

A review on Measurements and Reduction of Carbon dioxide to Carbon Footprint

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Abstract - The aim of this paper is to present a systematic review on carbon footprint and an insight to the methodologies and terminologies. There is also a cluster of literature discussing footprint evaluation methods and tools, its sources and ways to reduce Carbon Footprint. Findings revealed an increasing trend of publications in the carbon emission research domain and high demand for calculation of carbon footprint. Despite the fact that there are several studies or researches, the term ‘carbon footprint’ does not have a generally acceptable academic definition. The methodologies for carbon footprint calculations are still evolving and it is emerging as an important tool for greenhouse gas management and the most significant contribution to this domain is reported from China, the United States, and England. Present review describes the prevailing carbon footprinting methods and raises the related issues.

Index Terms - Carbon Footprint, Carbon Trading, Carbon Credits, Kyoto Protocol, Ecological Footprint.

INTRODUCTION

‘Carbon footprint’ has become a widely used term as a responsibility against the threat of global climate change. The expression of ‘carbon footprint’ is popular among meteorologists and also in people involved in public debates on abatement action in combating the threats of global warming and climate change, are being discussed.(Durojaye et al., 2020) According to the Intergovernmental Panel on Climate Change (IPCC) report, without action, the global temperature will rise by more than 1.5°C in the future, while in the past 10,000 years, the climate change was only 1°C. The concept of carbon footprint works on the measurement of greenhouse gas emissions. The

term “carbon footprint” evolved from the ecological footprint proposed by Wackernagel in 1996 which represents the integration of ecological footprint and carbon emissions (Pandey et al., 2011)

According to Ecological Footprinting (Wiedmann & Minx, 2007), the carbon footprint stands for a certain amount of gaseous emissions that are relevant to climate change and associated with human production or consumption activities. Unfortunately, there is no measure to quantify a carbon footprint. No units for measurements are clear. A Google search for the term “carbon footprint” found over four million sites, and each came out with their own definition of this term.

We countered the following definition of the term ‘carbon footprint’:

“The carbon footprint is a measure of the exclusive total amount of carbon dioxide emissions that is directly and indirectly caused by an activity and is accumulated over the life stages of a product.” This includes activities of individuals, populations, governments, organisations, processes, industry sectors etc. In any case, all direct (on-site, internal) and indirect emissions (off-site, external, embodied, upstream, and downstream) need to be taken into account.

But the fact is CO₂ is only being included in the carbon footprint whereas we all know that there are other substances with greenhouse warming potential. Many of those are either not based on carbon or are more difficult to quantify. Methane could easily be included. A greenhouse gas indicator should include all these gases and may be called ‘climate footprint’. The definition also expresses the carbon footprint as an area-based indicator. The total amount of CO₂ is

physically measured in mass units (kg, t, etc) and thus conversion to an area unit (ha, m², km², etc) takes place. But the conversion into a land area may increase the uncertainties and errors associated with a particular footprint estimate. For this reason, we usually try to avoid unnecessary conversions and attempt to express any phenomenon in the most appropriate measurement unit.(Keuning, 1994)(Stahmer, 2000).

However, it is important for the concept of ‘carbon footprint’ encompasses all possible causes that give rise to carbon emissions. (Wiedmann & Minx, 2007)

LITERATURE REVIEW

The origin of carbon footprint can be tracked back to as a subset of “Ecological Footprint” (Horst, 2020). In the last decades, the concept of carbon emission has been researched into by so many researchers and scholars. Most of the research works focus on the questions seeking to know the extent at which CO₂ emissions may be described .But it has been recognized that the academia has mostly neglected the issue of defining and describing carbon footprint.

