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Analyze on Carbon Emission due to Aircraft Movement and Carbon Reduction with Electric Vehicle

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Abstract: *Modern life is a way of living which has separated man from nature. But nature is all plants , animals, and other things in the world which are not made by people, and all the events and processes that are not caused by people. Though aviation system and airport operation are an important factor in our economy and business, emissions from aviation are a significant contributor to climate change. Air planes burn fossil fuel which not only releases CO2 emissions but also has strong warming non CO2 effects due to Nox (nitrogen oxides). If unmitigated, aviation emissions are expected to increase by two or three times by 2050. EVs are more efficient than fossil fuel vehicles and have few direct emissions. EVs remove emissions from the air, saving cyclists and pedestrians from breathing the dangerous CO2 gas. There will be a time when parts of the country, especially big cities, will have zero-emission zones. The fact that EVs don't produce any emissions will help reduce CO2 and other harmful green gases. This paper reveals the real facts occurring in the environment*

Key Words: *GHGs, EV , ICCTs, Air pollution, CO_2 , Vahan Dashboard, NEMMP.*

1. INTRODUCTION :

Due to concerns over climate change, pollution and depletion of fossil fuels and increase in energy costs, there has been a shift to EV from ICE globally. The total number of electric cars sold throughout the year in 2012 is almost equal to 1.3 lakh electric cars were sold every week in 2021. During the period 2019-2021, the market share of electric cars has more than tripled globally. It is a sign of environmental concern of human beings. In order to minimize the air pollution, Electric Vehicle (EV) can act as blessing in lowering the GHG emission. Electric Vehicles offer numerous advantages such as decreasing the pollution level and reduction in oil import bills etc. But electric cars still remain costlier by at least 30%, mainly due to imported batteries[1] .The main indicator of climate change performance is whether the atmospheric carbon dioxide concentration is increasing or decreasing.

2. STATEWISE INITIATIVE FOR ELECTRIC VEHICLE :

On the basis of data on the Government's e-vahan portal, UP has 2,76,217 EVs and Delhi has 1,32,302 EVs, which has close to half the number of EVs in UP. The three states that have the least EVs are Arunachal Pradesh, Mizoram and Meghalaya with 20, 20 and 28 EVs respectively. In total India has around 9.66 lakh EVs. Utter Pradesh alone has 29.6%(2.6 lakh) registration. Delhi has more than one lakh registration which is accounting for 12%. Ten states including UP, Delhi, Karnataka, Bihar , Maharashtra , Assam, Rajasthan, Tamil Nadu, West Bengal and Haryana have registered more than 25.000 EVs each and account for more than 87% of EVs registered between January 2017 and February 2022. Gujarat witnessed an 8.7 times increase in 2021, while Odisha and Kerala registered a 5 times increase. Based on the battery capacity , Gujarat government announced a subsidy of up to 15 lakhs , 5 lakhs, 1.5 lakh for 4-wheelers, 3-wheelers, and 2-wheelers respectively in 2021. Tamil Nadu government announced an offer of 100% road tax exemption till 30thDecember 2022 in addition to waiver on registration charges. Delhi government offers a purchase incentive of up to rupees 30,000/- per vehicle to the registered owner. Delhi Government aimed to increase electric vehicle share in total vehicle sales to 25% by 2024.

In 2018, 1,31,554 EVs were registered in India, this number jumped to 1,61,314 during 2019. In 2020, there was a dip in the number of EVs registered at 1,19,648.

In order to promote the adoption of electric and hybrid vehicles in the country, the Ministry of Heavy Industries had formulated the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME India) scheme in 2015.

Currently, Phase-II of FAME India scheme is being implemented for a period of 5 years with a total budgetary support of Rs 10,000 crore. Phase- II of the FAME India scheme had started on April 1, 2019.

"This phase focuses on supporting electrification of public & shared transportation and aims to support, through subsidies, 7090 e-Buses, 5 lakh e-3 Wheelers, 55000 e-4 Wheeler Passenger Cars and 10 lakh e-2 Wheelers," noted the Ministry of Heavy Industries in a press release.

