# Electric Mobility Rollout Potential in Zambia (initiating the discourse on the missing links)

*Is the electric mobility future in Zambia pragmatic? What are the current gaps and what can be done to leverage opportunities to realize an e-mobility revolution in Zambia?*

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## Acronyms & Abbreviations

| | |
|---|---|
| **BEV** | Batter Electric Vehicle |
| **CCG** | Climate Compatible Growth |
| **CIG** | Cities and Infrastructure for Growth Zambia |
| **$CO_2$** | Carbon Dioxide |
| **DRC** | Democratic Republic of Congo |
| **EaaS** | Energy as a Service |
| **E-Mobility** | Electric Mobility |
| **EV** | Electric Vehicle |
| **HEV** | Hybrid Electric Vehicle |
| **ICE** | Internal Combustion Engine |
| **IEA** | International Energy Agency |
| **IRP** | Integrated Resource Plan |
| **kWh** | Kilo Watt Hour |
| **MG** | Mini Grid |
| **MW** | Mega Watt |
| **PUE** | Productive Use of Electricity |
| **PAYGO** | Pay as you go |
| **PHEV** | Plug-in Hybrid Electric Vehicle |
| **REA** | Rural Electrification Authority |
| **RTSA** | Road Transport and Safety Agency |
| **SAPP** | Southern African Power Pool |
| **SHS** | Solar Home System |
| **SMP** | Solar Milling Plant |
| **SSA** | Sub Saharan Africa |
| **UN** | United Nations |
| **UNEP** | United Nation Environment Programme |
| **USD** | United States Dollar |
| **V2G** | Vehicle to Grid |
| **ZCF** | Zambia Cooperative Federation |
| **ZEMIA** | Zambia Electric Mobility and Innovation Alliance |
| **ZMW** | ISO 4217 code for Zambian Kwacha |

# 1.0. Introduction

As evidenced by the global electric mobility sales numbers from 2012 to 2022, momentum in the sector has increased exponentially [1]. This shift could be attributed to concerns on growing urban pollution, price volatility in crude oil and the emissions abatement commitments aligned with the Paris Agreement [2]. To contextualize, back in 2012, only about 120,000 EVs were sold globally, a figure that's comparable to weekly sales recorded in 2021 [3]. Moreover, the 2021 Global electric vehicle (EV) Outlook report published by the International Energy Agency (IEA) revealed an estimated 10 million EVs on the world's roads at the end of 2020, while the 2022 IEA report recorded an increase by 65% compared to the previous year, which is triple the amount in 2018 [1]. However, EV sales in Sub Saharan Africa (SSA) remain marginally low. To garner the right support from communities and governments, e-mobility adoption in SSA must be aligned with contributing to sort-out real problems facing society's today such as poor air quality emanating from tailpipe emissions and unaffordability of fuel for internal combustion engine (ICE) propulsion [4]. This can be attained by leveraging the abundance of clean energy sources in the region such as solar photovoltaics and wind [5-7].

Currently, an increase in prices of gas and other fuel related commodities aligned to ICE mobility poses as one of the drivers to adopt e-mobility in SSA with majority of countries relying on imports to sustain their transport sector [8]. In Zambia for instance, out of the 876,520 registered vehicles, 32% use diesel, 20% use leaded petrol, and 48% use unleaded petrol. Hybrid or electric vehicles are a rarity and make up less than 0.01% of the total [9-11]. Moreover, the transport sector in Zambia is faced with compounding problems ranging from traffic congestion, environmental pollution and poor road networks [9]. Consequently, the transition from ICE powered cars would be propelled by the level of demand from private and commercial vehicle owners. Therefore, it is imperative to start planning today on how the e-mobility diffusion will evolve and the nature of policy, regulatory framework and infrastructure development required. To appreciate the dynamics in this niche industry, the answers to the three questions below can help Zambia focus its attention in a timely manner by aligning the market design, energy legislation and energy policy (as shown in Figure 1).

1. What's driving the e-mobility market globally?
2. What are the current gaps faced in Zambian context?
3. Can the e-mobility (or electric vehicle) value chain breed the right policy mix and eventually leverage opportunities in Zambia?

The remainder of this writeup is structured as follows: Section 2.0 describes the drivers of e-mobility around the globe, section 3.0 tackles the current gaps impeding e-mobility adoption in Zambia, section 4.0 describes the e-mobility value chain and the required policy mix that could lead to opportunities in the sector by adopting innovative business models. Finally, section 5.0 draws a conclusion and makes recommendations.

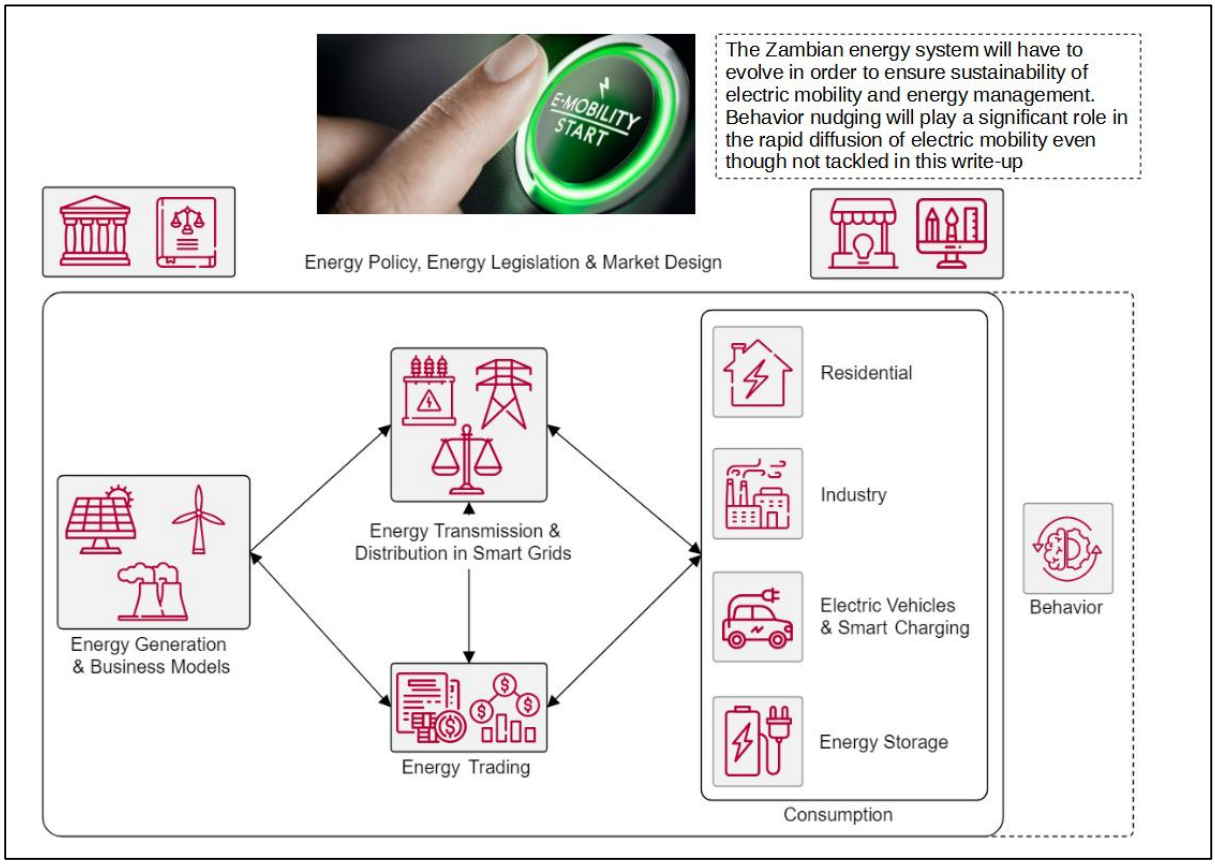


*Figure 1: The envisioned electric mobility and energy management future in Zambia (adopted from [12])*

## 2.0. Drivers of e-mobility

The 6.6 million global sales of EVs in 2021 translates into an increase in demand with Europe and China taking the lead [3]. In the same year, the United States, Europe, China recorded a boom in sales compared to previous years as illustrated in Figure 2 below.

