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Net Zero Carbon Analysis in Engineering Institution

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Abstract - *In the face of climate change, it has become increasingly important for all sectors to take action to reduce their carbon emissions. One sector that plays a crucial role in this effort is education. We have conducted a case study for analyzing the presence of carbon emissions in our college. In this article, we will explore various strategies that our college can implement to reduce their carbon footprint and foster a greener educational environment. This case study investigates the CO_2 emissions at Kongu Engineering College, identifying the primary sources and proposing measures for reduction. The energy consumption, transportation, and garbage generation of educational institutions, owing to their expansive campuses and elevated activity levels, greatly contribute to the contamination of CO_2. The purpose of this study is to estimate the institution's carbon footprint by examining waste management procedures, staff and student travel habits, and energy use in buildings. According to the research, the two biggest sources of emissions are power generated by fossil fuels and extensive car usage. The findings suggest a number of mitigating techniques, such as switching to renewable energy sources like solar power, encouraging the use of electric vehicles and public transportation, putting energy-efficient technology into practice, and enhancing garbage recycling initiatives. By adopting these measures, Kongu Engineering College can reduce its carbon footprint, promote a more sustainable campus environment, and serve as a model for other educational institutions aiming to achieve carbon neutrality.*

***Key Words*: Carbon emissions, CO_2, Renewable energy sources.**

1. INTRODUCTION

There have been numerous studies focused on trends and challenges in reducing these emissions in almost all sectors, from global industrial activities to more localized initiatives, such as college campuses. The authors identified key regions contributing to emissions and analysed how these factors influenced global climate change, emphasizing the urgency of international climate agreements to mitigate the growing emissions problem[1]. A detailed analysis of global CO_2 emissions trends, highlighting the major emitting countries and regions is presented. The report covered both historical and contemporary data, revealing significant increases in emissions, particularly from developing countries[2}. The relationship between culture, income, and CO_2 emissions, investigating how societal values and economic development influenced environmental impact was explored. The study analysed data across various countries, showing that higher income levels often correlated with increased emissions[3]. A review was done for CO_2 measurement procedures used in ventilation research, assessing the reliability and effectiveness of different methodologies. The authors compared techniques such as direct and indirect CO_2 measurement, discussing their implications for indoor air quality studies. They emphasized the importance of accurate CO_2 measurements in ensuring proper ventilation, particularly in indoor environments, to maintain healthy air quality standards[4]. A new instrumental concept was proposed for measuring CO_2 concentration in the atmosphere, utilizing space-based technology. The paper discussed the technical aspects of sensors and satellite systems designed for high-precision atmospheric CO_2 measurement[5&6]. A study reviewed the sources and health impacts of pollutants such as particulate matter, nitrogen oxides, and sulphur dioxide, with a focus on their interaction with CO_2 emissions[7&9]. The authors analysed various energy-efficient practices and technologies implemented on the campus, such as renewable energy adoption and efficient energy management systems[8]. A study explored how various ecosystems, including forests and grasslands, responded to increasing CO_2, temperature, and other environmental changes. The authors emphasized that ecosystem responses were complex[10]. Investigation have been made for indoor and outdoor air quality in schools across HongKong, focusing on pollutants like CO_2, particulate matter, and volatile organic compounds[11]. Analysis is carried out for the impact of CO_2 concentrations on indoor air quality in Serbian school buildings and explored correlations with relative humidity and temperature[12]. An assessement is done recent advances in measurement techniques for atmospheric CO_2 and methane observations[13]. A study revealed seasonal and yearly variations in CO_2 fluxes, with the forest acting as a carbon sink most of the time. It discussed the importance of long-term measurements to understand forest carbon dynamics and their role in mitigating global CO_2 emissions[14]. A study analyzed energy consumption patterns and corresponding emissions, linking high levels of CO_2 and other pollutant

