Carbon Footprint Assessment of MANIT

Abstract: Climate change is among the most important environmental issues of all the time. India is a developing country and is adapting science and technology for its progression. Carbon footprint is an indicator of impact of our activity on climate change. Educational institute plays an important role in development of nation and it is a growing field that consumes more energy and hence has significant carbon emissions. To assess the impact of various activities of colleges on environment carbon footprint is estimated by considering the energy consumption through electricity, vehicle fuel consumption, human factor and solid waste generation. A portion of carbon dioxide emitted will be absorbed by the trees during their photosynthesis process, so the trees have negative carbon footprint. Thus this study is a research regarding the emission of carbon dioxide in the engineering college. Results showed that emissions from Electricity are 581 tons flowed by emission from human breathing are 7.665 tons for the academic year 2024-25. Emissions from solid waste were 9.69 ton and the emissions from vehicles were 124 Ton which was the least emitting factor. The study also describes the suggestive measures to reduce the carbon footprint.

Introduction:

India stands third after china and United States of America as the biggest carbon dioxide (CO_2) emitting nations. India is a developing country, population and economic growth leads to greater consumption of energy. This leads to the problem of reduction of fossil fuel sources, as fossils contribute a major share for electricity production. The above problem has led to growing emissions of CO_2 and other gases known as Green House Gases (GHG) which leads to increasing the temperature of earth known as Global Warming.

Educational institutes play a vital role in development of any nation. Educational institutes are the driving force forthe nation's development and hence this field consumes more energy next to the industries and information technology parks. So, it is important to assess the contribution of educational institutes to GHG emissions.College campuses have large population and area. They have high electricity consumption due to various activities in classrooms, laboratories and offices. Due to large area and population the solid waste generation is quiet high.

The main objective of this project is to estimate total amount of carbon dioxide emissions from an educational institute. NIT BHOPAL is situated in Bhopal with area of 650 acres (236.046 hectare) with huge number of trees and greeneries. In this project; methodology for carbon footprint assessment, its application to educational institute and results for NIT BHOPAL are discussed. Calculating the carbon for any campus can help to identify hotspots in the campus which emits excessive amount of carbon. It can also help to make the campus more sustainable and will help to create environmental responsible students.

Methodology:

Methodology to carry out carbon assessment is divided into three stages.

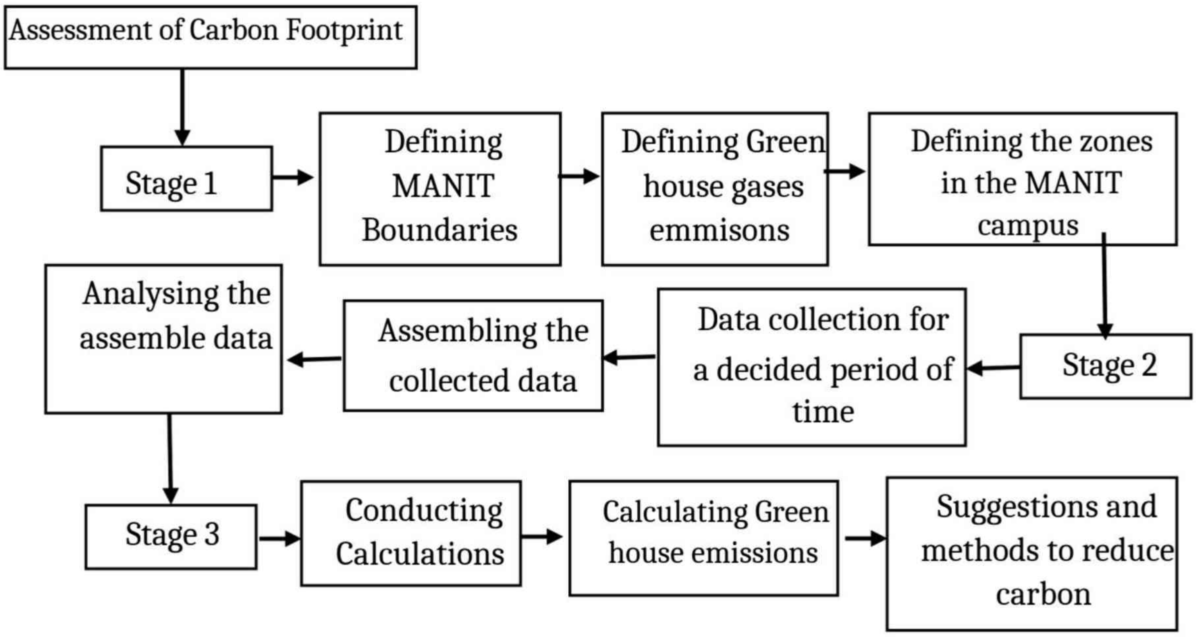

Fig. 1 Flowchart for Carbon footprint estimation

For this study 6 emission releasing activities have been considered. The above table shows the selected emission releasing activities and the source of information.

