



Science

## IMPACT EVALUATION OF CARBON DIOXIDE (CO<sub>2</sub>) IN BHOPAL DUE TO INCREASE IN NUMBER OF PASSENGER CARS

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### Abstract

India has been progressing steadily since last two decades in terms of affordability of commodity and purchasing power of the common man. This has given rise to demand which leads to the continuous economic growth. Of course, support from the Government of India as well as various state Governments has come in the form of reforms and infrastructure funding. However this growth has also seen the disadvantage of erratic consumption by wealthy persons as compared to the economically weaker sections, for example on one side there is heavy demand of passenger cars by the higher income group who uses it sparingly but on the other side people of the lower income group who are more in numbers have to rely on public transport. This imbalance creates a wider gap between public affordability to consume a particular commodity like passenger cars. On one side there are persons who buy the latest model introduced by the manufacturer in spite of having sufficient numbers at their disposal and on the other side basic lowest level model are out of reach of some persons in the society, who rely on two-wheeler or public transport which is not reliable.

This has not only created a huge gap in public expenditure but has also impact the environment. With year on year increase in number of vehicles in tier 2 cities like Bhopal, there is tremendous influence on the carbon dioxide (CO<sub>2</sub>) in and around the city. Past decade saw increase in maximum temperatures during summer rise by 3 – 4 degrees above normal in Bhopal and there is clear effect on the monsoon pattern too which has become inconsistent with rains reaching 120 mm in three days. Earlier this quantity was spread over a month. The last major season of winter is seen getting reduced to two months only from the earlier four, again with temperatures dropping suddenly below normal etc. This effect must be the result of increasing number of passenger vehicles in the city apart from other factors which also need detailed study for their influence.

**Keywords:** Progress; Passenger Cars; Transport; Affordability; Consumption; Carbon Dioxide; Effect; Temperatures; Weather; Environment.

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## 1. Introduction

In the last three decades, India has seen tremendous growth and its consumption of resources have increased rapidly, particularly in terms of metals, fossil fuels and biomass. According to an OECD report the world's consumption of raw material is set to nearly double by 2060 as the global economy expands and living standards rise<sup>1</sup>. The Global economic rise has also affected India which saw almost 8% growth in the past decade with employment requiring skilled manpower increasing. This demand created rise in payment levels too. Once there is surplus money in the hands of common man, consumption levels are set to rise. India is still a conservative place where people like to save more and spend less but this presumption is changing fast with the new generation of workers liking to spend lavishly. Companies too are supporting this pattern as it creates a demand – supply cycle which is much needed for economic growth. A study by the UN Sustainable Development has estimated that five people enter the middle class every second world over<sup>2</sup>. As per this report 3.6 billion people are middle class who spend Rs. 770.00 to Rs. 7700.00 per day (1\$ = Rs. 70.00, for this estimation). 200 Million People come under the rich category that spends more than Rs. 7700.00 per day per person. One person becomes rich every two seconds. According to this article, 41.6 Indian escape poverty every second and size of India's, middle class market by 2030 will become Rs. 861 trillion.

Although the demand in auto industry has seen a decline for the first time in decades, still there is growth in the sales of each manufacturer in year on year basis. Changing life styles, good living standards have resulted in seven time faster growth of SUVs as compared to passenger cars in 2017 - 2018<sup>3</sup>. Car Sales growth in 2017 – 18 was 3% against previous year, whereas SUVs/UVs were 21% in 2017 – 18 compared to previous year. Two Wheelers were also not behind with overall Scooter and Motorcycle growth recorded 34% putting pressure on the infrastructure and environment within cities in India. People here believe in show off more rather than necessity and this leads to more number of vehicles in one household than useful plus the high end luxury cars for showoff. These are the people belonging to the rich category who boast off spending more than Rs. 7700.00 per day.