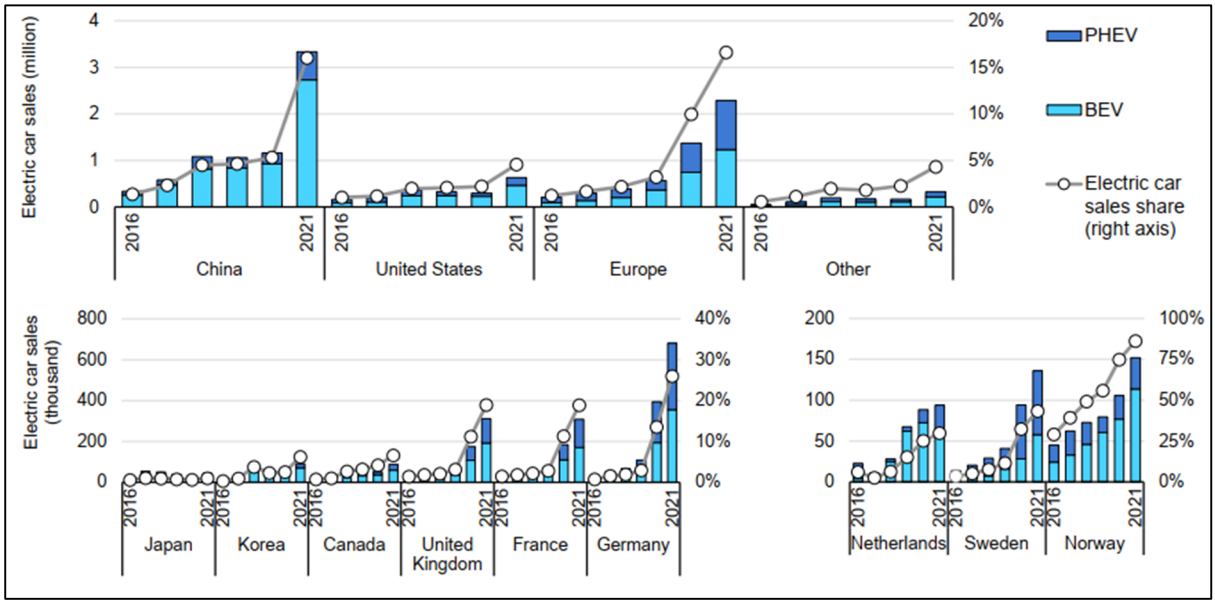


*Figure 2: Showing EV sales and registration share in selected regions 2016-2021 (source: [1, 3])*

EVs are cost-effective, zero-emission, high performance and fuel-efficient vehicles, with hybrid electric vehicles (HEVs) able to preserve fuel up to 49 percent as opposed to traditional ICE automobiles [13]. With these benefits in mind, China for instance introduced legislation requiring public service buses to reduce air pollution. This led to a surge in EV sales and at the same time leveraging zero emissions of EVs to tackle urban pollution [14].

EVs also offer sustainability in terms of environmental friendliness especially if the energy mix used for electricity generation is perceived to be clean or green. However, some studies have revealed that EVs tend to have marginal emissions reduction benefits compared to ICE vehicles if the generation mix is based on fossil fuels [15]. Moreover, when in all-electric operational mode, plug-in hybrid electric vehicles (PHEVs) produce no tailpipe emissions [16]. Even though EVs generally require low maintenance costs compared to their ICE counterpart, battery maintenance requirements and frequency thereof are unique to EVs [17]. Further, the initial high capital investments of EVs can be offset by fuel savings in the long run.

Besides, battery technology keeps improving every year owing to research and development spearheaded by financial investments and innovative minds. Battery charging speeds and average densities are on the rise at about 4 to 5 percent per annum [18]. Another driver of e-mobility adoption is the high learning rate of lithium-ion battery technology. The prices of these battery packs have dropped by 87% from 2010 to 2019 [18, 19]. This drive is not only technology centric but also rides on policy makers lobbying for emissions abatement in the automotive sector. Therefore, fast charging, longer range and reduced battery cost is making EVs more competitive than ICE vehicles [20].

Generally, legislators in this space are mainly concerned about quota systems, fuel economy regulations and sustainable transport policies. Numerous nations have introduced mechanisms to enhance e-mobility adoption such as subsides which have encouraged acquisition of battery electric vehicles (BEVs). Countries like UK, Norway, Japan, China, Korea, United States and France offered national subsidies in 2016 of USD $6,200, $20,000, $5,500, $10,000, $16,550, $8750 and $7,100 for BEVs per vehicle respectively [18, 21]. This effort culminated into 13 countries announcing their plans to ban the sale of ICE vehicles, consequently, leading to policy pressure on automobile suppliers and manufacturers [21, 22].

## 3.0. Barriers to adoption

Although EVs have a lot of potential for penetrating the Zambian market and eventually becoming part of the government's renewable energy policy framework, it faces several barriers as illustrated in Table 1 below.

*Table 1: Showing barriers to e-mobility adoption in Zambia (Authors compilation and [23])*

| Barriers to E-Mobility | | |
|---|---|---|
| | **Energy Poverty, Environment, Policy & Impact on Grid** | **Finance, Cost, Social & Market Acceptance** |
| **1** | **Impact on the grid**: Electric mobility will alter the demand curve characteristics in both shape and magnitude. A typical change to the daily load characteristic would be an increase in night-time | **Lack of Access to Finance**: There are no special funding opportunities for manufacturers of EVs. Players in the sector have complained of difficulties in acquiring equity and debt funding, |

