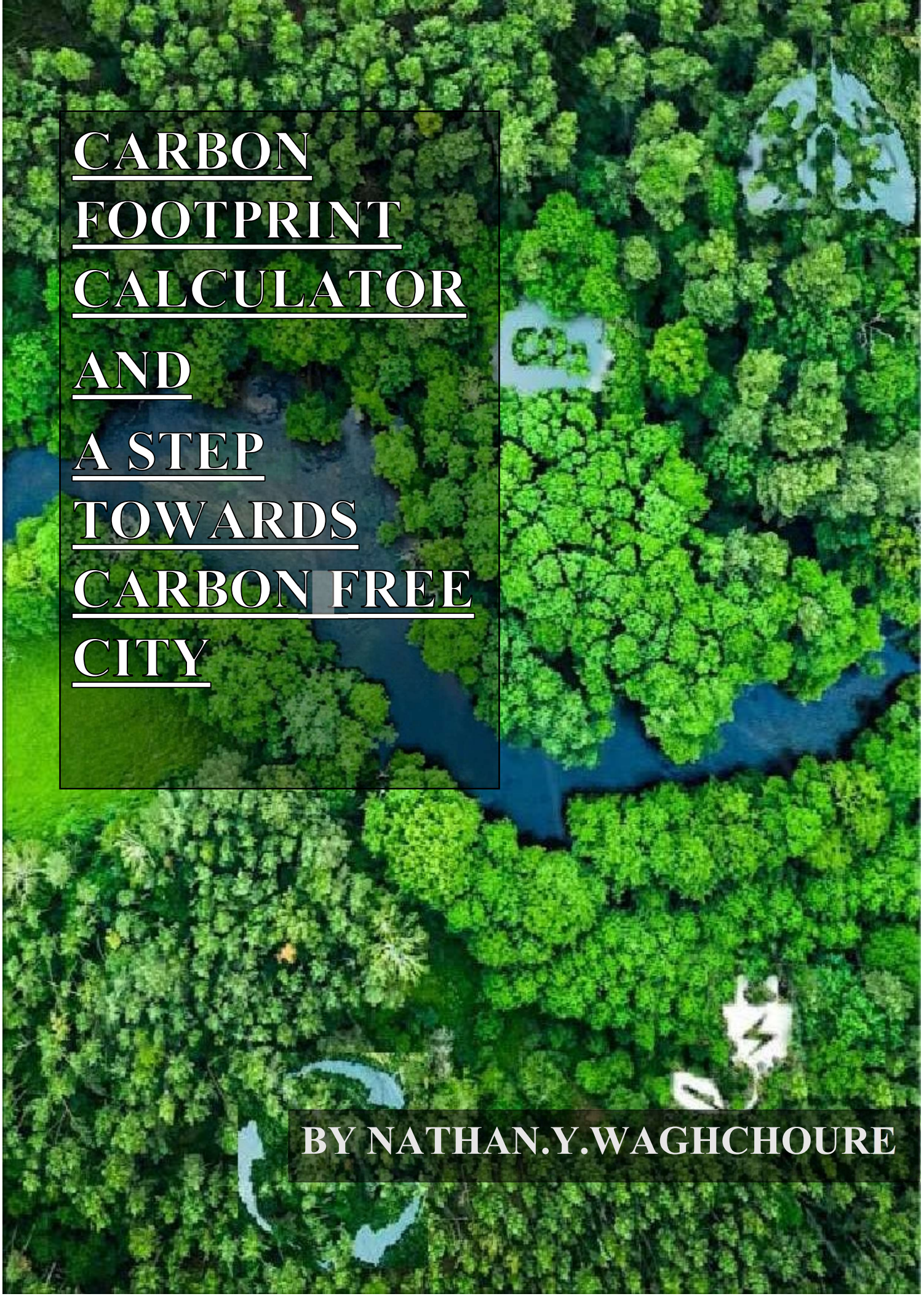

CARBON FOOTPRINT CALCULATOR AND A STEP TOWARDS CARBON FREE CITY

BY NATHAN.Y.WAGHCHOURE

Acknowledgement

In accomplishment of this project successfully many of them have being part with their bunch of blessing. Primarily, We would thank God for being able to complete the project tested successfully, then we would thank my Green Computing teacher Dr. Priti Pathak whose valuable guidance has been done ones that helped us for this project in terms of her instruction, examples. Then I would also extend my gratitude, to The Principal Dr. Sonali Pednekar and head of department (School of Computing and Technology) Dr. Hiren Dand for providing opportunity to show our work in the crowd of growing talent. It is pleasure were we got this opportunity to embark on this project with immense support of our parents and friends. At last but not least gratitude goes to all of my friends who directly or indirectly helped me to complete this project report.

SYNOPSIS

Title of the project:- TO CALCULATE CARBON FOOTPRINTS AND A STEP TOWORDS CARBON FOOTPRINT FREE CITY

Members of the project: - Name:- NATHAN WAGHCHOURE

Roll no:- 239160

Purpose of the project :-

- To reduce harmful effects on environment.
- By calculating it we can be able to know the reasons behind the emission of CO_2 .
- It helps you become more aware of how your actions impact the environment.
- You can start making more conscious decisions, such as abstaining from using plasticpackaged goods and switching from driving to cycling whenever possible.

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CHAPTER 1: INTRODUCTION

- GENERAL INTRODUCTION

What is a carbon footprint?

A carbon footprint is the total amount of greenhouse gases (including carbon dioxide and methane) that are generated by our actions.

The average carbon footprint for a person in the United States is 16 tons, one of the highest rates in the world. Globally, the average carbon footprint is closer to 4 tons. To have the best chance of avoiding a 2°C rise in global temperatures, the average global carbon footprint per year needs to drop to under 2 tons by 2050.

Lowering individual carbon footprints from 16 tons to 2 tons doesn't happen overnight! By making small changes to our actions, like eating less meat, taking fewer connecting flights and line drying our clothes, we can start making a big difference.

carbon footprint, amount of carbon dioxide (CO_2) emissions associated with all the activities of a person or other entity (e.g., building, corporation, country, etc.). It includes direct emissions, such as those that result from fossil-fuel combustion in manufacturing, heating, and transportation, as well as emissions required to produce the electricity associated with goods and services

consumed. In addition, the carbon footprint concept also often includes the emissions of other greenhouse gases, such as methane, nitrous oxide, or chlorofluorocarbons (CFCs).

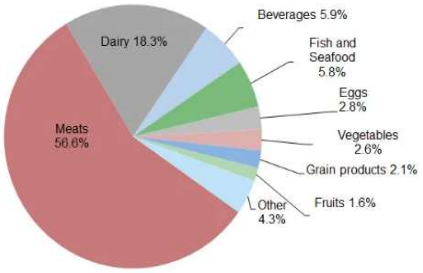
The carbon footprint concept is related to and grew out of the older idea of ecological footprint, a concept invented in the early 1990s by Canadian ecologist William Rees and Swiss-born regional planner Mathis Wackernagel at the University of British Columbia. An ecological footprint is the total area of land required to sustain an activity or population. It includes environmental impacts, such as water use and the amount of land used for food production. In contrast, a carbon footprint is usually expressed as a measure of weight, as in tons of CO2 or CO2 equivalent per year.

