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Estimation Of Carbon Footprint For Vimal Jyothi Engineering College

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Abstract:This study aims to estimate the carbon footprint and Indoor environmental quality of an educational institution, focusing on the relationship between energy consumption and environmental impact. The study will involve a comprehensive assessment of the institution's energy use, including transportation, electricity consumption, waste management etc. By calculating the carbon emissions associated with these activities, the project will provide insights into the institution's contribution to greenhouse gas emissions. Additionally, the project will evaluate indoor environmental quality levels within the institution, considering factors such as indoor temperature, humidity, and air quality. Surveys and measurements will be conducted to gather data on occupants comfort levels and preferences.

Index Terms - Carbon Footprint, Energy Consumption, Environmental Impact, Greenhouse Gas Emissions, Transportation Emissions, Electricity Usage, Temperature and Humidity Control, Sustainability Assessment, Emission Reduction Strategies, Data Collection and Surveys, Educational Institution Sustainability.

1. INTRODUCTION

Educational institutions are critical in moulding the next generation and hence have a mandate to act responsibly regarding the environment. The operation stage of an institution involves a number of activities, including energy usage, waste disposal, and transportation, all of which add up to its carbon footprint. The carbon output from these activities, including energy use for heating, cooling, and illumination of buildings, waste disposal, and transportation, is notable. Additionally, the indoor environment of educational facilities specifically aspects such as air quality, lighting, and temperature contributes directly to the health, well-being, and academic achievement of the students and workers. Being able to comprehend the environmental effects of such operational activities and the need for a healthy indoor environment is indispensable in order to encourage sustainability and effective practices in educational institutions. The focus of this project report is on estimating the carbon footprint of an educational institution throughout its operational stage.

It discusses the most important contributors to the carbon footprint, including energy use, transportation, waste handling, and use of resources. The report also delves into the importance of ensuring proper IEQ, which influences both the well-being and productivity of the academic community. Through a study of these determinants, the report presents suggestions on lowering emissions and making the educational sector as a whole more sustainable, eventually leading to a healthier and more productive learning environment. Current literature points to the increasing need for sustainability in schools. Research works such as those conducted by Clabeaux et al. (2020) and Valls-Val et al. (2021) have pointed towards assessing energy consumption, transportation, and waste handling to mitigate carbon footprints. Studies by Filza binti et al. (2021) and Ateş et al. (2023) emphasize the promotion of sustainable transport modes and indoor air quality improvement to ensure health and learning performance. This report integrates these findings to provide practical advice on how education facilities can minimize their environmental footprint and enhance indoor environmental quality, promoting a healthier teaching environment.

2. METHODOLOGY

2.1 Study Area

Vimal Jyothi Engineering College, Chemperi, is situated across 30 acres with a diverse population comprising students, faculty, and staff members. The campus has established infrastructure, including laboratories, libraries, and sustainability offices, which are supportive of research activities. This setting provides an excellent opportunity to explore the carbon footprint of an educational institution and identify potential strategies for carbon footprint reduction.

Fig 1:vimal jyothi engineering college

Fig 2:Google map location

2.2 Data Collection

The methodology for carbon footprint estimation follows the guidelines provided by the Intergovernmental Panel on Climate Change (IPCC) for calculating GHG emissions. Data was collected from the following key areas:

- **Electricity Consumption:** Monthly electricity bills (from July 2024 to December 2024) were collected to evaluate energy consumption patterns.
- **Transportation Emissions:** A survey of the campus population was conducted to gather information on transportation modes, fuel types, and vehicle usage.
- **Waste Generation:** Waste disposal records were reviewed to estimate emissions from solid waste.
- **Water Usage:** Water supply data was obtained from the relevant campus departments.
- **Human Breathing:** Estimates for CO_2 emissions from human respiration were calculated based on campus

population and average respiration rates.