Mr. Anand Mahindra, Chairman Mahindra Group is worried and find himself at crossroad for the first time in over 25 years at M&M<sup>4</sup>, because he feels that urban cities will be a living hell if new cars are added at the present rapid pace. The future will see explosion in sale of SUVs and cars, he feels. Companies now have to change from seeing themselves as car makers to mobility companies helping public to commute rather than congest the roads. Penetration in India is around 20 cars per thousand people, China is at 90 cars per thousand people and US is 750 cars per thousand. Even if we try to get to China, cities will be living hell. So, shared mobility must be encouraged. For newer

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<sup>1</sup> Resource Hungry World, The Economic Times, Bhopal dated October 30, 2018 (pg 12)

<sup>2</sup> More than Half the World is now Middle class, The Times of India, Bhopal dated November 11, 2018 (b/fp)

<sup>3</sup> SUV Sales grow 7x faster than cars, Pankaj Doval, The Times of India, Bhopal dated April 14, 2018 (pg 11)

<sup>4</sup> Cities will be living hell if car sales rise rapidly, Pankaj Doval, The Times of India, Bhopal dated February 07, 2018

cities India must promote robust mass transit network which should have last mile solution too, which is lacking in present scenario.

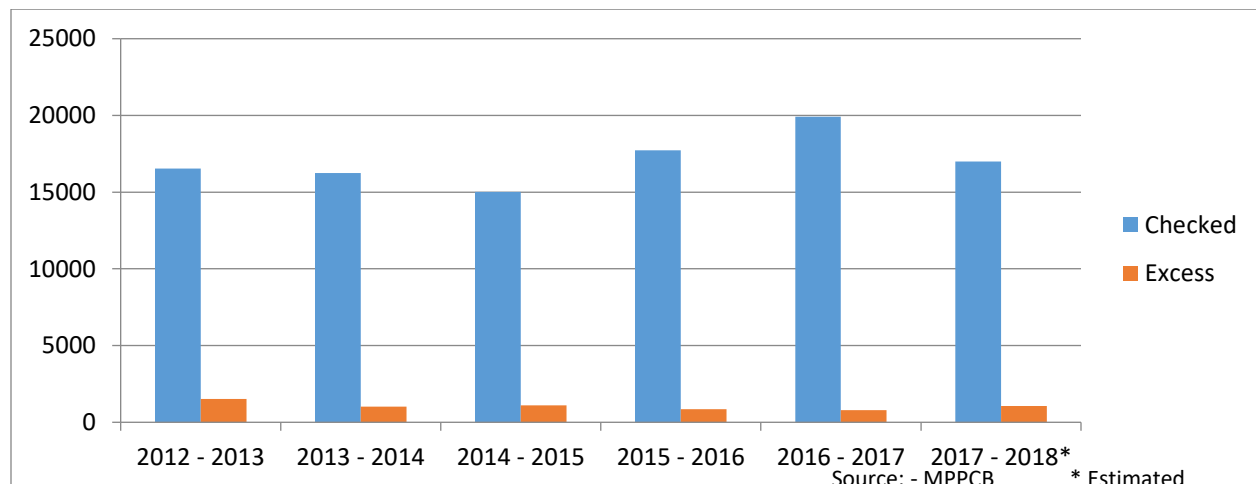
Air pollution is created due to Dust, Soot, Smoke, Droplets other than moisture, Oxides of Nitrogen, Sulphur and Particulate Matter. Main cause of air pollution in India is due to adulterated fuel and no rule for add-ons which reduces emission of pollutants, secondly due to high vehicle density, predominantly older vehicles in use for long period of time and inadequate maintenance. Badly maintained cars and public transport emits unburned hydrocarbons in the environment leading to pollution. Equipments designed to control the level of pollutants emissions do not function properly in poorly maintained vehicles. It is widely accepted that fine particulate emissions particularly the light absorbing black carbon from Diesel engines are harmful for environment. Countries witnessing strong growth in diesel vehicle numbers like India and China need to adopt black carbon emission control strategies at the earliest. As the table below shows, by 2030 India and China are projected to account for 2/3 of black carbon emission from global on road transportation.

