

Economic and Environmental Effects of Plugin Hybrid and Electric Cars in Pakistan

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Abstract—The world is facing serious environmental problems and the temperature of the earth is continuously increasing as a result of human activities. The major part of global warming consists of the pollution produced by burning fossil fuels and a part of it is by burning fuel in transportation. Pakistan is one of those countries which are highly affected by global warming. Plug-in hybrid and charging electric cars are much cleaner and their efficiency is higher than fossil fuel engine cars. This paper includes a review of electric cars and their economic and environmental effects. The specifications and economic benefits of the electric cars running around the world are included in this research, which supports and justifies the use of these vehicles. It is revealed that if we replace the engine cars which are half of the transportation resources, our economic losses and a significant amount of dangerous gases including carbon monoxide particles from the air can be reduced. Moreover, it is concluded that switching one car from a fossil fuels engine to an electric has an appreciable emission reduction effect. A comparison is constructed between the pollution of green cars and fossil fuel cars. It is recommended that a subsidy should be given in registration and annual tax bills by the government to promote the use of electric cars.

Index Terms—Environment, Renewable green energy, electric car, plug-in charging, hybrid, ecofriendly.

I. INTRODUCTION

Humans are responsible for today's crucial impacts on the environment on earth, deforestation, burning of fossil fuels [1, 2]. Industrial activities are continuously destroying the global environment, which results in the lack of rain, increase in temperature and death rate [3, 4]. The emission of harmful gases (NO_2), (CO), (SO_2), and solid particles (Carbon) due to incomplete combustion of fossil fuels are causing serious health problems [5-8]. Extreme weather events are ranked first place in the top risks most likely to happen in the next 10 years according to the global risks report [9]. The use of energy from fossil fuel from 1800 to 1900 was completely dependent on coal which was less than 10,000 TWh. The use of fossil fuel as energy sources with the prosperity in industries and transportation increased rapidly after the discovery of crude oil and natural gas greater than 120,000 TWh. This excessive burning of fossil fuel and high amount of production of hydrocarbons harshly affected the environment. Global primary energy consumption by fossil fuel source statistics (1800–2019) are shown in Fig.1 [10]. An increasing amount of hydrocarbons in breathing air is causing a burden of disease attributable to the source of environmental and occupational pollution. From the major causes of mortality

acute respiratory diseases are 8.7% of the total according to WHO [11]. However, YLL and DALYs estimate the different ranking of acute respiratory diseases which are 12% and 8.5% respectively [12].

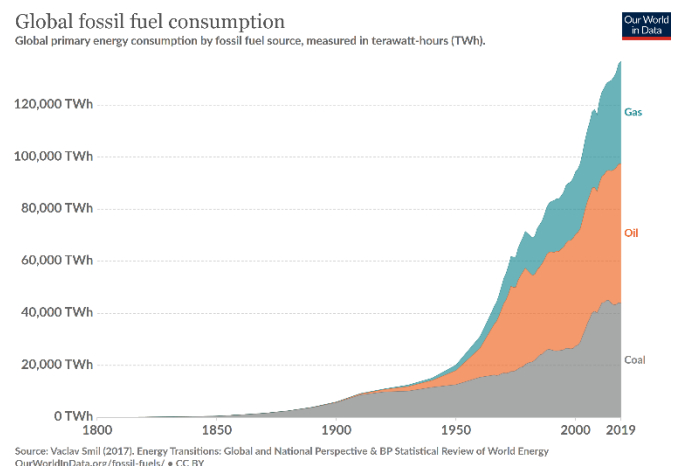


FIGURE 1. Global Fuel Consumption from 1800-2019 [10]

