A Vision for E-Mobility in Nigeria

The Opportunity, Challenges, and Path Forward

Report / September 2024

About RMI

RMI is an independent nonprofit founded in 1982 that transforms global energy systems through market-driven solutions to align with a 1.5°C future and secure a clean, prosperous, zero-carbon future for all. We work in the world's most critical geographies and engage businesses, policymakers, communities, and NGOs to identify and scale energy system interventions that will cut climate pollution at least 50 percent by 2030. RMI has offices in Basalt and Boulder, Colorado; New York City; Oakland, California; Washington, D.C.; Abuja, Nigeria; and Beijing.

About SEforALL

Sustainable Energy for All (SEforALL) is an independent international organization that works in partnership with the United Nations and leaders in government, the private sector, financial institutions, civil society and philanthropies to drive faster action on Sustainable Development Goal 7 (SDG7) – access to affordable, reliable, sustainable and modern energy for all by 2030 – in line with the Paris Agreement on climate change. SEforALL works to ensure a clean energy transition that leaves no one behind and brings new opportunities for everyone to fulfil their potential. Learn more about our work at www.SEforALL.org.

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Acknowledgments

This report was co-authored with Energy Transition Office Nigeria (ETO Nigeria). We would like to thank them for acting as a key partner in the creation of this report. ETO Nigeria supports the Nigerian government in the implementation of its Energy Transition Plan, and is resourced by GEAPP and SEforALL.

The authors would like to express gratitude to the following organizations for their contributions and partnerships: National Automotive Design and Development Council, the National Council on Climate Change, the Clean Technology Hub, the GreenMax Capital Group, Oando Clean Energy, and MAX.

The authors would also like to thank the Drive Electric Campaign for their generous support that made this report possible.

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Clay Stranger et al., *A Vision for E-Mobility in Nigeria: The Opportunity, Challenges, and Path Forward,* RMI, 2024, **https://rmi.org/insight/nigeria-mobility-support/**

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Foreword

“A tiger does not proclaim his tigritude, he pounces.”

These words come from renowned Nigerian author and winner of the 1986 Nobel Prize for Literature Wole Soyinka and can be said to represent Nigeria’s resolve to act quickly and decisively to address climate change.

In 2021 at COP26 in Glasgow, Scotland, Nigeria announced its goal of reaching carbon neutrality by 2060. Since then, it has taken significant steps in pursuit of this mission. In 2022, it published its Energy Transition Plan, summarizing the ways in which the country will reduce emissions, and established the Energy Transition Office to lead the plan’s execution.

Transportation electrification forms a critical part of Nigeria's decarbonization strategy. By accelerating the adoption of electric vehicles, including two- and three-wheelers; deploying biofuels; strengthening EV charging infrastructure; and developing the EV car market, Nigeria will not only decrease its emissions but also create jobs, bolster the economy, improve health outcomes, and provide its citizens with clean, affordable, efficient, and reliable transportation options that will enhance their daily lives.

The country faces significant challenges as it works to realize its ambitious climate goals; its fuel subsidy ended in 2023, nearly tripling transportation costs and affecting its economy, which is largely driven by oil, gas, and agriculture. Demand for transportation continues to outpace supply in both urban and rural areas and the country’s infrastructure needs to improve. This demand on the transportation system will continue to increase, and put additional pressure on supply, as Nigeria’s rapidly growing population is projected to reach 791 million by the end of the century.[1]

Nigeria is well-positioned to overcome these challenges — it has a dynamic economy, a strong entrepreneurial spirit, and a growing population eager to work. It also has the necessary political will, demonstrated through the development of a national Energy Transition Plan by the Energy Transition Office, which includes a goal of 100% EVs by 2060. In short, the opportunities exceed the barriers. Taking advantage of these opportunities will require intense collaboration between diverse parties, intentional resource sharing, and out-of-the-box thinking.

That’s why RMI and Nigeria’s Energy Transition Office worked together to develop this vision brief for the country’s e-mobility sector — to provide a framework stakeholders can use to advance their e-mobility efforts. It offers current and projected landscape analyses; identifies the environmental, economic, and social benefits of electrification; and describes what kinds of policies, finance mechanisms, and actions will rapidly, equitably, and efficiently electrify Nigeria’s transportation sector.

Nigeria finds itself at an inflection point, and the decisions made today will influence the way people live for decades to come. Our hope is that this brief’s insights help stakeholders make the dream of an equitable, accessible, reliable, and clean transportation system a reality.

As Africa's most populous country, with one of the continent's strongest economies, Nigeria has the power to not only transform the lives of its citizens but also those of billions of others, as other countries can learn from its experiences and develop and implement strategies of their own.

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Executive Summary

In 2021, Nigeria committed to reaching carbon neutrality by 2060. The country released the Energy Transition Plan (ETP), outlining the steps needed to achieve this carbon neutrality goal. This plan includes electric four-wheeler deployment, mode shift from passenger cars to public transportation and electric two-and three-wheelers, EV charging infrastructure, and EV manufacturing targets. Efforts to reach these targets have the potential to spur economic opportunities and improve environmental outcomes nationwide.

As a result of these national-level commitments to transform the transportation sector, the Nigerian public and private sectors have heeded the call. Several EV adoption and charging infrastructure projects have been implemented across the nation. From e-bus deployment in Lagos to 100% solar-powered charging stations through the National Automotive Design and Development Council's partnership with universities, stakeholders are ready to act. However, despite the enthusiastic response, challenges persist.

This report provides an in-depth look into the Nigerian transportation sector, analyzes the e-mobility opportunities and anticipated challenges, and provides steps for a successful path forward. In addition to the economic advantages of moving toward an electric future from establishing a local EV manufacturing market, we also assess the cost savings and emissions reductions from pursing Nigeria's 2060 goals: With these solutions, Nigeria can set themselves on a high adoption scenario and have over 60% electric 2W sales and can avoid up to two megatons of CO_2e annually by 2040. This will set the stage for rapid growth and impact in other vehicle segments. Action towards Nigeria's renewable power generation targets will significantly improve these emissions savings.

Achieving Nigeria's vision of a cleaner and efficient transportation sector requires a coordinated effort. This report contains recommendations for stakeholders across the public and private sectors, including:

Implement favorable EV policies: Fiscal and non-fiscal policies focused on EV deployment will further push EV adoption in an upward trajectory. Tax exemptions and vehicle purchase subsidies can help ease the cost of EVs for consumers, whereas feebates in the form of taxes on the sale of polluting vehicles can help shift consumers to EVs. Loan guarantees are also a tool that the Nigerian government can employ to lower interest rates for EV purchases. Supply-side non-fiscal policies can include EV sales mandates and placing limits on emissions intensity.

Expand access and availability to EVs: With the support of the government, the Nigerian manufacturing industry is well-positioned to capture the last stages of the EV supply chain, especially final assembly. In the longer term, these operations can then be diversified to incorporate other parts of the EV supply chain, including vehicle design and battery manufacturing. As local manufacturing takes hold over time, parallel policies to enable bulk procurement can create demand and justify local manufacturing. Bolstering local manufacturing and streamlining procurement in bulk can create new job opportunities and bring economic development to different regions of the country.

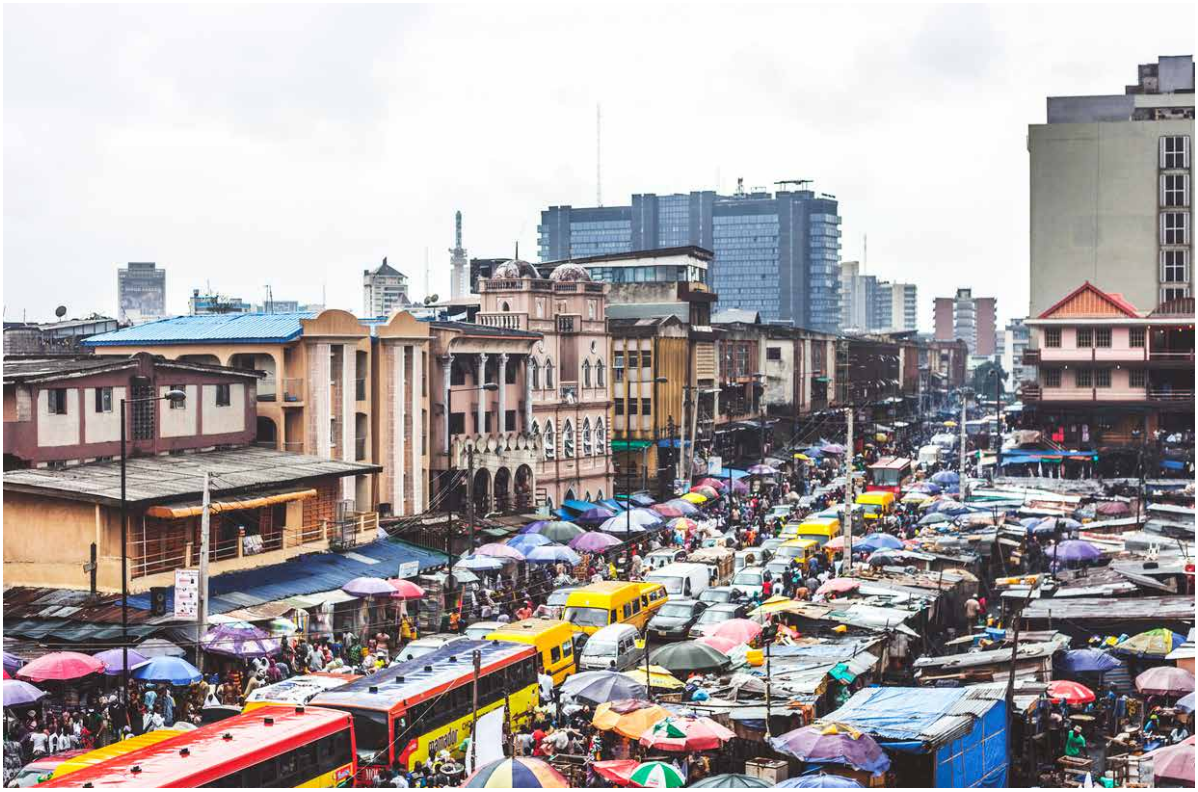
Establish EV finance facilities: Affordability is key in driving the initial growth of the market and accelerating EV adoption in Nigeria. Given the nascency of the EV industry, risk-sharing arrangements can help local commercial financiers provide affordable prices to customers. This will require partnerships between financiers and socially focused organizations (i.e., the government or development finance institutions).

Enhance convenience: Reliable and robust charging infrastructure will drive the success of e-mobility in Nigeria. Several factors must be considered in the deployment of charging infrastructure. These include prioritizing e-bus and two-wheeler charging, standardizing charging through interoperability, improving grid consistencies by utilizing renewable energy sources, and ensuring strong after-sales services for customers.

Cultivate engagement: Collaboration between the public and private sectors is the pillar for a thriving and sustainable e-mobility future in Nigeria. Knowledge sharing between the two sectors is an essential step. For example, a centralized information hub with local, state, and national-level policies that the private sector can refer to for their EV implementation plans can streamline the process for the private sector. Conversely, the public sector would benefit from understanding the needs of the EV industry to provide useful support and implement regulations that benefit all players in the ecosystem.

