

# **PLUG-IN ELECTRIC VEHICLES: A CHALLENGE TO NIGERIAN ENGINEERS**

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## **ABSTRACT**

Nigerian Engineers in recent times have been lagging in terms of invention and innovative ideas when compared to their counterparts in developed countries. Technological developments keep waxing stronger daily in all fields of life, ranging from communication and information technology, medicine, transportation e.t.c. At a time when climate change has become a very critical issue, World leaders keep meeting time after time to discuss on ways to minimize, if not completely eradicate the burning of fossil fuels which is considered to be the primary cause of climate change or global warming. Engineers in developed countries through researches finally arrived at the construction of Electric Vehicles which is environmentally friendly to replace cars with an internal combustion engine. This paper proposes and examines the urgent need for Nigeria Engineers to key into construction and maintenance of Electric Vehicles and charge stations.

Keywords: Electric Vehicles (EVs), Charge stations, Climate change, Fossil fuel.

## **1.0 INTRODUCTION**

Climate change is the catch-all term for the shift in worldwide weather phenomena associated with an increase in global average temperatures (Wired, 2018). World average temperature has been found to increase at a very fast rate due to human and industrial activities.

Efforts are in place to keep temperatures from increasing more than two degrees above the pre-industrial average of one point five (Wired, 2018). The effects of climate change in Nigeria today has become a serious issue demanding urgent action. Some of these effects can be seen in decreasing water level of Lake Chad, increase in weather temperature, desert encroachment in the north, decreasing food security, flooding and imminent drought in the northern region.

One of the major causes of this climate change is the emission of greenhouse gases (GHG) which comprises of methane, water vapour, Carbon dioxide and nitrous oxides. Carbon dioxide is released from the combustion of fossil fuels such as coal, oil and natural gases. Emission of Carbon dioxide can be seen in cars, generators, trucks e.t.c.

Nigeria with a population of over one-eighty million people has an estimated total number of vehicles of over eleven million (NBS, 2017). This means that Nigeria carbon dioxide emission rate is extremely high.

A major way to reduce climate change is by harnessing or keying into renewable energy sources such as solar, wind, geothermal and replacing fuel-dependent vehicles with Electric Vehicles.

## **2.0 AN OVERVIEW OF PLUG-IN ELECTRIC VEHICLES**

A Plug-in Electric Vehicle is one which uses one or more electric motors or traction motors for propulsion. It utilizes a battery which can be recharged by plugging into an external source of electric power. Most Plug-in Electric Vehicles are passenger cars though other versions include commercial vehicles, utility vehicles, buses, trains, motorcycles and military vehicles.

These vehicles use both internal combustion engines (ICE) and electric power train. They displace emissions from the exhaust pipe to the generators powering the electricity grid. These generators may be renewable or have lower emission than other internal combustion engines (ICE). They make use of an energy storage system which enables energy to be stored and used after been charged. The vehicles can be charged directly from the grid, this helps to reduce cost.

Various categories of Electric Vehicles include:

- ✓ Battery Electric Vehicle (BEV)
- ✓ Hybrid Electric Vehicle (HEV)
- ✓ Plug-in Hybrid Electric Vehicle (PHEV)
- ✓ Fuel Cell Electric Vehicle (FCEV)

This study is restricted to Plug-in Hybrid Electric Vehicle (PHEV)

### **3.0 ARCHITECTURE OF PLUG-IN ELECTRIC VEHICLE**

The Plug-in Electric Vehicle uses both an internal combustion engine (ICE) and electrical power train. It uses electric propulsion as the main driving force and when the batteries are low in charge, it signals the internal combustion engine (ICE) to provide a boost or charge up the battery pack.

These vehicles start in electric mode, the internal combustion engine extends the range of the vehicles. The vehicles utilize regenerative braking and run solely on electricity for most of their time. Hence, their carbon dioxide footprint is reduced as they consume less fuel thereby minimizing cost. (Fuad, 2017).

For a Plug-in Electric Vehicle to run on battery, they undergo a charging process that uses Alternating Current (AC) for onboard chargers and Direct Current (DC) for external charging. The batteries used are Lithium-ion batteries which have a higher energy density, longer lifespan and higher power density.