- DESCRIPTION OF EXISTING SYSTEM

A carbon footprint is the total greenhouse gas (GHG) emissions caused directly and indirectly by an individual, organization, event or product."1 It is calculated by summing the emissions resulting from every stage of a product or service's lifetime (material production, manufacturing, use, and end-of-life). Throughout a product's lifetime, or lifecycle, different GHGs may be emitted, such as carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), each with a greater or lesser ability to trap heat in the atmosphere. These differences are accounted for by the global warming potential (GWP) of each gas, resulting in a carbon footprint in units of mass of carbon dioxide equivalents (CO2e). See the Center for Sustainable Systems "Greenhouse Gases Factsheet" for more information on GWP. A typical U.S. household has a carbon footprint of 48 metric tons CO2e/yr.2

❖ Sources of Emissions:

1. Food
   i. Food accounts for 10-30% of a household's carbon footprint, typically a higher portion in lower-income households.2 Production accounts for 68% of food emissions, while transportation accounts for 5%.4
   ii. Food production emissions consist mainly of CO2, N2O, and CH4, which result primarily from agricultural practices.5
   iii. Meat products have larger carbon footprints per calorie than grain or vegetable products because of the inefficient conversion of plant to animal energy and due to CH4 released from manure management and enteric fermentation in ruminants.5Ruminants such as cattle, sheep, and goats produced 175 million metric tons (mmt) CO2e of enteric methane in the U.S. in 2020.6
   iv. In an average U.S. household, eliminating the transport of food for one year could save the GHG equivalent of driving 1,000 miles, while shifting to a vegetarian meal one day a week could save the equivalent of driving 1,160 miles.5
   v. A vegetarian diet greatly reduces an individual's carbon footprint, but switching to less carbon intensive meats can have a major impact as well. For example, beef's GHG emissions per kilogram are 7.2 times greater than those of chicken.7
   vi. GREENHOUSE GASES CONTRIBUTION BY FOOD TYPE IN AVERAGE DIET



2. Household Emissions (See Residential Buildings Factsheet)

i. For each kWh generated in the U.S., an average of 0.822 pounds of CO2e is released at the power plant.8Coal releases 2.3 pounds, petroleum releases 2.1 pounds, and natural gas releases 0.9 pounds. Nuclear, solar, wind, and hydroelectric release no CO2 when they produce electricity, but emissions are released during upstream production activities (e.g., solar cells, nuclear fuels, cement production).6,9

ii. Residential electricity use in 2020 emitted 561.1 mmt CO2e, 9.4% of the U.S. total.6

iii. Space heating and cooling are estimated to account for 43% of energy in U.S. homes in 2022.10

iv. Refrigerators are one of the largest users of household appliance energy; in 2020, an average of 621 lbs CO2e per household was due to refrigeration.8,11

v. 26 mmt CO2e are released in the U.S. each year from washing clothes. Switching to a cold water wash once per week can reduce household GHG emissions by over 70 lbs annually.12

3. Personal Transportation (See Personal Transportation Factsheet)

i. U.S. fuel economy (mpg) declined by 12% from 1988-2004, then improved by 32% from 2004-2020, reaching an average of 25.4 mpg in 2020.14 Annual per capita miles driven increased 9% since 1995 to 9,937 miles in 2019.15

ii. Cars and light trucks emitted 0.9 billion metric tons of CO2e or 16% of the total U.S. GHG emissions in 2020.6

iii. Of the roughly 66,000 lbs CO2e emitted over the lifetime of an internal combustion engine car (assuming 93,000 miles driven), 84% come from the use phase.16

iv. Gasoline releases 19.4 pounds of CO2 per gallon when burned, compared to 22.5 pounds per gallon for diesel.17 However, diesel has 11% more BTU per gallon, which improves its fuel economy.18

v. The average passenger car emits 0.77 pounds of CO2 per mile driven.14

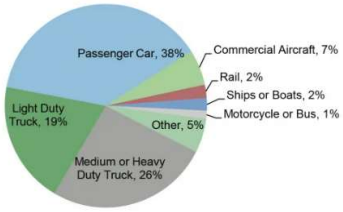
vi. Automobile fuel economy can improve 7-14% by simply observing the speed limit. Every 5 mph increase in vehicle speed over 50 mph is equivalent to paying an extra $0.28-$0.57 per gallon.19

vii. Commercial aircraft GHG emissions vary according to aircraft type, trip length, occupancy rates, and passenger and cargo weight, and totaled 92.1 mmt CO2e in 2020.6 In 2020, the average domestic commercial flight emitted 0.87 pounds of CO2e per passenger mile.6,20

viii. Domestic air travel fuel efficiency (passenger miles/gallon) rose by 115% from 1990 to 2019, largely due to increased occupancy.20 Emissions per domestic passenger-mile decreased 45% from 1990-2019, but increased 55% from 2019-2020 due to COVID.6,20

ix. In 2020, rail transportation emitted 34.2 mmt CO2e, accounting for 2% of transportation emissions in the U.S.

x. TRANSPORTATION GREENHOUSE GASES, 20206



- DESCRIPTION OF THE PROJECT

(A)The Aim of this project is to know how much carbon footprints are measured and how to reduce it.

According to the World Meteorological Organization, 20 of the warmest years in history have been in the last 22 years. It's a no-brainer that human activity is the number one factor contributing to this rise in global temperatures.

Fortunately, today, more people acknowledge the effects their actions have on the planet. This may explain why in a study by Accenture, 61% of those interviewed said that they were making more environmentally sustainable, eco-friendly, and ethical purchases.

Nowadays, the public realizes that they are just as responsible for reversing the damaging effects of CO2 emission as organizations. Thus, there is a growing demand for carbon footprint calculators and relevant software development services.

The carbon footprint calculator helps people be more aware of their contribution to the current environmental problem and what they can do to lessen their impact on the environment.

This article will help you understand the concept of carbon footprint, how it is calculated, how to develop a carbon footprint calculator, and much more

he importance of calculating carbon footprint cannot be over-emphasized. A CO2 tracker is a tool that allows to calculate a carbon footprint and helps people and organizations understand how their activities affect the environment.

Let’s look at the reasons why we all need to think about calculating our carbon footprint.

Why should I calculate my carbon footprint?

You may wonder why you personally should care about reducing your carbon footprint. Here are a few things to think of.

It helps you become more aware of how your actions impact the environment.

You can start making more conscious decisions, such as abstaining from using plastic-packaged goods and switching from driving to cycling whenever possible.

Influences change on a societal or global level. Leaders represent individuals, and when individuals in a society begin taking their carbon footprint seriously, they could influence their leaders to propose legislative changes that support these individual efforts.

And what about businesses?

Companies also need to calculate their carbon footprint. Here is why:

It helps organizations adopt sustainable manufacturing methods that are better for the environment. In 2018, the global CO2 footprint for the clothing industry exceeded that of Germany, France and UK combined. Such statistics should induce the industry leaders to make the necessary changes to reduce the carbon footprint.

Now more and more consumers want to purchase environmentally friendly goods and services. As such, this new generation of consumers will only support businesses that share in their values.

It will help them stay in line with the regulations while working towards achieving climatic change goals, which is the 13th Sustainable Development Goal.

How is carbon footprint calculated?

As stated earlier, the carbon footprint is calculated by the tons of carbon dioxide individuals and companies produce annually.

