

A case study on the potential impact of a private vehicles switch to electric vehicles in Lagos, Nigeria

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Abstract. Lagos is a major city in Africa that faces environmental challenges such as carbon emissions and air pollution. With the rising cost of fossil fuels and increasing environmental awareness, the movement of private vehicles to electric vehicles is worth discussing. This paper explores the potential impacts of switching private vehicles to electric vehicles in Lagos, including the impacts on air quality, carbon emissions, and energy infrastructure. The paper analyses the data by analysing the current state of transportation in Lagos, current energy demand and supply. It also discusses the future technology and costs of switching private vehicles to electric vehicles in Lagos, and forecasts the challenges and opportunities for the future development of electric vehicles in Lagos. It also explores current government actions and progress in related areas. The paper discusses and analyses various aspects of the conversion of private vehicles to electric vehicles in Lagos, Nigeria, and provides a reference for the future development of related areas.

Keywords: electric vehicles, Lagos, Nigeria, carbon emissions, renewable energy, sustainable development, infrastructure, transport, engineering.

1. Introduction

Lagos, Nigeria, has a population of over 21 million. Currently, Lagos' transportation system relies mainly on traditional fuel-powered vehicles. Global warming and public health issues, especially carbon emissions and air pollution, have become focal concerns in many major cities around the world. This paper aims to explore the potential impacts that the introduction of electric vehicles in Lagos, Nigeria, may have on air quality, carbon emissions, and energy infrastructure.

2. Background introduction of road traffic

Lagos holds the status of being both the commercial and economic hub not only for Nigeria but for the entire African continent. The population is estimated at 21,305,971 and the total land area is 3,577.28 km², of which approximately 22% is wetland area. The population density is approximately 6,515 persons per square kilometre [1]. The existing transport network in Lagos is shown in Figure 1. The two main sources of traditional transportation fuel in Nigeria are petrol and diesel, which account for almost all vehicles operating in the country [2]. As of 2019, the total number of newly registered motor vehicles in Lagos State was 154,056, of which private-use motor vehicles accounted for 82.5% of the total, reaching 127,058 vehicles. Passenger transportation mainly relies on buses (44.8%) and cars (42.5%).

Overall, more than 61% of trips are by gasoline vehicles, while the remainder are by diesel vehicles [3]. This situation makes Lagos a region with high carbon emissions, and according to projections, its greenhouse gas emissions may reach a staggering 39 MtCO₂ equivalent by 2040 [2]. Therefore, the conversion of private cars in Lagos to electric vehicles is very necessary for the ecological environment.



Figure 1. Existing Transport Network [1].

The low quality and poor state of the current road infrastructure in Lagos has adversely affected the development of the city. By replacing traditional gasoline-powered vehicles with electric vehicles (EVs), it is expected to improve living and working conditions in the region to a certain extent [1]. However, purchasing electric vehicles for private use still faces high costs, as approximately 40.1% of Nigeria's population still lives below the poverty line [4]. In light of this, the government of Lagos, Nigeria may implement a range of policies and incentives to encourage ordinary citizens to acquire EVs and thus, bolster the market share of this sustainable form of transportation.

3. Analysis of energy requirement for vehicles

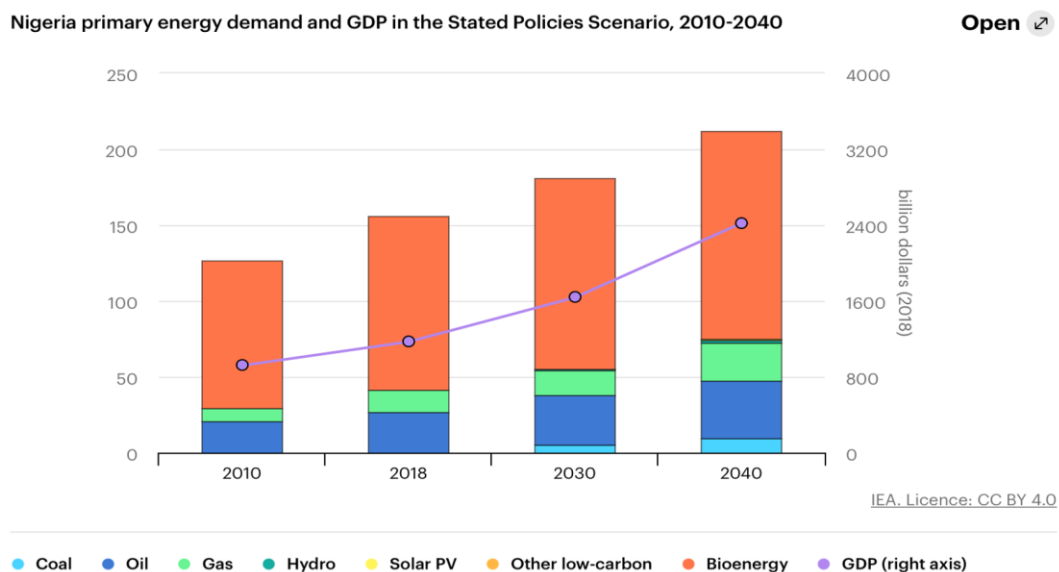


Figure 2. Nigeria primary energy demand and GDP in the Stated Policies Scenario, 2010-2040 [5].

