill Details (2020-21)						
Name of the Consumer			**Mahatma Gandhi College, Trivandrum**			
Connected Load (kW)			**2**	Consumer no	**1145163001351**	
Tariff		**LT-6A/Ndom**		Section	**Kesavadasapuram**	
Month	kWh	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Total amount to be paid (Rs)
Apr	168	120	1116	112	15	1362
Jun	167	120	1109	111	15	1355
Aug	126	120	837	84	15	1055
Oct	126	120	837	84	15	1055
Dec	105	120	697	70	15	902
Feb	165	120	1096	110	15	1340

Electricity Bill Details (2019-20)						
Name of the Consumer			**Mahatma Gandhi College, Trivandrum**			
Connected Load (kW)			**2**	Consumer no	**1145163001351**	
Tariff		**LT-6A/Ndom**		Section	**Kesavadasapuram**	
Month	kWh	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Total amount to be paid (Rs)
Apr	399	120	2649	265	15	3049
Jun	89	120	591	59	15	785
Aug	458	120	3041	304	15	3480
Oct	370	120	2457	246	15	2837
Dec	414	120	2749	275	15	3159
Feb	325	120	2158	216	15	2509

Electricity Bill Details (2018-19)						
Name of the Consumer			**Mahatma Gandhi College, Trivandrum**			
Connected Load (kW)			**2**	Consumer no	**1145163001351**	
Tariff		**LT-6A/Ndom**		Section	**Kesavadasapuram**	
Month	kWh	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Total amount to be paid (Rs)
Apr	306	120	2032	203	15	2370
Jun	167	120	1109	111	15	1355
Aug	454	120	3015	301	15	3451
Oct	312	120	2072	207	15	2414
Dec	479	120	3181	318	15	3634
Feb	337	120	2238	224	15	2596

Electricity Bill Details (2022-23)						
Name of the Consumer			**Mahatma Gandhi College, Trivandrum**			
Connected Load (kW)			**8**	Consumer no	**1145165001349**	
Tariff		**LT-4A/Ndom**		Section	**Kesavadasapuram**	
Month	kWh	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Total amount to be paid (Rs)
Apr	904	120	6003	600	15	6738
May	837	120	5558	556	15	6248
Jun	836	120	5551	555	15	6241
Jul	942	120	6255	625	15	7015
Aug	921	120	6115	612	15	6862
Sep	758	120	5033	503	15	5671
Oct	758	120	5033	503	15	5671
Nov	922	120	6122	612	15	6869
Dec	922	120	6122	612	15	6869
Jan	921	120	6115	612	15	6862
Feb	848	120	5631	563	15	6329
Mar	791	120	5252	525	15	5912

Electricity Bill Details (2021-22)						
Name of the Consumer			**Mahatma Gandhi College, Trivandrum**			
Connected Load (kW)			**8**	Consumer no	**1145165001349**	
Tariff		**LT-4A/Ndom**		Section	**Kesavadasapuram**	
Month	kWh	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Total amount to be paid (Rs)
Apr	594	120	3944	394	15	4474
May	368	120	2444	244	15	2823
Jun	367	120	2437	244	15	2816
Jul	457	120	3034	303	15	3473
Aug	456	120	3028	303	15	3466
Sep	527	120	3499	350	15	3984
Oct	367	120	2437	244	15	2816
Nov	586	120	3891	389	15	4415
Dec	648	120	4303	430	15	4868
Jan	736	120	4887	489	15	5511
Feb	684	120	4542	454	15	5131
Mar	905	120	6009	601	15	6745

Electricity Bill Details (2020-21)						
Name of the Consumer			**Mahatma Gandhi College, Trivandrum**			
Connected Load (kW)			**8**	Consumer no	**1145165001349**	
Tariff		**LT-4A/Ndom**		Section	**Kesavadasapuram**	
Month	kWh	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Total amount to be paid (Rs)
Apr	297	120	1972	197	15	2304
May	297	120	1972	197	15	2304
Jun	297	120	1972	197	15	2304
Jul	297	120	1972	197	15	2304
Aug	295	120	1959	196	15	2290
Sep	245	120	1627	163	15	1924
Oct	468	120	3108	311	15	3553
Nov	367	120	2437	244	15	2816
Dec	367	120	2437	244	15	2816
Jan	356	120	2364	236	15	2735
Feb	453	120	3008	301	15	3444
Mar	594	120	3944	394	15	4474

