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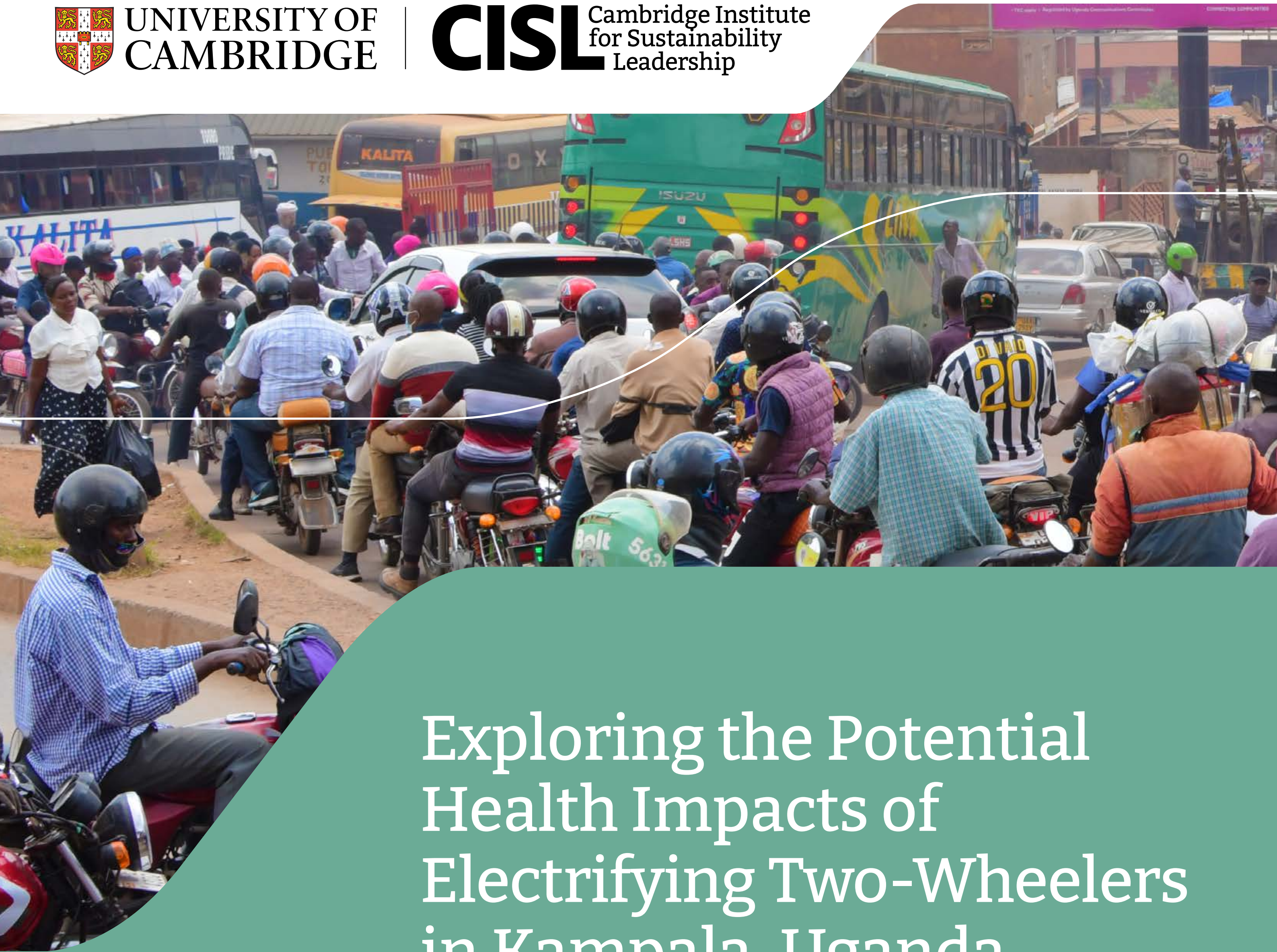

Exploring the Potential Health Impacts of Electrifying Two-Wheelers in Kampala, Uganda

CAMBRIDGE AFRICA

UKRI MRC Epidemiology Unit

The University of Cambridge Institute for Sustainability Leadership (CISL)

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Authors

Dr Gabriel Okello, University of Cambridge Institute for Sustainability Leadership (CISL) and MRC Epidemiology Unit, University of Cambridge

Dr Lambed Tatah, MRC Epidemiology Unit, University of Cambridge

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Executive Summary

Responsible for over 7 million premature deaths annually, air pollution is the second leading global cause of death. Fine particles penetrate the lungs, adversely affecting both health and wellbeing while ultimately contributing to reduced life expectancy.

Foetal lung development, too, can be impaired by air pollution, increasing lifelong disease risk and burdening healthcare systems. It also reduces workforce productivity, causes premature mortality and lowers gross domestic product (GDP), imposing significant economic costs.

7 million+
premature deaths annually linked to air pollution

Petrol-powered motorcycles

are vital to the transport system in parts of Africa

Two-wheeled petrol-powered motorcycles (commonly known as ‘boda bodas’ in Uganda) are vital to the transport system in many African cities, providing essential ‘last mile’ services and navigating congested traffic due to their size and manoeuvrability. However, they significantly contribute to air pollution, emitting more particulate matter per kilometre than cars.

