Nature Environment and Pollution Technology
An International Quarterly Scientific Journal
p-ISSN: 0972-6268
(Print copies up to 2016)
e-ISSN: 2395-3454
Vol. 23 No. 4 pp. 2469-2476 2024
Original Research Paper
https://doi.org/10.46488/NEPT.2024.v23i04.053
Open Access Journal

Evaluating Sustainability: A Comparison of Carbon Footprint Metrics Evaluation Criteria

Mahima Chaurasia, Sanjeev Kumar Srivastava† and Suraj Prakash Yadav
Department of Environmental Sciences, Dr. Rammanohar Lohia Avadh University, Ayodhya, U.P., India
†Corresponding author: Sanjeev Kumar Srivastava; sanjsri2001@gmail.com

Nat. Env. & Poll. Tech.
Website: www.neptjournal.com

Received: 06-03-2024
Revised: 09-05-2024
Accepted: 18-05-2024

Key Words:
Carbon footprint
Climate change
Carbon emission
Global warming
Greenhouse gas emission

ABSTRACT

The two biggest environmental issues the world is currently dealing with are global warming and climate change. Minimizing energy consumption will help to cut down on greenhouse gas emissions, which is our responsibility. Companies choose 'Carbon Footprint' as a tool to calculate greenhouse gas emissions to show the impact of their activities on the environment. The techniques and procedures used in the analysis of carbon footprints are the primary focus of this study. Several criteria for evaluating carbon footprints were compared to one another to uncover parallels, variances, and deficiencies. Carbon footprints of companies and items were analyzed, and their objectives, ideas, topics of inquiry, calculation techniques, data choices, and additional elements were investigated. Standards for both organizations (ISO14064 and the GHG protocol) and products were compared and contrasted to arrive at accurate carbon footprint estimates. The most important aspects of a carbon footprint and assessment criterion are the research of GHG, system settings, measurement and carbon footprint, date, and treatment of individual emissions. Especially true for commercial enterprises and consumer goods. Guidelines have been produced for these challenges based on valuation criteria that have been used up to this point; nonetheless, they should be enhanced. This study highlights the need to formulate policies to reduce greenhouse gas emissions.

INTRODUCTION

The problem of global warming indeed began as a scientific mystery; nevertheless, it has now expanded to encompass a wide variety of other topics, including politics, economics, society, technology, ecology, and the environment. It quickly becomes one of the most difficult problems that individuals in the modern world must deal with. The issue of global warming, in addition to a wide range of other problems, is a major source of concern for the international community. Programs for the reduction of carbon emissions will be implemented in most nations, according to the consensus. Any comprehensive strategy for global growth must, as a result, place a significant emphasis on the creation of a low-carbon economy, a low-carbon city, a low-carbon lifestyle, carbon trade, a carbon tax, and strategies for reducing carbon emissions. Many different groups want to see progress made toward low-carbon development, thus many different types of organizations, including governments, NGOs, and universities, have done studies on the economic, social, and other factors that are relevant to this topic. Recent years have seen significant advancement in the solution to the low-carbon challenge as a result of research into emission accounting and reduction, carbon emission trading platforms, carbon taxes, and emission restrictions. One of the most important studies that have been done in the realm of low-carbon research is the carbon footprint and assessment standard. On the other hand, due to this problem, researchers have been unable to acquire reproducible results, which have had a significant impact on the industry. Recent months have seen a rise in the level of interest shown by governments as well as academic institutions in research about carbon footprint and evaluation criteria (Lenzen 2007, Letete et al. 2011, Klein-banai et al. 2013, Larsen et al. 2013). This article investigates the procedures and approaches used in investigations of various forms of carbon footprints.