Table I Emission releasing activities and source of information

Emission releasing Activity	Source of Information
Emission from use of Electricity	Electricity Bills of an average Institute
Emission from human breathing	Total count of humans in institute
Emission from fuel used in vehicles	Mileage and vehicle intensity in institute
Emission from solid waste	Amount of solid waste generated in Kg
Emission from buildings	Total built-up area in m2
Absorption from trees	Area of green cover in m2

To estimate the actual amount of carbon emissions various factors have been considered for each emission releasing activity. The above table shows the emission factors for various emissions releasing activity.

Table II Emission factors for various parameters

Emission releasing Activity	Factor (Kg CO2) (Assumptions)
Emission from use of Electricity	0.82 per2kWh
Emission from human breathing	1000 g/person/day
Emission from fuel used in vehicles	Petrol Cars: 113 g/km Bikes: 26.6 g/km
Emission from solid waste	0.8647 per kg
Emission from buildings	0.2 kg/m2/year
Absorption from trees	12 g CO 2/m/yea

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Results and findings:

Stage 1:

Defining organization boundaries

For defining of organization boundaries the compound boundary of WCE campus was considered. This boundary contains Academic buildings, hostels, residential quarters, laboratories, workshops, vegetation's, open spaces, play grounds and amenities. The following figure shows the organization boundaries marked in black line.

Fig. 2 Organization Boundaries

Defining Zones of campus

The whole campus is divided into 6 blocks. The sections have been made on the basis of functional group. Each section represents the buildings with same function and similar working nature.

Table IIIBlocks of WCE campus

BLOCK	**SECTION**
Block A	Departments
Block B	Hostels
Block C	Administrative wing Mess
Block D	and canteen Residential
Block E	quarters Supportive
Block F	amenities.

