Integrating Electric 2&3Wheelers into Existing Urban Transport Modes in Developing and Transitional Countries

August 2023

KENYA

INTRODUCTION

MARKET OVERVIEW

The transport sector is the largest consumer of petroleum products in Kenya and thus is a major contributor to Greenhouse Gas (GHG) emissions. In 2019, total domestic transport sector emissions in Kenya amounted to 12.343 MtCO2e, an increase of about 4.6 MtCO2e from 2010. Given Kenya's target of reducing 3.46 MtCO$_2$e emissions by 2030 against a 21 MtCO$_2$e baseline as set in the Nationally Determined Contribution (NDC), mitigation actions for the transport sector are included in the National Climate Change Action Plan (NCCAP 2018-2022).

Two & three-wheelers are Kenya's fastest growing vehicle segment with a 46% share of all annual registrations (see Figure 1). Due to the aggressive growth in this segment, internal combustion (ICE) two & three-wheelers are contributing significantly to air pollution and GHG emissions. The number of newly registered motorcycles rose by 15.6% from 246,705 units in 2020 to 285,203 units in 2021 (see Table 1). Newly registered three-wheelers also increased by 7.7% to 6,350 units over the same period.

The motorcycle segment is Kenya's largest vehicle segment (see Table 2). The high growth rates of motorcycles can be explained by their affordability, retailing at between KES 65,000 and KES 130,000, enabling many youths to acquire them for business. 99.9% of sales are concentrated in the 100-150cc segment with the most common brands being Honda, Bajaj, TVS, Yamaha as well as a myriad of low-cost Chinese brands like Skygo and Captain.

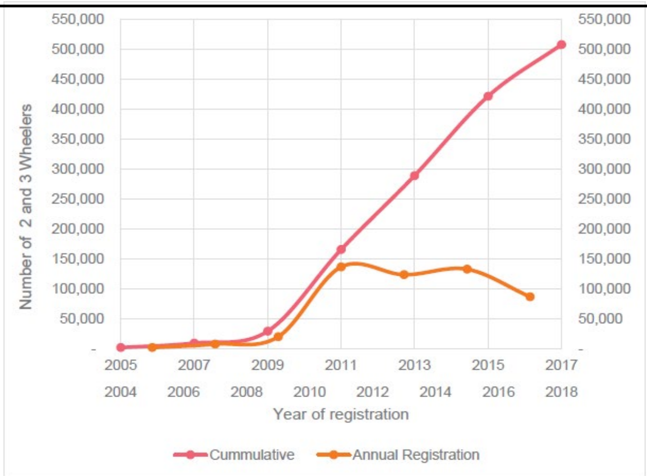


Figure 1: Annual and Cumulative Two and Three Wheelers Registration

Motorcycle Registrations in Kenya over the last 6 years						
Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Motorcycles Registered	119,724	186,434	188,994	210,103	246,705	285,203

Table 1: Source: KNBS 2022 Economic Survey

Type of motor vehicle	2020	2021	Change
Motorcycles	246,705	285,203	15.6%
Station Wagons	57,962	64,350	11%
Panel Vans & Pickups	6,065	5,986	-1.3%
Saloon Cars	7,754	8,170	5.4%
3-Wheelers	5,896	6,350	7.7%
Lorries/Trucks	6,476	7,071	9.2%
Minibus/Matatu	1,084	822	-24.1%
Buses & Coaches	900	893	-0.8%

Table 2: Source: KNBS 2022 Economic Survey

The motorcycle taxi industry is a vital segment of Kenya’s economy. An estimated over 1 million motorcycle taxis called *Boda bodas* collect Sh980 million daily (Approx. $9.2 million) and the sector’s annual earnings are estimated at 357 billion shillings ($3.3 billion). On the other hand, there are negative societal impacts - hospital morbidity statistics in Kenya show that injuries from motorcycle crashes account for 2%–3% of all hospital visits, 22%–64% of trauma admissions, and 50%–52% of surgical interventions. Also, boda-boda drivers, usually young men, have a reputation for breaking traffic laws and attacking motorists in accidents.

KENYAS GROWING E-MOBILITY ECOSYSTEM

Almost no electric two and three-wheelers were on the market at the start of the project in 2018. Today, according to the National Transport and Safety Authority (NTSA), 1,350 electric vehicles (EVs) are registered in Kenya. Motorcycles take up almost half the share at 844, three-wheelers stand at 153, and motor vehicles (Saloons-5, Station Wagons-167, double cabins-3, vans-5, buses-3, lorries-3) at 186. The remaining classified as “other” vehicle categories are 150.

