GREEN AUDIT REPORT

SAFI INSTITUTE OF ADVANCED STUDY

VAZHAYOOR

2019

Executed by

OTTOTRACTIONS
Energy-Engineering-Environment

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Vazhayur

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Green Audit Report

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Report No: EA 822

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 SAFI Institute of Advanced Study for their timely help extended to complete the audit and bringing out this report.

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

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

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

Thank you.

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

Preface

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

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

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

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

B Zachariah

Director, OTTOTRACTIONS

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Introduction

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 SAFI Institute of Advanced Study, Vazhayur 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.

SAFI Institute of Advanced Study (SIAS)

SAFI Institute of Advanced Study (SIAS) is a centre for research and higher education founded in August 29, 2005. It is the academic wing of Social Advancement Foundation of India (SAFI). SIAS is partly residential and is located on a vast campus, 22 Kms away from Calicut City towards Calicut Airport. Along with the management, a dynamic team of teachers and scientists contribute significantly to the fulfilment of the academic programmes. The Institute is housed in a sprawling building in a lush green backdrop and serene and picturesque environment.

SAFI Institute of Advanced study (SIAS) provides rich avenues of teaching, learning and research with excellent infrastructure. SIAS envisages total personality development and generation of manpower capable of providing leadership and direction at the cutting edge in science and technology as well as management, commerce and other areas of humanities studies.

SOCIAL ADVANCEMENT FOUNDATION OF INDIA (SAFI) is a non-profit, registered charitable trust, which came into existence in September 2001. The trust is constituted by educationists, philanthropists and social activists, with the objective of taking up academic and research programmes in the frontier areas of science and technology and humanities in order to produce highly proficient manpower. SAFI is committed to generating skilled manpower capable of providing leadership and direction in the areas of science & technology, commerce, management, information technology, arts and other spheres of studies. SAFI envisages setting up of a Deemed to be University in due course. SAFI Institute of Advanced Study is an endeavour in this direction.

Occupancy Details	
Particulars	2018-19
Total Students	1111
Staffs	91
Total Occupancy of the college	1202

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	SAFI INSTITUTE OF ADVANCED STUDY									
2	Address (include telephone, fax & e-mail)	Rasiya Nagar, Vazhayoor East P.O. Via Ramanattukara, Malappuram-673633. Kerala, India,+91 483 2880 000 mail@siasindia.org									
2	Year of Establishment	2005									
3	Name of building and total No. of Electrical Connections/building	College (1), Hostel (1)									
4	Total Number of Students	Boys		Girls		Total	1503				
5	Total Number of Staff	97									
6	Total Occupancy	1600									
7	Total area of green cover (Acre)	10									
8	Type of Electrical Connection	HT	1	LT	0						
9	Contract Demand (KVA) /Connection	90									
10	Average Maximum Demand (KVA)	67									
11	Total built up area of the building (M^2)	15000									
12	Number of Buildings										
13	Average system Power Factor	0.88									
14	Details of capacitors connected	NA									
15	Transformer Details (Nos., kVA, Voltage ratio)	TR 1	TR 2	TR 3	TR 4	TR 5	TR 6				
		NA	-	-	-	-	-				
15	DG Set Details (kVA,)	DG1	DG2	DG3	DG4	DG5	Remarks				
		100	-	-	-	-	-				
16	Details of motors	Rating		Nos.		Remarks					
		5 to 10		NA		NA					
		10 to 50		NA		NA					
		Above 50		NA		NA					
17	Brief write-up about the firm and the energy/environmental conservation activities already undertaken.	LED Lighting, Tree Plantation, Awareness Programs									
18	Contact Person & Telephone number	Principal									
		04832880010									

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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 staff 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 438 occupants of this campuses will reach same number of households. This message will spread to at least 1750 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 an entire nation. It is usually measured as tons of CO_2 emitted per year, a number that can be supplemented by tons of CO_2-equivalent gases, including methane, nitrous oxide, and other greenhouse gases.

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

a gas will absorb over a given period of time, relative to the emissions of one ton of carbon dioxide (CO_2).

