

ENVIRONMENTAL IMPACT OF VEHICLE EMISSION: REVIEW

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Abstract: Vehicle emissions pose a significant silent threat to the environment, impacting air quality, climate change, and human health. This paper reviews the sources, composition, and environmental effects of vehicle emissions. Through a comprehensive review of scientific research and studies, it aims to raise awareness about the detrimental consequences of vehicle emissions and the urgent need for sustainable transportation alternatives. Overall, this paper explores a comprehensive resource to understand the environmental effects of vehicle emissions, creating awareness and inspiring action towards adopting cleaner and sustainable transportation solutions.

Keywords: environment, vehicle emissions, sustainable transportation, review, etc

1 INTRODUCTION

In recent years, the environmental impact of vehicle emissions has emerged as a topic of escalating concern. As people become more conscious of climate change and the importance of cutting down on greenhouse gas emissions, the effects of vehicles on the environment have become a major concern. This paper aims to explore the environmental impact of vehicle emissions, covering their sources, impact on nature, and measures to lessen their effects, all in a comprehensible manner.

Vehicle emissions are the gases and particles that are released into the atmosphere by vehicles. The emissions from vehicles come from a variety of sources, including the exhaust system, fuel evaporation, and the wear and tear of tires and brakes.

These emissions from vehicles add to the pollution in the air, which can have negative effects on both the environment and people's health. These emissions contribute to air pollution, which can be harmful to the environment and human health.

Many countries have put restrictions on the quantity of pollutants that cars can emit into the air in order to lessen the detrimental impacts of automobile emissions. Catalytic converters, cleaner fuels, and other technologies that lessen the quantity of dangerous pollutants emitted into the air are frequently used in order to comply with these regulations. The release of heat into the air from burning fuels is commonly known as thermal air pollution. A rise in temperature at a particular place beyond its usual ambient air temperature can suggest the presence of thermal air pollution in that area. The Earth's average temperature remains stable because there is a constant equilibrium between the energy it receives from the sun and the heat it releases back into space. Any disturbance in this balance can result in a shift in the average temperature of the earth's surface. The sun's energy gets to the Earth's surface without any problems, warming it up and making it bright. However, the heat energy that goes back into space as infrared radiation can't easily move through the air. This is because water vapor and carbon dioxide (CO₂) in the air absorb this kind of radiation. This creates a greenhouse effect, trapping heat in the atmosphere and hindering its

escape into space. As more CO₂ is produced by the burning of fossil fuels, it can cause further hindrance to the escape of infrared radiation from the earth's surface, leading to a warming of the earth's surface.

2 Greenhouse Effect: To prevent severe climate change we need to rapidly reduce global greenhouse gas emissions. The world emits around 50 billion tonnes of greenhouse gases each year. Greenhouse gas emissions from vehicles are a significant contributor to global climate change. When vehicles burn fossil fuels, such as gasoline or diesel, they release carbon dioxide (CO₂) and other greenhouse gases into the atmosphere. These gases trap heat from the sun and cause the Earth's temperature to rise, leading to a range of negative impacts, including more frequent and severe weather events, sea level rise, and damage to ecosystems and human health.