| | | |
|---|---|---|
| | demand due to EV battery charging. Vehicle to grid (V2G) technologies could provide ancillary services to the grid. Utilities will need to revise their grid codes and operate as flexible orchestration platforms bringing together network resources and ecosystem partners to balance the grid through decentralized, flexible units such as EVs. | especially since banks and other investors are not too convinced about the viability of the Zambian EV market. Nonetheless, the continuation and growth of several initiatives including small energy companies, logistics companies, mini-grid companies and tricycle operators may help improve investors' perceptions of Zambia as a viable investment destination for EVs over time. |
| **2** | **Availability of Electricity**: The energy supply in the country and the grid's capabilities to support increased uptake of electric mobility is an important consideration. Electricity availability is a paramount challenge that the introduction of EVs will need to confront in Zambia with national electricity access currently at 31%. The highest peak average power supply as of June 2022 was about 2600 MW (with a demand of 2213MW) which is insufficient for a population of around 18.38 million. Some, therefore, might argue that Zambia does not generate enough electricity for electric vehicles. However, in the long run, as people embrace it, charging stations will begin to emerge, some of which will generate their own power from various sources, such as solar which is in abundant supply in Zambia. Charging system technologies are advancing so rapidly that a user can get a full charge in a very limited time, lasting hundreds of kilometres. | **Costs of Importation**: Zambia does not possess the technology and skills to manufacture all the parts for EVs domestically. Therefore, most parts have to be imported from abroad, often from China or the United States. This, therefore, raises the costs of production, exposes the manufacturer to greater foreign exchange risks, and raises the cost of transporting parts from the ports to the assembly or manufacturing plant. There are no policies for offsetting these costs e.g., provision of import duty waivers or subsidies by the government. |
| **3** | **Lack of Government Regulation and Support**: There is a stark absence of government policies such as tax holidays, import duty reduction or waivers, concessionary loans and subsidies available to EV manufacturers, assemblers and projects in Zambia. This not only discourages investments in the sector, but also makes it more difficult for existing players in the sector to grow, expand sales, and overcome bottlenecks along the supply chain. However, just as it took renewable energy players in the solar home system (SHS) and the Mini-Grid (MG) space to grow organically at the beginning with little state intervention, the nascent Zambia EV sector is likely to grow steadily through private sector efforts and gain attention from policymakers in coming years as it reaches a critical mass. | **High Cost of Electric Vehicles**: A major hindrance to the growth of the electric mobility market is the high cost of manufacturing electric vehicles. This is due to the high cost of importing parts, as well as the inability to undertake mass production and exploit economies of scale, due to lower market demand for electric vehicles compared to petrol-powered vehicles. Technological advancements in electric vehicles and proactive government initiatives will however present significant opportunities for growth in the electric vehicle market. |
| **4** | **Environmental Concerns**: While it is accepted that the introduction of EVs will reduce $CO_2$ emissions, there is also the environmental issue of local battery manufacturing and disposal, which could be quite challenging in Zambia, where the normal domestic waste management system is already an area of concern. These batteries are complex and contain toxic chemicals, making their disposal at the end of an electric vehicle's life a major environmental challenge | **Social-political and Market Acceptance**: Socio-political acceptance refers to general attitudes towards an innovation, in this case an electrified transport system, and behaviors related to an expression of these attitudes like political support or opposition. Market acceptance describes the (potential) market success of an innovation. Market acceptance of EVs can be analyzed in market shares, the purchase behavior of car-drivers in the Zambian context. |

# 4.0. E-mobility value chain and various linkages

This section explores the dimension of the e-mobility ecosystem in Zambia and how it could contribute to breed opportunities by having the right political framework and innovative business models in the space.

## 4.1. E-mobility value chain and opportunities

With the global shift towards a just energy transition, Zambia could leverage this opportunity and be a key player in the e-mobility global value chain. At local level, this would lead to sustainable jobs owing to the demand for specialized range of skills beyond the assembly value chain. Local human capital availability would also translate into affordable and cheaper EVs with minimal maintenance costs [24]. Additionally, Zambian businesses would thrive due to competitive advantage leading to aggregated economic growth. The electric mobility ecosystem (Figure 3) is composite of multiple stakeholders and business segments forming a continuous loop of rapidly evolving interactions aimed at developing the sector. Additionally, the transition of mobility electrification supports Zambia's economic transformation aspirations through the facilitation of the critical economic tenets highlighted in Table 2.

*Table 2: Opportunities leveraged from the e-mobility ecosystem (Authors compilation and [25, 26])*

| No. | Critical Economic Tenets attainable |
|---|---|
| 1 | **Reducing Oil Imports & Foreign Currency Loss**: Substituting a moderate supply of fossil needs for transport will reduce import demand for petroleum products and curb foreign currency outflows, mitigating trade deficits, improving current account balances and reducing complexity in exchange rate management. |
| 2 | **Path to Energy Independence**: Reducing the transport sector's dependence on wholly imported petroleum fuels by switching demand to locally produced electricity will not only drive energy security but optimize macroeconomic management and insulate pass-through inflation effects of petroleum price volatility. |
| 3 | **Enhancing Economic Productivity**: Economic growth is sharply correlated to growth in demand for fuel. Shifting and decoupling Zambia's economic growth from fossil fuels to renewable energy sources is critical in achieving economic productivity, structural economic transformation and reducing the environmental impact that comes with national development |
| 4 | **Creation & Development of New Industries**: Leveraging Zambia's potential comparative advantage in battery manufacturing can catalyze Zambia to become an electric mobility hub in the region. A wider local EV ecosystem and industry will be created along with supporting secondary industries enhancing technology driven industrialization and economic diversification. The initiative will not only create import substitution but generate mass scale export growth supported by a rapidly growing global electric vehicle industry. |
| 5 | **Creation of High Wage & High Skill Jobs**: Transitioning to electric mobility will develop skilled, high wage local green jobs across the entire electric mobility ecosystem from battery manufacturing, charging infrastructure deployment, renewable energy asset growth to technical training centers. Determined by the scale of the transition, the result will be wide youth job creation and socio-economic transformation. |

Moreover, Zambia could benefit from the e-mobility value chain by transitioning from selling raw materials such as copper and cobalt, to selling finished products (i.e., electric batteries, copper wires etc.). This is in line with the cooperation agreement between Zambia and Democratic Republic of Congo that was signed in May 2022 which aims at developing a value chain in the clean energy and electric battery sectors [24].