Carbon Footprint Theory

The influence that humanity has had on the ecosystems of the globe is sometimes referred to as their "ecological footprint," which is where the term "carbon footprint" originated from. It is a standardized measurement of the impact that human use of natural resources has on the surrounding ecosystem. It is the quantity of biologically productive land and waters that is necessary to satisfy the needs of a population as well as to

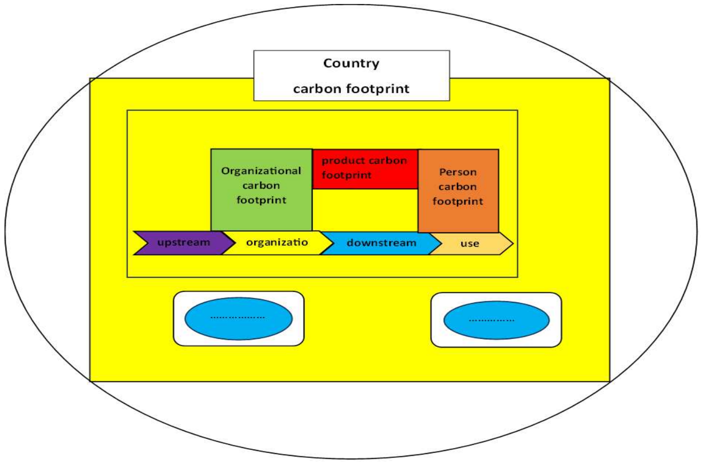

Fig. 1: Limits on carbon dioxide emissions vary by person, product, enterprise, and country.

digest the waste products that are produced by the activities of that population. Using this approach, it is feasible to calculate how much of Earth (or how many planet Earths) would be required to maintain a particular level of living for humanity.

However, a universally accepted or suitable definition of a carbon footprint has yet to be established. However, the term "footprint" denotes a certain action. Popularized the concept of a "carbon footprint," which is a way of calculating the entire amount of carbon dioxide emissions produced by an activity or accumulated throughout the lifetime of a product. The "footprint" of the product during its whole lifetime might be analyzed in this way. Conversely, carbon footprints may be thought of as numerical representations of carbon dioxide (CO_2) emissions (Chaurasia et al. 2022a, Hertwich & Peters 2009, Larsen & Hertwich 2009, Robinson et al. 2015).

Carbon Footprint Categories and Computation Approaches

The phrase "carbon footprint" is frequently used to refer to the influence that individuals, corporations, governments, and other entities have on the surrounding environment. A person's "carbon footprint" refers to the amount of carbon dioxide (CO_2) that is created by the individual's day-to-day actions, such as getting dressed, eating, and driving. The total amount of energy that goes into the production of a product is what is referred to as its carbon footprint. This encompasses the whole life cycle of the product, from extraction of raw materials through final disposal, whether through reuse, recycling, or repurposing (Garg et al. 2001, Nagarajan et al. 2011, Wiedmann & Minx 2007, Weidemma et al. 2008). Greenhouse gas (GHG) emissions are produced as a result of a company's energy use in its buildings and cars, as well as its manufacturing processes and transportation, and may be measured by calculating its "carbon footprint." The "carbon footprint" of a country is the sum of the greenhouse gases released into the atmosphere by that country due to its total consumption of materials and energy, its vegetation and other carbon sequestrations, and its direct and indirect import and export operations (Chaurasia et al. 2022b, Lenzen et al. 2010, Letete et al. 2011, Rippon 2008, Suwanmontri et al. 2013). The different limitations of personal, industrial, institutional, and national footprints are depicted in Fig. 1.

There is a degree of overlap between the characteristics of the four different groupings. The production stage, which is frequently linked to the PLC, would also be included in the organization's carbon footprint if it were to be calculated.

The carbon footprint definition should not contain the method used to calculate the footprint. The approach can be regarded as effective only if it meets the requirements specified in the definition. Consequently, a carbon footprint study may be performed for a wide range of functional units across sizes and using a variety of approaches. Estimating carbon emissions may be done with one of these three major methods: analysis of inputs and outputs (IO), life-cycle assessment (LCA), or a combination of the two.

In actual use, the methodology scales based on a functional unit. In national studies, the top-down IO analysis is utilized, but the bottom-up LCA approach is favored when analyzing consumer items. Hybrid methods, which combine the most beneficial aspects of LCA and IOA, are becoming an increasingly popular option among businesses (Battistini et al. 2022, Li et al. 2015, Addie et al. 2015, Chaurasia & Srivastava 2022).