to adverse health effects on workers[15]. A study explored the potential risks of CO_2 toxicity on human health in the context of climate change. The study highlighted that while CO_2's role in climate change was well known, its direct effects on human health at elevated concentrations were often over looked[16]. A study explored various renewable energy technologies and their feasibility in replacing fossil fuels to enhance energy sustainability. The authors concluded that integrating multiple renewable sources could significantly reduce CO_2 emissions while ensuring a stable and sustainable energy supply[17]. A study found that countries with higher economic and environmental sustainability tended to have lower emissions, emphasizing the role of policy-driven approaches to achieving emission reductions[18]. A study explored political, economic, and environmental factors influencing emissions reduction efforts, highlighting differences in policy approaches and cooperation among these countries[19]. A case study evaluated energy- efficient technologies and sustainable practices implemented on the campus to reduce CO_2 emissions. The study demonstrated how educational institutions could serve as models for sustainability, showing that net-zero development was achievable through renewable energy integration, energy-efficient buildings, and effective resource management[20].

2. PROBLEM IDENTIFICATION AND OBJECTIVE

2.1 Problem Identification

Like many other sizable educational establishments, Kongu Engineering College contributes significantly to the community by offering high-quality instruction and encouraging technological innovation. But the campus's environmental effect increases along with its size and activity level, especially in terms of CO_2 emissions. The energy used by campus buildings for lighting, air conditioning, and electronic equipment; the emissions from everyday staff, professor, and student commutes and waste management procedures are the main causes of the institution's carbon footprint. The college contributes significantly to global climate change by its reliance on conventional electricity derived from non-renewable sources, wasteful resource use, and conventional transportation patterns. To determine their scope and create workable mitigation plans, it is essential to identify and measure these emissions.

2.2 Objective

This study's main goal is to evaluate and examine the CO_2 emissions at Kongu Engineering College's(Fig3.1) various operational activities produce. The research will point out inefficiencies in the organization's current processes and suggest workable solutions to lower emissions overall. Measuring CO_2 levels in various campus facilities and evaluating building energy use and pin pointing high-demand locations are some of the specific goals. The study will identify inefficiencies in current systems and propose actionable measures to reduce the institution's over all emissions.

Specific objectives include:

- Measuring indoor CO_2 levels across various campus facilities.
- Analysing emissions from student and staff transportation.
- Making remarks for the analysed data

3. METHODOLOGY

The study follows a multi-step methodology to gather data, calculate emissions, and perform a detailed analysis.

3.1 Process Flow

The process of identifying the problem is starts form determining the sources of occurrence, for the progress initialisation the location is first chosen wisely and started the reading. The process flow is mentioned in the flow chart (Fig.1.):

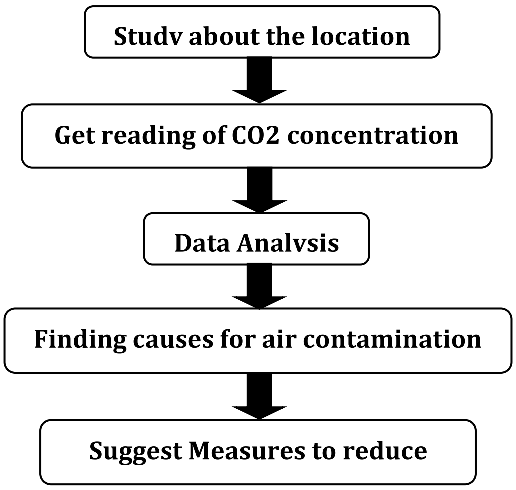

Fig. 1. Methodology of Case Study

3.2 Measuring CO_2

To keep an eye on air quality, sensors are positioned strategically throughout buildings such as offices, labs, dorms, and classrooms. Data is gathered over a predetermined time period in order to identify patterns related to occupancy and ventilation efficiency in the device(Fig.2).