Calculating carbon footprint revolves around evaluating everyday activities against their effects on the environment. For instance, if you cycled or walked to work, you leave a lesser carbon footprint as compared to a person who drove.

Also, as a farmer, you leave a significant carbon footprint. The reason being, farming is notorious for producing methane, a greenhouse gas that is harmful to the environment.

Manually calculating carbon footprint is difficult and tiresome. For this reason, you need a carbon footprint calculator.

A carbon footprint calculator offers a more accurate and convenient way to calculate the amount of carbon dioxide in our environment, helping us make better decisions when trying to offset the existing carbon footprint.

Below is a breakdown of the average carbon footprint from daily activities.

What does a carbon footprint solution do?

A carbon footprint solution allows individuals and organizations to monitor the amount of carbon dioxide emitted as a result of their everyday activities.

And when you realized how your actions contribute to global warming or water acidity, you may want to reduce your carbon footprint.

This is how changes occur – in what you eat, what you purchase, how you travel, and so on.

In order to create the best solution, hire remote developers with the relevant expertise who will help you develop a carbon footprint calculator fast and easily. This advanced tool helps in estimating the carbon footprint based on various factors, using the average US estimate values.

(B) A Step towards carbon free city/ zero carbon city

A zero-carbon city is a goal of city planners that can be variously defined. In a narrower sense of energy production and use, a zero-carbon city is one that generates as much or more carbon-free sustainable energy as it uses. In a broader sense of managing greenhouse gas emissions, a zero-carbon city is one that reduces its carbon footprint to a minimum (ideally 0 or negative) by using renewable energy sources; reducing all types of carbon emissions through efficient urban design, technology use and lifestyle changes; and balancing any remaining emissions through carbon sequestration.Since the supply chains of a city stretch far beyond its borders, Princeton University's High Meadows Environmental Institute suggests using a transboundary definition of a net-zero carbon city as "one that has net-zero carbon infrastructure and food provisioning systems".

Most cities throughout the world burn coal, oil or gas as a source of energy, resulting in the release of carbon dioxide into the atmosphere, a key greenhouse gas. The development of cities is therefore intimately linked to the causes and impacts of climate change.As of 2019, cities accounted for two thirds of all energy consumption and generated 70% of energy-related greenhouse gas emissions. Over 50% of the people in the world currently live in cities, a proportion that is projected to rise to 70% by 2050, and almost 80% by 2080.

Rooftop solar photovoltaic system array in Hong Kong

Urban development focused on lowering carbon is seen as an inevitable trend for sustainability in urban spaces. Underlying goals include avoiding harm to the planet and countering the impacts of climate change. As of 2022, over 1000 cities worldwide have undertaken steps to transition in response to climate change as part of the Cities Race to Zero campaign, one part of a larger United

Nations Race to Zero campaign. Among them are 25 mega-cities including Rio de Janeiro, New York, Paris, Oslo, Mexico City, Melbourne, London, Milan, Cape Town, Buenos Aires, Caracas, Copenhagen, Vancouver and Hong Kong. In the United States, more than 100 cities have pledged to become carbon neutral.

An established modern city attempting to achieve net-zero status needs to assess seven key provisioning systems, for energy, transportation-communications, food, construction materials, water, green infrastructure, and waste-management. Strategies for reaching net zero include developing renewable energy supplies, reducing energy and resource use through better urban design and lifestyle changes, reducing waste, and creating green spaces and carbon sinks to remove carbon from the atmosphere. Approaches to sustainable urban planning of zero carbon cities increasingly emphasize the use of locally sourced food, energy, and renewable resources.

Some city planners have designed zero-carbon cities from scratch, instead of using and adapting established cities. This gives city planners greater control over all aspects of city design and how each city can contribute to being without carbon emissions. Such design enables the city to benefit from economies of scale and from construction options that might not be feasible in a city with existing structures. Such zero-carbon cities maintain optimal living conditions and economic development while eliminating environmental impact.

CHAPTER 2 : REVIEW OF LITERATURE

2.1 Edger.G.Hertwich and Glen.P.Peters, 2009[20] Auth purposed the Processes causing greenhouse gas (GHG) emissions benefit humans by providing consumer goods and services. This benefit, and hence the responsibility for emissions, varies by purpose or consumption category and is unevenly distributed across and within countries. We quantify greenhouse gas emissions associated with the final consumption of goods and services for 73 nations and 14 aggregate world regions. We analyze the contribution of 8 categories: construction, shelter, food, clothing, mobility, manufactured products, services, and trade. National average per capita footprints vary from 1 tCO2e/y in African countries to ~30t/y in Luxembourg and the United States. The expenditure elasticity is 0.57. The cross-national expenditure elasticity for just CO2, 0.81, corresponds remarkably well to the cross-sectional elasticities found within nations, suggesting a global relationship between expenditure and emissions that holds across several orders of magnitude difference. On the global level, 72% of greenhouse gas emissions are related to household consumption, 10% to government consumption, and 18% to investments. Food accounts for 20% of GHG emissions, operation and maintenance of residences is 19%, and mobility is 17%. Food and services are more important in developing countries, while mobility and manufactured goods rise fast with income and dominate in rich countries. The importance of public services and manufactured goods has not yet been sufficiently appreciated in policy. Policy priorities hence depend on development status and country-level characteristics.

2.2 Tao Gao, 2013[19] Auth purposed that This paper focuses on the research methods and steps involved in carrying out studies on different types of carbon footprints. Furthermore, a comparative study of different carbon footprint assessment standards was carried out to identify their similarities, differences and deficiencies. Goals, principles, research boundaries, calculation methods, data selection and other aspects of organizations footprint and product

carbon footprint were analysed, respectively. Organizations carbon footprint assessment standards—ISO14064 and Greenhouse Gas (GHG) protocol and product carbon footprint assessment standards—PAS2050, TSQ0010, ISO14047 and Product and Supply Chain GHG Protocol were analysed comparatively. The selection of GHG, system settings, quantification and carbon footprint, selection of date and treatment of specific emissions are the most important part of the study of the carbon footprint and assessment standards, especially for organizations and products. Guidelines had been made on these issues from existing assessment standards, but further improvement is still needed.

2.3 Sakhshi Sahni, 2014[5] Auth purposed With fast pace of urbanization across the world and in India, certain issues have augmented globally like climate change which in turn is leading to melting of ice caps, pollution of air, water and land, exhaustion of non renewable sources of energy like coal, petroleum. It has led to global efforts to find an alternate and sustainable way to make a move towards low energy consumption. The new concept of green cities , eco city, zero carbon city or low carbon city are upcoming each of which emphasizes low levels of all kinds of pollution, low discharge of green house gases. An attempt has been made through this article to study various concepts of low carbon cities, to identify the parameters of low carbon city across the world and its impacts. The article is an exploratory research kind where we have tried to incorporate various practices going across the world for a model low carbon city. The research article reviews various scenarios of urbanization across the world, in India and its causes. It also aims to understand various concepts of low carbon cities defined by different agencies and Indian initiatives.