Table 1:

% Share	2015	2020	2025	2030
US	12%	11%	10%	9%
RUSSIA	52%	41%	29%	26%
CHINA	84%	83%	80%	77%
INDIA	91%	88%	85%	82%

Source: World Bank<sup>5</sup>

In Bhopal, official record of MPPCB (Madhya Pradesh Pollution Control Board) show that around 1618 petrol vehicles monitored for emission norms and nearly 200 were found to have above permissible limits of pollutants emission<sup>6</sup>. In the recently published data on MPPCB web-site Vehicular Pollution found excess from the standard emission norms are as per the Graph below: -



Graph 1: (Number of Vehicles checked versus Number of Vehicles found to emit excess pollutants)

<sup>5</sup> Reducing Black Carbon Emissions from Diesel Vehicles 86485, dated April 12, 2014

<sup>6</sup> In Bhopal 3.3% of petrol vehicles emit excessive pollutants, The Times of India, Bhopal dated June 04, 2014

## 2. Material and Method: - Study of Co<sub>2</sub> Emissions from Passenger Cars

Sales of passenger cars has fallen the most from May 2018 to May 2019, a decline of almost 20% is seen which is highest in 18 years<sup>7</sup>. Still 2,39,347 passenger cars were added in the year as compared to addition of 3,01,238 in the previous period. Madhya Pradesh recorded new Vehicle Registrations as per table given below, from the Prashaskiye Prativedan 2014 – 2015<sup>8</sup> published on 10 Mar 2016 by the MP Road Transport Department, out of which rest of the numbers for passenger cars and further years registrations have been estimated on the basis of previous average increase (13.77%) and considering the downfall of 20% in the last financial year. Then in the same publication under Remarks it is mentioned that out of the total registered vehicles of 9721625 from 2001 – 2002 till 2014 only 611082 are passenger cars, taking this fact as applicable on the whole data the number of passenger Cars added every year have been calculated as under: -

Table 2:

Number of Cars registered in Years			
Year	New Registration MV	Percentage increase in new Registrations	Passenger Cars
2007 - 2008	500454	-	31529
2008 - 2009	513848	2.68	32372
2009 - 2010	623598	21.36	39287
2010 - 2011	813628	30.47	51259
2011 - 2012	859397	5.63	54142
2012 - 2013	667053	(-) 22.34	42024
2013 - 2014	911268	36.61	57410
2014 - 2015	1173321	28.76	73919
2015 - 2016*	1334829	13.77	84094
2016 - 2017*	1518569	-	95670
2017 - 2018*	1727601	-	108839
2018 - 2019*	1619886	-	102053

Another data available from the Ministry of Statistics and Program Implementation shows much more number of Motor Vehicle registrations in Madhya Pradesh during the same period<sup>9</sup>, which includes Loading Vans, Tractor & trolleys, Cars and Jeep etc., table 3 is given below, but the figures are too wary from the data of MP Transport dept. However similar table 4 is published by this Ministry of Statistics and program Implementation (MOSPI) for Registration of Motor Vehicles – Cities also which is given below (table 4):

<sup>7</sup> Passenger vehicle sales fall the most in 18 years, The Economic Times, Bhopal dated June 12, 2019

<sup>8</sup> Government of Madhya Pradesh, Transport Department, Departmental Annual Prashaskiye Prativedan, Year 2014 – 2015 dated March 10, 2016

<sup>9</sup> Total Registered Motor Vehicles – State-wise, As on 31 March, <http://mospi.nic.in/statistical-year-book-india/2016/189>

Table 3:

Year	New Registration MV
2007 - 2008	5523000
2008 - 2009	6011000
2009 - 2010	6591000
2010 - 2011	7356000
2011 - 2012	8144000
2012 - 2013	8873765
2013 - 2014	9668923
2014 - 2015	10535333
2015 - 2016*	11479380
2016 - 2017*	12508021
2017 - 2018*	13628836
2018 - 2019*	14850085

The figures are not matching with the data of MP Transport dept.

