Policy Brief

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The impact of scaling up electric motorbikes in Rwanda

In brief:

- Approximately one in five trips in Kigali are taken by petrol-fuelled motorcycle taxis, contributing to poor air quality, high demand for imported fuel, and rising Green House Gas emissions that contribute to climate change.
- This brief analyses the potential impact of scaling up the use of electric motorbikes to 100% (as a proportion of all motorbike taxis) in Kigali by 2025.
- The authors find that it would prevent an annual 70 kilotonnes of carbon dioxide emissions, and through improved air quality, produce annual health benefits equivalent to 1350 Disability-Adjusted Life Years (DALYs) per year.
- Economically, the transition would result in an annual reduction of approximately 23 billion Rwandan Francs (RWF) in fuel imports, an energy cost that would be replaced by an additional 14 billion RWF spent annually by e-motos on electricity, a net saving of 9 billion RWF per year on energy. Lost fuel tax revenues would be an estimated 6 billion annually.
- Reduced costs to e-moto companies would be substantial, but it is impossible to know in what proportion this benefit would accrue to motorbike drivers in the form of higher wages, motorbike companies in the form of higher profits, or to consumers in the form of lower prices.

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Background

As Amsterdam and Copenhagen are synonymous with cycling, Curitiba and Bogotá with bus rapid transit, and London, Shanghai and Tokyo with the subway, Kigali could be the city global policymakers look to for best practices on the electrification of transport, especially electric motorbikes (e-motos). Motorbikes (motos) are a critical component of the transport network in Kigali, providing a relatively low-cost mobility option in parts of the city that other forms of public transport have not reached, and providing first and last mile mobility where the concentration of travel is too low for mass transport. Companies including Safi, Rwanda Electric Mobility and Ampersand are already operating in Kigali and have plans to deploy thousands of e-motos in the near future. Realising the ambition to scale up e-motos, however, will require not only private investment and enterprise, but also forward-looking policymaking and investment.

Kigali is a rapidly growing city with a population of around 1.6 million which is predicted to reach 4 million by 2050[1]. Rwanda is also urbanising rapidly from a low level. The country has a tremendous opportunity to avoid 'lock in' to high urban energy use and emissions from various sectors if actions are taken today before large investments supporting the business-as usual pathway are made[2]. A University of Leeds report by Gouldson et al (2018) called "The economics of low carbon cities – Kigali, Rwanda"[3,4] found that an important sector to target with large emission-reducing investments, is the transport sector. In particular, the study predicted that scaling up electric bikes would not only result in significant net carbon emissions but would also be economically beneficial. This policy brief examines the electric moto sector further and presents more precise calculations of the benefits of a shift to e-motos for the City of Kigali.

A shift to e-mobility offers any large city the promise of substantial economic, environmental and health benefits. Electric engines are dramatically more energy efficient compared with combustion engines, potentially leading to reduced energy expenditure on imported energy. Electric motorbikes also emit no direct Greenhouse Gas (GHG) emissions or air pollutants from combustion, are less likely to break down, are cheaper, offer the promise of reduced congestion by moving people away from private cars and new sources of employment. At the same time, a shift to electric mobility could deprive the Government of significant tax revenue from fuel sales and increasing numbers of motorbikes and cars could pose a risk to public safety.

How large are these costs and benefits, where do electric motos fit in the transition to more accessible, affordable and sustainable urban mobility in Kigali, and what role do policymakers play in this transition? Combining city-level transport and economic modelling this policy brief presents evidence of the environmental, economic and health impacts of a rapid transition and a set of key take-aways for transport policymaking in Rwanda.