2.3 Greenhouse Gas (GHG) Inventory Parameters

A comprehensive GHG inventory was created using the following parameters to estimate carbon dioxide equivalent (CO_2e) emissions:

- **Green Coverage:** Green spaces on campus, such as lawns and gardens, contribute to carbon sequestration through photosynthesis. A tropical tree can absorb 0.5 to 1.5 metric tons of CO_2 per acre per year.
- **Solar Panels:** Solar energy generation helps reduce reliance on fossil fuels. Solar panel efficiency averages 15- 20%, with an emission factor of 0.02 to 0.08 kg CO_2 per kWh.
- **Electricity:** CO_2 emissions associated with electricity consumption are calculated using the emission factor of 0.20493 CO_2e per kWh.
- **Transportation:** CO_2 emissions from transportation were calculated based on fuel type and consumption, with emission factors of 2.27193 kg CO_2 per liter for petrol and 2.7 kg CO_2 per liter for diesel.
- **Solid Waste:** Solid waste disposal emissions were calculated using the emission factor of 6.41 kg CO_2e per tonne.
- **Human Breathing:** Although a minimal source of emissions, CO_2 from human respiration was included at an emission factor of 0.0342 kg CO_2 per person per hour.

2.4 Calculation of GHG Emissions for the Study Area

The total CO_2 emissions for the study area were determined by multiplying activity data with corresponding emission factors. The following formula was used:

Activity Data×Conversion Factor=Carbon Emission

Table 1.Conversion Factors:

Item	Emission Factor
Petrol	2.27193 kg CO_2e per liter
Diesel	2.7 kg CO_2e per liter
Electricity	0.20493 CO_2e per kWh
Water Supply	0.5 kg CO_2e per cubic meter
Solid Waste	6.41 kg CO_2e per tonne
Human Breathing	0.0342 kg CO_2 per person per hour
Solar Panel	0.02 to 0.08 kg CO_2 per kWh
Green Coverage	0.5 to 1.5 metric tons of CO_2 per acre per year

2.5 Emission from Transportation

To assess emissions from transportation, a survey was conducted to gather data on vehicle types, fuel types, and driving distances. The campus parking zones were categorized into four sections, each with varying concentrations of two-wheelers, four-wheelers, and faculty vehicles. The CO_2 emissions from each zone were calculated using the emission factors for petrol and diesel. Special attention was given to factors such as vehicle idling during peak hours and fuel consumption patterns. The study recommends strategies for emission reduction, including carpooling, promoting electric vehicles, and improving parking management.

Fig 3:Parking area of vimaljyothi engineering college

2.6 Emission from Electricity Consumption

The electricity bills for the period of July 2024 to December 2024 were analyzed to assess the carbon emissions due to electricity consumption on campus. The CO_2 emission factor of 0.20493 kg CO_2e per kWh was applied to the total energy consumption recorded in the billing data. A graph was plotted to illustrate the variation in CO_2 emissions over the study period, providing insights into energy consumption trends and their environmental impact.

2.7 Green Coverage

The green coverage of Vimal Jyothi Engineering College was determined using Google Earth to calculate the area of green spaces on campus. Polygons were drawn around identified green areas, and the area of each polygon was computed. The total green coverage of the campus was found to be 14 acres. This green cover is estimated to sequester between 7 and 21 metric tons of CO_2 annually, depending on the type and density of vegetation.

Fig 4:Total green area

2.8 Solar Panel Impact

To quantify the reduction in CO_2 emissions due to solar energy generation, the total electricity produced by the installed solar panels was determined. This data was then multiplied by the emission factor for solar energy, ranging from 0.02 to 0.08 kg CO_2 per kWh. The results indicate the significant role that solar panels play in reducing the carbon footprint of the campus

Fig 5:Solar panel

3. RESULT AND DISCUSSIONS

The following sections summarizes the principal results of our study,outlining the key findings and observations .

