Research Article

Carbon Footprint In Surat City Household

[1]Deeksha Sehgal, [2]dr. Hitesh Desai & [3]dr. Hemangi Desai
[1]PG Scholar, Environmental Science Department, Shree Ramakrishna Institute of Computer Education And Applied Sciences, Surat, Gujarat, India. ,
[2] Associate Professor, Sarvajanik College of Engineering & Technology, Surat, Gujarat, India.
[3]Assistant Professor, Environmental Science Department, Shree Ramakrishna Institute of Computer Education And Applied Sciences, Surat, Gujarat, India.

Article History: Received: 10 January 2021; Revised: 12 February 2021; Accepted: 27 March 2021; Published online: 16 April 2021

Abstract: The carbon footprint has a great impact on our environment which is caused by our day to day activities. A Google form was made to collect the data related to carbon footprint which involves various parameters like electricity consumption, LPG consumption, cylinder consumption; petrol etc. And from the results obtained by the survey in the seven zones in Surat have different values of consumption and different values of emission of CO_2 which were calculated with the help of a carbon footprint calculator (approved by ISO). Total Carbon Footprint: 261.1 Ton Of CO_2 and Average: 5.2 Tonnes of CO_2. According to the zone wise calculated data it is observed that the zones which have higher value of CO_2 emission have the medium or large size of home, their lifestyle like use of electrical appliances, the type of food they prefer, waste and plastic produced, purchases they do, transportation modes they use etc. have a great impact on the carbon footprint.

Keyword: *Carbon Footprint, Greenhouse gases (GHS), electricity, and comparison of parameters.*

Introduction

Carbon Footprint:

A gas which has the ability to absorb the radiation and remit them in the thermal infrared range are greenhouses gases (GHG).The total of emission of these GHG by is called as "Carbon Footprint". These gases are emitted through various ways like automobiles exhaust, industries etc. Various gases that are major contributors for higher value of carbon footprint are Carbon Dioxide (CO_2), Carbon Monoxide (CO), Nitrous Oxide (N_2O) and Methane (CH_4). The measurement of the emissions of carbon dioxide and methane by a defined system or activity, population can be used to calculate the CO_2 equivalent. This type of measurements must include both direct and indirect sources. The common examples for direct sources are from automobiles or gas stoves whereas for indirect sources are purchased electricity, waste disposal .There are two types of sources which emit carbon dioxide that are natural and human. We know under human sources, activities like transportation, fuel burning (coal, oil and natural gas), and consumption of electricity and natural sources are volcanic eruption forest fire etc. The increase in carbon dioxide emissions started after Industrial revolution i.e. since late 1900s, the emissions of CO_2 is increased from 280 ppm to 412 ppm.

Origin of Carbon Footprint

Beginning of carbon footprint can be followed back to as a subset of "ecological footprint" proposed by Wackernagel and Rees (1996). Ecological footprint all used to the naturally profitable land what's more, ocean territory required to continue a given human population communicated as worldwide hectares.

The idea of carbon footprinting has been being used since quite a few years however known contrastingly as life cycle sway classification pointer an unnatural weather change potential (Finkbeiner 2009). In this way, the current type of carbon footprint might be seen as a hybrid, by getting its name from "**ecological footprint"**, and thoughtfully being a dangerous atmospheric deviation potential pointer.

Thus, the term ordinarily called as carbon footprint ought to accurately be called as "carbon weight" or "carbon mass" (Jarvis 2007).Be that as it may, CO_2-e mass has been advanced as unit of carbon footprint because of helpful figuring and wide acknowledgment (Lynas 2007). In this way carbon footprint might be characterized as, "the amount of GHGs communicated regarding CO_2-e, discharged into the environment by a person, association, procedure, item, or occasion from inside a predefined limit". The arrangement of GHGs also, limits are characterized as per the strategy received and the goal of carbon footprinting. [1]

A glimpse of CO_2 emission:

Grow Climate change is one of the world's most squeezing difficulties. Human discharges of ozone depleting substances – carbon dioxide (CO_2), nitrous oxide, methane, and others – have expanded worldwide temperatures by around 1°C since pre-modern occasions. A changing atmosphere has a scope of potential biological, physical and wellbeing impacts, including outrageous climate occasions, (for example, floods, dry seasons, storms, and heat waves); ocean level ascent; modified harvest development; and disturbed water frameworks. The broadest wellspring of examination on the potential effects of climatic change can be found in the fifth Intergovernmental Panel on Climate Change (IPCC) report.