Promote awareness: Generating positive attention would signal to smaller fleets and other stakeholders in the country that transportation electrification business models are achievable. Building confidence that EVs can be scaled in Nigeria would also bring more investment into the industry in the long-term. Additionally, consumer awareness about the cost and health benefits would further drive demand for electrification in the nation.

Nigerian Context



Home to more than 218 million people, Nigeria is currently Africa's most populous country; by the end of the century that number is expected to grow to 791 million, surpassing China's population.[2] Given that it's one of the largest economies on the continent, the country's transportation-related climate actions can have an outsized impact on the continent and globe.

As Nigeria's growth trajectory continues to challenge its existing transportation system, its government and the transportation sector are exploring ways in which clean and cost-effective mobility solutions can serve citizens' needs. Sudden economic shifts — including the removal of a long-standing but costly fuel subsidy — and the goals set by Nigeria's Energy Transition Plan have highlighted the need for quick, decisive action.

Nigeria's Economy

Nigeria has sub-Saharan Africa's second-largest economy after South Africa; as of October 2023, Nigeria's gross domestic product (GDP) was $390 billion, with a real annual GDP growth of 2.9%.[3] It boasts a rapidly growing tech sector and strong private sector leadership, particularly in finance and software[4] — 6 of the top 20 fastest-growing companies in Africa were based in Nigeria.[5] Additionally, a relatively supportive local commercial capital market, which includes venture capital and private equity investors, has helped drive startup growth.

Transportation Needs and Impacts in Nigeria

Nigeria faces significant underlying challenges hindering its ability to meet its potential, including unmet transportation needs; these challenges were further complicated by the end of the fuel subsidy in 2023, which caused transportation costs to almost triple.[6]

Before the fuel subsidy was removed, Nigeria paid $10 billion in 2022 for oil subsidies.[7] While the removal of the fuel subsidy has eased pressure on government finances, the burden on Nigerian households has been significant, leading to a nationwide cash-transfer scheme and other measures intended to ease the burden on low- and middle-income households.[8]

In an economy still largely driven by oil, gas, and agriculture, transportation is essential for continued development, but demand for transportation has consistently outpaced supply in both urban and rural areas.[9] At present, it is estimated that Nigeria's annual demand for vehicles is 720,000, but local production is only 14,000, meaning that hundreds of thousands of vehicles, primarily used vehicles, must be imported each year with little benefit to the local economy.[10] This heavy reliance on imported used vehicles also contributes to the prevalence of high-emissions vehicles, as those imported to Nigeria do not meet minimum emissions regulations in the countries from which they are exported.[11] The result of this dependency is not only high levels of pollution, but also high costs; the import of used vehicles costs the country an estimated $8 billion each year.[12]

The domestic auto industry in Nigeria is ripe for change, not only to encourage growth in this segment of the economy, but also to improve access to transportation and — through solutions like electric vehicles (EVs) — reduce CO_2 and air pollution emissions.

The rapidly growing transportation demand in the country is expected to more than double by 2050, with a corresponding impact on greenhouse gas emissions.[13] Transportation in Nigeria emits 43 million tons of CO_2 equivalent ($MtCO_2e$), 72% of which comes from passenger vehicles.[14] The transportation challenge will only increase as the country's population continues to grow. By the government's own estimate, under a road transportation-dependent business-as-usual scenario, these emissions will increase by 50% by 2035, and by over 100% by 2050.[15]

For its continued economic growth, quality of life for its citizens, and environmental protection, Nigeria needs a new and electrified approach to transportation.

Nigeria's Energy Transition Plan

Nigeria has already taken significant steps to further the transition to EVs, including positioning itself as a climate leader. At COP26 in 2021 Nigeria announced a goal of reaching carbon neutrality by 2060.[16] Subsequently, Nigeria released its Energy Transition Plan (ETP), to lay out the steps needed to achieve Nigeria's carbon neutrality goal, including establishing the Energy Transition Office (ETO).[17] Regarding the transportation sector, the ETP notes a four-wheeler EV deployment goal of 13 million vehicles — 60% of the total number of vehicles — by 2050, and 100% by 2060.[18] The ETP also includes transportation-specific goals including mode shifting from passenger cars to public transportation and electric two- and three-wheelers, deployment of biofuels, deployment of EV charging infrastructure, and development of the EV manufacturing market.[19] Achieving Nigeria's net-zero goal in the transportation sector will have significant positive economic and development impacts for the country and its citizens.

Transportation Electrification Initiatives in Nigeria

As an early indication of enthusiasm for e-mobility, public and private sector stakeholders across Nigeria have launched initiatives to test and grow both EV adoption and charging infrastructure. For example, in 2023, Oando Clean Energy began a three-month proof-of-concept project to incorporate electric buses into the Lagos Metropolitan Area Transport Authority's bus fleet.[20] Following the project's proof-of-concept phase, Oando plans to launch a larger pilot, which it wants to implement across the country.[21] The ETO's partnership with Sustainable Energy For All (SEforALL) provides another example of a promising initiative: they published an e-mobility plan for the northeast region of Nigeria in January of 2024, focused primarily on electric two- and three-wheeler deployment. Multiple other initiatives are supporting deployment of charging infrastructure, including the National Automotive Design and Development Council's partnership with universities to launch electric vehicle charging stations that are 100% solar-powered.[22]

Additionally, the electric two-wheeler manufacturer MAX, headquartered in Nigeria, recently initiated a successful EV pilot project supporting drivers in Gbamu Gbamu, which leased electric two-wheelers at the Rubitec solar minigrid. Drivers were able to transport goods and people within a 20 kilometer radius in a fee-for-service structure.[23] The rentals required approximately 1 kWh of electricity from the minigrid per rental per day and utilized a battery swapping model for charging.[24]

The Need for Low-Cost, Low-Emissions Transportation Solutions

While Nigeria's goals for transportation decarbonization are ambitious, they align with global EV trends, which indicate that the market will continue to grow. In 2022, global electric two-wheeler sales totaled 9.2 million, and EV car sales in 2023 increased by an estimated 35% over 2022 sales,[i] with an estimated 14 million electric cars sold.[25] This trend is not limited to major EV markets: outside of China, Europe, and the United States, where EV sales are already high, EV sales were expected to be 50% higher in 2023 than in 2022.[26]

While there is a widespread perception that transitioning to EVs is difficult and costly, many countries have already shown that, when public and private stakeholders support enabling policies, access to low-cost finance and consumer engagement market growth exceeds that of leading, authoritative forecasts. For example, the International Energy Agency updated its share of EV sales forecast in 2030 from 15% in 2019 to 35% in 2023.[27] Similarly, Bloomberg New Energy Finance projections of 2030 EV share of expected global sales has changed over time, increasing from 24% to 44% in seven years.[28]

Market Conditions in Nigeria

A uniquely supportive set of conditions has emerged over the past year in Nigeria. Key among them is the removal of Nigeria's national petrol subsidy in June 2023. While the subsidy's end has saved the Nigerian government the approximately $500 million a month it was spending to subsidize petroleum imports,[29] it has contributed to petrol prices more than tripling, eventually reaching a record high of 617 naira per liter in July 2023.[30]

These increased costs have significantly impacted individual behavior. Many Nigerians have moved in with relatives to be closer to their jobs, the price of food has increased, and the broader economy has felt the wide-reaching inflationary effects of the shift in costs.

While the fuel subsidy removal has had a major and immediate negative impact on many Nigerians, it has also highlighted the urgent need for a radical shift in Nigeria's transportation sector. If deployed at scale, EVs could reduce transportation costs, restore and even improve Nigerians' mobility that was lost because of petrol price increases, decrease air pollution, create a new domestic manufacturing industry, generate jobs, and stimulate economic development.

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i This is inclusive of battery-electric vehicles and plug-in hybrid electric vehicles.

The Examples of China, India, and Vietnam

China is currently the largest EV market in the world and illustrates the sustained pace at which the EV market can grow.[31] In 2022, the country's EV sales increased by 60% from the previous year, totaling 4.4 million vehicles and accounting for 50% of all electric cars on the road globally[32] BYD — China's highest selling car brand — sold a total of more than 700,000 EVs and PHEVs in 2023, its best quarter ever.[ii,33]

However, while China is clearly a global leader, its growth trajectory is not unique and much of global growth has been in the two- and three-wheelers segment in Nigeria's economic peer countries. In 2023 in India, 5% of three-wheeler sales, not including e-rickshaws, which play a key role in urban passenger and freight transportation, were electric.[34] In Vietnam, the electric share of the two-wheeler market grew from 5.4% in 2019 to 10% in 2021.[35]

In most countries, a crucial growth stage starts to occur when sales reach around 5% to 8%, "after which the steep part of the consumer adoption 'S-curve' hits."[36] This increase has led to the rapid development of a robust domestic manufacturing base; ten manufacturers, five of which were Vietnamese, sold electric two-wheelers in Vietnam in 2020, representing 69.6% of sales.[37]

This growth has been particularly robust in the urban commercial vehicle segment. Electric light commercial vehicles sales increased by more than 90% in 2022, reaching 310,00 vehicles, and almost 66,000 electric buses and 60,000 medium- and heavy-duty trucks were sold globally.[38] Delhi, the capital city of India and a close analogue to Nigeria's burgeoning megacities like Lagos, clearly demonstrates the potential of this market segment. Between December 2021 and February 2022, commercial electric vehicles in Delhi were 10% of all vehicle sales.[39] EVs have been particularly compelling in commercial applications such as last-mile delivery, due to high utilization rates, sustainability benefits, and the strong cost-competitiveness of electric two- and three-wheelers.

This global trend of rapid growth into new market segments indicates the beginning of a steep S-curve of adoption. For this reason, EVs are cited as one of the few global sectors on track for global net-zero 2050 targets. The sale of electric two- and three-wheelers in emerging economies represents a significant amount of the transition to electric transportation worldwide, accounting for 60% of the reduced global oil demand from electric mobility, or 1.08 million barrels daily.[40]

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ii "New energy vehicles" are defined as battery electric vehicles, plug-in hybrid electric vehicles, and fuel cell vehicles, **https://www.iea.org/reports/global-ev-outlook-2023/trends-in-electric-light-duty-vehicles.**

