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Carbon Credits for Common Man

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***Abstract*— Environmental imbalances are the biggest challenges that the world is currently subjected to. There is an immense need for the creation of Eco-friendly zones for the better cause of the mankind and wellbeing of one and all on our "One Earth". The need of the hour is to throw light on the social awareness concept with regard to the prevention of the environment degradation. The "Carbon Credit" is the new currency and each carbon credit represents one ton of Carbon dioxide either removed from the atmosphere or saved from being emitted. Carbon credits have been a topic in the high society and industrial community these days, but it is equally applicable to a common man who can get credits due to his altered life styles and his practices. According to "Patrick Gonzalez", a Nature Conservancy climate scientist each, person can make a difference because one small positive act multiplied millions of times produces immense benefits. In this paper it is discussed and highlighted how a common man can earn Carbon credits with minimum effort. The study examines the life styles of citizens in selected communities along with the domestic energy audit in Indian context.**

Keywords*— *Climate change, Carbon footprint, Carbon offsets, Carbon credits, Emissions, Greenbelt, Greenhouse gases (GHGs), Sequestration, Sustainability

INTRODUCTION

The growth of population is a major factor behind climate change today. Human-caused climate change is fundamentally an imbalance of scale, as people release heat-trapping gases called green house gases (GHGs) into earth's atmosphere faster than the oceans and living beings can sequester them. This imbalance is due to the combustion of fossil fuels since the late 1700s and the more than sevenfold increase in human numbers since that time. According to the latest on-site measurements by the Scripps Institute of Oceanography, global atmospheric Carbon dioxide (CO_2) concentrations reached 409.65 parts per million (ppm) in May 2017 from 280 ppm from pre-industrial times. The upper safety limit for atmospheric CO_2 is 350 ppm. Atmospheric CO_2 levels have stayed higher than 350 ppm since early 1988[4].

A "carbon credit" is a generic term for any tradable certificate or permit representing the right to emit one ton of carbon dioxide or the mass of another greenhouse gas with a Carbon dioxide equivalent (tCO_2e) to one ton of carbon dioxide [5]. The idea for carbon credits came from the Kyoto Protocol of 1997 an international agreement between 169 countries. This is placing a monetary value on the cost of polluting the air. A credit is a measure representing one metric ton (a mass equal to 1,000 kilograms) of carbon dioxide. This is either saved from being emitted or removed from the earth's atmosphere. Carbon credits create a market for reducing greenhouse gas emissions by giving a monetary value to the cost of polluting the air. Carbon credits and Carbon markets are a component of national and international attempts to mitigate the growth in concentrations of GHGs. Credits are awarded to countries or groups that have reduced their GHGs below their emission quota.

Carbon credits can be traded at international market at their current market price. These credits need to be authentic, scientifically based and verification is essential. For example, if an environmentalist group plants enough trees to reduce emissions by one ton, the group will be awarded a credit. If a steel producer has an emissions quota of 10 tons, but is expecting to produce 11 tons, it could purchase this carbon credit from the environmental group. The Carbon credit system looks to reduce emissions by having countries honor their emission quotas and offer incentives for being below them.

Another important factor is that most of the individuals who are unconcerned about their contribution to the GHG emissions are leading to the harmful climatic changes. Yet, there are many things each of population, as individuals, can do to reduce one's carbon emissions. The choices that are made in the houses, in the itinerary, the food and the left outs after the parties all influence one's Carbon footprint and if stringent measures are taken up and implemented strictly can ensure a stable climate for future generations. Non-govt. organizations (NGOs) can make this dream true. There is now widespread political and scientific acknowledgment that reduction of GHG emissions has to be a major public policy focus at both national and international levels [6].

I. ENERGY SCENARIO

The world economy needs ever-increasing amounts of energy to sustain economic growth, raising living standards, and reduce poverty. But today's trends in energy use are not sustainable. As the world's population grows and economies become more industrialized, non-renewable energy sources will become scarcer and more costly [8]. Energy consumption is loosely correlated with gross national product and climate, but there is a large difference even between the most highly developed countries, such as Japan and Germany with an energy consumption rate of 6 kW per person and the United States with an energy consumption rate of 11.4 kW per person. In developing countries, particularly those that are sub-tropical or tropical such as India, the per person energy use rate is closer to 0.7 kW. Bangladesh has the lowest consumption rate with 0.2 kW per person. The US consumes 25% of the world's energy with a share of global GDP at 22% and a share of the world population at 4.59%. [20].