In the last decades, a growing rate of interest in estimating and disclosing carbon emissions via Carbon Footprint analysis at different scales has been observed (Pandey et al., 2011). Several carbon emission research studies have grabbed the attention of researchers worldwide due to the rapidly changing global climate. But besides its widespread favourable reputation as an indicator of contribution of a particular person or product to global warming, there are confusions over what it exactly means. The scientific literature on this subject is petrifying. Most of the studies carried out to calculate Carbon Footprint have been organised by private companies and organisations predominantly and that too to improve business sense rather than their environmental responsibilities (Finkbeiner, 2009), (Donglan et al., 2010), (Peters, 2010), (John & Growcom, 2008), and (Hussain et al., 2017)]. It contains important findings in the field of greenhouse gas emission and carbon footprint calculation, but there is a lack of studies for incorporeal assets like Research & Development and knowledge.

The Kyoto Protocol, a legally binding international agreement, was proposed by the United Nations Framework Convention on Climate Change (UNFCCC) in December 1997 to tackle

environmental problems (Čuček et al., 2012), (Ki-moon, 2008). Its objective is the stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent any intercession with the climate system (Čuček et al., 2012). About 191 countries have ratified this protocol. Under this agreement, countries have flexibility in how they will meet the development and industrial target without harming the environment. But the Protocol doesn’t provide any guidance regarding the actions required to reduce greenhouse gas emissions (Čuček et al., 2012)(Ki-moon, 2008) There is no specific data available on how to calculate the Carbon Footprint from knowledge intensive organisations and neither from Research & Development organisations nor from Technology research centres. Several methods and calculators available online to calculate carbon footprint of an individual doesn’t measure Carbon Footprint precisely and thus needs upgradation.

METHODOLOGY

Carbon footprint is a dynamic process and is calculated periodically, usually annually. For calculating carbon footprint, the amount of GHGs released needs to be estimated.

It is argued that there is no known method of calculating the total carbon footprint emission because of the large amounts of data allegedly required to do the calculation. But still there are some methods defined to calculate the carbon footprint. These are as follows:

1. INDEX DECOMPOSITION ANALYSIS: The IDA method is an established technique for decomposing aggregate energy or environmental indicators into several contributing factors that influence observed changes in the aggregate indicator (Han et al., 2015), (Yuliana, 2016), and (Ki-moon, 2008).
2. MASS BALANCE APPROACH: Quantitative analysis is applied to evaluate resource materials used in industrial processes such as industrial production, manufacturing, processing, electricity supply, heating and road transportation, based on the Law of Mass Conservation (Wiedmann & Minx, 2007), (Ki-moon, 2008).
3. IPCC: Calculate CO₂ emissions based on energy, industry, transportation, land use, agricultural and waste activities (Khan et al., 2016),(Wulandari et

al., 2013),(Liu et al., 2011),(Long et al., 2019),(Purwanto et al., 2019),(Nansai et al., 2012),(Chen et al., 2019),(Reay et al., 2007).

4. CONSUMER LIFESTYLE ANALYSIS: CO₂ emissions are calculated based on direct energy use and indirect energy contained in the production of goods and services [(Ki-moon, 2008), (Wang & Yang, 2014),(Long et al., 2019)]
5. ENERGY CONSUMPTION: Energy used from fossil fuels for cooking and electricity from the use of electronic equipment is considered [(Wiedmann & Minx, 2007),(Finkbeiner, 2009),(Han et al., 2015),(Wulandari et al., 2013),(Chen et al., 2019), (Wang & Yang, 2014),(Abeydeera et al., 2019),(Geng et al., 2011)].

