Article

Electric mobility in East-Africa: How the policy and stakeholder environment tackles the integration of informal transport systems into low-carbon transition – case studies from Kigali, Kisumu, Nairobi and Dar es Salaam

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Abstract: Electric mobility begins to enter East-African markets. This paper aims to investigate what policy level solutions and stakeholder constellations are established in the context of e-mobility in Dar es Salaam, Kigali, Kisumu and Nairobi and in which ways they attempt to tackle implementation of electric mobility solutions. The study employs two key methods including content analysis of policy and programmatic documents as well as interviews based on purposive sampling approach with stakeholders involved in mobility transitions. The study findings point out that transport operators and their representative associations are less recognized as major players in the transition, far behind new e-mobility players (start-ups) and public authorities. The study further indicates that a set of financial and technical barriers persist such as high upfront investment costs in vehicles and infrastructure, or anxieties regarding competitiveness with fossil fuel vehicles, that constrain the uptake of such private e-mobility initiatives. This study concludes by identifying current gaps that need to be tackled by policy makers and stakeholders in order to implement inclusive electric mobility in East-African cities, considering modalities that include transport providers and address their financial constraints.

Keywords: electric mobility, paratransit, informality, transportation, East-Africa

1. Introduction

Facing climate change and associated issues such as humanitarian crises and growing socio-economic disparities, the global agendas uniformly recognize the urgent need to transition to sustainability. Development of low-carbon transportation in urban centres is positioned as a key element of this process, since the transportation sector is estimated by the Intergovernmental Panel on Climate Change (IPCC) to generate 23% of global energy-related greenhouse gas emissions[1]. Consequently, promotion of public transportation and electric mobility is identified as a crucial point in the combat against climate change[2]. Pathways to reach more sustainable urban mobility are structured around the three-pronged "Avoid-Shift-Improve" paradigm that promote trip reductions, shift towards public transport and non-motorized modes, together with increased vehicle efficiency.[3] Electrification of mobility is commonly conceptualized as part of the "Improve" component and as a low-carbon transport strategy[4]. This transition

links also with the necessity to phase out the old solutions[5] such as internal combustion engines (ICE), inevitably resulting in socio-economic consequences for those who depend on these technologies as a source of income and livelihood.

A specific focus on aspirational, quantitative improvements is visible in the major international development agendas, while focusing to a smaller degree on the local complexities of the transition to sustainability process. For instance, some authors argue that documents like the New Urban Agenda reinforce path dependency on techno-managerial approaches and ecological transformation paradigm, even though those have failed to work in the past[6]. Similarly, the SDGs are discussed to require stronger integration in local contexts and their evaluation measures to integrate more robust qualitative components[7]. On a broader level, even some of the most acknowledged eco-friendly planning solutions, such as promotion of compact city design, walkability and public transportation, may have adverse social effects and lead to displacement or marginalisation of low-income groups[8] [9]. While the current pandemic may accelerate transition to some of these solutions, it also puts an enormous economic strain on sectors operating outside of regularised and formal markets. The restrictive measures, enforcing reductions in mobility in the poorest parts of densely populated cities, epitomises the paradox embedded in the process of transitioning into sustainability. The costs of changes, which are beneficial for the majority of society, may be borne disproportionately by specific sectors or groups or affect them in a more direct manner.

Along the theoretical debate, ground realities of urban transformation illustrate similar difficulties in prioritisation of public transportation and e-mobility solutions, also East African cities experienced challenges when implementing integrated public transport solutions or pushing for new technical standards and fuel taxation[10].

Electric vehicles are beginning to enter the market in East-Africa, mainly in the context of micro-mobility[11]. The situation is slowly evolving with the introduction of some electric vehicles, albeit at stages of small fleets or pilot projects. Such vehicles include two and three-wheelers, including bikes, motorcycles, tricycles, as well as buses and cars, the latter both in the forms of private vehicles and for commercial purposes as taxi services. The transition towards electrification is a complex process, characterised by a triple value chain of vehicles, charging and surrounding network[12], commonly requiring deep multi-sectoral cooperation, and seeing the emergence of new electric mobility players such as private transportation or energy companies. Therefore, e-mobility may add further complexities to local systems and, arguably, could run the risk of being contested on various levels.

Contestations as a reaction to transportation regulation and innovation are not uncommon. Recently, protests and unrest instigated by policies addressing climate change were significant and concerned different dimensions of transportation planning. This included contestation of regulations on fuel taxation as in France during 'Yellow Vests' protests, imposed technological standards in electrification of jeepneys in Metro Manila[13] or Cape Town where   extension of the bus system to townships was contested by operators of mini-buses. Those examples illustrate why neglecting socio-economic issues in climate change oriented policy planning may result in a spontaneous contestation of a specific solution and in some cases entangling it with political agendas. More recently, these kinds of tensions have been fuelled by the public health regulations linked to COVID-19, and were perceived as a further threat to the economic wellbeing of small scale entrepreneurs. The pandemic context is thus likely to further complicate the transitioning process to electro-mobility due to the disruption of supply chains and redirection of budgetary sources to other priorities.

