Study of the Reality on Electric Vehicle in Indian Scenario

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Abstract: In this work, the estimation of the actual CO₂ emission of a conventional IC engine vehicle and an electric vehicle have been studied in different phases and those vehicles are in same segmented also. How much time it would be taken in order to convert an electric vehicle in to a Green Vehicle (GV) also been studied. In our work, we compare two similar SUV’s in there same segment one is Electric Vehicle (EV) and another is conventional IC Engine Vehicle (ICV). Both the cars have very similar power output; torque and design in there segment. Although there are many options of fast charging, long refuelling or recharging time is a major problem of the EV but this is not our concern study. In science each and every innovation has one good and a bad side, and there is no exception about the EVs also.

Keywords: CO₂ emission, Lithium ion battery, Conventional IC engine vehicle, Electric Vehicle, Green vehicle

1. Introduction

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 [1]. In order to reduce emitted greenhouse gases slowly then it should be moved in to the Electric vehicles (EV). That’s why many vehicle manufacturers are presently manufacturing different types of EVs. Many of peoples are appreciated that every EV is a Green Vehicle (GV) that means all EV are environment friendly then the conventional IC Engine Vehicles (ICV). But in reality there be a short of attention.

1.1. Introduction of both cars

In this work, we consider two similar SUV segmented cars; one is conventional IC engine vehicle having 1.5 L turbo charged diesel engine which has the mileage of around 17 to 22 km pl, company claims that. That car has a power of 108 bhp and maximum 260 Nm torque. Another is electric vehicle is a fully electric suv car and it’s reach upto 312 km maximum range during a single charge. The
battery pack used in this is a 30.2 kWh li-ion battery. The car has a power of 127 bhp and maximum torque is around 245 Nm [2].

1.2. Dark side of Lithium- ion Battery production:

The Lithium Triangle is a region of the Andes rich in lithium reserves around the borders of Argentina, Bolivia and chilli. The area is thought to hold around 54% of world’s lithium reserves. The production of a battery cell requires sourcing of as much as 20 different materials from around the worlds, which will pass through several refining stages, for those refining stages depending on the different energy sources, and those energy sources all are not renewable. Another think is for several material purification processes is not environment friendly [3].

The Car manufacturers are basically used lithium ion battery because li-ion batteries power density is much high than any type of other conventional battery’s and li-ion batteries has another advantages that li-ion batteries are weight/ power ratio is high and those are less dangerous than lithium polymer batteries. Emission of high amount of CO₂ during mining and production phase is the main dark side of li-ion batteries. In li-ion batteries there is a small amount of lithium is used around 6% only, another component of this batteries is Cobalt. Blasting and electricity consumption in Cobalt mining is damaging the environment. Carbon dioxide and nitrogen dioxide emission are much larger during cobalt mining. CO₂ emission in battery production is depends upon the capacity of the battery. The maximum charge density of this battery is around 240 wh per kg. 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 [4].

1.3. Power Electronics

Figure 1 shows power electronics employed in electric vehicles. In an EV power electronics plays the various power conversion processes from the plug to wheel. The different power electronics converters working in EVs like a) AC-DC converter b) DC-DC converter c) DC-AC converter d) AC-AC converter [1].

Figure 1: Power Electronics employed in an EV [1]
1.4. Different ways of Electricity produce in India

There are different ways of grid electricity production in India; most of the electricity is produced by fossil fuels simply from coal. And the coal mining is also not environment friendly.

![Figure 2: Resource for production of electricity in India](image)

This is simply understandable from Fig.2 is that the maximum energy of grid is produced from burning the coal and few from natural gas is around 57%. Now if the power station with an efficiency of 34% burns coal, it emits \(1.0 \text{ kg} \) CO\(_2\) for generating of \(1 \text{ kwh}\) of electricity (i.e. \(1 \text{ kwh} \text{ electricity} = 1 \text{ kg of CO}_2\)). And approx 57% of electricity is generated by burning of fossil fuels. This data is very vital for farther calculating the CO\(_2\) emission [5].