3.1 GREEN COVERAGE

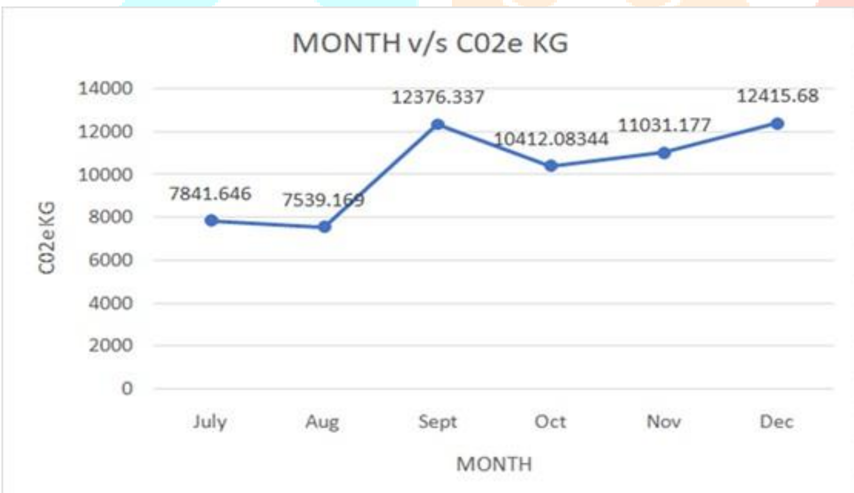
This image shows the map of Vimal Jyothi engineering college .We used Google Earth to find out the total green coverage in our institution. By drawing polygons the green areas are separated. The green areas are highlighted in yellow. The total green area obtained as 14 acres .The emission factor for green coverage according to IPCC is 0.5 to 1.5 metric tonnes of CO_2 e per year. The total emission from green coverage is obtained by multiplying area and emission factor.

The total green area = 14 acres CO_2 emission from green coverage = 7metric tonnes of CO_2e per year

3.2 ELECTRICITY

Total carbon impact from electricity (July–Dec 2024) was 61,616.092 kg CO_2e, with significant fluctuations. Emissions were highest in September (12,376.337 kg CO_2e), lowest in October (10,412.083 kg CO_2e), then increased throughout December(12,415.68 kg CO_2e). Seasonal and operational variations probably affec ted trends. Energy-conserving measures were required.

CO2 Emission from Electricity (July 2024 – December 2024)



MONTH	Kg CO2 e.
JULY	7841.646
AUG	7539.169
SEPT	12376.337
OCT	10412.08344
NOV	11031.177
DEC	12415.68

Fig3.2 Variation in GHG emission from electricity during study period

3.3 TRANSPORTATION

Transportation emissions from Vimal Jyothi Engineering College's parking areas vary month-wise, reaching the peak during August (176.831 kg CO_2e) and November (189.9 kg CO_2e), perhaps reflecting heightened campus activities. Emissions dropped during September (154.32 kg CO_2e) and December (137.28 kg CO_2e), possibly indicating low commuting. Four parking area emissions illustrate the role of idling, mobility, and parking duration in vehicles. Carbon- saving actions such as carpooling, pedestrian infrastructure ,and electric vehicle charging points can be a emission.

CO2 Emission from transportation (July 2024 – December 2024)