Criteria for Evaluating Carbon Footprints

Numerous carbon footprint assessment standards have been introduced, primarily for businesses and consumer goods, by the likes of the "International Organization for Standardization (ISO)", the "World Resources Institute (WRI)", the "World Business Council for Sustainable Development (WBCSD)", and the "British Standards Institution (BSI 2008)". Some of these organizations are the "International Organization for Standardization (ISO)", the "World Resources Institute (WRI)", and the "World Business Council for Sustainable Development (WBCSD)". In the long run, we were able to learn more about carbon footprint assessment standards including ISO14064, GHG Protocol, and PAS2050. These rules were a big help in the worldwide effort to cut carbon emissions.

Despite this, there are still a lot of problems with how these standards are being implemented. For instance, no method of accounting for carbon emissions is recognized by the majority of people. Insufficient scientific rigor has been applied to both the boundary definition and the carbon emission factors. It is necessary to do research and analysis, in particular about the organization and the product (Fig. 2).

Standards for Measuring and Reducing the Carbon Footprint of Organizations

Carbon footprint of the organization: A company's "carbon footprint" is the sum of all of its CO_2 emissions, both direct and indirect, within the boundaries it sets for itself.

As a component of an organization's carbon footprint, an inventory of sources and information on greenhouse gas emissions may be fully provided to the public as part of the findings of an assessment. This can be done as part of the results of an assessment.

The most common approach to measuring an organization's carbon footprint at now is IO analysis-based terminal consumption analysis. Fig. 3 depicts the primary operations involved in determining an organization's carbon footprint.

(1) Limiting the scope of the carbon footprint to only those parts of the business that are truly necessary is crucial. Companies commonly integrate their greenhouse gas (GHG) emissions and removals at the organization level utilizing control and equity-sharing approaches even if they have several sites.

(2) Establishing operational boundaries is necessary for deciding which emission sources will be monitored. Emissions from all preventable sources must be included. Emissions in Scopes 1 and 2 are mandated, but those in Scope 3 are discretionary. (Scopes 1, 2, and 3 are shown in Fig. 3) (GHG Protocol, 2004).

(3) Gathering consumption data from all emission sources within the specified area is important for a precise carbon footprint to be calculated. If there were any assumptions or queries left unresolved during the footprint calculation, these should be clarified. A person's carbon footprint is calculated by multiplying their activity data with standard emissions coefficients. However, there are other ways to calculate, such as through the use of models or by direct measurement.

(4) A report should be generated by firms to help with inventory verification, and GHG program participation, or to alert external or internal users. Independent verification of carbon footprints was also recommended to boost confidence in publicly available carbon data.

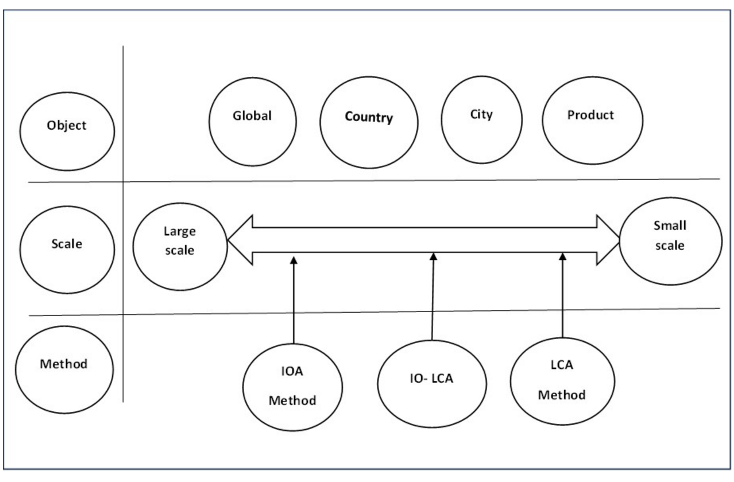

Fig. 2: Carbon footprint applications and associated methodologies.