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Studies show that a person spends nearly 90% of his time indoor, thus building proves as the main locus of human activities and is responsible for climate change. The main source of GHG emissions from buildings is energy consumption [1]. A person's everyday actions consumes energy and emits CO_2 and other GHGs e.g. taking holiday flights, driving cars, cooking food, heating, cooling and ventilating the homes and offices. Carbon Offsets can be used to compensate for the emissions produced by funding an equivalent Carbon dioxide saving somewhere else.

II. METHODOLOGY

Carbon credits can be created in many ways but there are two broad types:

1. Sequestration (capturing or retaining carbon dioxide from the atmosphere) such as afforestation and reforestation activities.
2. Carbon Dioxide Saving Projects such as use of renewable energies.

Determination of Carbon credits is nothing but determination of carbon footprint in various activities. This consists of two phases such as defining the carbon footprint and quantifying the same.

Phase I: Defining the Carbon footprint:

According to GHG protocol boundaries are selected for the each inventory for calculating carbon footprint.

- Study area: "Kakinada" a major coastal town in state of Andhra Pradesh, India.
- Duration of study: One year i.e. 2012-13
- Selecting relevant emission inventories for each activity.

Phase II: Quantifying the Carbon footprint consists:

- Collection of emission source data from the identified activities.
- Assembling the collected data and determining the data gaps.
- Double checking and verification of data to assure quality and accuracy of the work.
- Collection of all relevant unit conversion factors emission factors in the emission inventory data base.
- Converting the consumption quantities for each source to a common unit that is compatible with the emission factors available.
- Creating "inventory management plan" to summarize the result.
- Identifying the inventories contributing high emissions. Suggest viable measures to reduce carbon footprint and acquiring carbon credits.

A. Energy in construction and maintenance of buildings

The built-environment is responsible for the single largest share of resource and energy consumption and demand [3]. According to World watch institute, each year 3 billion tons of raw materials are used for construction. Building accounts for 50% of the global output of carbon dioxide. It has been estimated that 30% of GHG emissions are contributed by the construction sector in India [6]. Buildings do not have energy efficiency standards, despite the tremendous impact on environment. Today commercial and residential buildings account for about one third of the world's final energy consumption. But most people give little thought to their contribution to increased levels energy consumption. The use of alternative building units like hollow concrete blocks for masonry construction reduces the energy consumption by 60% as compared to brick masonry. The composite beam-panel roof is 13% energy efficient as compared to the RC roof. A 50% and 25% energy saving may be achieved in roofs made of Ferro-cement channel units and brick-vaults as relative to RC roofs and thus are the most energy efficient choices amongst the various alternatives considered[22]. Careful citing can make buildings perform better from both environmental and human perspectives. Proximity to transportation reduces pollution and improves occupants' quality of life.

B. Domestic travelling-Transportation

Transport is essential for social and economic activities. According to the report of the International Transport forums research findings, transport is responsible for 13% of all anthropogenic emissions of the greenhouse gases and 23% of world CO_2 emissions from fossil fuel combustion. These emissions are set to double over the next 40 years. Road transport accounts for the largest part of CO_2 emission from the transport sector.

Public transportation reduces overall greenhouse gas emissions without reducing the mobility so vital to the nation's economic health and its citizens' quality of life. Public transportation reduces energy consumption by the equivalent of 4.2 billion gallons of gasoline each year [10]. According to U.S. Census data, 46% of American households do not have access to any public transportation. Public transportation must expand geographically to capture shifts in population, both within regions and across the country [11].

