Managing **Carbon Footprint** of IITJ Campus

Indian Institute of Technology Jodhpur

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1. Introduction

The target of 1.5℃ above the pre-industrial level set at COP21 can be crossed in the next two decades which is a very alarming sign for the world. The planet is now on the way to being warmer by 2.5-4℃ by the end of this century. Despite having very little obligation, as a developing country, India is working hard to reduce carbon emissions and keeps on increasing its nationally determined contributions(NDCs). At the COP26 summit, India announced five elixirs that will be an unprecedented contribution towards climate actions. They are

1. India will increase its non-fossil energy capacity to 500 GW by 2030.
2. India will fulfil its 50% energy requirements from renewable resources by 2030.
3. India will reduce carbon intensity by 45% by 2030.
4. India will reduce 1 billion tons of carbon dioxide emissions by 2030.
5. India will reach the target of net-zero emissions by 2070.

Technical education institutions are important for GHG emissions as there are 7000+ technical institutes in India, so their contribution to carbon emission is significant. So in this project, we have calculated the carbon footprint i.e. total greenhouse gas emissions of the IIT Jodhpur campus, and also made a plan that the institute can adopt to reduce and reach net-zero emissions.

2. Materials and Methods

In this project, the GHG protocol is used to calculate the total CO_2 emission of the IITJ campus. A survey was conducted to know the usage of LPG in faculty and staff households. Diesel usage of college-hired buses was calculated by tracing the route followed by them, and some estimations were made to estimate the taxis' diesel consumption. Respective departments provided lab fuel usage data. Mess fuel consumption data of the financial year 2019-20 was not present, so this year data was collected and scaled according to the number of students. The detailed data collection and the methodology of the GHG protocol are explained in section 3.2.

3.1 IIT Jodhpur Campus

IIT Jodhpur campus is located 24 km away from the center of Jodhpur on the National Highway 65. Also, IIT Jodhpur is known for its state-of-the-art residential campus of 852 acres of land. The campus is designed so that anyone can reach any spot within a 10-minute duration with a bicycle. Right now, the campus is in the developing phase. Berms enclose the Campus on most of the circumference to deflect sand storms and heat waves prevalent in the city of Jodhpur. Also, every building has double walls with insulation in between to maintain the inside temperature of the building. When the final phase will be completed the institute will accommodate around 15,000 people. Right now the campus has 1,600 students. The climate of Jodhpur is very harsh, sizzling, and exhausting. And the city deals with severe climatic changes. The city has a very low water level. So to accommodate the civilization of 15,000 people in the dense desert, the campus must be net-zero energy, water, and waste.

3.2 GHG Protocol

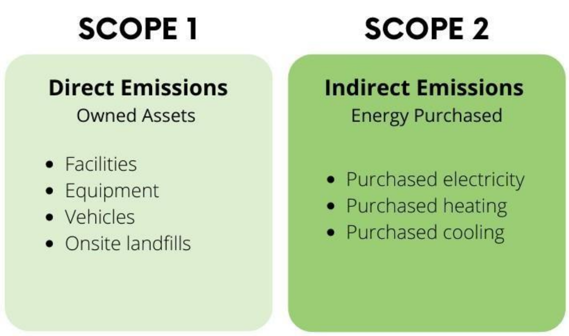
The Greenhouse Gas (GHG) Protocol of the World Resources Institute (WRI) and the World and the Business Council for Sustainable Development (WBCSD), published in 2011, gives requirements for quantifying GHG emissions within organizations under the Kyoto Protocol. This is the initiative where multiple stakeholders are involved, like businesses, NGOs, and governments. It gives the stakeholders a step-by-step guide to finding out the carbon emissions. A carbon footprint measures the emission of greenhouse gases.

The protocol is organized to account for emissions in a bottom-up method calculating emissions from each segment of the business individually. In the protocol, we define GHG emissions in two parts: direct emissions and indirect emissions.

- Direct GHG emissions come from the emissions which are owned or controlled by the organization.
- Indirect GHG emissions come from emissions that the organization does not control. These emissions are also consequences of the activities of the reporting entity.