2010

less than **5 million** motorcycles in Africa

440% increase

2022

estimated **27 million** motorcycles in Africa

As of 2022, there were an estimated 27 million registered motorcycles in Africa up from under 5 million in 2010; this figure represents a 440 per cent increase over the last decade. Crucially, traffic-related air pollution (TRAP) accounts for 25 per cent of global urban air pollution and is linked to higher rates of non-communicable diseases like cardiovascular disease, lung cancer and asthma.

25%
of global urban air pollution caused by traffic-related air pollution

Our prior work in Uganda involved collaborating with actors in policy, businesses, communities and academia to co-create contextual evidence-informed solutions to tackle air pollution to protect both people and the environment. Building on this, this nested project assessed the potential impacts of electric mobility transition on local air pollution and related health risks in Kampala and explored insights to identify barriers to and facilitators of electric boda boda adoption.

We used World Health Organization (WHO) AirQ+, a software tool for quantifying the health burden and impact of air pollution. We quantified the impact of very small/fine air particles, commonly known as $PM_{2.5}$, on overall mortality and disease-specific deaths, including respiratory diseases, and undertook surveys across 280 boda boda riders to generate insights and identify barriers to and facilitators of electric boda boda adoption.

Our modelling showed that switching to electric boda bodas in Kampala would reduce $PM_{2.5}$ levels from annual mean concentrations of 41.1 µg/m³ to 34.9 µg/m³, a 15 per cent decrease. The conversion to electric mobility, hereafter referred to as e-mobility, would decrease all-cause mortality deaths due to $PM_{2.5}$ by 18 per cent – from an estimate of over 2,600 to less than 2,200 (from nearly 500 deaths per 100,000 people to around 400. Deaths from circulatory diseases would drop by 17 per cent, from 500 (94 per 100,000) to 413 (78 per 100,000), under-five mortality due to acute respiratory infections by 12 per cent, and deaths from chronic obstructive respiratory disease (COPD) in adults (age 25 or over) by 11 per cent.

41.1 µg/m³
Annual mean concentrations of $PM_{2.5}$

15% decrease

34.9 µg/m³
Annual mean concentrations of $PM_{2.5}$

Out of 280 motorcycle riders included in the survey, 92 per cent used petrol-powered boda bodas while 8 per cent used electric. Fifty-two per cent of petrol riders would have preferred electric bikes but cited factors such as high cost, limited charging stations, uncertainty about resale value, and health concerns as barriers to adoption. Those favouring electric bodas noted benefits like lower fuel costs, lower maintenance costs and ease of upkeep. Despite making fewer trips, electric boda boda riders turned a greater net profit than their petrol-using counterparts.

Benefits of electric boda bodas include:

- **Lower** fuel cost
- **Lower** maintenance
- **Greater** net profit

Recommendations:

Expanding e-mobility in Uganda requires investment in key infrastructure, including charging stations. To build a skilled workforce, vocational training and apprenticeships should be strengthened, ensuring people are equipped for jobs in the sector. Gender inclusion is also essential, as the current boda boda industry is male dominated. More women should be trained and employed in technical roles to create more opportunities and promote diversity in the sector. Additionally, the government should transition its motorcycle fleet to electric, setting an example for wider adoption.

To boost public confidence and uptake, awareness campaigns should educate people on the benefits of e-mobility. Expanding battery-swapping networks can help reduce concerns about charging and range. High upfront costs remain a major barrier, but partnerships between e-mobility companies, financial institutions, and savings groups can provide microloans to help riders make the switch. Supporting women-led pilot projects will further ensure inclusivity and drive sustainable growth in the sector.

Transitioning to electric-powered motorcycles can offer a direct, transformational solution for the reduction of air pollution in Uganda and other African cities, and decreasing health risks from air pollution and greenhouse gas emissions, all with the potential to create thousands of 'green' jobs in the process.

*This project builds on The King's Global Sustainability Fellowship in Air Quality and NCDs (supported by **AstraZeneca**) led by Gabriel Okello (GO), with support from colleagues in the UK and Africa. This ongoing study has focused on applying transdisciplinary collaborative approaches to address air pollution in rapidly urbanising cities in Africa. Through this collaboration, GO and colleagues have investigated the link between air pollution and respiratory health in Kampala,[1] conducted a scoping review of air quality management strategies in Africa,[2] assessed perceptions of air pollution among stakeholders (in review), and explored evidence-informed pathways to transition to e-mobility in Uganda.[3]*

1.0 Background and rationale

1.1 Air pollution and non-communicable diseases (NCDs)

Air pollution is now the second leading cause of death globally, responsible for over 7 million premature deaths annually worldwide.[4] Of these, over 1million occur in sub-Saharan Africa. Human exposure to fine particles that penetrate deep into the lungs and cardiovascular system leads to health hazards, which result in respiratory diseases, cardiorespiratory diseases, cancers and, at worst, death.[5] Air pollution particles can also affect foetal lungs, leading to suboptimal lung function at birth,[6] which is associated with an increased risk of lung diseases across the life course.[7] Air pollution-related diseases cause a huge burden on healthcare systems and wider damage to the economy by reducing human productivity and increasing sick days.[8]

1.2 Context of sub-Saharan Africa

Recent global estimates suggest that 19 per cent of all cardiovascular deaths and 21 per cent of all stroke deaths may be attributable to air pollution. Sub-Saharan Africa is increasing in population, urbanising and undergoing an epidemiologic transition from communicable to non-communicable diseases. In this context, ambient air pollution in African cities is increasing: some of the highest air pollution levels globally recorded occur in African cities[9] and its impact on death and disease is growing.[10] In addition to its negative effects on health and the healthcare system in Africa, air pollution also imposes a heavy burden on the economy.[11] With approximately 1.1 million people estimated to have died in 2019 in Africa[12] due to air pollution, there is an urgent need to address it and create cities that enhance public health and wellbeing.