Temperature increase:
Global average temperature has increased by more than one degree Celsius since pre-industrial times. To set the scene, let's look at how the planet has warmed. In the chart we see the global average temperature relative to the average of the period between 1961 and 1990.

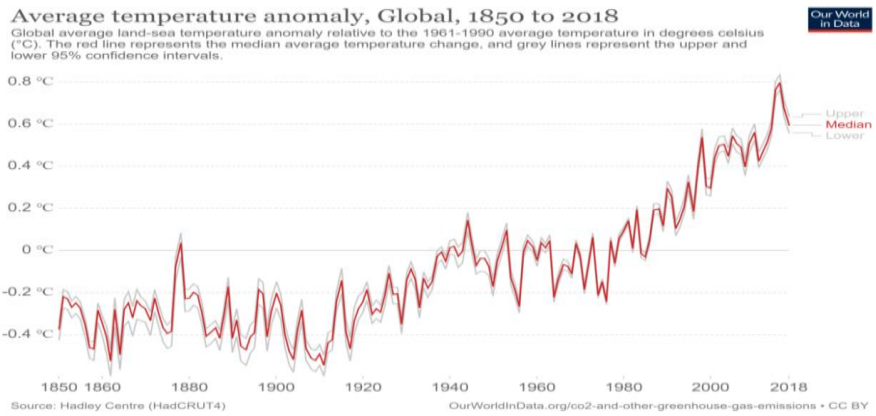

FIGURE -1

The red line represents the average annual temperature trend through time, with upper and lower confidence intervals shown in light grey. Because there are small year-to-year fluctuations in temperature, the specific temperature increase depends on what year we assume to be 'pre-industrial' and the end year we're measuring from. But overall, this temperature rise is in the range of 1 to 1.2℃.

Increase in global CO_2 emissions changed over time:
The visualization presents the long-run perspective on global CO_2 emissions. Global emissions increased from 2 billion tonnes of carbon dioxide in 1900 to over 36 billion tonnes 115 years later.

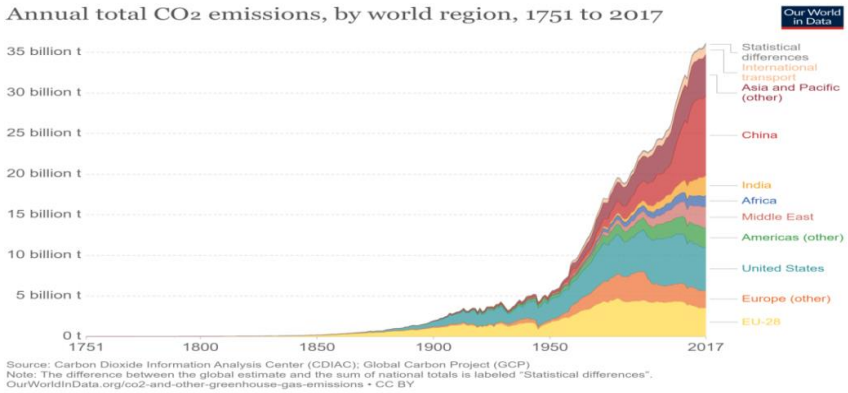

FIGURE- 2

Emission of CO_2 by individual person around the world:
Today, China is the world's biggest CO_2 producer – representing more than one-fourth of discharges. This is trailed by the USA (15%); EU-28 (10%); **India (7%)**; and Russia (5%).
Huge numbers of the world's biggest producers today are in Asia. Notwithstanding, Asia's quick ascent in outflows has just happened in ongoing decades. This also has been a result of gigantic upgrades in expectations for everyday comforts: since 1950 future in Asia has expanded from 41 to 74 years; it has seen an emotional fall in outrageous destitution; and just because a large portion of its populace got formal training. [2]

The Carbon Profile of India:
India is the world's third largest emitter of greenhouse gases (GHGs), after China and the US. India is also very vulnerable to climate change, notably due to the melting of the Himalayan glaciers and changes to the monsoon.The country has pledged a 33-35% reduction in the "emissions intensity" of its economy by 2030, compared to 2005 levels. (Fig.1).[4]

