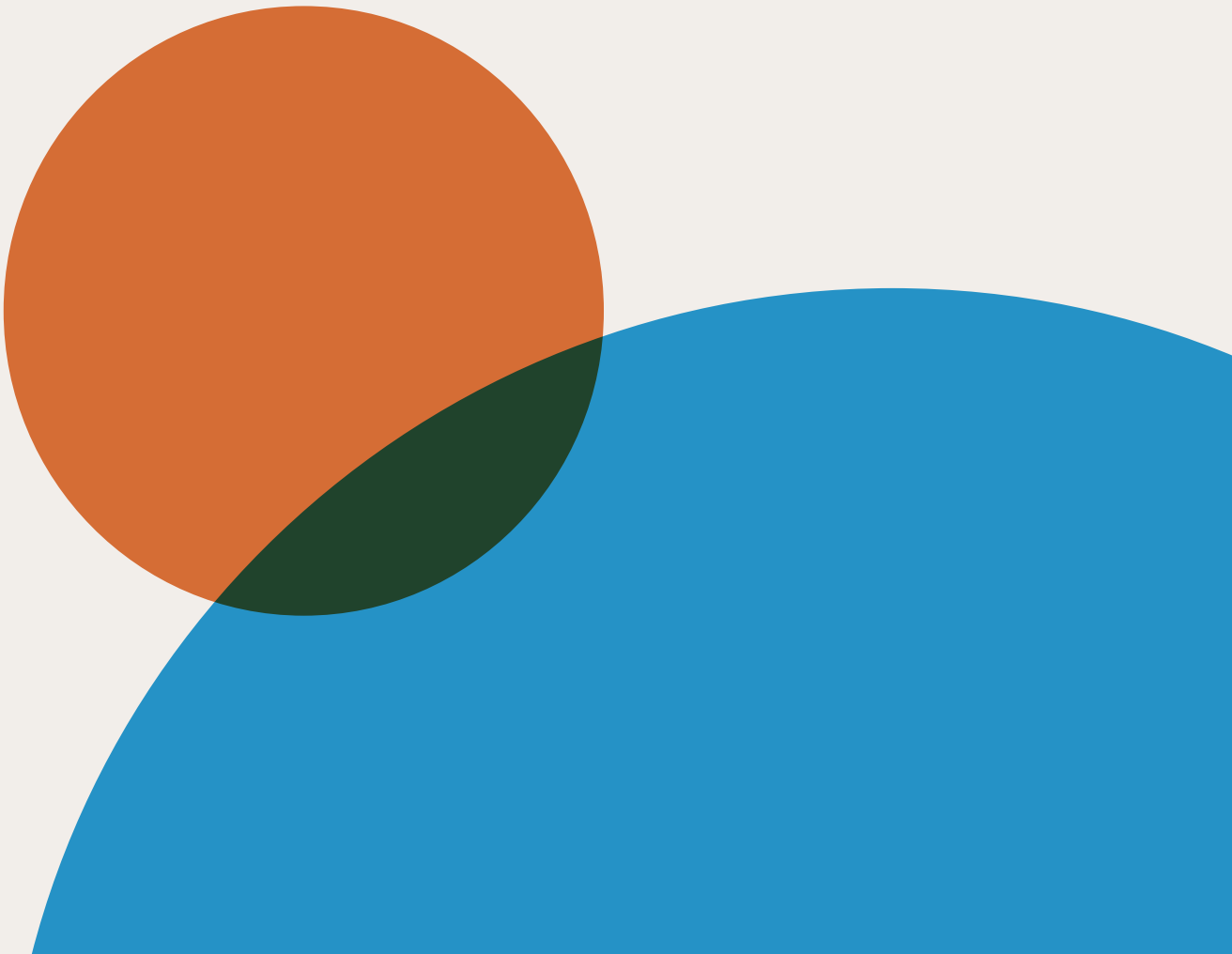
PREO Powering Renewable Energy Opportunities

CHARGING AHEAD
ACCELERATING E-MOBILITY IN AFRICA

IKEA Foundation
UKaid Transforming Energy Access
CARBON TRUST
ENERGY4IMPACT POWERED BY MERCY CORPS

Contents



Executive summary

"Sustainable mobility" incorporates the movement of people, goods and services, and represents a sector with untapped potential to enhance access to opportunities and economic growth in developing markets. By 2050, the market for global electric vehicles is expected to comprise about 80% of all vehicle sales, driven by increasingly progressive regulations, changes in consumer behaviour and declining technology costs, according to research by McKinsey Energy Insights.

It is no secret that sub-Saharan Africa (SSA) often faces unique challenges exacerbated by low economic development, poor access to electricity and lack of manufacturing ecosystems. Despite these challenges the continent is making steady progress in the transition to electric mobility. Recent analysis by McKinsey & Company suggests that as much as 35% of the vehicle fleet in sub-Saharan Africa's five largest vehicle markets (excluding South Africa) will be electric by 2040.[1] A study commissioned by FMO (the Dutch Development Bank) in 2022 found 50 EV-related startups in Kenya alone.[2] Electric motorcycles are expected to lead this transition since they are most representative of the transport scenario.

However, the electric motorcycle startups face three key hurdles in their road to scaling up in SSA:

1. **More than 90% of electric motorcycles sold are imported from China and India and are not built for African conditions.**
2. **Baseline electricity access at 48% is poor to support the charging network; also, electricity supply is weak and unreliable.**
3. **High-quality storage technology is not accessible to early-stage African startups.**

It is unlikely that a single company can address all these challenges on its own, as each challenge requires diverse resources and capacities. Instead, an ecosystem of solutions is required, which is starting to emerge.

This report provides insights on the electric mobility landscape in sub-Saharan Africa

- **Roam (previously Opibus)**, a domestic manufacturer of electric motorcycles with a goal of electrifying Africa one vehicle at a time.
- **Zembo,** which intends to build, own and operate reliable pan-national charging networks across Uganda and expand to other African countries.
- **Mobile Power**, which brings high-quality battery technology and affordable battery management solutions to the market.

While each of these companies addresses a specific value chain challenge (hardware, charging or software) in the ecosystem, together they move the sector towards scaling up electric mobility solutions in SSA.

This report provides a brief overview of electric mobility in sub-Saharan Africa, followed by a primer on how PREO companies are coming together to solve hardware, charging and software challenges. Further on, the report discusses the three companies in detail, breaking down their business models, their value chain solutions as well as the key challenges they face and how they could scale. Finally, this report outlines seven key learnings for investors, companies and stakeholders, who wish to understand, support and engage with this exciting industry.

[1] Source – McKinsey Energy Insights' Global Energy Perspective, June 2020
[2] https://www.fmo.nl/l/en/library/download/urn:uuid:d39db2ef-afde-45d6-b246-5f5514cd66bd/dalberg+reporrt.pdf?format=save_to_disk

Why did we decide to write this report?

