

Introduction

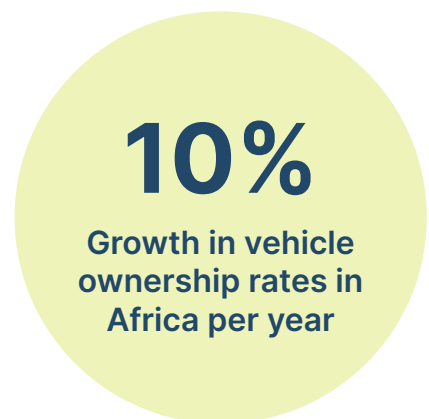
The electric mobility (e-mobility) industry is nascent in sub-Saharan Africa, but it has the potential to significantly improve the lives of millions of people as well as reduce the impact of the transport sector on the environment. This fact sheet focuses on two-wheel electric vehicles (e-2W) in East Africa, where motorcycles are a common mode of transport.

Key Facts of the Application Environment

Vehicle ownership in Africa is growing quickly at a rate of 10% per year, but with just 26 vehicles per 1000 people in sub-Saharan Africa compared to 182 vehicles per 1000 people in the rest of the world, it is still comparatively low.^{1,2} Technology Many e-2Ws are often operated as taxi businesses that ferry both people and goods as

well as employ numerous young people as drivers. The penetration of electric vehicles (EVs) is extremely low, with only 350 out of 3.2 million registered vehicles listed as using electricity in Kenya in 2019.

Technology	Electric motorcycles (e-2W) and electric vehicles in general.
Application	Motorcycles are often used as taxi businesses and provide jobs for millions of people, particularly young people, in East Africa.
Technology Overview	Electric motorcycles use electric motors powered by rechargeable batteries and can typically travel between 40–150 km on a single battery charge. Battery swap stations and charging hubs provide the energy for vehicles. Batteries usually take 1.5–4 hours to charge.
Economic and Financial feasibility	Electric motorcycles have lower lifetime costs than their petrol equivalents despite having roughly twice the CAPEX costs (\$2,000, including batteries, vs \$1,000). Battery swap stations require \$1,800–\$2,500 capital investment for batteries and chargers but can serve riders multiple times per day
Start-up Models	Electric mobility start-ups in the region are exploring diverse models such as: electric motorcycle manufacturing and distribution; delivery services; ride hailing services; safari vehicle conversion; and electrifying public transport. At least four e-mobility start-ups in East Africa have secured over \$1 million in investment.
Benefits and Outcomes	Electric vehicles can reduce greenhouse gas emissions and local air pollution caused by fossil fuel vehicles. The industry can also create local jobs and increase earnings for vehicle operators.
Constraints and Risks	The EV market growth is constrained by the lack of charging infrastructure. Ethical extraction of minerals and environmentally responsible disposal and recycling of batteries also need to be addressed.



Technical Information

Electric motorcycles use rechargeable battery packs to power a motor, which is either positioned in the centre (“mid-drive”) or integrated into the wheel hub (“hub-drive”). Battery packs often use LFP or another lithium-ion chemistry and deliver about 3–4 kWh, offering a range of 40–150 km on a e-2W before needing to be recharged. The charging time for battery packs depends on the charging current, but typically ranges between 1.5–4 hours when using 1–4 kW chargers. To reduce waiting times, companies such as Ampersand in Rwanda have established battery-swap stations that swap their depleted battery pack for a fully charged one in less than five minutes.

Electric vehicles can be charged with solar power in off-grid areas and serve as anchor loads for mini-grids. Off-grid markets may require higher battery-to-vehicle ratios so that battery packs can be charged during the day when power is plentiful and cheap. Unused batteries could potentially be used to support mini-grid peak loads in the evening. Regulation of electric vehicle technology is still at the early stages in East Africa and there are no current standards for batteries, chargers, or EVs in general. Consequently, EVs in East Africa may not be subject to any safety or quality tests and EVs from different suppliers might require different charging infrastructure.

