

# Carbon Footprints: What they are, How to Measure them, and what Efforts May Be Taken to Decrease Them

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## **ABSTRACT**

The total amount of greenhouse gases produced from any locality, area, population, factory, installation or unit to directly or indirectly support human activities, are usually expressed in equivalent tons of carbon dioxide CO<sub>2</sub> (eCO<sub>2</sub>) and is called as the Carbon footprint. Though all the greenhouse gases are

measured while measuring the carbon footprints, they are converted to their Carbon Dioxide equivalent while presenting the final result of emissions. Because to anthropogenic activity, the quantity of greenhouse gases in our atmosphere has grown at a rapid rate over the years, resulting in a major increase in the earth's temperature, creating the dreaded global warming. CO<sub>2</sub> e (e=Greenhouse gas equivalent to CO<sub>2</sub>) is the unit of measurement for carbon footprint. Measuring the carbon emissions from any source can be done by using the conversion factors given by different reliable institutions. The conversion factors of fuels like diesel, petrol, LPG, fuel wood, electricity are used to find the amount of emissions. Assessing the amount of emissions is extremely important to understand the environmental implications from the emissions from the device, factory, household or activity. Having quantified the emissions, the important source of emission can be identified and area of emission reductions and increasing efficiencies can be prioritised. This provides the opportunity for environmental efficiencies and cost reductions. It is also very important to reduce the emissions by making changes at personal, political and technological levels. A number of steps and

measures are discussed in this research paper that are critical in reducing the carbon footprint. The study is very important with the objective to calculate, measure and analyze the carbon footprints of any household with respect to energy consumption. To ignite concerns on energy saving and environmental protection while enjoying the modernized way of life

**Keywords:** Carbon footprints; greenhouse gases; CO<sub>2</sub>e; carbon emissions; global warming; fossil fuels; emission inventory; emission factors.

## 1. INTRODUCTION.

In 21<sup>st</sup> century every nation, every state, every individual is in a race for betterment, development and success but in this race we have forgotten where we live and on what we thrive. In developing countries like India, policy makers always lay more stress on the economic growth that has kept environmental considerations as secondary objectives. This indifference towards environmental protection has led to serious environmental problems in the developing countries and has threatened the sustainable future of these countries. The main principle of sustainable development is the development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs (Brundtland Commission 1987). Development is the ordering of natural resources for improving the productivity, health, cultural and socio-economic conditions of man. Nature provides the material and energy resources for developmental activities, while it is left to us to gainfully utilize the resources for human welfare. On our earth, the resources are not evenly or uniformly distributed and many of these are in limited

quantities and are non-renewable. Harnessing these resources, for human welfare, needs lots of energy. Hence, development is tagged with resource and energy availability.

The formation and growth of industry, as well as the exploitation and use of natural resources, are vital for the advancement of civilization. There can be no stop to progress, and hence no escape from pollution, because progress and pollution are inextricably linked. The word "pollution" is derived from the transitive verb "pollutes," which meaning "to render filthy or unclean, dirty, impure or morally unclean." Pollution is described as the act or process of rendering land, water, air, and other natural resources unclean and unfit for human use. Thus, the activities of man have resulted in various environmental changes thereby disrupting the balance of present day nature. Man is responsible for deteriorating the quality and standard of natural environment leading to environmental pollution. Amongst the various environmental pollutions the most worry some are: air pollution caused by harmful gaseous emissions, solid waste pollution and noise pollution besides various other environmental issues.

Researchers have been considerably more concerned about global warming in recent decades as a result of human impact on the climate system via the increase of the natural greenhouse effect. The warming of the Earth's surface is a natural phenomenon.

The process is called the greenhouse effect because the exchange of incoming and outgoing rays of the sun that warms the planet works in a similar way to a greenhouse. The radiations of sun penetrate through the Earth's atmosphere and the earth's surface warms up. Some of the Sun's energy is immediately

reflected back into space, while the remainder is absorbed by land, sea, and atmosphere. The greenhouse gases in the atmosphere trap the long wave terrestrial radiations radiating from the Earth toward space. The energy radiated from the sun is absorbed by gases, which warms the lower part of the atmosphere and is necessary for life to exist on Earth. However, in recent decades, these energy trapping gases have increased alarmingly, raising the temperature of the earth, and the surface temperature of the earth is expected to rise by 20 to 60 degrees Celsius by the end of the twenty-first century (Riebeek, 2010). Between 1970 and 2004, human-caused greenhouse gas emissions climbed by a startling 70%. The Intergovernmental Panel on Climate Change (IPCC) published a report in 2007 that said Water vapour (H<sub>2</sub>O) and carbon dioxide (CO<sub>2</sub>) are the two most important greenhouse gases (CO<sub>2</sub>). Methane is a gas that is produced by a (CH<sub>4</sub>). Nitrous oxide (NO<sub>x</sub>) is a gas that is (N<sub>2</sub>O) Ozone is a gas that exists in the atmosphere (O<sub>3</sub>). CFCs (chlorofluorocarbons) and HFCs (hydrofluorocarbons) are two types of hydrofluorocarbons (incl. HCFCs and HFCs).