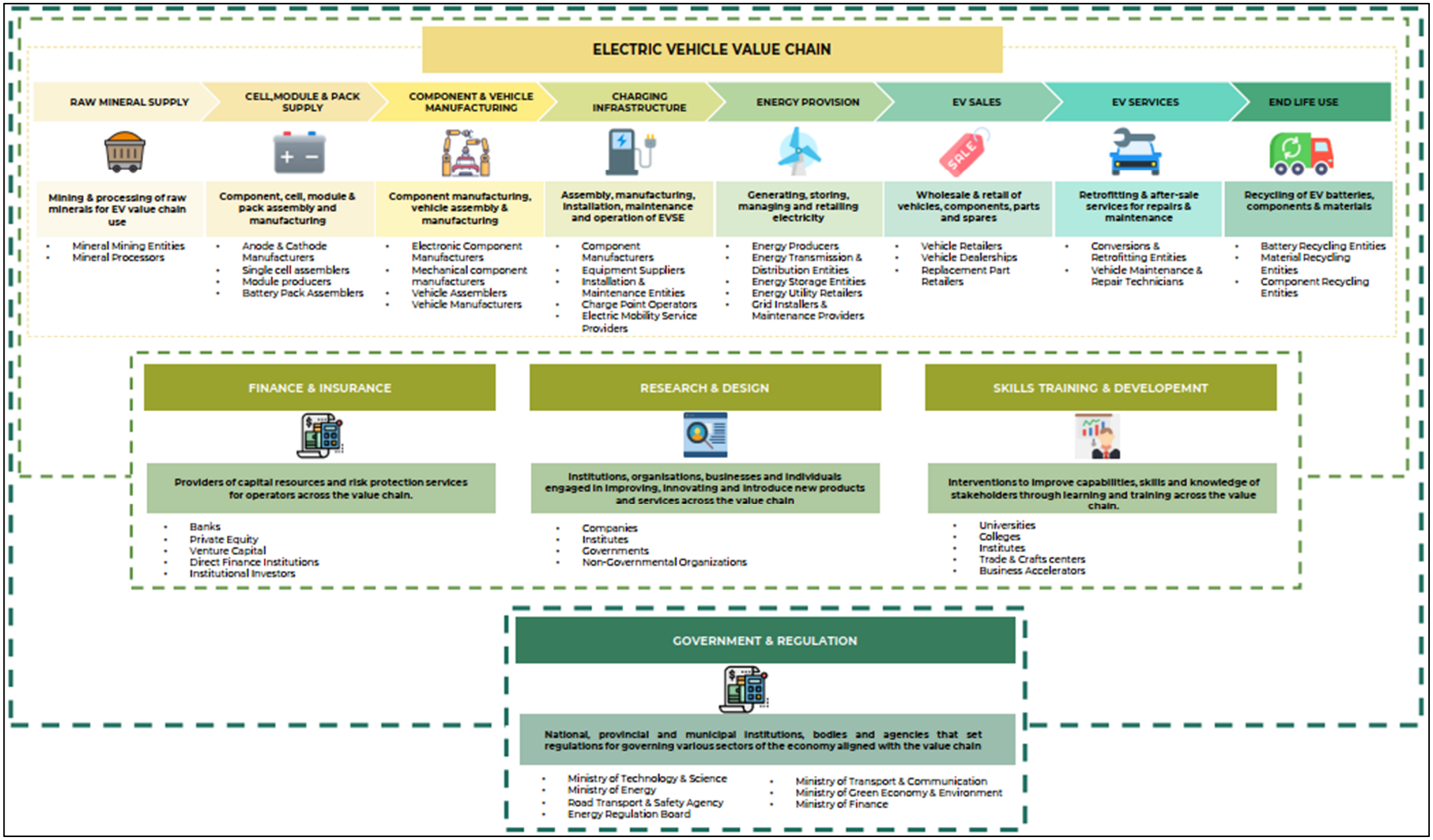


*Figure 3: Showing in the electric mobility value chain in the Zambian context (Adopted from [27, 28])*

While Zambia can take a leaf from the global north in the e-mobility space, pragmatic adaption is everything. To that end, e-mobility specialists from the United Nations Environment Program (UNEP) argue that motorcycles and tricycles must be prioritized in realizing an e-mobility revolution in developing countries such as Zambia [25]. Their adoption has proved successful in middle and low-income countries such as Rwanda and Kenya. Therefore, their impact on pollutant emissions and climate change is quite significant especially in emerging economies of SSA. Besides, they do not require as much investment in charging infrastructure compared to electric buses or EVs [29].

### 4.2. Political framework

This section covers the policy aspect of EVs and required government engagement in its adoption and is in line with what leading adopters have done successfully (i.e., Norway, Kenya, Rwanda, China, United Kingdom, United States). Zambia lags in EV policy and political attention compared to countries like Kenya and Rwanda which have transitioned in the right direction through provision of tax incentives and policy since 2017 [30]. There have not been significant incentives to spur the adoption of electric vehicles in Zambia. This is majorly due to Zambia's status as a low-income country, low electrification rates and the small size of the Zambian transportation sector [31, 32].

However, the dynamics are gradually changing more so that on November 24, 2021, the President of Zambia – Mr. Hakainde Hichilema was among other African leaders that attended the Democratic Republic of Congo (DRC) – Africa Business forum. The focus on the agenda was how Africa could take advantage of the global EV demand to supply large volumes of raw materials such as cobalt and copper. The ultimate objective was how the continent could profit from electrifying transport by embracing valorization in battery minerals, including copper and cobalt. Besides, Zambia already supplies a substantial amount of the world's cobalt utilized in EV battery production. Further, the country also boasts of being the second largest producer of copper in Africa after DRC. Therefore, Zambia can cash in on the increasing demand for EVs by ramping up production and refining of cobalt [24].

At present, activities from E-mobility suppliers and manufacturers are somewhat insignificant and their numbers too small to form a strong industry association to collectively lobby for greater government attention and systematic policy creation, coupled with a robust market design. As a result, it is up to individual actors in the industry, as well as climate activists and policy advocacy groups such as the Zambia Electric Mobility and Innovation Alliance (ZEMIA) [33], to lead the charge for a national E-mobility policy and institutional framework. It, therefore, appears that the private sector would need to grow to the point where it can gain greater public recognition and influence through its efforts in local market research, creating awareness and international collaborations with institutions such as the Climate Compatible Growth (CCG) [34-36].

The current political will though yet to be enacted into legislation or policy points to both ICE vehicle phase out by promoting automobile hybridization, full conversion from ICE to EV, and introducing e-mobility (i.e., starting with public transportation involving buses, taxis). Moreover, at the National level, transportation and renewable energy agencies are likely to be involved, especially in driving and adopting a national-level framework for the envisioned

E-mobility sector. Given the policy and regulatory needs of the Zambian E-mobility sector, an ensemble of government ministries, departments and agencies could be involved in developing a strong enabling environment for the sector as shown in Figure 4.