There is also a wide variety of online calculators for finding the carbon footprint of an individual. However, each calculator uses a slightly different method to estimate indirect emissions, and some are more detailed than others about calculating direct emissions (Mulrow et al., 2019)Here’s how several online carbon footprint calculators smash-up against each other:

- EPA: The calculator designed by the U.S. Environmental Protection Agency (EPA) calculates direct emissions of Greenhouse gases from home energy use and transportation, and it uses the amount of waste household products to estimate indirect emissions [(Loyarte-López et al., 2020), (Mulrow et al., 2019) and (Weidema et al., 2008)].
- Nature Conservancy: The calculator from The Nature Conservancy uses the same categories as the EPA’s, plus an additional category for food and diet (Mulrow et al., 2019) .
- Centre for Climate and Energy Solutions (C2ES): It asks a series of short, general questions about home, car, and use of other forms of transportation (Mulrow et al., 2019)
- Carbon Footprint Ltd.: This calculator contains separate sections for home, car, and other transportation, and it covers secondary emissions by asking questions about diet, shopping, and use of other services (Mulrow et al., 2019).
- Cool Climate Network: The Cool Climate Network at the University of California at Berkeley, has one of the most flexible carbon calculators. It asks questions about travel,

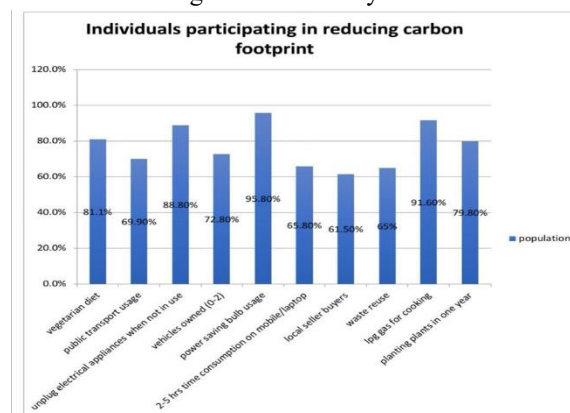
housing, food, and shopping habits, and the questions can be adjusted to be more or less specific and detailed [(Loyarte-López et al., 2020), (Mulrow et al., 2019)].

AN AUTONOMOUS SURVEY REPORT

We conducted a survey on “CARBON FOOTPRINT” involving 143 candidates. This includes participants of maximum 18-25 years of age and their overwhelming response helped us in obtaining a precise data on emission of carbon dioxide and other greenhouse gases.

This survey objectified the necessities like:

- Consumption of electricity
- Usage of public transport
- Power saving appliances
- Support to local marketers
- Waste management and many more...



The objective of this survey is to acknowledge the common individual about their lifestyles and to put the best conservation science into actions to save the world from tremendous climatic changes.

1. Most of the individuals prefer vegan diet and are aware of benefits of vegan diet as well as ill effects of non-vegetarian diet on environment (increases level of carbon footprint)
2. 69.90% individuals use public transport to save the environment from vehicle hazards.
3. About 88.8% people responded yes showing awareness regarding saving electricity and reducing carbon footprint.
4. People with more personal vehicles contributes more to carbon footprint. And 72.80% population have their own vehicles.

5. 95.8% individuals have power saving bulbs like CFLs. CFLs contributes in saving electricity and produce minimal greenhouse gases
6. 65.80% spend too much time on mobile and laptops and by far neglecting the hazards of electronic radiations on their health and the environment.
7. High strength of individuals buy products from local sellers usually. They take care of unnecessary expenses and fuel consumption which increases carbon footprint during import and export of products.
8. About 65% people reuse the waste produced and hence promote recycling and reusing.
9. LPG gas is preferred maximally to cook food and are aware of benefits of using LPG stove instead of burning fire with coal and wood.
10. 79.8% people come forward yearly for plantation and to reduce the global warming levels.

DISCUSSION

It is all important for a contamination (carbon footprint) to include one and the other unmediated and wandering CO₂ released. At large, the term carbon footprint is related with fewer conscientious, client position, publicized theory of conservatory gas depletions for the motive of merchandise the advantages of slighter leak intensive results and resources. [(Liu et al., 2011), (Ramachandra et al., 2015)]. Here is like an effect about the actuality of such a thing. There are main consequences developing from the implementation of carbon merchandising even as well as carbon contracting. Regardless of the procedure we take on to determine contaminations will enhance the dominant benefit to keep away from calculating twice through the bonds of contribute or Wheel of life as regards the effects as well as maintain. In the end, understandably the basis of the footstepping study is evaluative to telling a longer exhaustive Methodological conclusion on the scope and viewpoint to survey that is essential. [(Parliamentary office of science and technology, 2006), (Foran et al., 2005)].