Nigeria's E-Mobility Opportunity

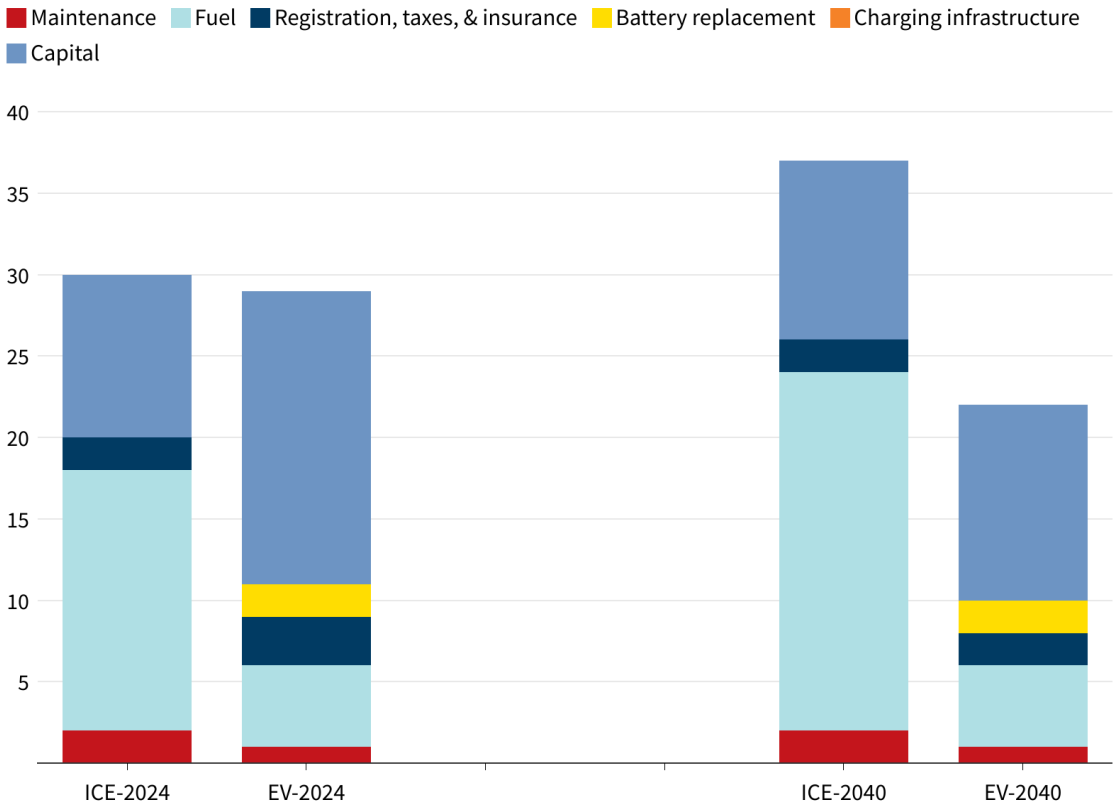
Nigeria is well positioned to rapidly shift to a clean and cost-effective transportation system through the accelerated adoption of EVs, and to reap the economic benefits of producing and using these low-emissions vehicles. By meeting a certain set of conditions, Nigeria can realize the cost advantages of electric vehicles: they can develop a supportive EV policy and regulatory framework, progressively build out a domestic EV assembly and manufacturing base, develop a widely available charging infrastructure with access to reliable power, scale EV production and procurement, and increase access to patient, low-cost capital.

Without these conditions, EV adoption rates will remain comparatively low for the foreseeable future. On the other hand, if Nigeria commits to building a robust e-mobility system, it can expect a cumulative fuel savings of up to NGN6.5 trillion and an emissions reduction of up to 2 megatons of CO_2e between now and 2040 in the passenger segment alone. These savings and emissions reductions are based on the assessed total cost of ownership (TCO) for each vehicle and fuel type, which combines the purchase price with the lifetime operating costs on a per-kilometer basis using cost and operational data from representative local models, specifically focusing on two and four-wheeler segments.

Exhibit 1 shows that removal of the fuel subsidy has resulted in TCO parity in the 150-kilometer range two-wheeler segment in high utilization cases, and that without incentives, higher range two-wheel models, which are yet to gain traction in the local market, can expect to achieve TCO parity over the next two years.

Exhibit 1 Two-wheeler TCO comparison: 2024 vs. 2040

TCO in NGN/km (ICE = Internal combustion engine vehicle)

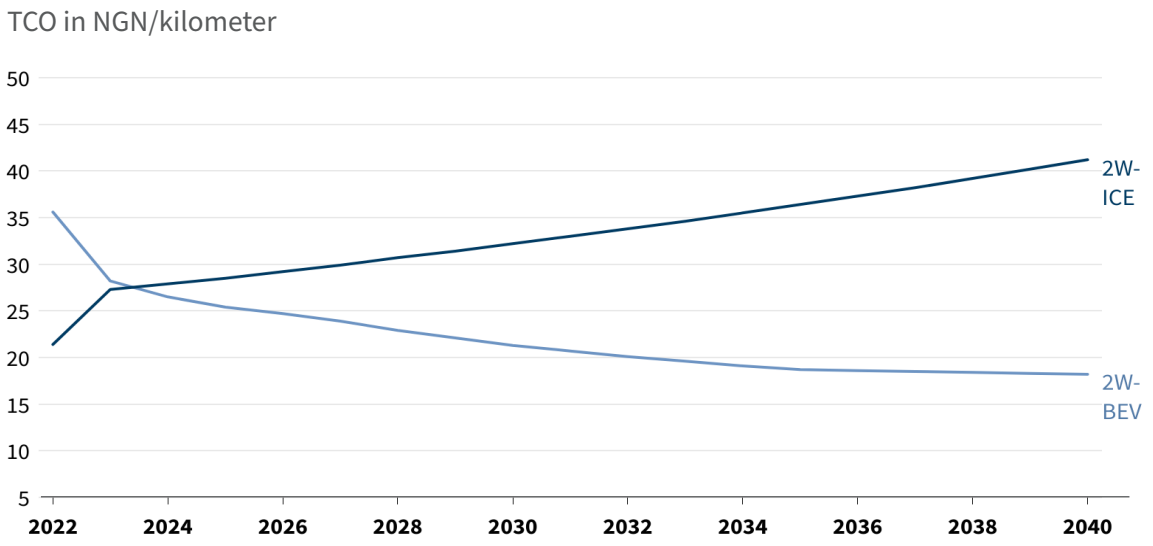


Calculations on a 150 km range two-wheeler. Capital costs include interest and principal payments on purchase loans, assuming a 3-year loan term, 75% loan-to-cost ratio, and 24% interest rate. Assuming a 1% real increase in fuel and electricity prices per annum and 15,000 km driven per annum. ICE vehicle up-front costs increase by 1% per annum due to increasing efficiency standards and battery costs decrease in line with projections by BloombergNEF in the 2023 EV Outlook.

RMI Graphic. Sources: RMI analysis, **Bob Eco**, **MAX**, **National Bureau of Statistics**, **Stears**, **World Bank**

Exhibit 2

TCO parity timeline for two-wheelers in Nigeria



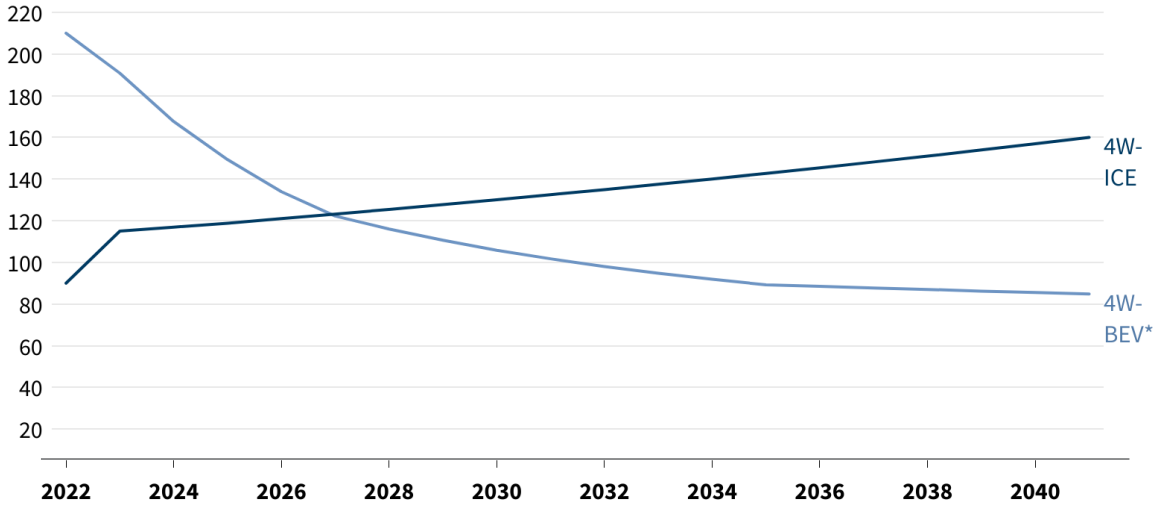
2W-BEV represents an electric two-wheeler with a 150 km range and 6 kWh battery

RMI Graphic. Sources: RMI analysis, **BNEF**, **Bob Eco**, **MAX**

On the other hand, TCO parity in the short- to medium-range four-wheeler segment is likely to be achieved by 2027 due to a combination of higher up-front costs, high interest rates, and lower annual utilization. Interest costs, in particular, accounted for 25% of total purchase (capital) costs and 12% of the TCO of an EV in our analysis.

Exhibit 3

TCO in NGN/kilometer for four-wheelers in Nigeria



** Four-wheel car with 250 km range.*

RMI Graphic. Sources: RMI analysis, **BNEF**, **ICCT**

The cost advantage of EVs over vehicles with internal combustion engines (ICEs) will increase due to projected modest operational efficiency improvements of EVs and falling battery prices that contribute to lower up-front and operational costs. These factors collectively lead to all EV vehicle types achieving cost parity and then cost advantage over ICE vehicles in the medium term.

Anticipated EV Adoption Rates

The TCO parity timelines have a material impact on EV penetration rates across the various vehicle segments. To illustrate these impacts, we consider two distinct scenarios:

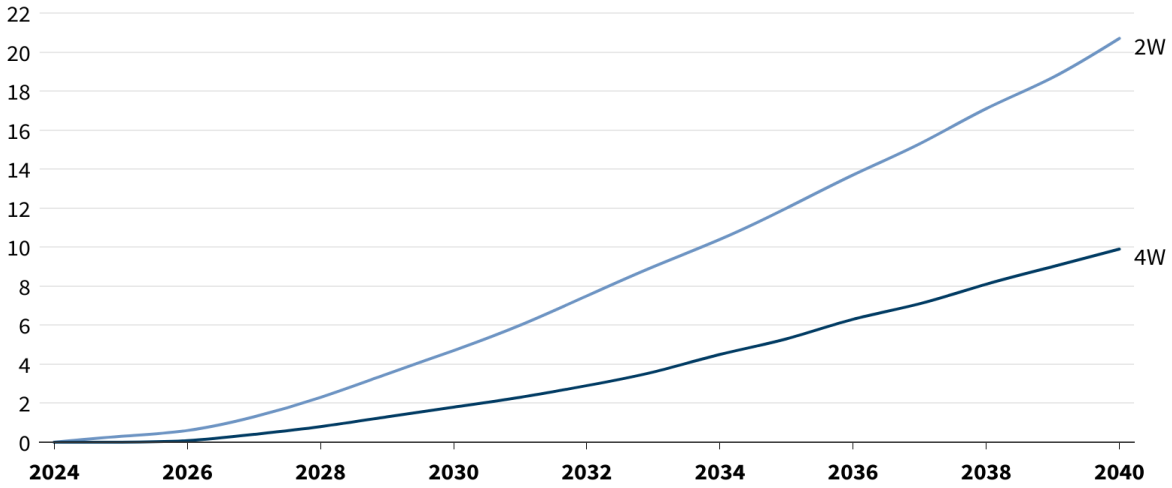
- A low-adoption scenario, which represents a business-as-usual scenario, characterized by a significant delay between achieving TCO parity and the actual adoption of EVs. This lag can be attributed to slow progress in developing the necessary supporting infrastructure and favorable policy environment for EVs.