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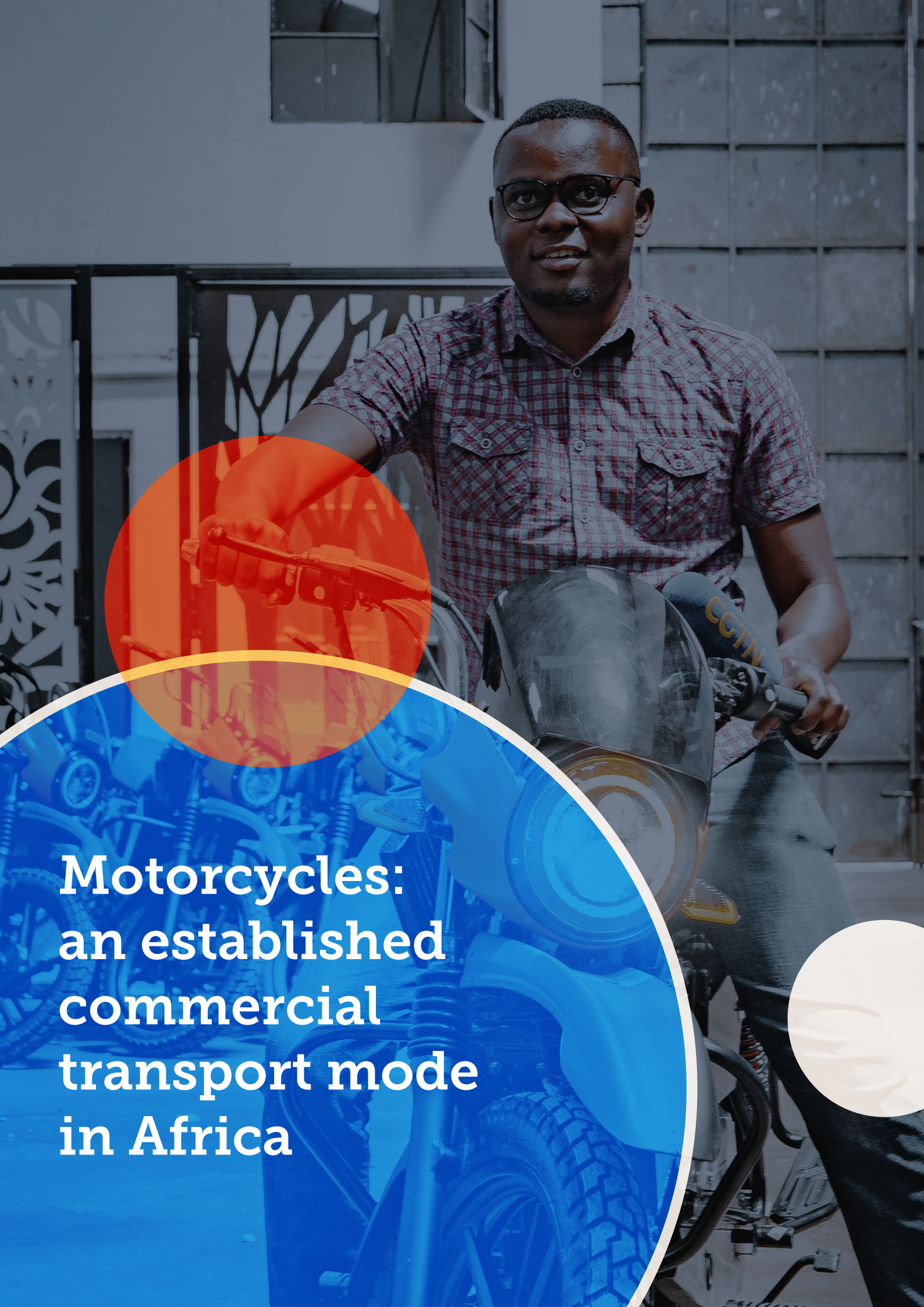
The PREO programme is a catalytic grant provider to projects demonstrating early-stage Productive Use of Energy (PUE) business models. To date, it has supported 27 PUE enterprises, four of which are within the e-mobility sector. In this report, we focus on the three e-mobility projects involving land-based electric motorcycles. The fourth project is a marine-based e-mobility company providing safe, affordable transportation to local fishing communities.

From motorcycles to *tuk-tuks*, buses, boats and agricultural mobility, these businesses are introducing various types of vehicles to electrify the African mobility market. We engaged with these companies during their early stage, which is why the PREO grant – whether alone or alongside a seed investor – was often the first institutional capital raised. PREO grants identify how valuable a product is for the market, establish viable unit-level economics, develop battery technologies, test off-grid charging solutions and demonstrate electric mobility business models.

We see this report as a channel through which we can share our knowledge for the wider benefit of electric mobility ecosystem partners. This report seeks to benefit individuals and organisations that have established or are investing in an electric mobility business. In the following sections, PREO, alongside our valued partners, shares first-hand, bottom-up experience of supporting and running electric mobility startups in Africa.

The three companies we focus on are: **Roam, Mobile Power and Zembo**. Each deploying distinct strategies but sharing a common goal: scaling their electric mobility solutions in Africa. While each company addresses different aspects of the value chain and faces unique challenges; all highlight the importance of partnerships. This report shares these observations, with the intent to influence decisions that lead to progressive interventions among private sector enterprises, donors, commercial capital providers and policymakers alike.



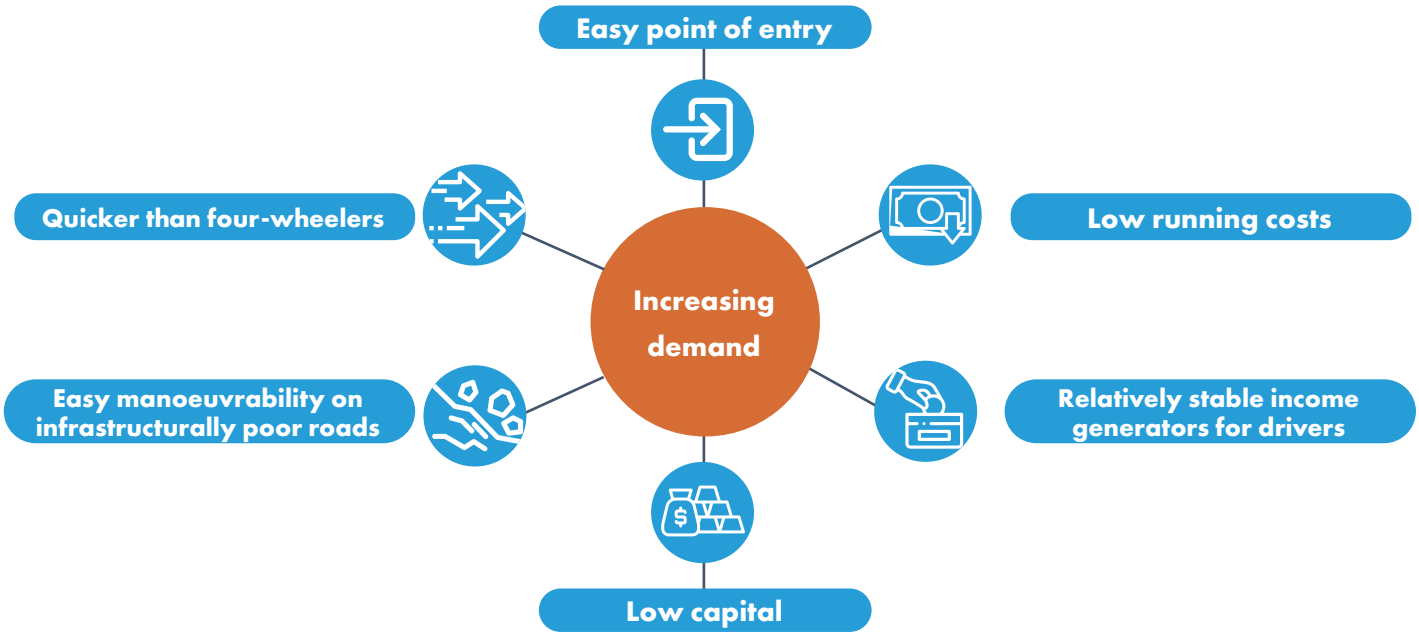
Motorcycles: an established commercial transport mode in Africa

Motorcycles: an established commercial transport mode in Africa

Africa's mobility landscape

Motorcycles have become a dominant force in Africa's mobility landscape. The widespread uptake of motorcycles as a commercial transport mode has resulted in significant socioeconomic benefits for individuals and communities, improving livelihoods and providing more affordable means of transportation.

Motorcycles are the popular entry solution in response to the lack of transport infrastructure in many underdeveloped regions and are both a mode of transport and a means of employment. Commonly used for last-mile movement, some of the driving factors encouraging increasing demand for motorcycles are:



Despite various challenges, the commercial market for motorcycles continues to thrive and attracts necessary investment into the sector. In some African countries, motorcycle riders benefit from government support, policy regulation and incentives such as import duty exemption, increased investment and market participation across the sector. According to a market overview by Mordor Intelligence, the African motorcycle market was valued at US$3.65 billion in 2021 and is expected to grow to US$5.07 billion by 2027.[3]

The COVID-19 pandemic impacted the two-wheeler industry. Slower production rates hindered the motorcycle market in Africa, given the reliance on imports and access to parts. Ongoing lockdowns and severe restrictions further exacerbated demand and supply issues, stalling the market. Since then, many countries have stabilised post-pandemic, causing the demand for motorcycles to regain momentum.

