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Carbon Footprint of an Educational Institution as a Technique for Sustainable Development

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Abstract
Carbon dioxide is the chief greenhouse gas that results from human activities and causes global warming and climatic change. The burning of the organic materials in fossil fuels produces energy and releases carbon dioxide and other compounds into the earth's atmosphere. Greenhouse gases can be emitted through transport, land clearance, production and consumption of food, fuels, manufactured goods, materials, wood, roads, buildings and services etc. A carbon footprint is the measure of the amount of greenhouse gases, measured in units of carbon dioxide, produced by human activities. A carbon footprint can be measured of an individual or an organization, and is typically given in tons of carbon dioxide equivalent per year. This paper deals with the study on emission of carbon dioxide from various emission inventories in an educational institution. The study has been undertaken in the college campus in order to evaluate the amount of carbon dioxide produced and to suggest the remedial measures for the reduction of emissions as a part of social commitment.

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I Introduction

A Carbon footprint is the measure of the impact of our activities on the environment, and in particular climate change. It relates to the amount of greenhouse gases (GHGs) produced in our day to day lives through burning of fossil fuels for electricity, heating and transportation, etc. It is a measurement of all GHGs we individually produce and has units of tones (or kilogram) of CO_2 equivalent.

A Carbon footprint is made of the sum of two parts: the Primary footprint and the Secondary footprint.

- The Primary footprint is a measure of our direct emissions of CO_2 from the burning of fossil fuels including domestic energy consumption and transportation. We have direct control of these emissions.
- The Secondary footprint is the measure of the indirect CO_2 emissions from the whole lifecycle of products we use- those associated with their manufacture and eventual breakdown.

A Carbon footprint is the total set of greenhouse gases caused by an organization, event, product or person through transport, land clearance, production and consumption of food, goods, materials, wood, buildings and services. In a nutshell, the more we buy, the more emissions will be caused on our behalf. The concept name of the Carbon footprint originates from Ecological footprint discussion. A Carbon footprint is a subset of the Ecological footprint and of the more comprehensive Life Cycle Assessment (LCA).

II Methodology

Determination of Carbon footprint consists of two phases such as defining the carbon foot print and quantifying the carbon foot print.

PHASE I: DEFINING THE CARBON FOOTPRINT

According to the primary resource for Carbon foot printing, the GHG protocol, there are specific boundaries that need to be drawn around each inventory. Decisions include:

- Define project location: (i) Select an educational Institution as the site for calculating Carbon footprint.
- Define project duration: Select Academic year, say (2011-'12)
- Define relevant & convenient zones for the college campus as it is a large area.

1. DEFINE GHG INVENTORY PARAMETERS

- Pick out relevant emission inventories at each site.
- Select data keepers for each emission inventory detail required.

PHASE II: QUANTIFYING THE CARBON FOOTPRINT

2. COLLECTION OF SOURCE DATA AND DETERMINATION OF DATA GAPS

- Collect emission source data from identified data keepers. This is a time consuming process.
- Assemble the collected data.

- Determine data gaps in the collected data.

3. ESTIMATE AND MODEL MISSING DATA

- If there are information gaps after uploading a database, try to fill in data by going back to source documents, making a second request of data holders, and checking for additional data sources.

4. CONDUCT QUALITY ASSURANCE PROCEDURES

- Double checking and verification of data to assure quality and accuracy of project.

5. CALCULATE GHG EMISSIONS

- Collect all relevant unit conversion factors and emissions factors for storage in the emissions inventory database.
- Convert the consumption quantities for each source to a common unit that is compatible with the emissions factors available.

6. CREATE AN INVENTORY MANAGEMENT PLAN AND SUMMARIZE RESULTS

- Use the database to report emissions data at varying levels of granularity and in various formats.
- Calculate zone wise value of Carbon footprint for the college campus.
- Determine the total Carbon footprint of the campus

7. SUGGESTION OF MEASURES TO REDUCE CARBON FOOTPRINT

- Identify the inventories contributing to high emission.
- Suggest viable measures to reduce CO_2 emissions into the atmosphere.

III Emission Inventory Survey

Feasible emission inventories are to be selected to analyze the Carbon footprint of the campus.The inventory survey is to be done for one academic year.The selected inventories are Human Factor, Transportation, Electricity, Solid Waste, Production and Consumption of Food, LPG , Natural Gas, Buildings.