- A high-adoption scenario, which assumes high sensitivity to TCO and no lag between TCO parity and actual adoption. Infrastructure and a favorable policy environment are prerequisites for this scenario. Other factors such as consumer preferences and market readiness may have a greater influence on purchase decisions than changes in TCO. This scenario suggests that consumers exhibit low sensitivity to TCO improvements.

Exhibit 4

EV Penetration Rates - Low Adoption Scenario

Percentage of new vehicles sold



2W adoption rates based in the weighted average of 100 km and 150 km range EV two-wheelers. 4W adoption rate based on weighted average of sedans and SUVs with a range of 250 km and 350 km respectively.

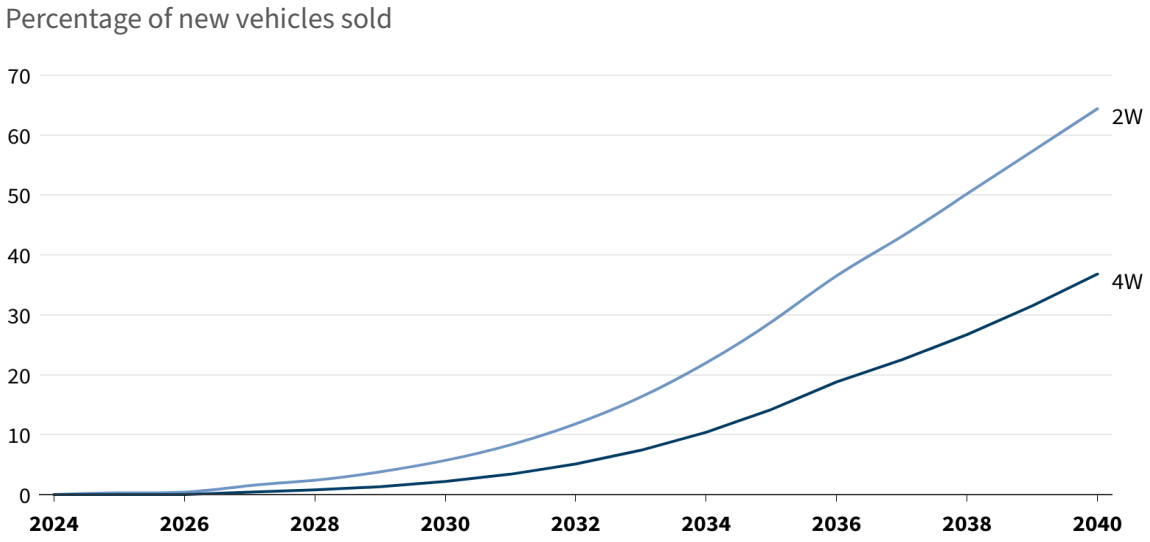
RMI Graphic. Source: RMI analysis

Ideally, with EV cost advantages improving over time, the adoption rates of all EV types should exponentially increase in Nigeria, particularly through 2030. This growth in adoption in response to TCO superiority has been observed in other countries transitioning to EVs. Our projections in Nigeria are based on that experience. In a high-adoption scenario, the correlation between cost advantage and adoption is strong for all vehicle segments.

To encourage EV adoption, there will need to be concerted policy and regulatory action, planning and investment in charging infrastructure, and improvements in current grid reliability. Public awareness campaigns will also be required to raise awareness of the benefits of switching to EVs so that passengers and fleet operators act quickly once TCO parity is achieved. Finally, EV availability and procurement will need to be able to rapidly accommodate rising demand from consumers and commercial fleets.

Exhibit 5

EV Penetration Rates - High Adoption Scenario



2W adoption rates based on the weighted average of 100 km and 150 km range EV two-wheelers. 4W adoption rate based on weighted average of sedans and SUVs with a range of 250 km and 350 km respectively. Assessment is independent of mode shift, which is included in the ETP's Net Zero Scenario.

RMI Graphic. Source: RMI analysis

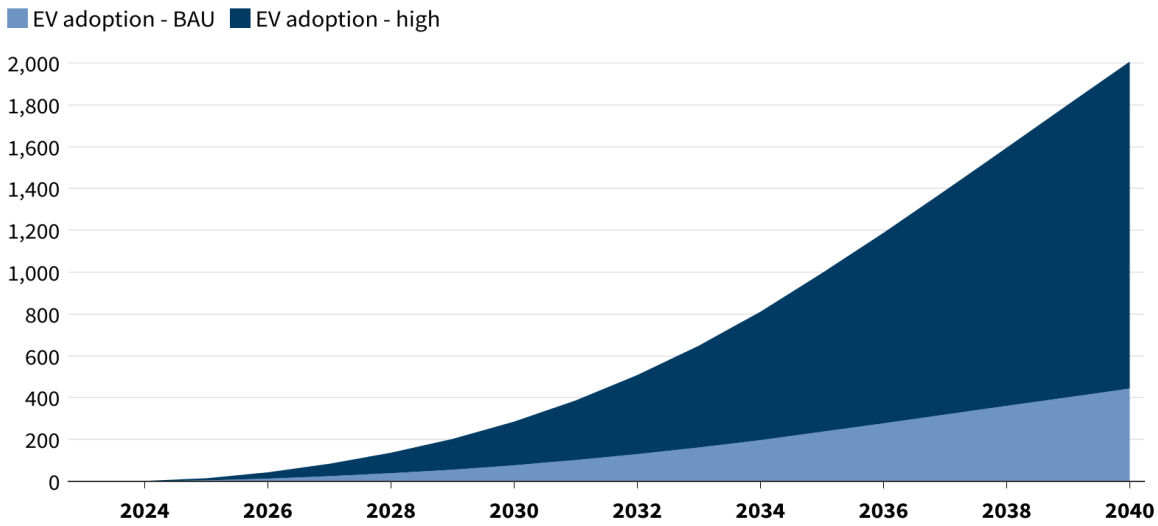
EVs' Emissions and Cost Savings Benefits

Across the various adoption scenarios, the transition to EVs in Nigeria will present compelling economic and environmental benefits, both of which are key pillars of the ETP and the Nationally Determined Contribution plan.

EVs' environmental benefits are well-documented: the lifetime emissions of an EV can be up to 53% lower than those of an equivalent ICE vehicle.[41] Without assuming any infusion of cleaner sources of electricity in Nigeria's current grid mix, the country may avoid up to two megatons of CO_2e annually by 2040 in the passenger two- and four-wheeler segment. A grid mix with cleaner sources of electricity will significantly improve these emissions savings.

Exhibit 6

Emissions savings



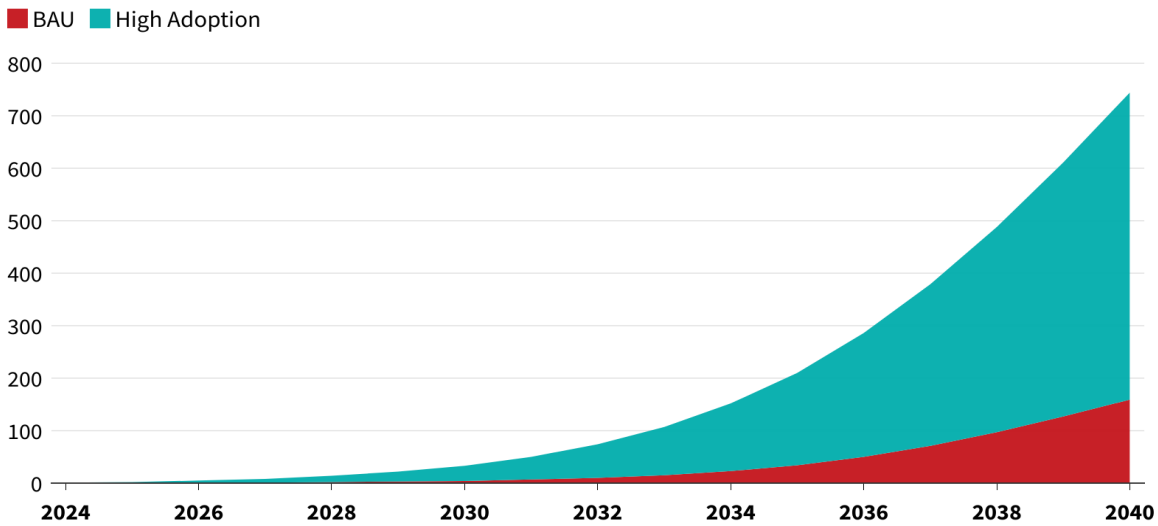
Private and commercial two- and four-wheelers, excluding the freight segment.

RMI Graphic. Sources: RMI analysis, **Ministry of Economic Planning and Budget (Nigeria)**, **Maduekwe et al.**, **Sam-Amobi et al.**

Higher EV adoption over time also has significant cumulative monetary benefits related to vehicle ownership: consumers who purchase an EV instead of an ICE vehicle will enjoy lower net costs, primarily as a result of lower maintenance and fueling costs. As Exhibit 7 indicates, the cumulative total benefits in a high-adoption scenario are more than three times those attained in a low-adoption scenario, at NGN3 trillion and NGN9.5 trillion respectively.

Exhibit 7

Annual net savings



Cumulative fuel and maintenance cost savings adjusted for capital costs. Excludes savings from medium- and heavy-duty vehicles. At constant 2023 exchange rate of NGN1,000 per USD.

RMI Graphic. Sources: RMI analysis, **Ministry of Economic Planning and Budget (Nigeria)**, **National Bureau of Statistics**, **Stears**

