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SUPPORTING E-MOBILITY START-UPS IN AFRICA: A CASE STUDY OF GHANA'S SOLAR TAXI LIMITED

Charles Odoom & George Baffour Awuah

Transitioning to low-polluting transportation in congested African cities is crucial to improving public health and environmental quality of life while dealing with transport-linked greenhouse gas emissions (GHG). Across Africa there are promising cases of local e-mobility start-ups, such as Ghana's Solar Taxi providing sustainable mobility solutions through innovative business models. They are evolving battery chemistries, designing charging infrastructure and building markets through unique demand and purchase incentives designs. However, accelerated growth of the nascent sector is limited by multiple firm, consumer and investor level challenges, most of which are reflections of poor and/or lack of government policy, regulatory and other support measures. The prospect of a mature e-mobility ecosystem offering sustainable mobility solutions requires a comprehensive policy framework that integrates all relevant concerns. Localization of EV value chains requires regional alliances and collaboration and active support of start-ups in building partnerships with multinational enterprises in the e-mobility space.

Ghana's transport-related air pollution

Like many African countries, Ghana is experiencing a 'perfect storm' of spiralling traffic congestion and air pollution in its major cities driven by rapid urbanization and motorization, poor urban planning and traffic management and inadequate non-motorized public transport solutions. Particular features of the country's motorized transport, including the dominance of imported second-hand vehicles and overreliance on inefficient and low-capacity passenger vehicles (cars, motorcycles, and light-duty vehicles) alongside the use of sub-standard fuels are driving emissions, degrading urban air quality, and posing significant public health threat.

As an end-use sector with the biggest reliance on fossil fuels, transport accounts for 37% of Ghana's Co2 emissions, and vehicular exhaust emissions are the single largest source of ambient air pollution. For many larger Ghanaian cities, the annual average air quality is below the WHO-prescribed levels. According to one estimate, air pollution kills over 20,000 people in Ghana annually, with deaths from air pollution in Accra alone projected to rise to 4,600 people per annum by 2030 if action is not taken.

The **African Industrial Policy in the 21st Century (AIP21)** network brings together scholars to share research results and outline a new research agenda in view of developing new thinking for a green and resilient industrial policy in Africa for the 21st century. The AIP21 Network organized a series of workshops in 2022 on green industrialization in Africa at Copenhagen Business School and the University of Johannesburg in South Africa, with co-funding from DANIDA's Knowledge in Action grant. These policy briefs are some of the outputs from the workshops.

Accelerated transition to electric vehicles (EVs) has emerged globally as a solution to sustaining economic growth and urban mobility whilst cutting emissions and improving local air quality. In the case of Ghana, high electricity access(87%), excess electricity generation capacity (2000 MW), and appreciable renewable energy share in the national electricity mix (34.65%) make it one of few African countries with a greater chance of EV penetration. In its Nationally Determined Contributions, the government of Ghana recognizes transport as a key mitigation area, signalling the intention to reduce the sector's emissions through, among other measures promoting alternative vehicle technologies, including EVs.

While the adoption of electric mobility in Ghana is still nascent, e-mobility start-ups and businesses enabled by the relative simplicity of electric motors technology, battery packs and related assembly, especially in small vehicle segments, have emerged, providing innovative e-mobility solutions and reducing the barriers to EV adoption. The emergence of promising cases of e-mobility start-ups in Ghana and across the region signals the need for and gradual development of enabling policies, regulations, technology roadmap and policy accelerators to build scale. Documenting cases of innovative e-mobility businesses, the support gaps and country experiences in developing capacities and roadmaps to support these businesses is crucial in driving peer learning in the transition to sustainable mobility in Africa.

Solar Taxi Limited: Providing e-mobility options

Founded in 2018, Solar Taxi is an e-mobility company that provides modern eco-friendly mobility facilities and services. Besides air pollution and climate change concerns, the company leverages opportunities created by Ghana's rising middle class, a persistent rise in fuel cost and demand for affordable mobility as well as growing e-commerce and demand for reliable and affordable courier services in providing e-mobility solutions.

Solar Taxi offers three major e-mobility solutions, namely, (1) EVs design, engineering, assembling- using parts imported from China and India- and building of small electric-powered vehicles(bikes, tricycles, mini cars), (2) EV fleet management, offering sales and rental of sustainable transportation services (3) Battery engineering and development, producing, maintaining and recycling lithium-ion battery packs.