The use of electric or plug-in hybrid electric cars is much

cleaner and economical as compared to fossil fuel cars. It can save people not only from respiratory diseases but also save billions of dollars annually spent on the treatment. Although the cost of electric cars is a little higher than the fuel cars due to the use of expensive batteries it saves buyers from other expenses in the future like fuel, maintenance, etc. Due to high environmental damage and loss of lives from the burning of fossil fuels the world is now moving towards renewable energy resources. With technological development, the governments of developed countries are taking serious steps to reduce the emission of carbon compounds in the air. Measurement of CO₂ emission in process of vehicle certification is mandatory. Climate change policies were made and targets were set to reduce the amount of CO₂ g/km. CO₂ emission controlled regularity authorities were made in Europe in 1995 to achieve a target of 130 g/km CO₂ by 2015, and 95 g/km by 2020 [13]. The implementation of this strategy to reduce the fuel consumption and CO₂ reduction from passenger cars is set compulsory to achieve the target of 95 g/km CO₂ by 2021. The failure of a manufacturer to comply with the mandatory limits are fined as per gram excess of CO₂ ranging from €5to€95on every sold vehicle. After 15 years of “Real-World” fuel consumption and CO₂ reduction law the divergence in the reduction of CO₂ produced from petrol, diesel and AFV are 33.3%, 31.4%, and 62% respectively. The overall reduction in CO₂ is 27.3% which is a reasonable achievement through the years.

II. ENVIRONMENTAL & ECONOMICAL CONDITIONS OF PAKISTAN

Pakistan is a developing country that’s why the industry and transportation sectors need cheap and easily available sources of energy. Unfortunately, due to the lack of technology, industrial knowledge, and wrong policies, we are using fossil fuels like oil, coal, and other products without taking any responsibility for the environment and health of the people. It is the result of these policies that Pakistan is standing at seventh place in the world that is going to face severe environmental conditions in the next few years according to the World Bank reports.

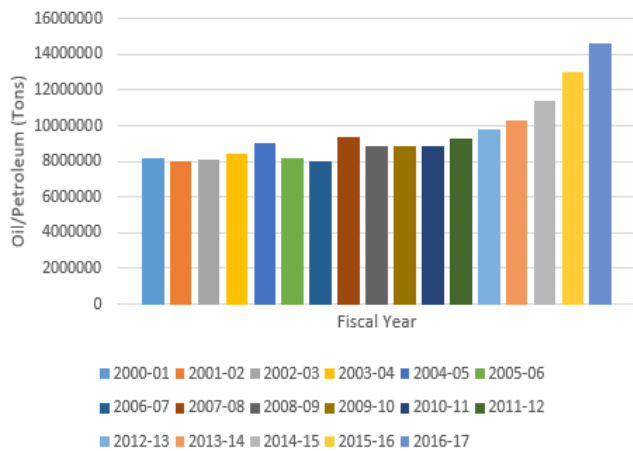


FIGURE 2. List of Oil/Petroleum Consumption

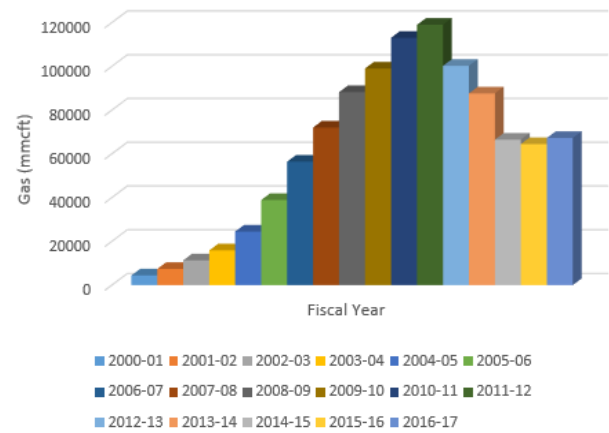


FIGURE 3. List of Natural Gas Consumption

At this time when the world is making progress in technology and shifting the industrial and transportation sectors from fossil fuel to renewable energy resources, we are still using the traditional methods to run our industries. The environmental and economic database uncovers the dangerous facts about the current situation of Pakistan.

A. Fossil Fuel Consumptions:

Economic Survey of Pakistan 2018 [14] shows the use of petroleum and coal products is increasing day by day. From 2000-2001 the use of petroleum was 81,57,893 tons in the transportation sector, while from 2016-2017 the usage of petroleum increased by 44% and has now reached up to 1,45,82,915 tons as shown in Fig.2. The CNG consumption from 2000-2001 was 4423 (mmcf) and exceeds up to (96%) 119000 (mmcf) during the fiscal year 2011-2012. From 2012 onward 2017 there is a decrease of (61%) in gas –consumption as shown in Fig.3.