Barriers to Increasing EV Adoption

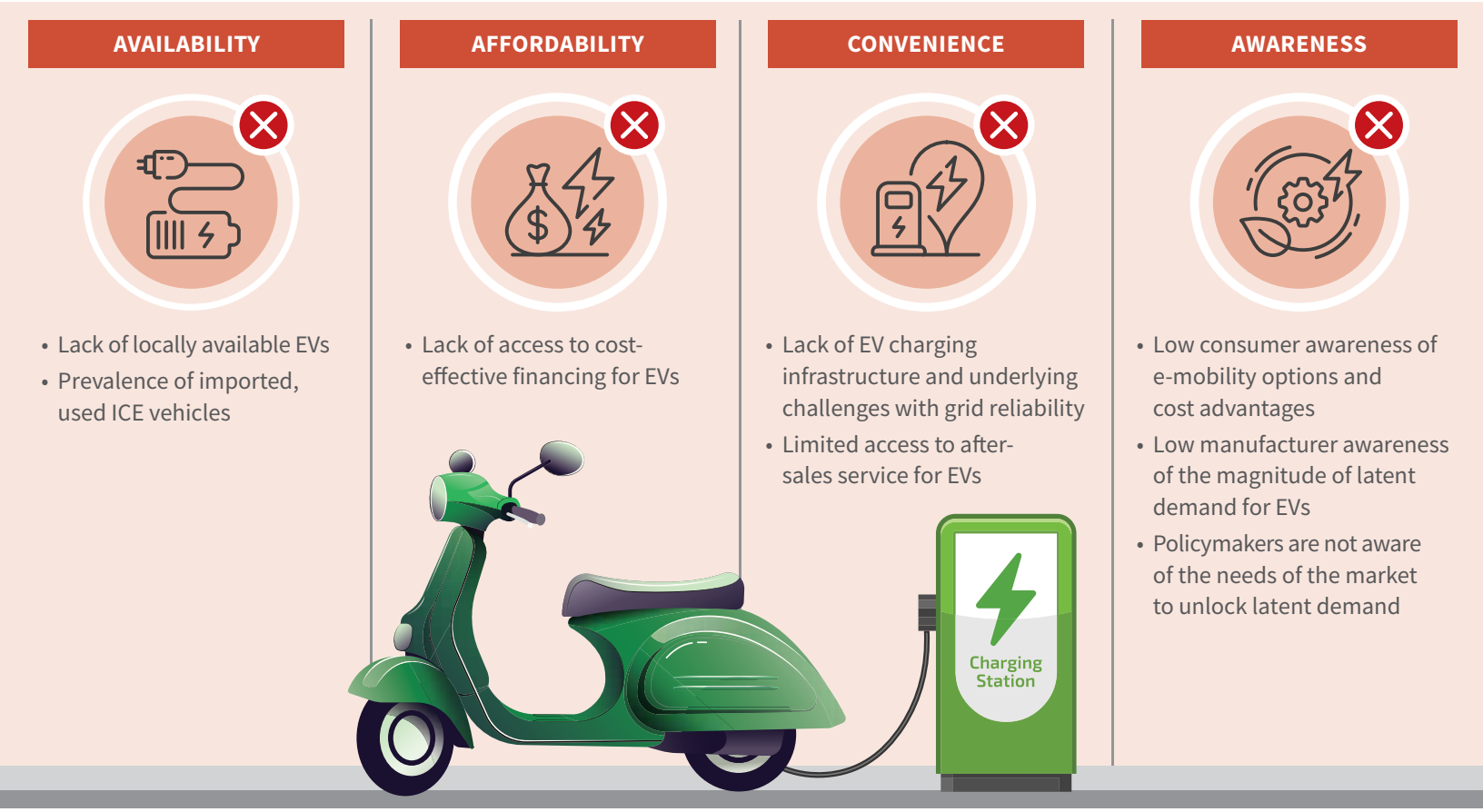
The potential benefits stemming from increased EV adoption and rapid rates of market penetration are well-established globally, particularly in the case of two- and three-wheelers. However, the transition to electric transportation typically does not occur spontaneously or in isolation. Rather, it is the result of a set of enabling factors necessary for rapid market growth, some of which currently exist in Nigeria, but many of which do not.

Key barriers to rapid e-mobility market growth in Nigeria include a lack of:

1. Locally available EVs, whether through local manufacturing or imports, and the prevalence of imported used ICE vehicles;
2. Affordability and access to cost-effective financing for EVs;
3. Consumer and private sector awareness of e-mobility options and cost advantages;
4. Charging infrastructure and grid reliability, as well as limited access to after-sales service for EVs; and
5. A broad supportive policy framework.

For the EV transition to achieve the government's desired adoption rates — and the associated benefits — coordinated action must be taken to address these barriers.

Exhibit 8 **Barriers to e-mobility growth**



RMI Graphic. Source: RMI Analysis

Availability

Lack of Locally Available EVs, Prevalence of Imported Used ICE Vehicles

Rapid growth of the e-mobility sector in Nigeria will require the widespread availability of affordable, fit-for-market EVs. There are estimated to be fewer than 1,000 EVs operating in Nigeria among 12 million vehicles, and annual EV sales are limited.[42] Instead, the Nigerian market relies heavily on used ICE vehicles to drive its transportation sector, with a recent estimate calculating nearly a quarter million used vehicles imported annually.[43]

While localization of the EV supply chain is a high priority, manufacturing of electric vehicles in Nigeria is similarly limited, and those that are manufactured in Nigeria still rely on imported batteries.[44] As with imported ICE vehicles, this dynamic reinforces the country's reliance on the foreign supply chain. If Nigeria is not able to strengthen its domestic supply chain, its residents will not be able to fully enjoy the transition's economic benefits, especially the creation of domestic manufacturing jobs. For the EV transition to fulfill its potential to accelerate economic development in Nigeria, it is critical that the domestic EV manufacturing base grow and eventually fulfill the market demand currently served by the existing supply chain of used foreign vehicle imports.

While used imported vehicles have a lower up-front cost than their new and/or domestically manufactured counterparts, they are not cheap to operate. Older vehicles tend to have higher maintenance needs and a substantially lower fuel economy, which drives up ongoing costs to users. These higher costs lead to substantial outflows of capital since Nigeria is a net importer of refined petroleum products.

The fuel subsidy's removal significantly increases consumer spending on gasoline, which reduces the disposable income of Nigerian consumers, which in turn decreases their budget for domestically produced goods and services. These effects deprive the Nigerian economy of the multiplier effect from that domestic economic activity.

Finally, there is an additional public health toll associated with Nigeria's current dependence on imported vehicles. With a minimum EURO 4 standard and 12-year age limit on imported vehicles, most vehicles exported to Nigeria are far below the required emissions standards in the markets that originally produced them.[45] Since these vehicles' emissions intensity increases over time, it's likely that their emissions ratings are even lower than emissions ratings suggest. In a country with dense urban areas, it is likely that imported vehicles negatively impact health outcomes, resulting in shorter life expectancy, lost worker productivity, and an overall lower quality of life.

Nigeria's current approach of importing used vehicles not only creates capital outflows from the country, but also makes any domestic production of vehicles difficult because heavily used, technologically obsolete vehicles are available at very low up-front cost. At present, Nigeria's automotive industry consists of approximately 30 assembly operators and has a capacity to assemble approximately 400,000 vehicles annually.[46] The industry has been supported by over US$1 billion in foreign direct investment, which flowed into the country following the development of the Nigerian Automotive Industry Development Plan in 2014.[47] Even with this direct investment, the Nigerian automotive market is still largely dominated by imported secondhand vehicles.[48] In 2022, manufacturing of motor vehicles and assembly accounted for just 0.53% of Nigeria's GDP.[49]

Automotive manufacturers in Nigeria face many challenges as they work to develop their operations, including difficulty achieving economies of scale due to the high number of imported vehicles as well as a lack of infrastructure, consumer access to affordable vehicle financing, a domestic market for domestically produced or assembled vehicles, and profitability.[50]

These challenges are even more pronounced in the e-mobility sector: EV charging infrastructure is inadequate to support EV adoption, and, compared to ICE vehicles, EV finance is more expensive and demand signals are, for now, quieter.

Affordability

High Vehicle Purchase Costs and High Interest Rates

While EVs are far cheaper to own and operate than ICE vehicles, they are not cheaper to purchase. For instance, an ICE motorbike costs about NGN600,000 in Nigeria while a similar electric version averages over NGN2.3 million. This discrepancy leads to both higher down-payments and larger loans for EVs than for ICE vehicles.

To overcome the higher purchase price of EVs and preserve the overall savings from owning and using an EV, financing must be available for EVs on terms that are at least equivalent, but preferably superior to, those available for ICE vehicles. The cost of debt finance available in Nigeria, even to the ICE vehicle market, is over 25% per year. Access to finance for EVs on similar or superior terms will be critical for EV adoption.

When effective financing is in place, EVs can have down payments similar to those of ICE vehicles and lower monthly payments — although principal and interest payments will be higher, maintenance and fuel costs will be lower — leaving the owner of an EV in an overall stronger financial position. However, early in the course of the EV transition, financing is often unavailable and, when it is available, is offered on much poorer terms than for ICE vehicles. This discrepancy is due to both the real and perceived risks of financing EVs, which are higher than those for financing ICE vehicles.

Some risks result from occasionally substandard product quality from first generation EVs. Those problems can include rapid battery capacity deterioration due to poor battery management, early vehicle obsolescence due to subpar design, and safety issues such as fire risks from badly designed battery charging systems. Other risks are not a function of the vehicle itself, but of the broader ecosystem in which it operates. For example, a vehicle that is dependent on a sparse public charging network may not be usable by someone without access to captive charging. Similarly, for vehicle owners who cannot repair an EV in-house or who don't have access to EV spare parts, the lack of a robust third-party maintenance network makes EVs undesirable to own. This limits the pool of potential buyers for secondhand EVs.

Furthermore, a lack of market data points on secondhand sales makes actual residual value impossible to assess. All EVs are new, and it will take several years before a robust secondhand market emerges. Assessing residual value is important to financing institutions, because most auto loans are secured by the financed vehicle — meaning that in the event of default, the bank will repossess and sell the vehicle to cover the losses on the loan. Banks are reluctant to finance EVs when there is little to no observed data on residual values and a concern that those residual values may be low.

Convenience

Lack of EV Charging Infrastructure

Research has shown that reliable and widely available charging infrastructure is essential to rapid EV adoption, especially in emerging markets.[51] Both a lack of grid reliability and extremely limited charging infrastructure present barriers to e-mobility adoption in Nigeria. If consumers are to buy an EV, they need to feel that charging their vehicle is as easy and convenient as filling their gas tank. To date, there are approximately four solar-powered EV charging stations in Nigeria and three automotive industrial parks with fully equipped charging infrastructure in Kaduna, Oshogbo, and Nnewi.

A much more robust charging network will be required to support the growth of EVs. This is especially true for car owners who expect a full charge either overnight or during stops on a trip. This will require dedicated EV charging stations with higher voltage connections. For two-wheelers like scooters and motorcycles, while dedicated charging infrastructure will be needed in the long term, lower-powered charging from a standard wall plug is often enough to meet the needs of a substantial share of users. Electric two-wheeler adoption therefore can likely begin without a large amount of dedicated charging infrastructure.

Underlying Challenges with Grid Reliability

Widely available charging infrastructure is only as good as the underlying electricity grid. In Nigeria, the coverage of the grid is limited; where power supply is available, it is often unreliable. In absolute terms, over 40% of the country's population does not have energy access.[52] In rural areas, the energy access rate is significantly lower than in urban areas, at only 26%.[53]

For those who do have a connection to the grid, reliability challenges are persistent. While Nigeria has more than 16,000 megawatts of electricity-production capacity, less than 5,000 megawatts of that electricity reach the grid each day.[54] While robust data is hard to find, as an example of the level of reliability, between 2013 and 2015 in Lagos City the average customer experienced 3,433 hours (about four and a half months) of electric disruptions over 540 different events per year.[55] During that same period in Kano City, the average customer experienced 1,666 hours (about two and a half months) of electric disruptions over 18 events per year.[56] To compensate for the unreliable grid, middle class households and businesses rely heavily on small gasoline and diesel generators. In 2018, the capacity of petrol and diesel generators in Nigeria was estimated to be eight times greater than the peak realized capacity of the grid.[57] The highly variable reliability of the grid presents a fundamental challenge to the development of charging infrastructure; alternative models such as battery-swapping or additional generation sources will need to be considered.

Limited Access to After-Sales Service for EVs

Dedicated EV after-sales service is virtually non-existent in Nigeria and until addressed will present a barrier to EV adoption, as noted by Nigerian e-mobility stakeholders in a recent study.[58] The low numbers of EVs in the country and limited investment in support services in the form of dedicated training are the two main contributors to the lack of after-sales services. While after-sales service lags behind range anxiety among consumer concerns, it is among the leading barriers for commercial fleet adoption. Without assurances that vehicles can be promptly repaired and maintained, commercial fleet owners will not take on the risk of electrification. The Energy Transition Plan, released in 2021 by the Nigerian government, identifies a gain of 420,000 jobs related to charging infrastructure and operations and maintenance needs.