According to data on Vahan Dashboard

Electric vehicles were registered from 2012 to 2021

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
EV Resisted	5495	3079	2433	9030	51129	87554	131554	164852	123528	324840

Table 1- Electric vehicles registration from 2012-2021.

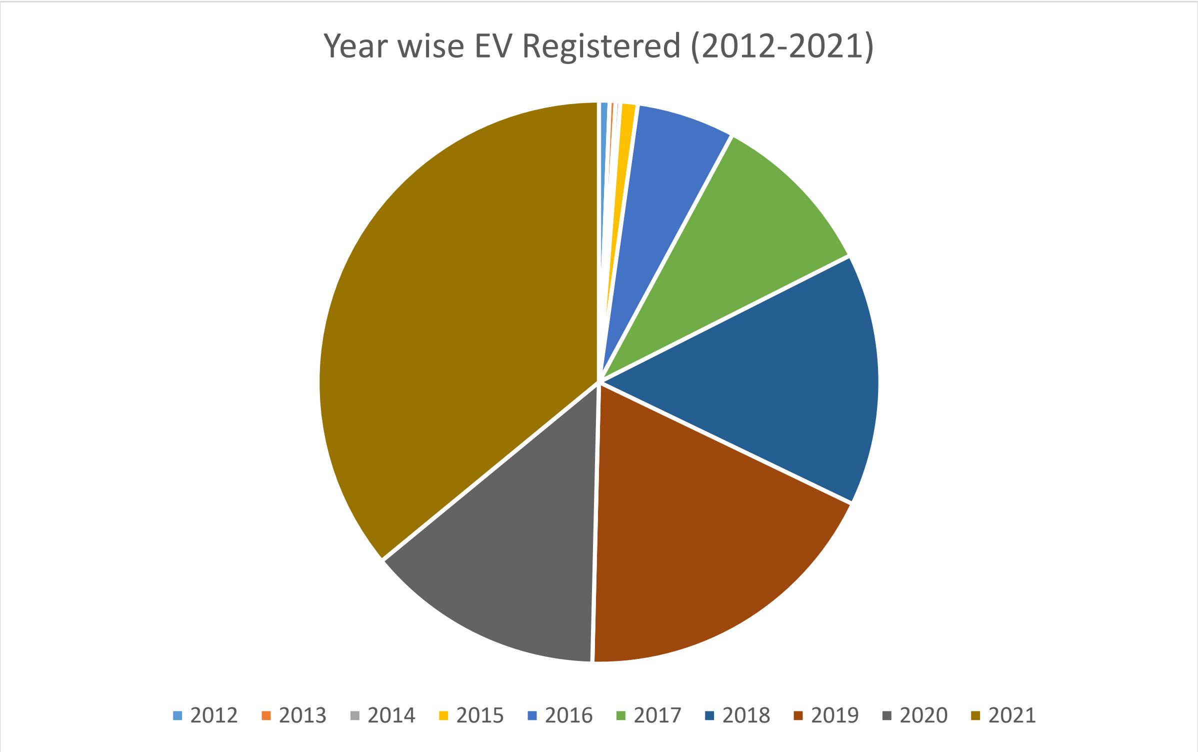

Figure 1- 2012 to2021 EV registration

Electric vehicles were registered from 2020 January to 2022 June.(month-wise)

Year	January	February	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
2020	16516	16337	14225	901	1327	6387	7767	8355	10838	11220	13224	15510
2021	16889	20598	27815	15117	3662	12534	28112	30931	36370	41488	44775	50899
2022	49676	54557	77234	72519	65813	72452						