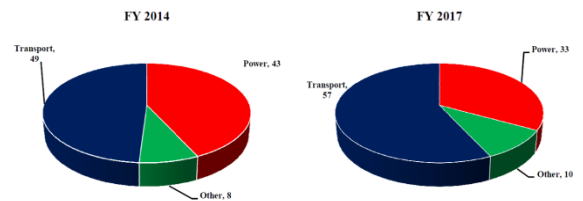


FIGURE 4. Comparison of fuel consumption in 2014 and 2017 in Pakistan [14]

The transportation sector is a major consumer of petroleum and gas. Oil consumption in 2014 was transportation sector was 49% in 2014 of the total and after 3 years this ratio increased up to 8% and reached 57% in 2017 as shown in Fig. 4.

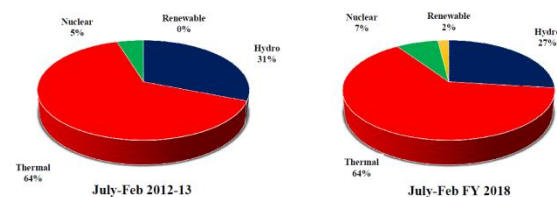


FIGURE 5. Comparison of sources of energy use in 2012-2013 and July-Feb FY 2018 in Pakistan [14]

The renewable resources of energy were not fairly used in Pakistan in any sector till 2012-13. Currently, 2% of renewable sources are used in electricity generation [8].

B. Vehicles on Road:

The number of motor cars on roads increased by 928,000 in 2000-01 in Pakistan which is now reached up to 7,887,100 in 2017-18 as plotted in Fig.6. In these 18 years, the percentage increment of motor cars is 88.23%. The production of cars in 2000-01 was 39,573 and in 2017-18 it has reached up to 154,732 which is an increment of 74.42% (Fig.7). The motor cars import in 2004-05 was 66,338 and in 2017-18 it has reached up to 976,374 with an increment of 93.2% (Fig.8). But still, there is no environmental policy made by the ministry of transportation and health, as a result, high carbon emission and no controls to the CO₂ emission which results in the destruction of the environment. [8]

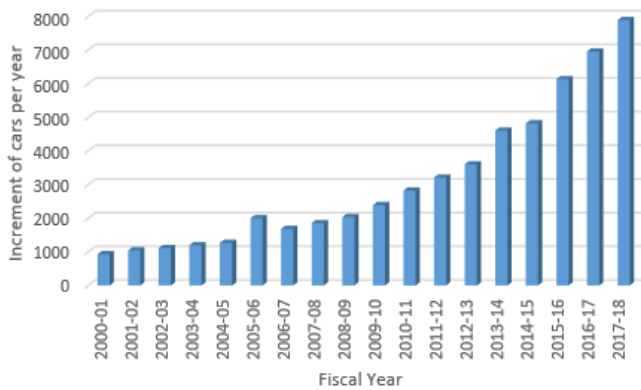


FIGURE 6. Increment in Motor Vehicles on Roads from 2000-2018 (In 000 Nos.)

C. Economic Loss:

The import of petroleum and other fuel products has a heavy burden on the trembling economy of Pakistan. Petroleum products cover one-fourth of the import bills. These continuously increasing imports of petroleum products are causing billions of dollars of economic loss. Also, a lot of amounts is spent on the people affected by the destruction of the environment.

