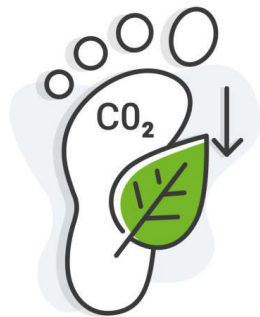# CO_2

FOOTPRINT REPORT

(Fuel, Energy, Water and Waste)

Indian Institute of Technology Madras

IIT MADRAS

The Indian Institute of Technology Madras is known both nationally and internationally for excellence in technical education, basic and applied research, innovation, entrepreneurship and industrial consultancy. A faculty of international repute, a highly motivated and brilliant student community, excellent technical and supporting staff and an effective administration have all contributed to the pre-eminent status of IIT Madras. The Institute is proud to bear the laureate of being No.1 engineering university in India. More recently, IIT Madras has been given the title of Institute of Eminence.

The Institute has sixteen academic departments and a few advanced research centers in various disciplines of engineering and pure sciences, with nearly 100 laboratories organized in a unique pattern. **IIT Madras is a residential institute with nearly 622 faculty, 12093 students and 587 administrative & supporting staff and is a self-contained campus located in a beautiful wooded land of about 250 hectares.**

INTRODUCTION

The Carbon Footprint Report of IIT Madras aims to assess and quantify the greenhouse gas (GHG) emissions arising directly and indirectly from campus operations. By focusing on Scope 1 and Scope 2 emissions, this report highlights the emissions from sources that are either owned or controlled by the institute or arise from the generation of purchased electricity. Understanding these emissions is essential for creating effective mitigation strategies that align with the institution's commitment to sustainability and climate responsibility. **The boundaries of this assessment cover the entire IIT Madras campus including academic buildings, hostels, laboratories, offices, and utility areas.**

METHODOLOGY

The methodology for calculating Scope 1 and Scope 2 emissions follows the guidelines set by the Greenhouse Gas Protocol, one of the most widely used standards for institutional carbon accounting. Scope 1 emissions include all direct emissions from combustion sources located within the boundaries of the campus, such as diesel generators, fuel use in campus vehicles, and refrigerant leakages from HVAC systems. Scope 2 emissions are the result of electricity purchased from the grid, 100% supplied by TANGEDCO.

Emission factors were sourced from the Central Electricity Authority (CEA)-India for grid electricity and IPCC values for diesel and refrigerants. Data was collected from relevant departments including the estate office, utility records, transport unit, and HVAC maintenance logs.