Criteria for evaluating a company's carbon footprint: In 2004, the World Resources Institute and the World Business Council for Sustainable Development collaborated to create the GHG Protocol. It lays the groundwork for effective climate policy and strong, prosperous enterprises. Using a consensus-based multi-stakeholder approach, groups from all around the world, including businesses, government agencies, NGOs, and educational institutions, collaborated to create the standards. In 2004, the Greenhouse Gas Protocol (GHG Protocol) was created to provide a benchmark against which organizations and projects may measure and report on their greenhouse gas emissions. It addresses the challenge of quantifying the decrease in greenhouse gas emissions attributed to the implementation of mitigation strategies, and it does so by integrating industry-specific and general computation tools into the project protocol.

The International Organization for Standardization (ISO) released the ISO14064 standard in March 2006 to help governments and businesses better understand how to monitor and reduce their carbon footprints.

A comparative study for the standards for evaluating an organization's carbon footprint: During the process of developing these standards, efforts were made to harmonize all qualifying criteria; yet, there are still some minor differences between the two. Both the GHG Protocol and ISO 14064 provide guidelines for determining how to evaluate an organization's contribution to the emission of greenhouse gases (GHG). Table 1 contains information on the methodologies, including the primary distinctions between them as well as an estimation of the effects that these changes would have on the overall result.

(1) Comparison of the criteria used by the two organizations to evaluate carbon footprints allows for the identification of any differences. The Greenhouse Gas Protocol is the first worldwide benchmark that is used to evaluate a company's contribution to the emission of greenhouse gases. The Greenhouse Gas Protocol is an initiative that is entirely voluntary but which sets a premium not just on the process of analysis but also on the outcomes of that process. These outcomes are then utilized in the process of reducing emissions and engaging in carbon trading. The certification process, rules, and framework are all aspects that are addressed by ISO14064, an international standard that is based on the GHG Protocol. As a consequence of this, it is most commonly used in the process of certifying firms' compliance with GHG accounting standards to demonstrate their dedication to social responsibility.

(2) The six greenhouse gases included in the Kyoto Protocol serve as the foundation for both of the criteria. The configurations of the two standards' organizational boundaries are the same, yet the configurations of their operational boundaries are completely different. There are a few different ways that the two standards are quantified in terms of their carbon impact. To get at a quantization, one popular and highly suggested method is to multiply the data on GHG activity by the components that represent emissions or removal. Guidelines for Quantifying GHG Reductions from Grid-Connected Electricity Projects (2007), the GHG Protocol for Project Accounting (2005), which was published in 2005, Land Use, Land-Use Change and Forestry Guidance for GHG Project Accounting (2006), and Corporate Scope 3 (value chain) (2008), which was published in 2008, were all published at roughly the same time as one another and serve as supplementary standards. Accounting and Reporting (2011), the Greenhouse Gas Protocol makes it simpler to recognize

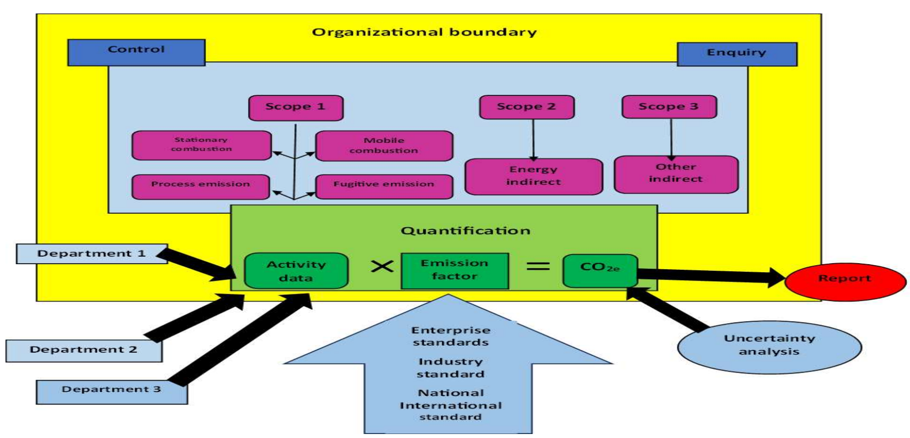

Fig. 3: Methods for evaluating an organization's carbon footprint.

Table 1: Contrastive analysis of the GHG Protocol and ISO14064.