3.3 Goal and Scope

The GHG protocol divides emissions into three categories: scope one, scope two, and scope three. Scope 1 emission is a facility's direct emissions, such as greenhouse gas emissions from fossil fuel combustion or coolant leakage from refrigerators. Scope 2 emissions are those related to purchasing power and include those involved with generating electricity from a variety of fossil fuel sources. Scope 3 emissions include all greenhouse gas emissions, including those that occur upstream and downstream in the supply chain, employee commuting, and various other categories. The amount of carbon dioxide generated from on-site natural gas heating in your building is an example of a direct emission you'd measure and report. Because the combustion of natural gas on-site provides the heat, all emissions created on-site are considered explicit and are registered under the scope-1 category.



For finding the GHG emissions, we will be following these steps:
1. We will first measure the energy consumption for each category, like the electrical consumption in kWh and liters for the LPG consumption.
2. After that, we will find the GHG emissions factor associated with each category, i.e., for example, LPG, the emission factor is 1.61 $KgCo_2$/unit. And if we get the LPG consumption as x amount, we will get the GHG emissions as 1.61x.
3. We will calculate the amount of CO_2e for each category by the consumption with the emission factor.

$$CF(tCO_2e) = \sum_{i=1}^{n} (X_i \times F_i)$$

Here X_i is the amount of energy (LPG, diesel, and electricity), and F_i is the GHG emission factor per type of energy.

3.4 Analysis

All the electricity consumption data is shown in table 1. When we analyzed the electricity data with other institutes, we noticed that the electricity consumption is much higher in our hostels than in other institutes. This may be because, in our college, each student gets a single room and in each, there are ACs installed, but for other colleges, most of them do not have ACs and if they have then most of them do not provide a single room to students. The highest electrical consumption happens in the department, which we can notice from Figure 1. This is understandable as in departments there is heavy machinery which requires a lot of energy.

It is evident from figure 2 shown below that we mostly use diesel and LPG. The use of petrol is almost negligible. The carbon emission because of Diesel is 109.3 tCO_2 which is around 28% of Scope 1 and the contribution of LPG in carbon emission is 280.8 tCO2 which is around 72% of Scope 1. LPG contribution is more as it is used in mess to make food for 1600 people.

Figure 3 shows us the distribution of the carbon emission in Scope 1 and Scope 2. Scope 1 contributes 390.17 tCO2 which is 7.04 % and scope 2 contributes 5145.16 tCO2 which is 92.96 % of total emissions. This type of distribution is a general trend among all technical institutes. In the net-zero plan, our primary focus will be on the reduction of electricity consumption and the generation of electricity from renewable sources because the contribution from electricity emissions is huge.

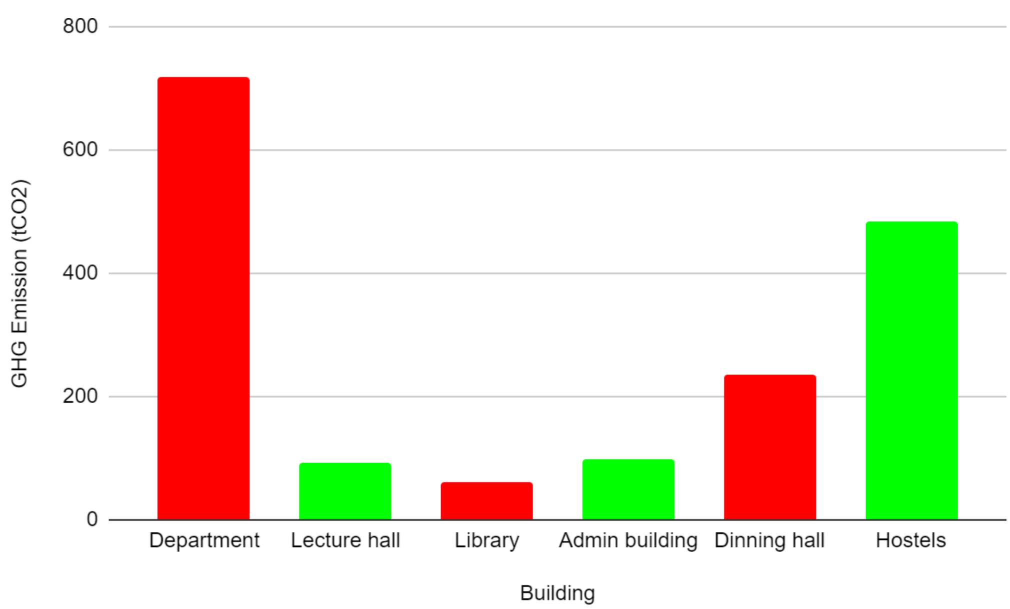
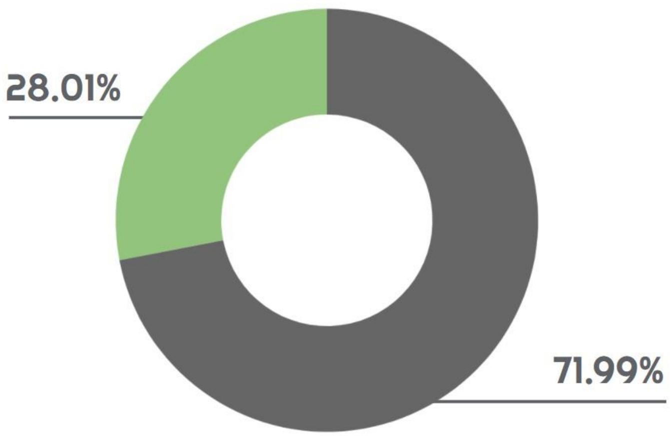