2.4 Shibu shong,2019[14], Carbon emissions are inevitably linked to lifestyle and consumption behaviours, and the concept of “carbon footprinting” is now well-recognised beyond academia. Life cycle assessment (LCA) is one of the primary tools for assessing carbon footprints. The aim of this paper is to present a systematic review of literatures focusing on carbon footprint calculated with life cycle assessment. We used CiteSpace software to draw the knowledge map of related research to identify and trace the knowledge base and frontier terminology. It was found that the LCA application in respects of carbon footprint studies was completed mainly for the following aspect: beef production and dairy

industry, seafood and fishery, nutrition, urban structure and energy use. The CiteSpace analysis showed the development path of the above aspects, for example, beef production and dairy industry has been a long-term topic in this kind of research, while the topic of nutrition appeared in recent years. There was also a cluster of literature discussing footprint evaluation tools, such as comparing LCA with input–output analysis. The CiteSpace analysis indicated that earlier methodological literature still plays an important role in recent research. Moreover, through the analysis of burst keywords, it was found that agriculture productions (dairy, meat, fish, crop) as well as global climate issues (greenhouse gases emission, global warming potential) have always been the areas of concern, which matches the result of co-citation analysis. Building materials (low-carbon building, natural buildings, sustainable buildings) and soil issues (soil carbon sequestration, soil organic carbon) are the topics of recent concern, which could arouse the attention of follower-up researchers

2.5 Lebunu Hewage, 2019 [12] Auth purposed that Greenhouse gases such as sulfur dioxide, nitrogen dioxide, and carbon dioxide have been recognized as the prime cause of global climate change, which has received significant global attention. Among these gases, carbon dioxide is considered as the prominent gas which motivated researchers to explore carbon reduction and mitigation strategies. Research work on this domain expands from carbon emission reporting to identifying and implementing carbon mitigation and reduction strategies. A comprehensive study to map global research on carbon emissions is, however, not available. Therefore, based on a scientometric analysis method, this study reviewed the global literature on carbon emissions. A total of 2945 bibliographic records, from 1981 to 2019, were extracted from the Web of Science core collection database and analyzed using techniques such as co-author and co-citation analysis. Findings revealed an increasing trend of publications in the carbon emission research domain, which has been more visible in the past few years, especially during 2016–2018. The most significant contribution to the domain was reported from China, the United States, and England. While most prolific authors and institutions of the domain were from China, authors and institutions from the United States reported the best connection links. It was revealed that evaluating greenhouse gas emissions and estimating the carbon footprint was popular among the researchers. Moreover, climate change and environmental effects of carbon emissions were also significant points of concern in carbon emission research. The key findings of this study will be beneficial for the

policymakers, academics, and institutions to determine the future research directions as well as to identify with whom they can consult to assist in developing carbon emission control policies and future carbon reduction targets.

2.6 Wei jiang, 2019[3] Auth purposed that This paper, using literature analysis, explores the development of low-carbon pilot cities in China and its research progress, including the enrichment of the connotations of low carbon and low-carbon city, the progress in building China's low-carbon cities, the relevant research by Chinese and foreign scholars and its trends. The result shows that for the construction of low-carbon cities in China, domestic and foreign scholars have conducted in-depth research on the connotations of low-carbon economy and low-carbon city, low-carbon index, carbon discharges peak value, technological approaches, energy utilization, low-carbon society, policy instruments and evaluating system, but the research is still subject to several limitations. For example, judging from the evaluation system of low-carbon cities, the research assigned small weights to the non-technical indexes such as low-carbon policies, governance mechanism and performance appraisal system. Judging from the spatial scale of case studies, the studies on the relatively developed cities in eastern China outnumber those on the cities in western China, especially in the minority areas. In terms of the factors influencing the construction of low-carbon cities, inadequate attention has been paid to the related psychological factors, in particular those of ethnic minorities.

2.7 Edurne lovarte-lopez,2020[16] Calculating the carbon footprint is fundamental to understand how an organization's activities impact global sustainability. The main challenge is how to calculate it when environmental aspects are intangible assets. The present paper investigates in what ways the environmental effects of 13 aspects in relation with R&D activities in an applied research center could contribute to sustainable development. For this purpose, we described methodology to routinely measure greenhouse gas (GHG) emissions and calculate the carbon footprint (CF) of all research activities related to intangible assets (R&D projects, researchers' knowledge and software libraries) with real-time data being provided. Selection of conversion factors to express all GHG emissions are described, in particular those related to air travel on account of its greatest contribution to CF. In addition,

these data were used as a factor in assessing the environmental impact of the center, under ISO 14001. As a result, our center can manage its CF and make decisions about how to enhance sustainability awareness at all levels of the organization and gradually improve CF data, of which the main contributors were transportation and travel (66.4%) and electricity (33.1%) in 2018.

2.8 Karen C. Seto, 2021[18] Auth purposed that This article provides a systematic review of the literature on net-zero carbon cities, their objectives and key features, current efforts, and performance. We discuss how net-zero differs from low-carbon cities, how different visions of a net-zero carbon city relate to urban greenhouse gas accounting, deep decarbonization pathways and their application to cities and urban infrastructure systems, net-zero carbon cities in theory versus practice, lessons learned from net-zero carbon city plans and implementation, and opportunities and challenges in transitioning toward net-zero carbon cities across both sectors and various spatial fabrics within cities. We conclude that it is possible for cities to get to or near net-zero carbon, but this requires systemic transformation. Crucially, a city cannot achieve net-zero by focusing only on reducing emissions within its administrative boundaries. Cities must decarbonize key transboundary supply chains and use urban and regional landscapes to sequester carbon from the atmosphere. Because of carbon lock-in, and the complex interplay between urban infrastructure and behavior, strategic sequencing of mitigation action is essential for cities to achieve net-zero.

2.9 Shanshan Li, 2021[11] Auth purpose that Greenhouse gases, especially carbon dioxide (CO2) emissions, are viewed as one of the core causes of climate change, and it has become one of the most important environmental problems in the world. This paper attempts to investigate the relation between CO2 emissions and economic growth, industry structure, urbanization, research and development (R&D) investment, actual use of foreign capital, and growth rate of energy consumption in China between 2000 and 2018. This study is important for China as it has pledged to peak its carbon dioxide emissions (CO2) by 2030 and achieve carbon neutrality by 2060. We apply a suite of machine learning algorithms on the training set of data, 2000–2015, and predict the levels of CO2 emissions for the testing set, 2016–2018. Employing rmse for model selection, results show that the nonlinear model of k-nearest neighbors (KNN) model performs the best among linear models, nonlinear models, ensemble

models, and artificial neural networks for the present dataset. Using KNN model, sensitivity analysis of CO2 emissions around its centroid position was conducted. The findings indicate that not all provinces should develop its industrialization. Some provinces should stay at relatively mild industrialization stage while selected others should develop theirs as quickly as possible. It is because CO2 emissions will eventually decrease after saturation point. In terms of urbanization, there is an optimal range for a province. At the optimal range, the CO2 emissions would be at a minimum, and it is likely a result of technological innovation in energy usage and efficiency. Moreover, China should increase its R&D investment intensity from the present level as it will decrease CO2 emissions. If R&D reinvestment is associated with actual use of foreign capital, policy makers should prioritize the use of foreign capital for R&D investment on green technology. Last, economic growth requires consuming energy. However, policy makers must refrain from consuming energy beyond a certain optimal growth rate. The above findings provide a guide to policy makers to achieve dual-carbon strategy while sustaining economic development.