For these reasons, addressing the issues of social justice[14], informal[15] solutions, workers' rights[16] and similar, emerges as a central component of transitioning processes. The social and economic aspect of integration of e-mobility solutions into local contexts, should be considered as equally important as their technological appropriateness or regulatory mechanisms they enforce. The picture gets further complicated considering that   transitioning to e-mobility happens within a variety of transport modes and

geographies having distinct operational, financial and organisational patterns, and may experience various reactions from operators and users. In some cases transport transformation   processes may be supported through bottom-up activism of the informal sector, local start-ups supporting mainstreaming of specific technology at a low cost, or pressure from users who appreciate specific mode (for instance public opposition against a ban on moto-taxis in centre of Kigali)[17]. In others the magnitude of required investments puts different challenges on the sector and arguably leads to various responses of the involved stakeholders. Urban and transportation studies have increasingly recognised this through a reflection on the interwoven relationship between formal and informal practice[18] and institutional bricolage it creates[19]. Facing inherent conflicting rationalities in urban development contexts[20], development of policies which may support integration of various systems, for instance through practices of co-production[21] or hybrid systems, could be positioned as a central step in increasing acceptance of e-mobility and technological innovations.

This article investigates what policy level solutions and stakeholder constellations are established in the context of e-mobility in East Africa and in which ways they try to tackle implementation of electric mobility solutions. The specific attention is given to the issues of integration of existing transport service providers, who operate on the intersection of formal and informal transportation systems. It reflects on the recognition of diversified transport modes within the policies, inclusion of different range of stakeholders into the transitioning process as well as differentiations in the focus of these policies, including: environmental, economic, technical and social issues. At the same time, the first responses to those external regulations and formats by the private sector entrepreneurs and informal (semi-formal) actors are discussed. The article finalises with recommendations on how the public sector can promote e-mobility solutions, through concrete actions and policies, while ensuring that negative socio-economic impacts of the transitioning process are mitigated. The analysis is conducted in the context of Nairobi, Kisumu, Kigali and Dar es Salaam.

2. Materials and Methods

This study takes an exploratory character and concentrates on the investigation of policy instruments and perceptions related to the introduction of e-mobility in mass transit in cities of East Africa. Two key methods are applied in the study including the content analysis of policy and programmatic documents as well as interviews with stakeholders involved in mobility transitions. This is supplemented with an analysis of the stakeholder landscape in each of the cities included in the study.

The content analysis encompasses the most important documentation, which has been identified as relevant for potential e-mobility transitions based on their focus on environmental, energy or transportation sectors. The review was conducted on a level of country, city and programme level documents (see Table 2).

The interviews are conducted with relevant actors involved in or affected by e-mobility transitions in Dar es Salaam, Kigali, Kisumu and Nairobi. The recruitment of interviewees was conducted based on a purposive sampling method with an intention of reaching multi-sectoral perspective on the issue in question. Overall 46 interviews with representatives from public sector, e-mobility start-ups, transport operators, academia, NGOs and international organisations were conducted between January and December 2020. Relatively equal distribution of sectors was attempted, although this was limited by availability of respondents in specific contexts (see Table 1).

Table 1. Number of Interviews in each sector by specific city

	Kigali	Nairobi	Kisumu	Dar es Salaam
Academia, NGOs, international organisations	-	8	3	2
Public sector – country level	4	1		1
Public sector –city level	1	1	4	3
Start ups/private sector	4	4	2	1
Operators	3	3	1	-

Consequently, rather than aiming for full representativeness, the study focuses on identifying perceptions on the transition process across different sectors as well as information on anticipated socio-economic impact on operators. Those perceptions are juxtaposed with the existing policy environment.