Electricity Bill Details (2019-20)						
Name of the Consumer			**Mahatma Gandhi College, Trivandrum**			
Connected Load (kW)			**8**	Consumer no	**1145165001349**	
Tariff		**LT-4A/Ndom**		Section	**Kesavadasapuram**	
Month	kWh	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Total amount to be paid (Rs)
Apr	566	120	3758	376	15	4269
May	484	120	3214	321	15	3670
Jun	1048	120	6959	696	15	7790
Jul	375	120	2490	249	15	2874
Aug	429	120	2849	285	15	3268
Sep	429	120	2849	285	15	3268
Oct	267	120	1773	177	15	2085
Nov	267	120	1773	177	15	2085
Dec	394	120	2616	262	15	3013
Jan	394	120	2616	262	15	3013
Feb	393	120	2610	261	15	3005
Mar	620	120	4117	412	15	4663

Electricity Bill Details (2018-19)						
Name of the Consumer			**Mahatma Gandhi College, Trivandrum**			
Connected Load (kW)			**8**	Consumer no	**1145165001349**	
Tariff		**LT-4A/Ndom**		Section	**Kesavadasapuram**	
Month	kWh	Fixed charge (Rs)	Energy charge (Rs)	Duty (Rs)	Meter rent (Rs)	Total amount to be paid (Rs)
Apr	840	120	5578	558	15	6270
May	312	120	2072	207	15	2414
Jun	165	120	1096	110	15	1340
Jul	336	120	2231	223	15	2589
Aug	406	120	2696	270	15	3100
Sep	451	120	2995	299	15	3429
Oct	656	120	4356	436	15	4926
Nov	587	120	3898	390	15	4422
Dec	333	120	2211	221	15	2567
Jan	228	120	1514	151	15	1800
Feb	371	120	2463	246	15	2845
Mar	312	120	2072	207	15	2414

Annual Electricity Consumption (kWh)						
Consumer No	**2018-19**	**2019-20**	**2020-21**	**2021-22**	**2022-23**	**Connected Load (kW)**
1145162001339	65497	39588	20660	28840	37729	178
1145165001338	2303	2204	1361	1830	1685	2
1145163001351	2055	2055	857	1021	1361	2
1145165001349	4997	5666	4333	6695	10360	8
TOTAL	74852	49513	27211	38386	51135	190

Solar

Solar Power Plant		
Location	**Capacity (kWp)**	**2022-23**
		Annual generation (kWh)
College Campus	1	1278
Total kWh		1278

LPG

LPG Consumption Details					
	2018-19	2019-20	2020-21	2021-22	2022-23
No Cylinders	36	36	24	48	60
Canteen/Lab LPG Consumption in kg	540.0	540.0	360.0	720.0	900.0
Total in kg	540.0	540.0	360.0	720.0	900.0

Base Line Energy Data						
Mahatma Gandhi College, Trivandrum						
		2018-19	2019-20	2020-21	2021-22	2022-23
1	Electricity KSEB (kWh)	74852	49513	27211	38386	51135
2	Electricity DG (kWh)	0	0	0	0	0
3	Electricity Solar , Off grid (kWh)	295	301	307	313	319
4	Electricity (KSEB + DG + Off grid) kWh	75147	49814	27518	38699	51454
5	Electricity Grid Tied (kWh)	1178	1202	1227	1252	1278
6	Diesel (L)	0.00	0.00	0.00	0.00	0.0
7	LPG (kg)	540.00	540.00	360.00	720.00	900.00
8	Biogas generated/year (kg)	608.76	621.19	633.86	646.80	660.00

Energy Consumption Profile						
Sl No	Fuel	2018-19	2019-20	2020-21	2021-22	2022-23
		kCal				
1	Electricity	64626060	42839690	23665246	33281129	44250763
2	Diesel	0	0	0	0	0
3	LPG	6480000	6480000	4320000	8640000	10800000
4	Biogas	2840894	2898871	2958032	3018400	3080000
	Total	73946954	52218562	30943278	44939529	58130763

Thermal Fuel Consumption					
Mahatma Gandhi College, Trivandrum					
	2018-19	2019-20	2020-21	2021-22	2022-23
Annual LPG consumption in kg	540.0	540.0	360.0	720.0	900.0
Annual Diesel consumption in L	0.0	0.0	0.0	0.0	0.0
Annual petrol consumption in L	0	0	0	0	0
Annual Biogas consumption in kg	608.76	621.19	633.86	646.80	660.00