1.3 Traffic-related air pollution (TRAP)

Traffic-related air pollution (TRAP) contributes to ambient air pollution from both the combustion of fossil fuels in the vehicle fleet and non-exhaust emissions.[13] Globally, TRAP constitutes 25 per cent of urban air pollution and has been directly linked to an increased risk of NCD morbidity and mortality, including from cardiovascular disease, lung cancer and asthma.[14] The greatest burden of TRAP is experienced in urban centres in low- and middle-income countries (LMICs) due to rapid urbanisation, population growth, an ageing vehicle fleet and limited emissions regulations. At a regional level, traffic can be the major contributor to $PM_{2.5}$ and PM_{10}, accounting for 54 per cent of these pollutants in Africa.[15]

In many African cities, two-wheeled motorcycle taxis (commonly called 'boda bodas' in Uganda) are an important component of urban mobility.[16] As of 2022, there were an estimated 27 million[17] registered motorcycles in Africa – up from under 5 million in 2010 (a 440 percent increase), with approximately 80 per cent of motorcycles being used as passenger taxis or for delivery services. Studies in low-and middle-income settings, where motorcycles are common, have shown that motorcyclists (and motorcycle passengers) experience greater exposure to air pollution than people using other forms of transport.[18] TRAP is a major contributor to NCDs in urban African settings, and interventions to reduce this exposure would not only advance population health but also address challenges relating to climate change and rapid urbanisation.

1.4 Context of Kampala city, Uganda

As in many African cities, two-wheeled motorcycle taxis – otherwise known as 'boda bodas' – are an important component of urban mobility in Kampala. Here, boda bodas comprise a significant proportion of vehicles on the road: estimates suggest that between 300,000 and 800,000 petrol-powered boda bodas are in use in Kampala, with boda boda rides responsible for approximately 42 per cent of all motorised trips in the metropolis.[19]

As in other LMIC cities, boda bodas provide an essential 'last mile' transport service for the movement of individuals and goods around Kampala. In increasingly congested urban corridors, they are also prized for their ability to evade the worst of urban traffic congestion due to their small size and manoeuvrability.[20] The contribution of two-wheelers to ambient air pollution, however, can be substantial, with previous studies demonstrating that petrol-powered motorcycles produce more particulate matter emissions per kilometre than cars.[21]

A recent study focusing on road-based hotspots showed that boda boda drivers in Kampala were exposed to poor air quality at levels deemed "unhealthy" or "unhealthy for sensitive groups" (according to the Environmental Protection Agency's air quality index) for 35–60 per cent of their total work day.[22] The risk of $PM_{2.5}$ to health is especially elevated in vulnerable populations that include children, the elderly, and those subjected to higher levels of exposure due to factors like occupation and socioeconomic level.[23] Urban boda boda drivers in Kampala are typically men, with limited alternative options for gainful employment. Many of them joined the informal transport industry after migrating from more rural areas.[24] With limited job security and resources, they face a high burden of health risks due to their occupation, which carries the risk of injury alongside the disease risks associated with air pollution[25] in addition to structural factors influencing their health status (for example poverty, stigma and poor housing conditions). **Boda boda drivers are thus both contributors to, and victims of, air pollution – and interventions that address them as central actors are sorely needed.**

Reducing vehicular tailpipe emissions in the transport sector has enormous potential to simultaneously benefit both health and climate. Globally, the transportation sector is estimated to be responsible for 23 per cent of CO_2 emissions.[26] In Uganda, this figure is estimated to be even higher, at around 45 per cent.[27] The drastic reduction in traffic and population mobility that occurred as a result of strict lockdowns at the start of the COVID-19 pandemic in 2020 provided a natural experiment to observe the potential for air pollution improvement that could be realised via reductions in transport-related emissions.

Figure 1: Traffic congestion in Kampala city

2.0 State of e-mobility in Uganda

Uganda's transition to e-mobility is progressing rapidly. The government and private sector have introduced 24 electric buses for mass transit, supported by 16 fast chargers and over 1,500 electric motorcycles, along with 100 battery-swapping stations.[28] Uganda's e-mobility ecosystem, co-ordinated by the Ministry of Science, Technology and Innovation (STI) Secretariat, is organised under the e-Mobility Consortium, which includes over 80 value chain actors. Seven key clusters have been established to ensure co-ordinated and sustainable e-mobility development, including:

- Research and Development
- Engineering and Manufacturing
- Energy
- Transport Planning, Management, Operations, and Support
- Value Chain Financing
- Policy, Regulations, and Standards
- Digital Infrastructure.

Uganda's national e-mobility priorities are to:

- boost local electric vehicle (EV) manufacturing and supply
- promote domestic EV battery production
- electrify public transport systems
- establish comprehensive EV charging infrastructure
- develop e-mobility skills and workforce
- increase EV adoption, including electrifying the government fleet
- create standards, regulations and guidelines for the e-mobility industry.