Methodology

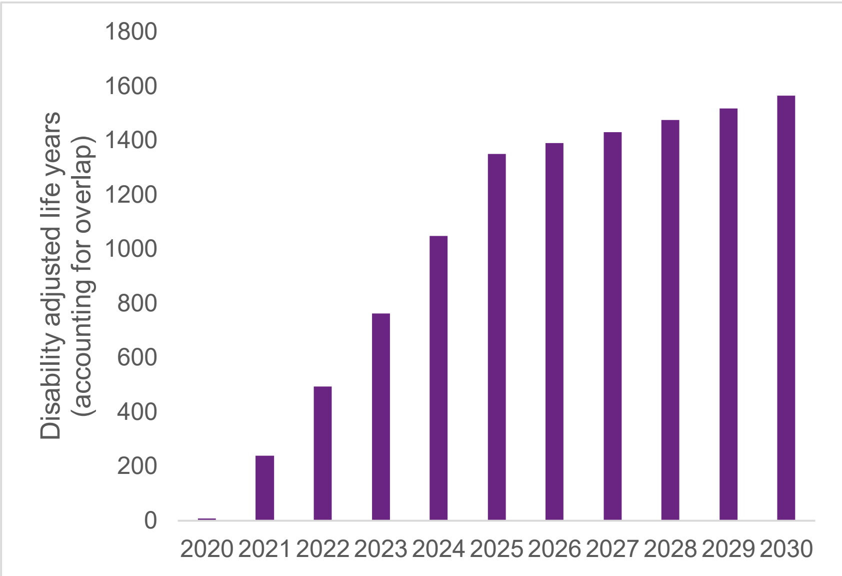
A city-level transport model for the City of Kigali, developed by the University of Leeds in partnership with the IGC, was used for the calculations in this policy brief. This model relies on travel demand and travel mode estimates for 261 city zones[5], vehicle ownership and composition data, vehicle occupancy rates, and demographic and economic forecasts for the city.

Supplementing this model are a set of calculations to estimate the public health impacts of a shift to e-motos. Air quality data is drawn from the most recent analysis which estimate that as much as 50% of key urban air pollutants may be generated from transport in Kigali[6]. The impact of ambient multipollutant air pollution on public health, and accounting for co-morbidities, was estimated using exposure–response functions[7].

Impacts on public health

Conventional motorbikes on Kigali's streets are a significant contributor to outdoor air pollutants that can cause cardiovascular and respiratory diseases, lung cancer and strokes[8]. One way to capture the diverse chronic and acute effects of poor air quality on public health is the disability-adjusted life year (DALY), a measure of overall disease burden expressed as the number of years lost due to ill-health, disability or early death.

Figure 1: Disability-Adjusted Life Years saved annually from reduced air pollution



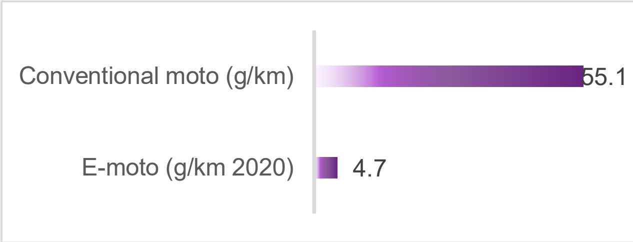
Drawing on the most up-to-date information on the sources of air pollution in Kigali, a rapid shift to 100% e-motos by 2025 would produce annual health benefits equivalent to 1350 DALYs saved in 2025. If methodology for valuing DALYs is applied, this represents a saving of 1.4 billion Rwandan Francs (RWF) per year[9]. To put this in context, ambient air pollution in Rwanda is estimated to cost approximately 50,000 DALYs per year in Rwanda[10]. Based on conservative assumptions, we estimate that 25% of the negative health impacts of outdoor air quality in Kigali could be eliminated by a shift to electric mobility for motos.

It should also be noted that the wider impacts on wellbeing of improved air quality extend beyond the impact on mortality and disability. Milder impacts of poor air quality, including allergies and reduced outdoor activity are not included in these figures.

Impact on GHG emissions

The impact on GHG emissions from a rapid transition to e-motos would also be significant. While electric motorbikes emit no GHG emissions directly, indirectly they contribute to GHG emissions through their use of grid electricity generated by burning peat, heavy fuel oil, diesel, and to a lesser extent natural gas. Importantly, however, the electricity grid in Rwanda has been utilising an increasing share of renewable energy in recent years. As a consequence, modelling suggests that conventional motos in Kigali emit ten times more GHG emissions per kilometre travelled (Figure 2) than e-motos.