2.10 Shaoging Shi, 2021[10] Auther purposed that In the context of global climate change, carbon footprint research has become a hot spot for many regions and scholars. However, a global, systematic and intuitive literature review of carbon footprint is still lacking, which has become the motivation of this research. Based on 7450 articles in the Web of Science Core Collection, this study conducted a literature review and analysis of carbon footprint from the perspective of scientometric. It is found that between 1992 and 2019, the theme of carbon footprint research has changed from ecology and botany to international trade and household behaviours, etc. Water vapour is the longest lasting carbon footprint research topic. The research scope shows a trend from small to large, that is, from the level of individuals and families to enterprises and organizations, and then to the countries and regions. Year 2008 is the main node in carbon footprint research: the classic literature before 2008 is the hubs of later research; the research after 2008 shows a significant trend of diversification and interdisciplinary development. The China's research institutions and scholars have shown an explosive trend after 2008. However, most international cooperation still occurs between North American and European countries, while developing countries such as China are still in the marginal area. The main source of knowledge for carbon footprint research is the subject “Veterinary, Animal, Science”; relatively, the research results are mainly applied to the subject “Environmental, Toxicology, Nutrition”. In addition, it is worth noting that carbon

footprint research is showing a trend of merging with Economics research. These trends prove that there has been a significant theme drift and knowledge evolution process in carbon footprint research.

2.11 Ryu Koide, 2021 [13] This paper presents an approach for assessing lifestyle carbon footprints and lifestyle change options aimed at achieving the 1.5 °C climate goal and facilitating the transition to decarbonized lifestyles through stakeholder participatory research. Using data on Finland and Japan it shows potential impacts of reducing carbon footprints through changes in lifestyles for around 30 options covering food, housing, and mobility domains, in comparison with the 2030 and 2050 per-capita targets (2.5–3.2 tCO2e by 2030; 0.7–1.4 tCO2e by 2050). It discusses research opportunities for expanding the footprint-based quantitative analysis to incorporate subnational analysis, living lab, and scenario development aiming at advancing sustainability science on the transition to decarbonized lifestyles.

2.12 Fei Pei and Peilu Wang, 2022[6] Auth purpose that To achieve China's 2030 target for reducing greenhouse gases, the government has implemented a low-carbon pilot city policy. One goal of this policy is to promote the green transformation of local firms; as such, this paper focuses on how the policy influences green innovation among firms. The study analyzed data on the number of green patents held by industrial firms listed in Shanghai and Shenzhen Stock Exchanges in China for the 2007–2017 period. This enabled an investigation of green innovation activity after implementation of the low-carbon pilot city policy, using a Differences-in-Differences model. We found that the low-carbon pilot cities policy has a significant impact on applications for green patents. The relationship is stronger for private owned firms compared to State-owned firms. The direction of the effect was mainly due to green utility patent applications by private owned firms. State-owned firms have strong path dependence and are protected by local governments, so they are less constrained by low-carbon pilot city policies, which makes it difficult for them to improve the green innovation of State-owned firms. Firms in a monopoly position have more motivation to pursue green innovations than firms in competitive settings. Because green innovations have double positive externalities and require cooperation between multiple departments, they are

associated with higher risk levels compared to nongreen innovations. It is difficult for firms in highly competitive industries to continuously invest many resources in green environmental R&D. This study provides important data supporting the basis of low-carbon pilot city policy implementation.

2.13 Jingwei Han,2022[9] auth purposed that Reducing the effect of mankind's activities on the climate and improving adaptability to global warming have become urgent matters. The carbon footprint (CF), derived from the concept of ecological footprint, has been used to assess the threat of climate change in recent years. As a "top to bottom" method, input–output analysis (IOA) has become a universally applicable CF assessment tool for tracing the carbon footprint embodied in economic activities. A wide range of CF studies from the perspective of the IOA model have been presented and have made great progress. It is crucial to have a better understanding of what the relevant research focuses on in this field, yet so far a systematic synopsis of the literature is missing. The purpose of this paper is to explore the knowledge structure and frontier trends in respect of the IOA model applied to CF research using scientometric visualization analysis. The main findings of this paper are as follows. (1) Published articles show a two-stage increase in the period 2008 to 2021, and present a complex academic network of countries, authors, and institutions in this important domain. (2) The classic studies are mainly divided into three categories: literature reviews, database application introduction, and CF accounting in different scales. (3) The research hotspots and trends show that the research scales tend to be more microscopic and applications of models tend to be more detailed. In addition, supply-chain analysis and driver-factor analysis will probably become the main research directions in the future.

2.14 Naga Dheraj kumar,2022[15]Carbon emission has been considerably higher in India in the last few decades. The greenhouse gases increased to an imaginary volume, a major contributor to global warming. Chennai is one of India's large cosmopolitan cities, contributing more Gross Domestic Product (G.D.P.) and carbon to the atmosphere. The infrastructure sector is always a booming sector in and around Chennai, which requires more construction materials. In turn, the construction of new buildings expands the city with a large area of urban and suburban Chennai, where I.T. division, automobile division, and industrial estates are available. Hence, this study deals with the carbon emission of a

residential building constructed with conventional materials in and around Chennai. So, one can estimate the emission of carbon by the conventional building, which leads to global warming and climate change.

2.15 Md. Nazirul Islam Sarker, 2022[8] Auth Urbanization is an important part of economic development in China which directly related to industrial development. Industrial development is based on energy production, consumption, and trade. A new type of urbanization with low carbon city development is an urgent matter in the researcher community for developing an appropriate strategy, policy, technology, and action. The aim of this study is to explore the status and assess the strategy and policy of low carbon city development in the context of urbanization. It also finds out the effects of new type of urbanization on low carbon city development by finding out constraints and providing recommendations. An extensive literature review with meta-analysis has been done considering various indicators of low carbon city development. This study reveals that most of the large cities are already under the pilot projects of low carbon city development. It also finds out some major indicators of low carbon city like economic growth, energy using pattern, social and lifestyle factor, carbon and environment, urban mobilization, solid waste management, and water management in the context of urbanization. Rapid urbanization requires more building construction and energy which emits more GHG. It suggests that an assessment index system should be introduced by the government to control, monitor and motivate people to use low carbon technology. It further suggests that rules and regulations, awareness building, locality-based technology and practices, and participation of all stakeholders in policy making should be maintained by the government for sustainable low carbon city development in China

2.16 Yunxi Zhu, 2022[1] Auth purposed that Global warming is a worldwide concern, with buildings generating more than 40% of the annual global CO2 emissions. A commonly accepted system of global standards for zero-carbon buildings and communities has not yet been established. In this research, the development history, hotspots, and trends at the urban scale with theoretical and data support are summarized based on the Web of Science (WoS) Core Collection. The review contains works from 1997 to 2022. A total of 19,014 papers were collected, with an overall increasing trend in the number of articles with specific

keywords. The scope of the research is broad, covering the environment, sciences, ecology, chemistry, material science, physics, meteorology, atmospheric sciences, and so on. The hotspots in the low-carbon community (LCC) and zero-carbon community (ZCC) involve a wide range of disciplines, and collaborative research between related disciplines should be strengthened to propose practical solutions for the development of zero-carbon cities. The establishment of the ZCC mainly focuses on a zero-carbon-emission construction and zero-carbon operations. This research found approaches such as the choices of building construction and material, a waste recycling system, a regenerating energy system, transportation, and an examination of the community composition to realize the ZCC. In the literature it is presented that the difficulties in the construction of the ZCC are due to the lack of research in practice, operation, and subsequent maintenance. Moreover, other scholars can deepen the research on the hotspots of ZCC.

