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

August 2023

UGANDA

INTRODUCTION

MARKET OVERVIEW

In Uganda, vehicle emissions are a major contributor to poor air quality particularly in urban areas. Transport also accounts for over 25% of the total Greenhouse Gas (GHG) emissions of the country. According to Uganda's updated Nationally Determined Contribution (NDC), GHG emission from the transport sector will more than double from 4.2 $MtCO_2e$ in 2015 to 9.6 $MtCO_2e$ in 2030 under Business-As-Usual conditions. If all planned mitigation measures, under the NDC scenario, which include electric mobility, are implemented, they have the potential to limit the growth of the emissions to 29% to 6.8 $MtCO_2e$ in 2030.

The high transport sector emissions are mainly due to the high age of the Ugandan vehicle fleet which are mainly used vehicles. According to the fuel economy baseline report for the period 2000 – 2014, new vehicles accounted for 33.6% of diesel vehicles mainly due to the import of new heavy-duty vehicles while the share of new vehicles was only 5.6% for petrol vehicles (see Figure 1). Diesel vehicles constitute the majority of the fleet at almost 60%, driving up the average age of the national vehicle fleet to 16 years. The high average age of motor vehicles implies high fuel consumption coupled with high emissions per kilometre (Figure 4).

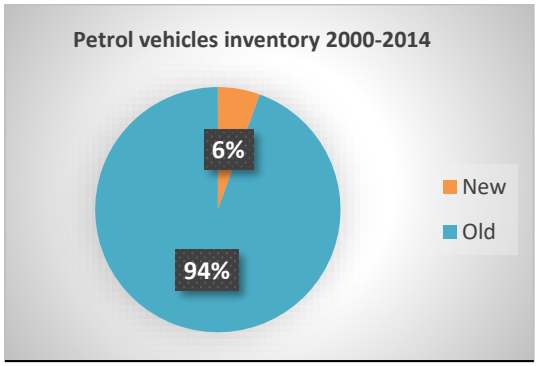


Figure 1: Petrol vehicles inventory

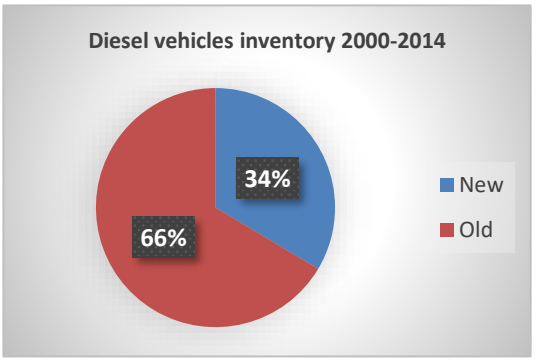


Figure 2: Petrol vehicles inventory

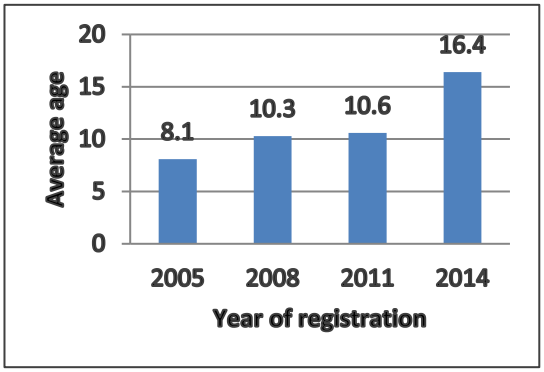


Figure 3: Average age of Diesel vehicles

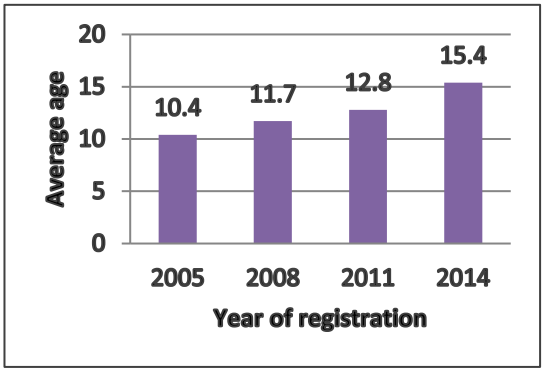
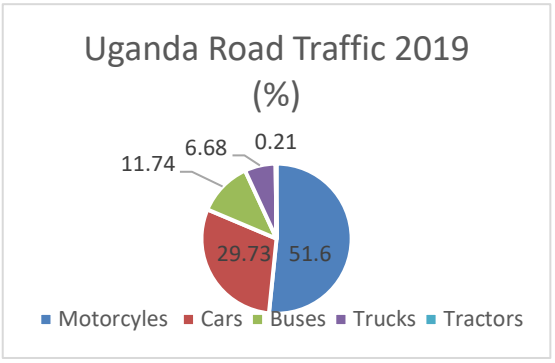
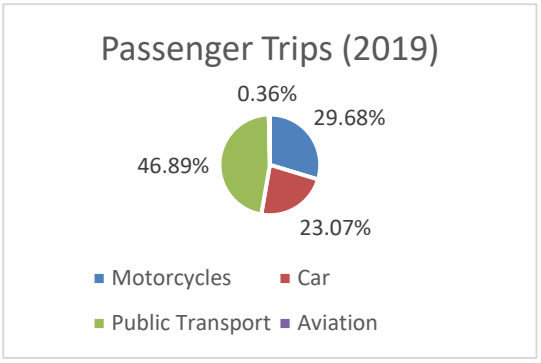


Figure 4: Average age of Petrol engine vehicles

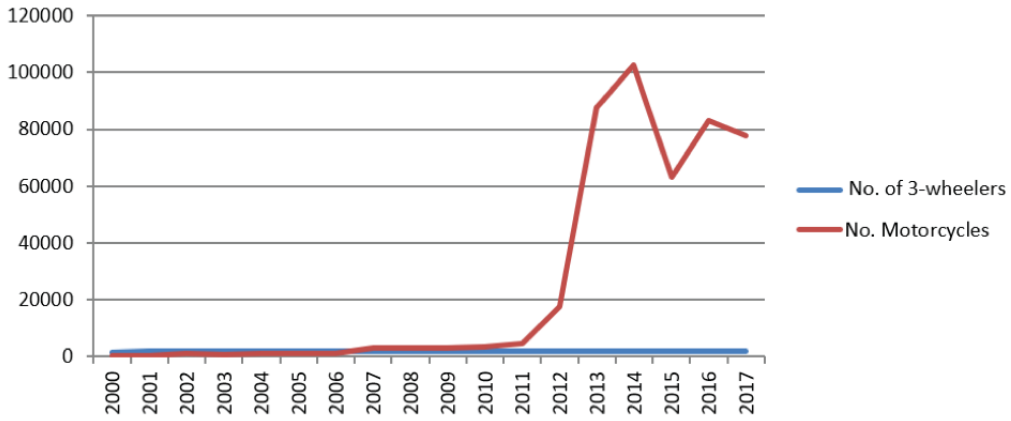