Motor bikes, cars and trucks run on fossil fuels, release Carbon dioxide into the atmosphere. It is always desirable to travel less and if it has to travel more distance; better performing it Carbon footprint friendly. For shorter distances one can walk, or at the most can use a bicycle. For every kilometre travel by walk or bike we can save 300g of carbon. Use of public transportation instead of using a private vehicle;
joining a car-pool; driving a smaller, more efficient vehicle at reduced speeds, will reduce a lot of carbon emission. One should drive less and make lesser trips. Use of telecommunications - telephone, fax or telex, instead of going places in person, video conferences, employers by allowing their personnel working from home one day in a week,

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Table 1.1 Inventory of Domestic transportation:

(A) Activity	(B) Distance to and fro km/trip	(C) Mode of transport	(D) No. of trips/year	(E) Fuel type	(F) Fuel efficiency km/l	(G) Kg CO_2 released/l fuel	(H) No of Occupants	(I) Emission per year kg CO_2=[(B)X (D)X(G)]/[(F)X (H)]	(J) Normal frequency
School									
	6	Motor bike	250	Petrol	55	2.36	1	64.36	Daily
	6	School bus	250	Diesel	4	2.77	40	25.97	Daily
Office									
	10	Bike	300	petrol	55	2.36	1	128.73	Twice Daily
	10	Car	300	petrol	15	2.36	1	472.00	Twice Daily
	10	car pool	300	petrol	15	2.36	5	94.40	Twice Daily
	1	By walk	300	NA	NA	NA	1	0.00	Twice Daily
Vegetable market									
	4	Motor bike	144	petrol	55	2.36	1	24.72	Thrice weekly
	4	Motor bike	48	petrol	55	2.36	1	8.24	Once weekly
Shopping (Grocery)									
	10	Bike	48	Petrol	55	2.36	1	20.60	Once weekly
	10	Bike	12	Petrol	55	2.36	1	5.15	Once monthly
	10	Share Auto	48	Petrol	20	2.36	5	11.33	Once weekly
	10	Share Auto	12	Petrol	20	2.36	5	2.83	Once monthly
	10	Share Auto	48	Diesel	20	2.77	5	13.30	Once weekly
	10	Share Auto	12	Diesel	20	2.77	5	3.32	Once monthly

reduces a lot of travels and carbon emissions.

Airplanes pump Carbon emissions high into the atmosphere, producing 12 percent of transportation sector emissions. Active operation accounts for 65–74% of on road, 24–39% of rail and 69–79% of air travel life-cycle energy, per passenger-kilometre-travelled (PKT) [2]. According to the report of the International Transport forums research findings
transport is responsible for 13% of all anthropogenic emissions of the green house gases and 23% of world CO_2 emissions from fossil fuel combustion.

In the present case study Carbon foot print of domestic transportation of a family of four members is considered. According to Indian conditions, a middle income group person rely on his motorbike mostly to drop his children at school, to go to office, fetching vegetables, grocery etc,. burning one litre of Petrol releases 2.36 kg of CO2 and Diesel gives off 2.77kg (under the 'perfect' fuel/air mixture) [16].Fuel efficiency of vehicles is taken from the survey results by averaging the fuel efficiencies of vehicles under local conditions .

• Instead of dropping children at school which is at a distance of 3km by the bike if he opts for school bus he can save a carbon of 38.4kg per year assuming school work for10 months. Ref. Table 1.1

• Similarly if this person is residing at a distance of 2.5 km from his office making two trips on his motor bike for lunch break and back to home he performs 10km journey per day. Instead if he stays near the office which is about 400m away from his office he can go by walk. In this case he can save a carbon of 128.73 kg per year. Similarly a person comes to office as single occupant in the car, if he opt for car-pool the carbon saving per year is 377.6kg. Ref. Table 1

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• Fetching vegetables once in a week instead of three times a week which is at a distance of 2km from his residence can save a carbon of 16.48kg per year. Person shopping at a distance of 5km, 4 times in a month can save 15.45kg of carbon per year if he performs once in a month. The same person if he opt for "share Auto-rickshaw" run by petrol instead of going on his bike he can save 17.77kg carbon per year. Ref. Table 1.1