Kenya now also has a growing electric mobility start-up ecosystem with about 20 e-mobility companies of which the majority fall under the two and three-wheeler segments. 86% of the surveyed companies have been in operation for less than 5 years, indicating that most companies are in their early stages. The newly formed Kenya E-mobility Association (EMAK) supports the development of the local e-mobility industry.

This growth has is expected to continue due to recently established government incentives for EVs. The 2023 Kenya budget includes various waivers on import excises and value-added tax for electric vehicles and its required components. In addition, a differentiated tariff for EV charging has been adopted. The measures contained in the Finance Act show the government’s commitment to e-mobility and are expected to further incentivize the local production of EVs and their respective components and spare parts. A Government task force on e-mobility has also been established to develop a comprehensive National E-Mobility Policy, Strategy and guidelines for the industry to develop.

Kenya’s energy sector is well set up to support the growth in e-mobility with renewables providing 92.3% of Kenya’s electricity generation in 2020. Presently, Kenya has an installed capacity of 3,321MW against a peak demand of 2,149MW, dropping to about 1,100MW at night. The Kenya Power and Lighting Company (KPLC) is confident that Nairobi’s power grid is strong enough to support the city's switch to 100% electric two-wheelers.

E 2&3 WHEELERS TARGET AND POLICY

Kenya has several legal and regulatory frameworks that are supportive of a sustainable transport future including the Constitution (2010), the National Climate Change Action Plan (2018-2022), the Finance Bill 2019 and 2023, the Kenya National Energy Efficiency and Conservation Strategy (2020), and the Electric Mobility Standards. The Constitution of Kenya guarantees the right to a clean and healthy environment to be protected for current and future generations. In the National Energy Efficiency and Conservation Strategy, Kenya set a target to have 5% annual vehicle registrations being electric by 2025 [5].

In addition, the Finance Bill 2019 amended the Excise Duty Act 2015, to provide for a graduated tax for different vehicles depending on engine capacity. The bigger engines above 2500cc attract an excise duty of up to 35% while smaller engines below 1500cc attract a 20% excise tax. Fully electric vehicles attract a further reduced 10% excise tax. The new 2023 Finance bill fully exempts EVs including electric motorcycles and lithium-ion batteries from taxes. Therefore, a faster growth of the sector is expected in the future with new and bigger companies entering the market and partnerships between local and international companies accelerating deployment of electric motorcycles in Kenya.

COUNTRY PROJECT – KENYA

PROJECT SUMMARY

Electric 2-Wheeler Pilot in Kenya

In 2018, the Shenzhen Shenling Car Company Limited (SSCC Ltd), an electric vehicle company from China entered a Memorandum of Understanding with UNEP to donate 48 electric 2 wheelers to be deployed in Kenya. The motorcycles were imported as Semi Knock Down kits (SKDs) to be assembled locally. Assembly training was conducted in the KPLC training workshop, with the help of experienced technicians from local e-mobility firms – Powerhive and Arc Ride. The demonstration project was launched at a high-level event at the Karura Forest in Nairobi on 2 March 2021. The selected pilot sites included a mix of urban and rural setups as well as different use cases as follows:

1. **KPLC** – 15 Motorcycles which were mainly used on peri urban and rural roads by Kenya Power meter readers, most of the time with one rider each.
2. **Kisumu County Government** – 15 Motorcycles mainly used in the urban areas for short commutes by social workers and City inspectorate officers with at most one other passenger each.
3. **Karura Forest** – 5 Motorcycles mainly ridden for short patrols by Kenya Forest Service warders within Karura Forest mostly with one rider each
4. **Powerhive** – 13 Motorcycles mainly ridden in Kisii town by motorcycle taxi (boda boda) operators. Most trips comprised of carrying of more than one passenger per motorcycle and frequently goods weighing over 100 kgs.

County/Region: Nairobi, Kiambu, Nakuru, Kisii, Kisumu

Project Timeframe: 12 months

Partners: UNEP, SSCC, STA, Kenya Forest Service, Kenya Power, Kisumu County Government, Powerhive.