According to the Expressway Development Master Plan traffic survey conducted in 2019, road traffic is dominated by motorcycles (51.64%) followed by cars (29.73%), buses (11.74%), trucks (6.68%) and tractors (0.21%). According to the National Integrated Transport Master Plan, public transport had the highest number of passenger trips at 46.89% followed by motorcycles at 29.68%. Aviation had the least number of passenger trips at distance 0.36%.





Motorcycles commonly called boda bodas are the fastest growing mode of transport. Uganda's fleet of motorcycles rose from 229 registered motorcycles in 2000 to just under 103,000 in 2014, with an average growth rate of 17% per year and to 923,700 by June 2018 with an average growth rate of over 140% per year. If the prevailing 2-wheeler registration trends are to remain, the motorcycles are projected to reach an annual import of more than 1.5M units by 2030. Many of the motorcycles use two-stroke engine technology that combusts an oil/fuel mix, resulting in high pollutant emissions. This is exacerbated by poor maintenance, misuse (e.g. overloading), and use of low quality fuel in poorly planned heavily congested urban areas. The average age of imported motorcycles was 0.6 in 2005, 1.0 in 2010 and 0.9 years in 2014. The improvement in age of motorcycles is attributed to introduction of importation of motorcycles in parts which are then assembled in country. Despite the improvement in age, the average fuel efficiency was still high at 1.91L/100km in 2014 resulting in high emissions of 43.87gco2/km. Therefore, motorcycle taxis have major climate and air quality impacts.

Figure 5: Imports of motorcycles in Uganda (2000 - 2018)



UGANDA'S GROWING E-MOBILITY ECO-SYSTEM

The growth and popularity of motorcycle transport in Uganda has been driven mainly by high unemployment rates among the youth, increasing traffic congestion and a lack of a formal public transport system. Given the fast growth of 2&3 wheelers as compared to other transport means, electric motorcycles represent an immediate opportunity for the decarbonisation process of Uganda's transport industry.