3. Cities' profiles -   Dar es Salaam, Kigali, Kisumu and Nairobi

The four cities included in this study are dynamically developing commercial and cultural centres located in Eastern Africa. Nairobi, Dar es Salaam and Kigali are the biggest cities and urban agglomerations of their countries inhabited respectively by 4.4[22], 6.4[23] and 1.29[24] million people. Kisumu is the third biggest city in Kenya with an urban population estimated at 567,963 and a county population of 1.1 million inhabitants. While differing in size, geographic context and specific functions, they share commonalities in terms of urban transformation processes they undergo. Additionally the cities experienced stable to rapid population growth (Kisumu in average by 1.63% in the years 2000-2015[25], Nairobi - 3.8%, Dar Es Salaam - 5.4% and Kigali - 4.2% in average in the years 2000-2018[26]). A large proportion of this growth is concentrated in informal settlements, emerging in a peri-urban context in most of them. For instance, 62% of Kisumu's inhabitants are estimated to live in informal settlements. In Nairobi, the spatial structure inherited from colonial times reinforced socio-spatial and income-based segregation and resulted in dramatic divergences in residential densities[27] (half of its population on 5% of the total residential area only)[28].   In Kigali, intensive efforts to modernise infrastructure link with waves of evictions and the concentration of low-income population in peripheral 'bedroom' types of districts[29]. Similarly, Dar es Salaam continues to experience radical urban sprawl[30].

Some commonalities are to be observed in terms of the modal split, characterised by high shares of collective transport and walking, and of the evolution of urban transportation systems in the last decades. In Nairobi, walking, informal private minibuses acting de facto as public transport (*matatus*) and semi-formal buses are the dominant mobility options with respectively 39.7%, 28.5% and 12.2% of modal share in 2013[31]. While Kisumu lacks a formal public transport system, moto-bodas (13.5%) and matatus/buses (13%) are, apart from walking (52.7%), the dominant form of transportation [32]. Similarly in Dar es Salaam, 62% of trips happen with *daladalas* (minibuses), 17% with walking, 12% with private vehicles in 2014[33]. In Kigali, the majority of trips are done on foot or bike (52%) or by public transport (PT) mostly bus services (16%), but also motorcycle taxis (12%). The city is also characterised by low to moderate levels of motorization (approximately 15 automobiles for every 1,000

inhabitants)[34]. Each of the cities initiated important investment into public transportation to various degrees, except for the case of Kisumu which is still planning to undertake a scoping study for a potential public transport project. Dar es Salaam is currently engaged in the Urban Transport Improvement Project with the support of the World Bank and the first phase of its BRT system was launched in 2016. A number of measures are discussed or in the wake of being implemented in Nairobi in order to improve the mobility landscape. This includes the future introduction of BRT services - even though significantly delayed - renewal of railway infrastructure and vehicles, and improvement of the non-motorized infrastructure, especially in the city core. Kigali has seen remarkable development of road and street infrastructure, and as part of this process, investments in safe sidewalks and incremental public transport reforms were advanced to benefit most of the urban trips.

While historically semi-formal transport operators played a relevant role in transport provision in each of the cities, currently this involvement varies across the region. The most advanced 'formalisation' process occurred in Kigali. First reforms leading to reductions in push-taxis and moto-taxis were introduced in the city around 2005[35]. Further public transport reform was initiated in 2008 by the City of Kigali Authority and led to regularisation and signature of bus operation contracts in 2013. Currently motorcycle taxis provide competing service to public transport buses on the same routes but on the other hand supplement public transport buses by providing door to door on-demand trips to various locations within the city. The City of Kigali government and Traffic Police department is engaging these motorcycle and bicycle taxi operators and an increased effort has been realized in the formalization process.

Public transport in Dar es Salaam is predominantly provided by a large fleet of privately-owned minibuses (so-called dala-dala), which are operated informally with often non-organised schedules and route services[36]. In addition to these bus services, motorised two and three-wheeler taxis (Boda boda and Bajaji respectively) are very common. They are used by the population for shorter distances and enable feeder-connectivity to the paratransit buses. In areas not served by buses, motorcycle-taxis are the only publicly available mode of transportation and hence offer a de-facto public transport service filling a gap in the transport system. In the face of the mobility challenges facing the city, public authorities responsible for the sector have in recent years, envisaged to phase-out the minibuses on all major roads and replace them with BRT buses in the medium to long term[37]. In the short term, current BRT initiatives introduced in the city in 2016 are expected to come along with the formalisation of the existing private transport services and their integration into the entire public transport system in Dar es Salaam[38].

In Nairobi the dominant modes of walking and collective transportation are undertaken in poor conditions including non-existent or poor-quality sidewalks, flawed bus services and in the absence of urban planning for paratransit, public regulation being either inexistent or repressive[39]. Planning has been additionally criticised for its focus on large road transportation projects and its top-down approach, lacking civil society participation[40] [41]. The public sector's efforts regarding boda-bodas (moto-taxis) included top-down attempts to regulate them, unapplied to a large extent. Recent attempts to increase control over the transport sector included bus route permits, the theoretical possibility of low-emission zones[42] and controversial attempts to expel matatus from the city core.