Figure 2: Gabriel assessing a frame meant for e-boda retrofit (left); Gabriel Okello inspecting a battery-swapping station in Mbarara city (right).

3.0 Aims and objectives

This project assessed the potential impacts of e-mobility transition on local air pollution and related health risks in Kampala and explored rider perspectives on petrol and electric boda bodas to identify barriers and facilitators to electric boda boda adoption.

4.0 Methods and approach

4.1 Theoretical framework: a transdisciplinary approach to addressing air pollution

This project builds on the already existing work on air quality and NCDs led by Gabriel Okello, centred on the collaborative and participatory involvement of actors (Figure 3). The actors are drawn from within and outside academia and health sectors (community, commercial and policy) and participate in the co-production and co-design process to create context-specific interventions to address air pollution in Uganda. Over the past four years, Gabriel Okello's fellowship has catalysed and been part of several major initiatives aimed to tackle air pollution in Kampala and Jinja cities in Uganda, including:

- drafting air quality standards for Uganda
- drafting the brief exploring evidence-informed approaches to e-mobility transition[29] and presenting to the national mobility think tank, which contributed to removal of import duty tax from electric motorcycles and hybrid electric cars (FY 2023/2024), VAT exemptions and tax breaks for local e-mobility companies
- investigating the link between air pollution and respiratory health in Kampala[30]
- scoping of air quality management strategies in Africa[31] for shared learning
- increasing participation of policymakers in tackling air pollution through workshops, roundtable discussions and joint activities.

The purpose of this project was to assess the potential impacts of the e-mobility transition on local air pollution and related health risks in Kampala, Uganda.

Transitioning to electric-powered mobility and other forms of non-motorised transport offers a direct, transformational solution to cleaning up air pollution in Africa's cities, reducing health risks from air pollution and greenhouse gas emissions, with the potential to create thousands of 'green' jobs.[32,33] Despite these benefits, our prior work has demonstrated that only 17 per cent of the air quality management strategies developed and/or implemented in Africa between 2000 and 2020 focused on ambient air pollution, and only 6 per cent on mobility.[34] Building on our prior work exploring evidence-informed pathways to the transition to e-mobility,[35] we evaluated the health impacts of transitioning to green mobility and expanding the intervention in Kampala. This analysis was supplemented with drivers' insights regarding petrol-powered and electric boda bodas.

Figure 3: Collaborative approach used for air quality and NCDs work

4.2 To evaluate the potential impacts of electric mobility transition on local air pollution and related health risks in Kampala

To estimate the health impacts of reducing air pollution, specifically particulate matter ($PM_{2.5}$), by switching from petrol-powered to electric motorcycles in Kampala, we used the World Health Organization (WHO) AirQ+ software.[36] AirQ+ is a specialised tool used to quantify the impact of air pollution on public health. It enables the estimation of attributable mortality and morbidity due to exposure to specific air pollutants, including $PM_{2.5}$, PM_{10}, ozone and NO_2. While the relationships between different air pollutants and health have been studied in the literature, evidence is most readily available for $PM_{2.5}$, hence our choice to focus on $PM_{2.5}$.

The primary input data required included:

- **Baseline $PM_{2.5}$ concentration:** The existing $PM_{2.5}$ levels in Kampala were obtained from a recent study based on local air quality monitoring data.[37]
- **Projected reduction in $PM_{2.5}$:** The expected decrease in $PM_{2.5}$ concentrations associated with the replacement of petrol-powered motorcycles with electric-powered motorcycles. This was calculated by modelling the emission reductions attributable to the switch to electric vehicles and estimating the subsequent change in ambient $PM_{2.5}$ levels. The proportional contribution of different modes to transport-related air pollution is unknown and is currently being investigated.[38] We used the ratio of registered motorcycles to other vehicles over the past decade to represent the fraction of transport-related air pollution due to motorcycles. The overall transport share of $PM_{2.5}$ was obtained from a recent study.[39]
- **Population data:** The total population of Kampala and the age distribution[40] were used to estimate the population at risk of the selected health outcomes.
- **Health outcome data:** Relevant baseline health statistics for Kampala, including all-cause and cause-specific mortality, were obtained from the Global Burden of Disease study.[41]

Table 1: Input parameters and data

Parameter	Values
Location	Kampala city: area: 195 square kilometres; latitude: 0.3476; longitude: 32.58252
$PM_{2.5}$ baseline	41.1 µg/m^3 (annual average from 2020 to 2022)
Transport share of $PM_{2.5}$	22.8 per cent
Motorcycle share of transport emissions	66 per cent (vehicle registration from 2012 to 2024; 1,314,373 motorcycles out of 1,989,804 vehicles). This value is a conservative estimate since these motorcycles use inefficient two- or four-stroke engines.
Population	1,875,834 (residents only); 296,921 (0–5 years); 679,701 (25+ years); 532,641 (30+ years)
Death rates per 100,000 population	2,314 (all natural causes in 30+ years); 339 (circulatory diseases in 30+ years); 67 (acute lower respiratory infection in 0–5 years); 4.4 (lung cancer in 25+ years); 21 (chronic obstructive respiratory disease in 25+ years)
The daytime population of Kampala increases by about 600,000 people (but their demographics are different from the residents'). In addition, the effect of air pollution may be similar across the metropolitan area of more than 4.5 million people, but the $PM_{2.5}$ monitors considered in this study were placed only in Kampala city. We further scaled these values to account for the difference in rural–urban mortality by multiplying by 1.095. The rates are obtained from the Global Burden of Disease estimates and are restricted to the ages for which the $PM_{2.5}$-health relationships are available in the model.	