Table 2 – Month wise EV registration

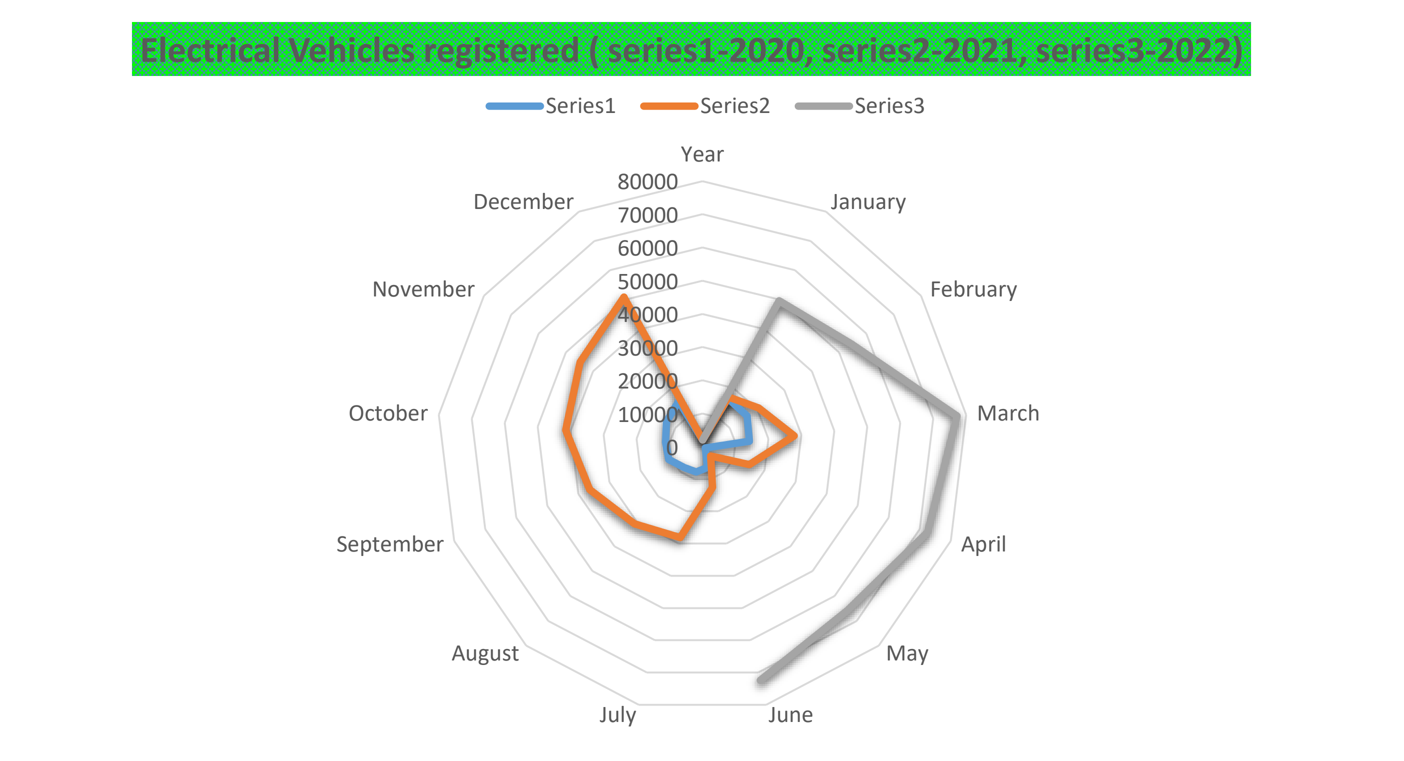

Figure 2 – Month wise EV registration(Jan 2020 to June 2022)

In the year 2021, the sale of electric vehicles increased significantly with a figure more than 3 lakh and 95 percentage of EV sold were 2-wheelers and 3 wheelers , which is more than the total number of electric vehicles registered between 2012 and 2018.

In order to boost EV manufacturing in the country and faster adoption of EV, the Government of India came up with National Electric Mobility Mission Plan (NEMMP) 2020 in the year 2012, which was successfully accomplished as per the data mentioned in the above table. Under Phase-I of the FAME India Scheme, More than 2.8 lakh electric vehicles were supported. Under Phase-II of FAME India Scheme commenced on 2019 , more than 2.31 lakh EVs have been supported till the beginning of march 2022.