Kisumu lacks a formal public transport system and its role is played by privately owned *matatus* (minibuses). The matatu industry is a major employer and creates revenues for the public sector through the fees they pay to the County Government of Kisumu. Additionally there is a rise in operations of two (bicycles and motorcycles) and three wheeler vehicles, which are often run by civilians seeking to make a living and yet form a crucial part of the mobility ecosystem in Kisumu. They supplement the matatus by providing on-demand trips to various locations within the city as well as the rural outskirts of the city. The County Government of Kisumu is constantly engaging these

informal transport operators and increased efforts have been realised in the current process to formulate a Kisumu Sustainable Urban Mobility Plan (SUMP) in partnership with ITDP and the Ford Foundation.

4. E-mobility policy environment: Barriers and opportunities for different mobility providers

Electric mobility could provide opportunities for different types of mobility providers and stakeholder groups. However, this requires an enabling policy environment that allows participation in the transport system of public transport companies, corporatives, associations, innovators and individual drivers alike. This subchapter reflects on these issues by scrutinising the emerging policies on e-mobility across the studied countries and cities. Rwanda, Kenya and Tanzania stand at the beginning of a path towards policies on transport electrification. Analysing the evolution of policies and project interventions over the last two years show that electric mobility is increasingly identified by public institutions as a relevant low-carbon strategy, allowing to mitigate carbon emissions and decrease urban air pollution. Yet, policies at national and local levels remain at a very nascent stage, fragmented and still uncoordinated and in case of Tanzania they are mostly absent. Across the analysed four East-African cities, similar trends of a progressive elaboration-or external push for elaboration-of policies and regulations enabling electric mobility can be observed; however, pace of adoption and levels of ambition vary in the four cases.

Table 2. Policy environment in Dar Es Salaam, Kigali, Kisumu and Nairobi

	Kigali	Nairobi	Kisumu	Dar es Salaam
Country level policies	- EV mitigation target in the updated Nationally Determined Contribution (NDC) (2020), following the third National Communication under the United Nations Framework Convention on Climate Change (2018) - Ongoing revision of the National Transport Policy, including EVs - Feasibility study on e-Mobility in Rwanda (2019), upcoming World Bank electric last mile connectivity study - Ongoing work on standards	- National Climate Change Action Plan 2018-2022 announcing EV technical standards, incentives, pilot projects and public procurement, implementing the 2020 updated NDC supporting low-carbon and efficient transportation systems - Ongoing revision of the Integrated National Transport Policy (2009), including EVs - Target of 5% of imported electric cars annually by 2025 (National Energy Efficiency and Conservation Strategy) - Kenya Bureau of Standards (KEBS) 21 standards for EVs in 2019 - Financial Bill of 2019 reducing excise duty rates for all battery electric vehicles - Exploratory work: e-mobility study, workshops, works on taxation, registration and importation of EVs		- No transport policy mentioning EVs, but fuel switching in transport systems mentioned in its climate mitigation strategy (2012)
City level policies	- Kigali Transport Master Plan 2050 (2020), with one unprecise reference to charging infrastructure	Climate Change Action plan in the making mentioning e-mobility Consideration of one	Kisumu Sustainable Urban Mobility Plan (SUMP) 2020 setting electrification	Absent at this stage

	- GGGI Quickscan charging infrastructure for Kigali e-buses (2020)	electric BRT corridor	targets	
Thematic focus				
Incentives for e-mobility uptake	Feasibility study recommendations: reduced import duties and VAT on EV parts, special electric tariff for charging stations Custom tax exemptions granted by the Rwanda Development Board	National incentives in the form of reduced excise tax for EVs from 20 to 10% in 2019; ongoing further work to reduce taxation and to facilitate importation and registration		Absent at this stage
Restrictive regulatory measures on conventional vehicles	National level: targeted (upcoming) introduction of vehicle emission standards, including tax incentives inspection and scrapping older vehicles (2020 updated NDC)	National level: age limit of 8 years to import second-hand cars		Age limit of 10 years importing second hand cars
		City level: possibility for low-emission zones (2019 Nairobi City County Transport Bill)	Absent at this stage	
Incentives for integration of transport providers in e-mobility	Absent at this stage	Absent at this stage	Absent at this stage	Absent at this stage

National Policies

Even still at a nascent stage, Kenya and Rwanda authorities are engaged in the process of developing e-mobility strategies. The sequential logic of steps and policies (e.g. targets via climate change policies, transport policies, standards and financial incentives, feasibility studies) however vary between the two countries. Kenya is more advanced in terms of standards and incentives but lacks a national mitigation target via e-mobility and a comprehensive feasibility study, two steps that Rwanda has already undertaken, before now working on incentives and standards. In Tanzania no specific policies or standards are in place.