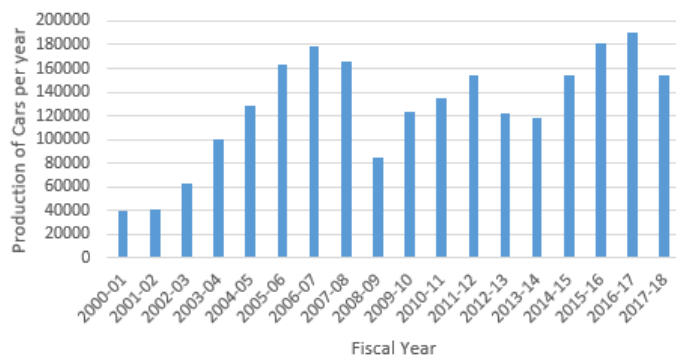


FIGURE 7. Motor Vehicles Production from 2000-2018

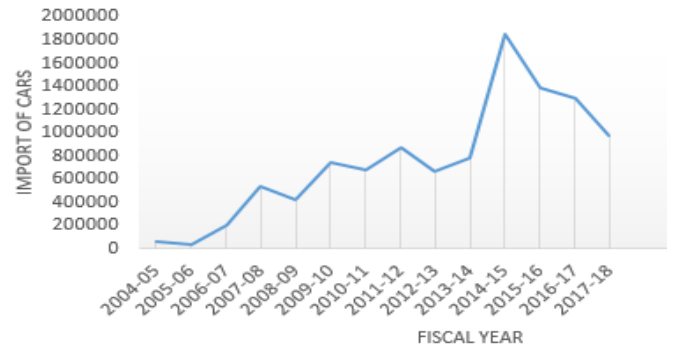


FIGURE 8. Motor Vehicles Import from 2004-2018

It needs a lot of factors for a developing country like Pakistan to consider while spending the national wealth. Moreover, there are 22,600 deaths per annum that are either directly or indirectly affected by ambient air pollution, of which more than 800 are children under 5 years of age, 80,000 admitted in hospitals and 5 million childhood illnesses. The direct cost of environmental damage in Pakistan due to air pollution was estimated at 1.1% of GDP in 2005 that was US\$1.07 billion [15].

III. REVIEW OF ELECTRIC AND SOLAR CARS

Some highest-selling electric or hybrid plug-in charging electric cars are included in the review.

A. BAIC EC 180 EV

BAIC EC 180 EV was the world's most selling electric car in 2017 having a range of 156km and a top speed of 100km/h. In 2017, 77,355 total units were delivered by BAIC, and about 40,000 units of E180 EV being sold. BAIC has the largest network in China and EC 180 comes with a price tag of 23500\$ [16].



FIGURE 9. BAIC EC 180 EV [17]

B. BYD E6 EV

Chinese manufactured BYD E6 EV is also one of the most selling electric cars in the world. At the start of the project in 2010, 33 EV units sold and after 6 years in 2016, 20,107 units sold which is 99.8% more than in 2010. The car comes with a price of around 60000\$ [18].



FIGURE 10. BYD E6 EV [19]



FIGURE 13. Wuling Hongguang MINI EV [26]

C. Tesla Model S

Tesla Model S is the fastest accelerating electric vehicle on the roads. Tesla delivered 57,039 model S cars in 2020 and 18,920 for the fourth quarter. Specifications of the Tesla Model S include 500km of range and a top speed of 250 km/h. It comes with a price tag of 81,000\$ [20, 21].



FIGURE 11. Tesla Model S [20]

D. Tesla Model 3

Tesla Model 3 was the bestselling car in many countries with a range of 500km. A total of 4,42,511 models were delivered to the customers. It comes with a price of around 40,000\$ [21, 22]



FIGURE 12. Tesla Model 3 [23]

E. Wuling Hongguang MINI EV

In 2020 Wuling Hongguang MINI EV is launched as a joint venture between SAIC and GM motors. It has a range of 170km and a top speed of 100km/h. Only in November 2020, it sold 33094 units. The main reason behind this massive sale is the very low price of 5,000\$ only [24, 25].

IV. METHODOLOGY

A comparison method is used between a solar electric car and an internal combustion engine car. All aspects of both cars are measured and compared to visualize the effects on the environment, economy, and health. First of all, emission of CO₂ g/km as calculated in the air from gasoline, diesel, and 50% gasoline + 50% diesel cars are measured at a speed of 20km/h. The measured values of CO₂ are 306.7, 250.0, and 278.3 respectively (Fig.14).

