REAL IMPACT OF ELECTRIC VEHICLES ON ENVIRONMENT: A REVIEW

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Abstract: This study has been undertaken to investigate the real impact of electric vehicles on the environment. Now as we know climate change is a real thing and the temperature of the earth is increasing every year. For the time being, humanity’s energy demands are entirely met by non-renewable assets such as natural gases, coal, and petroleum. The decision to rely on non-renewable power sources has two consequences: an unacceptably high rate of fuel usage, as well as negative health and environmental consequences. Researchers, technologists, industry experts, and strategy makers have been forced to look for an alternative, more reasonable, and less polluting energy options as a result of these consequences. Our global society is reliant on on-road transportation, which is expected to expand significantly in the coming decades based on current trends. Light-duty vehicles contribute about 10% of global energy use and greenhouse gas emissions. So reducing these greenhouse gas emissions, electric vehicles are widely regarded as the most effective alternative to conventional vehicles to achieve a cleaner transportation market. Electric vehicles have zero tailpipe emissions, they also help to combat localized pollution, which is especially significant in dense urban areas. So a literature review has been done to evaluate how electric vehicles are safer for the environment. Life Cycle Assessment of electric vehicles is done in three phases of their life to check whether or not they are better than conventional ones.

1. INTRODUCTION

Carbon dioxide and other greenhouse gases are released into the atmosphere as fossil fuels like diesel and petrol are burned. Carbon dioxide (CO2) and other greenhouse gases such as methane, nitrous oxide (N2O), and hydrofluorocarbons are forcing the Earth’s environment to warm, resulting in temperature changes that we are now seeing. Transportation-related greenhouse gas (GHG) emissions account for about 28% of overall U.S. GHG emissions, making it the biggest source of GHG emissions. In absolute terms, transportation GHG pollution rose more than any other industry between 1990 and 2018.

An average passenger vehicle emits approximately 4.6 metric tons of CO2 per year. This figure varies depending on the type of gasoline used, the vehicle's fuel economy, and the number of miles travelled each year. CO2 Emissions from a gallon of gasoline is 8.887 grams CO2/ gallon and CO2 Emissions from a gallon of diesel is 10.180 grams CO2/gallon in The USA.

These days electric vehicles are a hot topic of conversation as huge brands like Tesla claiming that their EVs can stop climate change but are battery electric vehicles any better than conventional vehicles, we did an extensive literature review to see if EVs are a realistic choice for environmental action.

Electric vehicles are widely regarded as the most effective alternative to conventional vehicles to achieve cleaner transportation because electric vehicles have no tailpipe emissions, so greenhouse gas emissions during their lifetime are approximately zero.

There are two types of electric vehicles—All-electric vehicle and plug-in hybrid electric vehicle

All-electric vehicles are the ones that operate entirely on electricity. Most of all-electric vehicles have ranges of 80 to 100 miles, with a few premium models reaching up to 250 miles. Depending on the type of charger and battery, recharging the battery will take anything from 30 minutes (with quick charging) to nearly an entire day (with Level 1 charging).

A plug-in electric vehicle (PHEV) could be a safer option if this range is insufficient. PHEVs operate on electricity for a short distance (6 to 40 miles), then turn to a gasoline-powered internal combustion engine when the battery runs out. PHEVs’ versatility helps drivers to use electricity as far as possible while also being able to use fuel if necessary. In contrast to traditional cars, using energy from the grid to power, the car lowers fuel prices, decreases oil consumption, and lowers tailpipe emissions.

A literature review has been done for this paper to calculate the total emissions released from an electric vehicle from its production process until the day when it is recycled. This process is known as the Life Cycle Assessment of a Vehicle.

Lifecyle Assessment of both electric vehicles and conventional vehicles has been done to compare which type of vehicle is better for the environment.

Lifecyle assessment of both types of vehicles is done in three phases:

1st phase is Vehicle Production and fuel production where emissions during vehicle production and fuel production are calculated, 2nd phase is Vehicle usage and 3rd phase is the Vehicle disposal phase.