Figure 1: Solar Taxi's E-mobility Solutions

Besides these core business solutions, Solar Taxi, in partnership with the MasterCard Foundation, runs Female Engineers and Riders Academies, training women and young people in EV engineering and how to operate EVs. Through engineering and hardware-related avenues, Solar Taxi equips young women with skills in new technologies creating a burgeoning network of like-minded individuals seeking social change through innovation. The driver training academy also provides young people and women with extensive training in the operation of electric vehicles while also providing them with insights into traffic laws, electric vehicle maintenance, and the need for a clean and reliable

means of transportation. Between 2019 and 2021, Solar Taxi, under this partnership had trained 219 women engineers and 320 youth riders of EVs, with a projected plan of training 500 more women engineers and 5000 young riders between 2022 and 2024.

Figure 2: Solar Taxi ICE bike conversion

Similarly, in partnership with Siemens Stiftung, Solar Taxi, undertakes internal combustion engine (ICE) bike to EV conversion through chassis redesign, electronic system design (including in-house battery development and controller hub configuration), and drive unit marriage that brings it all together to work. The company's services and platforms include sales and rental of electric cars(e-cars), electricity bikes (e-bikes), electric tricycles (e-tricycles); EV ride-hailing (Solar Taxi Ride), e-bikes for e-commerce - courier and delivery platform service providers (Solar Taxi Deliver) and easy charging stations with solar options.

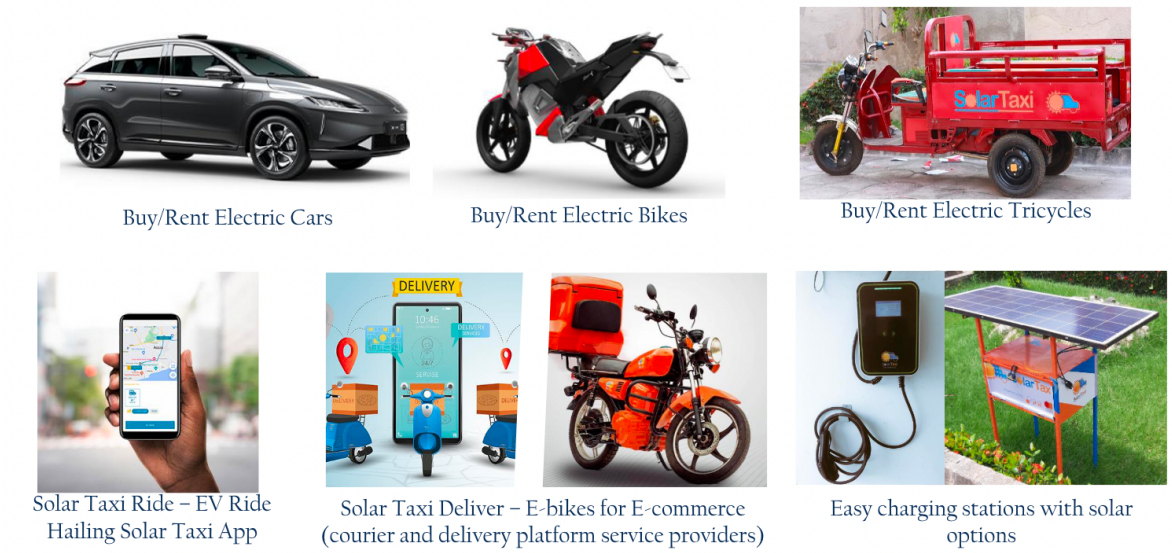

Figure 3: Solar Taxi services & platforms

Solar Taxi's business/revenue model and purchase arrangements include (1) Outright purchase, lease to own and rental of solar cars, (2) Outright purchase of tricycles, (3) Outright purchase and lease to own of solar bikes, (4) Outright purchase, rental and installation fees for solar chargers (5) Courier/delivery revenue (B2B/B2C), work-n-Pay, management fees, fault repairs fees for Solar Taxi Ride (6) Repair, recycling, production and sales of batteries and (7) Routine maintenance fees and fault repairs fees of all EVs. The rental model is favoured by individuals who do not have access to credit to purchase an electric bike or car outright;

the customer can rent the vehicle per month or year.

The company's launch of a ride-hailing app exclusively for electric vehicles in 2020 constituted a significant milestone. The use of the app is increasing, with about 100 rides hailed per day currently - including bookings of EVs from Solar Taxi's fleet but also electric cars owned by others. The company has ready-to-purchase asset financing contract arrangements with banks, microfinance and asset finance institutions, viz, Letshego (with unlimited fund allocation for e-bikes, e-cars and e-buses), Untapped Global (allocated funds of $2 million for e-bikes and e-cars) and CalBank (with allocated funds of $2 million for e-bikes). Some corporations in Ghana, for instance, have added Solar Taxi vehicles to their fleet, purchased with financing obtained from banks.