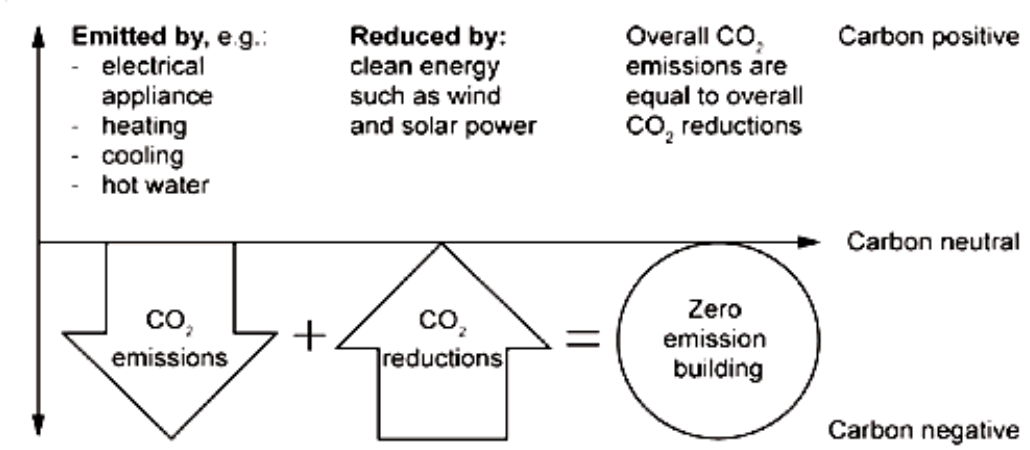
Global Warming Potentials (IPCC Second Assessment Report)					
Species	Chemical formula	Lifetime (years)	Global Warming		
			20 years	100 years	500 years
Carbon dioxide	CO2	variable §	1	1	1
Methane *	CH4	12±3	56	21	6.5
Nitrous oxide	N2O	120	280	310	170
HFC-23	CHF3	264	9100	11700	9800
HFC-32	CH2F2	5.6	2100	650	200
HFC-41	CH3F	3.7	490	150	45
HFC-43-10mee	C5H2F10	17.1	3000	1300	400
HFC-125	C2HF5	32.6	4600	2800	920
HFC-134	C2H2F4	10.6	2900	1000	310
HFC-134a	CH2FCF3	14.6	3400	1300	420
HFC-152a	C2H4F2	1.5	460	140	42
HFC-143	C2H3F3	3.8	1000	300	94
HFC-143a	C2H3F3	48.3	5000	3800	1400
HFC-227ea	C3HF7	36.5	4300	2900	950
HFC-236fa	C3H2F6	209	5100	6300	4700
HFC-245ca	C3H3F5	6.6	1800	560	170
Sulphur hexafluoride	SF6	3200	16300	23900	34900
Perfluoromethane	CF4	50000	4400	6500	10000
Perfluoroethane	C2F6	10000	6200	9200	14000
Perfluoropropane	C3F8	2600	4800	7000	10100
Perfluorobutane	C4F10	2600	4800	7000	10100
Perfluorocyclobutane	c-C4F8	3200	6000	8700	12700
Perfluoropentane	C5F12	4100	5100	7500	11000
Perfluorohexane	C6F14	3200	5000	7400	10700

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

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

Carbon neutrality refers to achieving net zero GHG emission by balancing the measured amount of carbon released into atmosphere due to human activities, with an equal amount sequestrated in carbon sinks. It is crucial to restrict atmospheric concentrations of GHGs released from various socio-economic, developmental and life style activities using

biological or natural processes. It is recognized that addressing climate change is not as simple as switching to renewable energy or offsetting GHG emissions. Rather, providing an opportunity for innovation in new developmental activities for viable and effective approach to address the problem.



Energy

In the campus carbon emission from energy consumption is categorised under two headings viz. energy from Electrical and Thermal. Energy used for transportation is calculated under the 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 no vehicles operating from campus for its logistics.

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

Carbon Emission = Number of each type of vehicle × 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 footprint 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 staff.

The calculation of the waste generated has been conducted by keeping measuring buckets for collecting the waste generated in a day. This waste 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 HT II (B) General Connections, the details are given below.

Electricity Connection Details		
SAFI INSTITUTE OF ADVANCED STUDY		
1	Name of the Consumer	SAFI INSTITUTE OF ADVANCED STUDY Karad
2	Tariff	HT II (B) GENERAL
3	Consumer Numbers	1365520011081
5	Connected Load (kW)	82.2
6	Annual Electricity Consumption (kWh)	117271