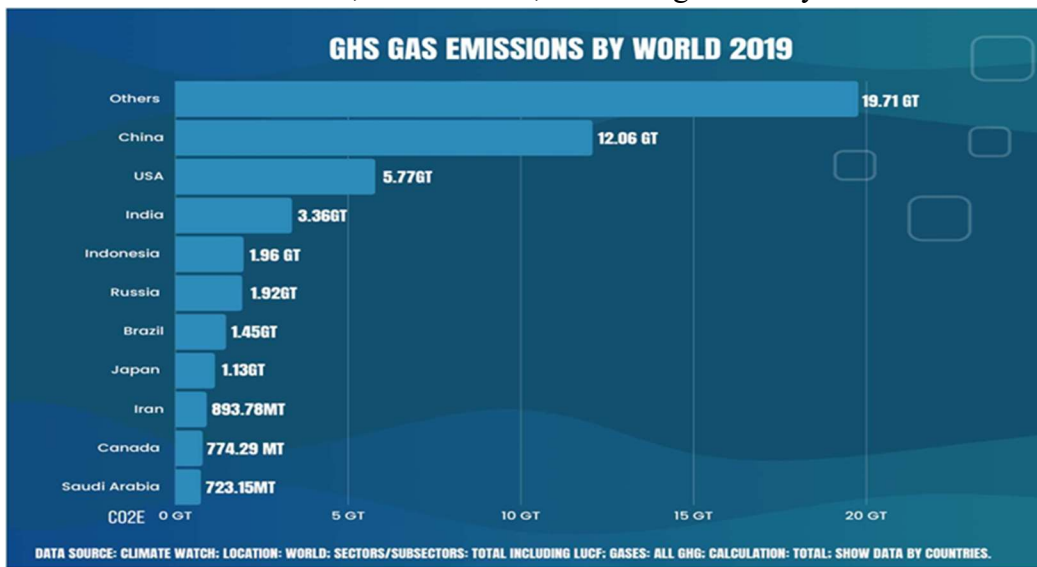


Figure 1: Greenhouse effect on world

The transport sector contributes around 14% towards the global emissions of greenhouse gases. Carbon dioxide represents the largest proportion of basket of greenhouse gas emissions. During, the past three decades, carbon dioxide emissions from transport have increased faster than those from all other sectors and are projected to increase more rapidly in the future. The Road transport alone emits around 16% of the global CO₂ emissions (Source: OICA). From 1990 to 2021, carbon dioxide emissions from the world's transport sector have increased by 37%. For the same period, road transport emissions have increased by 29% in industrialized countries and 61% in the other countries (IEA, 2006). The global emissions of GHG's from different sectors have been shown in figure

