Carbon Footprint Analysis for Educational Institute -A Case Study

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Abstract - **The concept of carbon emission has come into wide scenario in these few years. Air quality has decreased due to various anthropogenic activities. CO_2 emissions produced from both the industrial sector, transportation sector and settlement sector choose 'Carbon Footprint' as a tool to calculate the GHGs emission to show the impact of their activities on the environment. The information of carbon footprint helps us identifying the GHG emission and identifies where the greatest level exceed the original in order to reduce the GHG emissions. Carbon footprint is usually expressed as grams of CO_2 equivalent (gCO_2eq). Therefore, 'carbon footprint' can be expressed as a basic substitute for the emission of CO_2 or any other GHG expressed as carbon dioxide equivalents. Carbon credit-based ranking of industry is available however rare such ranking is available for educational institution; hence the analysis of carbon footprint is undertaken to evaluate the carbon credit available with the institute. Generally, educational institute is fulfilled with huge area and also the amount of lush greenery available within the campus, the institute has Carbon credit available with it. The surplus Carbon credit can be traded with organizations which are in dire need to raise their production capabilities. Such a trading can enhance CDM among the educational Institutes and a pollution free atmosphere. Thus, carbon credit earned by a campus goes hand-in-hand with the analysis of different parameters affecting carbon footprint. The paper deals with the analysis of carbon footprint for educational institute, wherein the study area will be divided into different zones and factors such as consumption of purchased electricity, mobile combustion, stationary combustion, human inventories and solid waste generated within the campus are in general surveyed and how it contributes to the generation of carbon footprint.**

Index Terms - **Carbon Footprint; CDM; CO_2 equivalent; GHGs emission.**

I.INTRODUCTION

The concept of carbon credit arose from the growing awareness of the need to reduce greenhouse gas emissions to combat global warming, formalized in the Kyoto protocol. There is a broad consensus that humanity must reduce carbon emissions to mitigate global warming. It is generally accepted that carbon trading is one of the most effective market mechanisms for reducing the amount of carbon emissions. Forests are important from a climatic point of view because they allow carbon to be sequestered, forming from biomass or stored in forest products. They act as carbon sinks, contributing significantly to climate change mitigation efforts. As we must remember that credits are not the only sensible policy options for responding to climate change. Carbon footprint is a commonly used term to describe the total amount of carbon dioxide (CO_2) and other greenhouse gas (GHG) emissions for which an individual or organization is responsible. It is usually defined as the total amount of CO_2 and other GHGs emitted over the full life cycle of a product or service. It measures the total GHG emissions caused directly by a person, organization, event or product. The total GHG emissions caused directly and indirectly by an individual, organization or product is expressed as a CO_2e. A carbon footprint accounts for six Kyoto GHG emissions, namely carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydro fluorocarbons (HFCs), per fluorocarbons (PFCs) and sulfur hexafluoride (SF_6). Over the last several years, calculations of carbon footprints have gained more importance due to the fact that the environmental norms and conditions specify a particular amount of CO_2 emissions for various activities. The term "carbon footprint" is defined by the IPCC Guidelines (2006) as "a representation of the effect on climate in terms of the total amount of greenhouse gases (GHG) that are produced, measured in units of CO_2e as a result of the

activities of an organization"GHG emissions can be calculated for each source using the following formula:

$$E_S=AD_S\times EF_S$$

where the GHG emissions from a specific source (E_S) are obtained from the product between the activity data from that specific source (AD_S), which represents a quantitative measure of the source expressed in units (for example liters of petrol or kWh of electricity), and its respective GHG emission factor (EF_S), which is a coefficient that allows activity data to be converted into GHG emission. Once the total GHG emissions from all sources have been calculated, they are added up to quantify the total CF in units of carbon dioxide equivalent (CO_2e). This is a common unit for describing GHG emissions, for any quantity and type of GHG it signifies the amount of CO_2, which would have the equivalent global warming impact. Today, the term "carbon footprint" is often used as shorthand for the amount of carbon (usually in tons) is being emitted by an activity or organization. Carbon emissions from burning fossil fuel accumulated to absorb these emissions. Therefore, when the carbon footprint is reported within the context of the total Ecological Footprint, the tones of carbon dioxide emissions are expressed as the amount of productive land area required to sequester those carbon dioxide emissions. This tells us how much bio capacity is necessary to neutralize the emissions from burning fossil fuels. Measuring the carbon footprint in land area does not imply that carbon sequestration is the sole solution to the carbon dilemma. It just shows how much bio capacity is needed to take care of our untreated carbon waste and avoid a carbon build-up in the atmosphere. Measuring it in this way enables us to address the climate change challenge in a holistic way that does not simply shift the burden from one natural system to another. Climate change, deforestation, overgrazing, fisheries collapse, food insecurity, and the rapid extinction of species are all part of a single, over-arching problem: Humanity is simply demanding more from the Earth than it can provide. By focusing on the single issue, we can address all of its symptoms, rather than solving one problem at the cost of another. Also, it makes the self-interest to act far more obvious The carbon Footprint is currently 60 percent of humanity's overall Ecological Footprint and its most rapidly growing component.