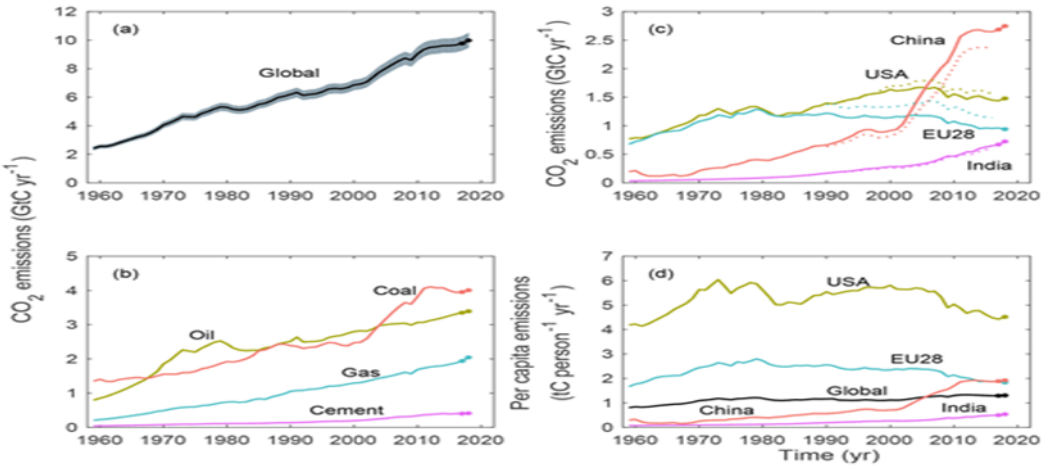

FIGURE-3

* Territorial (solid lines) and consumption (dashed lines) emissions for the top three country emitters (USA – olive; China – salmon; **India – purple**) and for the European Union (EU; turquoise for the 28 member states of the EU as of 2012) and (d) per capita emissions for the top three country emitters and the EU (all colors as in panel c) and the world (black).

The development in outflows of 2.1 % in 2018 is inside the scope of the anticipated development of 2.7 % (scope of 1.8 % to 3.7 %) distributed in Le Quéré et al. (2018b) in light of national outflows projections for China, the USA, and India and projections of total national output adjusted for IFF patterns for the remainder of the world. The development in discharges in 2018 for China, the USA, EU28, India, and the remainder of the world were all inside their recently anticipated range. (Table - 1)

	World		China		USA		EU28		India		Rest of the world	
	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual
2015[a]	−0.6 % (−1.6 to 0.5)	0.06 %	−3.9 % (−4.6 to −1.1)	−0.7 %	−1.5 % (−5.5 to 0.3)	−2.5 %	–	–	–	–	1.2 % (−0.2 to 2.6)	1.20 %
2016[b]	−0.2 % (−1.0 to +1.8)	0.20 %	−0.5 % (−3.8 to +1.3)	−0.3 %	−1.7 % (−4.0 to +0.6)	−2.1 %	–	–	–	–	1.0 % (−0.4 to +2.5)	1.30 %
2017[c]	2.0 % (+0.8 to +3.0)	1.60 %	3.5 % (+0.7 to +5.4)	1.50 %	−0.4 % (−2.7 to +1.0)	−0.5 %	–	–	2.00 % (+0.2 to +3.8)	3.90 %	1.6 % (0.0 to +3.2)	1.90 %
2018[d]	2.7 % (+1.8 to +3.7)	2.13 %	4.7 % (+2.0 to +7.4)	2.30 %	2.5 % (+0.5 to +4.5)	2.76 %	−0.7 % (−2.6 to +1.3)	−2.08 %	6.3 % (+4.3 to +8.3)	8.02 %	1.8 % (+0.5 to +3.0)	1.69 %
2019[e]	0.6 % (−0.2 to +1.5)	–	2.6 % (+0.7 to +4.4)	–	−1.7 % (−3.7 to +0.3)	–	−1.7 % (−3.4 % to +0.1 %)	–	+1.8 % (+0.7 to +3.7)	–	0.5 % (−0.8 to +1.8)	–