[3] https://www.mordorintelligence.com/industry-reports/africa-two-wheeler-market

Unpacking employment, environmental and economic opportunities

Sub-Saharan Africa remains largely reliant on internal combustion engine (ICE) motorcycles for transportation and employment opportunities. Infrastructural challenges force underdeveloped regions to rely on two-wheeler vehicles. The reliance on ICE motorcycles comes with relatively high running costs and long-term environmental implications from the use of fossil fuels.

As concerns around fossil fuel-powered vehicles grow, there are opportunities for alternative solutions that will decrease carbon emissions and help regions achieve their Nationally Determined Contributions (NDCs) submitted to the UNFCCC as part of the Paris Agreement. The electric motorcycle sector presents a viable solution to the challenges caused by high-emitting, costly ICE vehicles.

Electric motorcycles have significantly lower operating and maintenance costs than ICE alternatives, which allows drivers to generate higher profit margins from the same revenue base, leading to higher earning potential and improved livelihoods. Further, electric motorcycles have the potential to foster local economic development and create jobs across manufacturing and supply chain activities.

Several manufacturers already import parts, assemble electric motorcycles and offer maintenance services for electric motorcycle owners, thereby capturing some supply chain value in-country. Opportunities for local manufacturing of parts could significantly boost the impact of the electric motorcycle sector on local economic development and create more jobs.

Battery swap-out stations, used by many electric motorcycle users, have the potential to provide inherent economic advantages in the long term and offer efficient, fast-charging services. Currently, a single fully charged battery will run for an average of 90km before it needs to be recharged or replaced with a fully charged battery.[4]

Many companies now seek to build out networks of battery-swapping and fast-charging centres, whereby an electric motorcycle driver can replace or recharge a flat battery for a nominal fee. To fully optimise this untapped carbon-saving opportunity and increase the reliability of swap-out or recharging stations – particularly in weak grid locations – there is a drive to ensure swap-out and recharging stations are solar-powered. Renewable energy infrastructure will further boost job creation and the economic development potential of the electric motorcycle ecosystem, as well as clear emission reduction opportunities.

Developing supply chains, enhancing local manufacturing capacity and building out battery swap-out and fast-charging infrastructure requires significant investment. Given the climate and socioeconomic credentials of the electric motorcycle sector outlined above, climate finance, in the form of grants, concessional finance and low-interest loans, continues to play a major role in the sector's early development. Such finance is expected to continue to drive the ongoing development of the sector.

Our ongoing research indicates that increasing climate and private sector financing flows will rapidly accelerate the adoption of electric motorcycles, and in doing so, unlock transformative socioeconomic and environmental solutions. The transition to electric motorcycles will provide tangible evidence that the climate transition can be a win-win scenario. We hope this further catalyses climate action at both private sector and national levels.

[4] https://www.roam-electric.com/motorcycles#:~:text=What%20is%20the%20range%3F,a%20range%20of%2090%20km.

Scaling electric mobility in sub-Saharan Africa

Access to durable electric motorcycles, reliable charging infrastructure and high-quality batteries remain the three biggest barriers faced by electric motorcycle startups across Africa today.

1. Africa needs access to durable motorcycles

A large percentage of electric motorcycle startups in sub-Saharan Africa rely on fully built or complete knock-down (CKD) import units that are then assembled locally. The often rough terrain navigated by drivers across SSA results in significant wear and tear of the electric motorcycle caused by unpaved roads, long journeys and intense commercial use. Since suppliers are predominantly based in India, China and Southeast Asia, electric motorcycles are not customised for the African terrain.

2. Charging infrastructure needs to be reliable and dense

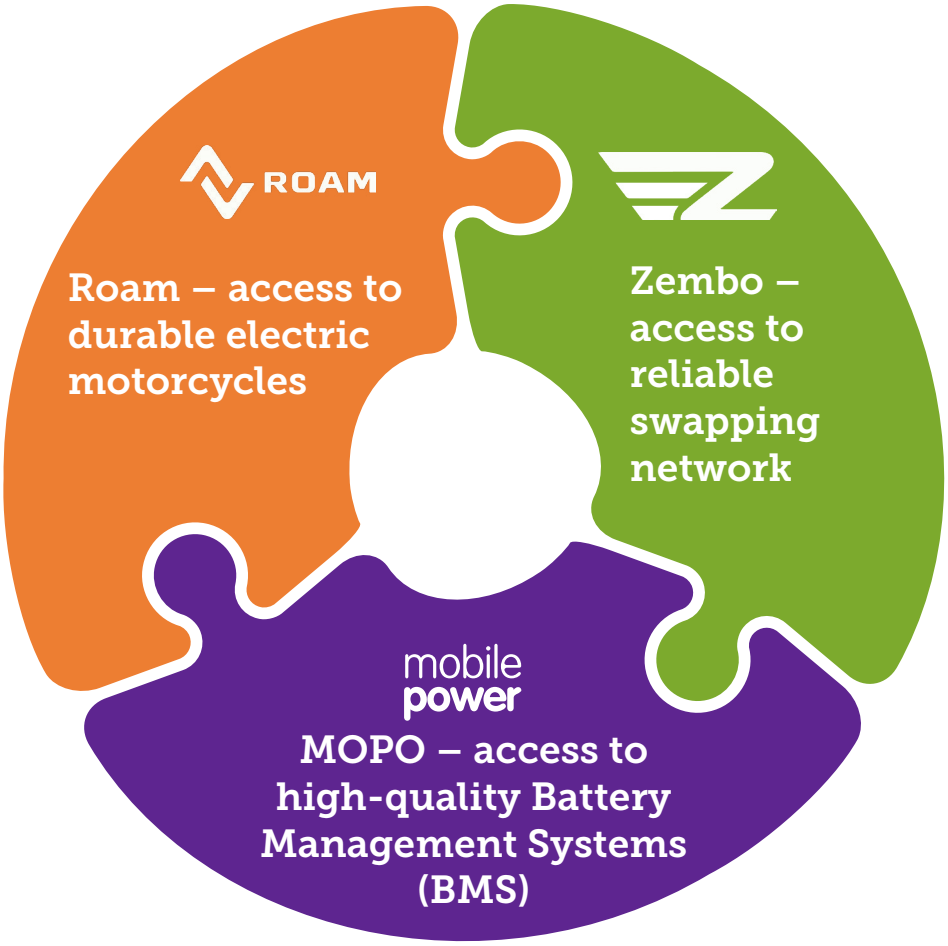
Existing off-grid electricity solutions are often unsuitable for electric motorcycle battery recharging. For instance, particularly in commercial settings throughout much of SSA, diesel generators provide a widespread replacement to grid power, but the high cost and carbon intensity of the electricity produced by diesel generators make them an expensive and less viable option. Alternatives such as solar home systems (SHS) used by many households for domestic needs provide only a fraction of the power needed for electric motorcycle battery recharging. The generation of on-site solar PV electricity and recharging of batteries at distributed recharging stations provides a necessary and viable solution. However, this solution requires substantial investment in a network of battery-swap stations, the absence of which is ultimately deterring investment into the electric motorcycle sector.

3. High-quality batteries should be made available to low-volume African buyers

Lastly, to compete with ICE counterparts, electric motorcycles must deliver reliable range and performance. But high-quality batteries from overseas suppliers are argely only available to large global buyers, who prioritise volume buyers, creating an obvious barrier among startups in sub-Saharan Africa. As a result, lower-quality batteries are often used, which fail to deliver on their stated performance, preventing electric mobility companies from making profits since batteries require extensive investment.

Recommendation: an ecosystem solution is required for successful electric motorcycle scale-up

Addressing each of the challenges mentioned previously requires diverse resources and capacities and it's unlikely that this could be delivered by any single company. Looking ahead, an ecosystem solution is already starting to emerge in SSA. Each of the three PREO-funded companies showcased in this report focuses on different stages of the ecosystem, yet are united in their ultimate objective of scaling electric mobility solutions in sub-Saharan Africa.