2. Comparison of both cars in different phases

This work does not compare the production or manufacturing phase, because the amount of CO\(_2\) emits for both the cases is more or less same. The reasons behind this the CO\(_2\) emission due chassis production is same for both cases and CO\(_2\) emission due to engine and transmission is equal to the electric motor and inverter production. Mainly we compare three phases those are:

- Fuel production for ICV.
- Battery production for EV.
- Performance and efficiency of ICV.
- Performance and efficiency of EV.
- CO\(_2\) emits per year of running those vehicles.

And finally it has been studied how many years it will take in order to convert an EV in to GV.

2.1. Fuel production for ICV:

1.06kwh power is required to purification or refining of 1 litre of gasoline. The approximate CO\(_2\) emission per litre of diesel fuel burning is \(2.68\text{kg}\), and for petrol it is around 2.31kg. LPG produces around 1.51kg per litre.
2.2. Battery production phase:

The average value of CO$_2$ emission is 177 kg co2/kwh power. So for the 30.2kwh battery pack total emission is around 5.3 metric tonne of CO$_2$. More bigger battery means it will emits more CO$_2$, for 60kwh battery emits more than 10 metric tonnes of CO$_2$ and for 100kwh emits 17 metric tonnes of CO$_2$ [6].

2.3. Performance and efficiency of ICV:

The average efficiency of an IC engine is more than 34%

15% of total energy is lost due Transmission system

The overall efficiency of an ICV is more of less 25%.

The overall efficiency of an ICV is around 25%. That means we have only 25 kwh of useful power out of 100 kwh power. This is a huge power loss in the ICVs. This huge power loss occurs due to a lot of mechanical parts sliding or moving inside the engine. The engines mechanical loss is around 20% of total energy [7].

2.4. Performance and efficiency of EV:

AC grid transmission efficiency is 90%

AC to DC conversion + battery charge efficiency is 85%

Power electronic motor is 90% efficient.

Overall efficiency is around 69%

So the overall efficiency of an electric car is mostly around 70%. That means if we have 100 kwh power on the electricity then we can use 70 kwh on the wheels. This efficiency is much higher than the conventional ICV but gasoline has much more energy density than the batteries. Gasoline contains more than 12 kwh power per kg of fuel burning. And 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 [8].
2.5. CO₂ emission per year for both the cars

For an Indian car annually runs average around 12000km, mostly runs around 15000km. Let’s consider the 15000km and this value is really helpful for us during compare the both cars.

**ICV:** For running of 15000 km that car needs to burn 833.34 lit of diesel (mileage consider as 18 kmpl). Fuel Production phase for 833.34 lit diesel purification we need 883.34 kw power that generates 503.5 kg CO₂ (833.34*0.57*1.06). During running: for burning 833.34 lit diesel CO₂ emits around 2233.35 kg CO₂ per year (833.34*2.68).

TOTAL CO₂ EMISSION= [total CO₂ emission per year is =fuel production +during running the car]

=503.5*Y+2233.35*Y  [Y is the time constant, represent the number of year]

=2736.85*Y kg of CO₂ emits per year running the car.

**EV:** For running of 15000 km that car needs to charge 48 times (considering 312 km range of this car for a single charge) [15000/312=48].

Charging the battery is 30.2 kwh battery for 48 times recharging needs total power of around 1452 kwh. During charge the total amount of CO₂ emission is around 1076 kg (1452*0.57*1.3).

During Battery production: For production 30.2kwh battery emits 5345.4 kg CO₂ (30.2*177).

Total CO₂ emission= [during charge per year + battery production]

=1076*Y+5345.4 kg CO₂.

In order to compare the CO₂ emission for a single year simply put Y =1 and we get that the CO₂ emission for EV is much higher than ICV because the high CO₂ emission of production of battery.

But when you put Y=more than 3 then we get the EV emits less CO₂ then ICV that is notable point. Above equations simply said that after 3 years of using, your EV emits less CO₂ then ICV, because the CO₂ emission during battery production is very high.

![Figure 3: CO2 emission for ICV and EV](image)
Form Fig. 3 it has been observed that the total 4 years of using both the cars the EV is to move on to the GV, for a more large battery it takes more than 6 to 7 years to make it eco-friendly. But ultimately the life cars are not more than 8 years.

3. Conclusion

In this study it has been concluded that 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. Perceptibly the source of power generation played a big role. If we move on to the renewable energy sources the CO₂ emission is reduces and it will take lesser time to make it eco-friendly.

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