Even though the state governments of India have announced subsidies for two , three and four wheeler electric vehicles, electric vehicles constitute only 1.9% of total vehicles registered in 2021. The VAHAN data revels that on 10th February 2022, nearly 28.28 crore vehicles have been registered in the country , of which 3.44% is electric vehicles [2]. Even though the overall vehicle registration has been dropped by 26% during the pandemic period of COVID-19, the registration of EVs is increased by 2.35 times. The registration of two-wheelers witnessed an increase by over five times in 2021.

Most of today's all-electric vehicles and PHEVs use **lithium-ion batteries**, though the exact chemistry often varies from that of consumer electronics batteries. Research and development are ongoing to reduce their relatively high cost, extend their useful life, and address safety concerns in regard to overheating. The batteries have mostly 240 wh power per kg of lithium that is the battery packs are very large and weighty. For bigger battery we add more weight on EV[3]. The actual CO2 emission of a conventional ICV and an EV through its production of life time using, CO2 for an EV is depends upon not only the power sources but also the battery production [4].

3. CARBON STATISTICS OF PETROL & DIESEL PRICE :

The increase of the price of petrol and diesel fuel is one of the reason for the introduction of electrical vehicles, especially the light motor vehicles. The Government policies are another reason for the same. But, many material purification processes is not environmental friendly[5]. India emits around 3 Giga tonnes of CO2 and other greenhouse gases per year. Nearly 25% of this emission occurs due to each and every types of road transport vehicles [6].

Petrol and Diesel price from April 2003 to April 2022.(in India)

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2016	2017	2018	2019	2020	2021	2022	2022
Month	April	June	April	April	April	April	April	April	April	April	April	April	April	April	July	July	July	July	June	July	Januar	April
Petrol/ Litre	33.49	35.71	37.99	43.5	43	45.5	44.7	48	58.5	65.6	66.09	72.26	60.49	59.68	62.51	63.09	75.55	72.96	79.76	99.86	95.41	105.45
Diesel/ Litre	22.12	22.74	28.22	30.45	30.25	31.76	30.86	38.1	37.75	40.91	48.63	55.48	49.71	48.33	54.28	53.33	67.38	66.69	79.88	89.36	86.67	96.67

Table 3 – Petrol& Diesel Price comparison (2003 to 2022)

4. FLIGHT MOVEMENT IN PANDEMIC PERIOD :

According to the traffic data complied with Ministry of Civil Aviation (MoCA), details of traffic handled, Flights movement in all airports in India

Particulars	2021, Aircraft Movement (in,000)	2020 Aircraft Movement (in,000)	2019 Aircraft Movement (in,000)
International	189.23	185.77	446.88
Domestic	1543.22	1154.10	2161.46
Total	1732.45	1339.87	2608.34

Table 4 – Flight movement in pandemic period .