- Roam (previously Opibus) is a domestic manufacturer of electric motorcycles with a goal to "electrify Africa one vehicle at a time".
- Zembo intends to build, own and operate reliable pan-national charging networks in Uganda, regionally expanding to other African countries.
- Mobile Power wants to bring high-quality battery technology and affordable battery management solutions to the market.


ROAM

Roam: manufacturing electric motorcycles in Africa for Africa

About Roam

Roam, formerly known as Opibus, is a Swedish-Kenyan company founded in 2017 by Filip Lövström and Mikael Gånge, with a mission to implement electric mobility in emerging markets. Initially it began as a research project at one of Sweden's top technical universities before transforming into an electric mobility company. Roam settled in Kenya given the country's steady rise as one of sub-Saharan Africa's fastest-growing nations, especially in relation to electric mobility adoption. Kenya's growing used-vehicle import market[5] also provides a basis for electric conversions, which was the focus in Roam's inception years.

Over the years, Roam has evolved to provide tailored solutions to meet market demand through business segments that today include:

- Roam Air, a tailored electric motorcycle for Africa.
- Roam Transit, a segment focused on manufacturing public transport solutions such as electric buses.
- Roam Energy & Charging distributes off-the-shelf energy products.
- Roam Canopy provides tailored software applications to fleet owners, business operators, financiers and others.

Roam's business model

In 2019, Roam's market research revealed a lack of reliable, high-quality and environmentally friendly transportation means for African commuters. It established that an affordable transportation alternative to the fossil fuel-powered vehicles can be provided by achieving end-user savings from lower operational and maintenance cost of the motorcycles. With these inputs and extensive product market analysis, Roam decided to design and manufacture its own electric motorcycles locally in Kenya.

Roam is now one of the leading electric motorcycle manufacturers in Kenya with sales exceeding 200 units. Roam's business model is selling electric motorcycles to asset financiers, energy companies and other enterprises in logistics and transportation. The company sells electric motorcycles at almost price parity with the ICE equivalent. By selling electric motorcycles on an upfront cash basis to businesses, Roam passes on the asset financing requirement and where possible, operating the charging infrastructure to its network partners. Most recently, Roam partnered with MKOPA, an African asset financing platform, signing a supply agreement that will see mass deployment of electric motorcycles financed through the MKOPA platform using a pay-as-you-go model.

[5] Mordor Intelligence: the African motorcycle market was valued at US$3.65 billion in 2021 and is expected to reach US$5.07 billion by 2027[1].
[1] https://www.mordorintelligence.com/industry-reports/africa-two-wheeler-market

Roam is also partnering with mini-grid companies that can finance and provide charging infrastructure to acquire rural customers. This is an attractive proposition for mini-grid developers as electric mobility could potentially increase demand at their sites, acting as anchor clients. Consequently, Roam has partnered with Powerhive, a mini-grid developer with existing sites in Kenya.

Local manufacturing and assembly: the key to Roam Air's growth

According to Roam, manufacturing and local assembly is key to reducing the final price of electric motorcycles while also allowing for product customisation to meet local market needs. In addition, Roam's ambition is to build all the hardware and software infrastructure which other key players in the industry can utilise. This is comparable with Gogoro's "hardware as a service" model.[6] In this model, they sell underlying hardware such as bike components and kit parts to original equipment manufacturers (OEMs) which greatly increases interoperability within the battery-swapping network.

Roam currently has the capacity to design 100% and manufacture 35% of its electric motorcycle in-house. It has an ambitious goal to manufacture and assemble as much as 70% of the motorcycle locally over the next 3-5 years. Its next-generation electric motorcycles will even include proprietary frames, a first of its kind in Africa.

Roam has prioritised components where local manufacturing capacity already exists, e.g. injection moulding, welding, metal bending and sub-assemblies. Roam is collaborating with 10 local suppliers that currently manufacture ICE motorcycle parts to help them transition to electric motorcycle manufacturing. Since some components such as battery cells and base components (resistors and converters) require high production standards and capital expenditure to set up locally, these will still have to be procured internationally.

Besides scaling locally, Roam has plans to expand beyond Kenya to other African markets through strategic partnerships. One such partnership is to supply Uber[7] with 3,000 electric bikes for its delivery services. Through this partnership, Roam will strategically position itself to scale across Uber's geographical reach, including Ghana, Nigeria, Ivory Coast, Tanzania, Uganda and South Africa.

[6] Refer to case study – Understanding the role of partnerships in progressing electric mobility start-ups in Africa
[7] https://www.roammotors.com/post/uber-partnering-with-opibus-to-scale-the-use-of-electric-motorcycles-in-africa

Accessing high-quality batteries, building local technical capacity and accessing scalable capital are key growth challenges

One of the most recent challenges has been faulty batteries, which led to a delay in the delivery of electric motorcycles. The batteries were depleted on arrival and inspection revealed that the internal wiring did not meet specifications. For safety purposes, the batteries had to be returned to China for redesign and testing before they could be used locally for the bikes. An in-depth quality control framework will be implemented in China to mitigate the above-mentioned risks, ensuring reliable batteries of high quality.

Scaling an electric motorcycle manufacturing business can be costly due to the large CAPEX needed to set up manufacturing infrastructure and the working capital to build inventory. The sale of EVs and maintenance of supporting infrastructure require substantial investments. Roam is looking to raise US$17.5 million in equity and debt for working capital as part of its Series A funding round to reach its 2024 operational targets.

From Roam's experience, there is a lack of local labour and specialist experience in the electric mobility sector. There is a need to upskill the existing workforce of engineers and technicians to meet the future demands of the sector, e.g. in design, manufacturing, operations and maintenance. To increase its own capacity, Roam staff receive on-the-job training and, in some instances, experienced specialists are brought in for specific assignments to bridge the skills gap.

Zembo

Zembo: building a pan-national battery-swap network through solar PV

Zembo, founded by Etienne Saint-Sernin and Daniel Dreher in 2018, is a startup selling electric *boda bodas* (motorcycle taxis) across Uganda. Drivers swap discharged batteries for fully charged batteries at one of 27 battery-swap stations operated by Zembo and pay for the energy consumed. Zembo has since expanded to 30 employees, spread across Lyon, France and Kampala, Uganda. The team has employed an additional 45 employees across its battery-swap stations who work as "battery swappers".

Uganda has an estimated 700,000[8] motorcycle taxis and a green grid: 90% of Uganda's national electricity generation is from hydropower. Uganda also does not subsidise the fossil fuel industry, which means high end-user prices allow the electric mobility market to be competitive. Leveraging this opportunity, Zembo aims to build, own and operate the nation's largest swapping network while selling electric motorcycles.