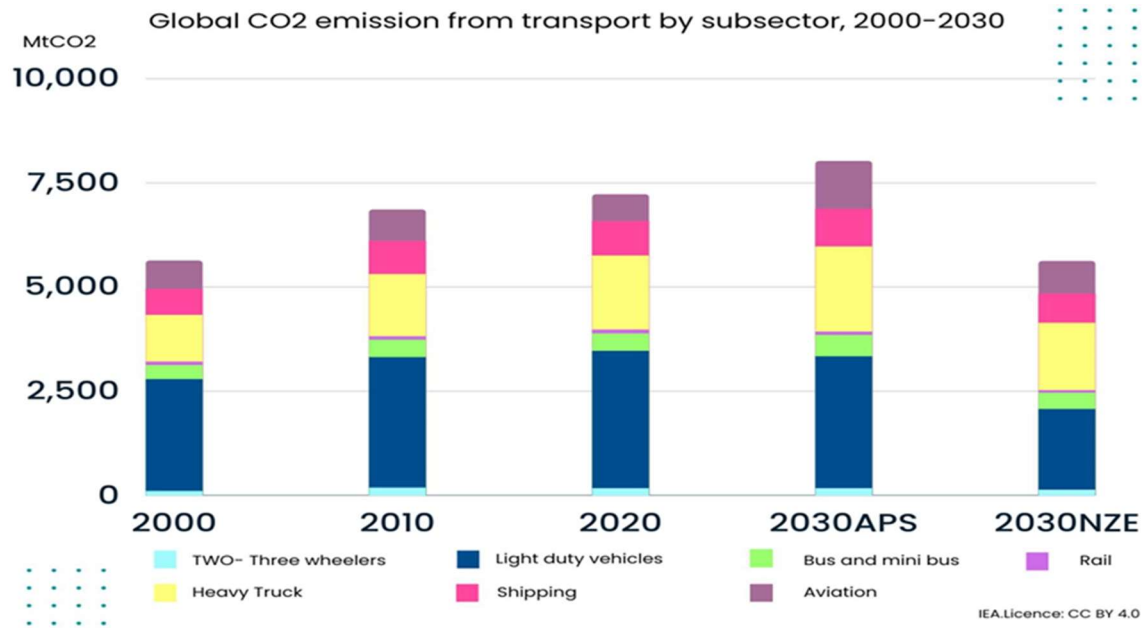


Figure 2: Global Co₂ Emission from transport sector

3 EFFECTS ON AGRICULTURE: Vehicles can have several negative effects on agriculture, particularly on soil and crop health. One of the main effects of vehicles on agriculture is soil compaction. Heavy vehicles, such as tractors and trucks, can compress the soil and reduce its porosity, which can make it more difficult for plant roots to penetrate and access nutrients and water. This can lead to reduced crop yields and lower quality produce. Vehicles can also contribute to soil erosion, especially when driven over unprotected soils or on steep slopes. The disturbance caused by vehicle wheels and treads can increase the likelihood of soil erosion, which can result in the loss of topsoil and the degradation of soil quality. In addition to soil impacts, vehicle emissions can also have negative effects on crop health. Air pollution caused by vehicle emissions can reduce the amount of sunlight reaching plants, as well as damage plant tissues and reduce the efficiency of photosynthesis. This can lead to stunted growth, reduced yields, and lower quality produce.

4 GLOBAL WARMING – One of the leading effects of vehicular pollution is global warming. Vehicular pollution results in the emission of greenhouse gases into the atmosphere, which results in the depletion of the ozone layer and an increase in atmospheric temperature, leading to global warming. As a result, it contributes to adverse weather such as heavy rains, flooding, and extremely high or cold temperatures linked to the loss of lives, destruction of property, damage to the soils, and sometimes even adversely impacting agriculture. - Vehicular pollution has destroyed the air so much that in some countries, people have to wear face masks, to reduce the number of harmful substances inhaled. In the US particularly, vehicles produce about a third of the nation's air pollution. It makes living in such cities uncomfortable, having to walk around with a mask all day, let alone the fact that there are possibilities of developing health complications. The air in such areas is filled with various kinds of pollutants, which greatly reduce the air quality index. Vehicles produce a lot of emissions, and can at times make visibility a problem, especially if an old vehicle or a truck carrying a lot of loads drives by. Such vehicles produce a lot of smoke, which hampers

visibility making one unable to see what is in front. This means that if you were driving behind such a vehicle, visibility would be affected, even if it is for a few seconds.

☐ **Acid Rains** - One of the gases produced by vehicles is nitrogen oxide and it contributes to the formation of highly corrosive smog which results in the rusting of vehicles and the corrosion of structures. When the nitrogen oxide dissolves in rain, acid rain is produced, which can significantly reduce the lifespan of buildings made by limestone and marble if they come into direct contact. Besides, any water harvested from this type of rain is not fit for human and animal consumption and can cause stunted growth in plants.

☐ **Effects on Tourism** - Because of the adverse effects of vehicular pollution, especially the formation of smog, tourism ends up being affected. Most people are not willing to visit cities or countries that are not going to be good for their health or knowing that their visit could lead to their premature death. The decrease in tourism results in the loss of foreign exchange income

☐ **Principal Harmful Components in Vehicular Emission**

The seven items that are classified as being “critical pollutants” contained in vehicular emissions are:

1. Lead (Pb)
2. Nitrogen Oxides (NOx)
3. Particulate Matter (PM) – PM10 and more so PM2.5
4. Sulphur Oxides (SOx)
5. Ozone (O3)
6. Carbon Monoxide (CO)
7. Benzene

Table 1. Vehicles emit significant amounts of several pollutants with varying effects as summarized.