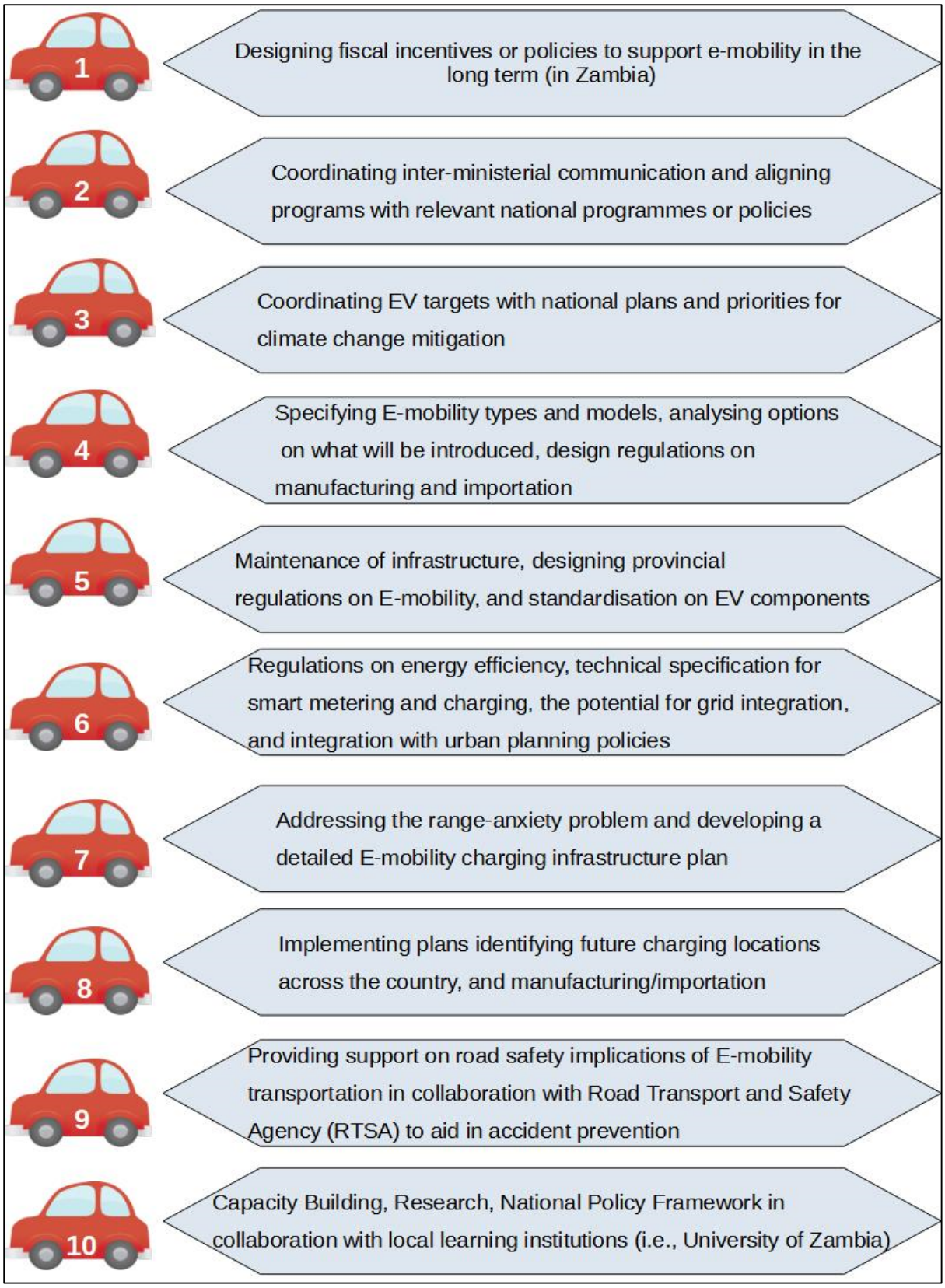


*Figure 4: Policy and regulatory needs for the envisioned E-Mobility sector in Zambia*

### 4.3. Business models

This section looks into possible business models that can be used for the adoption of EVs in Zambia, especially for the commercialization of it. Some African startups and companies are beginning to experiment with a variety of business models for commercialization [37, 38]. This has translated into EV sales spike in emerging markets (with slow notable growth in Africa as shown in Figure 5). The selling at full price (direct sales) business model used by the traditional automobile industry may be limited to business buyers (i.e., logistics and transport companies), but it is not viable for most individual customers in SSA [39]. This is because of the high costs of electric vehicles and the limited case of customers in the personal use category and the high costs of EVs. The private sector is at the forefront of the adoption of E-Mobility in other developing countries [40], therefore, Zambia does not need to reinvent the wheel but rather tap into the already proven business models (shown in Figure 6) that would eventually help boost the supply and demand for EVs. The other relevant dimension on business models includes car dealership selling EVs, full conversion of ICE to EV, EV component supply and repairs through garages and repair shops and independent charging station network operators [26, 41, 42].

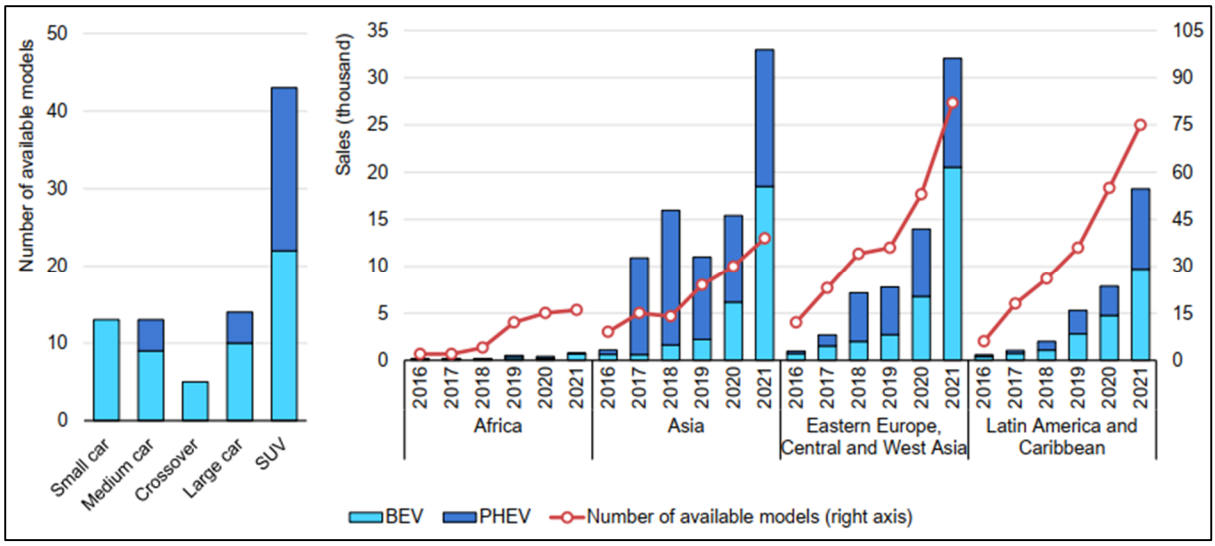


*Figure 5: EV sales spikes in emerging markets. Countries covered under Africa includes Zambia, Uganda, Tunisia, Togo, Tanzania, South Africa, Sierra Leone, Seychelles, Senegal, Rwanda, Mozambique, Mauritius, Madagascar, Kenya, Ghana, Ethiopia, Cote d' Ivoire and Burundi (source:[1, 3])*

The UN-HABITAT planned to issue a call for E-mobility innovators in Africa in the second half of 2021, Rwanda, Kenya, Mozambique, Zambia, South Africa, Cameroon and Nigeria were identified as replication countries [43]. This initiative was supposed to bridge the adoption gaps by proposing the right policy mix and innovative business models [44-46]. As such, there may be greater international financing attention paid to Zambia in a few years