Figure 2: Grams of CO2 per km for e-motos versus conventional motorbikes



Modelling this impact through 2025 we estimate that a rapid shift to 100% e-motos would reduce GHG emissions by approximately 70 kilotonnes of carbon dioxide emissions annually by 2025, reducing total transport emissions by approximately 10% in Kigali.

How much do these findings depend on the emissions intensity of the electricity grid? Increased renewable and low carbon electricity generation has seen the emissions intensity of electricity in Rwanda fall from 0.30 to 0.13 tonnes of carbon dioxide emissions per megawatt hour between 2013 and 2018. In the near future, however, emissions from the electricity grid may rise significantly with the addition of peat electricity generation, which could produce in excess of 1.00 tonnes carbon dioxide emissions per megawatt hour[11]. Analysis here suggests that as long as the average GHG emissions intensity of the grid is less than 1.56 tonnes of carbon dioxide emissions per megawatt hour, e-motos will produce fewer emissions per km than conventional motos. Therefore, even in the theoretical (but highly unrealistic) case where e-motos use energy solely generated from peat electricity generation they would still have lower emissions relative to conventional motos.

Impact from reduced journey costs

Whilst e-motos are more expensive to buy than conventional motos[12], they have lower costs per kilometre. In particular, although electricity prices in Rwanda are high by global standards, expenditure on energy for electric motorbikes is significantly lower than for conventional motorbikes. With current technologies, 100 RWF would provide fuel for a journey of approximately 5 kilometres on a conventional moto, but the same 100 RWF would provide electricity for a journey on an electric motorbike of 11 kilometres[13]. Over the lifetime of a motorbike[14] these savings would amount to approximately 1.9 million RWF of savings in fuel expenditure.

Other costs, for instance those associated with maintaining and operating electric motorbikes, are also reduced; for example, there is no such thing as an ‘oil change’ for an electric vehicle. Collectively these factors suggest that a doubling or even tripling of moto driver wages with no effect on passenger fares is possible. It is important to note, however, that e-moto firms face substantial upfront costs to starting their businesses that they will need to recover. These include the cost of additional batteries, charging stations, and maintenance and assembly facilities. In interviews with each of the three major e-moto firms Kigali all three committed to higher wages for moto riders, and Ampersand has made public a commitment to increase the typical wages of moto drivers by 50-100%[15]. Coordination between e-moto firms and the government, for example through the development of an e-moto taskforce[16], will be important towards developing policies.

Fiscal impact

In Rwanda, revenues from taxes on petrol and diesel are ring-fenced for investments in new roads[17]. With many parts of Kigali lacking paved roads, as well as other basic infrastructure including water, sewers and electricity connections, a decline in fuel tax revenue could put at risk wider programs of urban development.

Our analysis finds that a shift to 100% e-motos by 2025 could reduce government revenue from fuel taxes by 6.1 billion RWF annually. While this figure is substantial, it is dwarfed by an estimated **23 billion RWF that would be saved on fuel imports**[18]. In addition, e-moto owners will buy 13.5 billion RWF of electricity annually. Given projected excess capacity in the Rwandan electricity grid in the coming decade, this expenditure can be seen as additional to forecasted electricity revenues.

Conclusion

A rapid transition to e-mobility in Rwanda, led by e-motos, carries the opportunity for substantial economic, social and environmental benefits. Achieving these impacts, however, requires careful policymaking to support early stage e-mobility firms, coordinate between stakeholders in the transport sector, establish new standards and regulations and manage the impacts on the treasury and incumbent actors. These measures are outlined in more detail in Bajpai & Bower (2020)[19] and in the recommendations from the report of the MININFRA-IGC workshop "Scaling up sustainable transport systems in Rwanda" which took place on 25th February 2020.

End notes

[1] Bower, J., & Murray, S., 2019. Housing need in Kigali. International Growth Centre. Available at https://www.theigc.org/wp-content/uploads/2019/07/Bower-et-al-2019-Final-report.pdf

[2] Gouldson, A., Colenbrander, S., Sudmant, A., Chilundika, N., de Melo, L., 2018. The economics of low carbon cities – Kigali, Rwanda. University of Leeds and International Growth Centre. Available at https://www.theigc.org/wp-content/uploads/2016/11/Kigali-Low-Carbon-Cities-Report_dr6.pdf

[3] Colenbrander, S., Sudmant, A., Chilundika, N. and Gouldson, A., 2019. The scope for low-carbon development in Kigali, Rwanda: An economic appraisal. *Sustainable Development*, *27*(3), pp.349-365.