The size and range of an electric vehicle also play an important role in its greenhouse gas emissions, Cars are divided into 4 categories according to their size, Mini Car, Medium Car, Large Car, Luxury Car. GHG emissions based on car sizes are also compared in this paper.

2. LIFE CYCLE ASSESSMENT FOR ELECTRIC VEHICLES

The Life cycle assessment study for electric vehicles requires the lifetime driving distance of the vehicles as the functional unit. In this study the lifetime driving distance is described as a variable from 0 km to 200,000 km.

Life cycle assessment of EVs will be done in three phases:
2.1 Vehicle Production: Raw Material extraction, Material Production, Vehicle component Production, Vehicle Assembly, generation of electric power for electric vehicles.

2.2 Vehicle Usage: Tail Pipe Emissions.

2.3 Vehicle Disposal Phase: Disposal of vehicle parts once used, such as electric batteries and other metal parts.

3. CALCULATION OF EACH PHASE

3.1 Vehicle Production and Fuel Production Phase:
Carbon emission for the manufacturing process were determined by dividing them into four categories:
(1) Chassis, (2) Motor for EV, and (3) Battery for EV.
1. Chassis parts: Body, tires, interiors, etc. of all type of electric vehicles are identical. The quantities of CO2 emissions from the manufacture of chassis parts in this analysis were measured using the Life-Cycle Assessment Society of Japan's database. CO2 emissions from material extraction to the manufacturing of a small passenger electric vehicle is 4219 kg-CO2, according to the database, and chassis components account for 76.8% of total vehicle weight.
2. Inverter and Motor of EV: According to Hawkins et al., the CO2 emissions of the motor and inverter production for the EV were calculated to be 1070 kg-CO2 and 641 kg-CO2, respectively, based on material compositions and CO2 emission factors from the literature, and the CO2 emissions of each production phase were measured.
3. Battery of EV: The CO2 emission factor indicates how much CO2 is emitted per unit of battery power. The average of the values obtained was 177 kg-CO2-equivalent/kWh, with the lowest value (121 kg-CO2-equivalent/kWh) and the highest value (250 kg-CO2-equivalent/kWh) respectively according to the literature reviewed.

<table>
<thead>
<tr>
<th>Part Name</th>
<th>Referenced Data of CO2 Emission [kg-CO2]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chassis parts</td>
<td>4219</td>
</tr>
<tr>
<td>Inverter and Motor of EV</td>
<td>641 &amp; 1070</td>
</tr>
<tr>
<td>Battery of EV</td>
<td>6337</td>
</tr>
</tbody>
</table>

The amount of CO2 emissions of vehicle production phase.

In terms of the production of the motor, inverter and lithium-ion batteries, is the main source of the greenhouse gas emissions.

Electricity Production for charging of EVs:
The CO2 emission factors for electric power generation in each area were sourced from “GaBi,” with data dating back to 2013. The system boundary for electricity generation is the transition from energy resource production to electric energy transformation to low voltage as part of the grid mix.

The amount of CO2 emissions in the phase of electric power generation for BEV was obtained with the following equation:

\[ CO_2,_{EV \ (EG)} = \frac{CF_{EG}\cdot E_{EV}}{LD} \]

Where;

\[ CO_2,_{EV \ (EG)} \] = the amount of CO2 emissions in the phase of electric power generation [kg-CO2],
\[ CF_{EG} \] = CO2 emission factor of electric power generation [kg-CO2/kWh],
\[ E_{EV} \] = Electric efficiency of EV [km/kWh].

