CARBON NEUTRAL ENVIRONMENT FOR SUSTAINABLITY: A CASE STUDY OF AMC ENGINEERING COLLEGE

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Abstract

Purpose – The objective of this case study is to provide researched information about retrospect and prospect of achieving sustainable campus at AMC Engineering College (AMCEC) to reduce its carbon footprint and to establish a campus culture focused on the theme of environmental sustainability. Also parallely make available the solutions to globally similar institutions in achieving low carbon footprint.

Annually built environment releases billions of tons of carbon dioxide(CO2) which causes glassy layer in presence of Suspended Particulate Matter(SPM) at the outer atmosphere. This prevents the release of heat and reverts it back causing Green house effect. Lifestyle changes contribute to carbon footprint and hence a deviation in strategy such as use of Zero Energy Materials (ZEM) would mitigate ill effects. The recent theme is carbon neutral campuses which is incorporated in the accreditation process of National Assessment and Accreditation Council (NAAC) of University Grants Commission (UGC) and also National Board of Accreditation(NBA) under All India Council for Technical Education (AICTE).

The functionality of University affiliated colleges is hinged on Education and R&D towards reaching the micro economic societal requirements . This paper establishes the betterment of a 52 acre large campus towards holistic ecosystem having been located 6 kms from the famous Bannergatta National Park, achieving the desired goal of solutions through horizontal and vertical approach.

Keywords— *Carbon footprint(CFP), Suspended Particulate Matter(SPM), Green house effect, Zero Energy Materials (ZEM) , Colleges, NAAC,NBA, Case study.*

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1. PROLOGUE

Climate change crisis is a global environmental and societal afflicting the planet. Paris Declaration has been signed in 2016 by all serious countries committed to consensus both on the basic science behind climate change (i.e., its causes and mechanism) and on a broad range of future climate projections coming from the modelling efforts.

The main reason for climate change is heat-trapping gases, also called green house gases(GHG), a major portion of which is caused by human activity due to fossil fuel burning activity on which the world energy demand is met with. Other emissions such as methane and nitrous oxide in smaller proportions come from carbon changes (such as deforestation), agricultural activities, industrial processes, and waste management. Carbon dioxide is less offensive but comprises the majority of GHG emissions, at about 77% of the worldwide total. The remainder comes mostly from methane(CH_4) and nitrous oxide (N2O), with micro shares coming from fluorinated gases(SF_6, PFCs , and HFCs). Global climate change has the potential to alter the earth's average temperature, raise sea levels, and shift entire ecosystem zones to an extent not seen since periods of glacial transformation, which in turn undoubtedly will severely affect human well-being and cause massive species extinctions.

Small number of countries, including United States, produce a large majority of global GHG emissions. In 2000, the U.S was the higest total GHG emitter (contributing 20.6% of world's total emissions at 6,928 million metric tonnes of carbon daioxide equivalent), followed by China(14.7%), EU(14.7%),India(6%) and others.

2. CFP CONTRIBUTION PER YEAR

2.1 Carbon Foot Print (CFP) based on Embodied Energy of Construction Activity

Table 1

Sl NO	Description	Embodied Energy
1	Embodied energy for super built up area	450 MJ per m2
2	Total super built up area	59199.09 m2
3	Total energy	26.64 X 10^6MJ

CO2 DUE TO EMBODIED ENERGY = EMBODIED ENERGY X 1.06 KG OF CO2
= 26.64 X 106 X1.06
= 28.24 X 106 KG
=28.24 X 103 TONS
=28240 TONS OF CO2
NO OF YEARS AMCEC EXISTED =17 YEARS
= 28240/17
= 1661.17 TONS OF CO2

2.2 CFP based on Electricity Consumption

Electricity consumed per month =156 KWhr
Therefore for 12 months energy consumed = 156 X 12 X 43 =80.496 kg of CO_2 per year

Calculation of CO_2 emissions:

Table 2

Fuel type	Kg of CO_2 per unit consumption
Grid Electricity	43 Kg per KWhr
Natural gas	3142 Kg per tons
Diesel fuel	2.68 Kg per liter
Petrol	2.31 Kg per liter
Coal	2419 Kg per tons
LPG	1.51 Kg per liter

2.3 CFP due to Culinary Consumption (LPG)

CFP due to Culinary Consumption (LPG) = 14 X 4 X 12 X 1.51/1000
=1.014 tons of CO2 per kg
DATA:
1 Cylinder = 14 kg of gas
4 Cylinders.

2.4 CFP due to Diesel Generators for 82.5 KV and 125 KW Generators

CFP due to Diesel Generators for 82.5 KV and 125 KW Generators = 1500 X 12 X 2.68/100 = 48.24 tons of CO_2
Generators Diesel per month = 1500lt
(82.5 KV & 125 KV)
2.68 is hour conversion factor

2.5 CFP due to Transportation

The transportation department deals with removal of obsolete low performance vehicles by the replacing with more fuel efficient options.

Refer Table 3 for Details.
CFP due to Transportation = 146.81 tons of CO2

Total CFP Contribution CO2 per year
= **1937.72 tons of CO_2 Emission**

2.5 CO_2 Neutrality in Tons due to Green Initiative

2.5.1 Hexagonal Best Practices Model at AMCEC

1. Use of zero energy materials
2.Hybrid Wind and Solar Energy developed by National Aerospace Laboratory(NAL).
3.Use of recycled tertiary treated waste water.
4.Vermi Composting
5.Ecosystem modification and greening of campus.
6. Rain water harvesting system.