Electricity Bill Analysis

Electricity Bill Details (2018-19)											
	Name of the Consumer				SAFI INSTITUTE OF ADVANCED STUDIES						
	Contract				Consumer number & Section			1365520011081			
	Tariff		HT II (B)					Karad			
	kWh				kVA						
Month	Z1	Z2	Z3	Total	Z1	Z2	Z3	PF	PF Incentive	Rs (Total)	Rs/kwh
Apr											#DIV/0!
May	3420	1232	1592	6244	27	29.48	18.93	0.96	-1201.93	70630.65	11.3117633
Jun											
Jul	4194	1456	1982	7632	37	24.06	21.78	0.95	-1219	80095.45	10.49
Aug	4478	1714	2158	8350	36	25.62	24.36	0.96	-1612.15	85165.83	10.20
Sep	3424	1462	1924	6810	37	24.62	23.16	0.94	-875.44	74959.21	11.01
Oct	6314	1814	2734	10862	48	27.6	26.98	0.96	-2061.9	102986.06	9.48
Nov	7208	1980	2710	11898	58	27.86	26.3	0.96	-2271.15	110691.61	9.30
Dec	7256	2242	2776	12274	49	31.34	26.63	0.96	-2362.39	114065.42	9.29
Jan	5718	2076	2656	10450	47.36	27.84	27.16	0.95	-1677.72	100208.41	9.59
Feb	5846	2042	2088	9976	49.1	26.77	25.07	0.95	-1623.62	97540.72	9.78
Mar	8250	2060	2920	13230	71.47	35.11	28.33	0.96	-2516.58	118628.77	8.97

b. Diesel

Diesel Consumption Details		
	Total(L)	cost(Rs)
18-19	260	20800

c. LPG

LPG Consumption Details	
	2018-19
No Cylinders	45
LPG Consumption in kg	855

Base Line Energy Data		
SAFI INSTITUTE OF ADVANCED STUDY		
		2018-19
1	Electricity KSEB (kWh)	117271
2	Electricity Solar - Off grid (kWh)	0.00
3	Electricity (KSEB + Off grid) kWh	117271
4	Electricity Grid Tied (kWh)	0.00
5	Diesel (L)	260.00
6	LPG (kg)	855.00
7	Biogas (kg)	0.00

Energy Consumption Profile		
Sl No	Fuel	2018-19 (kCal)
1	Electricity	100853232
2	Diesel	2730000
3	LPG	10260000
4	Biogas	-
Total (kCal)		113843232
Total (kWh)		132375.9

Thermal Fuel Consumption	
SAFI INSTITUTE OF ADVANCED STUDY	
	2018-19
Annual LPG consumption in kg	855
Annual Diesel consumption in L	260.00
Annual petrol consumption in L	0.0
Annual Biogas consumption in m3	-

Specific Energy Consumption

OTTOTRACTIONS- ENERGY AUDIT		
SAFI INSTITUTE OF ADVANCED STUDY		
Energy Performance Index (EPI)		
Sl No	Particulars	2018-19
1	Total building area (m^2)	15000
2	Annual Energy Consumption (kCal)	113843232
3	Annual Energy Consumption (kWh)	132375.9
4	Total Energy in Toe	11.38
5	Specific Energy Consumption kWh/m^2	8.83

The specific energy consumption in 2018-19 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	
SAFI INSTITUTE OF ADVANCED STUDY	
	2018-19
Total Occupancy	1202
Waste generated in kg /day	24.04
Waste generated in kg /Yr	3173.28

Non-Degradable waste

Solid non degradable Waste Generation

SAFI INSTITUTE OF ADVANCED STUDY	
	2018-19
Total Occupancy	1202
Waste paper generated in kg /day	0.24
Waste plastic generated in kg /day	0.36
Waste paper generated in kg /Yr	52.89
Waste plastic generated in kg /Yr	79.33

3.4. Transportation

There are seven buses operating from the college.

Diesel Consumption Details		
	Total(L)	cost(Rs)
18-19	260	20800

Carbon Emission Profile (2018-19)

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

Emission Factors		
Item	Factor	Unit
Electricity	0.00079	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 2018-19

Carbon Foot Print			
Sl. No.	Particulars	2018-19	tCO2e
1	Electricity (kWh)	117271	92.64
2	Diesel (L)	260.00	0.83
3	LPG (kg)	0.00	0.00
4	Biogas (m3)	0.00	-
5	Degradable Waste in kg/yr.	3173.28	2.00
6	Paper Waste in kg/yr	52.89	0.03
7	Plastic Waste in kg/yr	79.33	0.03
Total Carbon Foot Print tCO2e/yr			96.81

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
Total number of trees	312
Carbon sequestrated by trees in the campus (tCO2e)	1.52

Trees sequestrate carbon dioxide through the biochemical process of photosynthesis and it is stored as carbon in their trunk, branches, leaves and roots. The amount of carbon sequestrated by a tree can be calculated by different methods. In this study, the volumetric approach was taken into account, thus the details including CBH (Circumference at Breast Height), height, average age, and total number of the trees, are required. Details of the trees in the campus compound are given in the Table 3.18. Detailed table is included in the technical supplement.

Carbon sequestrated by a tree can be found out by using different methods. Since this study is employed the volumetric approach, the calculation consists of five processes.