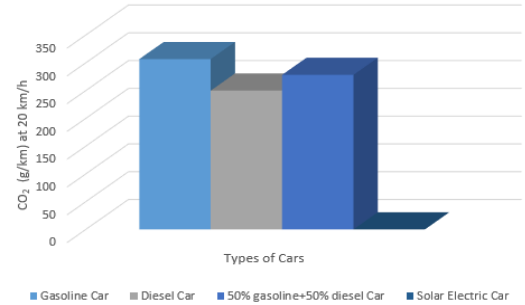


FIGURE 14. Emission of CO₂ from different cars at 20km/h

The amount of CO₂ emission at 50km/h for gasoline car is 198.7, for diesel car is 177.0 and 187.8 g/km for 50% gasoline+50% diesel car. The amount of fine particulate matter (PM_{2.5}) is also calculated for all types of fossil fuel cars. Gasoline car having EURO4 technology at 20 km/h emits 0.012 g/km PM_{2.5}. Similarly, 0.050 and 0.031 g/km are the amounts of emission for diesel cars and 50% gasoline + 50% diesel cars respectively. At 50km/h these values reduce to 0.011, 0.039 and 0.025 g/km (Fig.15).

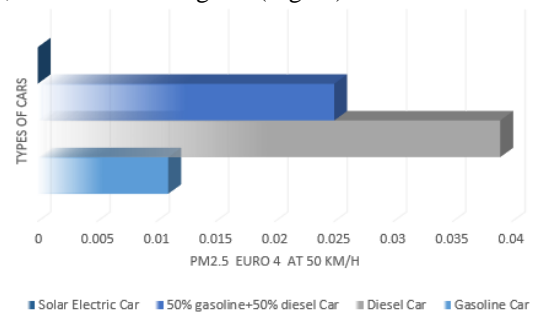


FIGURE 15. Emission of PM_{2.5}, EURO4 at 50 km/h

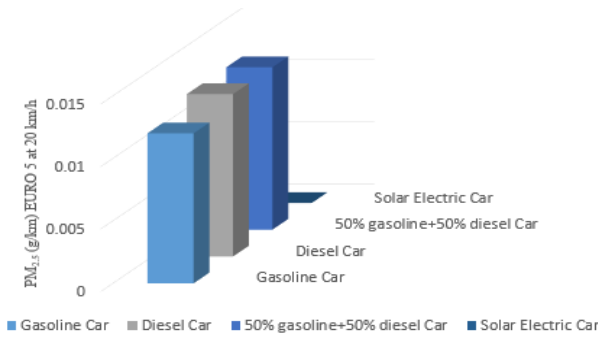


FIGURE 16. Emission of PM_{2.5} g/km from EURO5 at 20 km/h

EURO5 technology cars at 20km/h the PM_{2.5} emission value is 0.012g/km for gasoline car and 0.013 for both the diesel and 50% gasoline + 50% diesel cars (Fig.16) [27]. While on the other side the solar plug-in charging hybrid electric cars do not emit any harmful particles, carbon compounds, or particulate matter PM_{2.5}.

V. RESULTS

Comparing the prices of fossil fuel cars and electric cars the prices of electric cars are a little higher comparatively than fossil fuel cars. The most used cars in Pakistan are Toyota Corolla, Toyota Prius, and Honda Civic. Toyota Corolla GLI 1.3(VVTi) 2020 costs about Rs.27,50,000/17,000\$. Toyota Prius costs Rs.92,70,000/58,000\$ and Honda Civic Oriol 1.8 I-VTEC CVT costs Rs.39,79,000/25,000\$. Electric cars are not commonly available in Pakistan but for comparison Tesla Models S, Model 3 are Wuling is used. The observations show that a Tesla Model S costs Rs.1,30,33,000/81,000\$, Model 3 base costs Rs.64,00,000/40,000\$ and Wuling Hongguang cost around Rs.8,00,000/5,000\$ only. Cost comparison of cars is shown in Fig.17.