The materials extraction transport and manufacturing of a lithium-ion battery emits 60-150kgCO2/kWh this means the bigger the battery the more emissions it produces

For example, if we take a median value of 100kgCO2/kWh, 3 tons of CO2 equivalent will be produced for a low capacity 30kWh Nissan leaf and 7.5 tons for a high capacity 75kWh Tesla Model S
Literature Review on electric vehicle battery production emissions

<table>
<thead>
<tr>
<th>Authors</th>
<th>Battery Production emissions (kg CO₂eq/kWh)</th>
<th>Additional notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Message</td>
<td>56</td>
<td>Assumes vehicle with 30 kWh battery constructed in the European Union, finding that BEVs will have lower life-cycle emissions than a comparable diesel vehicle when operated in any country in Europe</td>
</tr>
<tr>
<td>Hao et al.</td>
<td>96-127</td>
<td>Uses China grid for battery manufacturing. Finds substantial differences between battery chemistries. Batteries produced in U.S. create 65% less GHGs.</td>
</tr>
<tr>
<td>Romare &amp; Dahllöf</td>
<td>150-200</td>
<td>Reviews literature, concluding manufacturing energy contributes at least 50% of battery life-cycle emissions. Assumes battery manufacturing in Asia.</td>
</tr>
<tr>
<td>Wolfram &amp; Wiedmann</td>
<td>106</td>
<td>Models life-cycle emissions of various powertrains in Australia. Manufacturing inventories come primarily from ecoinvent database.</td>
</tr>
<tr>
<td>Ambrose &amp; Kendal</td>
<td>194-494</td>
<td>Uses top-down simulation to determine GHG emissions for electric vehicle manufacturing and use. Manufacturing process energy represents 80% of battery emissions. Assumes manufacturing grid representative of East Asia.</td>
</tr>
<tr>
<td>Dunn et al.</td>
<td>30-50</td>
<td>Uses bottom-up methodology, with U.S. electricity used for manufacturing</td>
</tr>
<tr>
<td>Ellingsen, Singh, &amp; Strømmang</td>
<td>157</td>
<td>BEVs of all sizes are cleaner over a lifetime than conventional vehicles, although it may require up to 70,000 km to make up the manufacturing “debt.”</td>
</tr>
<tr>
<td>Kim et al.</td>
<td>140</td>
<td>Study based on a Ford Focus BEV using real factory data. Total manufacturing of BEV creates 39% more GHGs than a comparable ICE car.</td>
</tr>
<tr>
<td>Peters et al.</td>
<td>110</td>
<td>Reveals significant variety in carbon intensities reported across literature based on methodology and chemistry.</td>
</tr>
<tr>
<td>Nealer, Reichmuth, &amp; Anairj</td>
<td>73</td>
<td>Finds that BEVs create 50%-less GHGs on a per-mile basis than comparable ICEs, and manufacturing (in U.S.) is 8%-12% of lifecycle emissions.</td>
</tr>
<tr>
<td>Majeau-Bettez, Hawkins, &amp; Strømmank</td>
<td>200-250</td>
<td>Uses combined bottom-up and top-down approach. Different battery chemistries can have significantly different effects</td>
</tr>
</tbody>
</table>

3.2. Vehicle Usage: Tail Pipe Emissions:

There is no Tail Pipe Emissions in the case of Electric Vehicles.

3.3. Vehicle Disposal Phase:

Vehicle Disposal Phase consist of 5 steps for disposal of an electric vehicle

<table>
<thead>
<tr>
<th>Process Name</th>
<th>CO₂ Emission [kg-CO₂]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disassembly*</td>
<td>-</td>
</tr>
<tr>
<td>Shredding and sorting</td>
<td>24</td>
</tr>
<tr>
<td>Recycling of battery*</td>
<td>-</td>
</tr>
<tr>
<td>Transport</td>
<td>4</td>
</tr>
<tr>
<td>Landfilling</td>
<td>38</td>
</tr>
<tr>
<td>Total</td>
<td>65</td>
</tr>
</tbody>
</table>

*= Energy consumption in disassembly and recycling of battery is relatively lower than the other treatment.

4. LIFE CYCLE ASSESSMENT OF CONVENTIONAL VEHICLES

The Life cycle assessment study for conventional vehicles requires the lifetime driving distance of the vehicles as the functional unit. In this study the lifetime driving distance is described as a variable from 0 km to 200,000 km.