In 2016 (the most recent year accessible), the biggest total commitments to worldwide CO_2 discharges from an utilization point of view were China (25 %), the USA (16 %), the EU (12 %), and India (6 %). India, our projection for 2019 is for an expansion of +1.8 % (scope of +0.7 % to +3.7 %) more than 2018. This heavier precipitation prompted both overflowed coal mineshafts (Varadhan, 2019) and high hydropower age (CEA, 2019b). Furthermore, the Indian economy has eased back quickly during the year (IMF, 2019b). Moreover, our estimate for India covers its budgetary year, April 2019 to March 2020, mirroring the fundamental emanations information, adding to vulnerability. [4]

India has become a part of the Paris Climate Agreement, and they have set a goal for themselves to reduce emissions by over 30% by 2050, but only time will tell if they hold up their end of the bargain.[13]

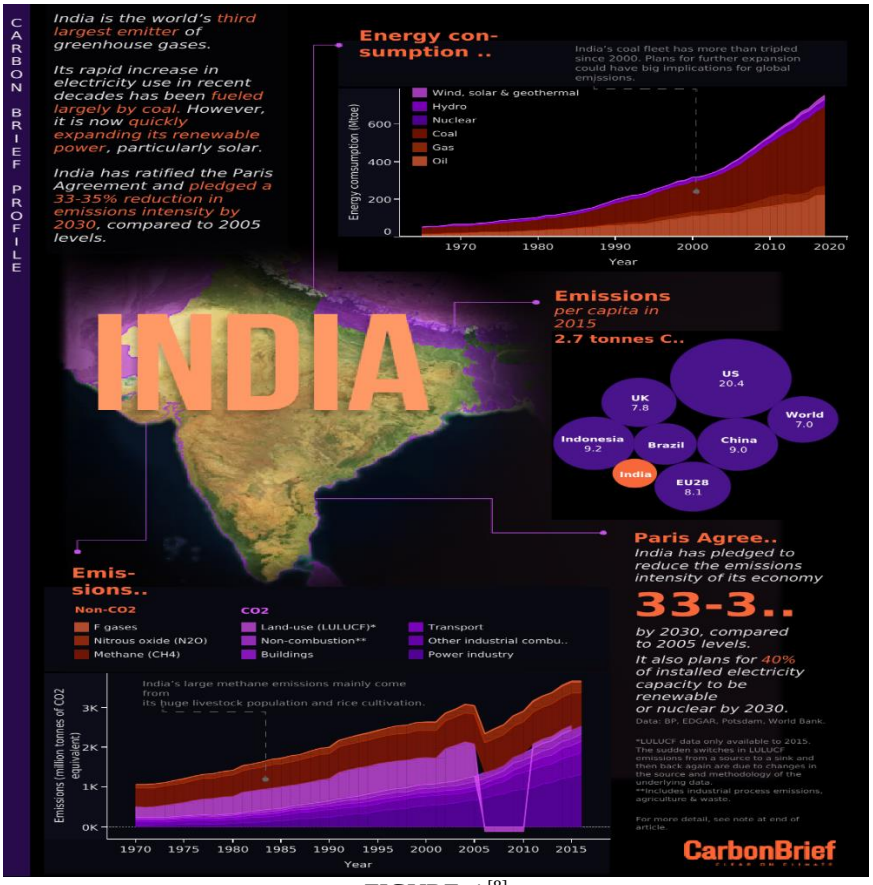

FIGURE-4 [8]

Carbon emission and Surat (Gujarat):

The advanced city of Surat is one of the quickest developing spots in the province of Gujarat. Well known everywhere throughout the world for its diamonds and textile business, Surat is the second biggest city in the state after Ahmedabad. Surat is viewed as fourth quickest creating urban communities of India with a clamoring metropolitan territory home to over 7,291,433 (7.2 million).An ongoing report from Oxford Economics expressed that 17 among the best 20 quickest developing urban communities on the planet are situated in India. Surat tops the rundown of top 10 urban communities evaluated to develop at the quickest pace on the planet somewhere in the range of 2019 and 2035, trailed by Agra and Bengaluru.[5]

Surat is divided into 7 zones:

Central zone: Chowk Bazar
West zone: Jahangirpura, Rander, Adajan, Pal
East zone: Mota Varacha Sarthana Nana Varacha
North zone: Amroli, Ved, Dhaboli, Katargam, Singanpore
South East zone: Dumbhal Dindoli
South West zone: Umara, Magdalla ,Hazira ,Dumas Althan
South zone: Pandesra, Bhestan, Khajod Kanakpur, Udhna, Bamroli

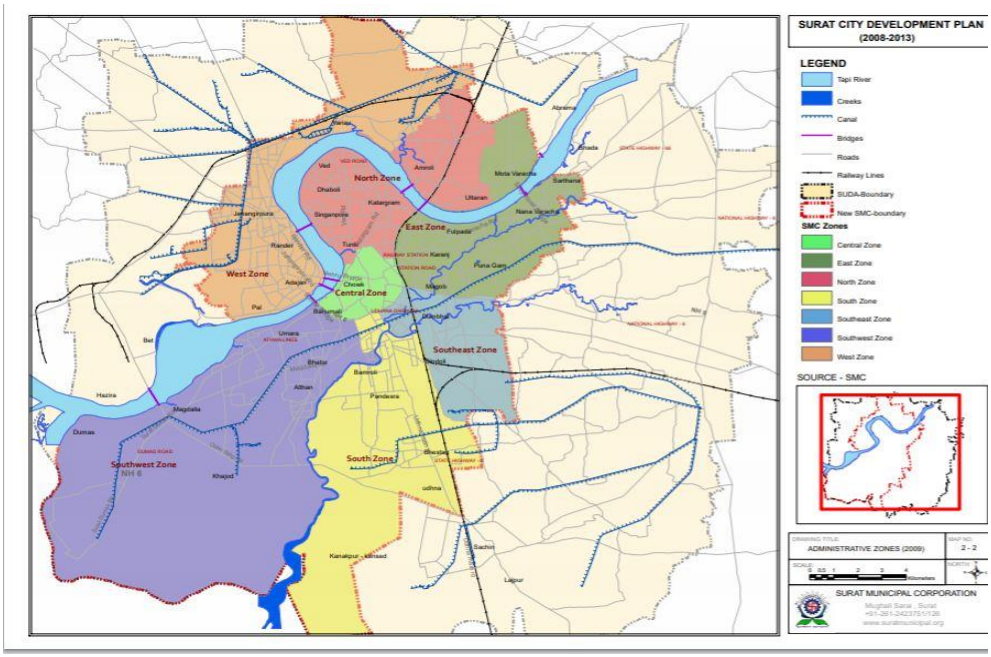

FIGURE-5[6]

Methodology

Our everyday exercises are additionally reliant on electricity which is for the most part originating from coal based force plants, Diesel and Petrol for our vehicles and LPG for cooking in our kitchen. The entirety of the vitality we use is gotten from these non-renewable energy sources which are GHG escalated. Following procedure causes you to figure your carbon footprint coming about because of the utilization of Electricity, Petrol, Diesel and LPG.

Step 1 - Data collection:

1. Electricity: Gather information on your yearly electricity bills. You can discover number of intensity units (In India, one unit = 1KWh of electricity) devoured in your home from the month to month electricity charges issues by State Electricity Board/Distribution/Collection organizations. Take month to month devoured units and afterward duplicate them by 12 (No of months in a year).
2. Petrol/Diesel: Add number of litres of petrol/diesel you utilized in your vehicle/cruiser in a year. On the off chance that you don't recollect the specific worth at this moment, if you don't mind include normal qualities.
3. LPG: Generally one LPG chamber has around 14 kg of condensed petroleum gas. Duplicate number of chambers utilized in a year by 14 and includes the came about an incentive in the estimation.[9]

For collecting the above mentioned information I made a Google form for the same: https://docs.google.com/forms/d/1sv9w-3LJ-sDRRDymRRDd1TNKTBh9Uu_aZ_l5zBb5Lp4/prefill

Survey of Carbon Footprint in Surat City

I am Deeksha Sehgal , student of M.Sc environmental science, from college Shree Ramkrishna Institute of Computer Education and Applied Science.
This google form helps me to calculate the amont of CARBON DIOXIDE produced.
* Required