2.17 Xinyi wang, 2022[2] Auth purposed that Low-carbon cities (LCCs) have attracted considerable attention from researchers over the past 15 years as an important initiative for mitigating global warming. The increased pilot LCCs in several countries and focus on theoretical research suggest the need to explore the associated research topics and characteristics, trends, and challenges. An in-depth analysis of literature on LCCs was conducted using the three-phase research involving documents searching, quantitative analyses and qualitative analyses. The quantitative analysis revealed that nearly 70% of LCC research was conducted in three countries. The results of the quantitative analysis also generated a map of term clusters, which identified the 9 major areas. A qualitative analysis of the literature indicated that transition to low-carbon energy is the most intensively researched category, and LCC planning and design dominates the research field. Based on the results of the quantitative and qualitative analyses, this study reports knowledge gaps in the literature and proposes future directions for LCC research in the context of four major trends: LCC planning and design, low-carbon energy transition, low-carbon decision support, and low-carbon management and policy. This study improves the existing knowledge on LCC-related research and provides a future guidance for theoretical research and pilot practices related to LCC.

2.18 Lin Chen,2023[7] auth purposed that The construction industry is a major user of non-renewable energy and contributor to emission of greenhouse gases, thus requiring to achieve net-zero carbon emissions by 2050. Indeed, construction activities account for 36% of global energy consumption and 39% of global carbon dioxide emissions. Reducing carbon emissions requires adapted government policies, carbon emission analysis and calculation models, and sustainable materials. Here, we review green construction with focus on history, carbon emissions, policies, models, life cycle assessment, and sustainable materials such as biochar, bioplastic, agricultural waste, animal wool, fly ash and self-healing concrete. Analysis of carbon emissions over the building life cycle shows that the construction phase accounts for 20–50% of total carbon emissions. The average ratio of construction phase annual emissions to operation phase emissions is 0.62. We present national policy frameworks and technology roadmaps from the United States of America, Japan, China, and the European Union, highlighting plans to achieve carbon neutrality in the building sector.

2.19 Miaomiao Zhao,2023[17] This study takes the carbon footprint of prefabricated buildings as the research object, and divides its physical and chemical process into four stages: building materials mining (production), prefabricated component production, material transportation and on-site construction. According to the carbon footprint sources of each stage, a carbon footprint model is established, and the carbon footprint factors and consumption factors required in the model are analyzed. Build a three-dimensional model based on BIM technology, and convert the consumption in combination with the project consumption quota to provide a data basis for calculation. The carbon footprint concentration produced in each stage of prefabricated buildings and cast-in-place buildings is analyzed by cases, and corresponding countermeasures and suggestions are put forward.

2.20 Yaxin Zheng, 2023[4] : research found that low-carbon pilot policies would positively influence the low-carbon cities' natural population growth by influencing (a) economic factors, (b) political factors, (c) technological factors, and (d) the living environment. This research establishes a framework for understanding the impact mechanisms of LCCP on natural population growth. This paper investigates how industrial structure optimization, policy design and implementation in different regions, technological innovations, and urban

green space theoretically affect natural population growth. This paper also proposed characteristics of LCCP which should be theoretically concerned by the government. From a practical perspective, this research suggests several policy recommendations. Central and local governments are encouraged to prioritize industrial structure optimization and assess populations' dependence on cultivated land. Providing additional policy support to underdeveloped areas is crucial to promote the balance between economic and environmental development. Furthermore, establishing online public health platforms and urban green spaces is proposed to enhance the population's health and complement the implementation of LCCP policies. This offers both theoretical and practical insights into the impacts of LCCP policies on natural population growth. Its findings contribute to designing and implementing LCCP policies in China and other developing countries at a similar development stage .

CHAPTER3: PROTOTYPE MODEL AND IMPLEMENTATION

A. Components used

1. SOLAR PANELS

2. WINDMILLS

3. ELECTRIC VEHICLES

B. DESCRIPTION OF COMPONENTS USED:

1. SOLAR PANELS

A **solar panel** is a device that converts sunlight into electricity by using photovoltaic (PV) cells. PV cells are made of materials that generate electrons when exposed to light. The electrons flow through a circuit and produce direct current (DC) electricity, which can be used to power various devices or be stored in batteries. Solar panels are also known as **solar cell panels**, **solar electric panels**, or **PV modules**.Solar panels are usually arranged in groups called **arrays** or **systems**. A photovoltaic system consists of one or more solar panels, an inverter that converts DC electricity to alternating current (AC) electricity, and

sometimes other components such as controllers, meters, and trackers. A photovoltaic system can be used to provide electricity for off-grid applications, such as remote homes or cabins, or to feed electricity into the grid and earn credits or payments from the utility company. This is called a grid-connected photovoltaic system.Some advantages of solar panels are that they use a renewable and clean source of energy, reduce greenhouse gas emissions, and lower electricity bills. Some disadvantages are that they depend on the availability and intensity of sunlight, require cleaning, and have high initial costs. Solar panels are widely used for residential, commercial, and industrial purposes, as well as for space and transportation applications.

2.WINDMILLS

Windmill, device for tapping the energy of the wind by means of sails mounted on a rotating shaft. The sails are mounted at an angle or are given a slight twist so that the force of wind against them is divided into two components, one of which, in the plane of the sails, imparts rotation.

Like waterwheels, windmills were among the original prime movers that replaced human beings as a source of power. The use of windmills was increasingly widespread in Europe from the 12th century until the early 19th century. Their slow decline, because of the development of steam power, lasted for a further 100 years. Their rapid demise began following World War I with the development of the internal-combustion engine and the spread of electric power; from that time on, however, electrical generation by wind power has served as the subject of more and more experiments.

3.ELECTRIC VEHICLES

An **electric vehicle** (**EV**)[note 1] is a vehicle that uses one or more electric motors for propulsion. It can be powered by a collector system, with electricity from extravehicular sources, or it can be powered autonomously by a battery (sometimes charged by solar panels, or by converting fuel to electricity using fuel cells or a generator).[1] EVs include but are not limited to road and rail vehicles, and broadly can also include electric boat and underwater vessels (submersibles, and technically also nuclear submarines), electric aircraft and electric spacecraft.