3.2. Specific Energy Consumption

OTTOTRACTIONS- ENERGY AUDIT						
Mahatma Gandhi College, Trivandrum						
Energy Performance Index (EPI)						
Sl No	**Particulars**	2018-19	2019-20	2020-21	2021-22	2022-23
1	Total building area (m^2)	10000	10000	10000	10000	10000
2	Annual Energy Consumption (kCal)	73946954	52218562	30943278	44939529	58130763
3	Annual Energy Consumption (kWh)	85985	60719	35981	52255	67594
4	Total Energy in Toe	7.39	5.22	3.09	4.49	5.81
5	Specific Energy Consumption kWh/m^2	8.60	6.07	3.60	5.23	6.76

The specific energy consumption in 2022-23 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					
Mahatma Gandhi College, Trivandrum					
Particulers	2018-19	2019-20	2020-21	2021-22	2022-23
Total Occupancy	2395	2420	2421	2382	2334
Waste generated in kg /day	47.9	48.4	48.42	47.64	46.68
Waste generated in kg /Yr	10538	10648	10652	10481	10270

Non-Degradable waste

Solid non degradable Waste Generation					
Mahatma Gandhi College, Trivandrum					
Particulers	2018-19	2019-20	2020-21	2021-22	2022-23
Total Occupancy	2395	2420	2421	2382	2334
Waste paper generated in kg /day	0.479	0.484	0.4842	0.4764	0.4668
Waste plastic generated in kg /day	0.7185	0.726	0.7263	0.7146	0.7002
Waste paper generated in kg /Yr	105.38	106.48	106.52	104.81	102.70
Waste plastic generated in kg /Yr	158.07	159.72	159.79	157.21	154.04

3.4. Transportation

The college does not have any vehicles for logistics.

Carbon Emission Profile (2022-23)

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	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

Carbon Foot Print 2022-23

Carbon Foot Print											
Sl. No.	Particulars	2018-19	tCO2e	2019-20	tCO2e	2020-21	tCO2e	2021-22	tCO2e	2022-23	tCO2e
1	Electricity (kWh)	75147	61.62	49814	40.85	27518	22.56	38699	31.73	51454	42.19
2	Diesel (L)	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
3	LPG (kg)	540	0.81	540	0.81	360	0.54	720	1.08	900.00	1.35
4	Biogas (kg)	608.76	0.85	621.19	0.87	633.86	0.89	646.80	0.91	660.00	0.924
5	Degradable Waste in kg/yr.	10538	6.64	10648	6.71	10652.4	6.71	10480.8	6.60	10269.6	6.47
6	Paper Waste in kg/yr	105.38	0.06	106.48	0.06	106.52	0.06	104.81	0.06	102.70	0.06
Total Carbon Foot Print tCO2e/yr			69.8		49.9		30.6		40.8		50.9

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					
Particulers	2018-19	2019-20	2020-21	2021-22	2022-23
Total No of Trees	318	318	318	318	318
Carbon sequestrated by trees in the campus (tCO2e)	6.5	7.2	8.0	8.9	9.84

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 FOOTPRINT OF THE CAMPUS (2022-23)

Various carbon emitting activities such as consumption of energy, transportation and waste generation leads to the total emission of **50.99 tCO_2e** per year by the campus. The total carbon sequestration by trees in the campus compound is **9.84 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:

Specific CO2 Footprint

Amount of Carbon to be mitigated for Low Carbon Campus						
Sl No	Particulars	2018-19	2019-20	2020-21	2021-22	2022-23
1	Total carbon emission tCO2e	69.98	49.29	40.38	50.99	50.99
2	Total carbon sequestration tCO2e	6.46	7.17	7.97	8.86	9.84
3	Amount of carbon mitigated through renewable energy tCO2e	1.82	1.86	1.89	1.93	1.97
4	To be mitigated tCO2e	61.71	40.27	30.52	40.21	39.18
5	Total No of Students	2395	2420	2421	2382	2334
6	Specific Carbon Footprint kg CO2e/Student/Yr	25.76	16.64	12.61	16.88	16.79

The total specific carbon footprint is estimated as **16.79** kg of CO_2e per student for the year 2022-23.

4

Carbon Mitigation Plans

The total emission of the carbon dioxide per student is **23.03** kg per year (2022-2023). Emission reduction plans were prepared to bring the existing per capita carbon footprint to zero or below so as to bring the campus a carbon neutral or carbon negative campus.