2.5.1.1 Use of Zero Energy Materials

Alternative sands such as processed slag sand from Oblapuram, M Sand from Peresandra, Quary dust from near by Bannnergattta equivalent to Zone II river sand are being deployed for sustainability.Sintered FlyAsh Aggregates, Construction and Demolition waste replace a part of granitic coarse aggregates.Alternative Cementitious Materials such as Ground Granulated Blast Furnace Slag from JSW,Class C and Class F FlyAsh from Neyveli and Raichur Thermal Powerplants are used either in total or as partial replacement and deployed as Geo Polymer vis a vis research programmes at the Centre for Global Environment and Ecofriendly Technology Applications (C-GEETA)

2.5.1.2 Carbon Neutrality due to 1 KW Hybrid NAL Wind Solar Station 4500 Kg

National Aerospace laboratory has collaborated with the solar energy club at AMCEC and an initial demonstration project on top of 5th floor of Civil Engineering Department is recently commissioned to utilize green energy for the cutter pumps provided at the equalization tank of fixed film bioreactor. This is unique because integration of both solar and wind energy gives a hybrid approach.

Carbon neutrality due to 1 KW hybrid NAL wind solar station 4500 Kg = 2500 X 43 = 107500 kg of CO2 neutralized
= 107.5 tons of CO2 neutralized per year
Data: 250 working days per year
10 hours of working per day
= 2500 KWhr

2.5.1.3 Sewage Treatment Plant (STP)

Sequential planted canna bio reactor using three types of patented bacteria convert a septic tank effluent into useable water for vegetation and cricket stadium, lawns etc. The quality is compatible to urban recycle standards as per Karnataka state pollution control board norms (Biochemical Oxygen Demand BOD less than 10 mg/l and Total Suspended Solids TSS less than 10 mg/l)

Water pumped per day = 55000 lts per day
= 55000 X 180(working days)
=9.9 X 106 lts

Waste water generated =80% of water supply = 0.8 X 9.9 X 106
=7.92 X 106 lts per year
=7.920 X103 KLD per year
Waste Water recycled = 7920 KLD per year
Zero Discharge Technology
20% of electricity consumed is for pumping = 0.20 X 80.496 = 16.09 tons of CO2 per year neutralized

2.5.1.4 Green Initiative due to Vermicomposting

It is a shallow rectangular plot with sufficient aeration for mega scolex maurity. The worms devour the organic leafy materials and excrete simple harmless substances called humus which is very high in NPK value.

A plot of 2.14 X 0.92 X0.56
For 10 numbers of plots CO_2 neutralized 1 ton of fertilizer (approximate) for 3 months
1 ton of fertilizer = 1 ton of CO_2 neutralized

2.5.1.5 CO_2 Neutralized due to Green Vegetation

This depends on girth of various trees at the campus as follows which compares well with observations of Dr I.K Bhatt at the NIT, Hamirpur Campus.

Table 4

Type of trees	No of trees	Kg of CO_2 neutralized	Kg of CO_2 neutralized per year
Teak	700	705	493500
Silver oak	700	650	455000
Mango	200	700	140000
Pongemia	500	800	400000
Neem	300	600	180000
Ficus Religiosa	50	700	35000
Gulmohr	32	300	9600
Camel foot	250	250	62500
Tecoma	500	250	125000
Avalanda	300	250	75000
Bottlebrush	305	250	76250
Pride of india	200	300	60000
Eucalyptus	50	150	7500
Ccycas	5	100	50
Jumbulena Indica	50	500	25000
Guava	100	150	15000
Custard apple	20	100	2000
Bamboo	150	350	52500
		Total = 2214350 kg	

Total CO_2 neutralized due to green vegetation =2214.350 tons of CO_2 neutralized per year.

2.5.1.6 Rain Water Harvesting Programme

The 52 acre green campus gives facility for using trees as recharging points and only 20% of the area is paved surface. Also the roof tops collect the rain water and passes through a filter to be collected in a leaching rain water pool with disjointed mortar rings using dry joints. This facility near the borewells keep the drawdown curve at higher elevations during summer season.

Total CO_2 Neutralized in AMCEC = 2338.94 tons of CO_2 per Year

3. CONCLUSION

Total CFP contribution (CO_2 per year) = 1937.72 tons of CO_2

Total CO_2 neutralized in AMCEC per year = 2338.94 tons of CO_2

401.22 tons of CO_2 can be used for Extra CFP in future

AMCEC Campus is thriving towards Carbon Neutrality as a commitment from the Management towards mitigation of Global Climate Change in a miniscule effort.

Table 3

Type of transportation	Types of fuel used petrol	Mileage Km/ltr	Distance travelled per day (Km)	Distance travelled per year (Km)	Total no of vehicles (Number)	Petrol/diesel Consumed/year (Ltr)	Emission of CO_2 /ltr of Petrol in Kg	Emission of CO_2 /litr of diesel in kg	Total Emission of CO_2 in tons
Bus	Diesel	4 km	30	30 x 180	2	(30*180*2)/4=2700		2.68	7.236
Bus	Diesel	7 km	50	9000	4	(9000*4)/7=5140.28		2.68	96.48
Car	Petrol	12 km	25	25 x 180=4300	20	(4300*20)/12=7500	2.31		17.32
Bike	Petrol	50 km	50	50	62	558000/50=11160	2.31		25.77
Total = 146.81 tons of CO_2									

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