Analysis

The modelling was done using AirQ+, in the following steps:

1. **Selection of health outcomes:** The model includes a limited range of key health outcomes related to long-term exposure to $PM_{2.5}$. We selected a set of health outcomes to show effects on overall mortality and mortality related to respiratory outcomes, including all-cause mortality, circulatory, lung cancer, chronic obstructive pulmonary diseases, and acute lower respiratory tract infection.

2. **Relative risk values:** AirQ+ uses pre-defined relative risk (RR) estimates from epidemiological studies that quantify the association between $PM_{2.5}$ exposure and the selected health outcomes. The relative risks used were based on the most recent WHO guidance. These pre-defined values were maintained since context-specific relative risks are not available.

3. **Attributable fraction calculation:** The software calculated the population attributable fraction (PAF), representing the proportion of health outcomes in the population that could be attributed to $PM_{2.5}$ exposure. This was determined for each health outcome by applying the relative risk values to the population data and the reduction in $PM_{2.5}$ levels.

4. **Burden estimation:** The PAFs were then used to estimate the number of deaths that could be prevented or reduced by the switch to electric motorcycles, assuming the selected relationships between $PM_{2.5}$ reductions and health benefits.

4.3 To explore insights about petrol-powered and electric boda bodas from riders.

We conducted researcher-led surveys across 280 boda boda riders using a combination of quantitative questionnaires and semi-structured interviews to collect information on:

- sociodemographic characteristics: age, sex, educational attainment
- type of boda boda – petrol-powered or electric
- working hours of riders per day
- daily expenditure on energy per day and average weekly revenue
- the maximum distance a fully charged battery allowed
- cost of maintenance and profit margins
- average daily travel distance
- preferences and facilitators to electric boda adoption.

Analysis

Descriptive analyses were summarised to evaluate the overall frequency (mean, median, frequency distributions) of responses and explored differences between electric and petrol-powered boda bodas for the various parameter categories.

5.0 Results

5.1 Modelling results

5.1.1 $PM_{2.5}$ change

By converting all petrol-powered motorcycles to electric-powered motorcycles, background air pollution could decline from 41.1 µg/m³ to 34.9 µg/m³. This change represents a 15 per cent decrease in background $PM_{2.5}$ levels, close to the 10 per cent decrease observed during the COVID-19 pandemic in Kampala.[42]

5.1.2 All-cause mortality in ≥ 30-year-olds

At the current levels, $PM_{2.5}$ accounts for 2,624 adult deaths (in those aged ≥ 30 years) (ie 493 per 100,000 population) from all natural causes in Kampala annually. Under the e-mobility scenario, deaths from all natural causes drop to 2,149 (i.e. 404 per 100,000 population), representing an 18 per cent drop in mortality (Figures 4 and 5).

5.1.3 Mortality from circulatory diseases in those aged ≥ 30 years

At the current levels, $PM_{2.5}$ accounts for 500 adult deaths (in those aged ≥ 30 years) (i.e. 94 per 100,000 population) from all circulatory diseases in Kampala annually. Under the e-mobility scenario, deaths from all circulatory diseases drop to 413 (i.e. 78 per 100,000 population), representing a 17 per cent drop in mortality (Figures 6 and 7).

5.1.4 Acute lower respiratory infection in those aged < 5 years

Under-five mortality follows a similar pattern of reduction in the number of deaths after switching to e-mobility, although only a 12 per cent reduction in deaths was observed in the model (Figures 8 and 9).

5.1.5 Chronic obstructive pulmonary disease

COPD is exacerbated by air pollution, with an 11 per cent reduction in deaths due to COPD following a complete shift from petrol to electric-powered motorcycles (Figures 10 and 11).

Figure 4: Decrease in number of deaths from all natural causes in those aged ≥ 30 years in Kampala following a total switch from petrol-powered to electric-powered motorcycles.

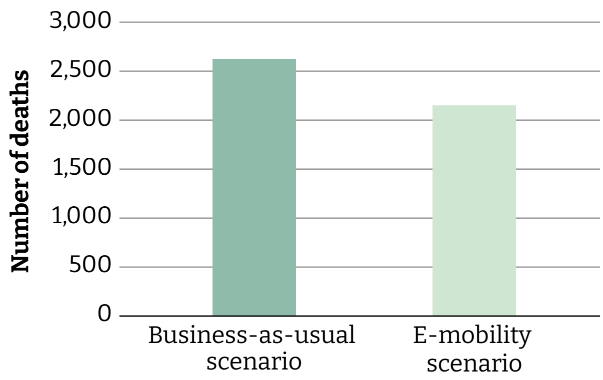


Figure 5: Decrease in deaths per 100,000 population from all natural causes in those aged ≥ 30 years in Kampala following a total switch from petrol-powered to electric-powered motorcycles.