Fig. 2. EXTECHEA20 (CO_2 meter)

The measurement of CO_2 emissions at Kongu Engineering College was carried out by gathering data on energy consumption, transportation activities, and waste management. Energy consumption data was collected from monthly utility bills, focusing on electricity usage in academic buildings, laboratories, and residential facilities. To convert this data into CO_2 equivalents, emission factors provided by national authorities were used, based on the type of energy consumed (e.g., coal based electricity or renewable sources). Transportation emissions were estimated through a survey of students, faculty, and staff, which assessed commuting distances, vehicle types, and fuel used. Waste management data, including the volume of waste sent to landfills, recycled, or incinerated, was also analysed. Emission factors were applied to waste generation data to calculate the Carbon foot print associated with waste disposal. This holistic approach to data collection enabled an accurate estimation of the institution's total CO_2 emissions.

3.3 Cause Explanation

Energy use, transportation patterns, and waste management analyses of the institution were conducted to determine its major sources of CO_2 emissions. The major source of carbon was the fossil fuel-based electricity dependence by the university in powering buildings and laboratory equipment. There existed a weak usage of renewable resources for energy and also inefficient usage, thereby resulting in a higher level of emissions. Transportation is another main emission source that was indeed the case as a significant percentage of the campus population commutes using private vehicles running on gasoline or diesel. The absence of extensive recycling programs and reliance on landfills as the primary mode of waste disposal added further to increasing the CO_2 emissions. The factors mentioned were pointed out as main sources of CO_2 contamination within the institution.

3.4 Remarks

The collected data revealed Kongu Engineering College has an enormous carbon footprint majorly caused by the energy consumption and transportation sectors. This study showed urgency on the grounds of energy management and transportable as well. Although there are quite many systems in place for waste management, lack of proper recycling infrastructure and mishandled segregation of wastes were great problems noticed. Dependence on conventional energy sources along with the growing populace on campus calls for an immediate shift in this institution towards cleaner energy solutions. It would suggest that, as of now, present practices are not aligned to the purposes of sustainable development.

3.5 Measures towards reducing CO_2 emissions

In light of the above findings, the following are some measures that would reduce the contribution of Kongu Engineering College to CO_2 emissions. Renewable sources of energy such as installation of solar panels and wind energy would substantially reduce the presence of fossil fuel use. Better Energy Efficiency Improvement in energy consumption can be achieved by using LED lights, intelligent building systems, and upgrading insulation for old buildings would reduce the absolute level of energy use. These improvements will begin to show with environmentally conscious policies for transport, like heightened awareness and increase of public transport, carpooling, and electric automobile vehicles. Bike-friendly infrastructure development is also encouraged to encourage non- motorized commuting. Waste management gets improved due to the expanded recycling programs, introducing composting for organic wastes, and trying to reduce it to a minimal usage of landfills. All the measures, when enacted, will reduce the carbon footprint of the institution to a significantly lower degree and ensure sustainability within the campus environment.

4. RESULT AND ANALYSIS

4.1 Air Quality Audit

The quality of air is measured in the atmosphere of various location within the campus and register as carbon dioxide contamination in parts per million (ppm). The green cover areas are noted and taken into account for the cause analysis.

4.2 Quality Measurement

The final result table 4.1 lists the carbon dioxide reading for each measured locations.