	ISO14064	GHG protocol
Essential Information		
Publisher	ISO	WBCSD&WRI
Date	2006	2004,2011 (revise)
Type Version	Official	Official
Operating	Instructional	Operability
Properties	International standard	Voluntary initiatives Standard
Objects	Organizations	Organizations
Application	Mainly used in industry enterprises	Various industries, governments, (NGOs), carbon trading platform
Goal, Scope and principle	Specifies principles and requirements for the design, development, management, reporting and verification of an organization's GHG inventory.	
Goal		
Principle	Essentially the same drawing on ISO14044, including relevance, completeness, consistency, accuracy and transparency.	
GHG		
GWP	Six GHGs in the Kyoto Protocol. The second report of IPCC (1996).	
System boundary	Same methods to consolidate organization facility-level GHG emissions and removals: by control or bye quite share	
Organizational Boundary	Both divide the whole emissions to three parts: direct emission, energy indirect emission and other indirect emission	
Operation boundary		
Qualification	Calculation, detection, combination of detection and calculation	
Quantization method	Energy indirect emission was denoted as indirect emissions from the generation of imported electricity, heat or steam consumed by the organization	Energy indirect emission was denoted as indirect emissions only from the generation of imported electricity consumed by the organization.
Double counting	Not expected	Refer to emission factors and direct monitoring, as well as cross-industry tools and industry-specific tools. The method was proposed to Avoid double counting.

and collect data about GHG-related activities as well as emission standards. These additional criteria might be used by the energy industry, for instance, to quantify its carbon footprint and gain a better understanding of how to lower the amount of greenhouse gas emissions it produces.

Carbon Footprint and Rating Criteria for Products

Product carbon footprint: Carbon footprints measure the entire quantity of greenhouse gases produced as a result of a product's manufacturing and use during its lifetime. A life cycle assessment (LCA) method is

Necessary to fulfill the requirements for increased precision and accessibility in carbon footprint estimates. In 1996, ISO announced the publication of the ISO14040/44 standards, which included assessment frameworks and methods for environmental management that were based on the LCA method.

Life cycle assessment (also known as LCA) is the method that is now considered to be the industry standard for evaluating the carbon footprint of a project. Fig. 4 depicts the main procedures involved in determining a product's carbon footprint:

(1) Identification of all materials, activities, and processes that go into the life cycle of the product of interest is a crucial step in doing a product life cycle analysis. First, you must disassemble the functional unit of the product you've chosen so that you may analyze its lifecycle. Prioritize the most important ones and write down what goes into making them, how they are made, where they need to be stored, and how they need to be transported.

(2) Once a product's life cycle has been analyzed, reasonable boundaries may be set for the carbon footprint study. This is important since it will determine which individual operations to include in the analysis of the product's carbon footprint.