By the launch of the electric mobility pilot in 2018, there were less than 10 electric motorcycles, no electric cars and only one company was selling EVs in Uganda. By the end of 2022, there were over 750 electric motorcycles on the market and over 20 companies involved in e-mobility. These companies include national, regional and international franchise companies working in importation and assembly of EVs, conversion from ICE to EV, provision of charging infrastructure and battery swapping. Local manufacturing is also starting with Kiira motors corporation, a state-owned company, establishing an EV plant in Jinja (80 km from the capital Kampala) with capacity to manufacture over 2,000 electric buses per annum.

Coupled with the fact that Uganda's power generation is largely renewable, the introduction of electric mobility would provide significant CO2 emissions reduction in the transport sector. The baseline study conducted as part of this project estimated the number of two wheelers in Uganda at 1 million in 2020. The transition of this entire ICE fleet to electric would result in a daily charging requirement of about 200MW which would be met comfortably by the excess generation capacity of 307MW as of December 2018.

E 2&3 WHEELERS TARGET AND POLICY

Uganda wants to be an early adopter in the African e- mobility space by planning strategically and anticipate the future needs in the energy infrastructure and manufacturing sectors. Electric mobility has been included in national policies such as the Energy Policy, laws such as the Energy Efficiency and Conservation Bill, plans including the National Development Plan III, the National Transport Master Plan and the NDC. The NDC was updated in 2022 and includes as an additional mitigation measure the introduction of electric motorcycles and buses in the country.

However, there are still significant gaps to spur the growth of electric mobility including but not limited to a specific electric mobility policy, standards, financing options, fiscal and non-fiscal incentives for electric vehicle importation and possible future manufacturing, and increased information and public awareness. To address these gaps, an Inter-Ministerial Committee and a national technical task force have been established by the President. According to the draft strategy that the task force is currently developing, the target is to achieve EV sales of at least 10% by 2025 and a complete electrification of the transport sector by 2034. The targets by segment are;

- 30% of new sales of 2 &3 wheelers to be electric by 2025
- 300,000 annual sales of electric 2&3 wheelers by 2026, with sufficient battery swapping stations in place
- 1,000 electric buses on fixed routes electrified by 2026.
- 300 bus charging stations established by 2026 with fast charging stations around mobility hubs in 4 cities.

COUNTRY PROJECT

PROJECT SUMMARY

Electric 2-Wheeler Pilot in Uganda

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 50 electric 2 wheelers to be deployed in Uganda. The objectives of the pilot were to demonstrate electric 2-wheelers and provide a proof of concept for the technology, to test appropriateness of the units for different use cases and to create awareness on electric mobility. The pilot was launched at a high-level event in April 2021 and served as the beginning of an electric mobility revolution in Uganda. The units were operated by 5 partners to test different use cases as follows:

1. **International University of East Africa (IUEA)** - 6 units used for office-to-office movements, courier services and research. The longest journey covered on a daily basis was from Kampala to Mukono, a distance of about 30km with an average speed of 50- 60 km/hr
2. **Lulu Fisheries -** 4 units used in the movement across fish farmers, ponds, office, town movements etc. The units operated in a relatively flat area of Jinja city. The charging time ranged from 2.5 to 6 hours and the daily distance covered ranged between 30 -40 km
3. **Pearl Rice -** 8 units used on rice fields for monitoring, supervision of the rice fields, access to markets etc. Data was collected from 8 units and the battery charging time was in the normal range of 2.5 to 5 hours. The daily distance averaged between 30 to 60 km. Regularly, the units would be used for long distance travel between Jinja and the farm at Busembatia an average distance of about 67 km.
4. **Glovo** - 8 units used in making courier and delivery services mainly in the Greater Kampala Metropolitan Area (GKMA), which covers Kampala, Wakiso and Entebbe. The units' daily distance covered ranged between 43-84km. Operation average speed ranged between 30- 50 km/hr
5. **More Green (U) Ltd** – 16 units used in public transport and logistics. The units operated in the capital city Kampala. The average distance covered by unit ranged between 60-110km.
6. **Clean Air Initiative Africa (CAIA) –** 8 units of which 5 were used for testing in different conditions, while 3 units didn't work from the beginning and were used to provide spare parts for the other 47 vehicles.

