iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** VII **Month of publication:** July 2019

DOI: http://doi.org/10.22214/ijraset.2019.7133

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue VII, July 2019- Available at www.ijraset.com

A Comparative Study of Carbon Footprint Lifecycle of Diesel Engine Automobile and Electric Vehicles

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Abstract: ***The carbon footprint is a very powerful tool to understand the impact of personal behavior on global warming. Carbon footprint is the sum of all emissions of CO_2 (carbon dioxide), which were induced by respective activities in a given time frame. The major contributor to the decline of the quality of climate and increased global warming is the incessant burning of fossil (coal enriched) fuels for nourishing the basic needs. Burning of coal and other fossil fuels generate energy, this energy is utilized in different ways for respective uses.***
One of the major fuel is "Diesel", also a contributor to the global warming. In the 1800's the electric battery based car was introduced following in 1880's when the petrol/gasoline based cars came into practice followed by the advancement and discovery of diesel led to the invention of diesel engine.
The EV's or the Electric Vehicles are the need of the century to combat the global warming to an extent possible, the EV's run basically on a rechargeable battery storage.
The efficiency compared to the diesel powered automobiles is remarkable. The electricity used can be generated using renewables which act as a key point .But these factors aren't the reliable sources for a comparative study between a diesel based engine and a EV, the most trusted model for comparison is the Life-Cycle Assessment of carbon footprint of both the automobiles, the study gave us some interesting facts.
Keywords: Carbon footprint, Diesel, Electric Vehicles, Lifecycle Assessment.

I. INTRODUCTION

A carbon footprint is defined as: The total amount of greenhouse gases produced to directly and indirectly support human activities, usually expressed in equivalent tons of carbon dioxide (CO_2). Carbon footprint is the sum of all emissions of CO_2 (carbon dioxide), which were induced by one's activities in a given time frame.
Usually a carbon footprint is calculated for the time period of a year. The carbon footprint is a very powerful tool to understand the impact of personal behavior on global warming. Most people are shocked when they see the amount of CO_2their activities create. To contribute to stop global warming, the calculation and constant monitoring of your personal carbon footprint is essential.
The carbon footprint concept is related to and grew out of the older idea of ecological footprint, a concept invented in the early 1990s by Canadian ecologist William Rees and Swiss-born regional planner Mathis Wackernagel at the University of British Columbia. An ecological footprint is the total area of land required to sustain an activity or population. It includes environmental impacts, such as water use and the amount of land used for food production. In contrast, a carbon footprint is usually expressed as a measure of weight, as in tons of CO_2 or CO_2 equivalent per year. Carbon footprint analysis has provided important findings that have helped to shape climate policy at the global and national level.
The carbon footprint approach gives consumers the responsibility for their environmental impacts in terms of GHG emissions, regardless of where those impacts occur. [1]
Two different sources of emissions are considered on the basis of the system analyzed:

A. Direct emissions; occurring inside the boundary of the system,
B. In direct emissions; occurring outside the boundary of the system for satisfying the demand.

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II. DIESEL ENGINE CO_2 ANALYSIS

Energy consumption analysis in Diesel Engine Components manufacturing [2]:
As per the report by the CEA, the average conversion factor (CO_2) is **0.82** [4].

Engine Components	Energy Consumption (kWh)	CO_2 Emitted (kg of CO_2)
Cylinder block and head	378.35	310.25
Crankshaft	291.26	238.83
Connection Rod	58.69	48.125
Gear Box	39.62	32.49
Flywheel	21.44	17.58
Else	922.35	756.33
Assembly	548.41	449.70
Total	2296.21	1882.90

As per the report by the Natural Resource of Canada,
The amount of CO_2 emitted for 1 Litre of Diesel is 2.66 kg of CO_2. [3]
Assuming the fuel efficiency of a diesel car is 18 km/L.
Now the emissions for the generic life of a diesel vehicle is 1,50,000 kms.
The amount of CO_2 emitted for the life-cycle of the vehicle is 22,166.67 kg of CO_2.
Energy consumption analysis in Diesel Engine Recycling [2]:

Metal	Energy Consumption (kWh)	CO_2 Emitted (kg of CO_2)
Steel	600	492.0
Aluminum	400	328.0
Cast Iron	560	459.20
Total	1560	1279.20

Also, the carbon emissions from the procurement of crude oil to the production of diesel are calculated .The fractional distillation column used notifies the temperature at which Diesel is being extracted. The temperature is found out to be 300^{o} C. We derive an analogy between degree Celsius and kWh. The energy is amounted to 0.16 kWh. Using the conversion factor assigned by CEA (0.82), the amount of CO_2 emitted is accounted to 0.13 kg of CO_2.
Now the total CO_2 emitted in the production, operation and recycling of a Diesel Engine is:
25,328.90 kg of CO_2.

III. CARBON FOOTPRINT ANALYSIS OF ELECTRIC VEHICLES

Electric cars have the potential to reduce carbon emissions, local air pollution and reliance on imported oil. Although there is widespread understanding that electric cars can reduce carbon emissions, just how effective they are depends on the electricity they use. Given that the vast majority of the world's power generation is grid-tied, the carbon reduction potential of an electric car depends largely on where it is charged Where power generation is coal dominated electric cars are the emissions equivalent of average petrol cars, while in countries with low carbon power they result in less than half the emissions of the best petrol hybrids. [5]
To assess the carbon emission we consider the scope of emissions in both the electricity generation and vehicle manufacturing. To estimate the climate impact of consuming grid electricity we account for emissions that result from fuel combustion at power plants, upstream fuel production and the share of electricity lost in transmission and distribution.
Core findings of the report: Power source of the electric car matters, it is accounted that the carbon emissions of a coal-dominated country is four time more(approximately) than the one dependent on sustainable green energy. Due to the dominant share of coal generation in India, South Africa, Australia, Indonesia and China, grid powered electric cars produce emissions comparable to

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normal petrol vehicles. With emissions ranging from 370-258 g CO_2 eq./km electric cars generate significant emissions, many multiples of those using low carbon sources. In these countries electric vehicles will have limited climate benefit. [5]

For each country we have a constant value of 70 g CO2 eq./km for manufacturing the electric car. Of the emissions that arise from the grid around 80% come directly from fuel combustion, 10% from fuel production indirectly, and a further 10% arise due to losses in transmission and distribution, though this varies from country to country. In the absence of relevant data we can calculate just the direct grid losses as such the indirect grid losses and the transmission losses do not account significant. The losses of the grid are multiplied by the pre-determined multiplication factor which converts the kWh to g eq. of CO_2.

For India the factor is calculated to be around 0.82 by the Central Electricity Authority [4].We assume the emissions to be 314(average) g eq. CO_2 / km. The total run time of a Electric Vehicle for comparison is 1,50,000 km.

So the Total Carbon Emission for the EV is 47,100 kg of CO_2. [6]

IV. CONCLUSION

The review of the articles and the paper gave me some serious insights into the future of the Electric Vehicles and their counterpart Diesel Engine Automobiles. They current scenario of the world stressing about Global Warming and it's impact has led to the idea and birth of reintroducing Electric Vehicles as a resort to curb the pollution and inhibit the dependency on fossil fuels for energy generation. The major source of our comparative study was the carbon footprint and the Life-Cycle Assessment of the carbon footprint of both the automobiles.

The results were shocking as the Electric Vehicles turned out to own more carbon footprint than the Diesel Engine Automobile.

What was more shocking was India's premature push to go Electric.

One of the convincing/assumptive answer to this phrase would be the growing tensions between Iran and the United States. Iran is one the major exporter of Crude oil in the world and India is a eminent buyer with the imports estimating to 11.1 billion USD in the fiscal year 2017-18. Moreover India also exhausted the 6 month waiver US extended to India for the oil trade on May 2nd. This lead to growing tensions for a paradigm shift in the economy, Indian Government had to resort to some alternative source of fuels and energy, hence they invested in bio-fuels but the investment wasn't proactive and they had to resort to the booming up of Electric Automobile sector aware of the cons it possessed.