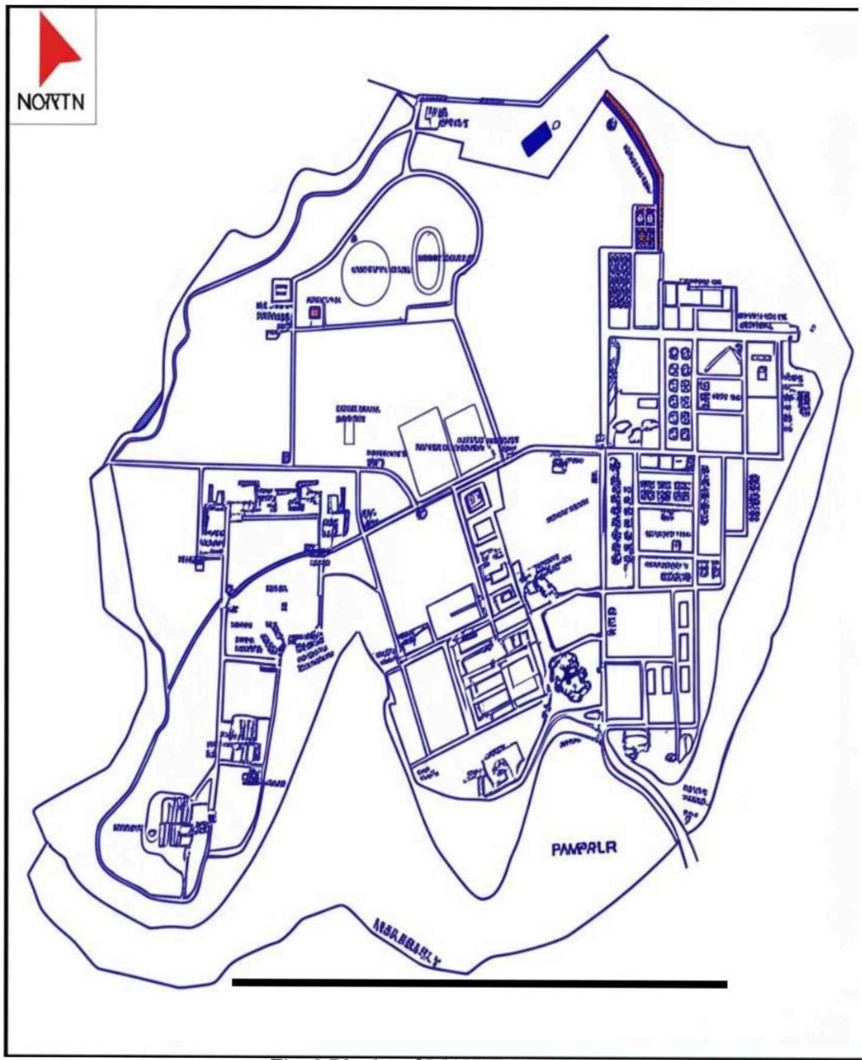

Fig. 3 Blocks of MANIT Campus

The above table shows the detail contents of each block.

Table IVDetail contents of each block in MANIT campus

Block	Content
Block A	Civil Engineering department, Mechanical Engineering department, Electrical Engineering department, Metallurgy and Material Engineering And Chemical Engineering department, Energy Centre, Computer Science Engineering department, New Teaching Block, Architecture and Planning department, Electronic and Communication Department, Mathematics and Data Science department.
Block B	H1, H2, H3, H4, H5, H6, H7, H8, H9, H10, H11, H12
Block C	Main Building, COW office, Dean Office
Block D	Amulya Canteen, Neelam Canteen, Manit Canteen, General store, Nescafe, Top n Town
Block E	Director's bungalow, professer's quarters ,worker's quarters, other staff houses
Block F	Manit Temple, Manit school, Sports complex, Central Library, LRC building, LRC ground, H7 park, SBI, Post Office, Faculty Guest House, Manit Guest House, Despensary

Stage 2

Collection of data for decided period of time

The data is collected for a whole academic year. The data collection is done based on the semester basis. An academic year consists of two semesters in it. The year is viz. 2024-2025. The above table shows days in each semester in the academic year.

Table V Academic years and working days in it

Academic year	Duration	Semester days
2024-2025	July-November	153
	January-Mid May	135

Taking in consideration of Covid Pandemic

Following are the set of assumptions:

1. Due to COVID-19 pandemic the vehicle intensity has been significantly reduced. Hence the current vehicle intensity is assumed to be 20% of the regular working conditions.

2. Due to COVID-19 pandemic the bin waste has significantly reduced since there are less students in the campus. Hence by conducting the survey of maintenance department for the waste condition of campus and survey of rector for the condition of waste in the hostel during the regular working days i should be considered.

Stage 3

Conducting Calculations & Calculating Emissions

Emissions from Electricity

Above table shows the results for emission of CO2 by consumption of electricity. The factor for electrical emissions is 0.82 KWh for one unit of energy consumed.

Table VI Results from Emission from electricity

Academic Year	Electricity consumed	Emission factor	Emission in Ton CO2 eq.
2024-2025	0.67*1,057,994= 708855	0.82	708855*0.82/1000= 581

There will be a significance reduction in emissions for academic year 2021-2022 as compared to the academic year 2024-2025. This was due to affect of Covid-19 on the MANIT Campus where almost no students are residing in the campus and department and other facilities were closed.

Emission from human breathing

Humans emit per person each day 1000 grams of CO_2. The above table shows the humans and their presence in campus in hours along with their emission factor.

Table VII Working hours of humans and modified emissions

Sr no.	Category	Hours in Campus	Emission Factor
1	Staff	24 hours	1000.00 grams/person/day
2	Campus Students	8hrs hours	333.33 grams/person/day
3	Hostel Students	24 hours	1000.00 grams/person/day
4	Quarters residents	24 hours	1000.00 grams/person/day

Table VIII Emission from human breathing

Academic Year	Staff	Students	Hostel students	Quarter residents	Emission in Ton CO2 eq.
2024-2025	500	6000	5500	1500	7.665

Emission from Vehicles

Table IX Parking points along with distance from entrance gates

Sr no.	Parking point number	Location	Access from	Distance in (km)
1	P1	Department Square	Residential area	1.5
2	P2	SBI Parking	Main Gate	0.5
3	P3	residential area type 1	Departmental Sq	1
4	P4	residential area type 2	Departmental Sq	1.7
5	P5	residential area type 3	Main Gate	2.5
6	P6	Girls Hostel	Departmental Sq	1
7	P7	Boys Hostel	Main Gate	2.4

Fig. 4 Parking points in MANIT Campus

Table X Yearly emission from fuel consumption in MANIT campus

Academic Year	P1	P2	P3	P4	P5	P6	P7	Emission in Ton CO2 eq.
2024-2025	29.356	7.272	3.102	23.314	33.055	1.762	26.444	124.305

It is observed that the emissions are less in the academic year 2019-2020. This is due to COVID-19 pandemic lockdown. During this period very few vehicles have approached the institute and hence there is reduction in vehicle intensity.