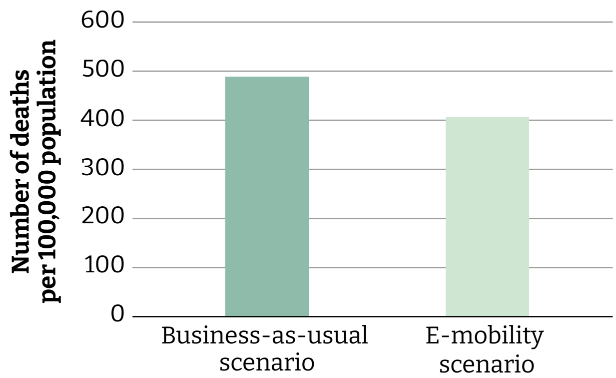


Figure 6: Decrease in number of deaths from all circulatory diseases in those aged ≥ 30 years in Kampala following a total switch from petrol-powered to electric-powered motorcycles.

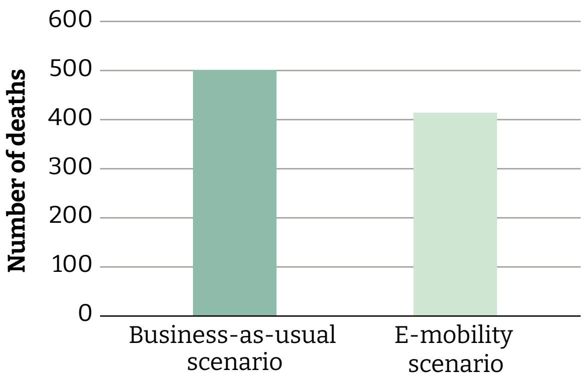


Figure 7: Decrease in deaths per 100,000 population from all circulatory diseases in those aged ≥ 30 years in Kampala following a total switch from petrol-powered to electric-powered motorcycles.

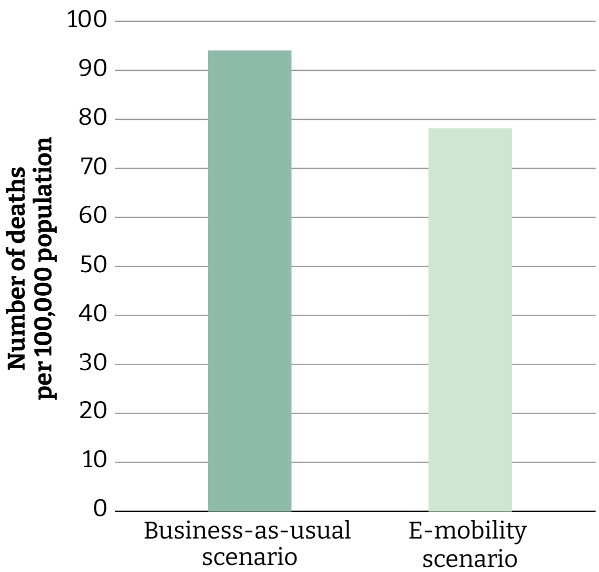


Figure 8: Decrease in number of deaths from acute lower respiratory infections among > 5 year olds in Kampala following a total switch from petrol-powered to electric-powered motorcycles.

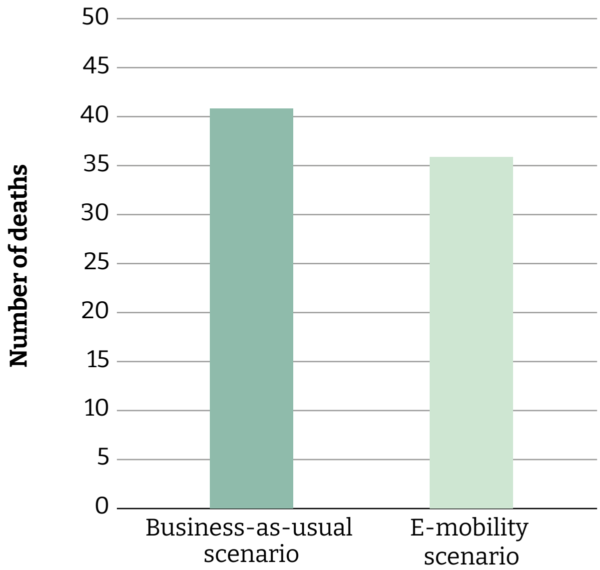


Figure 9: Decrease in deaths per 100,000 population from acute lower respiratory infections among < 5 year olds in Kampala following a total switch from petrol-powered to electric-powered motorcycles.

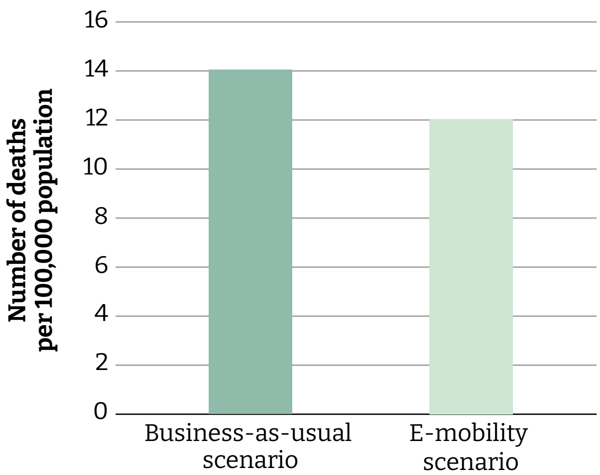


Figure 10: Decrease in number of deaths from COPD in those aged ≥ 25 years in Kampala following a total switch from petrol-powered to electric-powered motorcycles.