Electric vehicles procured from

abroad have likely been subjected to the standards of the country of origin and to the standards of markets that the supplier exports to (e.g. United States, the European Union). International regulations, such as the UN Global Technical Regulations Numbers 20–22, 7 outline common standards for electric vehicles that often influence a country’s national standards. Electric vehicles procured in East Africa should be vetted for compliance with international standards, but how they are being customised in local markets should also be considered. Many electric vehicle companies in East Africa customise the vehicle chassis or use proprietary battery technologies, and these modifications may be unregulated.

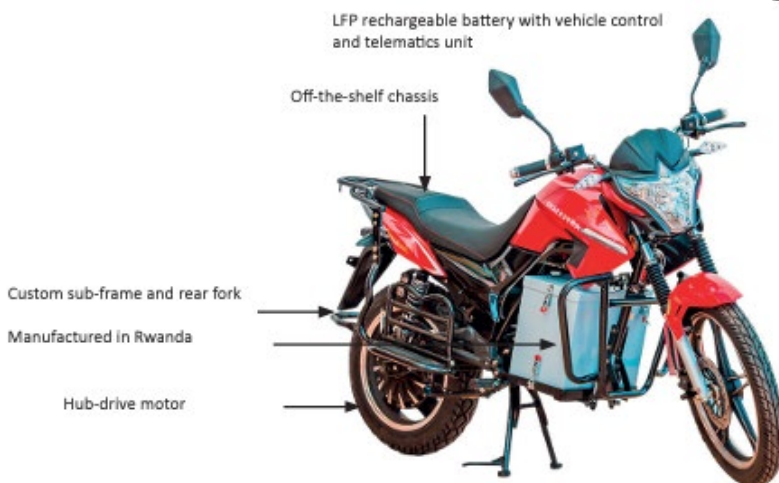


Image 1: A hub-drive Ampersand electric motorcycle (Picture: Ampersand)

25%-80%
Estimated operational savings for riders of electric motorcycles compared to petrol motorcycles

Economic and Financial Feasibility

For riders, electric motorcycles offer operational savings estimated between 25%–80% when compared to petrol-fuelled motorcycles. Although the vehicle’s upfront price is typically double that of petrol motorcycles (\$2,000, including batteries, vs \$1,000), e-2Ws are less expensive over their lifetimes.



On-board sensors (such as those that track battery health, maintenance issues, and geolocation) offer riders and suppliers data that can maximise vehicle performance and enable easier access to finance. Companies using a battery swap model retain ownership of the batteries and rent them out to customers who use and return them. Under this model, motorcycle riders typically only lease or own the vehicle chassis, which is valued at less than \$1,000. Charging hubs (or battery swap stations) are essential parts of infrastructure for electric vehicles and their lack of availability can limit the market for EVs. An e-2W battery swap station

requires an estimated \$1,800–\$2,550 in capital investment to purchase batteries (\$1,000 –\$1,500) and chargers (\$300), with companies targeting a total presence of 1.5 batteries for every vehicle on the road. In Rwanda, Ampersand riders pay \$1.17 for a fully charged battery swap and typically swap two to three times per day in order to ride 150 km. Riders increase their income by 41% compared to riders using petrol motorcycles, which would require 4L of fuel to cover the equivalent distance. The profitability of charging stations is largely dependent on the applied tariff.

Case Study: E-mobility Start-Ups in East Africa

One of East Africa's most mature emobility start-ups is Ampersand, which has 500 electric motorcycles on the road, ten battery swap stations in Kigali, and an average one million kilometres travelled by riders each month in 2022. Ampersand assembles their electric motorcycles that consist of an imported chassis, a customised battery pack with integrated electronics, and a chassis

sub-frame, which they manufacture in Rwanda. Ampersand partners with asset financing companies to lease their motorcycles to riders who operate them as taxis. Other start-ups are exploring the use of electric vehicles in other business models, such as using EVs for deliveries or converting safari vehicles to hybrid or electric models. In addition to lower operating costs, start-ups are high-

lighting other EV features as value propositions to their customers, such as environmental friendliness, low noise, and improved handling. Start-ups in this space are in the early stages, but some have secured significant early-stage investments, such as Zembo (\$3.4M, 2021), BasiGo (\$4.3M, 2022), Opibus (\$7.5M, 2021), and Ampersand (\$13M, 2021).