Life cycle assessment of EVs will be done in three phases:


4.2. Vehicle Usage: Tail Pipe Emissions of Internal combustion vehicles.

4.3. Vehicle Disposal Phase: Disposal of vehicle parts once used, such as gasoline engine and transmission.
5. Calculation of Each Phase

5.1 Vehicle Production and Fuel Production Phase:

Carbon emission for the manufacturing process were determined by dividing them into four categories:

1. Chassis parts: Body, tires, interiors, etc. of all type of conventional vehicles are identical. The quantities of CO2 emissions from the manufacture of chassis parts in this analysis were measured using the Life-Cycle Assessment Society of Japan's database. CO2 emissions from material extraction to the manufacturing of a small passenger electric vehicle is 4219 kg-CO2, according to the database, and chassis components account for 76.8% of total vehicle weight.

2. Gasoline engine and transmission: Based on JLCA, the volume of CO2 emissions from the gasoline engine and transmission output was estimated to be 1274 kg. The sum of CO2 emissions from the diesel engine and transmission output was calculated based on the weight gap of 50 kg between GE and DE and the 241 kg weight of the gasoline engine and transmission cited in JLCA. As a result, CO2 emissions from diesel engine and transmission output were determined to be 1,539 kg-CO2 (= 1274 kg-CO2 * (241 kg + 50 kg)/241 kg).

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<tr>
<td>Gasoline engine and transmission</td>
<td>1274</td>
</tr>
<tr>
<td>Diesel engine and transmission</td>
<td>1539</td>
</tr>
</tbody>
</table>

The amount of CO2 emissions of vehicle production phase.

Fuel Production: The amount of CO2 emissions in the phase of fuel production and combustion for ICV (GE and DE) was obtained by the equation below:

\[
CO_2_{ICV} = \left(\frac{CF_{FP} + CF_{FC}}{E_{ICV}}\right)LD
\]

\( CO_2_{ICV} \) = the amount of CO2 emissions in the phase of fuel production and combustion,
\( CF_{FP} \) = CO2 emission factor of fuel production [kg-CO2/L],
\( CF_{FC} \) = CO2 emission factor of fuel combustion [kg-CO2/L],
\( E_{ICV} \) = fuel efficiency of ICV [km/L],
\( LD \) = lifetime driving distance [km].

5.2 Tail Pipe Emissions:

The CO2 emission factors for gasoline and diesel fuel combustion were cited, with gasoline emitting 2.28 kg CO2/L and diesel emitting 2.62 kg CO2/L, respectively. The CO2 pollution factors of gasoline and diesel fuel combustion are 5 to 8 times higher than those of fuel extraction, which ranges from region to region.

5.3. Vehicle Disposal Phase:

Vehicle Disposal Phase consist of 4 steps for disposal of an electric vehicle

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<tr>
<th>Process Name</th>
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<tr>
<td>Total</td>
<td>65</td>
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</tbody>
</table>

*= Energy consumption in disassembly and recycling of battery is relatively lower than the other treatment.
6. **LIFE CYCLE ASSESSMENT OF EVS VS ICVs USING CLIMOBIL APP (CLIMOBIL.CONNECTING-PROJECT.LU)**

Using an average EU energy mix every EV produces less GHG emissions over their life cycle assessment than any fossil fuel burning car even the most efficient conventional car.

Using the average EU energy mix and the average EU annual mileage of 12000km/year after 4.5 years a 40kWh EV pays back its battery manufacturing emissions and produces less overall lifetime emissions than the most efficient petrol car available.

For average American mileage of around 21000km/year after 3 years a 40kWh EV pays back its battery manufacturing emissions and produces less overall lifetime emissions than the most efficient petrol car available.
7. Effect of Lifetime Driving Distance:

The cumulative life cycle CO2 emissions measurement results for five regions are shown, including (a) the European Union, (b) Japan, (c) the United States, and (d) China. CO2 emissions from GE, DE, and BEV were estimated in the EU and Japan, while GE and BEV emissions were calculated in the United States, China, and Australia. The averaged value of the CO2 emission factor of BEV battery output (177 kg-CO2/kWh) was used for these calculations. The point where the lines of GE, DE, and BEV intersect in each figure indicates the driving distance, which in this analysis was described as “Distance of Intersection Point (DIP).”