All emissions are reported in metric tons of carbon dioxide equivalent (tCO$_2$e), based on standard conversion factors.
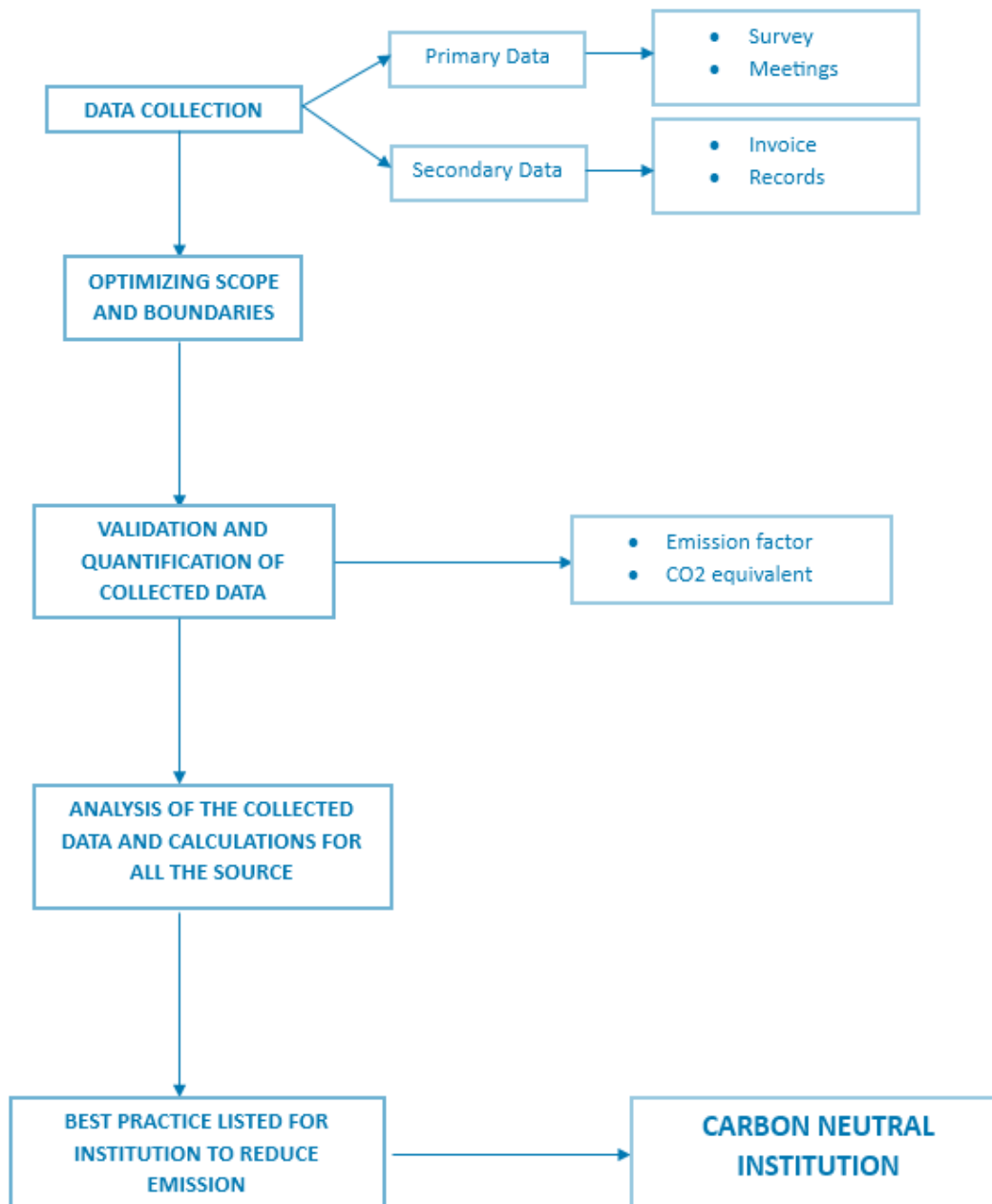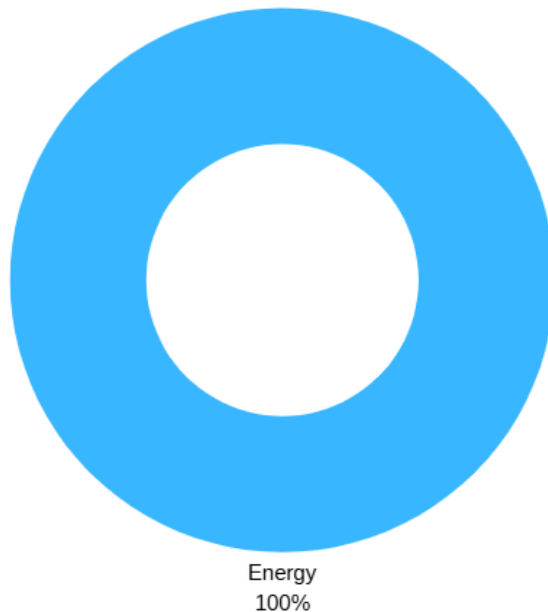
Scope 1: Direct Emissions

- Scope 1 emissions at IIT Madras originate primarily from three sources: diesel-powered generators, campus-owned vehicles, and refrigerant usage.
- Diesel generators are used during periods of power outages to ensure uninterrupted functioning of critical operations, including laboratories and data centers. These generators consume diesel fuel, resulting in the release of CO_2 and other pollutants.
- The second contributor is the fleet of vehicles operated by the institute for administrative, maintenance, and logistical purposes.
- Emissions from these vehicles vary depending on fuel type, engine efficiency, and utilization.
- The third contributor is fugitive emissions from refrigeration and air-conditioning systems.
- To quantify Scope 1 emissions, detailed fuel logs, vehicle usage records, and HVAC maintenance data were analyzed. Estimates are made using emission factors for diesel (approximately 2.68 kg CO_2 per litre) and HFCs based on refrigerant types and leak rates.