Ways to reduce CARBON FOOTPRINT: -

- Use Bicycle or workforce for short distances. General conveyance is a process of obtaining to

areas without settling a load continuously in nature. We should drive more efficient vehicles.

- Buying local food and products is also a way of curbing emission into the atmosphere. Drastic decrease in the amount of plastic used to package products and fuel uses during long road transits is also reduced.
- Turn off lights when not in use. Use CFLs, avoid using AC, which contributes a lot to global warming and emits chlorofluorocarbons (CFC) that destroy the Ozone Layer. Voltaic Machines must be stopped when there is no high utilisation.
- Recycling plastic, glass and paper can also reduce carbon footprint drastically. Buying vegetable produce can be converted into compost or menu.
- Green energy is an alternative to powerhouses and offices with environmental sustainable energy without compromising lifestyle and waiting for National grids to be connected via green energy supply sources. For example, solar power panels and atomic energy.
- Work from home facility. It will reduce the huge carbon dioxide burden as a result of decreased transportation. It is environmentally friendly as well as economically favourable.
- Planting more and more trees is one of the best ways to give back to the environment. A single young tree absorbs about 13 pounds of carbon dioxide each year.
- Buying carbon releasing appliances credits energy. Reducing carbon footprint at any cost is the sole duty.
- Energy realisation to all employees and encourage them to turn off lighting when not in use.
- Unplug battery charges when the tool is charged.
- Maximize the use of Daylight, do not turn lights on when daylight is sufficient.
- Separate Block from radiators. Low to medium cost, energy,
- Replace all lamps and tubes with low energy variations.
- Draught Windows and doors.
- Increase Loft insulation.
- Insured boilers are maintained and serviced, long term investment, energy.
- Consider installing micro generation at business premises.
- Choose energy efficient equipment and tools.

- Replace old boilers with modern energy difference alternatives.
- Choose fuel efficient vehicles.

CONCLUSION

This paper presents a literature review of previous work regarding carbon footprint. Carbon Footprint has emerged as a strong mode of Greenhouse gas expansions. It has been commercialized and is being utilized by organisations to count their carbon and adopt measures to cut down emissions. Most carbon footprint calculating facilities lack coherence and transparency. A systematic review of current methodologies for carbon accounting is presented. There are some limitations of this review which should be taken into consideration. This paper is based only on the literature that is obtained from various sources and might not cover all the available literature on the domain. Findings of this study can be used to obtain the basic knowledge, data consideration and methodology to calculate carbon footprint.

With the survey, we concluded that individuals are aware of increasing levels of global warming, environmental pollution and carbon footprint. A High majority also contributes in environmental friendly activities in day to day life. Though some amendments are needed to save the environment like more use of public transport, reuse and recycle of waste and reduction in the usage of electronic appliances. There is a need for more environmentally friendly steps in this modern era. One step towards nature can save millions of lives from the outrage of global warming.

FUTURE PROSPECT

In the present scenario, increasing carbon footprint level is a matter of concern. But Regulatory Policies lack uniformity over the selection of direct and indirect emissions. These need to be standardized and strengthened on a global scale. In the last decades, the concept of carbon emission has been researched into by so many researchers and scholars and the future is in the phase of increasing demand and fast growing market of Carbon Credits and Carbon Trading, in both developing and developed nations. Carbon Credit has been proved to be an effective tool to earn extra income and reduce emission of greenhouse gases and thereby improving environmental stability. It offers

green and better world. India is likely to emerge as the biggest seller in the world.

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