The very first takeaway from the findings is that cars with lower CO2 emissions, such as ICVs or BEVs, are affected by driving distance. For example, when the driving distance was less than 60,779 km, GE indicated lower Emissions than BEV, owing to the high CO2 emissions associated with battery output for BEVs, while BEV indicated lower CO2 emissions when the driving distance was greater than 60,779 km, as seen in Figure c for the US. These findings showed that the longer a vehicle was powered over its lifetime distance, the greater the CO2 reduction advantage for BEVs over ICVs.

Based on the above, it can be inferred that using electric cars eliminates air pollution for the vast majority of emissions. The higher the number of green energies in the power mix, the fewer emissions there are. As a result, the intensity of air emission mitigation due to switching to electric cars in an area is determined by the region's energy mix. However, as we know, SO2 is one of the pollutants that rises with the increased use of electric cars in fossil fuel-based generation systems.
8. GREENHOUSE GAS EMISSIONS COMPARISON ON THE BASIS OF SIZE

To compare first we need to classify different sizes of conventional cars and electric cars.

<table>
<thead>
<tr>
<th>Car Segment</th>
<th>Curb Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mini Car</td>
<td>1100 kg</td>
</tr>
<tr>
<td>Medium Car</td>
<td>1500 kg</td>
</tr>
<tr>
<td>Large Car</td>
<td>1750 kg</td>
</tr>
<tr>
<td>Luxury Car</td>
<td>2100 kg</td>
</tr>
</tbody>
</table>

Lifecycle impacts of conventional and electric vehicles. The graph on the left shows pollution over time as a result of processing, usage, and end-of-life (EOL) treatment. The grey shaded field, which we refer to as the fossil envelope, represents the traditional vehicle's Lifecycle GHG emissions (segments A, C, D, and F are indicated on the right of the fossil envelope). The EV findings are represented by a blue hue. The pollutants are broken down in a contributional way with battery output, car production, use, and EOL treatment in the column map on the right.
9. **INDIA’S ENERGY MIX:**

Even though India's peak demand is only 140 GW, the country's total installed capacity of 260 GW is largely dependent on fossil fuels, and many areas of the country lack access to electricity or experience regular outages.

India also has solar and wind power capacity of 10,000 GW and 2000 GW, respectively. By 2022, the Indian government has set an ambitious clean energy growth target of installing 100 GW of solar power and 40 GW of wind power. By 2022, India's electricity balance will have been revamped, with renewable energy accounting for more than 25% of total capacity.

India's energy could come from renewable energies for 50% of the time by 2030.

Switching to electric cars would have a much greater effect on air quality in the future since the energy used to charge the batteries would come from non-fossil fuel sources.

10. **POLICY RECOMMENDATION:**

Based on the above studies, literature review, and energy mix of India, it can be said that electric vehicles are a better future for India and they will a much greater positive impact on the environment. It will help to reduce the carbon footprint of India.

To encourage people to buy EVs and attract them to EVs, the government has to make some strict policies, which would be beneficial for both nature and the consumer.

Following are some of the policy recommendations according to literature reviewed:

1. Reduce the number of two-wheelers on the road that are powered by petrol or diesel: Two-wheelers account for a large proportion of all cars on the road and are big polluters of the air. The majority of two-wheelers are sold to people who used to use public transportation and want to make their everyday commute smoother. This consumers are from a low-income socioeconomic community. To accomplish this aim, the following two policies are suggested:

   1.1. Provide this focus market with subsidized shared mobility electric fleet service: Since this market is price sensitive, if subsidized and accessible shared mobility networks are made available, these consumers are more likely to move. Air emissions introduced into the atmosphere can be minimized because the joint mobility fleet is electric.

   1.2. Sell electric two-wheelers to this market segment: Since the target segment is price sensitive, electric two-wheelers would be preferred over conventional two-wheelers if cheaper electric two-wheelers are available on the market. To encourage adoption, the government might subsidize the cost of two-wheelers.