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

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

- Resource optimisation
- Energy efficiency
- Renewable energy

RESOURCE OPTIMISATION

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

WASTE MINIMISATION

Optimal utilisation of paper and plastic stationaries can reduce the frequency of purchase of items. This can reduce the unnecessary wastage of money as well as the excess production of waste. In the case of food, proper food habits and housekeeping practices can optimise its usage.

Currently, the campus is taking an appreciable effort to reduce the unnecessary production of wastes. But the campus still has opportunities to reduce the generation of waste and can improve much more. Resource optimisation can be effectively implemented in all type of waste generated in the campus and the campus can expect about 50% reduction the total waste produced.

ENERGY EFFICIENCY

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

FUELS FOR COOKING

The campus 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						
Mahatma Gandhi College, Trivandrum						
Greenhouse Gas Mitigation through Major Energy Efficiency Projects						
Sl No	Projects proposed	Energy saved(Yearly)		Sustainability (Years)	First year ton of CO2 mitigated	Expected Tons of CO2 mitigated through out life cycle
		(kWh)	MWh	Years		
1	Energy Saving in Lighting by replacing existing 51 No's T8 (40W) Lamps to 18W LED Tube	1077	1.08	10	0.79	7.86
2	Energy Saving in Lighting by replacing existing 20 No's T5 (28W) Lamps to 18W LED Tube	317	0.32	10	0.23	2.31
3	Energy Saving in Lighting by replacing existing 50 No's T12 (55W) Lamps to 18W LED Tube	1327	1.33	10	0.97	9.68
4	Energy Saving in Lighting by replacing existing 14 No's CFL(15W) Lamps to 9W LED Bulb	60	0.06	10	0.04	0.44
5	Energy Saving by replacing existing 310 No's in-efficient ceiling fans with Energy Efficient Five star fans	5833	5.83	10	4.26	42.58
Total		**8614**	**9**	**10**	**6.29**	**62.88**

OTTOTRACTIONS- ENERGY AUDIT						
Mahatma Gandhi College, Trivandrum						
Greenhouse Gas Mitigation through Renewable Energy Projects						
Sl No	Projects	Energy saved (Yearly)		Sustainability (Years)	First year ton of CO2 mitigated	Expected Tons of CO2 mitigated through out life cycle
		(kWh)	MWh	Years		
1	Installation of 35kWp Solar Power Plant	47906	47.91	25	34.97	874.29

OTTOTRACTIONS- ENERGY AUDIT	
Energy Saving Proposal	
Energy Saving in Lighting by replacing existing 20 No's T5 (28W) Lamps to 18W LED Tube	
Existing Scenario	
20 numbers of T5(28 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 T5 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	20
Total load (kW)	0.80
Annual Energy Consumption (kWh)	576
Expected Annual Energy saving for replacing all fittings (kWh)	317
Cost of Power	7.46
Annual saving in Lakhs Rs (1st year)	0.02
Investment required for complete replacements [@Rs 300 per fittings](Lakhs Rs)	0.06
Simple Pay Back (in Months)	30.47

OTTOTRACTIONS- ENERGY AUDIT	
Energy Saving Proposal	
Energy Saving in Lighting by replacing existing 51 No's T8 (40W) Lamps to 18W LED Tube	
Existing Scenario	
51 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	51
Total load (kW)	2.04
Annual Energy Consumption (kWh)	1958
Expected Annual Energy saving for replacing all fittings (kWh)	1077
Cost of Power	7.46
Annual saving in Lakhs Rs (1st year)	0.08
Investment required for complete replacements [@Rs 300 per fittings](Lakhs Rs)	0.15
Simple Pay Back (in Months)	22.85

OTTOTRACTIONS- ENERGY AUDIT	
Energy Saving Proposal	
Energy Saving in Lighting by replacing existing 50 No's T12 (55W) Lamps to 18W LED Tube	
Existing Scenario	
50 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	50
Total load (kW)	2.75
Annual Energy Consumption (kWh)	1980
Expected Annual Energy saving for replacing all fittings (kWh)	1327
Cost of Power	7.46
Annual saving in Lakhs Rs (1st year)	0.10
Investment required for complete replacements [@Rs 300 per fittings](Lakhs Rs)	0.15
Simple Pay Back (in Months)	18.19