The figures for Bhopal city in table 4 are quite close to the data in table 2 of MP Transport dept. The estimation of Passenger Car Registration for Bhopal is taken from the same and combined with the report of MP Transport dept wherein under remarks it is mentioned that out of total 9721625 MVs plying in the state, 611082 or 6.3% are passenger cars in the state.

Table 4:

Year	New Registration MV in Bhopal	Estimated @ 6.3% as Passenger Car Registrations
2007 - 2008	571000	35973
2008 - 2009	617000	38871
2009 - 2010	674000	42462
2010 - 2011	755000	47565
2011 - 2012	829000	52227
2012 - 2013	894603	56360
2013 - 2014	965398	60820
2014 - 2015	1041795	65633
2015 - 2016*	1124238	70827
2016 - 2017*	1213205	76432
2017 - 2018*	1309212	82480
2018 - 2019*	1150974	72511

TOTAL of Column 3: - 702162

Hence, Considering the data published by MOSPI (table 4), based on which the carbon dioxide emissions are being estimated for the present period as well as prediction for the next five years then the total number of Vehicles for Bhopal city added in FY 2017 – 2018 will be 1.3 million (13.09 Lac) and for FY 2018 – 2019 it will be 1.1 million (11.50 Lac), out of which 82480 and 72511 are passenger cars respectively. According to the Environmental watchdog “Greenpeace”, Delhi, Odisha, uttar pradesh and Madhya Pradesh regions are among the top 50 global hotspots

for Nitrogen dioxide emissions mainly from vehicular emissions<sup>10</sup>. Air Quality Index shows a combined effect of PM<sub>2.5</sub>, PM<sub>10</sub>, NO<sub>2</sub>, SO<sub>2</sub>, O<sub>3</sub>, NH<sub>3</sub> and CO. Data on the Website of MPPCB<sup>11</sup> shows levels of these pollutants for Industrial Cities like Dewas, Pithampur, Mandideep and Ujjain only etc. on Monthly basis, and AQI at a glance for all major cities of MP on daily basis. The calculation is based on the AQI data for last 10 days for Bhopal City and Gaseous Status for April, May and June data for Mandideep. Analysis of AQI shows consistently in the range of 113 to 116 for Bhopal which comes under 'moderate' category having range of 101 to 200. Similarly the NO<sub>2</sub> and CO status after analyzing the gaseous data show in the range for NO<sub>2</sub> 7.7 ~ 76.3 and for CO 0.26 ~ 1.59

Analysis Shown Below:

Table 5:

<b>AQI Status at a Glance in Bhopal</b>			
<b>Date</b>	<b>AQI</b>	<b>Category</b>	<b>Range</b>
16-Jul-19	116.2	Moderate	101 - 200
17-Jul-19	115.8	Moderate	101 - 200
18-Jul-19	115.8	Moderate	101 - 200
19-Jul-19	115.5	Moderate	101 - 200
20-Jul-19	Sat OFF	Moderate	101 - 200
21-Jul-19	Sun OFF	Moderate	101 - 200
22-Jul-19	115.9	Moderate	101 - 200
23-Jul-19	115	Moderate	101 - 200
24-Jul-19	113.8	Moderate	101 - 200
25-Jul-19	113.8	Moderate	101 - 200
26-Jul-19	113.8	Moderate	101 - 200
27-Jul-19	113.8	Moderate	101 - 200

Table 6:

<b>Gaseous Status of Apr 2019 for NO<sub>2</sub> and CO at Mandideep</b>					<b>Standard</b>
NO <sub>2</sub>	27.1	8-Apr-19	76.3	5-Apr-19	80 microgm/cu mtr
CO	0.52	1-Apr-19	1.59	23-Apr-19	4 microgm/cu mtr
<b>Gaseous Status of May 2019 for NO<sub>2</sub> and CO at Mandideep</b>					<b>Standard</b>
NO <sub>2</sub>	14.6	5-May-19	45.6	1-May-19	80 microgm/cu mtr
CO	0.26	9-May-19	0.77	1-May-19	4 microgm/cu mtr
<b>Gaseous Status of Jun 2019 for NO<sub>2</sub> and CO at Mandideep</b>					<b>Standard</b>
NO <sub>2</sub>	7.7	3-Jun-19	23.4	13-Jun-19	80 microgm/cu mtr
CO	0.29	29-Jun-19	0.85	8-Jun-19	4 microgm/cu mtr

<sup>10</sup> Report: Delhi, Odisha, UP-MP among the world's NO<sub>2</sub> hotspots, The Times of India, Bhopal dated October 30, 2018

<sup>11</sup> MPPCB web site - <http://www.mppcb.nic.in/>



Considering data of table no 4, total passenger cars plying in Bhopal are 702162, no addition has been considered for the current financial year. According to an article in Financial Express the Maruti Suzuki make Cars are found to be most efficient in terms of CO<sub>2</sub> emissions<sup>12</sup> and Toyota Cars are the worst in terms of CO<sub>2</sub> emissions. Therefore, for estimating the emissions of CO<sub>2</sub> in Bhopal, taking the most efficient emission @ 109.5 g per Km of Maruti cars and considering average run of Total cars as 20 Km in a day, the total emission is arrived at 702162 multiplied by 20 multiplied by 109.5g = 1537734287 g/day or 1538 metric ton/day. Similarly taking the worst condition of emission @ 160.7 g/Km with all the other data remaining same, the total emission will be 2257 metric ton/day.

Therefore, it can be reasoned that on an average the CO<sub>2</sub> emission in Bhopal is estimated at 1265 metric ton per day. The MPPCB data which considers other gaseous substances or the AQI do not consider CO<sub>2</sub> for arriving at ambient quality of air, has been mentioned above just to arrive at this conclusion that results are not affected by AQI status or Gaseous status.

Prediction for next five years based on best and worst emission conditions, taking increase in number of passenger cars depending on the last two financial year registrations.

Table 7:

Year	New Registration MV - Statewise	New Registration MV - Cities	Passenger cars out of MVs
2017 - 2018*	13628836	1309212	82480
2018 - 2019*	12124318	1150974	72511
2019 - 2020	8584385	820063	51665
2020 - 2021	9263410	884930	55751
2021 - 2022	9996146	954928	60161
2022 - 2023	10786841	1030462	64920
2023 - 2024	11640080	1111972	70055
		Increase	302552

The prediction is very conservative taking into account reduction in sales in the last financial year by 20%. The additional CO<sub>2</sub> emission in Bhopal due to addition of 3.02 Lac cars will be 546 metric ton apart for the present emissions. Total shall then be 1811 metric ton per day or 47090 metric tons per month (considering 26 working days in the month) and a whopping 12431787 metric ton per year (considering 264 working days in the year).

This will be a very grim situation for the next five years, with total emissions of 12.43 million metric ton per year (this is a very conservative assumptions that too only for passenger cars leave aside other modes of vehicles which are plying in Bhopal city emitting Carbon dioxide and therefore actual will be definitely much more than this figure) leading to climate change?

<sup>12</sup> CO<sub>2</sub> Emissions: Maruti Suzuki Cars most Efficient, Toyota Kirloskar least, Pritish Raj, Financial Express, New Delhi dated June 21, 2019

### 3. Other Articles Reviewed

None of the article was found to Study the vehicular emissions in Bhopal, however during the search for supporting material for this article, related papers found were as under: -