C Energy utilization at homes

Globally, the general breakup of energy consumption in buildings is 16:84 the former being the percentage attributed to manufacturing, construction, material transport and maintenance (including renovation) of a building, while the latter includes the energy share attributed to appliances and space conditioning and operation [19]. On an average, electricity sources emit 850g of CO_2 per kWh given by eGRID (India) 2010 version 1.1 and 50g of CO_2 is emitted from 1 unit of solar power. Approximately 30% of energy used in buildings is used inefficiently or unnecessarily. In India, the effective household energy consumption (and consequent CO_2 emission) per capita (between 1990–2003) was found to have increased by a factor of 1.4 in urban areas and 1.2 in rural areas [16].Electric power consumption in India in 1971 was 97.78 kWh per capita and in 2011 it was 684.10[19].One has to keep an eye on energy-use habits. One should turn off the lights, TVs, Geysers, Computers etc., when not in use. Only 10% of energy in an incandescent bulb is used to create light. Remaining 90% energy creates heat.

Compact fluorescents (CFLs) are a simple replacement of standard incandescent. A 15W compact fluorescent bulb gives as much light as 60W and they consume only 1/4 the energy and last about 10 times as long as standard incandescent lights. It saves 50kg of carbon for each incandescent bulb that replaced with a compact fluorescent, over the life of the bulb. In the case study by the authors in a suburban habitation every household are using at least two incandescent bulbs of one is 60W and the other is 40W.The carbon footprint of these two bulbs is 124kg per annual. If these two bulbs are replaced by 8W CFL bulbs this house can save a carbon footprint of 100kg annual. A one hour viewing of primary T.V releases approximately 90g of CO_2. Shutting down the computer and flat screen both during lunch break and after working hours will cut CO_2 emissions generated by these appliances by one third. Heating and air conditioning draw more than half of the energy that a home uses in cold countries. Turning down the heat or air conditioning while leaving the house, a programmable thermostat can easily be installed that can save up money and carbon.

To lower one's carbon footprint from water usage, one can do things like wash the car less often, recycling grey water produced in the house. Investing in water saving shower head will not only save 10 litres of water per minute, but will also slash CO_2 emissions resulting from a 3 minute hot shower by half. One can use climate-appropriate plants in the yard those don't need much water beyond the amount of rainfall occurs in the area. We can install drip irrigation to ensure our plants receive only what they need.

Waking up with a traditional windup alarm rather than beep of an electric one saves about 50g of CO_2 every day. Use of steps instead of opting for elevators reduces energy consumption. Replacing a 45 minute workout on a treadmill by jogging in a nearby park saves nearly 1 kg of CO_2.

Turning down the central heating slightly (try just 1 to 2 degrees C) will save considerable amount of Carbon. One should also remember that there is no point of heating the house after the left for work. Turning down the water heating setting (just 2 degrees will make a significant saving). Solar air heaters prevent 1.39 tons of carbon emissions generated by fossil fuels. Extra sweater or blankets damage less than room heating.

Filling dish washer and washing machine with a full load - this will save water, electricity, and washing powder. Choosing sun dried cloths versus a dryer saves off- a daily carbon diet of 2.3 kg of CO_2.

Replacing old fridge / freezer (if it is over 15 years old), with a new one with energy efficiency rating of "A", replacing old boiler with a new energy efficient condensing boiler reduce footprint. Heating bread rolls in a toaster versus an oven for15minutes saves nearly 170g of CO_2. Insisting on solar cooking system instead of Liquid Gas Burner and obtain tastier and healthy food while reducing Carbon footprint. Filling the kettle with only as much water as needed is considered for reducing energy usage.

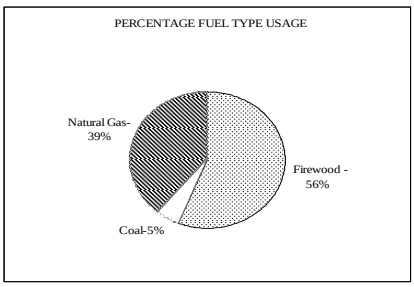
D. Kitchen

The most energy intensive part of the food chain is kitchen. Much more energy is used to refrigerate and prepare food in the home than is used to produce in the first place.

Eating lower on a food chain reduces environmental damage. Consumption of meat should be reduced. Grain based diets are more resource efficient than Carnivorous diet. Human muscles, teeth and very long digestion tract are designed for vegetarian food only.