- Determining the total weight of the tree
- Determining the dry weight of the tree
- Determining the weight of carbon in the tree
- Determining the weight of CO_2 sequestrated in the tree
- Determining the weight of CO_2 sequestrated in the tree per year

Carbon sequestrated by each species of trees in the campus compound is given in the Table.3.19 Detailed calculation results are listed out in the tables provided in the technical supplements of 'Carbon sequestration'.

Form 5										
Sl. No	Name of tree (Botanical name)	Circumference (cm)	Stem diameter (cm)	Height of trees (m)	Total weight of tree (Kg)	Weight of carbon in the tree* (tCO2e)	No. of similar trees	Total carbon sequestrated (tCO2e)	Carbon Sequestrated by each species	Average age (years)
1	Careya arborea	40	12.73	3	20.19	0.01	2	0.024	0.012	6
2	Alstonia scholaris	36	11.46	2	10.90	0.01	3	0.019	0.006	8
3	Terminalia paniculata	24	7.64	2	4.85	0.00	4	0.012	0.003	5
4	Santalum album	30	9.55	2	7.57	0.00	3	0.014	0.005	6
5	Thespesia populnea	46	14.64	2	17.80	0.01	2	0.021	0.011	8
6	Bridelia retusa	46	14.64	3	26.71	0.02	5	0.080	0.016	9
7	Xylia xylocarpa	29	9.23	2.5	8.84	0.01	6	0.032	0.005	5
8	Ailanthus triphysa	30	9.55	2	7.57	0.00	2	0.009	0.005	3
9	Sweitenia macrophylla	39	12.41	2.5	16.00	0.01	4	0.038	0.010	9
10	Terminalia bellarica	38	12.10	3	18.22	0.01	6	0.065	0.011	5
11	Adenanthera pavonina	40	12.73	3	20.19	0.01	10	0.120	0.012	6
12	Delonix regia	35	11.14	3	15.46	0.01	12	0.111	0.009	6
13	Ptreocarpus marsupium	46	14.64	3	26.71	0.02	5	0.080	0.016	4

14	Albizia lebbeck	46	14.64	2.5	22.25	0.01	6	0.080	0.013	3
15	Ficus arnottiana	33	10.50	2	9.16	0.01	7	0.038	0.005	8
16	Macaranga peltata	36	11.46	1.5	8.18	0.00	6	0.029	0.005	6
17	Caryota urens	39	12.41	2	12.80	0.01	9	0.069	0.008	6
18	Carallia brachiata	36	11.46	2	10.90	0.01	5	0.032	0.006	5
19	Psidium guajava	27	8.59	2	6.13	0.00	4	0.015	0.004	4
20	Dalbergia lanceolaria	50	15.92	3	31.55	0.02	3	0.056	0.019	6
21	Ficus auriculata	40	12.73	2	13.46	0.01	5	0.040	0.008	6
22	Mussaenda frondosa	33	10.50	3	13.74	0.01	6	0.049	0.008	3
23	Olea dioica	35	11.14	2	10.31	0.01	5	0.031	0.006	3
24	Casuarina equisetifolia	47	14.96	2	18.59	0.01	2	0.022	0.011	6
25	Anacardium occidentale	42	13.37	2	14.84	0.01	3	0.027	0.009	8
26	Sapium insigne	36	11.46	2	10.90	0.01	3	0.019	0.006	9
27	Cycas circinalis	33	10.50	2	9.16	0.01	5	0.027	0.005	5
28	Aegle marmelos	46	14.64	3	26.71	0.02	6	0.095	0.016	6
29	Aquilaria malaccensis	30	9.55	2	7.57	0.00	3	0.014	0.005	3
30	Syzigium caryophyllatum	29	9.23	2.5	8.84	0.01	2	0.011	0.005	4
31	Schleichera oleosa	31	9.87	3	12.13	0.01	2	0.014	0.007	5
32	Connarus paniculatus	35	11.14	2	10.31	0.01	1	0.006	0.006	3
33	Abutilon theophrasti	34	10.82	2	9.73	0.01	5	0.029	0.006	2
34	Tabernaemontana alternifolia	40	12.73	2	13.46	0.01	3	0.024	0.008	5
35	Cocos nucifera	43	13.69	3	23.34	0.01	20	0.278	0.014	9
36	Acacia mangium	33	10.50	2	9.16	0.01	3	0.016	0.005	6
37	Bauhinia acuminata	30	9.55	2	7.57	0.00	2	0.009	0.005	7