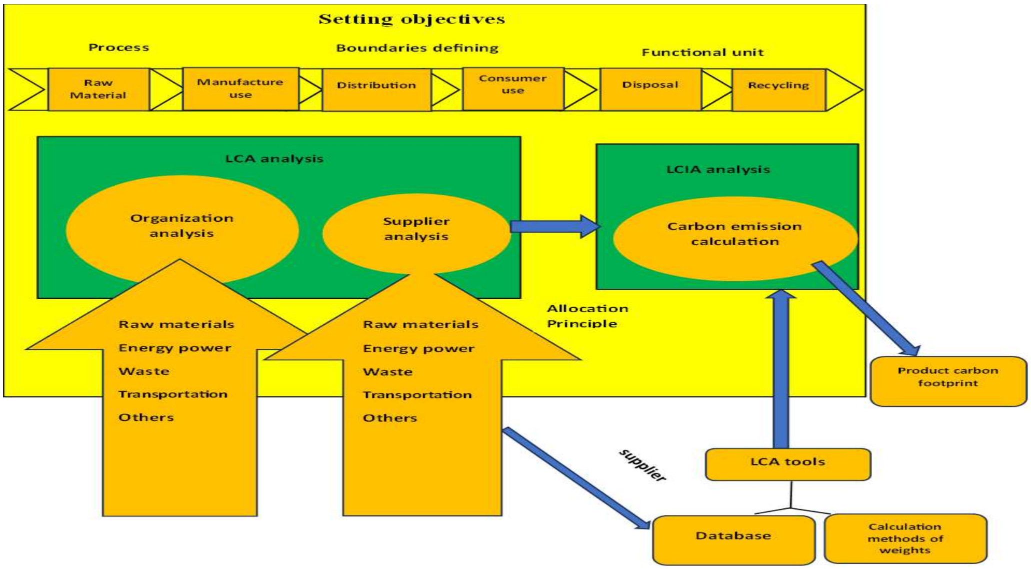

Fig. 4: Methodologies for evaluating product's carbon footprints.

(3) Consumption data for all emission sources inside the system boundary of the whole product life cycle must be compiled for an exact carbon footprint to be calculated. Throughout the many stages of a product's lifecycle, data on material amounts, activities, and emission factors should be gathered. A complete carbon footprint estimate takes into account all inputs, outputs, and waste products.

(4) To demonstrate compliance with this standard, businesses must compile a report detailing their product carbon footprint measurement results, outlining their goals, and detailing the steps they took to reach those goals. Meanwhile, declarations, labels, claims, reports, and performance tracking reports based on carbon footprint standards can be used to facilitate information exchange.

Methods for assessing one's carbon footprint:

- The British Standards Institution, the Carbon Trust, and the Department of Environment, Food, and Rural Affairs (DEFRA) have revised the Publicly Available Specification (PAS) twice since its first release in 2008. The goal of this document is to establish guidelines for utilizing Life Cycle Assessment (LCA) and Product Category Rules (PCR) to determine a product's total lifecycle greenhouse gas emissions.
- The Japanese Ministry of Economy, Trade, and Industry published the "General Principles for the Assessment and Labelling of Carbon Footprint of Products" as part of the Technical Specification TSQ0010 in April 2009 in response to a carbon footprint trial project and the creation of CF PCRs. Therefore, in April 2009, the TSQ0010 Technical Specification was released.
- A Product Life Cycle Accounting and Reporting Standard for the GHG Protocol's Product/Supply Chain Initiative is complemented by the Specifications for the Third Tier of Supply Chain Accounting and Reporting. World Resources Institute and the World Business Council for Sustainable Development released it as a joint publication.
- ISO has been working on a standard for measuring and communicating a product's carbon footprint since 2007, and it has also proposed a standard for measuring and communicating an organization's carbon footprint. Using this criterion, companies may track the "carbon footprint" of their products to see how they fare throughout their whole life cycle. In addition to public reporting and trade, this information may also be used for internal research. Publication of the international benchmark is planned for 2013.

A comparative study of the standards for evaluating the carbon footprint of products:

- Even though the four standards methodologies and methods are comparable to one another, there are still important differences between them. The evaluation of a product's impact on greenhouse gas emissions may be conceptualized and directed by the four criteria.
- We can see from a comparison of the four different standards that greenhouse gas selection, system

settings, measurement, and carbon footprint, managing specific emissions and removals, and other difficulties remain crucial to both the research and implementation of product carbon footprint assessment standards.