Data keepers are identified and the primary details are collected. Parameter wise and zone wise details are collected. The received data are assembled and the missing gaps are recognized. Zone division is pictorially depicted

3.1.1. HUMAN FACTOR

Carbon dioxide emitted by a person per day is not negligible. It is equivalent to the emission of a car in a 5km stretch. Humans emit 26 giga tons of carbon dioxide per year while CO_2 in the atmosphere is rising by only 15 giga tones per year. Just for breathing, humans emit per person each day 1140 grams of CO_2, assuming that they eat normally and follow a mean diet of 2800kcal.

The population details of each zone include the total number of teaching faculty, non-teaching staff and students. The carbon dioxide emissions will be larger in the Zone having highest population.

3.1.2. TRANSPORTATION

Fossil fuels are used for transportation. The carbon dioxide emitted by different fuels is in different amounts. The engine of the vehicle burns fuel and creates a certain amount of CO_2, depending upon its fuel type, fuel consumption and the driving distances. One liter of petrol and diesel emits 2.3kg and 2.7kg of carbon dioxide, respectively. Travelling by car for 1000km can produce about 200-230kg of carbon dioxide into the atmosphere. If a person travels by a bus for 1000km, it can add 1075kg of CO_2 to his/her Carbon footprint. Worldwide, the fossil fuels used for transportation contribute over 13% of GHG emissions.

The transportation details for the college campus include the type of vehicle, No. of vehicles and the fuel used. The details give us the idea that the vehicles' using petrol or diesel as the fuel is more in the college premises. The carbon dioxide emitted from petrol is less compared to that of diesel. The Carbon footprint by the emission inventory transportation will be quite high. Zone-wise details of transportation to be surveyed.

3.1.3. ELECTRICITY

Electricity is one emission inventory which contributes much to the Carbon footprint of the institution. Heating of the buildings with electricity generates a certain amount of CO_2 due to the generation of electric power. On an average, electricity sources emit 1.297lbs CO_2 per kWh i.e. 0.0005883 metric tons of CO_2 per kWh. The emission factor given by eGRID 2010 version 1.1 for hydro electricity is 6.8956×10^{-4} metric tons CO_2/kwh. 50 grams of CO_2 is emitted from 1 unit of solar power.

The details of the consumption of electricity and the use of generators in different zones are surveyed. If the number of classrooms and labs are more in a zone, consumption of electricity in that zone is more.

3.1.4. SOLID WASTE

Generally, 1kg of solid waste is generated per capita per day. For high income countries, the solid waste generation is 1.1-5kg per capita per day. For middle income countries, it is 0.52-1kg and for low

income countries the value is 0.45-0.89kg/capita/day. One kilogram of solid waste can emit about 0.125kg of carbon. The details regarding the solid waste generated in each zone is collected including the waste produced in canteen and hostels.

The solid waste generated in the canteen and hostel which is taken out of the campus comes under other indirect emissions. Solid Waste emits less amount of carbon dioxide compared to other emission inventories considered.

3.1.5. FOOD PRODUCTION AND CONSUMPTION

Food is one of the consumption categories which cause the highest environmental impact on the climate. According to the study conducted by the European commission (2006), the food and drink category causes 20-30% of the various environmental impacts of total consumption. Worldwide, agriculture contributes to nearly 14% of total GHG emissions.

The Carbon footprint of an average diet is 0.75 tons CO_2-eq, without accounting for food transportation. The amount of GHGs produced by the production of food differs much from one food type to other. Meat products have a larger Carbon footprint than fruits, vegetables and grains. The Carbon footprint of an average meat eater is about 1.5 tons CO_2-eq larger than that of a vegetarian. Consumption details of different zones are collected for the carbon foot print analysis.

3.1.6. LPG AND NATURAL GAS

The consumption of one liter of LPG can release 1.5kg of carbon dioxide to the atmosphere. Also burning of wood (250kg) can add 33kg of carbon dioxide to the Carbon footprint. The consumption details of LPG and Natural Gas in canteen and hostels are surveyed.

3.1.7. BUILDINGS

Buildings emit considerable amount of carbon dioxide into the atmosphere and add to the Carbon footprint. Continuous emissions are there from buildings. The manufacturing of building materials (cement, brick, gypsum wallboard, steel, etc.) accounts for about 12% of all emissions of carbon dioxide (CO_2). 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. Buildings cause 40% of the carbon emissions. The details of the total built up area of buildings and other structures in the campus are calculated.