In terms of opportunity for scale, Solar Taxi has clients and partnerships with e-commerce, mobility, delivery and microfinance companies - Jumia, Bolt Food, Glovo, Bolt and Letshego – with about 2900 units of e-bike and 300 e-car orders placed. Jumia and Bolt, for instance, use Solar Taxi's electric motorcycles to deliver customer orders. Regarding exports, the company receives orders from across the West African sub-region, including Senegal, Mali, Guinea, Cote d'Ivoire, Burkina Faso, and Togo.

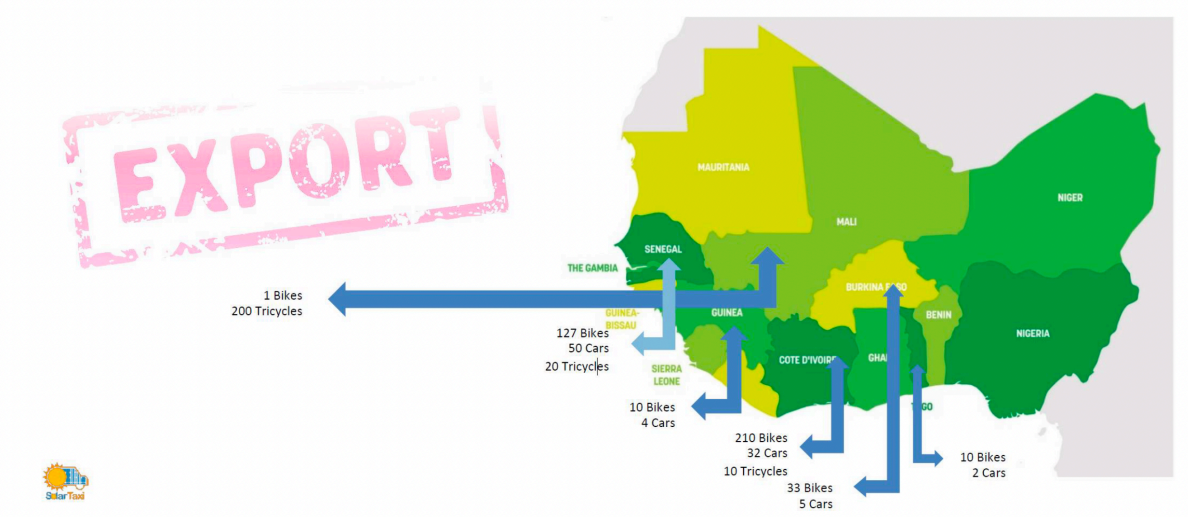

Figure 4: Export potential - Orders

In 2021, the Solar Taxi's production capacity was 5 units/day in the company's bike assembly plant, 20 kwh/day in the battery lab and a unit of tricycle/day, with a 2022 post-funding projection of 32 units/day in the bike assembly plant, 6 units/day in the car assembly plant, 20 units/day in the tricycle assembly plant, 200 kwh/day in the battery lab and 10 units/day in the charging unit. By 2030, the company projects a production capacity of 10,000 units/day in the bike assembly plant, 2,500 units/day in the car assembly plant, 5,000 units/day in the tricycle assembly plant, 10 Mh/day in the battery lab and 5,000 units/day in the charging unit.

The company estimates a job creation potential of 1774 by the third year of operations, deploying 4000 e-bikes, 834 tricycles, and 2084 e-cars. In 2021, the company had a team of 52 employees across four major cities of Ghana (Tamale, Kumasi, Takoradi and Accra), 61% of whom are women and 72% being technical persons. Looking ahead, Solar Taxi plans to expand operations across Ghana and other African countries. The company is looking to set up a larger assembly plant and eventually move towards a completely knocked-down kit approach where the cars will be fully built locally. Currently, the technology remains very expensive, and most parts are still imported from South East Asia with customization to the Ghanaian market demands.