Climate change policies

At national level, climate change policy documents recently released mention electric vehicles. Rwanda is the first country in the region to submit its second Nationally Determined Contribution (NDC) in May 2020, where it identifies electric mobility as part of its climate change mitigation measures. EVs are expected to contribute to a reduction of 9% of GHG emissions in the energy sector in 2030[43]. The NDC envisions a progressive adoption of electric buses, cars and motorcycles starting in 2020, replacing conventional vehicle sales and diminishing transport fuel imports. This measure is conditional,

meaning that it depends on external financial support from donors (DFIs, climate or private). Previously, e-mobility had been mentioned in the Third National Communication under the United Nations Framework Convention on Climate Change in the 'Mitigation Scenarios and Reduced Emissions', but only for the adoption of electric cars, planned to substitute 150,000 conventional cars by 2050[44].

Kenyan authorities have not quantified a similar overarching mitigation target via e-mobility yet; however, the National Climate Change Action Plan 2018-2022 announced a series of measures facilitating the introduction of EVs and identified the opportunity to reduce 60% of two-wheeler emissions via a transition to electric motorcycles[45]. Studies have shown that e-mobility bears the second highest mitigation potential for transport emissions in Kenya[46], (as 86% of the electric generation mix is produced from energies qualified as renewable in 2018, mostly geothermal and hydropower[47]. In addition, the country has a substantial electricity surplus of 25-30%, raising a financial interest to see demand for electricity rising through transport electrification.

Tanzania here lags behind, as its NDCs and the National Climate Change Strategy lack explicit mention of electric mobility, even though the Strategy outlines objectives and interventions in the field of energy, a crucial sector for e-mobility development, promotes fuel switching in transport systems and low emission transport via mass rapid transport systems[48]. Current significant developments in hydropower generation presents opportunities in the transport, industry and manufacturing sector, favouring increases in productive uses of electricity and e-mobility.

Transport policies

Following the inclusion of electric mobility in climate-related planning documents in Kenya and Rwanda, national transport policies are slowly starting to integrate this technological transition.

The Kenyan draft Updated Integrated National Transport Policy (2020) includes a principle of governmental support toward the uptake of EVs-possibly going up to full electrification of land transport vehicles, the need for further incentives and standards (safety of vehicles and personnel protection systems, charging infrastructure, infrastructure support). More recently, the Kenyan Ministry of Energy (2020) - not Transport - included a target of 5% EVs in total yearly car imports in its National Energy Efficiency and Conservation Strategy[49], raising the question of coordination between public institutions on e-mobility.

Rwanda is also in the process of revising its National Transport Policy, mirroring and operationalising the climate mitigation target on e-mobility set in its updated NDC. This leans on findings from the 2019 e-mobility feasibility study commissioned by the Rwanda Green Fund (FONERWA), which kick-started the work towards a future e-mobility strategy. This study identified the possibility to reduce GHG emissions by 17% in 2030 as compared to a business-as-usual scenario, provided EVs represent 30% of total motorcycles, 8% of cars, 20% of buses and 25% of taxi, mini and microbuses in 2030[50]. Subsequently to the study, Rwanda President Paul Kagame announced in August 2019 his intention to replace conventional motorcycles with electric ones. In contrast, Tanzanian authorities have not revised national transport policy yet to include e-mobility.

Standards and incentives

Besides national transport policies, a regulatory environment is slowly emerging around technical standards and financial incentives, though at a different pace in the three countries.

Kenya is one step ahead: by June 2020, 21 technical standards have been adopted, covering vehicles, batteries and safety requirements. On the fiscal level, a 10-point reduction of excise duty for electric vehicles from 20% to 10% was approved in 2019. Current discussions touch upon a further reduction of excise duty, targeted percentage of

EVs within total imports by 2025, modification of building code to plan for the integration of charging infrastructure in public building and residential estates[51].

In Rwanda, the above mentioned feasibility study positions financial incentives in the form of reduced import duties, VAT exemptions or special electricity tariffs for charging stations, as well as technical standards and environmental standards (for instance recycling of batteries) as crucial for the promotion of e-mobility in Rwanda and Kigali specifically. The Rwanda Standards Board is currently working on charging standards.

Local Policies

On a city level, e-mobility is a relatively new concept in local policies. At the time of data collection, local authorities were in the process of developing regulatory and facilitation strategies, not yet finalised or adopted. Again, analysis of the maturity of policies must be undertaken with caution as the policy field is charging rapidly. Most local authorities lag to some extent behind national authorities, especially Kenyan and Rwandan ones.