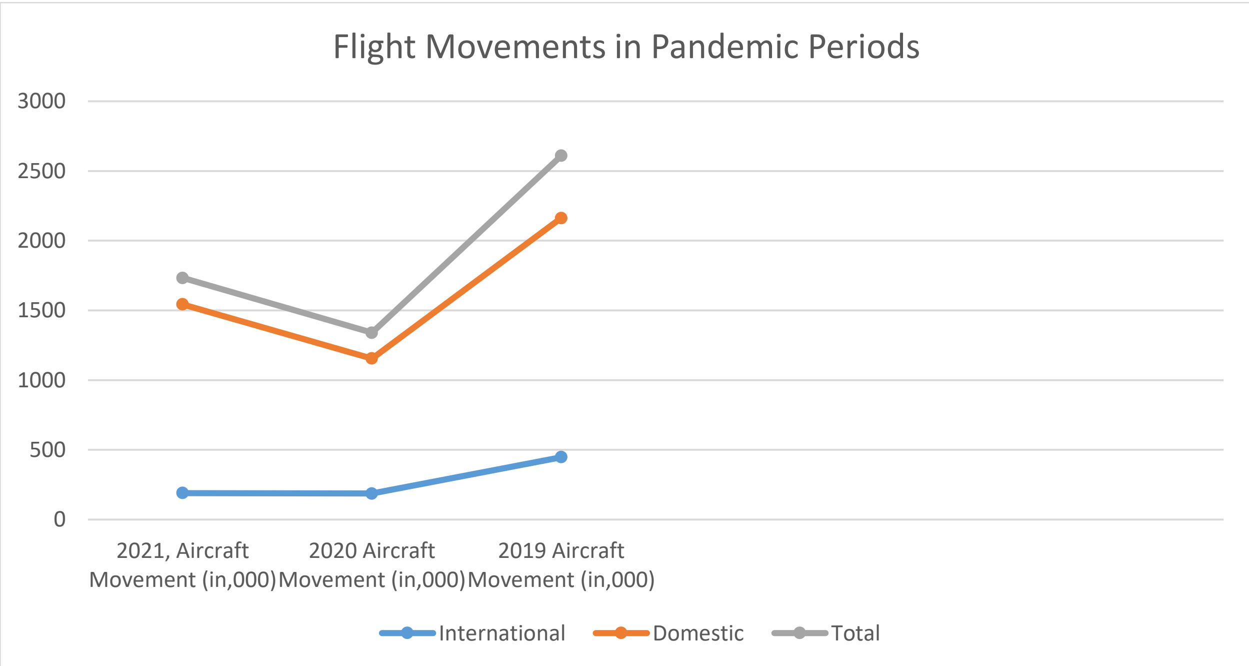

Figure 3 – Flight Movement in Pandemic periods(2019,20220,2021)

The World Airport Traffic Dataset is the industry's most comprehensive airport statistics dataset featuring airport traffic for over 2,600 airports in more than 180 countries and territories. In 2021 ,the top 20 airports , representing nineteen percentage of global traffic is mentioned here. 2021 global aircraft movements are close to 74 million, representing a gain of 18.7% from 2020 results or depreciation 28.2% versus 2019.

Today, there are over 41,700 airports all over the world according to central Intelligence Agency. The United States has the highest number of airports in the world, with 13,513 in total. In 2022, despite the coronavirus outbreak, the global aircraft fleet is expected to have **25,578 aircraft** in service worldwide.

The International Council on Clean Transportation (ICCT) developed a bottom-up, global aviation inventory to better understand carbon dioxide (CO2) emissions from commercial aviation in 2018. Passenger flights were responsible for approximately 85% of commercial aviation CO2 emissions. In 2019, this amounted to 785 million tonnes (Mt) of CO2. Between 2013 and 2019, passenger transport-related CO2 emissions increased 33%. The passenger air traffic increased nearly four times faster than fuel efficiency improved. The average value of CO2 emission is 177 kg CO2/kwh power, the lowest value is 121 kg CO2/kwh and highest value is 250 kg CO2/kwh[7].

The top five departure countries for passenger aviation-related carbon emissions in 2019 are the United States, China, the United Kingdom, Japan, and Germany. Flights departing airports in the United States and its territories emitted 23% of global passenger transport-related CO2 in 2019, two-thirds of which came from domestic flights. Collectively, the 28 members of the European Union (EU) were second behind the United States, having emitted 19% of the global passenger transport total. When adding China's 13%, these three largest markets were responsible for more than half of all passenger CO2 emitted in 2019. The top five countries for passenger aviation-related carbon emissions were rounded out by China, the United Kingdom, Japan, and Germany. CO2 emissions from aviation were distributed unequally across nations; less developed countries that contain half of the world's population accounted for only 10% of all emissions [8].