Policy gaps, company, investors and consumer challenges

Like Solar Taxi, there is a growing number of EV-focused firms in Ghana and across Africa working

across the EV, battery, and charging value chains and pioneering multiple innovative business models to grow the size of their serviceable market, reduce the cost to serve, and increase the defensibility of their business models. Ghana has a diverse range of EV-focused players including Kantanka automobile Ltd, currently constructing lithium powered EVs for private and commercial use; Great Walls Motors Ora 1 (aka Black Cat) with both motor and battery pack EVs for private and commercial use; Accraine, specialising in the supply, installation and servicing of electric vehicles and Arke Technologies that retrofits EVs and operates an EV conversion school and workshop.

These start-ups, the e-mobility solutions and services they provide, sufficient energy infrastructure, and the significant addressable markets they serve have created a nascent e-mobility ecosystem displaying viable e-mobility investment opportunities and conditions for long-term growth. However, challenges at the company, investor and consumer levels constitute significant impediments that could slow or limit the growth of the e-mobility sector.

For companies such as Solar Taxi, the key challenges are the emerging risk of ICE vehicle dumping, gaps in e-mobility investment and technology transfer. Ghana and most African countries absorb a substantial share of second-hand vehicles (especially 4-wheelers) from high-income countries. Thus, with planned bans on ICE, the region could become the dumping ground for second-hand ICEs stifling the domestic EV market. In terms of investment, a particularly limiting feature of the nascent e-mobility ecosystem is the lack of diverse and sufficient funding flows of (concessional) growth and working capital to meet the needs of start-ups. Solar Taxi, for instance, could benefit from equity investment to enable the scale-up of operations and improve unit economics, protecting against potential OEM competition. In addition, the company could benefit from convertible grants to enable the testing of different models for li-ion batteries and identify the most cost-effective approach. Lastly, technology transfer remains a challenge for e-mobility start-ups limited to assembling EVs where most parts are imported at high cost from South East Asia with some customization to local market demands.

On the side of investors, the gaps in e-mobility investment play out on both the supply and demand side, resulting in both lack of capital directed to e-mobility and a limited pipeline of e-mobility opportunities for investors. The limited funds directed towards e-mobility investment is due to a lack of information and data that makes it difficult to assess risks and market potential but also insufficient risk-return ratio to justify entry barriers or time to realize upside. On the demand side, the limited pipeline of e-mobility opportunities for investors stems from difficulties firms have in meeting investment criteria(e.g., collateral, managerial capabilities) and the lack of appropriate financial products to meet firms' needs (e.g., type, tenor)

Lastly, for consumers, significant economic barriers emerge from subsidized fossil fuel and high sticker prices of EVs that undermine the monetary incentive to adopt EVs. Other challenges are scarce and hard-to-find charging infrastructure that leads to range anxiety, low consumer awareness of the comparative advantages of EVs and limited non-monetary incentives (e.g., free parking, bus lane access) that limit mass uptake.

The multiple challenges faced by various actors in the evolving e-mobility ecosystem largely reflect a lack of enabling policies, regulations and support measures that integrate pioneering mobility solutions into medium and long-term strategies and create conditions for the development and scalability of these technologies and business models (See figure 5). Indeed, a complete e-mobility ecosystem is dependent on four interdependent segments, namely, EVs, e-mobility as a service, energy infrastructure and policy and regulation, including the monetary and non-monetary incentives for the use of e-mobility solutions.