Over the years the concentration of greenhouse gases in our atmosphere has increased at a very fast rate due to anthropogenic activities resulting in a very significant increase in the temperature of the earth causing the dreaded global warming. CO<sub>2</sub> is the most prevalent greenhouse gas that causes global warming, accounting for about 77 percent of total world CO<sub>2</sub> equivalent greenhouse gaseous emissions. Though the global warming potential of CO<sub>2</sub> is comparatively less being (01) as compared to (16300) of Sulphur hexafluoride (SF<sub>6</sub>)(UNFCCC unfccc.int/ghg\_data) but it is

the largest contributor to global warming due to large emissions of CO<sub>2</sub>. Directly or indirectly all human activities cause the carbon dioxide emissions by using electricity generated from fossil fuel power stations, burning gas for heating, driving or travelling in a diesel or petrol car. Furthermore, every product or service which humans consume directly or indirectly creates carbon dioxide emissions because energy is required for their manufacturing, transport and even removal. Other types of greenhouse gases may be released as a result of these products and services. Combustion of fossil fuels for energy is the major contributor to carbon dioxide in our atmosphere. Understanding and addressing the full range of our impact is very crucial for the effect of climate change to be minimised.

The The entire quantity of greenhouse gases generated by any place, area, population, industry, installation, or unit to directly or indirectly support human activities is known as the carbon footprint, and is commonly stated in equivalent tonnes of carbon dioxide CO<sub>2</sub> (eCO<sub>2</sub>). Carbon footprints are a measure of the overall quantity of carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) emissions of a specific population, system, or activity, taking into account all relevant sources, sinks, and storage within the population, system, or activity of interest's geographical and temporal boundary. Carbon footprint is measured in Kg or tons of CO<sub>2</sub> e (e=Greenhouse gas equivalent to CO<sub>2</sub>). Carbon footprint is measured in terms of carbon dioxide emissions because out of all six greenhouse gases present in atmosphere, carbon dioxide is the most abundant. As a result, while all greenhouse gases are quantified when calculating carbon footprints, the ultimate outcome of emissions

is converted to their Carbon Dioxide equivalent. This is why, when we specify the unit of carbon footprints, we add a little "e" at the end of CO<sub>2</sub>. It is a measure of the entire quantity of carbon dioxide emitted, both directly and indirectly, as a result of an activity or as a result of the product's life cycle (Wiedmann and Minx, 2008).

Carbon footprint, being a quantitative expression of GHG emission from an activity helps in emission management and evaluation of mitigation measures (Carbon Trust, 2007). Having quantified the emissions, the important source of emission can be identified and area of emission reductions and increasing efficiencies can be prioritised. This opens up the possibility of cost savings and environmental efficiency. The carbon footprint has been used as a measure of the influence of a citizen's lifestyle on carbon emissions. The UNDP (2007) and Edgar and Peters (2009) presented country-by-country per capita footprints as a quick approach to compare contributions to global warming by nations, cities, and sectors. Carbon footprints are increasingly widely utilised as a metric for event management (London 2012, Sustainability plan 2007).

The study was conducted with the following objectives:

- To analyze the carbon footprints with respect to energy consumption.
- To evaluate the awareness and attitude towards environment among the respondents of the study area.
- To identify the main sources of CO<sub>2</sub> emissions and suggest alternatives.
- To evaluate the general awareness among the people about pollution, Carbon emissions, its sources and effects.

- To ignite concerns on energy saving and environmental protection while enjoying the modernized way of life
- To encourage citizens to reduce their carbon footprints while increasing their quality of life, as well as to prevent future urban growth issues caused by current environmental protection deficiencies.

## 2. METHODOLOGY

To calculate the total Carbon footprint of an area CO<sub>2</sub> emissions from different sources are calculated first. To analyse the emissions firstly their consumption has to be calculated. The five major sources are given below

**Electricity:** Number of power units (one unit = 1KWh of electricity) consumed in home is to be recorded and verified from the monthly electricity bills issued by State Electricity Board. The average monthly units consumed are then multiplied by 12 to calculate the annual consumption.

**Petrol/Diesel:** Each household must report the number of litres of gasoline/diesel consumed in a month. The yearly gasoline/diesel usage is computed accordingly.

**LPG:** One LPG cylinder typically holds 14 kg of gas. The monthly consumption of LPG cylinders is calculated using the number of cylinders utilised, and the figure is multiplied by 12 to get the yearly consumption.