Four out of the top 10 departure countries with the most aviation emissions—China, Japan, India, and Australia—are located in the Asia/Pacific region. On average, global passenger aircraft emitted 90 g CO2 per RPK in 2019. Newer aircraft types like the Airbus A320neo (narrow body) and Boeing 787-9 (wide body) emit between 30% and 50% less CO2 per RPK than the most inefficient legacy aircraft

United States is both the largest aviation market and a particularly carbon-intensive one in terms of CO2 per RPK, it should adopt legally binding policies that require additional action to reduce greenhouse gases (GHGs) from aircraft as soon as possible. It is projected to be the single biggest source of emissions in the UK by 2050 due to the steadily increasing demand for flights [9].

Globally, two-thirds of all flights in 2019 were domestic. International operations increased faster than domestic operations over the time period: 47% versus 40% for ASKs and 52% versus 47% for RPKs. CO2 emissions from international flights increased by 35%, outpacing the 30% increase in emissions from domestic flights.

The least efficient route groups were flights within Africa and within the Middle East. These emitted more than 30% more CO2 to transport one passenger one kilometer than the global average. This is due primarily to the use of older, fuel-inefficient aircraft and low passenger load factors.

Four of the top 10 airports are in the Asia/Pacific region, three are in Europe, and two are in North America. Singapore Changi Airport had the least carbon-intensive flights of the top 10, with a CO2 intensity 8% lower than the global average. This could be attributed to the prevalence of low-cost air carriers with newer, more fuel-efficient aircraft making the airport their hub or focus city. Approximately 61% of passenger transport CO2 emissions in 2019 come from international aviation. International flights departing the United States emitted the most CO2.

A majority of operations from the United Kingdom (73%), the United Arab Emirates (>99%), Germany (75%), Spain (59%) and France (60%) were international in nature. In 2019, Dubai International Airport and London-Heathrow International Airport led all airports in CO2 emissions from international operations.

Domestic flights emitted 40% of global passenger transport-related CO2 emissions and made up two-thirds of all departures. Domestic operations accounted for a large majority of flights in a number of countries, including: Brazil, 93%; the United States, 91%; China, 89%; Indonesia, 88%; and Australia, 86%. These are all countries with large total area. Of the 230 nations and territories included in the Airline Operations Database, more than one-third had domestic flights account for 1% or less of total departures. The ruling is a major blow to the project at a time when public concern about the climate emergency is rising fast and the government has set a target in law of net zero emissions by 2050 [10].

Flights within mainland China, Hong Kong, and Macau accounted for 9% of both demand and CO2 from global commercial aviation passenger transport. Air travel within mainland China alone emitted 66 Mt of CO2 and supplied 747 billion RPKs. Approximately 324 MMT, or one-third of global aviation CO_2, will form the baseline for the voluntary phases of CORSIA between 2021 and 2026 [11].

CO_2 emissions by operation and aircraft seating class 2019, are as follows

Type	Wide body economy	Narrow body economy	Premium seating	Fright	Regional economy
Percentage	24	37	19	15	5

Table 5 – C02emission by aircraft 2019.