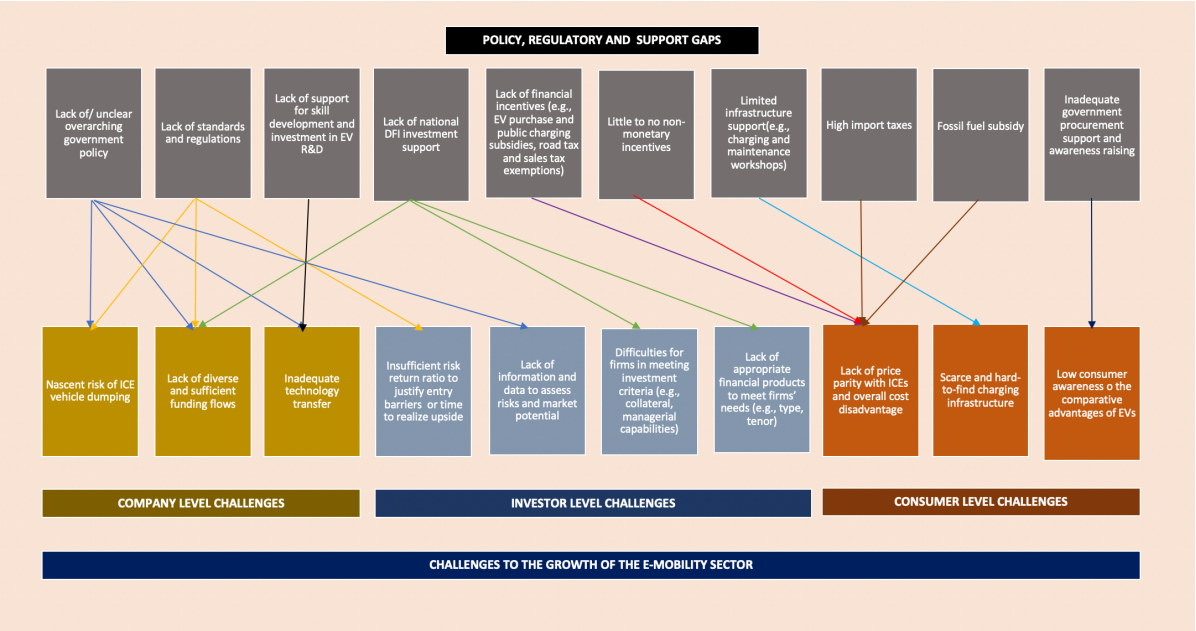

Figure 5: Links between government support gaps and e-mobility sector challenges

Experiences in successful e-mobility industries globally show the active role of government policy and support in developing a favourable ecosystem for the fast uptake of EVs and investment in the industry. Across Africa, however, strong enabling policies, regulations and target support measures from the government have been limited. Apart from a few countries in the region, proactive government policy action and support for the nascent sector has been lacking, with foundations and international development organizations leading market-shaping efforts towards the growth of e-mobility ecosystems.

An overarching EV policy is crucial to addressing the challenges of firms, consumers and investors towards driving EV use and investment in e-mobility. They reflect the government's long-term plan and goals for the sector and are critical to providing companies and investors with certainty in their planning and investment.

Similarly, regulations and standards are crucial to promoting EV adoption and investment. Globally, regulatory measures such as vehicle emission standards and banning the import and sale of new and second-hand ICE vehicles (within certain time frames) have been important to evolving matured e-mobility ecosystem. By disincentivizing ICE vehicles, EVs become the preferred alternative e-mobility technology and investment arena.

High taxes, particularly import duties on EVs, constitute a major policy failure in promoting EV adoption and driving investments in the sector. High import duties add to the cost disadvantage of EVs relative to especially cheap imported second-hand ICE vehicles

Other gaps in government support underpinning the multiple challenges to EV adoption and investment, including technology transfer across the evolving e-mobility ecosystems across Africa, are the existence of fossil fuel subsidies, lack of financial incentives, Little to no non-monetary incentives, Non-availability/limited charging infrastructure, lack or government procurement support and awareness campaign, and lack of support for skill development and investment in EV R&D.

Gaps in Government EV Support in Ghana

Ghana has one of the growing EV markets and a dynamic mobility investment ecosystem. EV sales and use are growing, and funding for mobility firms is increasing and flowing from diverse mobility-focused investors. The policy and support environment, however, has significant gaps, even though there have been some movements in recent years by the government towards supporting the growth of e-mobility. Table 1 presents existing EV policies and support measures for African countries active in electrification.

Table 1: Status of EV policies, regulations and government support measures, Select African countries

Country	EV policy, including ICE phase-out target	Standards (Co2) and regulations (EV), an outright ban on used cars	Import duty waivers	Fossil fuel subsidy removal	Financial incentives (subsidy/tax)	Non-monetary EV incentives	Social measures include awareness raisings and procurement support	Support for R&D and skill development	Infrastructure support (charging, maintenance shops)
Ghana							●		●
Cape Verde	●		●		●			●	●
Egypt		●			●				●
Kenya		●	●		●	●		●	●
Mauritius			●		●				●
Morocco		●			●			●	●
Rwanda	●		●		●	●			●
South Africa		●							●
Tunisia				●	●				●
Uganda	●				●				●
Zambia			●		●				

● Indicates that a given country has at least some policy actions for the given policy measure

Ghana lacks a long-term policy framework for EVs. Being an emerging sector, the need for clarity from the government on policy and a roadmap for adoption is critical and indeed considered by various stakeholders as a key concern. An overarching EV policy with a long-term plan and goal for the sector, for instance, could help encourage and support local companies such as Kantanka and multinational companies, including Toyota, Hyundai and VW, that are already manufacturing or locally assembling vehicles to retool and adapt their assembling plants to develop EVs quickly.