Emissions from solid waste

MANIT campus has plenty of tress present in its campus and vicinity. Solid waste is collected on daily basis in the campus. Waste from various sections in the college campus is collected and filled in a human operated trolley. The above table shows the details of sections in the MANIT campus and waste collected daily.

Table XI Daily waste collection in each section in WCE campus

Sr. No	Section	**Waste collected daily (in Kg)**
1.	Main building area bins	6*70=420
2.	Dean Office Area bins	4*70=280
3.	Manit Canteen Area bins	4*70+1*120=400
4.	Bins near sports complex	2*70=140
5.	Bins of MANIT Staff house	125*4*0.9*0.5=305
6.	Bins of professor's quarters	125*4*0.82*0.5=205
7.	Bins on road of MANIT	4*70=280
8.	H1, H2, H3, H4, H5, H6, H7, H8, H9, H10, 11, H12 Bins	0.7*6000=4200
9.	Departmental square bins and LRC	120*2*3*4+80*3=3360
10.	Bins of guest house road upto director's bungalow	2*50=100

Total daily waste collection in MANIT campus in kg =9690 Kg

Hence, Emission factor for waste disposal =

0.8647 per kg CO2 emission = 9690 x 0.8647 x 288 +0.3*9690*77= **4129234.584 kg CO2/year eq**.

Fig. 8 Open space area

Fig. 9 Human operated collection trolley

Emission from buildings

Buildings emit considerable amount of carbon dioxide into the atmosphere and add to the Carbon footprint. Continuous emissions are there from buildings. A square meter of brickwork produces 28 kg of carbon dioxide by the time it is delivered to site. That equates to just 0.0001867 tones per square meter a year, over 150 years, carbon emission of concrete work is 0.2 Kg/m2 in a year. The details of the total built up area of buildings and other structures in the campus are calculated and multiply with 0.2 provide the amount of carbon emission from buildings.

Table XIII Emission from buildings

Sr. No	Section	Area in metre sq	Emission in Ton CO2 eq.
1	Departments	500	0.099
2	Other Amenities	2,500	0.5
3	Office Area	250	0.049
4	Sports	150	0.029
5	Student's Hostel	14,011	2.844
	Quarters	25,116	5.098
	TOTAL	42527	8.619

Total emission due to building every year is **8.619 Ton eq of CO2**

Methods to reduce carbon footprints

MANIT can achieve significant reduction in electrical emissions by following ways:

Green roofing solution

Green roofing, also known as a living roof or vegetative roof, is a sustainable building practice where a roof is partially or completely covered with vegetation, soil, and a waterproof membrane. This type of roofing provides numerous environmental and economic benefits. It helps reduce the urban heat island effect by cooling the surrounding air, improves air quality by filtering pollutants, and enhances stormwater management by absorbing rainfall, thus reducing runoff. Additionally, green roofs offer better insulation for buildings, lowering energy costs associated with heating and cooling. They also contribute to biodiversity by providing habitats for birds and insects. Overall, green roofing is an eco-friendly solution that promotes sustainability and improves the quality of urban living.

In addition to environmental benefits, green roofs also offer aesthetic and social advantages. They can transform unused roof spaces into attractive green areas, which can be used for relaxation, gardening, or even community activities in residential or commercial buildings. This not only enhances the visual appeal of the structure but also contributes to the well-being of occupants by providing access to nature in urban settings. Moreover, green roofs can increase the lifespan of roofing materials by protecting them from direct exposure to sunlight and temperature fluctuations, reducing maintenance and replacement costs. As cities continue to grow and face the challenges of climate change, green roofing emerges as a practical and innovative solution for creating healthier and more sustainable urban environments.