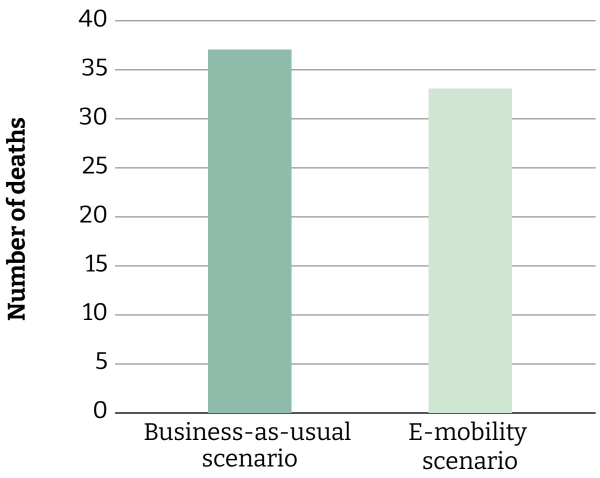
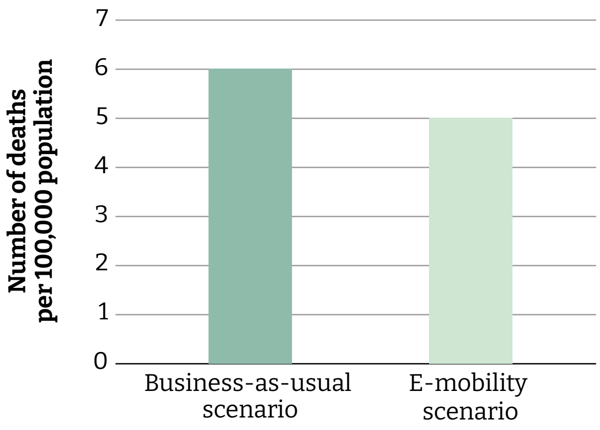


Figure 11: Decrease in deaths per 100,000 population from COPD in those aged ≥ 25 years in Kampala following a total switch from petrol-powered to electric-powered motorcycles.



5.2 Survey results

5.2.1 Comparison between petrol-powered and electric boda bodas

A total of 280 motorcycle riders participated in the survey. The majority of riders (n=257; 92 per cent) used petrol-powered boda bodas with a few using electric bodas (n=23; 8 per cent). When riders using petrol boda bodas were asked which type they preferred, 52 per cent of respondents stated a preference for electric for the following reasons:

- lower fuel cost (electricity versus petrol)
- lower maintenance costs
- ease of maintenance.

However, the respondents also gave several reasons for not yet owning an electric motorcycle. These included:

- higher cost of electric motorcycles
- few charging or battery-swapping stations
- uncertainty about resale value
- health concerns relating to electric batteries.

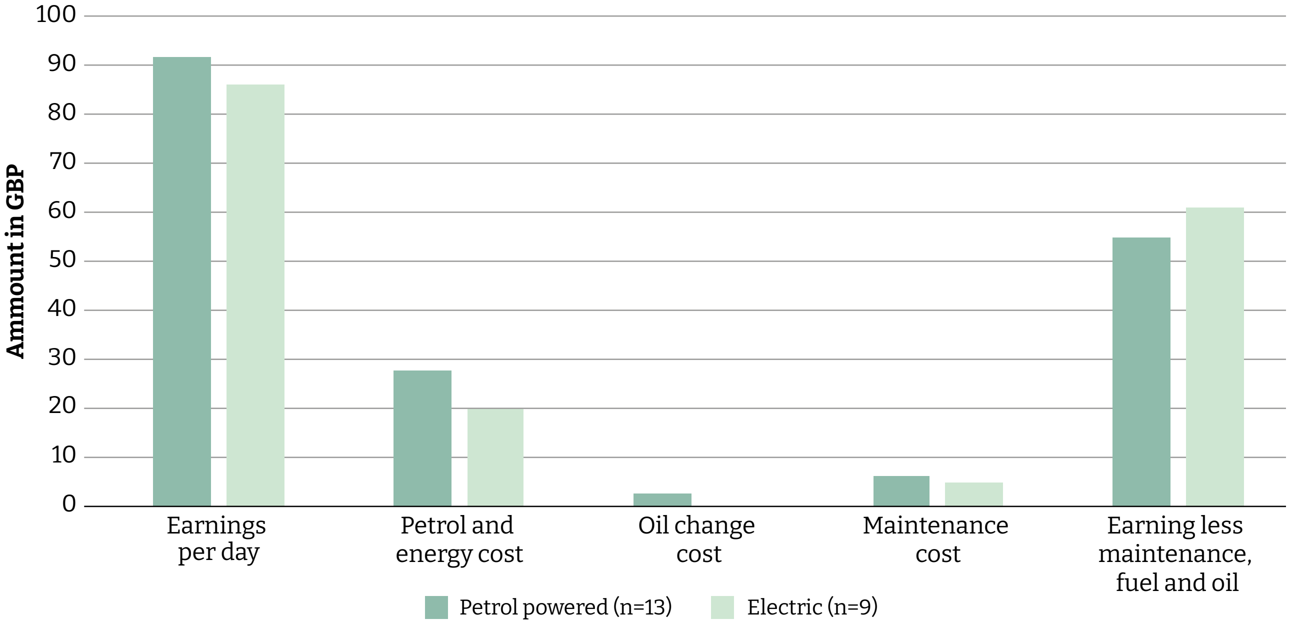
Analysis of the overall earnings (Table 2) of petrol- and electric-powered boda bodas and expenses (petrol, oil, electricity, maintenance) showed that electric boda boda riders achieved a greater net profit than petrol-powered boda boda riders, even though petrol-powered boda bodas made more trips.