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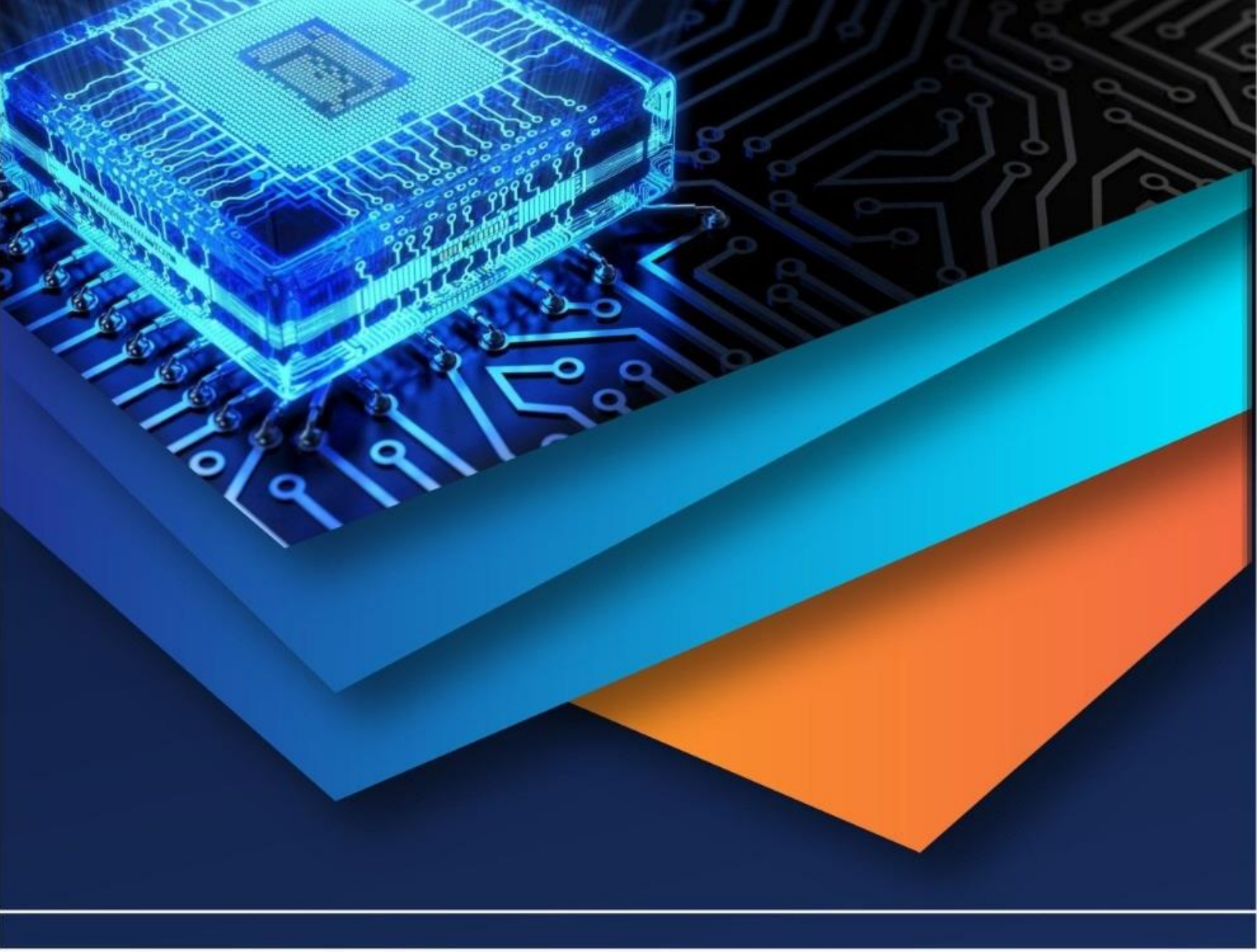
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NOMENCLATURE

1) kW= kiloWatthour
2) ^oC = DegreeCelsius
3) kg = Kilogram
4) L = Litre
5) km = Kilometre

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