In sub-Saharan Africa, factors such as rapid urbanization, the promotion of decentralized solar photovoltaic technology, and the increasing popularity of electric transportation are reshaping power planning options [6]. If the electricity used to charge the car comes from renewable sources such as solar or wind, the car's overall carbon footprint can be significantly reduced. The Nigeria primary energy demand and GDP in the Stated Policies Scenario from 2010 to 2040 is shown in Figure 2. From the figure, we can see that with the improvement of economic level, Nigeria's demand for various energy sources has also increased significantly. Therefore, the Lagos government also needs to gradually expand the proportion of renewable energy, which has a major impact on the country's future development.

3.1. Current Energy Consumption

As the modern technological revolution continues to advance, the continued growth of the global population has led to a sharp increase in electricity demand, which has raised a problem that urgently requires sustainable energy solutions [7]. In Nigeria's power sector, the vast majority of electricity supply relies on fossil fuels, especially natural gas, which accounts for approximately 80% of total fossil fuel energy. In fact, about 80% of the country's energy structure comes from thermal power generation, while the remaining 20% comes from hydropower and other renewable energy sources [8]. The Nigeria electricity generation by technology in the Stated Policies Scenario from 2010 to 2040 is shown in Figure 3. As can be seen from the figure, it is expected that the government of Lagos, Nigeria will gradually increase the supply of renewable energy in the future. This will improve the current problem of insufficient electricity and the high proportion of fossil energy.

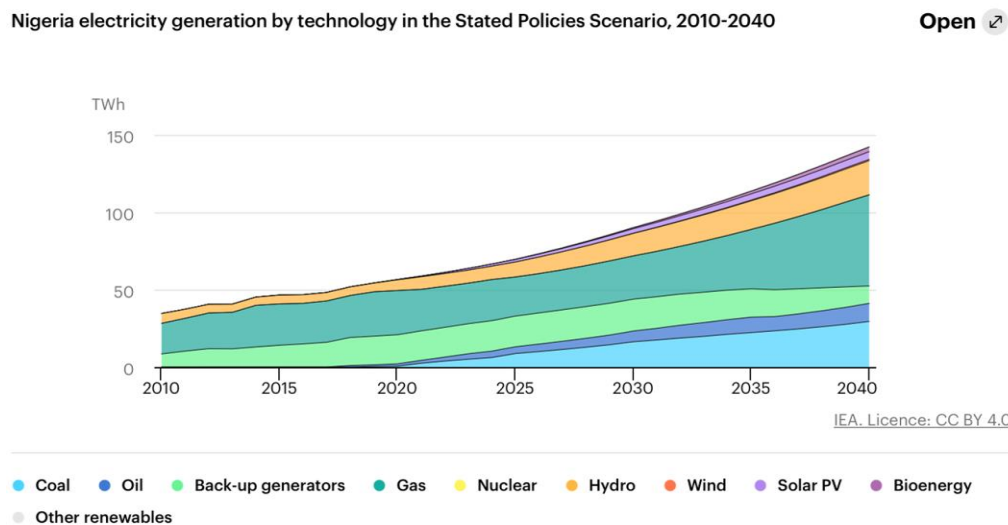


Figure 3. Nigeria electricity generation by technology in the Stated Policies Scenario, 2010-2040 [5].

As of 2020, Nigeria's transportation industry accounts for more than 70% of the country's energy consumption. Nigeria and other countries are actively taking measures to reduce greenhouse gas (GHG) emissions, which cause serious climate and environmental problems [8]. Switching to electric vehicles in Lagos, Nigeria could reduce dependence on imported fossil fuels and improve energy security. With fossil fuels becoming increasingly scarce and environmental awareness growing, using fossil fuels could become increasingly costly in the future, and switching to electric vehicles could reduce the economic cost.