1. Name: *
2. In which area do you live ? *
3. How many family members are their at your home? *
4. Do you know what is carbon footprint?
   Mark only one oval.
   - Yes
   - No

FEW BASIC QUESTIONS :
Please provide me :
1) The consumption reading from your GAS BILL (LAST MONTHS) .
2) The units consumed in kw/hr in ELECTRICITY BILL (LAST MONTH)
3) PETROL CONSUMPTION IN LITERS PER WEEK / MONTH

5. What is your consumption value in the gas bill? if you use cylinder then write "0" *
6. If you use gas cylinder,how many in a month ? *
7. What is your unit consumed in the electricty bill? *
8. How much petrol you consume in a week?(all vechiles) [Approx.] *

A) HOME

9. How many members live in your home? POINTS *
   Check all that apply.
   - 1
   - 2
   - 3
   - 4
   - 5
   - More than 5
10. What is the size of your home? *
    Mark only one oval.
    - Large house (> or 4 rooms)
    - Medium house (3 rooms)
    - Small house (2 rooms)

Step 2 – Calculation Method:

1. Electricity : Input value (in KWh/Yr) X 0.85 (Emission Factor) = Output value in (Kg of CO_2)
2. Petrol: Input Value(In Litres/Yr) X 2.296(Emission Factor) = Output value in (Kg of CO_2)
3. LPG: Input Value(In Kg/Yr) X 2.983 (Emission Factor) = Output value in (Kg of CO_2)

Step 3 – Addition of above cumulative data:
Your Carbon Footprint: Add (1+2+3+4) = Output value in (Kg of CO_2)
Step 4 – Converting the Calculated data into tonnes of CO_2:
The total carbon footprint is then divided by 1000 so the total carbon footprint is in ton of CO_2. [5]

Result and Discussion:

From the above data it is concluded that the different zones have different types of emissions as of CO_2 as they have different lifestyle and they travel in different mode of transport. (**Table -2**)

Table 2: Parameters and Emission factor towards contribution of Carbon Footprint.

Name:	LPG CONS. /MON	EMIS-SION FACTOR	LPG OUTPUT VALUE/YEAR	GAS CYLIN-DER IN KG	EMIS-SION FACTOR	OUTPUT / YEAR	ELEC UNITS/ M	EMIS-SION FACTOR	OUTPUT / YEAR	PETROL PER WEEK	EMISSION FACTOR	OUTPUT / YEAR	TOTAL CARBON FOOTPRINT(Approx.)Ton of CO_2 /YEAR
Aman shukl	**42.1**	**2.983**	**1507.2**	**0**	**2.983**	**0**	**250**	**0.85**	**2550**	**0**	**2.296**	**0**	**4.06**
Siddhi	**52.6**	**2.983**	**1884.0**	**0**	**2.983**	**0**	**97**	**0.85**	**991**	**2**	**2.296**	**239**	**3.11**
Zehra	**175.4**	**2.983**	**6280.0**	**0**	**2.983**	**0**	**114**	**0.85**	**1166**	**25**	**2.296**	**2985**	**10.43**
Mewara Divya	**12.3**	**2.983**	**439.6**	**0**	**2.983**	**0**	**143**	**0.85**	**1457**	**3**	**2.296**	**358**	**2.25**
Usmangani shaikh	**23**	**2.983**	**823.3**	**0**	**2.983**	**0**	**75**	**0.85**	**765**	**4**	**2.296**	**478**	**2.07**

Contribution of Parameters to Carbon Emission:

Electricity, gas cylinder, LPG & petrol release different tonnes of CO_2 per year.(**Table-3**)

Table 3: Contribution of Parameters to Carbon Emission:

Parameter	CO_2 (tonnes/Yr)	CO_2 %
Electricity	79.8	31.14%
Gas Cylinder	12.8	4.99%
LPG	57.6	22.48%
Petrol	105.9	41.39%

Comparison Graph of % Co_2 Emission:

Electricity, gas cylinder, LPG & petrol release different tonnes of CO_2 per year.(shown graphically.)