Vehicular emission
8.7%

Sequestration
5.6%

Energy (biomass)
2.6%

Natural Gas
22.9%

Refrigerant
60.2%
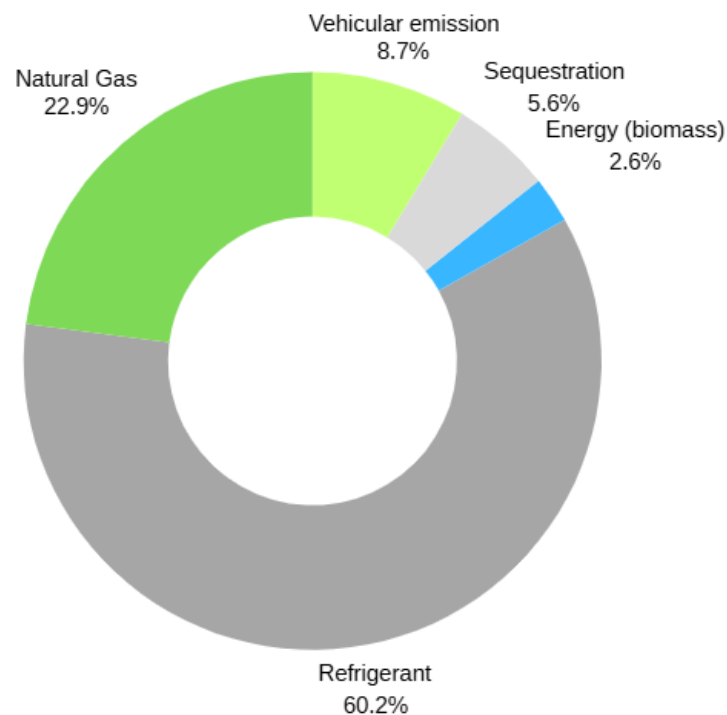
Scope 2: Indirect Emissions from Purchased Electricity

- Scope 2 emissions at IIT Madras are primarily due to the consumption of electricity purchased from the Tamil Nadu Generation and Distribution Corporation (TANGEDCO).
- This electricity is used for lighting, heating, cooling, computing, and powering laboratory equipment across the campus.
- Although the campus has made progress in adopting renewable energy sources such as rooftop solar PV systems, the majority of the power demand is still met through the state grid.
- Electricity usage data for the campus is collected monthly from the estate office and metering systems.
- The emission factor used for grid electricity (as per the CEA) is approximately 0.76 kg CO_2 per kWh (subject to annual updates).
- The total annual electricity consumption is multiplied by this factor to estimate the Scope 2 emissions.

Energy
100%

DATA COLLECTION FORMAT AND UNITS

Scope 1 – Direct Emissions

1. **Vehicle Emissions** – Data collected from fuel purchase records (liters of diesel/petrol) based on the following:
   - Buses: [Number] (Diesel)
   - Cars: [Number] (Petrol/Diesel)
2. **Natural Gas Usage** – Consumption tracked from facility management logs (cubic meters of natural gas) for cooking.
3. **Biomass Energy** – Usage monitored from supplier invoices and internal records (kilograms of biomass fuel) used for specific campus energy needs.
4. **Refrigerants** – Data obtained from HVAC maintenance logs, tracking refrigerant refills and losses (kilograms of refrigerants) used in central air-conditioning and laboratory cooling systems.

Scope 2 – Indirect Emissions

1. **Grid Electricity Consumption** – Monthly electricity usage data sourced from utility bills and campus energy monitoring systems (kilowatt-hours (kWh) for:

Campus-Related Data Collection

1. **Total Campus Area** – (Includes academic, residential, and green spaces).
2. **Number of Buildings** – (Includes hostels, academic buildings, research labs, administrative offices).
3. **Water Consumption Data** – Metered water usage recorded in kiloliters per month for drinking, sanitation, and irrigation.
4. Waste Management – Data collected on solid waste (kg/day), food waste (kg/day), and recycling efforts (kg/month).
5. Renewable Energy Generation – Solar energy data in kilowatt-hours (kWh/month) from on-campus solar panels.
6. Tree Plantation & Green Cover – Over 5,000 native trees planted, contributing to carbon sequestration (kg CO_2/year).