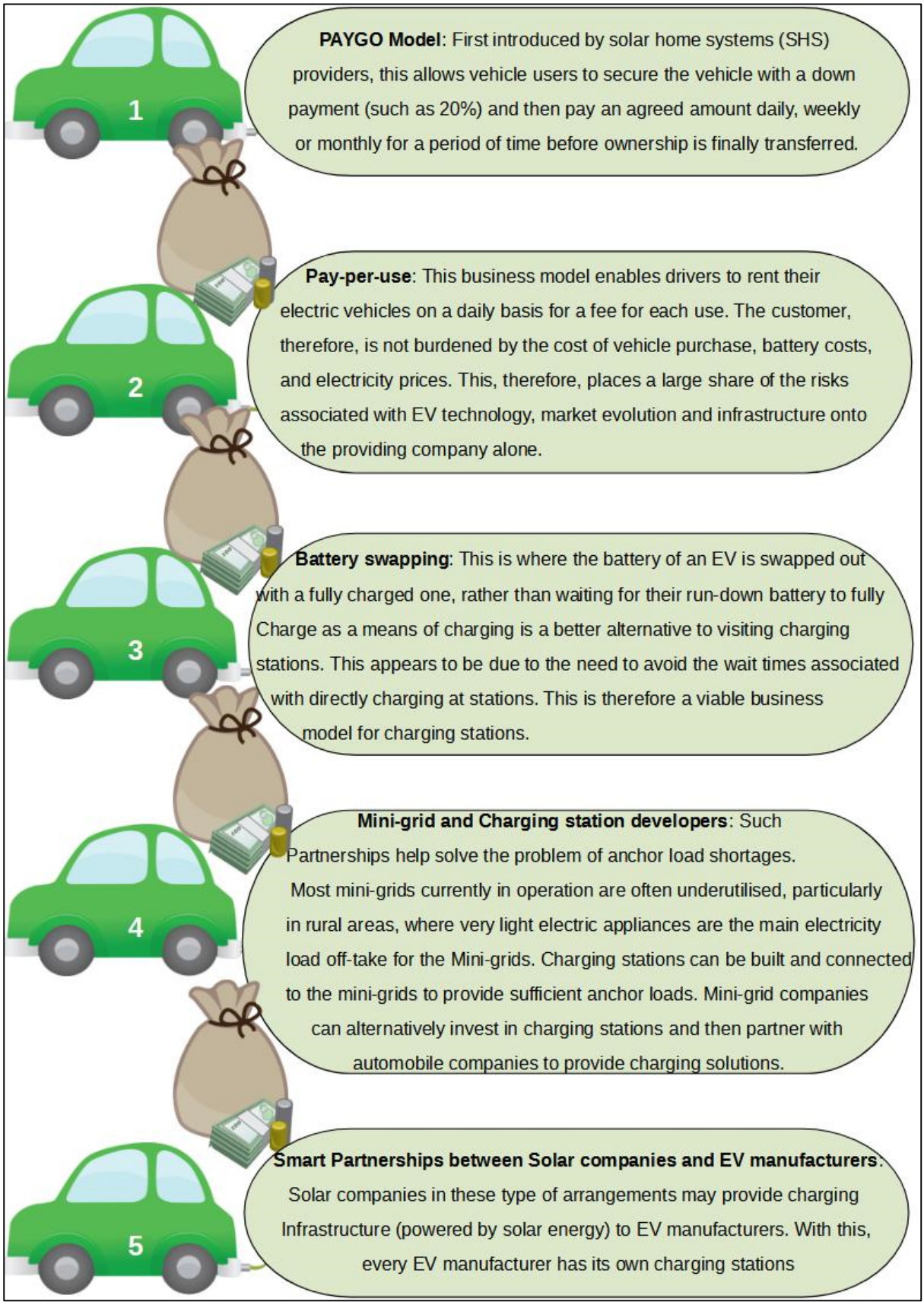


*Figure 6: Prospectus E-Mobility business models to be adopted and adapted in the Zambian context*

### 4.4. Application of business models

To tackle the challenge of limited energy access in rural areas, a small number of Solar Photovoltaics off-grid mini-grid solutions have been installed in Zambia in recent years but most of these projects have been economically unsustainable. Moreover, in 2016, the Zambian government embarked on a nationwide community empowerment initiative of procuring solar hammermills to be managed by the Zambia Cooperative Federation (ZCF). ZCF has to-date installed about 1580 Solar Milling Plants (SMPs) which generate up to 15kW of electricity per plant. To date, each milling machine uses only up to about 7.5kW for maize meal grinding purposes. This therefore leaves approximately 7.5kW unutilized, which translates to a capacity of about 12MW of unutilized electricity across the country [47].

In December 2019, the Rural Electrification Authority (REA) in collaboration with the Zambia Cooperative Federation (ZCF) embarked on developing and designing site-specific technical solutions that would ensure proper utilization of the excess solar energy from the SMPs (i.e., water pumping and other productive use of electricity – PUE) [48]. However, one aspect that remains to be explored is the incorporation of e-mobility such as the 3-wheeler electric loaders and 2-wheeled EVs (i.e., electric bikes or electric motorcycles) at the SMPs. This dimension will also contribute to eliminate women and children carrying heavy loads/bags of both raw and processed grain or traveling long distances to access health care services.

India and Nigeria have been quite successful in rolling out EV renewable energy based mini-grids [49] and Zambia could take a leaf from these two countries. Therefore, at the existing SMPs in Zambia, the solution would adopt an innovative business model by deviating from the tradition way of selling electricity in kWhs but selling of the service such as battery charging of two-and-three wheeled EVs. This is in a bid to ensure that energy efficient measures are incorporated and that many people can benefit from power generated by a small mini grid. For the reasons outlined above, the solution would promote the use of Energy as a Service (EaaS) business model using the Pay as you Go (PAYGO) approach in the billing system. The EaaS model offers various energy-related services to the consumers, rather than only supplying electricity. Adoption and rollout of e-mobility at existing SMPs and other min-grids in the Zambian space could follow the proposed business model in Figure 7. Moreover, by heightening quality control, local companies such as Engie Energy Access Zambia and Standard Microgrid have been successful in the rollout of mini-grid and expanded solar home systems targeting other PUE services (i.e., lighting, water pumping, food processing) [50, 51]. Therefore, rollout of 3-wheeler electric loaders and 2-wheeled EVs is poised to succeed in Zambia by adhering to both quality control, innovative and sustainable business models.