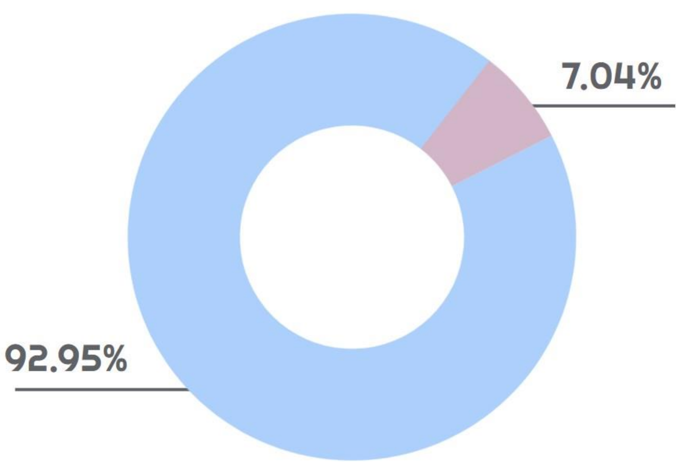
Figure 1 Section-wise energy consumption.

Distribution of Scope 1 Emissions



LPG percentage is significantly higher as it is used in mess to make food for 1600 people

Scope 1 vs Scope 2



Electricity Consumption	GHG Emission (tCO2)	Electricity Consumption	GHG Emission (tCO2)
Electricity usage of mechanical department	112.54	Electricity usage of G5 hostel	91.31
Electricity usage of the electrical department	105.79	Electricity usage of G6 hostel	88.03
Electricity usage of the chemistry department	305.32	Electricity usage of B2 hostel	88.66
Electricity usage of the basic lab building	48.86	Electricity usage of B3 hostel	4.86
Electricity usage of CSE lab building	147.28	Electricity usage of I2 hostel	6.00
Electricity use of Lecture Hall Complex.	91.69	Electricity usage of B5 hostel	7.63
Electricity usage of Library	62.64	Electricity usage of G4 hostel	0.90
Electricity use of Admin Block West	34.64	Electricity usage of Type B - 31	31.89
Electricity usage of Admin Block East	65.21	Electricity usage of Type B - 43	23.61
Electricity usage of Dining Hall	235.84	Electricity usage of Type B - 45	27.41
Electricity usage of B1 Hostel	90.84	Electricity usage of Type B - 42	22.84

Table 1. Building wise carbon emission due to electricity consumption

Sources of Emission	Total tCO2
Diesel usage in Bus	93.25
Diesel usage in cars	16.02
Mess LPG Consumption	163.60
Canteen LPG Consumption	64.46
Faculty LPG Consumption	52.73
Diesel usage in Labs	0.03
Biodiesel usage in Labs	0.02
Petrol usage in labs	0.06
	390.17

Table 2. Scope 1 Carbon emission distribution data

4. What is Net Zero?

The term "net-zero emissions" refers to attaining a balance between greenhouse gas emissions created and greenhouse gas emissions removed from the atmosphere, either naturally or using still-in-development carbon capture technologies. Because an excess of greenhouse gases in the atmosphere causes dangerous global warming, lowering the amount of these gases should aid in the fight against climate change. This can be accomplished in one of two ways:

I. By reducing the amount of pollution we emit into the atmosphere via industrial processes, electricity generation, transportation, and intensive agriculture
II. Reducing the greenhouse gas emissions from the environment, such as by trapping carbon before it is emitted during industrial operations or by planting more trees.