Table 2: Overall earnings of petrol- and electric-powered boda bodas less expenses

Parameter	Petrol-powered boda	Electric boda
Trips per day	13	9
Gross earnings (£/day)	9.18	8.63
Cost of petrol and electric energy (£/day)	2.79	2.01
Cost of oil change (£/day)*	0.25	0.00
Cost of maintenance (£/day)**	0.63	0.50
Net earnings less maintenance, fuel and oil (£/day)	5.51	6.12

*Oil is changed every two weeks (cost was divided by 14 days). **Total monthly cost/26 days.

Figure 12: Average daily earnings, maintenance, oil change and petrol/energy costs for petrol and electric motorcycles for average daily trips.



*n = average trips made per day

5.3 Limitations

While AirQ+ provides robust estimates, certain assumptions underpinned the analysis. These include the use of generalised relative risk factors, which do not fully account for local variations in susceptibility or underlying health conditions. Additionally, reductions in $PM_{2.5}$ were modelled based on available data on vehicle registration; the actual health benefits would depend on factors such as adoption rates of electric motorcycles and the carbon intensity of the power supply.

The number of riders using electric motorcycles was small, which could have skewed the results.

6.0. Discussion and conclusion

E-mobility, or the use of electric technologies instead of fossil fuel combustion, is key to reducing air pollutants and achieving positive-related health outcomes. It has been identified as a key component of low carbon urban transport policies (defined as urban interventions to reduce greenhouse gas emissions from the transport sector while also addressing urban mobility challenges).[43] Modelling studies conducted in North America and Europe have projected substantial health-related and economic benefits in association with an electric vehicle transition.[44] In California, USA, population-level respiratory health and air quality benefits have already been associated with electric vehicle adoption.[45]

The full environmental and emissions-related impact of electric vehicles depends heavily on the source of electricity generation (ie the share of renewable/low carbon to highly polluting sources, such as coal). Although studies have predicted reductions in climate change impacts associated with battery electric vehicles when the power is generated from fossil fuels,[46] in Uganda – where electricity is generated primarily by hydropower (82 per cent)[47] – the risk of highly polluting power generation outweighing the benefits of electrification is very low. In terms of ownership costs (including initial capital outlay and maintenance), several studies have found that the lifetime ownership costs of battery electric motorcycles are similar to or lower than conventional motorcycles.[48]

In Uganda, emerging e-mobility startups are providing new electric motorcycles, retrofitting and battery-swapping services. Alongside public support from government leaders, these services signal a readiness for change. However, the initial purchase cost of electric motorcycles, limited availability of charging or swapping stations, anxiety about the range of the electric motorcycles, uncertainty about resale value and health concerns regarding electric batteries are hindering the adoption of electric motorcycles.

From our project, transitioning to electric boda bodas presents a compelling case to alleviate air pollution and associated health risks in both Kampala and Uganda as a whole. Additionally, electric motorcycles may provide climate and economic co-benefits (via greenhouse gas reduction and 'green jobs', respectively).

Future work should build on existing evidence and stakeholder collaboration to address barriers to e-mobility adoption and co-develop strategies for expanding e-mobility in Uganda and other African countries. This will facilitate inclusive, just and sustainable pathways to decarbonising transport in Uganda and Africa.

7.0 Recommendations

- To unlock the benefits of e-mobility governments, innovators and investors should consider how to address constraints such as high initial purchase cost of vehicles, limited charging infrastructure, range anxiety, concerns around resale value and health concerns regarding electric batteries.
- Expanding e-mobility in Uganda requires investment in key infrastructure, including charging stations. To build a skilled workforce, vocational training and apprenticeships should be strengthened, ensuring people are equipped for jobs in the e-mobility sector. Gender inclusion is also essential, as the current boda boda industry is male dominated. Encouraging e-mobility companies to train and employ women in technical roles can create more opportunities and promote diversity in the sector. Additionally, the government should transition its motorcycle fleet to electric, setting an example for wider adoption.
- To boost public confidence and uptake, awareness campaigns should educate people on the benefits of e-mobility. Expanding battery-swapping networks can help reduce concerns about charging and range. High upfront costs remain a major barrier, but partnerships between e-mobility companies, financial institutions, and savings groups can provide microloans to help riders make the switch. Supporting women-led pilot projects in e-mobility will further ensure inclusivity and drive sustainable growth in Uganda's transport sector.

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Head office
The Entopia Building
1 Regent Street
Cambridge CB2 1GG, UK

T: +44 (0)1223 768850
info@cisl.cam.ac.uk

Brussels
Sustainable Hub
Rue du Commerce
72, Brussels 1040
Belgium

T: +32 (0) 2 894 93 19
info.eu@cisl.cam.ac.uk

Cape Town
Workshop17 NCG 146
Campground Road
Newlands 7780
Cape Town, South Africa

T: +27 (0)21 300 5013
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