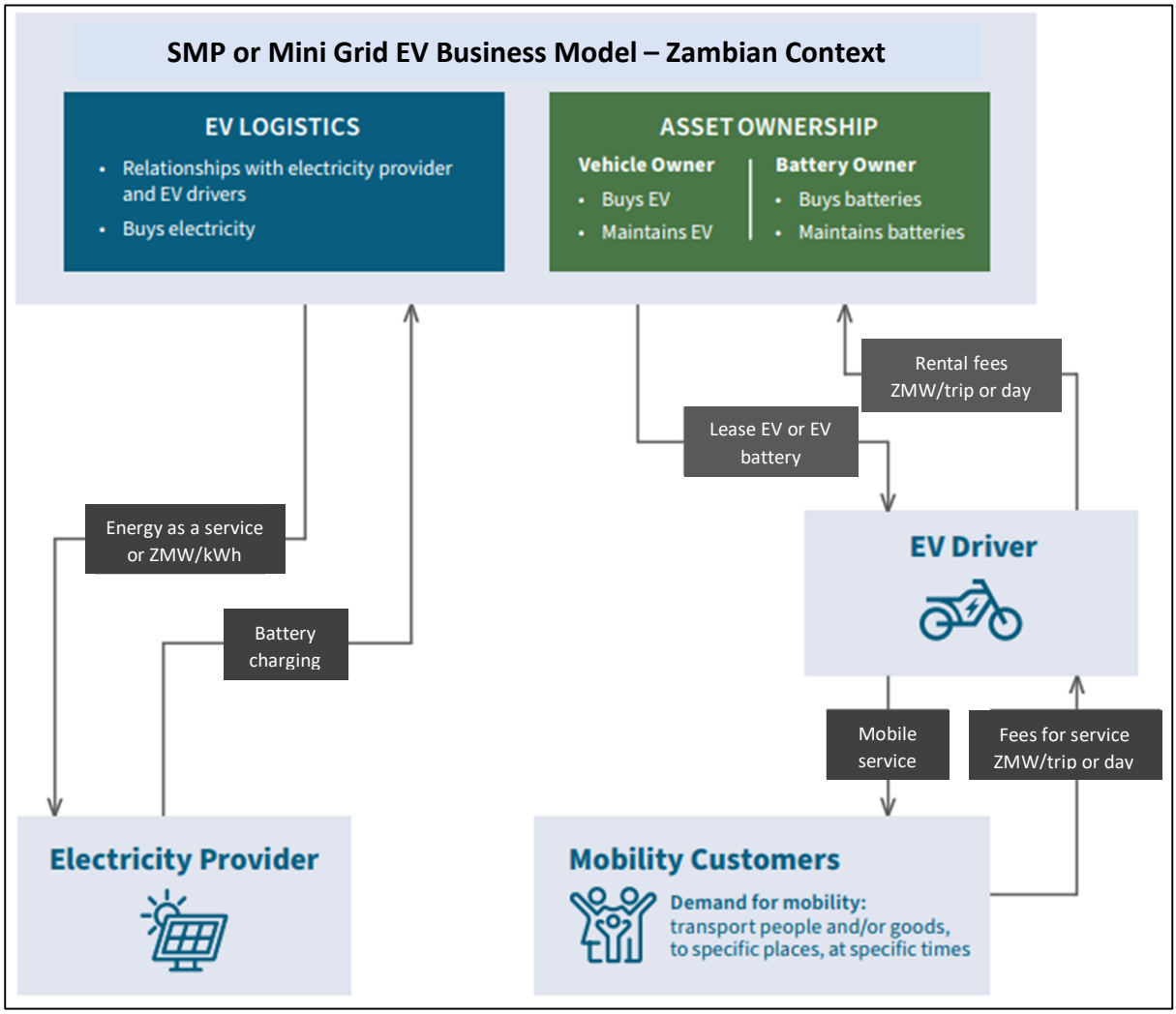


*Figure 7: EV-SMP/Mini grid Business Model Components (adopted from [49])*

## 5.0. Conclusions and Recommendations

Notwithstanding the environmental benefits such as cleaner air and abatement of greenhouse gas emissions in the Zambian urban cities (e.g., Lusaka, Ndola, Kitwe, Livingstone), electrification of passenger cars and minibuses offer an opportunity to improve and standardize the safety and quality of the public transport sector. Additionally, it would phase out inefficient ICE automobiles, create opportunities in the EV value chain such as charging station operation and sale of batteries. At national level, electric mobility would reduce the fiscal burden imposed by the importation of fuel.

Moreover, solutions to the barriers identified in section 3.0 that hinder adoption of e-mobility are springing up across Africa while providing alternatives to the causes of the problems. In Zambia, the barrier linked to electricity availability for charging EVs could also be solved by pay as you go (PAYGO) business models for renewable based mini-grids which have an option of making installment passed payment plan. However, this must also factor in the current poor state of the road network in the rural space.

Additionally, the high investment costs of EVs could be alleviated by setting up firm local manufacturing base for EV associated components instead of outright importation. This must be supported by a stringent ban on the importation of certain components to strengthen the local value chain. In the medium to long term, this will enable manufacturers (i.e., China, USA, Japan) to produce designs that fit into the Zambian context, consequently the country would gain in both the skills and manpower through knowledge and technology transfer to increase its local manufacturing capabilities.

Besides, the availability of charging stations is paramount for the effective, efficient and full transition to E-Mobility. This is an aspect that EV suppliers must contend with as a complementary component of E-Mobility that can aid the smooth rollout of EVs across the country. The recently completed integrated resource plan (IRP 2022 – 2050) did not tackle the aspect of e-mobility diffusion and how that would impact the electricity network infrastructure or the demand profile. Therefore, to complement the IRP, a detailed market assessment must be done together with an in-depth technical study looking at the local and regional (Southern African Power Pool - SAPP) dynamics of the electricity network. For the off-grid case leveraging on innovative business models, reference must also be made to the 2021 World Bank sponsored least cost geospatial electrification plan to review the location of renewable based mini-grids and standalone power systems and perceived demand growth.

Even with the highlighted obstacles to rapid adoption, the electric mobility space in Zambia is slowly gaining momentum. There is an increasing number of players coming in and driving the transition such as the Zambia Electric Mobility and Innovation Alliance (ZEMIA) and Cities and Infrastructure for Growth (CIG) Zambia. Therefore, for the country to develop in this nascent sector, efforts from both the private and public players must go towards realizing the following;

i. Public sector awareness of the transformative social, environmental and economic benefits yielded from developing the e-mobility sector in Zambia
ii. Context specific and targeted strategy to build the e-mobility ecosystem that complements Zambia's ambition to be the regional leader in battery (cell / pack) manufacturing. A strategy that would yield the highest economic and social impact
iii. Development of appropriate regulatory framework and catalytic policy to drive Zambia's near and long-term objectives towards becoming the regional leader in e-mobility
iv. Formulation of necessary interventions to ensure social benefits are inclusively shared amongst the youth and more importantly women through the creation of thousands of green high wage and high skilled jobs.
v. Strengthening national narrative and mission branding for developing an e-mobility ecosystem to leverage available impact capital and developmental assistance to initially fund the transition.
vi. Conducting feasibility and market assessments to assess the appropriate and necessary conditions and scope to support development of the local sector.