- The four criteria for the Kyoto Protocol were reduced to six GHGs after being narrowed down. Assessments of carbon footprints made between businesses and consumers can make use of GHG and ISO, whereas assessments made between consumers and consumers can only make use of TS-Q0010. The PCR method described in ISO 14025 has been singled out as the approach that should be used for determining the system boundaries.
- A company's carbon footprint can be determined using one of four distinct approaches, each of which is based on a somewhat different set of criteria. However, the most popular and credible approach is to multiply GHG activity data by GHG emission or removal factors. Data on activities and variables measuring emissions collected from either primary or secondary sources can be used interchangeably in either context. By definition, "secondary data" is information that has been gathered from sources that are in no way connected to the firm or the product in question. The objective of these metrics is to provide a standard, aggregate evaluation of similar processes or resources. Multi-sector life cycle databases, industry-specific databases, and country-specific data sources are all examples of databases that serve as secondary data repositories. Secondary data are measurements or averages of processes or materials that are conceptually equivalent to one another but are not taken directly from the product itself. Actual measurements taken at various points throughout the product's lifespan make up the bulk of the data set.
- To obtain a more comprehensive understanding of the carbon effect of a product, researchers and other organizations focused on a variety of aspects, including changes in land use, delays in emissions, renewable energy sources, and carbon storage. The four different standards each have their approach to dealing with the many different types of emissions and removals.
- All of the iterations of the Product Life Cycle Accounting and Reporting Standard (PAS2050) and the Technical Specification for Quality Assurance (TSQ0010) are now authoritative. The PAS2050 assessment standard is currently employed in the vast majority of carbon footprint.
- Assessment scenarios, whereas the TSQ0010 standards are only used in Japan and the applications of the Product Life Cycle Accounting and Reporting Standard are only being begun. However, only the Japanese market recognizes the TSQ0010 standards. All sorts of products, from food and drink to apparel and hygiene items, are made with these three things in mind. In 2013, ISO will produce ISO14047, which will bridge the gap between the current set of assessment standards and the forthcoming ones.

CONCLUSION

In recent years, the phrase "carbon footprint" has come to be linked with an all-encompassing accounting of greenhouse gas emissions (GHG) across the life cycle of a product or activity. The first step in researching ways to reduce one's carbon footprint is to investigate one's carbon footprint. Organizations are now counting their carbon output as well as the carbon output of their goods and adopting efforts to minimize emissions to fulfill the green consumer expectations of customers or the request of government agencies. The commercial use of the term "carbon footprint" comes about as a result of this trend. The commercialization of the carbon footprint presents a substantial potential to inspire businesses to increase production efficiency, decrease resource consumption and waste, and promote the expansion of innovation and technology; all of these factors may lead to the establishment of new business opportunities. These opportunities can be found in the commercialization of the carbon footprint. However, due to the growing reporting of carbon footprints in response to the needs of commercial and regulatory entities, the vast majority of calculations are now done by the GHG protocol and PAS worldwide. Now since it involves the natural world as well, it's crucial to address the inevitable emissions. The kind of greenhouse gas (GHG), the settings of the system, the quantification and the carbon footprint, the choice of date, and the management of individual emissions should all be given special consideration in the study on carbon footprints and assessment standards. Although these issues were amenable to the existing evaluation criteria, more work was required. It is crucial to establish legislative guidelines that will direct and monitor these estimates, and it is also crucial to ensure that these estimates are accounted for when choosing between businesses and products now that carbon emissions are a tradable commodity. To handle problems such as carbon leakage and border-tax adjustments brought on by the development of reliable procedures and instruments for the worldwide issue of climate heating, research on carbon footprints and assessment standards that have a global scope is required.

ACKNOWLEDGMENTS

The authors are grateful to the authorities of Dr. Rammanohar Lohia Avadh University, Ayodhya, and the Higher Education Department of U.P., India were highly thankful for rendering their support and help for the completion of this work.

REFERENCES

Addie, J.D., Keil, R. and Olds, K., 2015. Beyond town and gown: Universities, territoriality and the mobilization of new urban structures in Canada. *Territory, Politics, Governance*, 3, pp. 27–50.

Battistini, R., Passarini, F., Marrollo, R., Lantieri, C., Simone, A. and Vignali, V., 2023. How to assess the carbon footprint of a large university? The case study of University of Bologna's multi-campus organization. *Energies*, 16, pp.166-170.

BSI, 2008. PAS 2050-Specification for the assessment of the Geneva, Switzerland, life cycle greenhouse gas emissions of goods and services. *British Standards Institution*, London, UK.

Chaurasia, M. and Srivastava, S.K., 2022. Environmental carbon footprint: As an environmental sustainability indicator. *International Journal for Modern Trends in Science and Technology*, 8(04), pp.185-189.

Chaurasia, M., Prasad, N. and Srivastava, S.K., 2022. Carbon footprint as climate change disclosure: A step towards regulating climate changes. *International Journal of Multidisciplinary Research in Science, Engineering and Technology*, 5(3), pp.390-394.