IV Carbon Footprint Analysis

Carbon footprint analysis can be done by suitably combining data collected with respective emission factor of the selected emission inventories. Table 4.1 represents emission factors of the selected inventories.

Table 4.1.Emission factors

Sl.no	Emission inventory	CO_2 Emitted
1	Human factor	1.14kg per person per day
2	Petrol	2.3 kg per liter
3	Diesel	2.7kg per liter
4	Hydro electricity	0.68956kg per kwh
5	Solar based electricity	0.05kg per kwh
6	Solid waste	0.125kg per kg
7	Rice	0.92kg per kg
8	Fresh vegetables	1.5kg per kg
9	Chicken	3.5kg per kg
10	Milk	0.95kg per kg
11	LPG	1.5kg per kg
12	Natural gas	0.775kg per kg

The total carbon footprint of campus is determined, zone-wise and on the whole. Values are tabulated below as shown in Table 4.2.

Table 4.2: Total CO_2 emission from a college Campus

Emission inventory	Zones					
	1	2	3	4	5	TOTAL (metric Tones)
Human factor						
Transportation						
Electricity						
Solid waste						
Food						
LPG						
Natural gas						
Buildings						
TOTAL						

Note: The entry of the values will be based on the emission inventories of various zones and the emission factor of each inventories.

V Carbon Offsetting

The following effective measures can be suggested to reduce the present carbon footprint value in the next academic year.

5.1. HUMAN FACTOR

- Avoid rampant consumerism.

5.2. TRANSPORTATION

- Use energy efficient fuels for transportation, especially in the case of college & school buses.
- Use vehicles adhering to emission norms.
- Purchase vehicles with competitive mileage & fuel efficiency.
- Encourage use of public transport facilities.
- Car pooling can be encouraged.
- Ensure proper inflation of vehicle tyres.
- Use of Bicycles can be encouraged.
- Encourage walking when it comes to short distances.
- Remove unnecessary weight from vehicles.
- Use unleaded petrol in vehicles.
- Reduce use of petroleum products.

5.3. ELECTRICITY

- Use electricity effectively.
- Use the 'OFF' switch, rather than the 'STAND BY' mode.
- Switch off fans & lights when not in use.
- Use LEDs instead of conventional light sources.
- Check for Green Tags before purchasing goods.
- Air Conditioning should be minimally used.
- Keep equipments in power save mode.
- Use solar power.
- Make use of wind energy.

5.4. SOLID WASTE

- Avoid wasting paper.
- Avoid burning of paper waste.
- Recycle waste if possible.
- Reuse resources whenever possible.
- Adopt proper waste management techniques.

5.5. PRODUCTION & CONSUMPTION OF FOOD

- Do not waste food items.
- Avoid wastage in kitchen.
- Use local and seasonal fruits & vegetables.
- Reduce use of non-vegetarian food.
- Encourage use of organic food.

5.6. LPG

- Use LPG efficiently.

5.7. NATURAL GAS

- Use of Biogas made from waste can be encouraged.
- Use Natural Gas efficiently.

5.8. BUILDINGS

- Use eco friendly construction materials with low emission co-efficient.
- Plant more trees.
- Avoid cutting down trees.

Most of these measures can be effectively adopted in all the Educational Institutions. These little steps can be giant leaps to help reduce our Carbon footprints. As an integral part of the environment & giving due respect to our social commitments we all have to work hand in hand to effectively reduce the GHG emissions in our very own ecosystem.

VI Conclusion

Analysis of the Carbon footprint is basically a fair evaluation of the Carbon dioxide potency in the region under study. This gave us an idea as to how contaminated our environment is. It also provided us with the details regarding the amount up to which the inventories affect emission levels, helping us to know how and up to what extend each of our actions effect changes in the environment. This study is a sure shot that would help us realize and look back at each of our activities, and how exactly it have changed the very world we inhabit. The scope of such a study is very much relevant in the current scenario of rising CO_2 levels in our very own ecosystem.

The Carbon footprint is to be treated seriously as a quantitative yield of the quality of our very own surroundings. Necessary activity monitoring can be followed to contribute to the wellness of the planet in our own little ways. Awareness and Commitment can go a long way in keeping our environment clean. This study was undertaken with the sole motive to identify those factors that contribute to the excessive CO_2 emission, and to suggest measures that are to be put into practice for a cleaner, greener tomorrow!

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