Semi Knocked Down (SKD


Assembly training at KP


Assembly training at KP

Official launch at UNEP

INTERVENTIONS

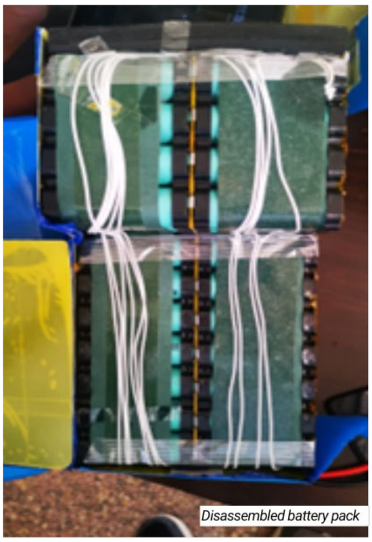
The electric motorcycles provided by the Chinese donor were tested over a period of 12 months under different use cases within different fleets. The motorcycles were charged using normal sockets at the respective premises of the pilot operators meaning no additional charging infrastructure was installed. The provided vehicles included both vehicles with center-mounted engines and a chain drive train and vehicles with hub engines deployed in the rear wheel. To monitor performance, the partners deployed a simple manual data collection methodology using hardcopy forms.

The following list provides a summary of key challenges:

- **Incomplete data collection -** Since data was manually filled, not all trips were properly recorded. Due to technical issues only 27 out of the 48 units provided long-time performance data for the pilot. Since the vehicles were donated, the pilot did not gather data on financing and business models for operation.
- **Low Range** - The maximum distance covered by a full charge for the tested units ranged from between 50km to 84km depending on the battery health, the terrain and elevation. However, since the capacity of the lithium-ion batteries used for the donated vehicles was just over 2kWh, the range of the pilot electric motorcycles is within the expected range.
- **Maintenance issues** – Due to rough riding circumstances in the Kenyan context including unpaved or badly maintained paved roads, high loads, steep terrains and the need for relatively high speeds, a number of electronic, and mechanical faults occurred, including:
  - Speed settings malfunction and speedometer/odometer displays not working.
  - Accidental actuation of the motorcycle when it looks like it is switched off.
  - Breakage of battery covers, indicators arms and pedals.

- Battery failure, rapid battery discharge.
- Electronic failure of controllers, displays, gear switches, & battery management systems.
- Frequent failure of the hub motor.
- Breakage of footrests, brake calipers, indicators and wheel covers.
- Unavailability of spare parts.

Kisumu County Govt. rider in Seme, Kisumu

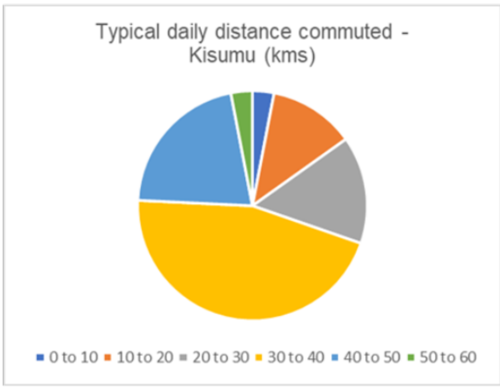


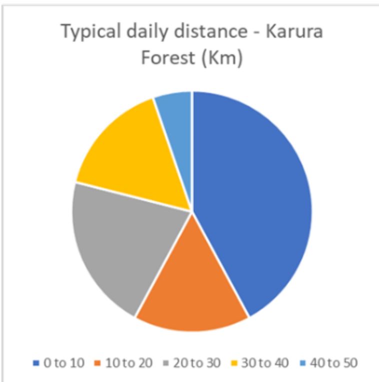
Disassembled battery pack

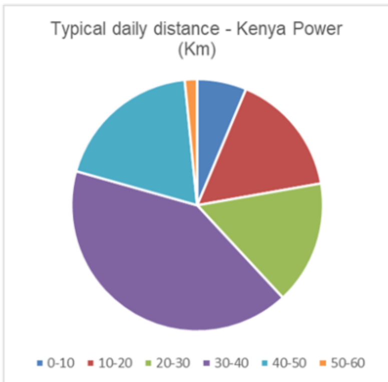
IMPACTS AND RESULTS

The 27 bikes for which full data was available covered 85,155km, which was relatively light usage within a period of a year, but in the process saved approximately KES 263,128 (USD 2,288) of fuel. Key observations on operating conditions within the tested fleets include:

- The average covered daily distance driven was between 30-40kms.
- The longest journey covered on a single charge was 60Km with the maximum payload being 177km, including the driver (Kisumu County Government)
- Maximum speeds were between 65 and 72 km/h
- The most typical time to recharge the batteries to full capacity was 5-6 hrs mostly done at night after normal working hours.