[8] Indicative estimates only

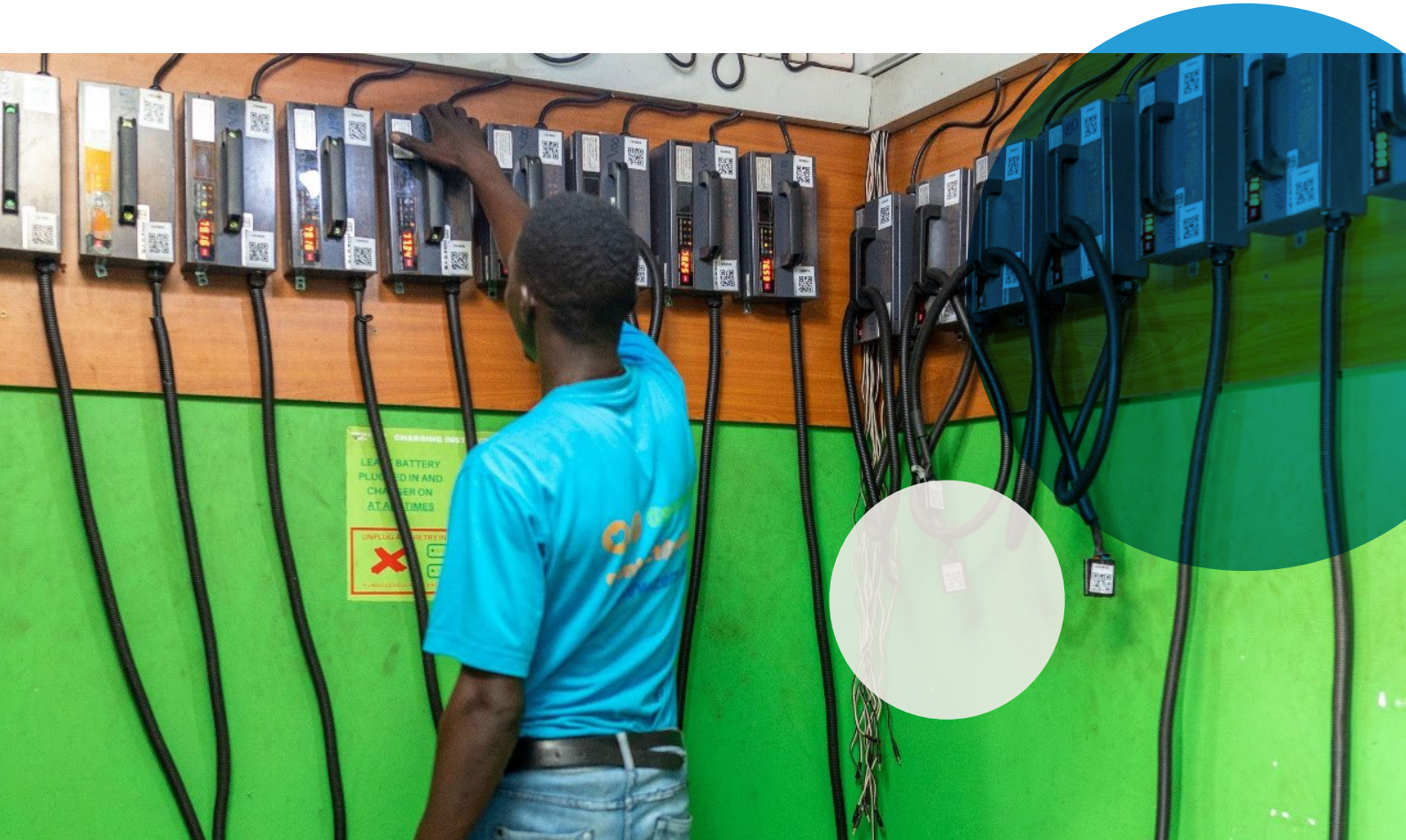
Zembo's business model

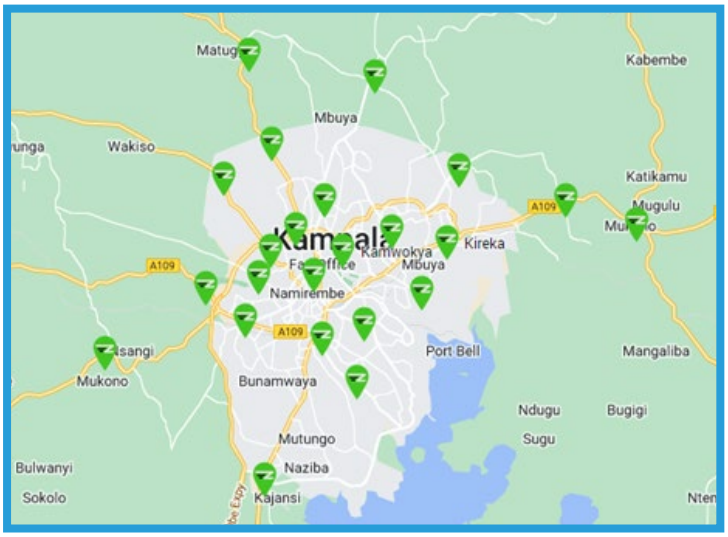
Zembo sells electric motorcycles on a pay-as-you-go basis to *boda boda* drivers and provides battery-as-a-service (BaaS) through a network of battery-swap stations. Zembo's target customers are *boda boda* drivers, as the battery-swap model ensures higher savings for those who use the motorcycle more intensely – as well as higher revenues for Zembo's swap stations. According to an environmental and social impact assessment by Zembo, regular Zembo drivers earn up to an additional US$7 per week, 50% more compared to ICE motorcycle taxis.

Zembo's battery-swap service is the infrastructure needed to make electric mobility a viable transport alternative in Uganda. At a battery-swap station, a driver pulls up and removes the battery for the swapper to scan the QR code on the outside. The swapper then selects a charged battery from the station and scans it before placing it in the driver's motorcycle. With the batteries identified, the difference in energy levels is then calculated and drivers are charged for the energy. The swap is done in just two minutes, making it as convenient as topping up fuel at a gas station.

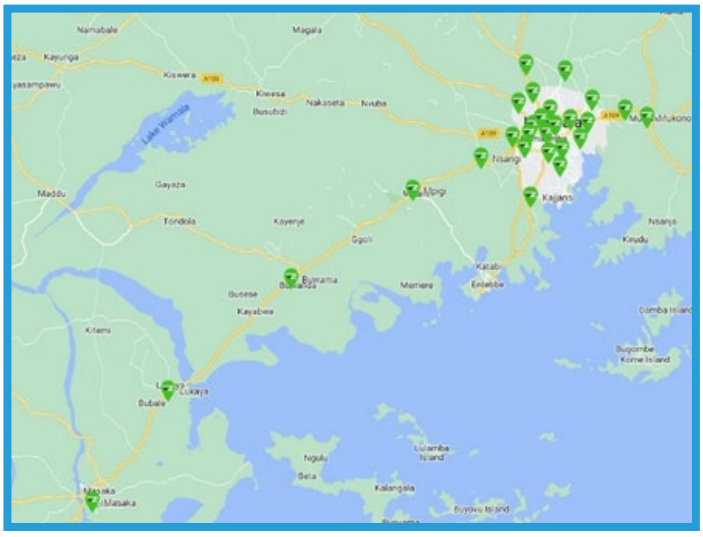
Zembo's bet on charging infrastructure to grow electric mobility

Zembo's core scale-up strategy involves building and owning a pan-national network of swapping stations, providing charging as a service to Zembo drivers and to drivers of other electric mobility companies. The 27 charging stations comprise 20 on-grid stations, three solar-hybrid stations and four off-grid stations. Zembo is rapidly expanding the lower-cost on-grid stations while implementing hybrid stations in areas with particularly high demand. Solar-powered off-grid charging stations are placed in areas without grid access. Zembo aims to complete a nationwide network of recharge stations, including off-grid areas, beginning by connecting major urban areas with roadside stations.





Zembo swap stations in Kampala



Zembo swap stations including Masaka

Urban hybrid stations combine the advantages of two power sources: the grid is generally available during the night while solar can bring down electricity costs and compensate for power cuts during the day. Implementing swap stations with solar in off-grid areas is challenging because of the need to provide recharged batteries at all hours and in all weather conditions. This means stations must either provide less service during sunless hours or scale both solar panels and energy storage, which is CAPEX-intensive.

A PREO scenario analysis[9] modelled with 500 electric motorcycles swapping at the existing 27 stations found that off-grid stations and hybrid stations are more profitable at operational level than the on-grid stations. This is due to the high unit cost of grid electricity (US$0.21/kwh) and fixed staff cost for the swappers, which is 55% of direct costs involved in operating a swap station.

To improve swap station unit economics, Zembo is testing out two innovations: franchising swap stations and using battery-swap cabinets.

Franchising swap stations would allow Zembo to eliminate labour and rental costs and instead negotiate directly with franchisees over revenue sharing. Battery-swap cabinets can take these savings a step further by reducing battery storage space from several shelves to a standalone cabinet. This would allow them to be placed in commercial establishments instead of requiring a dedicated storefront. It would also automate swaps after initial manned operations, creating a smoother experience for drivers and considerably reducing labour costs. Zembo is exploring partnerships with agent networks such as Copia by offering the opportunity to provide extra income to independent shop owners with a franchise model.