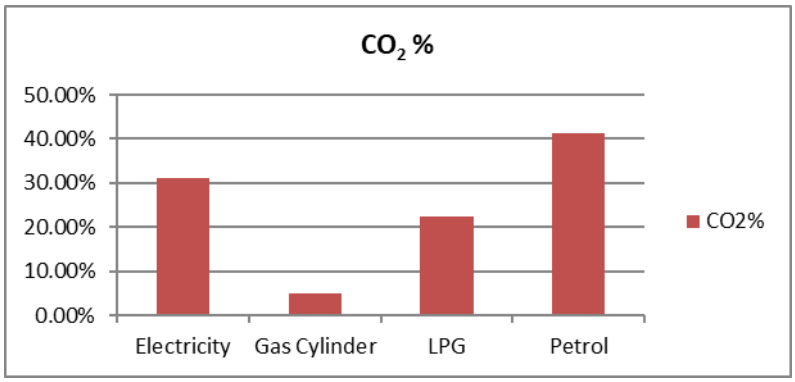

Figure -6: Comparison Graph of % Co_2 Emission:

Sample Result:

This is the sample of area & zone wise collection of data. (Table-4)

Table 4: Area & zone wise collection of data

Name	Area	Zones	Total Carbon Footprint(Approx.)Ton Of Co_2 / Year
Aman Shukl	Sayan	South East Zone	4.06
Siddhi Ramsnehi	Katargam	North Zone	3.11
Zehra	Zampa Bazaar	Central Zone	10.43
Mewara Divya	Parvat Patiya	South Zone	2.26
Usmangani Shaikh	Sagrampura	Central Zone	2.07
Nirupa Sonagara	Amroli	North Zone	3.25
Ruta	Katargam	North Zone	1.89
Kush Bhatia	Adajan	West Zone	4.32
Sarthak	Piplod	South West Zone	1.59
Sanjiv	Piplod	South West Zone	4.84

Zone Wise Carbon Emission in Surat City:

This is the zone wise collection of data. (Table - 5)

Table 5: Zone Wise Carbon Emission in Surat City.

Zones	**Total Carbon Footprint(Tco_2)*/Year**
Central	**6.44**
West	**4.97**
East	**6.15**
North	**5.37**
South East	**4.39**
South West	**5.23**
South	**3.08**
***Final Carbon footprint should be in tons of CO_2 (tCO_2.)**	

Comparison Graph of % CO_2 Emission @ Zone Level

This is the graphical representation of comparison of % CO_2 emission at zonal level.

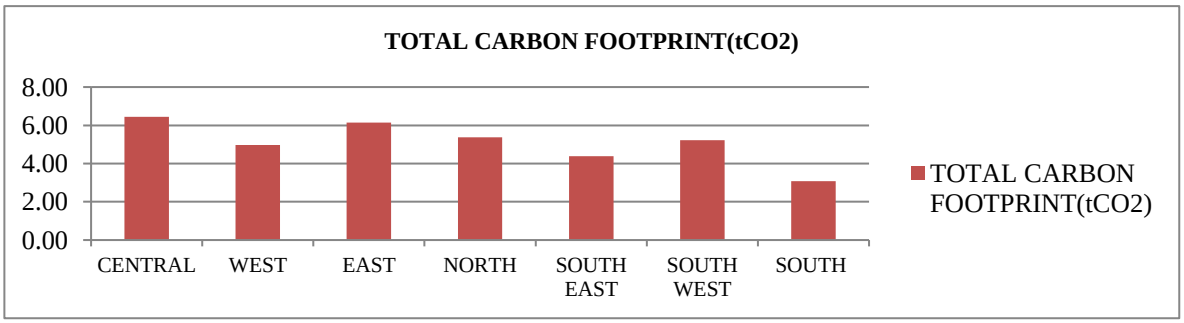

Figure-7: Average Carbon Emission and Surat City:

Total Carbon Footprint(approx.)Ton Of CO_2 (A): 261.1

Total number of people(B) : 50

Average = A/B= 261.1/50= **5.2 Tonnes of CO_2 per year**

Conclusion

At the end of this thesis I want to conclude that the carbon footprint has a great impact on our environment which is caused by our day to day activities. I have made a Google form to collect the data related to carbon footprint which has various factors like electricity consumption, LPG consumption, cylinder consumption; petrol etc. And I have concluded that the seven zones in Surat have different values of consumption and different values of emission of CO_2 which I have calculated with the help of a carbon footprint calculator (approved by ISO).