Reduction in emissions from vehicles

Emissions from vehicles can be controlled by following suggestions:

1. Development of bicycle zone inside the campus
2. Use of electrically operated transport inside the campus
3. Encouraging use of public transport instead of private
4. Suggesting use of unleaded petrol in vehicles
5. Encouraging walking or bicycling for students and staff coming from short distances
6. Encouraging carpooling

Reduction in emissions from solid waste

Emissions from solid waste can be controlled by following suggestions:

1. Avoiding paper waste generation inside the campus
2. Prevention of plastic inside the campus
3. Avoiding burning of waste to prevent pollution
4. Recycling of paper whenever possible
5. Converting the degradable pit inside the campus to composting or vermicomposting pit

Absorption by trees

Trees absorb significant amount of carbon from the environment. To increase this absorption 20 species having the highest carbon sequestration valued have been selected for plantation at WCE campus. Carbon sequestration refers to the process of capturing carbon dioxide (CO2) from the atmosphere that is derived from various anthropogenic (human) activities and its constant emission from large scale factories. The above table shows the selected species of plant.

Sr. No.	Scientific Name	Common Name	Absorption kg/yr
1	Ficus benghalensis	Banyan Tree	21.77
2	Ficus religiosa	Peepal Tree	30
3	Azadirachta indica	Neem Tree	31.3
4	Terminalia arjuna	Arjun Tree	64.05
5	Mangifera indica	Mango Tree	35
6	Madhuca indica	Mahua Tree	25
7	Tectona grandis	Teak Tree	30
8	Syzygium cumini	Java Plum Tree	20
9	Acacia catechu	Black cutch Tree	22
10	Tamarindus indica	Tamarind Tree	20
11	Eucalyptus globulus	Eucalyptus	34.7
12	Saraca indica	Ashoka Tree	25
13	Dalberiga latifolia	Indian Rosewood	50
14	Leucaena leucocephala	River Tamarind	24
15	Emblica officinalis	Indian gooseberry Tree	25
16	Butea monosperma	Scared Tree	8

Table XV Species of plants commonly found in MANIT

Fig. 10 Green cover area in MANIT campus

Calculation Regarding Carbon Absorption

- Total area of MANIT=650 acers = 263 hectares
- 70% of its area is covered in moderate level dense forest. Hence, around 200 hectares of area is covered from forest.
- Assume, 700 trees per hectare are there in the forest. Hence, 200*700=140,000 trees are present in MANIT Campus.
- By taking average of the above data, each of the tree is absorbing a total amount of 27.568kgs of Carbon per year.
- A total of 140,000*27.568=38,59,520 kgs of Carbon is absorbed by trees per year.

Discussion

The assessment of the carbon footprint of the institute provides critical insights into the primary sources of greenhouse gas emissions within the campus. The total annual CO_2 emissions have been calculated by evaluating different functional areas, including energy consumption (electricity and fuel), transportation, waste generation, water usage, and food services. Among these components, electricity consumption and transportation emerged as the most significant contributors, followed by emissions from solid waste disposal and water-related activities.

This not only highlights the areas where emissions are most concentrated but also enables a data-driven approach to sustainability planning. The results provide a baseline for tracking future progress and implementing targeted emission reduction strategies.

Total CO2 emission at MANIT campus is shown in the above table

Table XIV Total CO2 emissions at MANIT campus

Sr. No	GHG Emitting Factor	CO Emission in Ton CO Eq. 2
1	Emisson from use of electricity	
	Year	
	2024-2025	581
2	Emisson from Human Breathing	
	Year	
	2024-2025	7.665
3	Emisson from fuel used in vehicle	
	Year	
	2024-2025	124.305
4	Emisson from solid waste	
	Year	
	2024-2025	9.69
5	Emisson from buildings	8.213
6	Absorption from trees	3859.52

Results:

Total CO2 emission at MANIT campus is shown in the above table

Total Negative Crabon Footprint is = 3859.52 Ton eq of CO2

Total positive Carbon Footprint is= 581+7.665+8.213+9.69+124.305=730.873 Ton eq of CO2

Hence Total Carbon Footprint if Negative of **3128.647 Ton eq of CO2.**

Conclusion:

The analysis of the carbon footprint for the institute reveals a net negative carbon footprint, indicating that the institute is not only minimizing its greenhouse gas emissions but also actively offsetting more carbon than it produces. This achievement reflects the successful implementation of sustainable practices such as renewable energy usage, effective waste management, green landscaping, and eco-conscious transportation policies. The negative footprint positions the institute as a model of environmental responsibility and innovation, demonstrating that academic institutions can lead the way in combating climate change. Continued efforts and regular monitoring will be essential to maintain and further improve this commendable environmental performance.

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