38	Lagerstroemia speciosa	31	9.87	2	8.09	0.00	1	0.005	0.005	6
39	Delonix regia	35	11.14	2	10.31	0.01	1	0.006	0.006	5
40	Millettia pinnata	41	13.05	2	14.14	0.01	3	0.025	0.008	6
41	Cassia fistula	37	11.78	2	11.52	0.01	2	0.014	0.007	5
42	Mangifera indica	45	14.32	2	17.04	0.01	5	0.051	0.010	9
43	Mimusops elangi	37	11.78	2	11.52	0.01	3	0.021	0.007	9
44	Chrysophyllum olviforme	40	12.73	2	13.46	0.01	3	0.024	0.008	8
45	Artocarpus heterophyllus	50	15.92	3	31.55	0.02	6	0.113	0.019	9
46	Phoenix dactylifera	40	12.73	2	13.46	0.01	4	0.032	0.008	7
47	Leucaena leucocephala	33	10.50	2	9.16	0.01	3	0.016	0.005	5
48	Ayapana triplinervis	31	9.87	2	8.09	0.00	5	0.024	0.005	6
49	Alpinia calcarata	30	9.55	2	7.57	0.00	6	0.027	0.005	9
50	Syzigium cumuni	35	11.14	2	10.31	0.01	2	0.012	0.006	4
						Total	224	2.02	0.41	296.00

CARBON FOOTPRINT OF THE CAMPUS (2018-19)

Various carbon emitting activities such as consumption of energy, transportation and waste generation leads to the total emission of **96.81 tCO_2e** per year by the campus. The total carbon sequestration by trees in the campus compound is **1.52 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 2018-19.

Specific CO2 Footprint

Carbon Foot Print			
Sl. No.	Particulars	2018-19	tCO2e
1	Electricity (kWh)	117271	92.64
2	Diesel (L)	260.00	0.83
3	LPG (kg)	855.00	1.28
4	Biogas (m3)	0.00	-
5	Degradable Waste in kg/yr.	3173.28	2.00
6	Paper Waste in kg/yr	52.89	0.03
7	Plastic Waste in kg/yr	79.33	0.03
Total Carbon Foot Print tCO2e/yr			96.81

The total specific carbon emission is estimated as **96.81** kg of CO_2e per student for the year 2018-19

4

Carbon Mitigation Plans

The total emission of the carbon dioxide per student is **96.81** kg per year (2018-2019). Emission reduction plans were prepared to bring the existing per capita carbon footprint to zero or below so as to bring the campus a carbon neutral or carbon negative campus.

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

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

- Resource optimisation
- Energy efficiency
- Renewable energy

RESOURCE OPTIMISATION

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

WASTE MINIMISATION

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

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

ENERGY EFFICIENCY

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

FUELS FOR COOKING

The campus uses commercial LPG cylinders for its cooking purpose. The campus can install a biogas plant to treat food waste and the biogas thus generated can be used in kitchen. Installation of a solar water heater to rise the water temperature to a much higher level, then it has to consume only very less amount of thermal energy for preparing the same amount of food is another method. This can make a positive benefit to the campus by saving money, energy and can reduce the carbon emission of the campus due to thermal energy consumed for cooking.

TRANSPORTATION

Energy efficiency of the transportation sector is mainly depended on the fuel efficiency of the vehicles used. Here mileage of the vehicle (kmpl - Kilometres per Litre) is calculated to assess the fuel efficiency of the vehicle.

Percentage of closeness is the ratio of actual mileage of the vehicle to its expected mileage. If the percentage of closeness of mileages of each vehicle is greater than that of its average, then the efficiency status of the vehicle is considered as 'Above average' and else, it is considered as 'Below average'

Carbon Mitigation Proposals

After analyzing the historical and measured data the following projects are proposed to make the campus carbon neutral. The projects are from energy efficiency and renewable energy. The further additions in the green cover increase will also give positive impact in the carbon mitigation.

OTTOTRACTIONS- ENERGY AUDIT						
SAFI INSTITUTE OF ADVANCED STUDY						
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 through out life cycle
		(kWh)	MWh	Years		
1	Energy Saving in Lighting by replacing existing 58 No's T12 (55W) Lamps to 18 W LED Tube	3172	3.17	10	2.51	25.06
2	Energy Saving in Lighting by replacing existing 213 No's CFL(15W) Lamps to 9W LED BULB	1897	1.90	10	1.50	14.98
3	Energy Saving by replacing existing 239 No's in-efficient ceiling fans with Energy Efficient Five star fans	10782	10.78	10	8.52	85.18
Total		15850	16	10	12.52	125