- 1) India Specific Road Transport Emission factors, India GHG program, Mumbai, by Mr. Chirag Gajjar & Mr. Atik Sheikh. This article covered all the GHG emissions from all types of vehicles and Road transport sector with coverage all over India; where as present study was focused on CO<sub>2</sub> emissions from passenger cars and particularly for Bhopal City.
- 2) Vehicle Monitoring for the Year 2016 – 2017 by MPPCB. This paper covered the number of vehicles checked for emissions in the state of MP for petrol and diesel vehicles. It also mentioned number of violations in Bhopal City but does not show the parameters for the emissions like which gas was specifically checked and what the standards against which, such violations were found.
- 3) Analysis and Monitoring of Ambient Air Quality in Rewa (MP) city, Mr. Satya Singh, Ms. Riya Shrivastava & Ms. Arpana Mishra, Published in International Journal of Engineering Sciences & Research Technology [singh\*et al.,7(8): August 2018], covers monthly variations of all types of gases as is done by MPPCB and that too for Rewa City only. Role of vehicular pollution has not been considered particularly by this paper.
- 4) Air Quality Monitoring and Effects of Air Pollution on Animal Health in Bhopal India. Rather, Parvaiz. International Journal of Modern Biology and Medicine. (2014). 5. 100-110. This paper has taken into account emission from fossil fuels but again refers to pollutants such as SO<sub>x</sub>, NO<sub>x</sub> and particulate matter and it effect on animal health. This article was also not found to cover what the present study intends to present.
- 5) Motorized Passenger Travel in Urban India – Emissions & Co-Benefits Analysis, Dr. Sarath Guttikunda, June 2009 in Simple Interactive Model (SIM) for better Air quality, is a very elaborate report covering energy consumption, trends in four modes of transport like buses, motorcycles, 3-wheelers and passenger cars, emission analysis of all types of gases like particulate matter, NO<sub>x</sub>, CO and CO<sub>2</sub> etc. falling short for specifically Bhopal city and impact of increase in emission levels.

### 4. Conclusion

The average CO<sub>2</sub> emission in present day of 1265 metric ton per day is already very huge, leave apart the increase in next five years and this figure is accounted for passenger cars only, if all the Motor Vehicles and commercial Vehicles are accounted, this figure will definitely cross limits of standard set under the Bharat standards for emission and Fuel quality. An article which covered Delhi says that contribution of transport sector in PM<sub>2.5</sub> is 28%, out of which cars contribute the least Of 3.4%<sup>13</sup>.

Another Research paper by the European environment Agency which monitored CO<sub>2</sub> emissions from passenger cars in 2016 vide Report number EEA 19/2017<sup>14</sup> for the European Union where CO<sub>2</sub> emissions for the most efficient car is 118 g/Km and the worst performing car is 140 g/Km.

<sup>13</sup> Let only CNG Vehicles Ply in Delhi on bad air days: EPCA, Ritam Halder, The Times of India, Bhopal dated Nov 13, 2018

<sup>14</sup> Monitoring CO<sub>2</sub> emissions from new passenger cars and vans in 2016, EEA Report No. 19/2017, European Environment Agency publication, Luxembourg



It saw a reduction of 4 g/Km per year after the enforcement of a new legislation in 2009. India should also initiate such kind of legislation in order to contain the CO<sub>2</sub> emissions to below 100 g /Km and incentivize the manufactures who and bring it down to 50 g/Km as is being done in European Union by way of Super credit system referred in the article.

Air Pollution is recognized as threat to human health with World Health Organization (WHO) saying that India tops in under- 5 deaths due to toxic air, 60000 killed in 2016<sup>15</sup>. Over 2 million deaths occur prematurely in India due to pollution accounting for 25% of the global deaths due to air pollution. This will aggravate with the increase of CO<sub>2</sub> emissions from the increasing vehicular traffic until unless drastic remedial measures are taken like stringent emission standards, mandatory scheduled maintenance of all vehicles, banning diesel vehicles, complete ban on adulteration of fuel as well as increase in green cover in cities which are fast becoming concrete jungles in the name of development.

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<sup>15</sup> India tops in under-5 deaths due to toxic air, 60000 killed in 2016: WHO, Sushmi Dey, The Times of India, Bhopal dated Oct 30, 2018

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