Pollutant	Health Effect					Climate Change	
	Direct	Indirect	Acid rain	Eutrophication	Visibility	Direct	Indirect
HC	X						X
CO	X	X _a					X
NO _x	X	X _a	X	X	X	X	
PM	X				X	X	
SO _x	X		X		X		X

CO = carbon monoxide, HC = hydrocarbon, NOx = nitrogen oxides, PM = particulate matter, SO₂ = sulfur oxide, a Ozone

Table 2: Pollutants effect on human health (Source: CPCB)

Pollutant Effect on Human Health	
Carbon Monoxide (CO)	Affects the cardio vascular system, exacerbating cardiovascular disease symptoms, particularly angina; may also particularly affect fetuses, sick, anemic and young children, affects nervous system impairing physical coordination, vision and judgments, creating nausea and headaches, reducing productivity and increasing personal discomfort.
Nitrogen Oxide (NO)	Increased susceptibility to infections, pulmonary diseases, impairment of lung function and eye, nose and throat irritations.
Sulphur Dioxide (SO₃)	Affect lung function adversely
Particulate Matter and Respirable Particulate Matter (SPM and RPM)	Fine particulate matter may be toxic in itself or may carry toxic (including carcinogenic) trace substance, and can alter the immune system. Fine particulates penetrate deep into the respiratory system irritating lung tissue and causing long-term disorders.
Hydrocarbon	Potential to cause cancer
Lead	Impairs liver and kidney, causes brain damage in children resulting in lower I.Q., hyperactivity and reduced ability to concentrate.
Benzene	Both toxic and carcinogenic. Excessive incidence of leukemia (blood cancer) in high exposure areas.

□ **IMPACT OF SPECIFIC POLLUTANTS ON HUMAN HEALTH:** Many studies have been conducted over the years by leading Indian institutions such as Patel Chest Institute, AIIMS, Chittaranjan Cancer Institute, PG Medical College and Ramachandra Medical College of serious medical conditions that were attributable to a variety of toxins present in the ambient air, an important component of which is vehicular emissions. the “10 leading causes of death in the world, 2000 and 2011” lists ischemic heart disease at No.1, stroke at No.2, lower respiratory infections at No. 3, COPD at No. 4 and diarrheal diseases at No. However, apart from global figures, the WHO also separately reports for Low Income Countries, where lower respiratory infections have been the No. 1 killer, followed by HIV/AIDS, diarrheal disease, stroke and ischemic heart disease. As the evidence has mounted linking exposure to traffic emissions with adverse human health conditions, increasingly the focus has been to identify the more virulent elements in traffic pollution – even as one, namely lead has been removed – and increasingly strict restrictions placed on emissions and fuel quality. There has also been a shift away from mere correlation and towards developing causal linkages.

□ **Role of Alternative Fuels in Reducing Vehicular Pollution**

□ **Bio Fuels**

Biofuels, such as ethanol and biodiesel, are derived from organic matter and can be used as alternative fuels in vehicles. They are renewable and produce fewer emissions than conventional gasoline and diesel. They can also reduce the dependence on foreign oil and support local agriculture. However, the production and distribution of biofuels can have negative impacts on land use and food production.

□ **Hydrogen fuel cell vehicles**

Hydrogen being a clean, reliable and sustainable source of energy has been recognized as a fuel for the future. Hydrogen fuel cell vehicles use hydrogen gas to generate electricity, producing only water vapor as a byproduct. They have the potential to significantly reduce vehicular emissions and are highly efficient. However, the infrastructure for producing and distributing hydrogen is currently limited and expensive.

Table 3 : Comparison of Vehicular Emission from Different Fuel

Pollutant	Gasoline engine	Petroleum engine	Hydrogen engine
CO	✓	✓	X
HC	✓	✓	X
NO _x	✓	✓	✓
PM/Smoke	X	✓	X

Hydrogen is a carbon neutral fuel. The only pollutant from an Internal Combustion Engine powered by hydrogen is NO_x, which is extremely low

□ **Electric Vehicles**

Electric vehicles (EVs) use electricity as their primary fuel source. They are powered by rechargeable batteries that store electrical energy. EVs are becoming increasingly popular, and the electricity used to charge them can come from a variety of sources, including renewables like solar or wind power.

EVs have the potential to reduce greenhouse gas emissions and air pollution. While the emissions associated with an EV depend on the source of electricity generation, even when charged with electricity from fossil fuels, EVs tend to have lower emissions compared to conventional vehicles due to the higher efficiency of electric motors. As the electricity grid becomes cleaner with the increasing share of renewable energy sources, the environmental benefits of EVs further improve.