Zembo plans to expand its motorcycle fleet to more than 2,000 motorcycles and 60 swap stations by 2025. This will include 30 on-grid, 20 hybrid and 10 off-grid stations, to provide dense coverage within Kampala and routes between cities, and on the periphery.

Increasing the batteries deployed to overcome battery quality challenges results in higher capital intensity

The main challenge faced by Zembo is battery quality. Capacity of its existing batteries is decreasing faster than expected, leading to a shorter range per battery, which causes inconvenience for drivers. More than half of its

[9] Refer to Annex for complete analysis

batteries in operation are severely impacted, particularly the earlier battery batches. Zembo has retired the first batch of batteries and is using three sequential batches on the road: BH3, BH4 and BH5. After using a BH5, a driver is charged the full amount for a full charge. BH4 and BH3 battery swaps are priced with 10% and 20% discounts respectively, reflecting the reduction in battery capacity faced by the earlier batches.

To overcome the above hurdle, Zembo has increased the numbers of batteries available on its network, shifting from a 145% battery-to-vehicle ratio to 226%. Zembo is further mitigating these battery challenges by sourcing batteries from different suppliers from India and China, and has brought in an initial batch of batteries from Aceleron, a recyclable Li-On battery assembler in Kenya. But increasing the battery-to-vehicle ratio has also resulted in higher capital intensity and a delayed payback period on storage assets.

Fostering public and private partnerships to bolster growth

Zembo raised US$3.4 million at the end of 2021[10] from Mobility 54 Investment SAS – a corporate venture capital subsidiary of Toyota Tsusho Corporation and CFAO group – DOB Equity and InfraCo Africa to scale its operations in Africa. Zembo is now testing out operational partnerships that can help drive further growth and improve unit economics.

One of Zembo's key partnerships is with Untapped[11], a financier of income-generating smart assets that generate data about the asset use and income generation. Untapped purchases the loan asset through a revenue-share model, in which the monthly repayment from the borrower is shared with the productive-use company. The partnership helps remove motorcycle loan assets from Zembo's books and allows Zembo to focus on its core product of battery-swap stations. So far, Untapped has bought 83 motorcycle loans from Zembo.

Zembo is also engaging with public sector building agencies such as Uganda's Ministry of Science, Technology & Innovation to build policy, and is pushing for attractive electricity rates for electric mobility. To create demonstration effects, Zembo has sold motorcycles to Kampala Capital City Authority, which will also open a swap station in Mengo Hill.

Combining operational partnerships such as with Untapped with using franchised battery-swap cabinets can significantly improve the unit economics for Zembo's battery-swapping network. This would support Zembo drivers by keeping swapping costs low and paving a smoother road for all to electric mobility transition in Uganda.

"There's no oil, no fumes: when I'm stuck in traffic with all the black fumes, I think that everybody should go electric." – Ivan Kasule, Zembo *boda boda* driver

[10] https://infracoafrica.com/infraco-africa-dob-equity-and-mobility-54-announce-investment-to-scale-zembos-vision-for-electric-mobility-in-uganda/
[11] https://untapped-global.com/

mobile power

Mobile Power: high-quality storage solutions for an Africa on the move

About Mobile Power

Mobile Power was founded in 2013 with a vision to provide energy and mobility solutions to residential and commercial consumers across sub-Saharan Africa. To achieve its objectives, Mobile Power developed clean energy storage products (lithium-ion batteries) and rented them out rather than, like most energy access companies, selling solar home systems on payment plans. Since piloting its rental model for energy access in 2017, Mobile Power has grown to clocking over 500,000 rentals every month and is gaining 2,000 new customers every week at its peak growth rates. Mobile Power has set up operations in Sierra Leone, Liberia, DRC and Nigeria.

Mobile Power has been perfecting its rental model for provision of electricity over the last nine years. This innovative model does not require credit checks, deposits or contractual monthly or daily payment obligations from customers, and allows households to purchase the electricity they need by renting batteries on a need basis. Mobile Power made this model work by developing three key technology components:[12]

- MOPO batteries store and transport energy.
- MOPO hubs charge the batteries and house the agent operations.
- MOPO platform tracks the batteries through the sales cycle and manages agent activities.

Inspired by the success of the rental model in energy access, Mobile Power is now replicating its model in the mobility sector and generator replacement sector by leveraging the same technology components.

MOPO hubs

MOPO hubs are solar-powered charging stations used to collect discharged batteries, store the batteries securely and charge them. Each MOPO hub creates four full-time jobs (50% local women and 50% men) and has the capacity to charge 300 MOPO 50 batteries.

[12] Refer to Annex for a brief on the key technology components

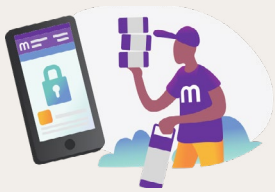
Mobile Power's business model

MOPO smartly layers its electric mobility business model over energy access infrastructure

MOPO Max batteries

MOPO's electric motorcycles are powered by MOPO Max batteries that use similar tech architecture to energy access batteries

MOPO platform



Mobile Power leverages the MOPO platform built for energy access to enable pay-per-use battery sharing for electric mobility

E-mobility business model

MOPO hub

MOPO charging stations for energy access are upgraded to charge larger MOPO Max batteries used in electric motorcycles

By layering the electric mobility model over the energy access business, Mobile Power is uniquely achieving several key synergies:

- **Minimising technology investments.** Without its energy access business, Mobile Power would have to build a network of charging stations, invest in developing a battery management system and build software backend platforms. These are time-consuming and expensive processes. Mobile Power estimates it has leveraged technology assets worth US$50 million[13], which it would have otherwise incurred for its electric mobility vertical.

- **Minimising OPEX for swapping network.** Operating a swapping network is plagued with high CAPEX costs, high fixed costs such as rental and staff salaries, and operational challenges such as theft and revenue pilferage. Electric mobility companies are exploring franchise models and automatic swapping cabinets as solutions to address these challenges. In the case of Mobile Power, the demand to charge batteries for electricity access is expected to improve the utilisation rate of the hubs by 200%, enabling Mobile Power to recoup investments faster and spread payroll expense across verticals.

- **Maximising return on storage investments.** Batteries used for electric mobility use cases have high upfront costs (typically the same as the electric motorcycle) and a lower life cycle, resulting in reduced range for older batteries. Mobile Power is able to provide meaningful second-life use cases by deploying the electric mobility batteries in its energy business for generator replacement.

[13] Estimated value of proprietary technology by Mobile Power

Mobile Power is betting on batteries in the electric mobility sector

Electric mobility companies providing solutions to commercial consumers such as fleet management companies and *boda boda* drivers are growing at a fast pace in Africa. Yet the majority of electric mobility companies have fewer than 500 electric motorcycles on the road, indicating the nascency of the sector in Africa.

The most critical challenge facing early-stage and larger companies alike is their inability to access high-quality battery technology. The batteries accessible to African electric mobility companies are observed to discharge more rapidly than they should, causing them to reach their end of life much sooner than the rated number of life cycles. Establishing relationships with high-quality suppliers willing to supply smaller orders under a thousand units has proven difficult.

Mobile Power has invested thousands of lab hours, millions of dollars in R&D efforts as well as thousands of rounds of field testing in developing its batteries for all its use cases, including electric mobility. The company is working on its fourth iteration of electric mobility batteries, which are ready for mass production. Mobile Power's UK-based R&D team and partnerships with research institutions[14] have supported these developments. It has now reached a stage whereby it can manufacture batteries at scale for its in-house use and satisfy the demand of its electric mobility peers.

What does the scale-up opportunity for Mobile Power look like?

Partnership with asset financiers

There is an increasing appetite among alternative lenders and asset financiers to finance electric motorcycles. These digital lending platforms have developed alternative credit appraisal methodologies[15] such as using cash-flow data from a mobile money account or references from local gatekeepers in the community. By basing the decision on alternative data and moving away from a hard paper trail, the asset financiers can disburse loans faster – as quickly as two hours – and reach unbanked populations more easily.