II.OVERVIEW OF LITERATURE

A. CO2 Equivalent (CO2e)

It is used as a metric measure used to compare the emissions from various GHGs based upon their global warming potential (GWP). CO_2 is taken as a reference for calculation of overall emissions because almost all of the materials contain the basic element as carbon, which on oxidation produces CO_2; and it is also the most prevalent GHG present in the atmosphere. Although CO_2 and CO_2e are interrelated, they are distinct measures for calculating the global emissions. The carbon dioxide equivalent for a gas is derived by multiplying the Tones of the gas by the associated GWP

$kgCO_2e$ = (Amount of a gas in kg) * (GWP of the gas)

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B. Understanding University's Carbon Footprint

For all building products and materials used throughout a campus, carbon is released in two stages: the embodied carbon stage and the operational carbon stage. The most commonly referenced, operational carbon, is defined as the greenhouse gases emitted during the use of a building. On the other hand, embodied carbon is the carbon footprint of a material and considers all greenhouse gases emitted during the creation of a product, including raw material extraction and manufacturing. The building and construction sector is responsible for nearly 40% of global greenhouse gas emissions related to energy use. And embodied carbon will be responsible for almost half of total new construction emissions. While it is critical for higher education stakeholders to decrease both emission types, many facilities have already taken steps to lower their operational carbon, so reducing embodied carbon is the most urgent opportunity. In fact, studies have found that many public institutions' embodied carbon emissions from purchased goods exceed their total operational emissions.

III.ETHODOLOGY

A. Carbon footprint Analysis

The GHG accounting and reporting approach was undertaken in this study follows the guidance and principles set out in the "greenhouse gas corporate accounting and reporting standards" (hereafter referred to as the GHG Protocol) developed by the Greenhouse Gas Protocol Initiative. This is the most widely used and accepted methodology for conducting corporate carbon footprints. The GHG Protocol requires emissions to be reported against the three different "scopes" described in table I.

Outside scope: Some activities fall outside these three scopes. An example is the combustion of biodiesel or other biomass-based fuels. GHG emissions associated with these activities are not derived from fossil sources and so are not adding to the net carbon dioxide load in the atmosphere. Emissions from burning biomass have been reported separately.

TABLE I. SCOPES OF GHG EMISSIONS

Scopes of emission		
Scope 1-(Direct Emission)	*Scope 2- (Energy indirect emissions)*	*Scope 3-(Other indirect emissions)*
Emissions from facilities within its organizational boundaries	Emissions from the imported electricity, heat or steam consumed by the organization	Emissions from commuting and business travel, transportation of materials, people or waste; waste generated by the organization but managed by another organization; production and distribution of energy products, other than electricity, steam and heat, consumed by the organization; purchased raw or primary materials

TABLE II. CARBON EMISSION FROM VARIOUS ACTIVITY SUBSET

GHG Accounting Activity	*Activity Subset*	*Units*
Purchased Electricity	Units of electricity used	KWh / yr
Employee Commuting	Teaching and Non-Teaching Staff, Labours on daily basis	Persons
Students Commuting	No. of students in premises	Persons
Mobile Combustion	Two wheeler and four wheeler used by students and faculty, carriage vehicles on daily basis	No. of vehicles
Stationary Combustion	LPG, solid waste generation	No. of Units

B. Calculation for Typical Educational Institution

The total amount of CO_2 estimated by accounting the electricity purchased, electricity generated by diesel generator, LPG consumption, food wasted and transportations.

Electricity, transportation, and waste generation have been chosen as target research elements as they are highly carbon-intensive and mainly contribute to GHG emissions. CF assessment of direct emissions from transportation activities indirect emissions from electricity usage for various daily operations within the campus and other GHGs emissions from solid waste generation and management activities. The primary and secondary data were acquired through many approaches. Field and questionnaire surveys were carried out to collect firsthand information. Questionnaires were filled up through mini interviews from students, faculty members, administrative employees, drivers, canteen owners, and guards, etc. throughout the campus. The secondary data was acquired from research journals, published reports, and documents from relevant sources. Total CO_2 emissions from transportation include the emission from private vehicles used by the faculty and students in the university area. The data relating to fuel consumption through transportation was gathered through monitoring the daily commute activity. Each car, bus, rickshaw, bike, or any other transport means entering the campus were monitored and data was recorded for a period of one month. A questionnaires survey was also conducted for estimations of the Number of vehicles (private and university's), total distance traveled, and type of fuel used. interviews were also conducted throughout the campus, The students who use bikes and the private car and rickshaw drivers were interviewed to calculate the distance traveled in the university. Carbon emissions were calculated from these transportation sources based on the fuel used. Calculation of the total CF was carried out by identifying the type of fuel used by transportation and then multiplying the emission factor for each type of fuel. Emissions from electricity are considered indirect emissions. Electricity supports the buildings used for learning and research activities, facility cooling and heating operations, and student support activities like communication and printing etc. Emission factors for producing and consuming electricity have schemed following the particular country's energy mix . Thermal and coal-based electricity generation leads to high GHG emission levels. Total carbon emissions for the consumption of electricity for a year were obtained by multiplying the