3.2. Future Energy Supply

Nigeria is located between 4° and 14° north latitude (slightly north of the equator) and between 2° and 15° east longitude (slightly east of the prime meridian). The entire country is in sunny areas [8]. Solar power can provide a sustainable solution to long-term energy needs. While the initial equipment cost of

solar power generation may be steep, its operational expenses are considerably lower. This can potentially lessen the reliance on fossil fuels such as oil and natural gas, thereby lowering energy expenses in Lagos. The government of Lagos should intensify efforts to advocate and implement solar power generation technology to foster sustainable development. Lagos has a huge energy demand, but the energy supply is unstable. Both solar and hydroelectric power can provide Lagos with a clean, renewable and stable electricity supply.

3.3. Action taken by the Government

The Nigerian government is actively working to reduce noise and air pollution, and a key measure is promoting the use of electric vehicles (EVs). To achieve this goal, the government has incorporated the popularization of electric vehicles into the national automobile industry development plan [8]. Faced with frequent power shortages in Nigeria that affect the efficiency and running time of electric vehicles, the government plans to increase fossil fuel power generation capacity to 18,200 megawatts, aiming to account for 30% of total power generation by 2030, and this power generation will come from Renewable Energy [8]. The Nigerian government should do more to increase the share of renewable energy. These actions reduce carbon emissions, increase energy security and sustainability, create jobs, and improve the environment and health.

4. Progress in switching private vehicles to electric vehicles

Nigeria is also following the trend and actively promoting the use of electric vehicles (EVs). In June 2021, Stallion Motors launched its first domestically manufactured electric car, the Hyundai Kona, and the unveiling ceremony was personally hosted by Nigeria's Vice President Yemi Osinbajo [9]. Furthermore, in April, Nigeria's first EV charging station was opened at Usmanu Danfodiyo University in Sokoto State, North-West Nigeria, by the National Automotive Design and Development Company [10]. In addition, EVs have the potential to support renewable energy development in Nigeria through a bidirectional charging strategy [11].

4.1. Technology

In the realm of energy systems, leapfrogging has already demonstrated the capacity to substantially decrease the energy intensity of economies, mitigate pollution, and even generate more extensive economic prospects [12]. According to Cavoli (2021), leapfrogging in rapidly expanding cities, particularly those in the Global South, can involve more than just replacing technologies [13]. It can also include cross-sector collaboration and systemic thinking, where communities adopt visionary planning or governance approaches. Leapfrogging may extend to integration across ministries or governmental initiatives related to mobility, and it may prioritize vision-led planning rather than responding to short-term political cycles. Despite current technical, legal, and economic obstacles, many experts believe that electric vehicles (EVs) could become more attractive in the future [14]. The government of Lagos, Nigeria needs to do more to increase the market share of electric vehicles.

4.2. Cost

In cities, most travel needs can be met by electric vehicles, and the batteries used in these vehicles have long been proven to be the most cost-effective option. Therefore, battery costs are falling rapidly every year, which will lead to a lower initial price of electric vehicles [1]. However, despite the lower life cycle costs of electric vehicles, their initial investment costs are much higher than those of conventional internal combustion engine vehicles (ICEVs). According to estimates by Cox Automotive, the average cost of a new electric car is about \$55,600 (equivalent to 23 million), which is much higher than the average annual income of the average Nigerian, which is about 2 million naira [5]. For Nigerians to consider the cost of electric vehicles attractive, the initial investment must be lower than the price of a second-hand internal combustion engine car, which can be a challenge without financial incentives.