OTTOTRACTIONS- ENERGY AUDIT	
Energy Saving Proposal	
Energy Saving by replacing existing 310 No's in-efficent ceiling fans with Energy Efficient Five star fans	
Existing Scenario	
There are 310 numbers of ceiling fans installed in the facilty 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	310
Total load (kW)	21.70
Annual Energy Consumption (kWh)	20832
Expected Annual Energy saving, for total replacement(kWh)	5833
Cost of Power (Rs)	7.46
Annual saving in Lakhs Rs (1st year)	0.44
Investment required for a total replacement (Lakhs Rs)[@3000 Rs per Fan with 50W at full speed]	9.30
Simple Pay Back (in Months)	256.47

OTTOTRACTIONS- ENERGY AUDIT	
Energy Saving Proposal 5	
Energy Saving in Lighting by replacing existing 14 No's CFL(15W) Lamps to 9W LED Bulb	
Existing Scenario	
24 numbers of CFL (15W) 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 CFL may be replaced to LED Bulb of 9W in phased manner and the savings will be of 40% (inclusive of improved light output and reduced energy consumption)	
Financial Analysis	
Annual working hours (hr)	2400
No of fittings	14
Total load (kW)	0.21
Annual Energy Consumption (kWh)	151
Expected Annual Energy saving for replacing all fittings (kWh)	60
Cost of Power	7.46
Annual saving in Lakhs Rs (1st year)	0.005
Investment required for complete replacements [@Rs 90 per fittings](Lakhs Rs)	0.013
Simple Pay Back (in Months)	33.51

Energy Saving Proposal	
Installation of 35kWp 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 35kW 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)	35
Total average kWh per day expected (3.5kWh/day average)	131.25
Total annual Generating Capacity (kWh)	47906
Cost of energy generated annually Lakhs Rs	6.37
Investment required (INR lakh)(Approx)	19.25
Simple Pay Back (in Months)	36.26
Life cycle in Yrs	25
Total Saving in Life Cycle (Approx) RS lakh	159.29

Executive Summary					
Consolidated Cost Benefit Analysis of Energy Efficiency Improvement Projects					
Mahatma Gandhi College, Trivandrum					
Sl No	Projects	Investment	Cost saving	SPB	Energy saved
		(Lakhs Rs)	(Rs)/Yr	Months	kWh/Yr
1	Energy Saving in Lighting by replacing existing 51 No's T8 (40W) Lamps to 18W LED Tube	0.15	0.080	22.85	1077
2	Energy Saving in Lighting by replacing existing 20 No's T5 (28W) Lamps to 18W LED Tube	0.06	0.024	30.47	317
3	Energy Saving in Lighting by replacing existing 50 No's T12 (55W) Lamps to 18W LED Tube	0.15	0.10	18.19	1327
4	Energy Saving in Lighting by replacing existing 14 No's CFL(15W) Lamps to 9W LED Bulb	0.013	0.005	33.51	60
5	Energy Saving by replacing existing 310 No's in-efficent ceiling fans with Energy Efficient Five star fans	9.30	0.44	256.47	5833
6	Installation of 35kWp Solar Power Plant	19.25	6.372	36.26	47906
	Total	**28.93**	**7.01**	**66.29**	**56520**
(The saving are projected as per the assumed operation time observed based in the discussions with the plant officials. The data of saving percentages are taken from BEE guide books and field measurements.)					

5

CONCLUSION

The carbon emission from different sectors namely, Energy, Transportation and wastes were calculated using standard procedures. Carbon sequestration by the trees present in the campus was also estimated. From these the total carbon footprint of the campus was arrived at.

Net Carbon Emission after implementing Energy Efficiency projects and Renewable Energy Projects Proposed		
1	Total Carbon Foot Print tCO2e/yr	50.99
2	Carbon Sequrested tCO2e/yr	9.84
3	Carbon mitigated by Renewable Energy tCO2e/yr (Installed)	1.97
4	Carbon mitigated by Renewable Energy tCO2e/yr (Proposed)	34.97
5	Carbon mitigated by Energy Efficiency (Proposed) tCO2e/yr	6.29
6	Effective Carbon footprint tCO2e/yr	-2.08
7	Total No of Students	2214
8	Specific Carbon Footprint kg CO2e/Student/Yr	-0.94

From this study it was found that carbon footprint of the campus to be **-0.94**kgCO_2e/ Student/ Year in place of current footprint. To achieve this, an investment of **28.93Lakhs Rs** is required through energy efficiency and renewable energy projects proposed. It will be around **1306** Rs per student to make the campus the carbon negative.