□ **Compressed Natural Gas (CNG)**

Compressed Natural Gas (CNG) is a type of alternative fuel that is used as a substitute for gasoline, diesel, or propane. It is made by compressing natural gas to less than 1% of its volume at standard atmospheric pressure, making it easier to store and transport.

Table 4 : Emission benefits of replacing diesel with CNG vehicles

Fuel	CO, g/km	NO _x , g/km	PM g/km
Diesel	2.4	21	0.38
CNG	0.4	8.9	0.012
Reduction	84%	58%	97%

5 Conclusions and Solutions to Vehicular Pollution

- Drive Less - We are desperately dependent on fossil fuels and the number of vehicles on the roads will continue to increase. We can only try and reduce vehicular emissions by doing our parts, and one of the easiest things to do is drive less and choose alternatives such as walking, using the train or public transportation, and even using a bike. Carpooling is another way to drive less, where people from the same neighborhood or the same area can share one vehicle instead of each using their own.
- Governmental Intervention - Most city governments can take action to lower vehicular pollution, seeing that more emissions are produced by vehicles in urban areas because of traffic and the fact that people have to drive slowly in towns. The necessary daily commute to work further worsens the problem of vehicular pollution.
To address the issue, city governments or municipalities can order that no vehicles enter the central business district and instead, they be parked on the outskirts. To overcome the shortage, bus rapid transit systems should be improved, as well as trains that operate within the cities. This would eliminate traffic jams, and lower vehicular pollution in urban cities
- Invest in Zero – Emissions Vehicles - Not all vehicles today are relying on fossil fuels for locomotion. Electric vehicles have moved away from burning fuel and use electrochemical processes to produce the energy required for a vehicle to move. The by-product of fuel-cell vehicles is water and that is why these types of cars are known as zero-emission vehicles. They store energy in an onboard battery and emit nothing from their tailpipe. More research needs to be invested in electric cars because as of now, they cannot handle difficult tasks such as ferrying heavy loads. There also exist hybrid-electric vehicles that use both a gasoline engine and an electric motor plus battery. They are a bit expensive, but eventually, they save at the gasoline pump.
- Burn Fewer Fuels - The key to burning fewer fuels is making vehicles more efficient. Governments need to set fuel-economy standards for all passenger vehicles, including the advocacy for the use of technologies that help cars and trucks to further on a gallon of gasoline. Most pickup, SUVs and minivans, on average travel less distance on a gallon of

gas than they did decades ago. If this is implemented, it can help reduce the number of dangerous gases that are emitted into the atmosphere.

- Having A Place Pollution Control Technologies - Some jurisdictions require the use of technologies that dramatically reduce the amount of smog-formation pollution and carbon gases coming from vehicles. For diesel vehicles, ‘two-way’ catalysts and engine controls reduce hydrocarbons and carbon monoxide emitted, although they still emit a lot of nitrogen oxide and toxic particulate matter.
For gasoline vehicles, ‘three-way’ catalysts, precise engine and fuel controls, as well as evaporative emission controls, reduce smog-forming emissions from new vehicles by a factor of ten. New technologies can identify emission-equipment control failures, as well as, help reduce the gross pollution problem.
- Civic Education - Many people know about the effects of these emissions but play ignorant, while some simply do not know about them. Civic education, especially on the short- term and long-term effects of vehicular pollution on our lives and the planet in general, could open up eyes and help people make sane decisions.
It is a task that should be imposed upon every individual, government, non-governmental institutions and various other institutions all over the world, and they could awaken the society to the realities of pollution, its effects and how to reduce it. A sense of responsibility should be cultivated in each person so that they grow a desire and willingness to do the right thing.
- Discarding Old Vehicles - old vehicles are responsible for more vehicular pollution because their transmission systems are outdated. They also cause accidents on the roads because of their many complications and getting rid of them for newer models serves as the most sensible and practical alternative or solution. Newer vehicles use new technologies and pollute the environment less than their older counterparts.
- Control The Formation of Nitrogen Oxide by Investing in Novel Designs - some changes can be done to the vehicle’s operation parameters or designing them in a way that it lowers the high temperature of the combustion system, which produces the dangerous gas. Some high-tech devices could also be used to reduce the formation and emission of the nitrogen oxide in combustion c