MONTH	Kg CO2e
JULY	138.996
AUG	176.831
SEPT	154.32
OCT	185.383
NOV	189.9
DEC	137.28

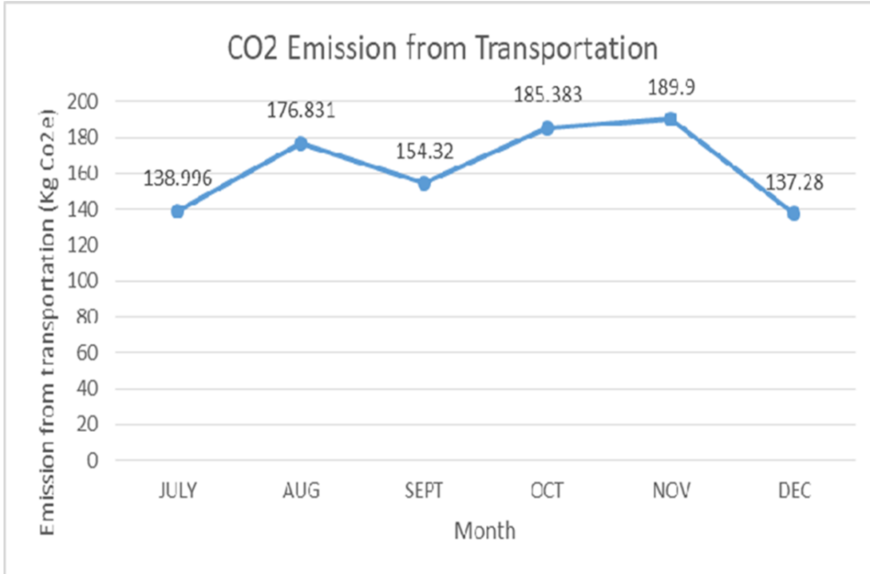
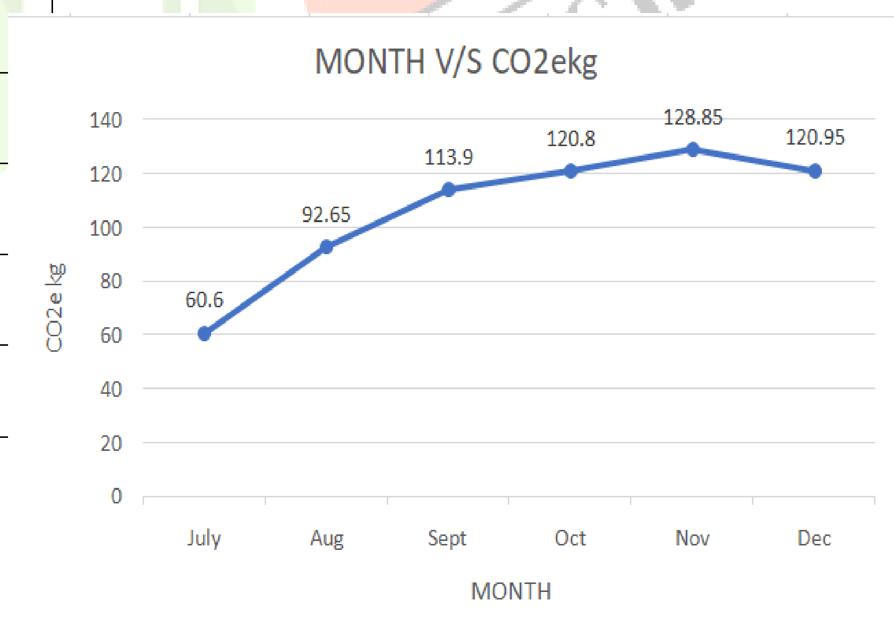


Fig3.3 Variation in GHG emission from transportation during study period

3.4 SOLAR PANNEL

Overall CO_2 absorption from the campus photovoltaic panels, based on an average IPCC conversion factor of 0.05 kg CO_2/kWh, are 637.75 kg CO_2. This underscores the green footprint of solar energy utilization and emph asizes optimizing panel efficiency to further minimize the carbon debt.

MONTH	KgCO2e
JULY	60.6
AUG	92.65
SEPT	113.9
OCT	120.8



NOV	128.85
DEC	120.95

HUMAN BREATHING

Fig 3.4Variation from GHG absorption from solar panel from study period.

The CO_2 emissions from human breathing in our college were calculated based on occupancy hours and population size. Institutional buildings are occupied for 8 hours daily, while hostel buildings are occupied for 24 hours daily, contributing to monthly CO_2 emissions. The highest emission was recorded in August (30.84 kg CO_2), followed by consistent levels from September to November (around 28.47 to 29.66 kg CO_2). A notable decrease occurred in December (20.17 kg CO_2), possibly due to reduced campus activity. This data reflects the impact of human respiration on the college's overall carbon footprint

CO2 Emission from Human breathing (July 2024 – December 2024)