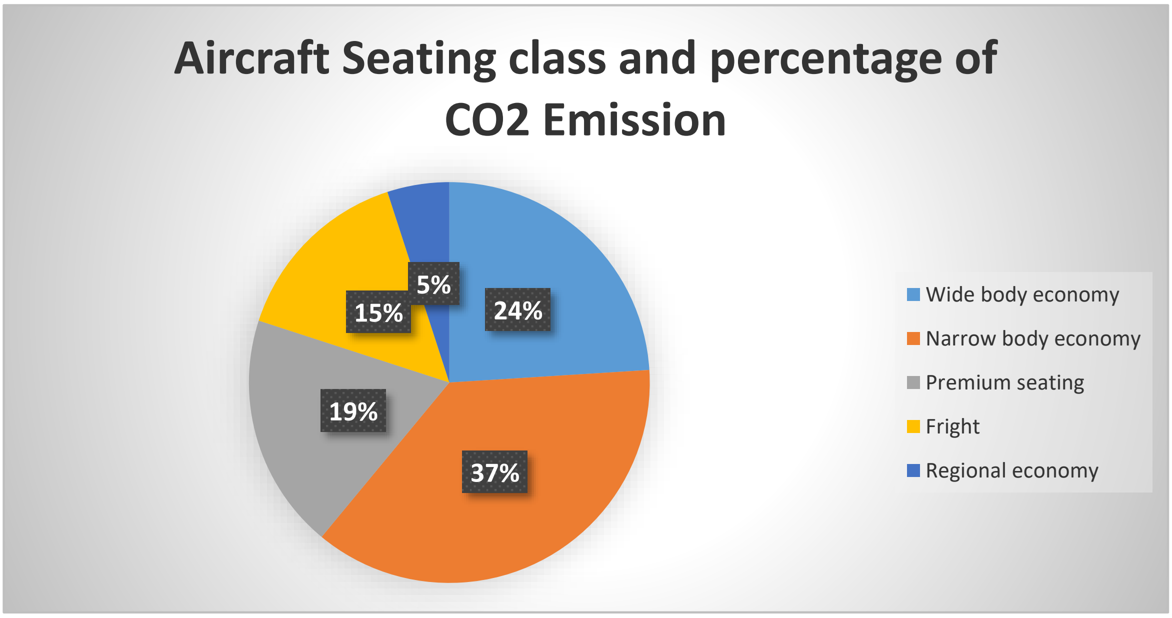

Figure 4 – CO2 emission by seating type.

Freight or passenger aircraft, fuel burn was apportioned to passenger and freight carriage using the following three equations:

Total passenger fuel use [kg] = (Total passenger weight [kg] Total weight [kg])(Total fuel use [kg]) .---(1)

Total passenger weight [kg] = (Number of aircraft seats)(50 kg) + (Number of passengers)(100 kg) .---(2)

Total weight [kg] = Total passenger weight [kg] + Total freight weight [kg]. ---(3)

The ten countries that produce the most emissions, measured in millions of tons of CO_2 in 2019.

Country	China	US	India	Russia	Japan	Germany	Iran	South Korea	Saudi Arabia	Indonesia
CO_2 in Million tons	10065	5416	2654	1711	1162	759	720	659	621	615

Table 6 – leading countries produce CO2 emission in 2019

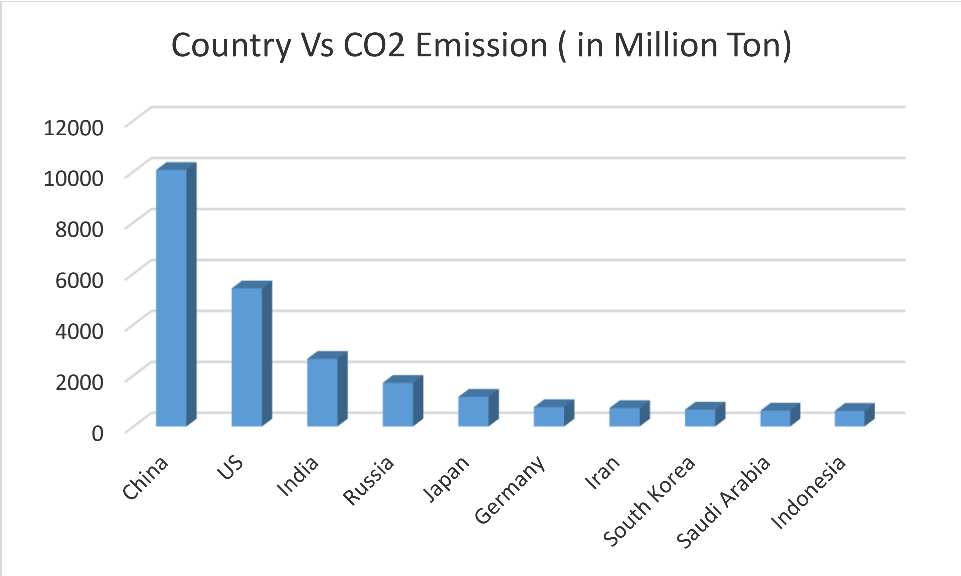

Figure 5 – Leading countries produce CO2

Aircraft movement (Landing and Takeoff) - the top 20 airports in the world.