2. Reduce the number of four-wheel vehicles on the road that is powered by gasoline or diesel: Four-wheeler owners come from a more wealthy society and are less price-oriented than two-wheeler owners. Customers must be enticed by offering them more comfort in their everyday lives. To accomplish this aim, the following two policies are suggested:

   2.1. Dedicated highways for electric vehicles: One of the most serious problems on Indian roads is traffic congestion. To entice four-wheeler drivers, the government should implement a policy that reserves some roads exclusively for electric vehicles. This non-monetary reward would improve the accessibility of four-wheeler owners and encourage them to embrace electric vehicles.

   2.2. The Government should promote registered four-wheeler owners to migrate to shared mobility by incentivizing them with incentives such as recognition in local media, as part of a marketing strategy to make shared mobility socially appropriate in the four-wheeler owner culture. The public's understanding of the advantages of electric cars encourages more people to buy them.

3. Create warehouses on the outskirts of cities and then allow EV-transported goods vehicles to enter. As part of this policy, the government constructs factories outside of the city limits of major metropolitan areas, where population density is much greater, which only permits electric goods vehicles to access the city, and does not pollute the air. As a result, the number of polluting cars accessing major metropolitan areas will be reduced.

4. Subsidize clean electricity generation schemes indefinitely: Based on the topic in the previous section, electric vehicles emit fewer emissions only when the fuel mix is greener. Therefore, more clean energy generation sources should be developed to ensure that EV adoption decreases air emissions.

5. Invest in battery technology innovation: To fully make electric vehicles pollution-free, advancements in the battery manufacturing process are needed.
11. Traditional Roadmap Followed by Automobile Manufacturers or Original Equipment Manufacturer

To remain competitive and successfully ride the wave of the electrification boom, Automobile manufacturers or OEMs must adapt, taking various moves around the entire value chain. Automobile manufacturers and OEMs would need to work on a range of main areas, from engineering to construction to recycling, to remain competitive and handle in the era of the electric motor.

1. Engineering:
   - Define a specific roadmap for technological advancement (and develop a dedicated EV platform). Use innovation resources to rethink products and take advantage of emerging technology to mimic component behavior, such as long-term battery performance.

2. In-car Software:
   - Rethink the vehicle information communications technology architecture with a holistic approach to simplify while simultaneously evolving software, enabling an efficient management of batteries and e-engines while integrating new services.

3. Supply Chain and Purchasing:
   - Establish a modern supply chain that ensures access to new technology by moving beyond conventional closed networks by adopting more collaborative Tier 1 thinking. Utilize emerging technology to ensure complete visibility and efficiency in the supply chain.

4. Manufacturing:
   - Plan modular assembly lines and turn the workforce using new digitized production solutions and modelling technology.

5. Marketing:
   - Create market for electric vehicles by offering detailed information about products and services, as well as creating alternative distribution channels. Enhance EV-specific touchpoints by redesigning the consumer experience.

6. Sales and Mobility Services:
   - Review distribution strategies for EV accessibility, including redesigning the store network, combining direct and indirect networks, and using mobility platforms. Introduce creative mobile programmes to provide consumers with valuable purchasing options.

7. Connected Vehicle Services:
   - To deliver creative and profitable e-digital technologies, use vehicle and consumer data and work with collaborators.

8. Aftersales:
   - Reevaluate OEM skills for managing new EV and dedicated modules (such as batteries) when providing new e-services.

9. Recycling:
   - Utilize recycled batteries and form partnerships with outside parties to manage the total environmental burden of e-vehicles, thus generating additional revenue sources.

12. Future:

   Electric vehicles (EVs) are an important part of America's transportation future because they have the potential to significantly reduce greenhouse gas pollution, particularly when powered by a clean electricity grid.

   And when the higher emissions associated with BEV production are taken into account, EVs that are typical of those sold today emit less than half the global warming emissions of equivalent gasoline-powered cars. Excess manufacturing emissions are balanced within 6 to 16 months of average driving, according to modelling of the two most common BEVs available today and the regions where they are currently being sold.