[4] Sudmant, A., Colenbrander, S., Gouldson, A. and Chilundika, N., 2017. Private opportunities, public benefits? The scope for private finance to deliver low-carbon transport systems in Kigali, Rwanda. Urban Climate, 20, pp.59-74.

[5] The zones are based on an assessment of the Kigali transport network originally commissioned by MININFRA in 2012: Development of a Hierarchical Multi-modal Transport Model: Model Development Task Specific Technical Report SSI Engineers, Kigali, Rwanda (2012)

[6] Gustavsson, M., Bergk. F., Helms H., Linden M., Jamet M., Ruberambuga R., & Wallmark, C. 2019. Electric Mobility in Rwanda: Background and Feasibility Report. Unpublished final report, Sustainable Mobility and Rapid Transport (SMART project), FONERWA, Government of Rwanda, Kigali, 15 December 2019.

[7] GBD, 2016. Risk Factors Collaborators. Global, regional, and national comparative risk assessment of 84 behavioral, environmental and occupational, and metabolic risks or clusters of risks, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. The Lancet 390, 1345–1422 (2017)

[8] Schraufnagel, Dean E. et al. 2019 Air Pollution and Noncommunicable Diseases. CHEST, Volume 155, Issue 2, 417 - 426

[9] Using methodology from Robinson, L.A., Hammitt, J.K. and O'Keeffe, L., 2019. Valuing mortality risk reductions in global benefit-cost analysis. Journal of Benefit-Cost Analysis, 10(S1), pp.15-50, we calculated that the Value of a Statistical Life in Rwanda is about 50,000 USD, and that this corresponds to a saving of 1.51 million USD, which converts to a saving of 1.4 billion RWF in 2025 alone.

[10] IMHE 2020. The Global Burden of Disease. The University of Washington. Available at https://vizhub.healthdata.org/gbd-compare/

[11] McIntyre, J., Berg, B., Seto, H. and Borchardt, S., 2011. Comparison of lifecycle greenhouse gas emissions of various electricity generation sources. World Nuclear Association (WNA) Report.

[12] A review of recent e-moto and conventional moto options suggests e-bikes to be approximately 125% more expensive

[13] This figure assumes retail electricity prices. Using industrial rates would significantly increase the potential distance.

[14] The useful life of a conventional moto is estimated to be 175,000km (175km/day x 250 working days per year x 4 years, all figures from consultation with industry members).

[15] Ampersand (2020) Sparking mass market electric transport in Africa. Presentation by Josh Whale to MININFRA/IGC workshop "Scaling up sustainable urban transport systems in Rwanda", 25th February 2020

[16] J. Bajpai and J. Bower (2020). "A roadmap for e-mobility in Rwanda". International Growth Centre, April 2020

[17] Government of Rwanda. 2017. National feeder roads policy and strategy. Ministry of Infrastructure. Available at https://www.mininfra.gov.rw/fileadmin/user_upload/NATIONAL_FEEDER_ROADS_POLICY_AND_STRATEGY_FOR_RWANDA.pdf

[18] Calculations for this figure include several key assumptions: Gasoline is assumed to average 1089 RWF/litre, the tax rate is assumed to be 183 RWF per litre fuel and retail and distribution are assumed to account for 18% of pump prices. The total volume of fuel saved from the transition to e-motos is estimated by the city level model and converted to total fuel expenditure using the assumed fuel price. Taxes, retail and distribution costs are then removed in order to provide an estimate of the cost of bulk fuel purchases. These estimates are strongly dependant on underlying assumptions, most important of which are energy prices and exchange rates built into the assumption about average gasoline prices.

[19] J. Bajpai and J. Bower (2020). "A roadmap for e-mobility in Rwanda". International Growth Centre, April 2020