Executive Summary					
Consolidated Cost Benefit Analysis of Energy Efficiency Improvement Projects					
SAFI INSTITUTE OF ADVANCED STUDY					
Sl No	Projects	Investment	Cost saving	SPB	Energy saved
		(Lakhs Rs)	(Rs)/Yr	Months	kWh/Yr
1	Energy Saving in Lighting by replacing existing 58 No's T12 (55W) Lamps to 18 W LED Tube	0.17	0.254	8.23	3172
2	Energy Saving in Lighting by replacing existing 213 No's CFL(15W) Lamps to 9W LED BULB	0.23	0.15	18.53	1897
3	Energy Saving by replacing existing 239 No's in-efficient ceiling fans with Energy Efficient Five star fans	5.98	0.86	83.12	10782
	Total	**6.38**	**1.27**	**36.63**	**15850.46**
(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.)					
Cost Benefit Analysis of Renewable Energy Efficiency Projects					
5	Installation of 100 kWp Solar Power Plant	75.00	10.22	88.06	127750
6	Installation of 15Kg/day Biogas plant	0.2	0.26	9.39	5647
	Total	75.20	10.48	48.73	133397

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	96.81
2	Carbon Sequrested tCO2e/yr	1.52
3	Carbon mitigated by Renewable Energy tCO2e/yr (installed)	0.00
4	Carbon mitigated by Renewable Energy tCO2e/yr (Proposed)	100.92
5	Carbon mitigated by Renewable Energy (Biogas Plant)	1.94
6	Carbon mitigated by Energy Efficiency (Proposed) tCO2e/yr	12.52
7	Effective Carbon footprint tCO2e/yr	-20.09
8	Total No of Students	1111.00
9	Specific Carbon Footprint kg CO2e/Student/Yr	-18.08

From this study it was found that carbon footprint of the campus to be – **18.08** $kgCO_2e$/ Student/ Year in place of current footprint i.e., **96.81** $kgCO_2e$/ student/ Year. This will be achieved after implementing energy efficiency projects and implementation of 100kWp solar power plant. To achieve this an investment of **81.58 lakhs Rs** is required through energy efficiency and renewable energy projects proposed. It will be around **7343.2 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	6.38
2	Cost of implementation in Renewable Energy Lakhs Rs	75.20
3	Total Lakhs Rs	81.58
4	Total number of students	1111
5	Cost per student to make the campus carbon negative Rs/ Student	7343.2

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OTTOTRACTIONS
Energy-Engineering-Environment

6

TECHNICAL SUPPLEMENT

Sl.No	Location	LIGHT					FAN			IT				AC	
		T8	T12	CFL	LED TUBE	LED BULB	CF	WF	EF	PC	Scanner	Printer	1.5	2tr	3tr
1	105			1			4								
2	108						2		1						
3	109			2			4								
4	110			2			6								
5	111			1			2								
6	112			1			2								
7	114			5			8								
8	115			2			2								
9	118		2				2								
10	121			1			4								
11	122			1			4								
12	130			3			2								
13	131			4			6		2						
14	133			1			8								
15	136		1				2						1		
16	201		2	2			2								
17	202			1			4								
18	203			2			6								
19	205			2			2								
20	208-A			1			2								
21	209			1			4								
22	210			1			6								
23	211						2								
24	211b						2								
25	212			2			2								
26	214						3								
27	308			2			3								

28	307						1								
29	305						2								
30	304						1								
31	303						4								
32	302						2								
33	301						2								
34	101		1	2			2			3		1	1		
35	102		2	2			2			3		4	1		
36	103		2	1			2			1		2	1		
37	104		2	1			2						1		
38	106		3	3			6			31			2		
39	107			2			2			2		1			
40	126			3			2		1	1		1			
41	MB lab		5	6			8			2		1	1		
42	store		1	2			1								
43	BT lab		4	4			8								
44	instrument lab		7	6			4			2			2		
45	sickroom			2			1								
46	MCJ lab			1			2			11		1			
47	208		2	1			2			1		1			
48	ft lab		6	1			10			1		1			
49	chemistry lab			4			8								
50	boys bathroom														
51	ladies bathroom														
52	staff washroom														
53	aud 2			6			5								
54	aud 1			4			5								
55	213			1			2		1	1		1			
56	security room														
57	confrence hall		4	8			8						4		

58	Conf. bedroom			2			1						1		
59	principal		1	2			2			1		1	1		
60	306			1			1			1		1			
61	gents bathroom														
62	ladies bathroom														
63	reception								1	2		1			
64	GF main loby								1						
65	micro loby			6											
66	ladies lobby			10											
67	bt lobby			4											
68	first floor lobby			18					1						
69	II floor lobby			9											
70	COO office			6			3			1		1	1		
71	SAFI Office		2						2	2		2			
72	LIB- REFRENCE			12			6								
73	Digital library			10			6			18					
74	lib entrance														
75	Lib - server						1								
76	lib lobby			10			4			1					
77	lib bathroom			6											
78	IS staff room		2				1			1		1			
79	seminar hall		5	2					7						
80	lib - 301			2			2								
81	lib - 302			12			5						4		
82	lib - 304			1			2								
83	lib - staff room econ						2			1					
84	lib- 201		4				4								
85	lib 202						3								
86	lib- eco- bathroom														
87	lib -B- hindi			1			2								