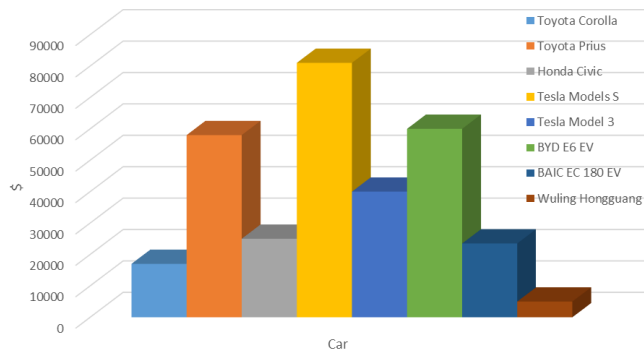


FIGURE 17. Price comparison of fossil fuel and electric cars

The price of EVs is reduced sharply compared to fossil fuels and a comparison can be made while reviewing the car prices in 2018 as shown in Fig.18. Toyota Corolla GLI 1.3 (VVTi) 2018 costs were about Rs. 22,59,000, Toyota Prius cost was Rs. 61,50,000 in 2018, and Honda Civic Oriol 1.8 I-VTEC CVT cost was Rs. 27,49,000 in 2018. Tesla Model S 100 PD cost was Rs. 1,68,75,000 in 2018 and Model X base costs was Rs. 1,20,00,000 in 2018.

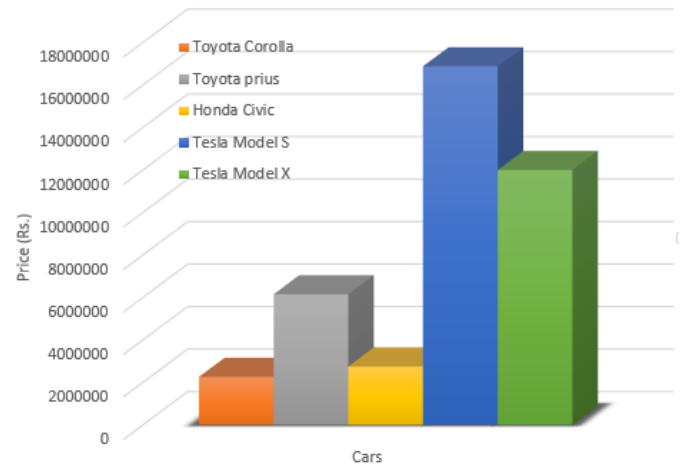


FIGURE 18. Price comparison of Cars in Pakistan 2018

The comparison figures for maintenance and fuel for fossil fuel car are; the schedule maintenance to 75K miles for Toyota Corolla costs Rs.2,00,000/1250\$ and a Honda Civic costs Rs.1,68,500/1050\$. The fuel expenses depend on the mileage of the car, the mileage of Toyota Corolla is 8.4L/100 km in urban areas, Toyota Prius 10L/100km, and Honda Civic 15 km/L on average. The maintenance cost for Tesla Model S and Model X is only Rs.3750/30\$ per year and the electricity cost depends on the source of power generation. If we are using any renewable energy source (solar, wind, etc.) then it is of less cost and clean but using fossil fuel for electricity production may cost more than average and also not clean.

VI. CONCLUSIONS

The detailed analysis and study of both fossil fuel and electric cars differentiate the use of both cars. The electric cars were expensive but their prices are coming down. With new Chinese automotive brands, the prices have become equal to or less than fossil fuel cars. Electric vehicles also have less maintenance cost, low fuel cost depends on the source of electricity production, and completely environment friendly, and also have a more safety factor. Although fossil fuel cars are cheap but have a high maintenance cost, more fuel cost and burning of fuel leaves behind the dangerous carbon, Sulfur, and fine particulate matter which are destroying the environment, endangers the human lives, and economy of Pakistan.

It is concluded from this paper that using the electric car in Pakistan can be very useful, cost-saving, environment saving, fuel-saving, and life-saving as well. The increasing population and increasing number of cars on roads are creating serious problems for the nation. As the world is moving towards renewable sources of energy so, it is the responsibility of our government to invest in using the new technology resources to save the lives and environment of Pakistan. In the light of the current automotive market, new electric car manufacturing is encouraged and a tax-free import of electric vehicles is allowed.

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