In another case study of the suburban village, about 56% population still uses fuel wood in their kitchen (ref fig 1.1).

Fig 1.1Percentage of type fuel usage



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Fuels being used for cooking purpose are: From the Fig 1.1

a. Firewood: 56%
b. Coal: 05%
c. Gas: 39%

It is estimated that a family of five members need about 300 kg of firewood per month for the preparation of food and hot water. At the same time these families also has access for subsidized LPG (Liquefied petroleum Gas) from the government. It creates 1.63 kg of CO_2 by burning 1kg of firewood [17]. So CO_2 released from the kitchen of average family using firewood is 5.868t per year. Instead of using firewood if the family uses LPG a cylinder containing14.2 kg of gas per month meets all the demands of the same kitchen. $CO_{2\ released}$ by burning 1 kg of LPG is 3kg [18] hence it becomes 42.6kg of CO_2 emission per month. So if the family opts for LPG gas instead of firewood they can save CO_2 of 5.357 ton per year.

E. Shopping habits

As well as primary Carbon footprint, there is also a secondary footprint that citizens cause through their buying habits. The food bought from supermarket, may travel in a plane from the other side of the world, burning fossil fuels for the entire trip. One has to act globally, eat locally. Shopping at local farmer markets we will find fresh and healthy food, and help save our climate by reducing carbon footprint.

Products made from recycled paper, glass, metal and plastic reduce carbon emissions because they use less energy to manufacture than products made from completely new materials. For instance, one can save one kg of carbon for every 20 glass bottles that he recycles.

Recycling paper also saves trees and lets them continue to reduce climate change naturally as they remain in the forest, where they remove carbon from the atmosphere. Buying the locally made, long lasting materials rather than momentary fads and styles reduce size of footprint. For example it is not desirable to buy plastic chairs and other plastic items. Durability costs less than obsolescence.

It is also equal important if one avoid bottled water if the tap water is safe to drink; and avoiding the use of bottled water unless absolutely necessary. Drinking from reusable metal or glass containers filled with tap water when travelling is also necessary. The Pacific Institute estimates that production of bottled water for U.S. consumption in 2006 released over 2.5 million tons of carbon dioxide (Excluding transportation). The total amount of energy embedded in the use of bottled water is the equivalent of filling a plastic bottle one quarter full of oil. The overall Carbon footprint for the European 1.5 litre bottle format was estimated at 163 grams of CO_2 per 1.5 litre bottle. The overall carbon footprint for the North American 500 millilitre bottle was estimated at 83 grams of CO_2 per 500 millilitre bottle [13].

Buying products made close to home can be welcomed. It is like keeping healthy environment if we buy local fruit and vegetables, or even try growing our own. The studies say that it is better to buy foods that are in season locally. It is not recommended to buy fresh fruit and vegetables which are out of season; they may have been flown in. Buying organic produce is the need of the hour. It is always safe to avoid buying over packaged products.

It is to note that 20 huge trees or 250 Eucalyptus trees or 500 Bamboo plants will be cut to produce 1 ton of paper. It is to encourage use of recycled paper. Use of both sides of paper, old calendars for rough work, and Greeting Cards as Visiting Cards.

G. Solid waste

Burning of solid waste release CO_2 and indiscriminate disposal and decay of solid waste emits Methane (CH_4). Methane has 21 times global warming potential than CO_2 in 100 years life span. There has been a significant increase in solid waste generation in India in the last few decades because for rapid population growth and economic development in the country. The per capita solid waste generation daily, in India ranges from about 100g in small towns to 500 g in large towns [24].The average collection efficiency for solid waste for Indian cities is about 72.5% and around 70% of the cities is due to lack of adequate waste transport facilities (TERI 1998).There is land use change due to dumping of waste and also Methane emissions. This landfill gas which is 50% to 60% Methane contributes significantly global warming [24].In house-hold solid waste management by individuals save a considerable amount of Carbon footprint.