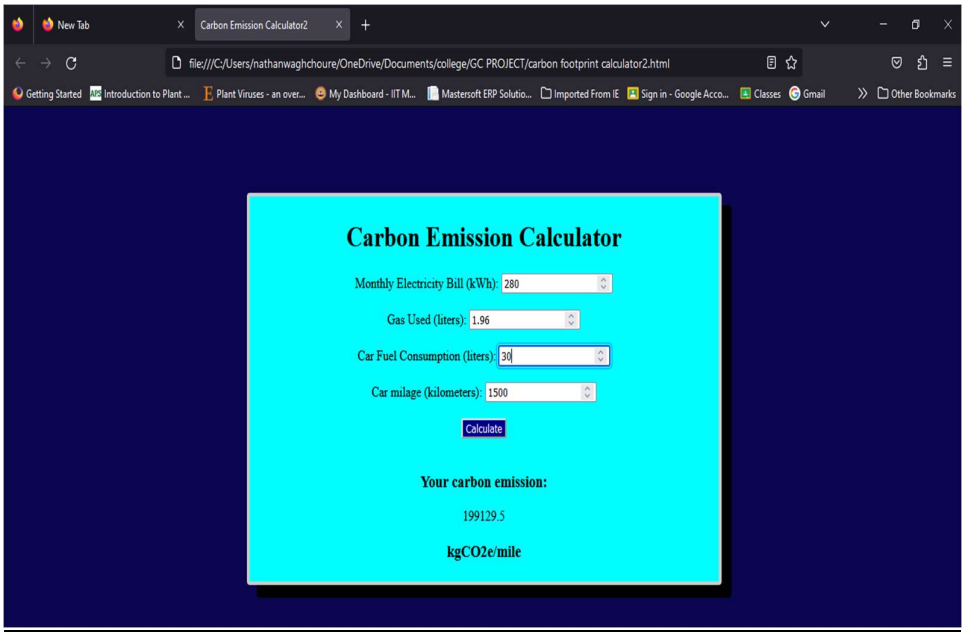
Electric road vehicles include electric passenger cars, electric buses, electric trucks and personal transporters such as electric buggy, electric tricycles, electric bicycles and electric motorcycles/scooters. Together with other emerging automotive technologies such as autonomous driving, connected vehicles and shared mobility, EVs form a future vision of transportation called Connected, Autonomous, Shared and Electric (CASE) mobility.[2]

C. DIAGRAMS AND PICTURES OF MODELS

A) A CARBON FREE CITY

B) CARBON FOOTPRINT CALCULATOR

file:///C:/Users/nathanwaghchoure/OneDrive/Documents/college/GC%20PROJECT/carbon%20footprint%20calculator2.html



D. STEP BY STEP IMPLEMENTATION

For Widget to calculate Carbon footprint:

1. It's a webpage program, which is created by using html, css and java-script code.
2. It will take the input from the user and then it would calculate the carbon footprint of you and then show the output.
3. You just have to enter the values according to the requirements.
4. With the help of this widget you can access your daily carbon usage and then can follow the methods to reduce it

For Widget to Become an Carbon Free City

1. Drive less

Driving a car is a major source of greenhouse gasses. Cutting down on the miles you drive is one of the best things you can do for reducing carbon emissions. Organize shopping trips to get more done on each outing, walk or bike when distances are shorter, and use public transportation as much as possible.

2. Go easy on the acceleration and brakes

How much you drive is not the only factor to consider. Acceleration burns more fuel, so applying the brakes and speeding up is less fuel efficient than maintaining a smooth, even speed.

3. Regularly service your car and keep tires properly inflated

When your car runs efficiently, it uses less energy. Clean oil and belts and timing gears that are perfectly adjusted will help you get the most out of every gallon of fuel. Also, when properly inflated, tires require less energy to achieve and maintain speed while driving. If the pressure is too low, your car is sluggish and burns more gasoline than necessary.

4. Carpool

Sharing a ride to work every day or going shopping can reduce your carbon footprint by about 2,000 pounds of CO_2e every year.

5. Use cruise control

You may not realize how much your speed varies when you are driving. We tend to speed up in certain conditions and slow down in others. Using cruise control allows your car's computer to accelerate smoothly and carefully maintain an even speed.

6. Cut down on air conditioning

Cut usage of the most power-intensive appliance in your car. Running your air conditioning less frequently or raising the temperature so that your system does not work as hard will reduce your carbon footprint.

7. Consider purchasing a hybrid or electric vehicle

It is easy to tell people to drive less, but that might not be possible in your situation. Driving an electric vehicle and doing your electric car charging at home can help eliminate the greenhouse gasses that your conventional car produces. Not all homes are wired for an electric car charging station. Rewiring may be expensive. Another option is to find an electric car charging station and power up there.

8. Avoid flying if possible

Traveling by air spews more greenhouse gas than traveling by car. To help put this in perspective, a single round-trip flight across the U.S. produces roughly 2 tons of carbon dioxide per person, which equals about 10 percent of a U.S. citizen's annual carbon footprint. If you can fly less often, it's an effective way to reduce your carbon footprint.

9. If you must, fly nonstop

Taking off and landing burns more jet fuel than simply cruising at altitude. You can reduce your carbon footprint by avoiding multiple stops and plane changes on your journey. You will also reduce the wear and tear of travel on you.

10. Eat less meat and stick with fruits, veggies, grains and beans

Raising animals requires more energy than growing plants. When you consider using power to produce and ship their food, then ship them to processing and eventually to market, you are talking about a sizable carbon footprint. One of the delicious and healthy ways to reduce your

carbon footprint is to switch to high-protein vegetables and certain grains for some of your meals.

11. Choose organic and local foods that are in season

It takes energy to plant, cultivate and harvest food. It takes even more to transport it for processing, storage and then distributing it to markets. If you choose , you eliminate that part of the energy use.

12. Reduce your food waste

Buying more food than you need and throwing it away wastes the food item itself, along with all the resources used to get it to you.

13. Compost

Dealing with waste consumes energy. A garbage truck needs to pick it up from your home, haul it to a landfill or processing center, then it undergoes even more energy-using processing. By composting some of your organic waste, you cut down on the volume of refuse headed for the dump and also create useful organic matter for fertilizing your garden.

14. Use reusable cups, plates, utensils, bottles and containers

Disposable utensils used once and tossed after a meal are a tremendous waste of resources and contribute to your carbon footprint. Many items are made of plastic derived from oil. The carbon footprint includes the material itself and the energy used in manufacturing and transporting it to you. Once used, it becomes waste that consumes even more energy. Switching to reusable containers has a much lower impact on the environment.

15. Turn down your water heater to 120˚F

Another area to look for ways to reduce your carbon footprint is by changing habits at home. Most people find that when they turn down their water heater to 120˚F, they don’t notice the difference when taking a shower or bath.

16. Lower your thermostat in winter and raise it in summer

When it comes to indoor temperatures, accepting a wider range is one thing you can do to reduce your carbon footprint. If you adjust your thermostat to allow your home to be five degrees colder in the winter and five degrees warmer in the summer, you will cut your energy usage.

17. Turn off lights and unplug appliances when not in use

Many people waste energy by leaving unused lights on for hours. Another common energy-wasting habit is leaving appliances plugged in when not in use. Modern appliances in stand-by mode draw small amounts of power all the time. When you unplug appliances, you can save energy.

18. Change incandescent light bulbs

Incandescent light bulbs produce more heat than light. Switching to LED or CFL bulbs eliminates this waste, while providing a longer useful life. The result is that you will replace them less frequently and send less waste to landfills. CFL bulbs are made with some toxic ingredients, so learn how to recycle light bulbs like these.

19. Use a low-flow showerhead

Getting water to your home and heating the water both use fossil fuels. Reducing your water usage could help reduce your carbon footprint. Low flow showerheads and toilets may slash your water usage. Reducing how long you spend in the shower also helps. We have an entire article devoted to water conservation tips.

20. Look for an ENERGY STAR® symbol when buying new products

You can reduce how much energy your home uses by updating to ENERGY STAR® appliances that are much more efficient than older and non-rated appliances. Smart kitchen gadgets connect to your smart home system for the most convenient and efficient operation. Our guide to energy-saving kitchen appliances can help you make informed choices.