LESSONS LEARNED

The following list provides an overview of lessons learnt from the Kenya pilot.

a) **Port clearance and registration** – Customs regulations have no established duty categories for EVs. In Kenya, vehicles are classified using engine capacity as a guideline for duty calculation. The National Transport and Safety Authority also doesn't have a category for registration of EVs.
b) **Data collection** –The EV should be electronically tracked to monitor location, mileage and speed and the batteries monitored for charge levels and location, using hidden tracking devices to ensure completeness of data and security.
c) **Swappable batteries** – Battery swapping would allow for more intense usage as the driver doesn't have to wait several hours for the vehicle to charge. Swapping cabinets also have battery charging capacity monitoring software, making the charging process controlled and seamless.
d) **High quality batteries** – The quality of the battery is critical to improve the lifespan of the vehicle which is critical for comparable performance with ICE motorcycles.
e) **Robust vehicle** - Electric vehicles need to be adapted to the sturdiness required in the African use case. In this pilot the lightweight construction of some protective components such as plastic cladding could not withstand the rough road conditions and overloading that is common in the daily usage of boda boda motorcycles.
f) **Mechanical Safety** – Electric motorcycles may be used in a number of modes, including an "idle" mode where accessories (such as lights) are operable, but the vehicle is not capable of motion. There needs to be a specified key switch operation intended to prevent accidental actuation (motion) of the vehicle.
g) **Charging safety** - In this pilot use of normal sockets for charging was the norm. Charging modalities need to be explored and implemented to prevent overheating and fire accidents largely attributed to level 1 charging.
h) **Prior Testing** – The vehicle should be tested in different operating environments to ensure the durability of the electronics and external and internal components would improve overall EV quality over time.
i) **Spare parts** – Locally available and compatible vehicle parts are needed for continued operation and maintenance of EVs.
j) **Technicians** – Electric motorcycle suppliers should have a well-trained, locally based technical team, to respond rapidly to maintenance issues, including minor electronic failures that can handicap a project.

RECOMMENDATIONS

1. **Government (national and local) policies and regulations**
    1.1. Improve the EV registration process making it more straightforward and efficient.
    1.2. Offer purchase subsidies, duty exemption, and registration or tax rebates to lower upfront cost.
    1.3. Shift Vehicle taxation policy from an engine capacity base to a carbon emissions-based regime.
    1.4. Implement low- and zero-emission zones.
    1.5. Considering the frequent breakdowns that were experienced, the authorities must set up specifications and standards for electric motorcycles. The Kenya Bureau of Standards (KEBS) is spearheading such efforts with support from UNEP.
    1.6. Establish differentiated electricity tariffs for high peak and off-peak rates to encourage electric vehicle charging at night. This has recently been done by KPLC.

2. **Vehicle supplier**
    2.1. More robust electronics are required as their fragility led to downtime and breakdowns. An example is that the instrument panels failed on many of the units.
    2.2. Sturdy and working lights and signaling for day and night-time driving need to be a requirement for electric motorcycles.
    2.3. Mechanical items like brake calipers need to be more durable.
    2.4. A dashboard range indicator is preferred to a percentage charge display.
    2.5. Insulation tests should be performed to ensure the vehicle has sufficient electrical insulation to prevent shocks, or other electrical hazards.
    2.6. Ensure local availability of spare parts, especially wear and tear parts such as tyres or lights should be easily accessible or interchangeable with those of popular ICE motorcycles.
    2.7. Training of mechanics and electricians on electric vehicle maintenance. Trained operation and maintenance

workers and electronics technicians for existing petrol motorbikes need support to acquire the technical skills to maintain and service electric motorcycles.

3. **Battery**
    3.1. Due to a relatively limited range of between 50 and 84kms of this type of electric motorcycle, a solution for range extension needs to be sought, either through the provision of bigger batteries, battery swapping or fast charging stations, to be able to achieve the same distances as their ICE equivalents.
    3.2. Introduction of battery quality standards and tests to ensure sustained battery state of health and to prevent shorting, overcharging, over-discharging and high charge current.
    3.3. A battery charge level indicator would be useful to riders.
    3.4. Protocols for battery end of life management including recycling and disposal need to be introduced.
    3.5. Battery standardization or interoperability of batteries for different makes of electric motorcycles should be implemented.

4. **Market Development**
    4.1. Local assembly, design and manufacture of EVs shall be encouraged. This will create a sustainable foundation for the EV market including better parts inventory and improved maintenance.
    4.2. Initiatives to support the development of an electric vehicle maintenance curriculum for tertiary institutions need to be developed.
    4.3. Licensing of both public and private sites that meet safety criteria for the establishing of charging infrastructure as well as battery swap stations will help solve the problem of range anxiety.
    4.4. Public Private Partnerships (PPP) for large-scale charging infrastructure rollouts need to be established.
    4.5. Awareness-raising campaigns for the general public on the advantages of electric mobility need to be carried out.

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