Awareness

Low Consumer and Private Sector Awareness of E-Mobility Options and Cost Advantages

While EVs have rapidly emerged on the global mobility and automotive scene over the past decade, they are still a relatively new technology and lack the century-plus track record and universal acceptance that ICE vehicles enjoy.

When ICE vehicles currently meet operational needs, consumers and commercial fleet owners need strong evidence of the benefits of electrification to persuade them to shift to a new technology.

Consumer surveys in Nigeria have shown a high awareness of EV technology, but a low awareness of its benefits, particularly the operational cost advantages over ICE vehicles. In a facilitated discussion, Nigerian e-mobility stakeholders identified consumer awareness as an underlying driver for two of the top five challenges facing the sector, and after enabling policy and investment, the highest priority intervention to support e-mobility market growth.

Lack of Demand Signals and Policy Requests from the Private Sector

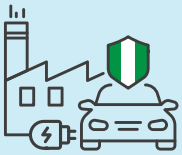
ICE vehicles depend on infrastructure and supply chains that have been built over decades. Even though EVs are cheaper to maintain and fuel than gas-powered vehicles, existing systems give ICE vehicles such a dominant position that EVs struggle to gain market traction. Additionally, there is a lack of EV-focused policy frameworks that would boost demand signals. Without EV-focused policy, the EV market will fail to match the infrastructure and supply chain that is needed to enable the emergence of an EV transport system at scale. There is a need for targeted policy measures to focus on decreasing the cost of EVs and enhancing their convenience.

The Path Forward

Despite the daunting nature of these barriers to e-mobility, Nigeria has ready access to the tools necessary to address them, and the opportunity to learn from similar efforts in comparable markets. Nigeria is positioned to realize a market transformation like India's if it takes the right actions to realize the opportunity. Exhibit 9 outlines key steps in the path forward for Nigeria's e-mobility sector.

Exhibit 9 **Solutions to drive e-mobility growth in Nigeria**

AVAILABILITY



Support local manufacturing

- Provide production linked incentives (PLIs)
- Support access to industrial land
- Provide labor force development/training
- Encourage joint ventures
- Provide tax breaks
- Institute local EV production requirements

Increase ease of import

- Reduce import tax on EVs
- Institute increasing clean car import standards to favor EVs
- Coordinate EV component import policies with increasing domestic EV manufacturing targets

AFFORDABILITY

Implement fiscal policies

- Up-front purchase incentives
- Feebates
- Registration fee discounts
- Reduced import tax
- Loan guarantees
- EV energy tariffs

Implement non-fiscal policies

- Zero-emission vehicle sales requirements
- Parking access
- Preferred urban access

CONVENIENCE

Improve ease of EV charging

- Support charging infrastructure planning at national and sub-national levels
- Outline investments needs and plan for charging infrastructure

Train labor force for after-sales service

- Partner with universities to ensure training for after-sales EV service

AWARENESS

Raise consumer awareness

- Launch consumer awareness campaign to communicate cost advantages and emissions benefits of EVs
- Address consumer concerns around range anxiety and vehicle charging

Engage industry stakeholders

- Support bulk or aggregated procurement schemes
- Encourage broader private sector engagement in e-mobility
- Government should consult with industry and industry associations on key policy and infrastructure needs for EVs

Supported by an enabling e-mobility policy framework

RMI Graphic. Source: RMI Analysis

Supportive Policies for EV Development

National e-mobility policies, strategies, and guidance signal a commitment to electrification and encourage investment. Policies should focus on:

- Reducing the high up-front costs of EVs by strengthening EV production capacity and encouraging EV imports
- Building factories
- Designing resilient supply chains
- Deploying charging infrastructure
- Encouraging investment

By creating a policy framework, governments signal a commitment to a transition to electric mobility, increasing companies' confidence that they will make a return on those investments. An e-mobility policy framework also serves as the basis for more detailed national policies and complementary state-level policies.

While some of the policies described have been drafted in Nigeria, as in the National Action Plan for the Development of Electric Vehicles, they have yet to be implemented. As government leaders look to develop EV policy, examples of model EV policies are available in markets such as Kenya, India, and Thailand. These include subsidies for EVs; preferential electricity tariffs and land prices for EV charging; favorable tax treatment for investments in EV supply chains, import, sales, and purchase requirements; and preferential road access for EVs. Given the myriad pathways to support the growth of EVs, and the many pain-points that early movers in the EV market experience, it is important to not only study any potential policy before implementing it, but also to engage with private sector actors in the design of the policy. By understanding the current or anticipated cost structures, revenue models, and pain points of EV manufacturers, operators, and chargers, the government can design policies that efficiently address these issues without excess expense or complexity.

Globally, policies have focused on:

- Providing financial support for the purchase and use of EVs
- Enhancing the convenience of EV use and refueling
- Encouraging supply-side change through EV sales requirements and providing financial support for the emergence of manufacturing capacity for EVs

Many policies have implemented direct payments to EV buyers, using different approaches that have had varied impacts on government budgets and incentives.

For example, tax exemptions and vehicle purchase subsidies are typically a transfer directly from the central government to vehicle purchasers, which can challenge cash-strapped government budgets. States can also design and implement similar policies. Feebates, a tax charged on the sale of polluting vehicles with an equivalent subsidy given to zero-emissions vehicles, can help avoid straining government budgets.

Loan guarantees, in which government entities cover complete or partial losses in the event of defaults, are another tool governments can use to accelerate EV deployment. These guarantees allow for lower interest rates on loans to EV buyers, creating a contingent obligation on the government in the case of default, but one that can often be shared with financial institutions, both private and multilateral.

No one policy will be able to accomplish a country's climate goals, which is why governments need to adopt a multi-pronged approach to policymaking. For example, a feebate to fund a subsidy for the purchase of an EV, in combination with a loan guarantee to reduce the interest rate on monthly payments, a preferential EV charging rate offered by the utility, and local policies such as vehicle registration fee exemptions or toll exemptions, can make EV ownership much more attractive to consumers without unduly burdening the finances of any single government entity.

Exhibit 10 **Vehicle purchase and use — fiscal incentives**

POLICY	SELECT GLOBAL EXAMPLES
Up-front purchase incentives	In India, FAME II provides incentives for the purchase of public and commercial electric three- and four-wheelers, and privately owned electric two-wheelers.[67] Similar policies exist in China, the United States, Europe, and elsewhere.
Feebates	France introduced a feebate system in 2008 that charges a fee on cars that have CO_2 emissions above a certain level and provides a rebate for vehicles that have emissions below a certain level.[68] Several US states have feebates on gasoline with transfers to zero-emissions fuels such as electricity for EV charging and hydrogen.
Registration fee discounts	In the Indian state of Uttar Pradesh, EVs purchased and registered in the state are eligible for a 100% registration fee and road tax exemption for the first three years of the policy. Similar policies exist in many states globally.
Reduced import tax	Multiple African countries, including Kenya, the Seychelles, Mauritius, Rwanda, and Zambia have either waived or reduced taxes and import duties for EVs.[69]
Loan guarantees	The Small Industries Development Bank of India has partnered with the World Bank to launch a US$1 billion fund to provide guarantees for the purchase of electric two- and three-wheelers.[70]
EV energy tariffs	Many utilities globally have special EV charging tariffs that are lower than average rates — especially during electricity system off-peak hours.

Non-Fiscal Approaches

Non-fiscal approaches can also increase EV adoption in ways that are budget-neutral to the government. Some examples of these budget-neutral approaches include improving the convenience of operating an EV, allowing EVs access to urban core areas that are restricted to ICE vehicles, and adopting targeted parking restriction exemptions for EVs.

Stakeholders can also regulate vehicle production and require decreasing air pollution emissions from ICE vehicles over time. While this approach does not directly mandate automakers to increase EV sales, banning the sale of highly polluting ICE vehicles will cause more sophisticated and higher-quality vehicles with lower emissions to be sold instead. These types of regulations prevent a race to the bottom in which old, highly polluting vehicles dominate roads and compromise public health. Higher-quality vehicles tend to be more expensive, which lessens the cost gap between EVs and ICE vehicles.

EV sales mandates or average emissions intensity limits are examples of more directive supply-side non-fiscal policies. In EV sales mandates, manufacturers and/or importers of vehicles must ensure that an increasing share of vehicles sold is zero emissions to meet targets set by the government. For average emissions limits, manufacturers and/or importers must ensure that the average emissions of all vehicles they sell meet targets set by the government. Such targets are often designed to give EVs a prominent role in ensuring compliance. Typically, these requirements are enforced in two ways: through fines for non-compliance or through forced purchase of credits from other sellers of vehicles who have surpassed minimum compliance levels. This credit trading scheme plays a similar function as feebates.

For a market like Nigeria, which is currently heavily dependent on the import of new and used vehicles to meet demand, an EV credit system could be designed to initially apply primarily to imports. In this case, vehicle importers would receive credits for each EV sold while being held to a minimum compliance level of credits. Importers who do not import enough EVs to comply could purchase credits from importers with a surplus of credits. As with a manufacturer-focused EV credit system, initial minimum compliance levels should be set near zero, with clear, planned increases in compliance levels each year. As with a manufacturer-focused EV credit system, an importer-focused system would be budget-neutral.

Exhibit 11 **Vehicle purchase and use — non-fiscal incentives**

POLICY	GLOBAL EXAMPLES
Zero-Emissions Vehicle Sales Requirements	All new vehicles sold in the European Union must be zero-emissions from 2035. An interim target for 2030 will require that all new vehicles sold will emit 55% less carbon dioxide, relative to 2021 levels. Twelve US states have joined California's Advanced Clean Cars II initiative, which builds on the Advanced Clean Cars (ACC) rule passed in 2012. ACC II decreases emissions by increasing EV sales requirements gradually over time while also regulating emissions from ICE vehicles. China's New Energy Vehicle (NEV) mandate, implemented in 2019, applies similar EV sales requirements and allows for some compliance flexibility. The NEV mandate requires that EVs make up 40% of all vehicle sales by 2030.
Parking Availability	The Indian state of Jharkhand has lane and parking preferences for EVs, and all future public parking spaces are to be free for EVs.[71] Many similar schemes exist globally.
Urban Access	London has an Ultra-Low Emissions Zone, which charges a fee to any polluting vehicle entering the city. In many Chinese cities, EVs are exempt from urban entry regulations and vehicle registration limits.

Availability: Support Local Manufacturing

Breaking Nigeria's dependency on imported vehicles can reduce capital outflows, create jobs, support consumer spending, and improve public health. However, building a new industry from the ground up is a complex project that can take years. Fortunately, it is a process that can be undertaken in phases as Nigeria transitions from being an importer of both ICE vehicles to full-scale domestic manufacturing. In the near term, Nigeria can begin to capture the benefits of a transition to EVs — both for manufacturers and consumers — without needing to bring the entirety of the EV value chain into the country on the first day.

Nigeria can accelerate EV adoption through the following actions:

Identifying elements of the EV value chain that are ripe for change. For example, some Nigerian firms are currently well-positioned to capture the last stages of the value chain, such as final assembly, that could be onshored. They could then expand to other areas of assembly. With study and consultation with industry, Nigeria could identify other low-hanging fruit in the EV production chain that could provide jobs and economic development in the near term.