MONTH	KgCO2e
JULY	26.11
AUG	30.84
SEPT	28.47
OCT	29.66
NOV	29.66
DEC	20.17

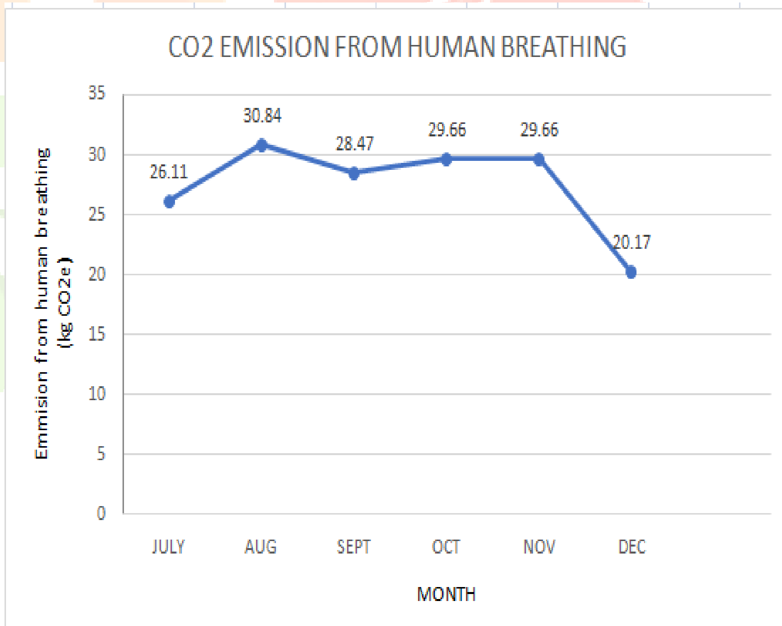


Fig Variation in GHG Emission From Human Breathing During Study Period

4. SUGGESTED MITIGATION MEASURES

- **Promote Electric Vehicles (EVs):** Install EV charging stations and encourage students and staff to use electric vehicles.
- **Carpooling System:** Develop a carpooling app to reduce the number of vehicles on campus.

- **Bicycle-Friendly Campus:** Create dedicated cycling lanes and provide bicycle rentals to reduce fuel- based transport**.**
- **Air-Purifying Parking Lots:** Install CO_2-absorbing plants and moss walls in parking areas to improve air quality.
- **Solar Pavement**: Install solar panels on walkways and parking lotsto generate electricity and reduce heat absorption.
- **Artificial Intelligence-Driven Lighting:** Implement AI to adjust lighting levels based on occupancy and daylight availability, minimizing unnecessary usage.
- **Solar-Powered Parking**: Install solar panels over parking lots to generate clean energy and provide shade.
- **Green Parking Zones:** Increase green cover around parking areas to absorb CO_2 and improve air quality**.**
- **Awareness Campaigns:** Conduct regular workshops and events to educate students and staff on sustainable transport practices.
- **Rain-Powered Turbines:** Install small hydro turbines in drainage systems to generate electricity from rainwater flow.
- **Microgrid System:** Develop a campus microgrid powered by solar and wind energy, allowing energy independence and reducing reliance on the main grid.

CONCLUSION

The carbon footprint analysis of Vimal Jyothi EngineeringCollege offers important information regarding th e environmental footprint of the institution. The overall GHG emissions documented during the study pe riod (July 2024 December 2024) were 37625.932 kg CO_2e, with electricity usage being the largest contributor at 61,616.092 kg CO_2e. Variations in emissions on a monthly basis reflected fluctuations in energy demand, wh ich may be affected by operational activities and seasonal influences. Transportation emissions also fluctuated, pointing to the necessity of green commuting habits. Solar panel emissions, while much lower, point to the nece ssity of maximizing solar energy efficiencyto achieve the greatest environmental rewards. Human respiration ac counted for a measurable but small contribution to the overall carbon footprint.To reduce emissions, the institut ion must implement energy efficient technologies, encourage the use of electric cars, increase green cover,and e nhance waste management systems. The adoption of renewable energy and maximization of solar panel efficien cy will also aid sustainability efforts. With these interventions,the institution will be able to significantly lower i ts carbon footprint and set an example for sustainable campus management.This research highlights the need fo r constant monitoring and preventive measures to attain long-term sustainability.

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