5. Net Zero plan for IIT Jodhpur

To achieve net-zero emissions, we can follow these three steps a) Demand Reduction b) On-site renewable energy generation.

5.1 Demand Reduction

To reduce the carbon footprint, we can reduce our energy consumption by taking important measures like using better equipment types that save energy or buying environmentally friendly products.

Following measures can be taken to reduce the energy consumption -:

I. Sometimes we can avoid air travel by having meetings virtually through zoom or google meet.
II. For the college commute purpose Institute is using Diesel cars right now, they can use electric vehicles.
III. Also while calculating the carbon footprint we noticed that the electricity consumption of hostels is huge so there is definitely some misuse of ACs by a few students. We could have better building management systems.
IV. Also, some awareness programs can be launched by the college to promote energy-efficient student and staff behavior like if someone in staff is buying a new car they could purchase a hybrid or electric vehicle.
V. There should be no vehicles allowed that cause carbon emissions for usage inside the campus. Students should only be allowed to use bicycles whereas, for faculties, some system of electric golf carts can be developed.

5.2 On-site renewable energy generation

Carbon emission because of electricity in our campus is 5145 tCO_2 which is around 88.8 percent of total carbon emission so if we use renewable energy it will reduce our carbon emission a lot. The weather is mostly sunny in Rajasthan, so the potential to generate energy with the help of sunlight is a lot here. We have 125 acres of land allotted to the institute for an energy park and from 1 acre 0.25 MW of electricity can be produced if solar panels can be installed. So around 9000 MWh(assuming 10 hours of daily sunlight) of electricity can be generated if solar panels are installed in that area. We can also use other spaces like roofs. We can also have a solar shed in car parking to have more space, as shown in Figure 4.

Figure 4.[Source Pintrest]

5.2.1 Rooftop Solar panel

Rooftop solar panels (grid-connected) are going to be installed of 1 MW capacity for admin buildings. It will be zero-export electricity generation. The solar panel will also provide insulation to the roof. Therefore It will reduce the amount of heat reaching the roof by about 38 percent.

S. No.	Building Name	Area (in sqm)
1	Chemistry Department.	1665.33
3	Lecture Hall Complex.	2594.33
4	Library Building.	1026.67
5	Administration Building (West).	982.67
6	Administration Building (East).	982.67
7	Basic Laboratory	1665.33
8	Bioscience & Bio Engineering.	1596.67
9	Material Science and Metallurgy Engineering.	1691
10	Physics Department.	1691

11	Central Workshop.	1555.5
12	Computer Centre.	1691
	Total	17142.17

The total area required to have 1MW electricity generation is 17142.17 sqm. Also, We will be using the OPEX model for solar panels. OPEX model means that the company owns the asset and the customer will just have to pay the fees. According to the plan, Institute will be paying less than 4 Rs/Kwh which is 50 percent less than the amount which we are paying right now.

5.2.2 Hybrid Wind and solar Electric systems

Wind & solar can be used for generating power called a wind-solar hybrid system. This system is designed using solar panels and small wind turbines generators for generating electricity. As it is usually seen that in winter there is more wind and less sunlight. So to have a hybrid solar-wind system will be much better.

Figure 5. Hybrid wind and solar electric system[source: The Economics Times]

Conclusion

This project assesses the carbon footprint of the IITJ campus. It is observed that electricity consumption is the biggest contributor to greenhouse emissions from the university. This is due to the high electricity needs of air-conditioning systems used for about 8 months in the year. The key issue in the evaluation is the lack of data and the time it takes to acquire it in order to calculate greenhouse gas emissions. On the other hand, this study has enhanced staff and student awareness of the possibilities for GHG emission reduction. The current study may be used as a model for Indian institutions to decrease their consumption-related consequences and build carbon management policies.

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For More Information about the Carbon Emissions Study at IIT Jodhpur Campus

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