Identifying longer-term EV supply chain opportunities: Nigeria should supplement its investment in EV assembly by supporting the development of other fields associated with EV production such as vehicle design and battery manufacturing. They can explore requiring the formation of joint ventures for domestic production of vehicles combined with import controls on foreign vehicles.

China deployed this strategy successfully in the development of its automotive sector. Foreign companies seeking to manufacture and sell vehicles in China were required to engage in joint ventures with existing Chinese manufacturers. This arrangement was mutually beneficial to both the foreign manufacturers, who gained access to the large and growing Chinese automotive market, and the Chinese companies, who were able to rapidly grow their production and engineering expertise. Many of these Chinese companies are now among the most advanced producers of EVs in the world. Nigeria's large, growing, and increasingly affluent consumer market could be similarly attractive to globally established EV producers.

Government efforts may initially require incentives to encourage both foreign and domestic firms to enter Nigeria's vehicle production segment. Investing in plants and equipment may be considered risky, especially in a product segment like EVs where demand is not yet mature. Identifying and implementing ways to mitigate that risk to firms can help to overcome any initial reluctance to invest. Incentivizing of vehicle production, which represents a long-term investment in the productive capacity of the country, may be preferable to incentivizing vehicle purchases, which, especially in the case of imported vehicles, does not create domestic workforce opportunities or long-lived manufacturing assets.

Incentivizing production can obviate the need for cash on hand, such as preferential access to industrial land or tax breaks on future profits. It can also provide financial assistance in the form of production-linked incentives (PLIs) as production occurs. When a government has limited budget flexibility, the ability to create economic growth and tax revenue without needing to spend cash in advance of that growth can be valuable. Any tax breaks or PLIs offered can be structured to meet value-capture strategies undertaken by the government. For example, relaxing import duties on EV components for assembly in Nigeria while increasing import duties on used ICE vehicles can help maintain budget neutrality while encouraging domestic final assembly of vehicles. This "feebate" style strategy can help maintain budget neutrality while supporting the growth of domestic industry.

Finally, even if companies want to invest in EV production in Nigeria, they will only do so if there is the sufficient labor force to operate those factories. Nigeria can identify skills gaps and help workers gain those skills, again in line with a broader value capture strategy. Like investment in plants and equipment, such training would represent a long-term asset to the development of Nigeria's economy.

Exhibit 12 **Vehicle and infrastructure production and investment**

POLICY	GLOBAL EXAMPLES
Production-linked incentive (PLI)	India launched a PLI scheme for 14 sectors to promote domestic manufacturing, including auto components and automobiles.[59]
Labor force development/training	India has a National Skill Development Corporation (NSDC), which includes skill development in electric mobility. The NSDC is a public private partnership company. Its goals include upgrading skills, coordinating private sector initiatives for skills development, and acting as a "market-maker."[60]

Availability: The Power of EV Bulk Procurement to Increase Demand

While government action can catalyze a nascent EV manufacturing industry, it will not succeed without demand. Sales of electric vehicles are ultimately the only thing that can support the manufacturing sector. However, in the early years of a country's transition to EVs, projected sales are often insufficient to justify the construction of large-scale EV manufacturing facilities. This lack of demand creates a vicious cycle: production volumes stay low, keeping unit costs high, which in turn keeps demand low. Bulk procurement of EVs can break that cycle.

In a bulk procurement scheme, several large purchasers of vehicles — for example fleets or leasing companies — band together to purchase EVs, ideally for several consecutive years. This approach creates sales volumes that justify significant investment in manufacturing capacity, lowering the unit costs of vehicles and sales price points, inducing demand for EV purchases from fleets or individuals who didn't participate in the initial bulk procurement.

Currently in Nigeria, interest in EVs is high due to the removal of the fuel subsidy and resulting rise in transportation costs. However, there is no EV seller ready to step in and meet that demand with a high-quality product at an acceptable price point. Deploying a bulk procurement process can:

Determine EV performance needs: Document the EV application, including distance to cover, time of use, operating conditions, road quality, etc.

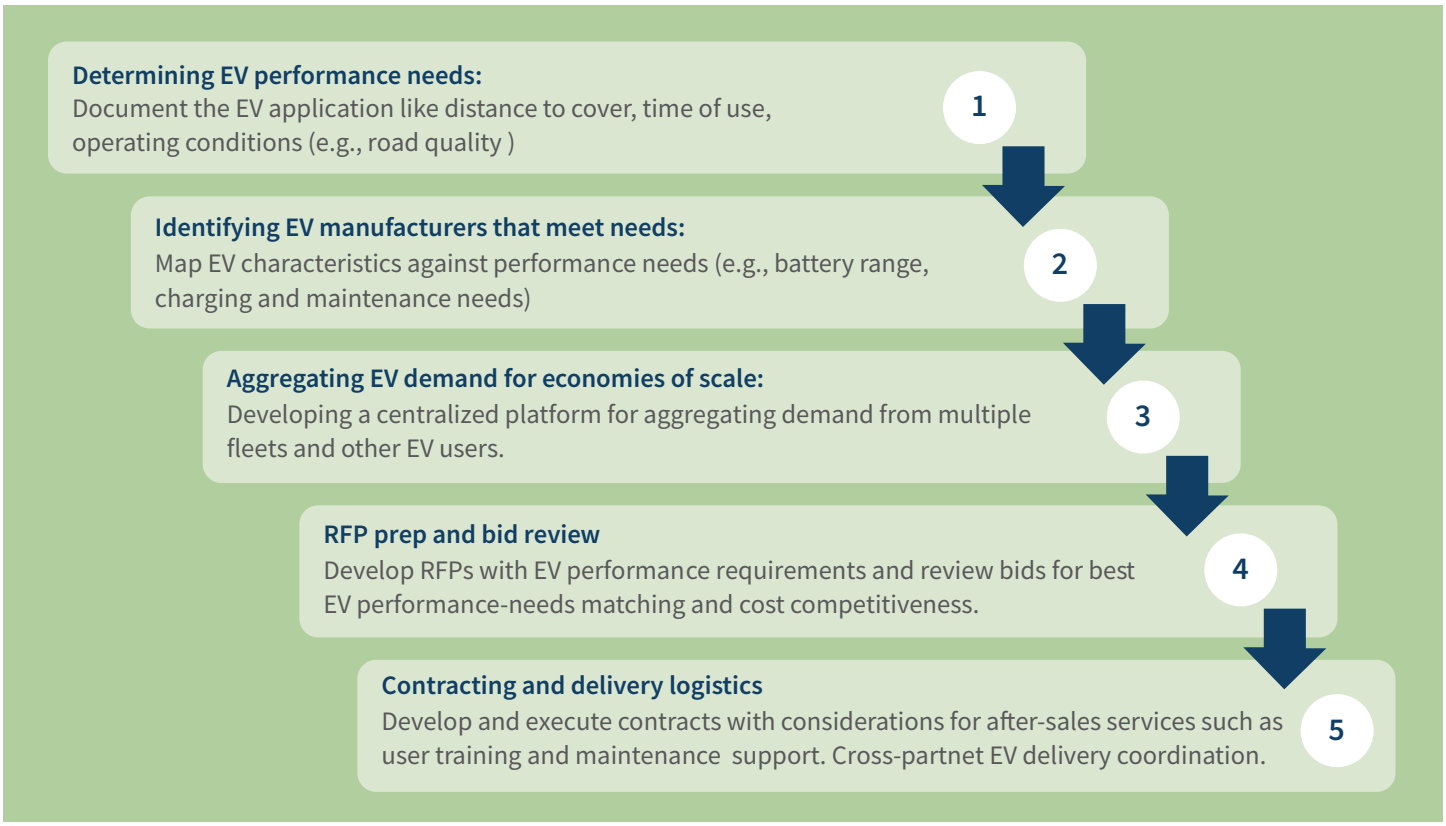
Identify EV manufacturers that meet needs: Map EV characteristics against performance needs (e.g., battery range, charging and maintenance needs, etc.)

Aggregate EV demand for economies of scale: Develop a centralized platform for aggregating demand from multiple fleets and other EV users.

Prepare request for proposal (RFP) and review bid: Develop RFPs with EV performance requirements and review bids for ones that best match the needs and are most cost competitive.

Execute contracts and coordinate delivery logistics: Develop and execute contracts including after-sales services such as user training and maintenance support. Coordinate with partners for EV delivery.

Exhibit 13 **Steps to aggregated EV procurement**



RMI Graphic. Source: RMI Analysis

Given the time needed to establish an EV industry in Nigeria — even if only for final vehicle assembly — Nigeria should plan any bulk EV purchases, alongside any other policy moves to catalyze local production, well in advance of the order itself. Alternatively, Nigeria could structure a bulk EV procurement that allows for imported vehicles in the initial years, with increasing requirements for local content in later years.

Like most solutions discussed in this section, bulk procurement works best when pursued as one element in a portfolio designed to collectively target multiple barriers, especially financing barriers.

One example of combining scaled procurement with EV financing is the Green-Shift Africa (GSA) blended finance facility that GreenMax Capital and Tradeable House Africa are piloting in East Africa.[iii] The GSA facility's pilot phase, funded by GreenMax, will provide longer-tenure capital for bulk EV

iii GreenMax Capital is a specialized advisory and fund management firm focused exclusively on the clean energy sector in emerging markets. Tradeable House Africa is a company focused on promoting trade into Africa by sourcing, aggregating, and supplying a wide range of quality finished goods.

procurement; at the same time, it will leverage the limited capital EV suppliers have on hand. It requires that EV suppliers such as wholesale importers and mobility startups provide 10%–30% of the total capital for a bulk order of EVs and/or related equipment (e.g., batteries and charging infrastructure), with the rest of the order cost paid directly to the OEM from the facility. EV suppliers receive the vehicles and sell them to consumers. The suppliers have up to 360 days to repay the facility's capital contribution to the order.

The target deal size for the facility is US$1 million, with consideration for smaller deal sizes to support market entry of African-owned startups. With the average cost of an electric two-wheeler in Nigeria at over US$2,000, an initial investment of US$1 million could procure about 500 EVs.

Development financial institutions can support banks in Nigeria to implement similar blended financing models at scale to support bulk procurement and lower per-unit EV importation costs. They can also provide technical assistance with facilitating fleet aggregation for bulk procurement (e.g., of two-wheelers, to meet higher order quantities that make more appealing deal sizes for financier and OEM participation).

Affordability: Financing Facilities for EV Adoption

Ensuring low-cost capital is available to purchase EVs can be one of the strongest drivers of EV market growth, especially in low- to middle-income countries like Nigeria. Risk-sharing arrangements between financiers and socially focused organizations such as the government or development finance institutions can help shift risk away from private sector lenders, lowering the rates they are able to provide to consumers.

Across a wide range of sectors, certain actions can reduce the risk of financing EVs. These actions include:

- The introduction of enhanced warranties from EV manufacturers;
- The use of telematics data collection;
- A process to evaluate battery state of health on used EVs — a key component of accurate residual value estimation; and
- Transparent, accurate prices in secondhand markets, which can enable market pricing of EV loans on par with ICE vehicles.

Additionally, one particularly promising action to de-risk EV finance is the implementation of a risk-sharing finance facility dedicated to EVs. A risk-sharing facility can backstop loans provided by commercial lenders to EV buyers through credit enhancements such as a first loss guarantee. This form of risk-sharing can embolden financiers to lend to EV buyers and spur initial growth in the sector.