H. Agriculture:

Agriculture is the priority sector in India. In China 80% and in India and 50% of the ammonia production is based on other fossil fuels such as oil and coal [21]. Agricultural machinery, tractors per 100 sq. km of arable land is increased from 1.99 in 1961 to 128.5 in the year 2000 which operate on fuel diesel. The average per hectare fertilizer use in India has increased from 100.64kg in 2002 to 178.52 kg in 2010 per hector, while the increase in cultivable agricultural land is 2.8% in between 1961 to 2011 [19]. The Carbon footprint kg Carbon per kg Urea varies from 3.49 in Europe to 7.41 in China and India while the world average is 5.0 [21]. The average per hectare fertilizer use in terms of NPK in coastal districts increased from 47 kg in 1980-81 to 115 kg in 92-93 to 155 kg per hector in 2000-2001[25]. Instead of disposing the solid waste in the village indiscriminately, preparation of vermin-compost reduces the use of synthetic fertilizers in turn reduce the carbon footprint.

H. Energy plantation and Greenbelts for Carbon credits

Trees absorb carbon dioxide from the air and use it as their energy source, producing oxygen for us to breathe. A tree in the temperate zone found between the tropics and the polar circles can remove and store 300 to 3,000 kg of carbon over its lifetime. A tree that shades a house can reduce the energy required to run the air conditioner and save an additional 100 to 1,000 kg of carbon over its lifetime.

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Green belt is rural land around the cities that is protected from excessive housing and other development thus preventing urban sprawl. The main function of Green belt was to limit urban sprawl, evacuate centralized urban population and improve ecological environment. They improve urban ecological conditions such as purifying atmospheric environment, regulating local micro climate, protecting water resources, restoring and generate ecosystem and increasing urban bio diversity.

If an area of 1km x 1km wasteland is developed by a community for energy plantation at 10m spacing,100x100 i.e. 10000 plants ,after 5years the yield wood would be 1 ton each i.e. 10000 ton of carbon (wood)=>10000x44/12 i.e., 370,000 ton of CO_2 ($C+ O_2 \rightarrow CO_2$).That equals to 36667 carbon credits [23]. Suppose if one carbon credit is 12 US dollars in international market, then credit got per year is 440000 US dollars from this plantation. Such projects can be developed by government or entrepreneurs or societies sponsored by government. Similar small projects can be taken up by a common man holding small infertile farm area with energy plantation.

III. CONCLUSION

Many national and international studies have identified the residential sector as a potential source for significant greenhouse gas emission reductions. The quantum of the predicted reductions depends on particular social, technical and economic constraints adopted, including the extent of government intervention. In the present case study one can understand the details regarding the amount up to which the inventories affect emission levels, helping everybody to know how and up to what extent each of human actions effect the changes in the environment. The "carbon footprint" is automatically calculated by the price system Carbon credits. Consumers would still not know how much of the price is due to carbon emissions, but they could make their decisions confident that they are paying for the social cost of their carbon footprint. The scope of this study is very much relevant in the current scenario of rising CO_2 levels in our own ecosystem.

Sustainability in the living environment requires a paradigm transition to environmentally conducive habitats based on judicious energy and resource use to foster a community that is happy, harmonious, healthy and productive. In the absence of necessary controle by the government, it is necessary for the common public and voluntary agencies to take initiative to prevent such pollution. This can be done by creating environmental awareness among various groups of people. Everybody can lower one's carbon emissions by following top energy and climate-saving tips and can earn Carbon credits. One has to adopt a 'green' way of life. Think green, Plan green, Act green through 7 R's: Retire or Refrain i.e. Refuse or Reject, Reduce, Recover, Repair, Reuse,
Recycle and Rethink. Avoid exploitation of Resources-
Avoid Over-feeding, Over-breeding, Over-ploughing, Over-grazing, and Over-felling.

On the global scale any international agreement on carbon emissions will set the carbon cap low enough to force most nations to cut back on the consumption of fossil fuels according to a regulated standard. Inthe idea of carbon trading if a country does not cross its emissions limit it receives carbon 'credits', which may then be sold to other nations who have exceeded, or expect to exceed, their limit. This regulatory structure will increasingly generate demand for carbon credits as nations need to get their hands on a license to exceed their carbon caps, avoid paying penalties, and limit curtailment of industrial production. Carbon credit demand will soar if such regulatory burdens are imposed and policed by governments or supranational regulators.

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