Total Carbon Footprint (approx.) Ton of CO_2 = 261.1 Ton Of CO_2

Average = **5.2 Tonnes of CO_2 per year**

Reference

1. Esther Sanyé-Mengual, Introduction to the Eco-Design Methodology and the Role of Product Carbon FootprintRaulGarcía Lozano, Ramon Farreny, Jordi Oliver-Solà, Carles M. Gasol and Joan Rieradevall, Introduction to the Eco-Design Methodology and the Role of Product Carbon Footprint, Assessment of Carbon Footprint in Different Industrial Sectors, 1,1-24, 2014.
2. Ahmed, A. Kaleel, C. B. Senthilkumar, and S. Nallusamy. "Study on environmental impact through analysis of big data for sustainable and green supply chain management." Int. J. Mech. Prod. Eng. Res. Dev. 8 (2018): 1245-1254.
3. J. Solís-Guzmán,A. Martínez-Rocamora ,M. Marrero, Methodology for Determining the Carbon Footprint of the Construction of Residential Buildings, Assessment of Carbon Footprint in Different Industrial Sectors, 1,49 - 83, 2014.
4. Kumar, Dipu, and Mohammad UL Hassan. "Experimentation and Performance Evaluation of Heat Recovery from Domestic Refrigerator." International Journal of Mechanical Engineering (IJME) 7. 3, Apr-May 2018; 41 50.
5. Hannah Ritchie and Max Roser,CO and Greenhouse Gas Emissions , December 2019.https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions
6. Global CO2 emissions in 2019Data Release: Global energy-related CO2 emissions flattened in 2019 at around 33 gigatonnes (Gt), following two years of increases Article — 11 February 2020https://www.iea.org/articles/global co2-emissions-in-2019
7. Trivedi, Prachi, and M. E. G. H. N. A. Sharma. "Impact of green production and green technology on sustainability: Cases on companies in India." International Journal of Mechanical and Production Engineering Research and Development (IJMPERD) (2017).
8. Pierre Friedlingstein1,2, Matthew W. Jones3, Michael O'Sullivan1, Robbie M. Andrew4, Judith Hauck5, Glen P. Peters ,Global Carbon Budget 2019 https://www.earth-syst-sci-data.net/11/1783/2019/
9. Our World in Data based on Global Carbon Project; Carbon Dioxide Information Analysis Centre; BP; Maddison; UNWPP jean-Robert Wells, Jean-Franc¸ois Boucher, Achille-Benjamin Laurent, and Claude Villeneuve,Carbon Footprint Assessment of a Paperback Book RESEARCH AND ANALYSIS, 16(2), 212 - 222,2012.
10. https://www.suratmunicipal.gov.in/
11. RAJA, P., and M. MUTHAIYAN. "GREEN BANKING-AWARENESS ON DEVELOPING PLANS IN PUBLIC SECTOR BANKS FOR FUTURE ENVIRONMENT." International Journal of Environment, Ecology, Family and Urban Studies (IJEEFUS) 9.4, Aug 2019, 67-74
12. https://www.suratmunicipal.gov.in/Content/Documents/TheCity/ADMINISTRATIVE%20ZONES%20Map.pdf
13. Jocelyn Timperley ,The Carbon Brief Profile: India, 2019. https://www.carbonbrief.org/the-carbon-brief-profile india
14. Shailesh, Carbon Footprint Calculation,2011 https://greencleanguide.com/calculate-your-carbon-footprint/
15. Bhalla, Rupa, and P. O. O. J. A. Mehta. "Green Hr: The Essence for Sustainability in the 21st Century." International Journal of Human Resource Management and Research (IJHRMR) 6.1 (2016): 1-6.
16. Carbon flux https://energyeducation.ca/encyclopedia/Carbon_flux
17. https://www.weforum.org/agenda/2019/06/chart-of-the-day-these-countries-create-most-of-the-world-s co2-emissions/
18. Awasthi, Rochna. "Effect of Green Marketing on Buying Preferences of Youngsters." International Journal of Sales & Marketing Management (IJSMM) 6.4: 1-6.
19. 5 Countries With The Smallest Carbon Footprints (& 5 With The Largest) BY REBECCA O'NEILL SEP 13, 2019