Sl. No.	AIRPORT	2021	2020	Growth rate	Rank Position 2021	Rank Position 2020
1	ATLANTA GA, US	707661	548016	29.1	1	1
2	CHICAGO IL, US	684201	538211	27.1	2	2
3	DALLS/FORTH WORTH TX ,US	651895	514702	26.7	3	3
4	DENVER CO ,US	580866	436971	32.9	4	4
5	CHARLOTTE NC, US	519895	397983	30.6	5	6
6	LOS ANGELES CA,US	506769	379364	33.6	6	7
7	LAS VEGAS NE,US	486540	323422	50.4	7	10
8	PHOENIX AZ,US	408285	310324	31.6	8	13
9	MIAMI FL US	387973	251315	54.4	9	24
10	HOUSTON TX, US	378562	267655	41.4	10	21
11	SEATTLE WA ,US	374510	296048	26.5	11	14
12	GUANGZHOU,CN	362470	373421	-2.9	12	8
13	LONG BEACH CA ,US	350022	287478	21.8	13	16
14	SHANGHAI, CN	349524	325678	7.3	14	9
15	GRAND FORKS ND,US	349520	246905	41.6	15	26
16	SALT LAKE CITY UT,US	342519	276730	23.8	16	19
17	MEXICO CITY,MX	327889	239567	37.0	17	31
18	NEW DELHI,INDIA	327429	248580	31.7	18	25
19	SHENZHEN ,CN	317855	320348	-0.8	19	11
20	SANTA ANA CA,US	311684	238340	30.8	20	33

Table 7 – Landing and take off of aircraft –top 20 airports.

- CO_2 emissions from all commercial operations in 2019 totaled 918 million metric tons, an increase of 29% since 2013. 85% of emissions derive from passenger transport.
- On average, passenger aviation emitted 90 grams of CO_2 per passenger-kilometer in 2019, a decrease of 2% from 2018 and of 12% from 2013. Thus, airlines remain on track to meet their goal to improve fuel efficiency by 2%

per year for international flights. Smaller regional aircraft that are used on shorter flights emitted nearly 80% more CO2 per RPK than the global average for all aircraft

- The three largest passenger markets in 2019 were the United States (23% of CO_2), the European Union (19%), and China (13%). Collectively, they accounted for more than half of CO_2 from passenger operations.
- 19% of CO_2 from commercial aviation in 2019 was linked to passenger movement in premium seating (first and business classes), higher than the share from air freight. A passenger in premium class emitted 2.6 to 4.3 times more CO_2 per kilometer than a passenger in economy class, depending on aircraft class.
- CO2 emissions from aviation fuel are 3.15 grams per gram of fuel , which gives CO2 emissions from a Boeing 737-400 of 115 g per passenger per km. At a cruising speed of 780 km per hour [Wikipedia, 28.2. 08], this is equivalent to 90 kg CO2 per passenger per hour.
- Researchers calculated that aviation contributes around 4% to human-induced global warming,
- Research by the European Energy Agency found that, even with electricity generation, the carbon emissions of an electric car are around 17 – 30% lower than driving a petrol or diesel car.

5. CONCLUSION:

With a measure of ‘We are now burning 80 percent more coal than we were just in the year 2000’ , the scientific community has warned that if greenhouse gas emissions keep increasing, the planet will reach a point of no return. Global warming will become catastrophic and irreversible. This paper reveals the ejection of CO_2 with aviation system to the environment all over the world and reduction of CO_2 with introduction of Electric Vehicle in the developing countries, which is a motivation for protection of environment in the digital era.

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