total KWh used in one year to a factor of 0.932 Kg CO_2/ kWh. To estimate the quantity and composition of solid waste generated in the campus a preliminary field study was conducted. The samples were collected from the final disposal sit. This sampling identified different components of waste being produced from four main sources 1) Teachers and staff residential area, 2) Boys and girls' hostels, 3) Academic and administrative Departments, and 4) Canteens. This study labeled waste into 16 different waste categories as Styrofoam, shopping bags, wrappers, plastics, papers, cardboard, metals, food waste, yard waste, leather, textile, glass, concrete, rubber, soil, and wood. CO_2 emissions from waste generation are estimated by totting up the carbon emissions from disposal and transportation of waste. The inventory analysis of the activities under scope 1 was done through record sheets of the transport services division and estate management unit. Inventory analysis of scope 2 was performed for purchased electricity using the service provider purchase bills. The amount of carbon dioxide emitted is calculated by using the conversion factors:

TABLE III. CARBON EMISSION FACTORS

Conversion factors	
Materials	*Kg of CO_2 emitted /unit consumption*
Grid Electricity	0.932/ kWh
Diesel	2.68/ltr
LPG	1.665/ltr
Petrol	2.31/ltr

IV.DISCUSSION

The assessment was made by accounting the data from the electricity department, administration department and some measured data and then the calculations were made by using conversion parameters. Impacts are quantified on the basis of ISO 14064 standard using integrated life cycle analysis. It is observed that the energy consumed in the facilities of the university campus is the biggest contributor to the greenhouse gas emissions from the university. This is due to high energy needs of air-conditioning systems used for about eight months in a year. Commuting and business travel are found as major contributors in scope 3, which is due to the no connectivity of campus by rail or air. The second largest emissions in scope 3 are by engineering services/workshop of the institute because the institute related engineering work; mostly using metals, wood, polishing, including practical labs; are carried out by the workshop. The institute in an effort to reduce the commuting has started teleconferencing facilities among all the four campuses. The main problem in the assessment is found to be the availability of data and collecting the available data to determine the greenhouse gas emissions. However, this study has raised the level of awareness among faculty and students for possible reduction potential of GHG emissions. The present study can serve as an example for Indian universities to reduce their impacts due to consumption. Educational institute is fulfilled with huge area and also the amount of lush greenery available within the campus, the institute has Carbon credit available with it. The surplus Carbon credit can be traded with organizations which are in dire need to raise their production capabilities. Such a trading can enhance CDM among the educational Institutes and a pollution free atmosphere and they can also develop their carbon management plans.

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REFERENCE

[1] Trends in global CO_2 emissions, A report-PBL Netherlands Environmental Assessment Agency. 2014.
[2] Kyoto Protocol to The United Nations Framework Convention on Climate Change: http://unfccc.int /resource/docs/convkp/kpeng.
[3] C. Nagarajan, P. Sai Adithya, R. Jayalakshmi, Corporate Ecological Footprint (CEF) of SRM University towards Sustainability, International Conference on Environmental Science and Development. IPCBEE 4 (2011) 53-55.
[4] ISSN College of Engineering, Tamilnadu: http://www.ssn.edu.in/.
[5] The Green House Gas Protocol, A Corporate Accounting and Reporting Standard: http://www. ghgprotocol.org/stadards/corporae- stamdard/.

[6] Carbonfootprint:http://www.carbontrust.com/resources/guides/carbon-footprinting-and reporting / carbon foot printing.
[7] CO_2Sequestration:http://en.wikipedia.org/wiki/Albizia_saman#CO_2_ Sequestration.
[8] Ambreen Aslam, Assessment of Carbon Rating in Kinnaird College of Women Lahore, International Journal of Environment Science.3(5) (2013) 1587-1602.
[9] A. Garg, S. Bhattacharya, P.R. Shukla, V.K. Dadhwal, Regional and Sectorial Assessment of Green House Gas Emission in India, Atmospheric Environment. 35(15) (2001) 2679-2695.
[10] C. Suwanmontri, C. Kositanont, N. Panich, Carbon Dioxide Absorption of Common trees in Chulalongkorn University. Modern Applied Science. 7(3) (2013) 1-7.
[11] Baboulet.O., Lenzen.M.: Evaluating the environmental performance of a university. Vol.18. Journal of Cleaner Production, (2010) 1134– 1141
[12] Bastianoni. S., Pulselli. F. M., Tiezz. E.: The problem of assigning responsibility for greenhouse gas emissions, Vol.4. Ecological Economics, (2004) 253–257
[13] Bull. J.G., Kozak. R.A.: Comparative life cycle assessments: the case of paper and digital media. Vol.45. Environ. Impact Assess. Rev, (2014) 10–18
[14] Burgess. B., Lai. J.: Ecological Footprint Analysis and Review. Kwantlen University College.