Company	Vehicles	Country	Core Business
Ampersand	E-2W	Rwanda, Kenya	Assembly and manufacturing of electric motorcycles for motorcycle taxis. Operates battery swap stations
Greenfoot	E-2W, E-3W	Tanzania	Deliveries with electric scooters and electric three wheelers
eMo BodaBoda	E-2W	Tanzania	Sales and leasing of electric motorcycles
e-Motion	E-4W	Tanzania	Conversion of 4x4 vehicles to electricity
Bodawerk	E-2W, E-4W	Uganda	Manufacturing and sales of electric motorcycles for taxi and deliveries and three-wheel vehicles for cargo deliveries. Battery pack assembly and battery second-life recycling
Zembo	E-2W	Uganda	Sales of electric motorcycles and operations of solar-powered battery swap stations
Opibus (Roam Motors)	E-2W, E-4W	Kenya	Sales of electric motorcycles and conversions of buses and 4x4 vehicles
Kiri	E-4W	Kenya	Sales of electric motorcycles and three-wheelers for taxi and delivery businesses
BasiGo	E-4W	Kenya	Sales and local assembly of buses for mass transport
Asobo	E-OB	Kenya	Electric outboard motors for use on boats

Benefits and Outcomes

Electric mobility has the potential to reduce greenhouse gas and other air pollution emissions. In Kenya, transportation accounted for over 50% of national greenhouse gas emissions, and across Africa, air pollution causes about 176,000 annual deaths. Motorcycles are particularly harmful, emitting 10 times more hydrocarbons and carbon monoxide per kilometre than passenger vehicles. Transitioning to e-2W would have an overall positive effect on air pollution, particularly locally, but may increase some emissions such as PM2.5 at power generation sites⁸ depending on the primary energy used. Estimates for CO2 reduction

from e-2W transition range from 0.5–5 tons per vehicle per year. E-mobility can also have positive effects on jobs and the economy. Electric vehicle taxi drivers and riders can reduce their expenses due to fuel savings while also having easier access to asset financing due to on-board sensors. Local manufacturing, assembly, and servicing of electric vehicles can create new local jobs. Ampersand currently employs 150 people in Rwanda, with 60 staff working on vehicle production. Electric mobility can also reduce criminal activity by disrupting black markets for petrol.

Constraints and Risks

Electric mobility adoption can be limited by the lack of charging and battery-swap infrastructure. How this market develops will depend on gaining access to affordable battery technologies. Battery technology prices have declined from \$1,191 per kWh in 2010 to \$132 per kWh in 2020, but recently began to increase due to a shortage of lithium. E-mobility poses long-term environmental risks if not managed properly. Battery disposal and e-waste will be a growing concern. While some companies, such as Enviroserve and Bodawerk, repurpose lithium batteries for second-life purposes, there are no facilities for recycling lithium-ion batteries in East Africa. Consequently, batteries not used for second-life purposes currently need to be exported and recycled elsewhere. Ethical resource extraction is also an issue. The Democratic Republic of Congo produces over 70% of the world's cobalt, which is used in some lithium-ion batteries. Resource extraction in the DRC has historically fuelled regional conflict and instability and the cobalt mining industry has been heavily criticised for human rights violations.¹⁰

Future Perspectives

Investors in electric mobility should consider the need for large-scale, long-term investments in infrastructure and in the operating ecosystem. Early-movers face a chicken-and-egg problem: they need to decide between having limited charging infrastructure or customers. Tech start-ups with models such as taxi services (e.g. Uber for EVs in Tanzania) can help open the market, but governments and investors should think about how to support local motorcycle importers that are transitioning to importing

electric vehicles. Similarly, petrol station owners are ideal candidates to establish electric vehicle charging hubs and franchises. Partnerships among stakeholders, such as mini-grid operators, charging station owners, vehicle distributors, and asset financing companies can help spread the initial investment across different actors. A strong and consistent regional policy framework will also be important for the success of electric mobility. Ampersand is leading e-mobility in East Africa partly due to support from the

Rwandan government, which includes VAT exemptions, import tax exemptions, and low-energy tariffs. However, the company has not received such support expanding into neighbouring countries. Product standards will improve the market and help consumers in the long-run, but these need to be implemented with consideration for international standards and the ongoing, rapid product innovation happening in local companies.

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