The Kigali 2050 Transport Master Plan updated in 2020 entails one reference to electric mobility, namely the deployment of charging stations at fuel stations in the City[52], yet without further details on the extent and location of deployment or corresponding timeline. In Nairobi, local public institutions and partners are since Spring 2020 in the process of drafting a local climate action plan, which may include measures supporting electric mobility. Such support will likely target projects addressing electric car taxis and electric motorcycles, both being the most mature initiatives among e-mobility developments. Impacts and barriers for these private projects to be executed will be examined, as well as supporting measures through local policy.

The Kenyan city of Kisumu stands out with a draft Sustainable Urban Mobility Plan (SUMP) establishing targets for the integration of e-mobility in its transport system by 2030. This will start with a feasibility study for electrification of public transportation in 2021-2022. The period between 2023 and 2030 is set out as an implementation period whereby the vision is to electrify 50% of Kisumu's motorcycle taxis and three-wheeler taxis by 2025 and fully electrify the bus fleet by 2030. In addition to this SUMP, Kisumu County has been involved in the UNEP demonstration project where electric motorcycle taxis will be deployed.

Finally, no local policy reference to electric vehicles could be found in Dar es Salaam plans. Despite this gap, Dar es Salaam authorities show their interest in electric mobility by taking part in the EU-funded project SolutionsPlus, in which Kigali authorities also participate. The project encompasses demonstration actions which cover electric tuk-tuks (Dar es Salaam), e-shared bicycles, e-motorcycles and business models of e-buses (Kigali). Some thought is given to electrification of public buses feelt on BRT lines.

On both national and local levels, the few nascent and sporadic electric mobility policies do not mention transport providers, involvement of them or impacts on transport systems. An exception is the feasibility report on e-mobility in Rwanda[53] which briefly mentions the need to include transport operators in the transitioning process as they may be under the threat of job loss.

5. Electric mobility stakeholder landscape in Dar es Salaam, Kigali, Kisumu and Nairobi

Literature shows that transportation is generally considered as a system and a functional sector which requires a wide range of institutions to support it[54]. Such multiplicity of institutions calls for greater importance to be placed on the roles of actors and players in the sector as well as the relationships and networks that occur between them[55]. In the four cities under study here, it is evident that several actors and stakeholders, both public (ranging from national to local) and private, including new e-mobility companies and traditional transport providers, are involved in the process of introducing EV and corresponding infrastructure, or will be impacted by this transition.

Yet, the intensity of involvement strongly varies among these stakeholders. New e-mobility players drive projects on the ground (Table 3), triggering thoughts from public authorities on policies enabling e-mobility. The involvement of traditional transport providers is limited or variable, mostly depending on the strategies of the new e-mobility companies.

Table 3. Project level activities

Projects (public and private)			
Kigali	Nairobi	Kisumu	Dar es Salaam
- Projects driven by international and local actors at various levels of operationalization: e-cars (Volkswagen), e-motos (Ampersand, Safi Ride, Rwanda Electric Mobility), shared e-bicycles (Gura Ride) - Participation to the e-mobility programme SolutionsPlus - Electric Last Mile Connectivity Study (World Bank)	Projects led by foreign-led or Kenyan private companies: - operational: e-car taxis (Nopea Ride), safari EVs (Opibus) - small fleet: e-tricycle (Solar E-Cycle), deliveries e-light duty vehicles (Drive Electric) - current pilots: e-motorcycles (Fika Mobility, Ecobodaa, Kiri EV Ltd, Stimaboda, WEEE center), e-tuk-tuks and handcarts (Auto Truck), wheelchairs (Lincell Technology), e-minibus and batteries (Opibus, Mazi) - upcoming pilots of energy entities KenGen and KPLC - upcoming research by Nairobi University (Mechanical Engineering Department)	Operational e-tuk-tuks Upcoming pilot on e-buses / matatus (Opibus) Exploration of future participation to SolutionsPlus	- Participation to the e-mobility programme SolutionsPlus - National academic institutions advancing research in e-mobility e.g. Dar es Salaam Institute of Technology , the National Institute of Transportation (EV prototypes)
	Public-private: upcoming pilot of 50 electric motorcycles to be distributed between Kisumu, Nairobi and Kisii, run by UNEP (GEF funding) in partnership with the Chinese company TAILG and the Kenya Power & Lighting Company		

Public authorities

Overarching transport policy development in all four cities is the responsibility of national level institutions. Yet, coordination of urban transport infrastructure and services is a challenging task, especially in Kenya where 15 public agencies are responsible for urban transport, with overlapping duties[56]. In addition to these urban institutional challenges, e-mobility adds a further complexity layer as it potentially mobilises public authorities covering transport, energy, industry, environment, R&D segments. In the study countries, not only mobility institutions and parastatals are getting active, but also energy stakeholders and industry representatives. For instance, in

Kenya, energy actors are looking for vectors to increase electricity consumption in context of oversupply, explaining the involvement of the Ministry of Energy on targets for the share of EVs in total vehicle imports, and of the energy regulatory body EPRA in feasibility assessments and workshops.