# References


1. IEA, *Global Electric Vehicle Outlook*, in *Securing supplies for an electric future*. 2022.
2. Savaresi, A., *The Paris Agreement: a new beginning?* Journal of Energy & Natural Resources Law, 2016. **34**(1): p. 16-26.
3. Zhongming, Z., et al., *Global EV Outlook 2021.* 2021.
4. Van Vliet, E. and P. Kinney, *Impacts of roadway emissions on urban particulate matter concentrations in sub-Saharan Africa: new evidence from Nairobi, Kenya.* Environmental Research Letters, 2007. **2**(4): p. 045028.
5. Nyoni, K.J., et al., *Hydro–Connected Floating PV Renewable Energy System and Onshore Wind Potential in Zambia.* Energies, 2021. **14**(17).
6. Collett, K.A., et al., *Can electric vehicles be good for Sub-Saharan Africa?* Energy Strategy Reviews, 2021. **38**: p. 100722.
7. Maronga, A., et al., *Evaluation of PV and CSP systems to supply power in the Zimbabwe mining sector.* Energies, 2021. **14**(13).
8. Kammer, A., et al., *How war in Ukraine is reverberating across world's regions.* Washington: IMF, March, 2022. **15**: p. 2022.
9. Communication, M.o.T.a. *MTC Sector Performance Report*. 2017 [cited 2022 July 2]; Available from: https://zambiamtc.opendataforafrica.org/kenvome/mtc-sector-performance.
10. CEIC. *Zambia Number of Registered Vehicles.* 2022 [cited 2022 July 2]; Available from: https://www.ceicdata.com/en/indicator/zambia/number-of-registered-vehicles.
11. CEIC. *Zambia Registered Motor Vehicles*. 2019 [cited 2022 July 2]; Available from: https://www.ceicdata.com/en/indicator/zambia/motor-vehicle-registered.
12. FIM. *Sustainable Energy Management and Mobility*. 2022 [cited 2022 July 2]; Available from: https://www.fim-rc.de/en/expertise/sustainable-energy-management-and-mobility/.
13. Austmann, L.M., *Drivers of the electric vehicle market: A systematic literature review of empirical studies.* Finance Research Letters, 2021. **41**: p. 101846.
14. Zhang, X., et al., *Review of electric vehicle policies in China: Content summary and effect analysis.* Renewable and Sustainable Energy Reviews, 2017. **70**: p. 698-714.
15. Rapa, M., L. Gobbi, and R. Ruggieri, *Environmental and economic sustainability of electric vehicles: Life cycle assessment and life cycle costing evaluation of electricity sources.* Energies, 2020. **13**(23): p. 6292.
16. Plötz, P., S.Á. Funke, and P. Jochem, *Empirical fuel consumption and CO2 emissions of plug-in hybrid electric vehicles.* Journal of Industrial Ecology, 2018. **22**(4): p. 773-784.
17. Hawkins, T.R., et al., *Comparative environmental life cycle assessment of conventional and electric vehicles.* Journal of industrial ecology, 2013. **17**(1): p. 53-64.
18. Kolek, B., *Electric Vehicles: What is the Future?* 2021.
19. Nykvist, B., F. Sprei, and M. Nilsson, *Assessing the progress toward lower priced long range battery electric vehicles.* Energy policy, 2019. **124**: p. 144-155.
20. Martin, G., et al., *Lithium market research–global supply, future demand and price development.* Energy Storage Materials, 2017. **6**: p. 171-179.
21. Rietmann, N. and T. Lieven, *A comparison of policy measures promoting electric vehicles in 20 countries*, in *The Governance of Smart Transportation Systems*. 2019, Springer. p. 125-145.
22. Wang, N., L. Tang, and H. Pan, *A global comparison and assessment of incentive policy on electric vehicle promotion.* Sustainable Cities and Society, 2019. **44**: p. 597-603.
23. Chidambaram, K., et al., *Critical analysis on the implementation barriers and consumer perception toward future electric mobility.* Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering, 2022: p. 09544070221080349.
24. SALUSEKI, J., *Zambia: Global Shift Towards Green Energy Opportunity for Mineral-Rich Nations*, in *Times of Zambia*. 2022.
25. UNEP, *Supporting electric mobility.* 2022.
26. UNEP, *Global Electric Mobility Programme.* 2022.
27. Africa, E. 2022 [cited July 2. 2022]; Available from: https://www.linkedin.com/company/electrify-africa/.
28. WRI. *Electric Mobility: Increasing access to electric vehicles and charging infrastructure, and optimizing to reduce emissions.* . 2022 [cited 2022 July 2]; Available from: https://www.wri.org/cities/electric-mobility.

29. Zhongming, Z., et al., *E-Boda-Bodas: a promising day for electric transportation in East Africa*. 2021.
30. Galuszka, J., et al., *East Africa's policy and stakeholder integration of informal operators in electric mobility transitions—Kigali, Nairobi, Kisumu and Dar es Salaam.* Sustainability, 2021. **13**(4): p. 1703.
31. USAID, *ZAMBIA: POWER AFRICA FACT SHEET*. 2021.
32. Bank, W. *Access to electricity (% of population) - Zambia*. 2022 [cited 2022 July 2]; Available from: https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=ZM.
33. ZEMIA. 2022 [cited July 2, 2022]; Available from: https://www.linkedin.com/search/results/all/?keywords=zambia%20electric%20mobility%20and%20innovation%20alliance&origin=RICH_QUERY_TYPEAHEAD_HISTORY&position=0&searchId=ddaf7dc3-548b-4328-a5c7-35256d43c5bd&sid=FfI.
34. Cloete, D., N. Grobbelaar, and T. Bertelsmann-Scott, *SADC Futures of e-Mobility: EVs as Enablers of a New Energy Paradigm.* 2020.
35. Collett, K.A. and S.A. Hirmer, *Data needed to decarbonize paratransit in Sub-Saharan Africa.* Nature Sustainability, 2021. **4**(7): p. 562-564.
36. HABITAT, U. *Mobility and Transport*. 2021 [cited 2022 July, 2]; Available from: https://unhabitat.org/topic/mobility-and-transport.
37. Adib, A., et al., *E-mobility—Advancements and challenges.* IEEE Access, 2019. **7**: p. 165226-165240.
38. Bugaje, A., et al., *Investigating the Performance of Rural Off-Grid Photovoltaic System with Electric-Mobility Solutions: A Case Study Based on Kenya.* Journal of Sustainable Development of Energy, Water and Environment Systems, 2022. **10**(1): p. 1-15.
39. Bauer, C., et al., *Opportunities and challenges for electric mobility: an interdisciplinary assessment of passenger vehicles: Final report of the THELMA project in co-operation with the Swiss Competence Center for Energy Research "Efficient technologies and systems for mobility".* 2016.
40. de Rubens, G.Z., et al., *The market case for electric mobility: Investigating electric vehicle business models for mass adoption.* Energy, 2020. **194**: p. 116841.
41. Jittrapirom, P., et al., *Mobility as a service: A critical review of definitions, assessments of schemes, and key challenges.* 2017.
42. Sima, A.C., et al., *Smart Mobility in Africa*, in *Holistic Approach for Decision Making Towards Designing Smart Cities*. 2021, Springer. p. 199-211.
43. HABITAT, U. *Role of electric mobility for low carbon cities*. 2021 [cited 2022 July, 2]; Available from: https://unhabitat.org/un-habitat-launches-technical-publication-on-the-role-of-electric-mobility-for-low-carbon-cities.
44. Petrauskiene, K., et al., *Situation analysis of policies for electric mobility development: Experience from five european regions.* Sustainability, 2020. **12**(7): p. 2935.
45. Petit, M., et al. *Electrical energy and mobility issues in Africa: which complementarities?* in *2017 IEEE PES PowerAfrica*. 2017. IEEE.
46. Leurent, F. and E. Windisch, *Triggering the development of electric mobility: a review of public policies.* European Transport Research Review, 2011. **3**(4): p. 221-235.
47. LWIZI, G., *REA to pilot power generation from solar milling plants*, in *Zambia Business Times*. 2020.
48. Tembo, M., *REA, ZCF SIGN MOU ON RURAL INDUSTRIALISATION*, in *Lusaka Star*. 2019.
49. Andrew Allee, J.S., James Sherwood, *Powering Small-Format Electric Vehicles with Minigrids: Assessing the Viability of Two- and Three-Wheeled EVs for Rural Mobility*. 2021.
50. Engie. *About Engie Energy Access Zambia*. 2022; Available from: https://engie-energyaccess.com/countries/zambia-en.
51. Microgrid, S. *About Standard Microgrid Zambia*. 2022; Available from: https://standardmicrogrid.com/.