These asset financiers underwrite thousands of two-wheeler loans every month and seek to work with electric mobility companies such as Mobile Power for the following reasons:

- Electric motorcycles incur significantly lower fuel costs and maintenance expenses, which creates significant cost savings when compared to ICE bikes. This means that a *boda boda* driver using an electric motorcycle has more flexibility and earnings to repay the financier than an ICE bike driver.
- Though both electric motorcycles and ICE bikes are financed with the bike being hypothecated, the electric option disincentivises fraud since the MOPO Max battery can only be used with MOPO electric motorcycles. This is expected to result in lower defaults for asset financiers. Mobile Power can also track where an electric motorcycle is located using the vehicle's GPS tracking device.
- *Boda boda* drivers make digital payments to Mobile Power every day for swapping batteries. Each recharge can include a small amount of the loan being repaid to the asset financier. This way, the financier can get repaid multiple times every day, resulting in a steady and faster repayment.

[14] The University of Sheffield, a public research university in UK with more than 20 years of research experience in understanding cell chemistries, has supported Mobile Power in conducting cycle life tests in a controlled lab environment, analysing performance data from the lab and the field, and finding the root cause behind failures to inform the progressive iterations

[15] The borrower will be required to pay a downpayment of 20%, furnish a reference letter from the applicant's local government chairperson or *boda boda* stage chairperson, and provide two guarantors who are willing to guarantee the loans.

Partnership with electric mobility companies

Mobile Power has received inquiries from electric mobility startups that have several import options for the hardware (electric motorcycle) but are struggling to access high-quality batteries. Mobile Power intends to sell its swappable-battery system through an upfront cash sale B2B model, in which Mobile Power will sell the batteries for a cash price and will license the use of its technology platform.

Achieving growth by developing products for mass production comes with unique challenges

- In Sierra Leone, *boda boda* drivers often have difficulty with regulators, leading to frequent business disruption and even seizure of electric motorcycles by law enforcement authorities. Raising awareness among the local communities and law enforcement authorities about the profession that *boda boda* drivers engage in is one of Mobile Power's key objectives that will unlock growth.
- Mobile Power believes that its MOPO Max batteries for the electric mobility use case are ready for mass production and has been testing them through 35 electric motorcycles on a rental model in Sierra Leone. However, any incremental progress leading to manufacturing in large volumes can be slowed if Mobile Power decides to iterate its technology further.
- Mobile Power is planning a £10 million Series B equity raise in 2023 matched by a similar amount in debt. This will be used to further scale all its services, including electric mobility. While early-stage equity investments are already happening in the electric mobility sector, growth-stage equity and debt capital are generally poorly available.

Key learnings

Key learnings for the e-mobility sector

Roam, Zembo and Mobile Power have all taken unique routes to bringing electric motorcycles to the local transport market across sub-Saharan Africa. Each has focused on a specific value chain opportunity, faced challenges integral to the value chain and is building different solutions: Roam identified the need to offer bespoke mobility solutions to African riders and is working on building local capacity to manufacture electric motorcycles; Zembo is surmounting the steep unit economics challenge of operating battery-swap stations and is trimming the model through adoption of renewable energy and automation; and Mobile Power's promising battery management offering appeals to electric mobility companies struggling to access high-quality storage solutions.

Collectively their experience offers seven key learningsz for investors, companies and stakeholders looking to understand, support and engage with this exciting industry.

1. The time is now

With tens of millions of motorcycles across the continent and thousands more sold daily, the potential market for e-mobility is signficant.. On the supply side, the cost of lithium-ion batteries and electric vehicles has plunged drastically over the past decade, bringing vehicles closer to price parity. High petrol prices and the global cost of living crisis are pushing many to try out EV models as a means of saving on daily expenses.

2. Partnerships are key

For electric mobility companies to successfully penetrate new markets, they must provide adequate battery-swapping services and infrastructure as well as ongoing vehicle maintenance. Although there are some pros to minimising the reliance on outside entities to operate, vertically integrated companies face the burden of handling several business streams, which can be both CAPEX-intensive and logistically difficult. Partnerships are therefore critical to ensure that companies do not drown under the weight of their commitments.

3. Source realistically to build manufacturing capacity

The lack of purpose-built electric motorcycles for African markets is what created potential for Roam to begin to build its own. While it has made an exciting product, the initial promise of manufacturing in Africa has been delayed. A stronger bet would be to partner with OEMs, who have shown themselves to be paying close attention to the market, and to ensure high compatibility for spare parts with market-dominant ICE models. The value chain can then be brought to the continent piece by piece, e.g. battery assembly or ICE-compatible parts like headlights.

4. Ensure battery longevity to win in the battery-swapping game

For battery swapping to work, the batteries must last as long as intended to recoup their cost. Battery longevity can be improved with higher-quality batteries that have longer life cycles and can endure intensive usage. Close maintenance would also benefit the longevity of the batteries. In some cases, batteries may need to be correctly sized so that motors are not drawing too much power from them. Whatever path companies choose to care for their batteries, this is the rock on which electric mobility rests.

5. Plan for second-life application of batteries

Even with long-life batteries, there will be a need to move them on to other applications to reduce environmental waste. This can be done after their depth of discharge has dropped to 80-90% of their original capacity. There are many potential applications, including solar PV installations for homes or mini-grids, telecom towers, or back-up energy storage. However, as used batteries are in short supply and companies are busy focusing on their core businesses, there has been little development of a used-battery supply chain. This is an opportunity for experienced battery firms to step in and work with whole markets to provide a channel to second-life uses.

6. Partner with asset financing companies to remove CAPEX

Electric mobility startups have several business streams to run because of being vertically integrated, and vehicle CAPEX is one of the top capital destinations. Removing these from their logbooks, by having asset financing partners buy out their loans, is a key means of reducing CAPEX commitments and freeing up funds to support battery-swap stations, maintenance and staff.

7. Engage with government regulators

While the policy landscape looks different across Africa, there is very little in the way of regulations, standards, or supportive policy. At best, this lack of policy leaves an open field for companies to try innovative new business models. At worst, it hampers attempts to roll out clean mobility. Electric mobility companies can improve this by actively engaging with relevant government bodies, on their own or through associations, to improve understanding of the potential benefits of electric mobility and the means to support the industry.

Annex

About Roam Air

Roam recently launched Roam Air, its second-generation electric motorcycle that has the following main features:

- A digital dashboard.
- Dual lithium-ion batteries.
- A larger electric motor.

The digital display shows the driver all vital information about the vehicle, including speed and battery capacity. Lithium-ion batteries are preferred for electric mobility compared to lead-acid batteries because of their deeper depth of discharge and higher life cycles.

Technical specifications:

- Power: 8,650W
- Torque: 185Nm
- Top speed: 90km/h
- Acceleration: 0-90km/h, 5 sec
- Range (dual battery): 200km
- Battery capacity: 2x2.9kWh
- Payload: 200kg

These second-generation electric motorcycles will be priced at US$1,550 at mass production – the same price point as an ICE bike. They will first be deployed in urban and peri-urban areas around Nairobi where several charging points will be installed. Roam is working with reliable partners who will focus on developing and deploying the charging infrastructure.

A Roam Air can be charged at any outlet where a mobile phone can be charged, breaking the infrastructure barrier for mass market deployment. The configuration to use dual battery is designed for many different use cases and business models, which allows the user to charge at home, swap out or charge at a public station.

Zembo's loan-and-swap service offering to boda boda drivers

To purchase a Zembo motorcycle, drivers must provide a valid driving licence and a downpayment of 400,000 UGX (US$108) before being vetted. The drivers then make weekly loan payments of 70,000 UGX (US$19), which is under or on par with the most common payment plans for the ICE market favourite Bajaj Boxer.

As the battery costs are nearly the same as the motorcycle itself, it would double the asset cost and loan amount for drivers if it were sold with the motorcycle. Zembo shifts the burden of this cost off drivers by retaining ownership of the battery. This allows Zembo to lower the upfront cost, maintain the batteries for longevity, and provide rapid swapping services. Zembo then pays off the battery (CAPEX) through battery swaps. The range of a fully charged battery is roughly 60km, though it varies with driving habits and topography. As of mid-2022, Zembo had around 200 electric motorcycles on the road.