At the local level, the responsibility for the overall development of cities is generally entrusted to the local city authorities as it is in the case of all four cities. The Constitution of Kenya assigns fourteen functions to the county governments in Kenya, one of them being county transport planning, including construction and maintenance of county roads, street lighting, traffic management, parking, and public road transport. The Dar es Salaam City Council is the decentralised local government institution in charge of coordinating developmental issues cutting across the five municipalities (Kinondoni, Ilala, Ubungo, Kigamboni and Temeke) under its jurisdiction[57]. The five municipalities are responsible for the provision of basic social services including urban planning. Likewise, the City of Kigali government takes full responsibilities for the development of areas under its respective jurisdiction. The case of Nairobi is specific, with the transfer of the County transport responsibilities to the national level and the creation of the Nairobi Metropolitan Services (NMS) office, placed under the President's Executive Office as of June 2020. In addition, urban governance structures have been characterised by the creation of entities coordinating transport at local level in Dar es Salaam, Nairobi and Kigali, touted as a way of reducing institutional complexities, especially in cases where the innovation deployment cuts through several local administrative boundaries[58]. Such new entities include Dar Rapid Transit (DART) Agency, the Nairobi Metropolitan Area Transport Authority (NaMATA), and the Rwanda Utilities and Regulatory Authority (RURA) playing an active role in the regulation of urban transport services in Kigali.

Though it is expected that reform processes happening at local level includes both national and local public authorities, it is found that national authorities are often cited as dominating transport evolutions, including e-mobility, even happening at the local level. Exploratory studies, discussions, workshops and e-mobility have been mostly led and held at national level in Rwanda and Kenya. As mentioned above, except for the case of the Kisumu SUMP, thoughts on national policies on e-mobility, even though at the stage of drafts, are more advanced than local policies. Hence, In Nairobi for instance, national authorities have until recently been perceived as dominating the e-mobility sphere, with little to no involvement of the County' administration, even in the case of the motorcycle pilot to be deployed in Nairobi and Kisumu. National project leaders were seen as 'people from the Ministry coming to run a project at the County level without ownership at the County level' (interviewee affiliated with the County government, January). This limited involvement of the County must be framed within the past context of the political leadership crisis in Nairobi, resulting in the transfer of responsibility and creation of NMS.

New e-mobility private players

Transport authorities in all study countries have policies and plans that place emphasis on private sector involvement. It is therefore not surprising to note that there is a gradual rise in new private sector mobility initiatives in all the four cities. An exploratory review of technology-enabled mobility start-ups in Africa (from 2010 to 2019) revealed that Nairobi for instance is among one of the cities with the highest concentration of mobility start-ups in Africa, involved in shared mobility services, technology innovations for vehicle performance, commuter experience or data-driven decision making[59]. Kigali, Dar es Salaam and Kisumu are also experiencing this emerging rise in start-up activities.

Regarding electric mobility specifically, projects already carried out on the ground by private actors and start-ups, mostly in Kenya and Rwanda, play a critical role in the e-mobility discussion. In Kenya, the range of EV types explored by private e-mobility companies is significantly broad. Several projects are led in Nairobi, introducing or still exploring e-car taxis, e-safari vehicles, e-motorbikes (vehicles and charging), e-tricycles and e-tuk-tuks, e-light duty deliveries, e-handcarts, e-wheelchairs and in the upcoming

months e-minibuses. Similarly, pilots are led in Rwanda by foreign and local companies such as Volkswagen, Ampersand, Safi Ride, Rwanda Electric Mobility (REM) and Gura Ride. Some electric tuk-tuks are also operational in Kisumu. Dar es Salaam differs as currently not showing such a dynamic e-mobility pilot landscape in urban settings, but rather in rural ones, or at research stage.

As e-mobility companies are driving pilot projects on the ground in Rwanda and Kenya, they are tightly embedded in discussions with public institutions on upcoming policies and regulations shaping the uptake of e-mobility. Such talks are either organized by public institutions themselves (e.g. multi-stakeholder workshop hosted by the Ministry of Infrastructure in Kigali in February 2020) or attended by civil servants when organized by third parties such as industry associations, supranational entities or DFIs (e.g. conference on e-mobility in Kisumu in November 2019, Kenyan Ministry of Energy partnering with the Association of Energy Professionals Eastern Africa in a conference in February 2020, GIZ workshops in 2019 and 2020). In these fora, start-ups and private companies are vocal about incentives that they consider necessary to scale-up their pilot projects. The market-led development is clearly expressed in the 2019 feasibility study in Rwanda, stating that the approach should be "inclusive and rely on market actor initiatives and innovation", while "government initiatives should support but not distort the market".