Chaurasia, M., Prasad, N., Srivastava, S.K. and Shukla, S., 2022. Role of plant canopy in reducing carbon footprint of an institutional area. *International Journal of Innovative Research in Science, Engineering and Technology*, 11(3), pp.2456-2471.

Garg, A., Bhattacharya, S., Shukla, P.R. and Dadhwal, V.K., 2001. Regional and sectorial assessment of greenhouse gas emission in India. *Atmospheric Environment*, 35(15), pp.2679-2695.

GHG Protocol, 2004. The greenhouse gas protocol: A corporate accounting and reporting standard. *World Resources Institute / World Business Council for Sustainable Development*.

Hertwich, E.G. and Peters, G.P., 2009. Carbon footprint of nations: A global, trade-linked analysis. *Environmental Science & Technology*, 43, pp.6414–6420.

ISO, 2010. Carbon footprint of products (ISO/CD 14067-1, Under development). *International Organization for Standardization*, Geneva, Switzerland.

ISOI, 14064-1, 2006. Greenhouse gases-Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals. *International Organization for Standardization*.

Klein-Banai, C., Theis, T.L., Brecheisen, T.A. and Banai, A.A., 2013. Greenhouse gas inventory as a measure of sustainability for an urban public research university. *Environmental Practice*, 12(1), pp.35-47.

Kyoto Protocol, 2008. Kyoto Protocol. Reference manual. On accounting of emissions and assigned amount.

Larsen, H.N. and Hertwich, E.G., 2009. The case for consumption-based accounting of greenhouse gas emissions to promote local climate action. *Environmental Science & Policy*, 12, pp.791–798.

Larsen, H.N., Pettersen, J., Solli, C. and Hertwich, E.G., 2013. Investigating the carbon footprint of a university - The case of NTNU. *Journal of Cleaner Production*, 48, pp.39-47.

Lenzen, M., 2007. Shared producer and consumer responsibility: Theory and practice. *Ecological Economics*, 61, pp.27–42.

Lenzen, M., Wood, R. and Wiedmann, T., 2010. Uncertainty analysis for multiregional input–output models-a case study of the UK's carbon footprint. *Economic Systems Research*, 22, pp.43–63.

Letete, T.C.M., Mungwe, N.W., Guma, M. and Marquard, A., 2011. Carbon footprint of the University of Cape Town. *Journal of Energy in Southern Africa*, 22(2), pp.514-520.

Li, X., Tan, H. and Rackes, A., 2015. Carbon footprint analysis of student behavior for a sustainable university campus in China. *Journal of Cleaner Production*, 106, pp.97-108.

Nagarajan, C., Adithya, P.S. and Jayalakshmi, R., 2011. Corporate ecological footprint (CEF) of SRM University towards sustainability. *International Conference on Environmental Science and Development*, IPCBEE 4, pp.53-55.

Rippon, S., 2008. Green campus action plan. *University of Cape Town*, Cape Town.

Robinson, O., Kemp, S. and Williams, I., 2015. Carbon management at universities: A reality check. *Journal of Cleaner Production*, 106, pp.109–118.

Suwanmontri, C., Kositanont, C. and Panich, N., 2013. Carbon dioxide absorption of common trees in Chulalongkorn University. *Modern Applied Science*, 7(3), pp.1-7.

The United Nations Intergovernmental Panel on Climate Change, 2007. Climate change. Synthesis report. *IPCC*, Geneva, Switzerland, 10.

Weidemma, B.P., Thrane, M. and Christensen, P., 2008. Carbon footprint. *Industrial Ecology*, 12, pp.3-6.

Weidemma, T. and Minx, J., 2007. A definition of carbon footprint. *ISA Research Report*, 7, pp.1–7.

WRI, 2011. The greenhouse gas protocol: A corporate accounting and reporting standard (Revised Edition). *World Business Council for Sustainable Development*, Geneva, Switzerland.

WRI, 2011. Product life cycle accounting and reporting standard. *World Business Council for Sustainable Development*, Geneva, Switzerland.

ORCID DETAILS OF THE AUTHORS

Sanjeev Kumar Srivastava: https://orcid.org/0000-0002-8640-0712