The working mechanism of a PHEV is shown below:

- The KO clutch is used to disconnect and shut down the engine from the wheels when the vehicle is on electric mode.
- IAE clutch is used to link the electric machine and engine to the planetary gearbox
- Mechanical oil pump generates oil flow and pressure for automatic transmission
- E-pump sustains the oil pressure in the hydraulic system during stop and start states.

## KEY COMPONENTS OF PLUG-IN ELECTRIC VEHICLES.

- Auxillary battery: This supplies electricity to start the car before switching to traction battery and also powers the vehicle accessories
- Charge port: It permits the vehicle to connect to an external power supply to charge the traction battery pack
- DC/DC converter: This changes DC of high voltage from the traction battery pack to low DC power required to operate the vehicle accessories and recharge the auxiliary battery
- Electric generator: It provides electricity from the rotating wheels while braking. It also returns energy to the traction battery pack for charging the batteries
- Electric traction motor: This uses power from the traction battery pack to drive the wheels of the vehicle
- Exhaust system: It removes exhaust gases through the tailpipe. The emissions are minimized in the exhaust system through a three-way catalyst
- Fuel filler: This is used to refuel the tank
- Fuel tank: it stores gasoline
- Internal combustion engine (ICE): This is spark-ignited and promotes or initiates fuel combustion in the vehicle engine
- Onboard charger: It accepts the incoming AC supply through the charge port and converts it to DC power for traction battery charging. It also controls battery properties such as current, voltage, temperature and charging condition when charging the pack.
- Power electronic controller: This part controls the flow of electricity supplied by the traction battery and also the speed of the electric traction motor as well as the torque produced
- Cooling system: This system maintains a proper operating temperature range of the vehicle engine, power electronics, electric motor and other components.
- Traction battery pack: It houses the battery which stores electric energy to be used by the traction motor
- Transmission: It relays mechanical power from the engine and / or electric traction motor to drive the wheels.

#### **4.0 PROBLEMS OF PLUG-IN ELECTRIC VEHICLES IN NIGERIA**

- Voltage instability: Power systems operate at a limit close to theirs. However, instability may set in due to load characteristics which may lead to a blackout. Electric Vehicles have nonlinear characteristics hence draw large quantities of power in a short period.
- Purchase cost: The price of Plug-in Electric Vehicles is higher than that of internal combustion engine counterparts.
- Longer charging duration: It takes quite a long time to charge the batteries of Electric Vehicles than just fueling vehicles with internal combustion engines
- Interruptible power supply: The epileptic power supply in Nigeria makes the environment unfriendly for these Electric Vehicles.

#### **4.1 POSITIVE IMPACT OF PLUG-IN ELECTRIC VEHICLES IN NIGERIA**

- ❖ Environmental friendly: Electric Vehicles utilize renewable sources of energy. Thus, they minimize the emission of greenhouse gases (GHG)
- ❖ Smart grid technology: Here, intelligent communication and decision making is incorporated with the grid architecture. The linking of Plug-in Vehicles to the smart grid system promotes better renewable energy interaction
- ❖ Vehicle to grid (V2G): These vehicles provide power to the grid system. Since these vehicles draw energy, they become dynamic energy sources by returning energy to the grid
- ❖ Economic impact: These vehicles facilitate less operating cost due to their superior efficiency when compared to internal combustion engines.

#### **5.0 CONCLUSION**

Plug-in Electric Vehicles have a great capacity of becoming the future of world transportation as they will save our planet from imminent doom caused by climate change. They represent an alternative to conventional vehicles which facilitates decreasing fossil fuel reserves. The benefits of these vehicles cannot be underestimated as the fight against global warming can only be won using them as key weapons.

With further research, Plug-in Electric Vehicles will be provided at affordable cost and also harness other renewable sources of energy for charging them as well as greater efficiency for performance. Hence, eradicating vehicles with only internal combustion engines completely.

Nigerian government should encourage policies that will facilitate the domestic production of Plug-in Electric Vehicles.

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