Table 4.1:Measurement of Carbon Dioxide in Kongu Engineering College

Location	Appliances	CO_2 Accepted	CO_2 Percentage	Temperature	Humidity	Remarks
		(ppm)	(ppm)	(°C)	(%)	
Food Court	Ovens, Cook tops, Grinders/ Blenders	1000	400	33.1	59	More than normal
Maharaja Auditorium	AC	800	279	33.5	56.2	Controlled
Naturopathy Block	AC,Burner, Fume Hoods	800	321	32.6	60.3	Need ventilation
Mechanical Block	AC,3dPrinters	800	302	32.8	57.4	Need ventilation
Mechatronics Block	AC,CNC Machines, Lab Equipment	800	292	32.9	58.5	Need ventilation
Civil Block	AC, Lab Equipment	800	315	33	59.4	Normal
Automobile Block	AC, Automobile Experiments, Elevators	800	328	33.1	56.7	Need ventilation
Workshop Complex	Gas Cutting & Welding, Furnace	800	298	34.2	55.5	Normal
Lathe	Diesel Engine	800	311	37.2	51`	Normal
Thermal Lab	IC Engines (Idle Condition)	900	308	35.1	54.4	Normal
ECE Block	AC, Lab Equipment	800	415	30.9	67.3	Need ventilation
Food Tech Block	AC, Refrigerator, Fume Hoods	800	328	32.4	58.7	Normal
Library	AC, Computing Servers, Desktop Computers	800	409	32.8	59.4	Need ventilation
Chemical Block	AC, Refrigerator, Fume Hoods	800	349	32.2	5974	Need ventilation
EEE Block	AC, Power Supply Units	800	434	31.4	69.7	Need ventilation
CT Block	AC, Computing Servers	800	426	31.1	65.7	Need ventilation
IT Park	AC, Computing Servers	800	378	31.3	65.8	Need ventilation
Administrative Office	AC, Computing Servers	800	365	31.1	67.7	Need ventilation
S&H Block	AC, Lab Equipment	800	348	30.2	70.2	Need ventilation
MBA Block	Computing Servers, AC, Elevators	800	446	30.8	61.4	Need ventilation
BusStand1	Buses	900	311	32.4	61.1	Controlled
BusStand2	Buses	900	325	33.1	58.3	Normal
Student Parking1	2 Wheeler, Car	900	252	32.9	56.1	Controlled
Student Parking2	2 Wheeler, Car	900	273	32.9	58.5	Controlled
Singles Canteen	Ovens, Cook tops, Grinders/ Blenders	900	408	33.1	57.2	More than normal
Fruit Stall	Ovens, Cook tops, Grinders/ Blenders	900	296	32.3	56.4	Normal
Conventional Centre	AC	800	280	33.1	56.7	Normal
Hostel 1 (Dheeran)	Gas Stove, Idly Steamer, Rice Boiler	1000	498	33.4	60.7	More than normal
Hostel 2 (Valluvar & Bharathi)	Gas Stove, Idly Steamer, Rice Boiler	1000	512	33.7	62.4	More than normal

Hostel 4 (Illango & Kamban)	Gas Stove, Idly Steamer, Rice Boiler	1000	286	33.2	61.3	Controlled
Hostel 6 (Ponnar & Sankar)	Gas Stove, Idly Steamer, Rice Boiler	1000	568	33.2	63	More than normal

4.3 Air Quality Study

The quality of the air is finally analysed by auditing the contamination of carbon dioxide in the atmospheric air around the campus. The concentration of CO_2 in air is compared with an accepted standards of CO_2 contamination in ppm after limiting some levels of concentration of CO_2 in air.

4.4 CO_2 Acceptance and Regards

The acceptable level of CO_2 concentration varies depending on the purpose of each location in an engineering institution, particularly with regard to indoor air quality and occupant comfort. While outdoor atmospheric CO_2 concentrations generally over around 400-450 parts per million(ppm),indoor spaces often have higher concentrations due to human activities, equipment use, and ventilation systems.

4.4.1 Class rooms and Lecture Halls

- **Acceptable CO_2 Levels**: **600 –1,000ppm**

CO_2 concentrations above 1,000 ppm may indicate inadequate ventilation and can lead to drowsiness and reduced cognitive performance. Proper ventilation systems, such as natural airflow or mechanical HVAC, should maintain levels under 1,000 ppm.

4.4.2 Laboratories

- **Acceptable CO_2 Levels**: **600 –1,000ppm**

Due to the high usage of equipment and varying occupancy, lab scan have fluctuating CO_2 levels. Effective ventilation is crucial to prevent the accumulation of harmful gases, including CO_2, especially in chemical or biological labs.

4.4.3 Computer Labs and Research Centers

- **Acceptable CO_2 Levels**: **600 –1,000ppm**

These spaces often have high energy use from computing equipment and servers. CO_2 levels should be maintained within the range to avoid discomfort and ensure that the system do not compromise air quality.