Convenience: Charging Infrastructure and Business Models

As Nigeria plans its EV transition, it must ensure that charging is available, reliable, and affordable for all EV users — even where there's a lack of energy access or where the grid is inconsistent.

Stakeholders will need to identify the different charging needs of a variety of vehicle types and market segments, and the solutions that can best serve these needs.

Smaller vehicles

Smaller EVs with smaller batteries and power needs are better suited for an intermittent electricity grid. For example, an electric scooter on a standard wall socket will typically charge from a depleted battery in 3–4 hours. The power it draws during its charge is typically slightly greater than 1 kW — roughly equivalent to two to three window AC units. Because smaller vehicles often do not deplete their entire battery during the course of a day and are left overnight for 8–10 hours, they can be charged on intermittent grids, even if electricity supply is not always reliable. Furthermore, because such vehicles can be charged on a standard wall outlet, charging stations are not required. An adapter with a cord to plug in, which easily fits in a small compartment on the vehicle, enables convenient charging anywhere with electricity. Fixed charging stations can enable faster charging but are not strictly necessary.

Another advantage of small batteries is that, since they are light and easily handled, users can use a battery-swapping charging model. In a swapping model, batteries are charged in a kiosk where drivers deposit a depleted battery in exchange for a fully charged one. This model is useful in areas where drivers may not have access to electricity at home or where electricity isn't available during usual nighttime charging windows, as is the case for some areas that rely on isolated solar minigrids. A further benefit of swappable batteries is that the vehicle can be purchased separately from the battery, with the cost of the battery representing a portion of the fee for using the swapping service. An electric two-wheeler purchased without batteries can be quite inexpensive — oftentimes considerably less so than its ICE equivalent. If consumers can pay for a battery over time, the EVs' up-front cost decreases significantly, making them more accessible to more people.

Larger vehicles

Larger EVs that need more powerful and longer-duration charging can also be charged effectively on Nigeria's grid. Enabling charging for larger vehicles usually requires on-site electricity generation and/or storage to manage grid intermittency. Deploying these types of backup systems makes sense in cases where vehicle charging time and location are easy to predict. For example, buses have known routes with known

energy requirements and charging needs. Designing backup power systems at bus depots to ensure power availability can enable electrification of these vehicles.

The convenience of charging for any size vehicle is complicated in Nigeria by variable grid reliability. Risks of low grid reliability raise the potential value of battery-swapping technology and stand-alone or grid-back-up minigrids. In the case of rural areas where energy access is lower, either grid extension or isolated minigrids, possibly in combination with battery-swapping technology, will be needed to serve customers. The country will need significant investments and increases in electricity generation to meet the anticipated demands for future EV charging.[61]

Leading with e-bus and two-wheeler charging

Since electric two-wheelers and electric buses are likely to lead the market, stakeholders should prioritize deploying chargers that fit these vehicles' charging needs: electric two-wheelers will need level 1 and level 2 charging stations and battery swapping stations, while e-buses will need charging depots. Given that it's improbable that personal EVs will lead the e-mobility market for the next 5–10 years, stakeholders should primarily focus on strengthening charging infrastructure for electric two-wheelers and buses.

The importance of standardization

Ensuring that all vehicles can use all chargers makes for a more efficient and ultimately cheaper system. As EV adoption grows in Nigeria, it will be necessary for the country to take stock of existing global standards and decide which ones it should adopt and whether it is necessary to develop other standards to meet the country's needs. Such determinations could be made through a multi-stakeholder design process to identify needs and paths forward and the establishment of standing industry task forces. Stakeholders could include representatives from domestic university research hubs, existing EV companies with solutions in Nigeria, utilities, and international standardization entities.

Awareness: Corporate and Consumer Engagement

To accelerate EV adoption, consumers need to be confident that EVs can serve their needs. To build this confidence, consumer awareness campaigns communicating EV capabilities, cost-effectiveness, and public health benefits will be critical. There is also a need to build trust in the government's ability to build a reliable electric mobility ecosystem.

To raise awareness of EVs' benefits, stakeholders should engage intensely and frequently with businesses and fleets, who can greatly increase EV demand and rapidly accelerate market development. Through their public relations, they can also help increase confidence in EVs, thereby encouraging others to electrify their vehicles.

As they develop their electrification strategies, stakeholders must first understand what barriers fleets face in their electrification efforts. Organizing stakeholder working sessions can help them gain important insights about fleets' existing electrification projects and the challenges impeding further progress. Stakeholders can then use this information to design more effective programs. These sessions can also serve as a forum for fleets, OEMs, and other solution providers to share ideas, network with each other; and forge new product alliances. Fleets investing in electrification can also help convince those with little to no awareness of the benefits of electrification.

Fostering collaboration between the public and private sectors

Electrification will require intense collaboration between the public and private sectors. Governments can advance these partnerships by providing resources useful to fleet decision-making on EV purchases. For example, centralized information on vehicle availability and specs, charging infrastructure availability, and EV TCO — including all state local and national policies meant to incentivize EV adoption — can greatly help fleets develop and implement their EV transitions.

As corporations begin to adopt and deploy EVs, governments can help publicize their efforts, generating positive attention for fleets and enhancing their appeal to customers. At the same time, the public success of EVs in large corporate and fleet contexts can give smaller fleets and individuals confidence that EVs can be successfully deployed in Nigeria. Fleets' successful transition to EVs can send strong demand signals to government and manufacturers, which in turn can drive clear policy and lead to greater access to lower-cost vehicle financing.

Case study: India's Shoonya campaign

Shoonya - A NITI Aayog initiative to drive EV adoption for deliveries and rides

India's Shoonya campaign, designed to electrify final-mile deliveries, can serve as a blueprint other countries can use in their efforts to cultivate corporate coalition building and consumer awareness.[62] Within 18 months of launching, the campaign brought together 150 entities from the vehicle electrification ecosystem including OEMs, ride-hailing companies, charging infrastructure providers, e-commerce providers, financiers, and fleet aggregators.[63] To date, partner entities have completed more than 70 million zero-pollution deliveries and 40 million rides through EV ride-hailing services.[64] After the first year, 28 corporate partners made new commitments to scale e-mobility.[65] The Shoonya platform includes information for consumers such as kilometers electrified, carbon savings, and criteria pollutant savings, as well as resources to help consumers purchase EVs, including an impact calculator, a policy map, and financing information.[66]

As Nigeria develops its EV ecosystem, the Shoonya campaign provides a valuable model on how to develop a strong and motivated corporate coalition, and how to provide essential information to a customer base, driving uptake and growth.

Conclusion

As Nigeria works to advance transportation electrification, it is also prioritizing the wellbeing of its residents, who are struggling with significant increases in transportation costs in the wake of the removal of the country's fuel subsidy. The Nigerian government understands the urgency of their electrification efforts, both for the climate and their communities, and they recognize that they must lessen their reliance on imported old and inefficient ICE vehicles.

Nigeria, with its large domestic market and deep pool of highly qualified labor, is in a strong position to lead the transition to electric mobility in Africa. Doing so can catalyze the emergence of a domestic vehicle manufacturing sector, provide Nigerian citizens with jobs, reduce transportation costs, and decrease vehicle and fuel imports and the associated balance of payments challenges.

However, the emergence of a robust electric mobility ecosystem will not happen without informed policies and intense collaboration between multiple stakeholders. The country must take deliberate action to:

- Catalyze the formation of a domestic EV and charger supply chain;
- Ensure that EV chargers are available and reliable;
- Increase demand for EVs by improving affordability; and
- Convince the public that EVs can affordably meet the country's transportation needs.

To meaningfully advance their electrification efforts, stakeholders need to move in unison toward shared goals. They need to develop strategies to gain a foothold in the global EV supply chain, mapping out sub-sectors where it is immediately positioned to gain market share. At the same time, they must align on a set of standards that allow mass production of EVs that will be safe and compatible with developing charging infrastructure.

Nigeria must also heavily engage with the public and private sectors to map out policies that can support the emergence of an EV ecosystem and generate private sector confidence that future policy will be supportive of EV adoption. This collaboration will give the private sector a chance to take a leading role in mobility electrification. These planning steps should begin immediately and not become a bottleneck in the overall electrification process.

As stakeholders develop and implement their electrification strategies, Nigeria can catalyze vehicle supply. Although the private sector is responsible for the actual manufacturing of EVs, it cannot increase demand by itself; it will need government support.

Now is the time to begin the transition to EVs in Nigeria. Overcoming the challenges may seem daunting but, as other economies have shown, the rewards are substantial. Economic development, job creation, reduction of import dependency, and a leadership position in Africa's energy and transportation transition are all on the table. Nigeria should act now to seize these considerable benefits.

Appendix: Modeling Methodology

RMI has developed a techno-economic model for the light-duty four-wheeler and two-wheeler segments to forecast EV sales share through 2040 to estimate the associated cost saving and carbon emissions reduction potential. Although the model primarily focuses on cost and economics, it also considers market constraints such as the lack of EV model availability and how charging and grid electricity supply may limit EV sales in the near to medium term and applies limiters to model outputs to reflect these.

A bottom-up cost modeling method is applied to vehicle types and the resulting TCOs are used as parameters in a logistics regression function to determine the percentage of sales share of EVs and ICE vehicles. Other parameters that define the shape of the S-curve are derived from expert interviews with industry players and comparisons with other countries for which we have data with some adjustments for local nuances.

Assumptions

We apply a bottom-up cost-based modeling approach in which we look at a representative ICE vehicle type and its cost by the key components such as the engine and drivetrain, transmission, chassis and body, etc. We then exclude the ICE vehicle-specific parts (ICE engine, drivetrain, etc.) and add the EV- specific parts, such as batteries, electric drivetrain, and power electronics, and calculate the representative costs for the EV. Cost was adopted from reports and studies by the ICCT and UBS and were fitted to local models. Exhibit A1 includes the key assumptions.[72]

Exhibit A1 **General TCO Assumptions**

CATEGORY	ASSUMPTIONS
Analysis time frame	The model uses a 10-year analysis timeframe for an individual vehicle depending on vehicle use case.
Two-wheeler annual kilometers traveled	This assumption, based on expert interviews, suggests that private passenger motorcycles travel an average of 9,000 km annually, while commercial motorcycles travel 21,000 km.
Four-wheeler annual kilometers traveled	This assumption, based on expert interviews, suggests that private passenger cars travel an average of 15,000 km annually, while commercial four-wheelers travel 21,000 km.

Two-wheeler pricing and specifications	Pricing data for ICE vehicles and EVs was collected from individual manufacturers. We assumed an average efficiency of 0.04 kWh/km for EVs and a fuel economy of 25 km/l of gas for ICE vehicles.
Four-wheeler pricing and specifications	Pricing data for ICE vehicles and EVs was collected from individual manufacturers. We assumed an average efficiency of 0.32 kWh/km for EVs and a fuel economy of 13 km/l for ICE vehicles.
Energy rates	For electricity, we used the average retail rate (NGN/kilowatt-hour) in Nigeria. For gasoline, we used the average price (NGN/liter) for regular unleaded gas. The average retail rate increase was calculated as the average yearly real increase over the past 15 years.
Incentives	No incentives were applied in the model.

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