Cost to make the campus Carbon Negative		
1	Cost of implementation in Energy Efficiency Lakhs Rs	9.68
2	Cost of implementation in Renewable Energy Lakhs Rs	19.25
3	Total Lakhs Rs	28.93
4	Total number of students	2214
5	Cost per student to make the campus carbon negative Rs/ Student	1306

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OTTOTRACTIONS
Energy-Engineering-Environment

6

TECHNICAL SUPPLEMENT

Mahatma Gandhi College, Trivandrum																														
Sl. No	**Location**	**Lights**									**Fans**					**IT**				**UPS**				**AC**			Others				
		LED-T	**LED-B**	**LED-B (5W)**	**LED-SQ**	**LED(30W)**	**T5**	**T8**	**T12**	**CFL**	**CF**	**BLDC**	**WF**	**EF**	**PF**	**Printer**	**Photostat**	**Projector**	**PC**	**1kVA**	**3kVA**	**6kVA**	**10kVA**	**2Tr**	**1 TR**	**1.5 TR**	**PA**	**Induction cooker**	**TV**	**Fridge**	**Electric Kettle**
1	Principal Room				8						7					1	2		3							2			1		
2	Class 61	1						1	1		4																				
3	Research room-1	2									2																			1	
4	13 Head of Dept	91						13			65					13			13												
5	2 Lab	18								4	10							2													
6	Instrumentation Lab	6						1			2							2	1												
7	Research Lab	1							3		2																			1	
8	Physics Lab	4						2	2				2																		
9	Pg Physics Lab								2				1	1																	
10	Physics dept	3							4	1	3				1	2			2												
11	Physics lab	1	1						4	2	2																				
12	Room	6						2			3							1													
13	Library	34									3		2						2												
14	S3 Room	6							1		3																				
15	Room	5						3	1		2		4		1			1	41				1		1						1
16	Msc Physis Lab	2						3	2	1	3																				

17	Spectroscopy Lab	2						3	1		2		1																	
18	Electronics Lab		1						8		2	1								1										
19	Dept. of PB	2									2								1											
20	Police	1									1																			
21	Corridor	12				1																								
22	Dept. of Chemistry	2							2	1	4								2							1				
23	HOD Hindi	7					1	1			1		1			1			3											1
24	First MA Hindi	2									1																			
25	First MA Economics	1						3			2																			
26	Chemistry Lab	2							5		1		1		1	1			3						2				1	
27	Smart Class	1						1			2							1												
28	Lab	16							2		2			5																
29	Lab Assistant room							1	1		1																			
30	Corridor	2	1																											
31	Store	1						1	1																					
32	Chemisty Research Lab	7	2							2	3																			
33	Chemistry Lab-3	2	6								2			3																
34	Lecture Hall							1	1																					
35	Class 103x3	6									9																			
36	Class 102x3	12									12																			
37	Class 101x3	9									9																			
38	Class 104x3		3				6	3			9																			
39	Class 105x3	3					3				3																			
40	Class 103x3	6									6																			
41	Department of	1					6				2					3			9											

	Malayalam x3	5									1																			
42	Class 1	2									2																			
43	Department of Sociology	2									2							1												
44	UG English	5							1		5			3																
45	Department of History	2	1						2		3		1			1		1	2											
46	HOD	1									1					1			1											
47	Class 71	2									2																			
48	Class 70	2									1																			
49	Room 81	1	3								1														1					
50	Room 69	3							1		3		1														1			
51	Accounts Section	10									10		1		1	3	2		8		1									
52	Seminar Hall	9											4		2	1	1		1					1	3					
53	Auditorium	8		2						3	9																			
54	Class 65								1		1																			
55	English PG	1	2				2				5																			
56	Maths Department	3									5																			
57	Computer Lab							8					6			1			32			2			2					
58	Seminar Hall	1						2			2																			
59	HOD	3									4								1											
60	Library	2							4		5		1		1				1											
61	Zoology Department	10									6																			
62	Russian Department	2					2				5																			
63	Classx3	6									6																			
64	Scholar Room	2									2							1												
65	Library	1									1																			

66	HOD	2									1																			
67	Class	1						1			4																			
68	Classx3	12									12																			
69	Department of commerce	2						1			6					1			1											
	Total	**386**	**20**	**2**	**8**	**1**	**20**	**51**	**50**	**14**	**310**	**1**	**26**	**12**	**7**	**29**	**5**	**10**	**127**	**1**	**1**	**2**	**1**	**1**	**9**	**3**	**0**	**1**	**1**	**3**	**2**