Similarly, in terms of standards and regulations, Ghana has no standards for electric vehicles and vehicular emissions. There is only a limited restriction on used vehicle imports that involves 10 years age limit – compared with African countries such as Algeria, Sudan, South Africa, Egypt and Morocco that outrightly bar used vehicle imports.

Notably, despite the most significant barrier to EV diffusion in Ghana being economic and financial, there are currently no incentives for EV users in Ghana, including tariff waivers, dedicated EV tariffs, EV sales tax exemptions etc. Import of EVs enjoys no import tariff reduction or removal. In effect, the purchase price of EVs is relatively high in Ghana, primarily attributable to the high import duties, vehicle tax, and undifferentiated HS codes. EV importers pay customs duties of 20%, irrespective of the size and capacity of the EV, in addition to all the other taxes at the port. Altogether various taxes charged at the point of entry raises the initial price of an EV in Ghana further by about 30% or more of the manufacturer's suggested retail price after import. There are equally no financial and non-financial incentives post-EV imports. Across Africa, countries such as Cape Verde, Kenya, Seychelles, Mauritius, Rwanda, and Zambia waive or reduce various EV taxes or duties. Rwanda, for instance, has tax exemptions in place for EV sales. In Mauritius, yearly EV renewal license fees and one-time registration fees are 50% less, while import duties are up to 30% less than conventional vehicles.

Public charging infrastructure is scarce, with currently only four pilot 4 public charging stations but all are located in Accra. Other gaps in government support for the emerging sector are limited support for skill development and investment in EV R&D activities and lack of procurement support for demonstration effect and

awareness raising. Indigenization of EV-related technology requires government investment in research institutes, incentivizing private automotive R&D activities, in the training of engineers and skilled workers and supporting local automotive companies in their capability-building efforts. Limited government investment and consequent skills gaps are huge, driving slow low-carbon technology transfer

The gaps in government support notwithstanding, there are recent plans and efforts at policy design, regulatory reforms and support measures for the emerging e-mobility industry, including the development of an e-mobility policy, the introduction of emission standards, removal of import duties and annual tax exemptions, installation of charging stations across the country with space for private sector participation.

Such support policies and measures will be critical to the penetration and adoption of e-mobility if there are well-designed and targeted. The multiple barriers, though, suggest the need for an all-inclusive and integrated approach rather than focusing on a specific barrier and thus the relevance of a comprehensive policy framework that integrates economic (such as subsidies and tax exemption), technical (such as workshops and expertise) and infrastructural (charging systems and stations) considerations.

RECOMMENDATIONS

Besides providing policy and business environment conducive for growth of e-mobility business, the following recommendations are targeted measures important to addressing the unique challenges of finance, technology transfer and regional collaboration.

Finance: Government need to support start-up (including vehicle assemblers) attraction of investment through promoting local demand, providing adequate infrastructure and enabling vehicle and component imports and exports. Besides, government support in deploying the right mix of commercial and concessional capital, including blended finance tools, is critical. A national development finance institution with a dedicated financing facility for e-mobility start-ups along the EV value chain is crucial for firms to test their technologies and business models and to apply their solutions.

Technology transfer: Localizing EV-related technology requires strong collaboration of local firms with foreign multinational enterprises(MNE) that facilitates knowledge transfer and human capital training. Government and other development partners should build networks and create platforms to facilitate ties between local firms, external financiers, and MNEs.

Regional collaboration: Economies of scale are crucial in the localization of EV manufacturing of sub-components and materials. Actively pursuing partnerships with other countries in the sub-region, coordinating policies and evolving production networks through specialization will be crucial to facilitating technology transfer than small unconnected production structures. Regional opportunities can be actively pursued through alliances and collaborations among e-mobility start-ups in both parts production and EV assembling. Government, along with other relevant international entities, can stimulate and support regional collaboration by creating platforms for regional dialogues for knowledge exchanges and establishing communities of practice and e-mobility marketplaces.

ABOUT THE AUTHORS

Charles Odoom until recently was head of the private sector development unit at the African Center for Economic Transformation (ACET) and supervised implementation of the ACET Business Transform Program, which is aimed at developing and supporting Ghanaian businesses to make them investment-ready and integrate into global value chains. Prior to ACET, Charles had over 12 years of experience in the consulting arena, engaging clients from both public and private sectors. He holds an MBA in Strategy and International Business from Nyenrode Business Universiteit in the Netherlands and an Executive Certificate in Marketing from the Kellogg School of Management (Northwestern University, USA).

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