21. Choose renewable energy through Energy Choice

Many states offer energy choice which gives you more options. You may also be able to select a plan that powers your home with green energy sources, such as wind and solar. Plans vary by location, so you will have to compare your renewable energy options.

22. Do an energy audit of your house

You may be wasting energy in ways you don't notice. Hiring a professional to perform a home energy audit can identify how to make your home more efficient. You can identify factors that affect your home energy usage and focus on the changes with the greatest impact.

23. Recycle effectively

Handling waste can be a carbon-intensive process. Recycling reduces the waste going to landfills and gives plastics made from fossil fuels a second life. While recycling programs vary by location, you can recycle common items and help reduce your carbon footprint.

CHAPTER 4: RESULT AND DISUSSION

PROS AND CONS

1. Pros: funds projects

When "done right", carbon offsetting could "inject huge sums into underfunded climate solutions", said the Financial Times. Writing for the World Economic Forum, Bronson Griscom, senior director in natural climate solutions at Conservation International, highlighted several "success stories" of projects that have benefited as a result of offsetting. These examples included a scheme that reduced reforestation in an area of the Peruvian Amazon by 75%, resulting in the equivalent carbon emission avoidance of "taking more than one million cars off the road each year".

The Costa Rican government also generates $30m a year for forest conservation through carbon credit sales, which has helped to conserve millions of acres of forests.

2. Cons: 'flawed' estimations

Calculating emissions and carbon footprints is "a complex and flawed process", said The New York Times. "At best it provides an estimate, usually reported as kilograms of carbon dioxide equivalents."

Even if these estimates are accurate, offsets are "a super-murky world without a whole lot of oversight", according to Jamie Alexander, director of Drawdown Labs, a nonprofit that works with tech companies on climate solutions.

Greenpeace concluded that "the big problem with offsets isn't that what they offer is bad – tree planting or renewable energy and efficiency for poor communities are all good things – but rather that they don't do what they say on the tin.

"They don't actually cancel out – er, offset – the emissions to which they are linked."

3. Pros: technological developments

Criticism of carbon offsetting is nothing new, but companies are working to address efficiency and transparency issues through new technologies. Patricia Wyllie of Founders

Intelligence, writing for medium.com, said these innovations provide the necessary solutions to make offsetting "a real tool to transition us" to more sustainable systems.

Wyllie highlighted that some companies are using GPS to track and monitor tree planting and deforestation, while others are working to incentivise local communities to help with offsetting projects by providing reliable incomes and planning for reforestation through drone use. Direct carbon capture technology (DCC) is also an emerging solution.

4. Cons: lack of regulation

There is "no requirement" for people purchasing carbon offsets to disclose "who is using offsets, and how many", said the Financial Times. The system is "voluntary and unregulated, unlike compliance markets such as the EU's emissions trading system".

A report from investment bank Credit Suisse earlier this year described the voluntary market as a "wild west" with "poor transparency" and "low (if any) correlation between price and credit quality".

Former governor of the Bank of England Mark Carney has said there is "lots of bad" happening in the system, which "does actual harm".

5. Pros: one of many solutions needed

In response to a report published by the Intergovernmental Panel on Climate Change in April this year, Green Party MP Caroline Lucas said that "there's no silver bullet to tackling the climate emergency", but there are "an array of effective, realistic and genuine solutions at our fingertips", including "reversing the depletion of our natural world's carbon sinks".

Carbon offsetting may be one of many solutions needed to tackle climate change, and its effectiveness could be boosted through further investment in DCC and other carbon-mitigating measures.

6. Con: doesn't always add something

Independent investigative news site ProPublica said that any true test of effective carbon offsetting centres around so-called "additionality". The alleged environmental gains "are only real" if the offsets fund projects such as solar farms or windmills that "would never have been built without the credits".

A 2016 study for the European Commission into UN-sanctioned offset projects found that more than three-quarters were unlikely to have resulted in additional emissions reductions, meaning that the vast majority of those projects would have been built anyway, without the offset money.

So "in most cases it seems clear that carbon offsetting doesn't work in practice", said Friends of the Earth, although "it clearly depends on which projects are being funded".

7. Pros: climate concerns drive action

Despite concerns over carbon offsetting, trade is on the rise and the market has attracted huge levels of interest and investment. "Many companies are being pressured by customers and shareholders to drive the market for offsets", said The Wall Street Journal.

"There are just certain things that you simply can't eliminate altogether," Columbia Business School Professor Bruce Usher told the newspaper: "And so your only solution at the end of the day, is to use offsets".

EcoChain.com stressed that offsets "can have a positive effect if they are used appropriately", but on an individual level, people should make sure offset credits are "credible, permanent, additional and verified by the voluntary market standards".

8. Cons: lack of consistency

Another key issue in the offsetting debate is whether schemes that provide carbon removals are permanent. To limit climate change, greenhouse gas emissions need to be kept out of the air effectively forever.

"Tree planting is a very popular offset scheme, largely because it's a lot cheaper than other schemes," the environmental campaigners network continued. "But sadly, trees can burn down." Critics have pointed to last year's wildfires that tore through forest projects on the US west coast that had generated offsets bought by major companies including BP and Microsoft.

By contrast, taking pre-emptive measures to limit emissions would guarantee consistent carbon management. A 2015 report by the Stockholm Environment Institute found that 75% of the credits issued were unlikely to represent real reductions, and that if countries had cut pollution on-site instead of relying on offsets, global CO2 emissions would have been 600 million tonnes lower.

B. RELEVENCY OF TOPIC WITH GREEN COMPUTING:

1. Carbon foot-printing and green computing go hand in hand since they both aim to lessen how much of an impact technology and computing have on the environment. Green computing is the process of creating, utilizing, and discarding computer systems and other electronic equipment in a manner that is environmentally benign. Carbon foot-printing is a process used to measure the greenhouse gas emissions associated with human activities, including the use of technology and computing.

2. Power usage and green computing go hand in hand since energy use is a significant factor in the environmental impact of technology and computing. Electricity utilization is a crucial component of green computing since it may considerably lessen the impact of computers on the environment.

3. Green computing and power backup are important because they both help achieve the overarching objective of lessening the environmental effect of technology and computation. Modern technology cannot function without power backup, but it also has an influence on the environment.

CHAPTER 5: FUTURE ENHANCEMENT AND CONCLUSION

1. The measurement and reporting of indirect emissions, such as those related to the production and transportation of goods and services, is one area where carbon foot-printing could be enhanced. These indirect emissions are currently frequently calculated using generic variables, which might not adequately reflect the actual emissions connected to particular goods or services. Businesses and individuals could make more informed decisions about their environmental effect if they had access to more precise data on these indirect emissions.

2. Using more energy-saving technologies, such as LED lights, smart thermostats, and efficient appliances, is one way to reduce power consumption. These gadgets are becoming more accessible and affordable because to technological advancements, and they have the potential to drastically lower energy expenses and consumption.

3. Making investments in clean, renewable energy sources like solar or wind. These systems are becoming more accessible and affordable thanks to technological advancements, and they might potentially offer dependable and long-lasting power backup in the event of an outage.

4. To sum up, power backup is crucial in our current civilization because we

depend more and more on technology and electronic equipment. There are numerous chances for power backup systems to be enhanced and improved as the demand for energy rises and worries about climate change and the environment intensify.

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