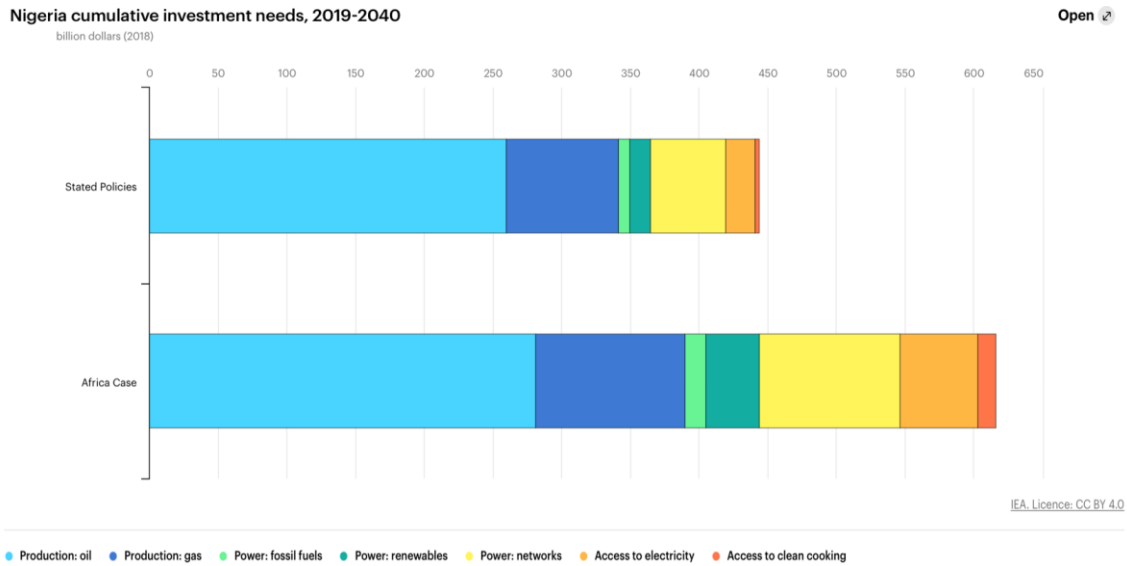


Figure 4. Nigeria cumulative investment needs, 2019-2040 [5].

Nigeria's cumulative investment needs for 2019-2040 are shown in Figure 4. The figure shows that investment in all types of energy will continue to grow. In order to better increase the share of electric vehicles, the Lagos government can reduce the cost of electric vehicles through tax relief, construction of charging infrastructure, policy support and publicity activities. Thereby encouraging more people to buy electric vehicles and promoting the development of electric vehicles.

4.3. Challenges

Nigeria's political and economic landscape occupies a pivotal position in the oil and gas industry, as more than 90% of the country's foreign exchange earnings come from crude oil exports. However, Nigerian policymakers may begin to worry that demand for crude oil exports to Europe and Asia may decline, while domestic demand may also decrease. Currently, Nigeria has little public EV charging infrastructure and no clear plans to develop it. Automotive maintenance technicians in Nigeria usually receive informal internal combustion engine vehicle (ICEV) maintenance training and have relatively poor maintenance knowledge of electric vehicles [11]. Although the development of electric vehicles in Lagos is promising, there is still a lot that the government needs to do.

5. Carbon emissions and air quality impacts of private car shift to electric vehicles

Since 1960, Nigeria's per capita carbon dioxide emissions have increased from approximately 0.08 tons to 0.67 tons in 2018 [8]. The popularity of fossil fuel vehicles is declining sharply in major cities around the world as sustainable and environmentally friendly alternatives emerge, and the spread of electric vehicles is having a profound impact. In fact, for every 1,000 electric vehicles driven, approximately 500 barrels of diesel are saved [1]. Lagos needs to increase the use of more renewable energy sources such as solar and hydropower, which will effectively reduce carbon emissions and reduce the number of petrol-powered cars on the road.

Urban air quality is affected by particles and gases in the environment, and the decline of urban air quality is closely related to the increase in industrial and transportation emission levels [15]. However, African countries, including Nigeria, have limitations in monitoring air pollution, which limits the adoption of effective measures to address air pollution [16]. In 2013, the Lagos Metropolitan Area Transport Authority (LAMATA) announced through a press release that they were committed to reducing greenhouse gas emissions from the transport sector by 45% by 2030 through Sustainable Transport and Integrated Planning (STMP) [17]. The Lagos government continues to do more than it needs to do to improve air quality.

6. The future development of electric cars

Although Nigeria's electricity system relies largely on natural gas, the rollout of electric vehicles has the potential to drive decarbonization of the transport and power sectors, albeit at a relatively high cost. In order for electric vehicles to be cost-competitive, their prices need to be reduced by 40% [11]. Lagos's public transport system needs improved infrastructure as climate change, traffic congestion, population growth and increases in harmful emissions have become huge threats to the environment. Therefore, there is an urgent need to invest in sustainable infrastructure. When it comes to climate action, active collaboration is crucial to promote improvements in public transport systems and strengthen cybersecurity measures [1]. The Lagos government must develop a strategic plan to achieve the set targets for greenhouse gas emissions from road transport [18]. There is still a lot the Lagos government can do to convert private vehicles to electric vehicles.

7. Conclusion

The transition from fossil-fuel-powered vehicles to electric vehicles is important in reducing dependence on fossil fuels and mitigating climate change. The high cost of EVs remains a barrier to their development in Lagos, but the government can implement policies and subsidies to increase the market share of electric vehicles. The conversion to electric vehicles will improve the ecological environment and working and living conditions in Lagos. In conclusion, taking steps to facilitate the transition of private vehicles to electric vehicles in Lagos will play a vital role in reducing carbon emissions and reducing the number of gasoline-powered vehicles. This paper analyses the changes that are also required in the government sector from various aspects in Lagos State. Such as the upgrading of infrastructure, the introduction of more policies to achieve the goals set by the government.

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