**Wood:** The quantity of firewood burnt in a month is noted down which is then multiplied by 12 to get annual consumption. The values calculated for different variables (electricity, petrol, diesel, LPG and wood) are now multiplied with their respective emission factor to get the carbon dioxide emission in Kg (Kg CO<sub>2</sub>). Value is divided by 1000 to get carbon dioxide emission in tons (tCO<sub>2</sub>). To get the final carbon footprint of the study area the

Carbon dioxide emission values of each of the above given variables are added.

### 3. OBSERVATIONS

Amount of consumed units are then multiplied by their respective emission factors to calculate the amount of emissions. Various emission factors are given below

**Table 1: Different emission factors used to calculate the carbon dioxide emissions in Kg.**

S.No	Emission source	Emission factor	Source
1	Electricity (in KWh/Yr)	0.85 kg CO <sub>2</sub> per KWh	CEA(Govt. of India ) <a href="http://www.cea.nic.in/reports/planning/cdm_CO2/cdm_CO2.htm">http://www.cea.nic.in/reports/planning/cdm_CO2/cdm_CO2.htm</a>
2	Petrol( in litres/Yr)×	2.296 kg CO <sub>2</sub> per litre	<a href="http://www.ghgprotocol.org/calculation-tools/all">http://www.ghgprotocol.org/calculation-tools/all</a> tools
3	Diesel( in litres/Yr)×	2.653kg CO <sub>2</sub> per litre	“
4	LPG	2.983kg CO <sub>2</sub> per kg	“
5	Wood	1.8kg CO <sub>2</sub> per kg	“

### Transport conversion table

Vehicle type	Kg CO <sub>2</sub> per litre
Small petrol car of 1.4 litre engine	0.17/km
Medium car of (1.4 – 2.1 litres)	0.22/km
Larger cars	0.27/km
Average petrol cars	0.20/km
Smaller diesel car (>2 litres)	0.12/km
Larger car	0.14/km
Average diesel cars	0.12/km
Articulated lorry, diesel engines	2.68/km (0.35litres fuel per km)
Railways	0.06 per person per km
Air travel in short haul ( 500km)	0.18 per person per km
Air, long haul	0.11
Shipping	0.01 <b>per tonne per km</b>

#### Source:

[https://people.exeter.ac.uk/TWDavies/energy\\_conversion](https://people.exeter.ac.uk/TWDavies/energy_conversion)

### 4. DISCUSSION

Our greenhouse gases emissions are increasing dangerously. Some greenhouse gases, like



methane, are produced from agricultural practices, including livestock manure. Others, like CO<sub>2</sub>, largely result from natural processes such as respiration and from the burning of fossil fuels like coal, oil and gas.

The second cause of CO<sub>2</sub> release being deforestation, according to research published by Duke University. When trees are killed to produce goods and heat, they release the carbon that is normally stored for photosynthesis. This process releases around a billion tons of carbon into the atmosphere per year, according to the 2010 Global Forest Resources Assessment.

Forestry and other land-use practices may offset some of these greenhouse gas emissions, according to the EPA.

Ours is a developing country and the massive developmental and infrastructural work going on keeps on adding more and more CO<sub>2</sub> to the atmosphere.

**PLATE-I**



**Pictures: Major sources of CO<sub>2</sub> emissions in India.**

**Suggestions:**

- 1) The negative impacts of greenhouse gases, global warming, and the direct health repercussions of their emissions must be made known to the locals. Prohibit the use of wood as a source of energy.

- 2) Fuel efficient, eco-friendly and hybrid cars should be preferred. Old heavy trucks and load carriers should be abandoned.
- 3) Product labels that display the carbon footprint value of the product are used. Increased energy efficiency regulations for new homes, as well as the inclusion of an energy efficiency rating in the sale of residential buildings. When purchasing new appliances such as furnaces, air conditioners, dishwashers, heaters, or refrigerators, make energy efficiency a top priority. Products with the ENERGY STAR designation are known to be more energy efficient.
- 4) Promote public transportation, fuel efficient vehicles, hybrid cars, raise awareness among public about the health benefits of walking and cycling. Spread environment awareness and ensure peoples participation through training and extension programmers and by mass media.
- 5) Plantation on community and waste lands will ensure the rate of natural sequestration of carbon dioxide emitted from the fossil fuels.
- 6) Discourage the use of fire-wood and go for alternative fuels. Switch to electric cars. Also old buses and cars should be abandoned.
- 7) Introduce the concept of green buildings to decrease energy consumption and switch to eco-friendly life practices. Install solar panels to the roof of your home. This costs a little more than other options, but many providers offer financing options which minimize upfront costs.
- 8) Insulate and seal the houses. Reduce drafts and air leaks with caulk, insulation, weather stripping and other materials.
- 9) Lighting. Turn off the lights you're not using and when you leave the room. Replace incandescent light bulbs with improved compact fluorescent or LED ones.

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