88	lib-B - bathroom														
89	lib- B - 101			1			4								
	TOTAL	**0**	**58**	**213**	**0**	**0**	**239**	**0**	**17**	**87**	**0**	**21**	**21**	**0**	**0**
	W		40	20			80		60	100		140	1200		
		0	2320	4260	0	0	19120	0	1020	8700	0	2940	25200	0	0
	63.56														

List of Trees in the Campus (above 15 cms growth)				
Sl No.	**Malayalam name**	**Scientific name**	**English name**	No:
1	പേഴ്	Careya arborea	Ceylon oak	2
2	ഏഴിലം പാല	Alstonia scholaris	Devil's tree	3
3	വെള്ളമരുത്	Terminalia paniculata	Flowering Murdah	4
4	ചന്ദനം	Santalum album	East Indian sandalwood	3
5	പൂവരശ്	Thespesia populnea	Portia tree	2
6	മുള്ളുവേങ്ങ	Bridelia retusa	Spinous Kino tree	5
7	ഇരുൾ / കടമരം	Xylia xylocarpa	Burma Ironwood	6
8	മട്ടി	Ailanthus triphysa	Maharukh	2
9	മഹാഗണി	Sweitenia macrophylla	Mahogany	4
10	താന്നി	Terminalia bellarica	Belliric myrobalan	6
11	മഞ്ചാടി	Adenanthera pavonina	Red bead tree	10
12	ഗുൽമോഹർ	Delonix regia	Royal poinciana	12
13	വേങ്ങ	Ptreocarpus marsupium	Malabar kino	5
14	നെന്മേനി വാക	Albizia lebbeck	Siris tree	6
15	കല്ലരയാൽ	Ficus arnottiana	Indian rock fig	7
16	വട്ട / ഉപ്പൂത്തി	Macaranga peltata	Macaranga	6
17	ചൂണ്ടപ്പന	Caryota urens	Solitary fishtail palm	9
18	വങ്കണ	Carallia brachiata	Freshwater mangrove	5
19	പേര	Psidium guajava	Guava	4

20	വെള്ളീട്ടി	Dalbergia lanceolaria	Bastard rosewood	3
21	കൃഷ്ണകിരീടം	Clerodendrum paniculatum	Pagoda plant	2
22	ചെമ്പരത്തി	Hibiscus rosa-sinensis	Hibiscus	12
23	റോസ്	Rosa chinensis	Rose	10
24	സീതപ്പഴം	Annona squamosa	Sugar apple	8
25	വലിയ അത്തി	Ficus auriculata	Elephant ear fig tree	5
26	വെള്ളില	Mussaenda frondosa	Schizomussaenda	6
27	എടല / കരിവെട്ടി	Olea dioica	Indian olive	5
28	കാറ്റാടി	Casuarina equisetifolia	Beef wood	2
29	കശുമാവ് / പറങ്കിമാവ്	Anacardium occidentale	Cashew tree	3
30	കണ്ണാംപൊട്ടി/ കല്ലരം	Sapium insigne	Tuning fork tree	3
31	ഈന്ത്	Cycas circinalis	Queen sago	5
32	കൂവളം	Aegle marmelos	Indian bael	6
33	ഊദ്	Aquilaria malaccensis	Agarwood tree	3
34	ചെറുഞാവൽ	Syzigium caryophyllatum	South Indian plum	2
35	പൂവം	Schleichera oleosa	Lac tree	2
36	കുരികിൽ വള്ളി	Connarus paniculatus	Connarus vine	1
37	മലതാങ്ങി	Abutilon theophrasti	Buttonweed	5
38	കുനൻപാല	Tabernaemontana alternifolia	Alternate-leaved crape jasmine	3
39	തെങ്ങ്	Cocos nucifera	Coconut tree	20
40	മാഞ്ചിയം	Acacia mangium	Mangium	3
41	മന്ദാരം (വെള്ള)	Bauhinia acuminata	Dwarf white bauhinia	2
42	മണിമരുത്	Lagerstroemia speciosa	Pride of India	1
43	ഗുൽമോഹർ	Delonix regia	Royal poinciana	1
44	ആര്യവേപ്പ്	Azadirachta indica	Neem	3
45	ലക്ഷ്മിതരു	Simarouba glauca	Paradise tree	1
46	ഉങ്ങ്	Millettia pinnata	Indian beech	3