4.4.4 Hostels

- **Acceptable CO_2 Levels**: **500 –1,000ppm**

In residential spaces, higher CO_2 levels can be common at night due to poor ventilation when windows are closed, Levels over 1,000 ppm may indicate inadequate air exchange and should be addressed by improving airflow.

4.4.5 Administrative Offices

- **Acceptable CO_2 Levels**: **500 – 800 ppm**

Offices are typically smaller spaces with fewer occupants, so CO_2 levels tend to be lower. However, with poor ventilation or high occupancy, levels may rise above 800 ppm, affecting productivity.

4.4.6 Libraries

- **Acceptable CO_2 Levels**: **500 – 800 ppm**

In spaces designed for concentration CO_2 levels should ideally be kept low. Prolonged exposure to concentrations above 800 ppm can reduce focus and cognitive function.

4.4.7 Cafeterias and Dining Areas

- **Acceptable CO_2 Levels**: **600 – 1000 ppm**

These spaces see high traffic during meal times, so ventilation should be adequate to maintain CO_2 levels below 1,000 ppm to avoid discomfort.

4.4.8 Conference Halls and Seminar Halls

- **Acceptable CO_2 Levels**: **600 – 1000 ppm**

Similar to class rooms, these areas often host large groups of people, which can rapidly increase CO_2 levels. Effective ventilation is crucial to keep CO_2 levels within acceptable limits, as concentrations above 1,000 ppm can cause discomfort and reduce attention.

4.4.9 Server Rooms and Data Centers

- **Acceptable CO_2 Levels**: **400 – 600 ppm**

Server rooms typically need to maintain low CO_2 levels to ensure equipment functions properly. These rooms are generally well- ventilated with cooling systems that help maintain low CO_2 concentrations.

4.5 Graphical Data Representation

The comparison of CO_2 concentration in various locations within the campus is shown as bar graph in Fig 3.

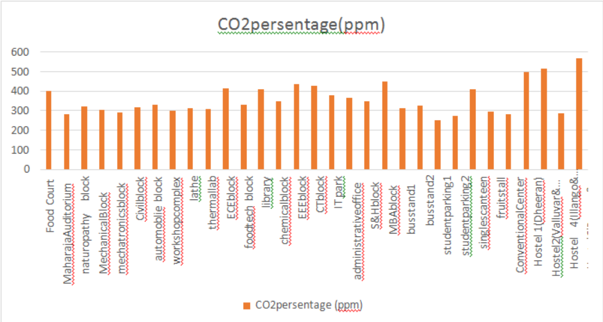

Fig. 3: Overall data of CO_2 reading

5. RESEARCHES TO BE FOLLOWED

- Identification of measures need to be identified for treating the elevated concentration of carbon dioxide in the air over the period of time.
- With the same activities which involves high carbon dioxide emission taking place the concentration remain increasing and a controlled usage of those activities are need to be empathised.
- Identification of different ways to achieve less carbon dioxide emission for the necessary events.
- Ways for clearing the source of producing huge quantity of carbon dioxide into the atmosphere.
- Creating awareness against extra polating the usage of activities which tends to produce huge amount of carbon dioxide into the atmosphere, and letting them to know about the limitations of the utility.

6. CONCLUSION

This case study highlights the significant role educational institutions, such as Kongu Engineering College, play in contributing to CO_2 emissions through their various operations, including energy consumption, transportation and waste management. As centres of learning and innovation, engineering colleges have both the responsibility and opportunity to lead by example in the fight against climate change. By transitioning to renewable energy sources, enhancing energy efficiency, promoting sustainable transportation and improving waste management practices, institutions can significantly reduce their carbon footprint. Implementing these changes not only mitigates the environmental impact but also fosters a culture of sustainability within the campus community, preparing future engineers and leaders to prioritize environmental stewardship. The implementation of these measures not only benefits the environment but also fosters a culture of sustainability, setting an example for students, faculty, and staff to adopt eco-friendly practices in their daily lives. On the final report the analysation of the data from the table is further remarked on the bases of the carbon dioxide contamination and then listed the sources of the possible CO_2 emission activities.

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