Data Collection Approach

- Standard emission factors applied for accurate **kg CO_2e conversion**.
- Cross-verification conducted with finance, operations, and facility management teams.

AVOIDANCE: SOLAR ENERGY

Avoidance: The campus's renewable energy contributions (like rooftop solar) are netted off while calculating the final Scope 2 emissions, providing an accurate picture of the indirect emissions associated with purchased electricity.

SOLAR ENERGY	
Capacity of Solar panel (KWp)	3,300
Overall Annual Solar Energy generation (KWh)	32,63,170.50
Avoidance in kgCO2	24,70,220.07

SUMMARY

Scope	Category	Description	Emission (Kg CO2e)
Scope 1	Vehicle Emissions	CO2 emissions from the fuel combustion in vehicles owned or operated by the company.	86,417.40
	Natural Gas	Emissions from the burning of natural gas for heating, cooking, or other direct usage within the company operations.	2,42,133.30
	Energy from Biomass	CO2 emissions resulting from the combustion of biomass for energy production in the company's facilities or operations.	23,663.06
	Refrigerant Emissions	Emissions caused by the leakage of refrigerants (used in cooling systems) that have a high global warming potential.	5,93,412.9
Total Scope 1 Emissions			**9,31,383.53**
Scope 2	Energy (Electricity)	Emissions associated with the generation of purchased electricity, steam, heating, or cooling used by the company.	4,17,61,447.29
Total Scope 1 and Scope 2 Emission			**4,26,92,830.82**

CARBON FOOTPRINT REDUCTION EFFORTS

1. EV BUS: The campus management team has procured 5 EV bus from switch brand (35+ seater) instead of diesel/ petrol operated vehicle reducing the carbon footprint

Fuel Consumption:

- **Diesel bus**: 4 liters of diesel per 10 km.
- **Petrol bus**: 5 liters of petrol per 10 km.
- **Electric bus**: 2.3 kWh per km (average energy consumption).

CO_2 Emissions:

- **Diesel:** 2.68 kg CO_2 per liter of diesel.
- **Petrol:** 2.31 kg CO_2 per liter of petrol.
- **Electric:** Average CO_2 emissions of 0.4 kg CO_2 per kWh of electricity (assuming average grid emissions).

Diesel to Electric:

From switching to EV IIT Madras has reduced 5.5 metric tons of CO_2 emission/year.

2. Carbon sequestration: IIT Madras has actively undertaken afforestation and sustainable landscaping measures, with over 5,000 native trees planted across its 611-acre campus. The carbon sequestration potential of these trees depends on species, age, and growth rate. Based on standard estimates, a mature tree sequesters an average of 22 kg CO_2 per year. Since the newly planted trees are still growing, a conservative estimate assumes 10 kg CO_2 per tree per year for the first few years.

- Number of Trees Planted **= 5,000 at varies stages of growth**
- Estimated Carbon Sequestration per Tree (kg CO_2/year) **= 10**
- Total Annual Carbon Sequestration **=** 5,000 × 10 = **50,000 kg CO_2/year (or 50 metric tons CO_2/year)**

These trees not only provide essential ecosystem services but also contribute to carbon sequestration, with an estimated annual removal of **50 metric tons of CO_2 from the atmosphere.**

ANNEXURE

Solar Energy generation calculator:

https://pvwatts.nrel.gov/pvwatts.php

Emission factors:
https://people.exeter.ac.uk/TWDavies/energy_conversion/Calculation%20of%20CO2%20emissions%20from%20fuels.ht

https://legacy.winnipeg.ca/finance/findata/matmgt/documents/2012/682-2012/682-2012_appendix_h-wstp_south_end_plant_process_selection_report/appendix%207.pdf

Emission factor for energy:

https://cea.nic.in/wpcontent/uploads/baseline/2023/01/Approved_report_emission__2021_22.pdf (Table S-1)

Emission Protocol:

https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf

Emission factor for Refrigerants:

https://www.realalternatives.eu/app/images/Tools/fgas-refrigerant-calculator.xls