47	കണിക്കൊന്ന	Cassia fistula	Golden shower tree	2
48	മാവ്	Mangifera indica	Mango tree	5
49	ഇലഞ്ഞി	Mimusops elangi	Spanish cherry tree	3
50	മിൽക്ക് ഫ്രൂട്ടി	Chrysophyllum olviforme	Milk fruit tree	3
51	പ്ലാവ്	Artocarpus heterophyllus	Jackfruit tree	6
52	ഈന്തപ്പന	Phoenix dactylifera	Date palm	4
53	സുബാബുൽ പീലിവാക	Leucaena leucocephala	River tamarind	3
54	ബുദ്ധമുള	Bambusa ventricosa	Buddha's bamboo	3
55	പെൻസിൽ മുള			8
56	അയ്യമ്പന	Ayapana triplinervis	Water hemp	5
57	പനിക്കൂർക്ക	Coleus aromaticus	Mexican mint	6
58	രാമച്ചം	Chrysopogon zizanioides	Vetiver	3
59	ചിറ്റരത്ത	Alpinia calcarata	Snape ginger	6
60	കൃഷ്ണ തുളസി	Ocimum tenuiflorum	Holy basil	3
61	എരുക്ക്	Calotropis gigantea	Giant milkweed	3
62	വാതംകൊല്ലി	Justicia gendarussa	Willow-leaved Justicia	2
63	കരിനൊച്ചി	Vitex negundo	Chaste tree	2
64	ഞാവൽ	Syzigium cumuni	Jamun	2
65	ആടലോടകം	Adathoda vasica	Malabar nu	4
66	കറിവേപ്പ്	Murraya koenigii	Curry leaf tree	6
67	ചെറുനാരകം	Citrus limon	Lemon	6
68	മുഞ്ഞ	Premna serratifolia	Headache tree	3
69	സർവ്വസുഗന്ധി	Pimenta dioica	Allspice	2
70	നായ്ക്കുമ്പ	Pogostemon quadrifolius	Pogostemon grass	1
71	മാതളം / റുമ്മാൻ	Punica granatum	Pomegranate	3
72	മുള്ളിലം	Zanthoxylum rhetsa	Indian prickly ash	4
73	കാവളം	Sterculia foetida	Java olive	3

74	ചേര്	Holigarna arnottiana	Black varnish tree	2
75	സിന്ദൂരമരം	Mallotus philippensis	Kamala tree	1
76	ഓടമുള	Ochlandra travancorica	Elephant grass	5
77	ശംഖുപുഷ്പം (നീല)	Clitoria ternatea	Asian pigeonwings	6
78	ശംഖുപുഷ്പം (വെള്ള)	Clitoria ternatea alba	White Asian pigeonwi	9

Electricity Bill Details (2018-19)												
Month	Name of the Consumer				**SAFI INSTITUTE OF ADVANCED STUDIES**							
	Contract Demand(kVA)				Consumer number & Section			**1365520011081**				
	Tariff		**HT II (B) GENERAL**					**Karad**				
	kWh				**kVA**			**PF**	**PF Incentive**	**PF Penalty**	**Rs (Total)**	**Rs/kwh**
	Z1	**Z2**	**Z3**	**Total**	**Z1**	**Z2**	**Z3**					
Apr												
May	3420	1232	1592	6244	27	29.48	18.93	0.96	-1201.93		70630.65	**11.31**
Jun												
Jul	4194	1456	1982	7632	37	24.06	21.78	0.95	-1219		80095.45	**10.49**
Aug	4478	1714	2158	8350	36	25.62	24.36	0.96	-1612.15		85165.83	**10.20**
Sep	3424	1462	1924	6810	37	24.62	23.16	0.94	-875.44		74959.21	**11.01**
Oct	6314	1814	2734	10862	48	27.6	26.98	0.96	-2061.9		102986.06	**9.48**
Nov	7208	1980	2710	11898	58	27.86	26.3	0.96	-2271.15		110691.61	**9.30**
Dec	7256	2242	2776	12274	49	31.34	26.63	0.96	-2362.39		114065.42	**9.29**
Jan	5718	2076	2656	10450	47.36	27.84	27.16	0.95	-1677.72		100208.41	**9.59**
Feb	5846	2042	2088	9976	49.1	26.77	25.07	0.95	-1623.62		97540.72	**9.78**
Mar	8250	2060	2920	13230	71.47	35.11	28.33	0.96	-2516.58		118628.77	**8.97**
	56108	18078	23540		71			0.95			954972.13	
				9773								