- City/Region: Kampala, Jinja and Busembatia in Uganda.
- Timeframe: April 2021 – December 2022
- Partners: UNEP, SSCC, Clean Air Initiative Africa (CAIA), International University of East Africa (IUEA), Lulu Fisheries, Pearl Rice, Glovo, More Green (U) Ltd

INTERVENTIONS

The project activities included, planning for the importation and customs clearance, selection of partners, definition of the operation areas, assembly and distribution of the units, training of the operators, development of data collection tools, collection of data, undertaking of public awareness activities such as an e-mobility parade and exhibitions. Manual data collection instruments were utilized, supplemented by an electronic tracking system which was installed in all units to enhance their security, safety and as a control mechanism. Data was collected from participating partners and was sent to the central CAIA e-mobility center based at the International University of Africa (IUEA) for processing. The assembly of the semi-know-down (SKD) e-motorcycle kits was done at the IUEA R&D laboratory, assisted by the engineering students pursuing mechanical engineering and automobiles studies. Due to the COVID-19 pandemic at that time, it was not possible to have a physical training with SSCC. Audio and video assembling guides shipped with the units were utilized.

The original plan was to distribute the vehicles to different partners spread across the country. However, due to the COVID–19 pandemic and the restrictions on travel, the scope was revised from the earlier envisaged countrywide coverage to selected areas covering the greater Kampala metropolitan area which accounts for 80% of the transport demand and the Eastern part of Uganda covering Jinja and Busembatia.


Launch of e-mobility pilot, Kampala Uganda, 2021


A More Green Rider on daily work April 2021


Green Mobility Uganda logistics team set off for the daily work using pilot electric vehicles May 5, 2021


Riders using ICE motorcycles for public transport in Kampala, 2021

PERFORMANCE OF THE PILOT UNITS

The units were utilized for different use cases and their performance was measured as follows;

- **Range -** the EVs covered a range of 60 – 85km on a single charge dependent on the usage, driving pattern and load carried. One of the units had a range coverage of 120km for a single charge. This was attributed to the terrain which was relatively flat and good operation by the driver.
- **Speed -** to achieve the higher end of the range above, the rider operated at a speed in the range of 20- 40km/hr.
- **Charging time -** the charging times averaged between 2.5hrs and 6hrs for a single full charge.
- **Acceleration and ability to climb hills -** The units with mid mounted motor vehicles were faster at take off than the units with hub motor. They were also more effective in hilly terrains.
- **Operation and maintenance cost** - The units have a lower operation and maintenance cost than ICE motorcycles.

For ICE, the average daily fuel consumption for operators ranged between $5.5– $8.2 per day. This translates to $16.5- $24.7 per month. This is in comparison to $13.5 for the electric unites considering a daily consumption of 2 units of electricity for charging. In addition, the ICE units require changing oil and repair of the chain which is at an average cost of $68.5 per single service which isn't required for the EVs.

- **Emissions -** Perhaps the most attractive feature of the EV is their zero local emissions. This was more vivid during COVID when units were significantly used for transport and deliveries of groceries to clients during the lock down.

The pilot was critical to accelerate the uptake of EVs, especially because it showed some performance deficits of the electric motorcycles that have to be addressed, including:

- **Limited Range -** 2 wheelers used for public transport cover 80km – 120km per day, higher than what was achieved with the range of the electric vehicles which was 50km – 80km.
- **Smaller Carriers -** In the case of a delivery of larger sized cargo, the carrier was found too small compared to the ICE motorcycles whose carriers are wider and longer.
- **Lack of Spare Parts -** A number of spare parts were not always readily available.
- **Quality of parts:** some of the body parts were relatively more fragile than the ICE units.
- **Lack of charging facilities -** Unlike the ICE units where there are many fuel stations for refiling, there are no publicly available charging stations in the cities which creates a risk of running out of power.
- **Weather resistance -** whereas many units operated well during the summer/ dry seasons, during the rainy season, some of the units experienced electric short circuits and could not operate. This grounded over 70% of the fleet.
- **Jerking -** On the ICE motorcycle, when starting, the customer feels the starting of the engine and engagement of gears enabling them to hold firm as the operator takes off. However, for electric vehicles, the passengers do not feel the engagement of the gear and therefore, if not alerted, the customer gets scared at takeoff as there is some jerking.
- **Security -** On some occasions, there were attempts by the operators to steal the units they were riding. However, in all cases using the tracking system pre-installed, the partners were able to locate the units and recover them.