REFERENCE

1. Central Pollution Control Board, Ministry of Environment and Forests, New Delhi, Govt. of India. STATUS OF THE VEHICULAR POLLUTION CONTROL PROGRAMME Objective Series no. 136, (2010)
2. “AUTO FUEL VISION AND POLICY 2025”, GOVERNMENT OF INDIA, May 2014
3. Bolaji B.O., Adejuyigbe S.B., “Vehicle emission and their effects on natural environment”, Journal of the Ghana Institution of Engineers, Journal of the Ghana Institution of Engineers, Vol. 4, No.1, pp 35–41,2006

4. Alam Md., “The Impact Study of Vehicular Pollution on Environment”, IJSART, Volume 6 Issue 12,2020
5. Khandar Chetana and Kosankar Sharda., “A review of vehicular pollution in urban India and its effects on human health.” *Journal of Advanced Laboratory Research in Biology*, Volume 5, Issue 3, July 2014 PP 54-61
6. Ren, X.; Jiang, N.; Li, Y.; Lu, W.; Zhao, Z.; Hao, L. “Application of Remote Sensing Methodology for Vehicle Emission Inspection.” *Atmosphere* 2022, 13, 1862.
7. Song, X.; Hao, Y. “Research on the Vehicle Emission Characteristics and Its Prevention and Control Strategy in the Central Plains Urban Agglomeration, China.” *Sustainability* 2021, 13, 1119.
8. Hoekman, S.K.; Welstand, J.S. “Vehicle Emissions and Air Quality: The Early Years (1940s–1950s).” *Atmosphere* 2021, 12, 1354.
9. Singh, S., Kulshrestha, M. J., Rani, N., Kumar, K., Sharma, C., and D. K. Aswal. "An Overview of Vehicular Emission Standards," *Science of the Total Environment* 834, 12 May 2022 : 155441.
10. Desai A Aneri, “A review on Assessment of Air Pollution due to Vehicular Emission in Traffic Area,” *Sarvajanik College of Engineering and Technology, Surat, Gujarat, India*, Vol.8, No.2,18 April 2018.
11. Wu, T., Lo, K., & Stafford, J., “Vehicle non-exhaust emissions – Revealing the pathways from source to environmental exposure”, *Environmental Pollution*, 268, 2021,115654.
12. Liu, X., Reddi, K., Elgowainy, A., Lohse-Busch, H., Wang, M., & Rustagi, N., “Comparison of well-to-wheels energy use and emissions of a hydrogen fuel cell electric vehicle relative to a conventional gasoline-powered internal combustion engine vehicle” *International Journal of Hydrogen Energy*, October 2019.
13. Kawajiri, K., Kobayashi, M., & Sakamoto, K., “Lightweight materials equal lightweight greenhouse gas emissions? A historical analysis of greenhouse gases of vehicle material substitution”, *Journal of Cleaner Production*, December 2019,119805.
14. Ayetor, G. K., Quansah, D. A., & Adjei, E. A., “Towards zero vehicle emissions in Africa: A case study of Ghana”, *Energy Policy*, 143,2020,111606.
15. International Council on Clean Transportation (ICCT). (2022). *The Global Greenhouse Gas Emissions from Road Transport*. ICCT, 2022, 1-84.
16. National Academy of Sciences. (2020). *Air Pollution from Motor Vehicles: Assessing Health and Environmental Impacts*. National Academies Press, 2020, 1-384.
17. European Environment Agency. (2022). *Air Quality in Europe—2022 Report*. European Environment Agency, 2022, 1-272.
18. California Air Resources Board. (2021). *2021 Fuel Economy and Emissions Trends Report*. California Air Resources Board, 2021, 1-100.