In case of a default on loan repayment, the first step is usually to lock the driver's ID, preventing the driver from being able to do any more swaps. If the driver's loan is overdue by more than four weeks, Zembo recovers the bike with the help of a GPS tracker fitted in all the bikes. After full payment of the loan, entire ownership is transferred to the *boda boda* driver. At this point, warranty for the parts expires as the warranty coverage provided is initially for the loan tenure only – but the driver can still access aftersales service and battery swaps.

> **"The Zembo bike has less cost when it comes to quality repair, maintenance and servicing ... so all that money is saved. I've been with this bike for more than two years. If it was a fuel bike it would be taking a lot of money to service the engine, but with the Zembo bike it is serviced for free" – James Kalungi, *boda boda* driver**

Two years after starting out with seven swap stations in the first year of operations, Zembo now has 27 swap stations in the Greater Kampala Metropolitan Area and all the way to Masaka, a town 130km southwest of Kampala. There are three types of charging stations: full grid, hybrid (grid and solar) and full solar (three stations along the Masaka corridor). Across all stations, a swap for 100% state of charge costs UGX 5,000 (US$1.30), providing 2.4kWh of electricity. The charging stations only accept mobile payments; the price varies based on the quality of the battery batch.

Zembo's 2023 scenario with 500 motorcycles

	On-grid only	Grid-solar hybrid	Off-grid station
CAPEX per station (incl. battery) (USD)	25,400	58,500	45,400
# of operational stations	20	3	4
Solar capacity per station (kWp)	**0**	**10**	**15**
Storage capacity per station (kWh)	**0**	**0**	**5**
# of batteries per station	**32**	**65**	**32**
# of swappers per station	**2**	**2**	**2**
# of swaps per month	**1,210**	**2,419**	**1,210**
Revenue per swap (UGX)	**2,478**	**2,478**	**2,478**
Total revenue station/month (UGX)	**2,997,581**	**5,995,161**	**2,997,581**
Salary to swappers (UGX/month)	**1,200,000**	**1,200,000**	**1,200,000**
Grid electricity cost, when applicable (UGX/month)	**1,360,887**	**1,596,774**	**0**
Rental expense (UGX/month)	**400,000**	**400,000**	**250,000**
Other operational expenses (UGX/month)	**150,000**	**150,000**	**150,000**
Total operational expenses (UGX month)	**3,110,887**	**3,346,774**	**1,600,000**
Operational profit (or loss)/month (UGX/month)	**-113,000**	**2,648,000**	**1,398,000**

mobile power

Understanding the MOPO rental model and the infrastructure that makes it work

Three components are needed to make the rental model work: MOPO batteries, MOPO hubs and Mobile Power's software platform.

MOPO batteries

Mobile Power initially developed MOPO 50 batteries with 50Wh storage capacity and four USB outputs, 2x70W outputs and a 500-lumen light built in. A MOPO 50 battery can charge 10-15 mobile phones or run the light for 24 hours.

Following the MOPO 50 for household use, Mobile Power built the MOPO Max with a capacity of 1,000Wh (1kWh), enough energy to power electric motorcycles. The MOPO Max is a multipurpose battery that is used to power MOPO EVs for its first life and is then used for generator replacement for its second life. This planned use of the battery means that the daily rental price point is cheaper than using fossil fuels as the CAPEX price and returns can be spread across both the first and second life of the battery.

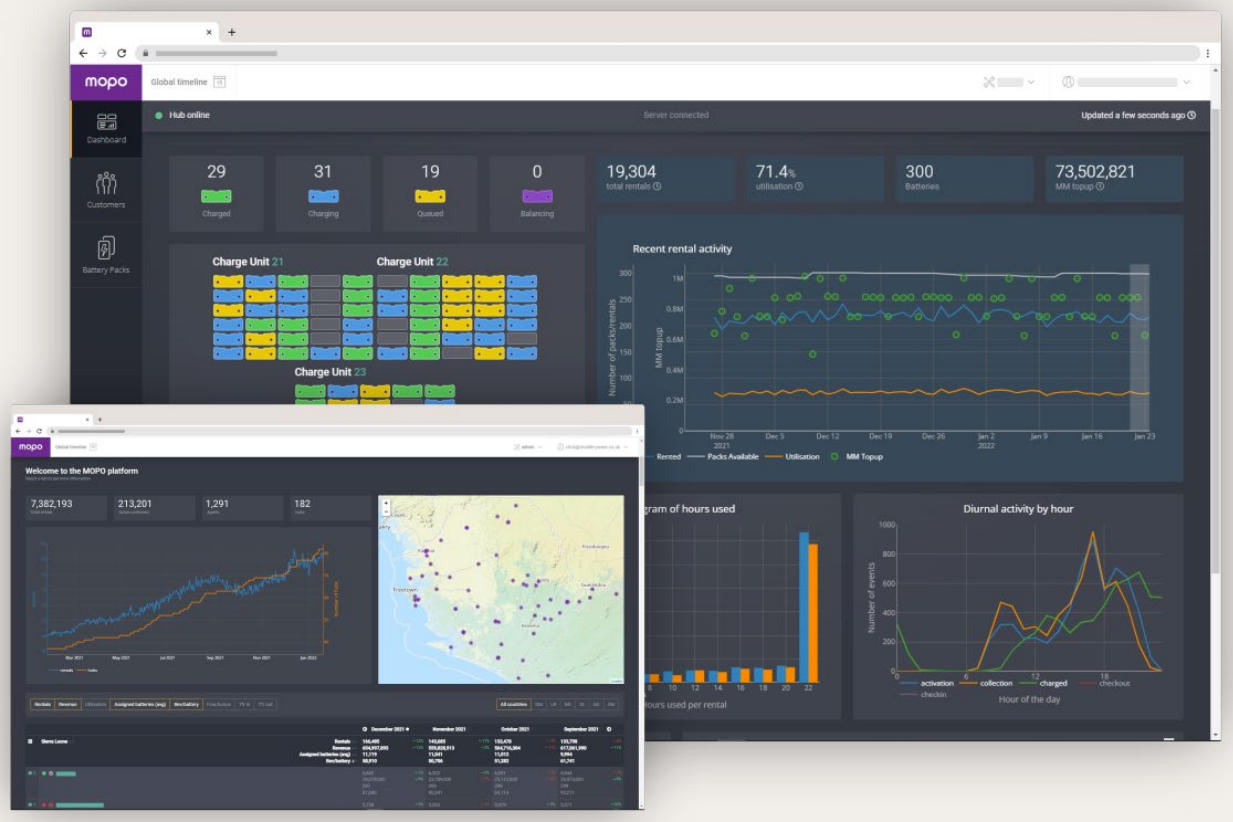
MOPO 50 and MOPO Max batteries.

MOPO hubs

xisting MOPO hubs are being updated to charge the larger MOPO Max batteries used for both generator replacement services and electric mobility. This is done by expanding the generation capacity or by reducing the number of MOPO 50 batteries charged. The MOPO Max batteries, however, will require their own charging units.

As of August 2022, Mobile Power is carrying out 500,000 rentals a month, gaining 2,000 new customers every week and employing a new agent almost every day. Mobile Power has demonstrated that the rental infrastructure it has built is modular and scalable such that it can support rapid growth.

MOPO software platform



The MOPO software platform enables MOPO batteries to be tracked through the entire rental cycle. MOPO agents rent charged MOPO batteries to customers directly from the MOPO hub or transport them to nearby areas, typically less than 10km from the MOPO hub, where they can be rented to customers.

The agents purchase activation credits that are loaded onto their near-field communication (NFC) wristbands, a short-range wireless technology enabling quick transfer of information between devices, creating a MOPO wallet. Agents are then able to rent out the MOPO batteries, even in areas without mobile network coverage. The agent activates the battery using NFC and the entire transaction is tracked using patented offline Internet of Things technology.

The MOPO platform is built so that it can support a range of use cases, such as electric mobility.

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