IMPACTS AND RESULTS

Economic impact

- **Energy savings:** From the baseline survey, on average, a 2-wheeler consumes 5.7liters of gasoline per day of operation. Over the project life time a total of over 171,000 liters of gasoline was saved.
- **Growth in income:** according to the operator's survey in 2022, the ICE motorcycle operators, make between US $13.6 and US $16.4 per day. When cost of fuel is deducted, the operator makes about $8.12 per day. Using the EV, the operator was able to make US $24.7 per day including the charging cost.

An operator under training on operation of an EV

A data collection staff takes initial data capture from a pilot operator April 2021

Environment impact

- **Savings in CO2 emissions**: According to the project survey, on average, a motorcucle covers a distance of 80-120km. Using the average rate of 0.1g/km, it is estimated that between 4,800-7,200g of CO2 was saved during the project time.
- **Use of locally produced clean energy.** Uganda has considerable renewable energy endowments; hydro, solar, wind and geothermal power installations which can be used to charge electric vehicles and avoid import and exploration of oil products.

LESSONS LEARNED

The pilot project provided a number of lessons including;

a) **Importation and registration -** Prior to the introduction of electric mobility, the customs clearance and the registration were all designed for the ICE vehicles. As the units arrived at the Mombasa port in Kenya, CAIA experienced numerous challenges with respect to customs clearance. For instance, while it was envisaged that one clearing firm would handle both the consignments for Kenya and Uganda, each country had to have its own clearing firm. This process took over four weeks.

b) **Customs clearance -** The clearing of the units through customs presented the biggest challenge. Given that the units were for a not-for-profit pilot, it was expected that they would be tax exempt. However, the process of getting an exemption was difficult, as it required the project partners to have obtained tax exemption approvals prior the importation of the units. After 3 months of no progress and with the units in the customs warehouse accumulating storage surcharges, the project partners decided to pay the taxes to move ahead with the pilot.

c) **Reliability of charging -** The charging time ranged from 2:08hrs to 6:20hrs. This charging time is too long for a commercial operator if done during the day. As a result, the pilot relied on charging at night which exposed the charging to disruptions in power supply bringing about issues of safety and power availability.

d) **Mechanical Faults and fragile parts -** A number of partners reported the fragility of the body parts of the electric vehicles. Therefore, more durable parts for the electric units need to be considered to appropriately manage the tough terrains and conditions of Ugandan roads.

e) **Spare part availability -** Most of the parts were not available on the Ugandan market. Therefore, local manufacturing should be encouraged to provide for sustainable transition through knowledge transfer, creation of local manufacturing capacity and green jobs.

f) **Electronic Faults -** A number of units experienced electronic failure, including the dashboard lighting off, self-movement of bikes, battery/ power going off suddenly etc. A more strengthened electronic system is necessary for the units to operate on the market.

g) **Repair and maintenance skills –** Due to the Covid-19 pandemic, no the envisioned in person training for the local partners by SSCC was not possible. As a result, when the electric units experienced any mechanical failure, operators had little knowledge on what and how to repair the vehicles. The mechanics in the local garages had no knowledge of electric vehicles. Thorough capacity building and skills development is needed before and during the pilot.

RECOMMENDATIONS

1. **Policy and Regulatory framework**
   - 1.1. A national e-mobility needs to be developed as a framework for all other interventions.
   - 1.2. Considering the cost of production, shipping clearance and taxes, the total cost of a unit CIF Kampala was in the range of $2,200- $2,800. The average cost of an ICE is in the range of $1,095 - $1,200. Therefore, fiscal incentives for EVs, such zero rating of EVs, spare parts and associated infrastructure are needed.
   - 1.3. Provide non-fiscal incentives such as special routes, zones and spaces
   - 1.4. Develop standards for charging infrastructure, vehicle safety, energy efficiency etc.

2. **Charging infrastructure**
   - 2.1. Integrate requirements for charging infrastructure in public spaces and buildings.
   - 2.2. A special lower tariff for e- mobility should be developed
   - 2.3. As commercial motorcycles cover a daily distance of 80 – 130 km, a dual battery system, fast charging infrastructure or swapping options at various points on the route are recommended.

3. **Industry and value chain**
   - 3.1. Promote the design of customised electric vehicles for African market
   - 3.2. Promote local manufacturing of 2&3 wheelers and associated parts,
   - 3.3. Provide affordable financing for the value chain players
   - 3.4. Improve the importation, clearance and registration process by dedicated procedures for EVs
   - 3.5. Develop domestic skills and capabilities for e- mobility value chain.
   - 3.6. Provide financing solutions to support acquisition of EVs addressing the perceived challenge of high upfront cost.
   - 3.7. Increase awareness to reduce negative perceptions on EVs.

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