   EVs are now cleaner than they've ever been. In regions covering two-thirds of the US population, driving an average EV emits less greenhouse gases than driving a gasoline car that gets 50 miles per gallon (MPG), up from 45 percent in our 2012 survey. Based on current EV sales in the United States, the average EV emits the same amount of global warming pollution as a gasoline vehicle with a 68 MPG fuel economy rate.

   If more power is produced from renewable sources, EVs can become much cleaner. Manufacturing an EV would result in a reduction of over 25% in manufacturing emissions and an 84 percent reduction in driving emissions in an 80 percent renewable energy system, for a total reduction of more than 60%. (Compared with a BEV manufactured and driven today).
IV. CONCLUSION:

The life cycle CO2 footprint of a car depends on two main factors = the emissions from vehicle production + emissions from vehicle use

Emissions for vehicle production:
Manufacturing a conventional car releases about 7 tons of greenhouse gas emissions
Manufacturing an electric car releases about 7 tons of greenhouse gas emissions excluding battery and if we include battery it will be more than double the greenhouse gas emissions as of conventional cars
The materials extraction transport and manufacturing of a lithium-ion battery emits 60-150kgCO2/kWh this means the bigger the battery the more emissions it produces
For example, if we take a median value of 100kgCO2/kWh, 3 tons of CO2 equivalent will be produced for a low capacity 30kWh Nissan leaf and 7.5 tons for a high capacity 75kWh Tesla Model S
So we can say that manufacturing EVs produce more greenhouse gas emissions from any type of conventional car.
Manufacturing batteries emit so many GHG emissions because manufacturing EVs requires huge mining to extract the elements from the earth such as Lithium, as lithium counts about only 1% of a typical EV battery but extraction and refining of all the other materials account for nearly 60% of emissions of making the whole battery.

Emissions for vehicle use:
For this, we have to compare fuel cycle emissions of EVs and fuel + tailpipe emissions of conventional vehicles
Fuel cycle accounts for any fossil fuel burnt in production of electricity for an EV or refining and transportation of petrol for a conventional car
Tail Pipe refers to the emissions released in burning fuel in a conventional car.
Referring the fuel cycle emissions burning fossil fuel directly in a car is not more efficient than burning fossil fuel in power stations for generating electricity because power stations are way more efficient at making power than car engines including transmission losses and with the increasing drive for decarbonization countries are becoming more and more reliant on renewable energies.

Renewable electricity production grown from 19 to 28% in the last 10 years and this is reducing the GHG emissions of every kWh of electricity produced in the electric grid making electric cars more sustainable every year.
The average European car has manufacture determined tailpipe emission rate of 165gCO2/km adding in the inefficiencies of the real world we get total greenhouse gas emissions of 31.3 tons of CO2 equivalent over the average lifetime of 150,000 KM + the fuel cycle emissions of 3.75 tons
Using an average EU energy mix every EV produces less GHG emissions over their life cycle assessment than any fossil fuel burning car even the most efficient conventional car.
Using the average EU energy mix and the average EU annual mileage of 12000km/year after 4.5 years a 40kWh EV pays back its battery manufacturing emissions and produces less overall lifetime emissions than the most efficient petrol car available.
For average American mileage of around 21000km/year after 3 years a 40kWh EV pays back its battery manufacturing emissions and produces less overall lifetime emissions than the most efficient petrol car available.
But if you live in a country with a dirty energy profile then buying an EV could cause more harm than good. Countries with dirty energy profiles can be made more favorable for EVs as renewable energy is expensive to set up but once the infrastructure is built it can supply clean and cheap energy.

Benefits of Electrification of transportation:
1. Lower fossil fuel dependency
2. Raising environmental consciousness
3. Reduce air pollution in urban areas

EV research is already evolving, and there are short- and long-term prospects to minimize GHG emissions during their lifecycle.

If the technology advances, it is critical to continue evaluating the environmental effects of EVs to identify possible benefits and pitfalls, as well as provide guidance to R&D and policymakers.

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