Contrasting with this private dynamism in three of the four cities, publicly led projects have been delayed. For instance, pilot projects in Kenya testing electric motorcycles and tuk-tuks in two counties by 2020 and public procurement of 150 electric hybrid buses and cars by 2019 (unspecified distribution by vehicle type) were announced in the 2018-2022 Climate Change Action Plan[60] but these were not operational as of November 2020 with COVID pandemic further delaying the implementation process.

Traditional transport providers

There is a strong presence of informal transport operators mainly made up of mini-bus operators, moto-taxi and 3-wheeler operators in all four cities. In all the cities except in Kigali where non-licensed minibuses are being phased out[61], private minibus operators continue to provide the greater share of motorised public transport services as is the case in many African countries[62]. There is also growing modal shares of moto-taxi services which account for 12% in Kigali [63] and 13.5% in Kisumu [64]. In Nairobi, two-wheelers still account to a moderate modal share of 5.4% in 2013, but their progression has been one of the most dynamic between 2004 and 2013 in the city[65] and at national level[66]. Similar growth phenomenon is prevalent in Dar es salaam as well[67].

Despite this strong presence, representatives of transport providers (associations) seemed limitedly involved in discussions with public authorities on electric mobility at time of data collection. In Nairobi, for example, the local administration has seemingly given priority to start-ups, seen as a "higher" or "strategic" level, contrasting to a "lower" level of the transport representatives (interviewee affiliated with the County government, January). The Boda Boda Safety Association of Kenya (BAK) and local authorities do not seem to be in discussions on electric mobility, which the former regrets. In addition, although the BAK is formally on the list of involved partners in the national motorcycle taxi pilot, interviews revealed a limited role conferred to the BAK. The same seems to apply with regards to minibus transport workers, as their representative Transport Workers Union (TWU) states not to be in talks yet with public institutions or start-ups on the topic of e-mobility (interview TWU, May).

With regards to relationships between start-ups and motorcycle taxi drivers directly and their representatives, patterns seem to fluctuate, mostly depending on the strategies of e-mobility companies. In Nairobi, two start-ups took the initiative to engage with the BAK, which resulted in the involvement of the latter to facilitate contacts between these two companies and individual drivers, including interviews and data collection in the perspective of market entry. Apart from these two private players, the BAK does not seem to appear as a natural or priority partner to other start-ups. Engagement also varies

as representative associations differ (BAK or another association named Sauti ya bodaboda) depending on the local area (start-up, December). In contrast, delivery companies using motorcycles for various services, including food products, are commonly seen as a low-hanging fruit. Direct contacts between some e-mobility companies and motorcycle drivers happen in Nairobi and Kigali - depending on the companies' strategies, mostly in order to collect data on internal combustion engine vehicles, test feasibility and the transition to the new vehicles.

It is important that the discussion on the involvement of transport providers in e-mobility is gradually shaped in the larger context of stakeholder involvement in mobility policies. In Dar es Salaam, where similar limitations on involvement of informal operators persisted over the years, local authorities had taken note and were making efforts to create active engagement platforms for all stakeholders. A current Dar es Salaam Urban Transport Improvement Project to expand the BRT development in Dar es Salaam, places emphasis on the need to actively engage the existing informal transport operators in the city. The project for that matter has dedicated a specific sub-component to support the existing Daladala (minibus) operators to establish companies, cooperatives, or franchises in line with the sector transformation efforts that will see the hitherto informal operators become one of the licensed operators of future BRT phases[68]

International organisations, development finance institutions and academia

Academia and research institutions, both national and foreign, also play essential roles in the co-development of e-mobility in the study cities where there is growing research activities into the development of electric mobility products and services, and in assessing the baseline scenario of internal combustion engines (e.g. fleet assessment).

Finally, NGOs (e.g. Transport for Africa in Kenya) and international organizations such as UN Environment or UN Habitat play an important supporting role. In Kenya, the "Socially Just Public Transport Working group", a hybrid think tank organised by the German Foundation Friedrich Ebert Stiftung, works on principles for just transportation, including from the perspective of new mobility options. Other examples of stakeholders playing an important role on the e-mobility landscape include actors such as the World Bank, DFID, GIZ and several private sector foundations.

6. Opportunities and barriers for promotion of e-mobility in the local transportation systems - perceptions on transitioning process

The analysis of the interviewees' perceptions of incentives and barriers for the mainstreaming of e-mobility presents quite a complicated and diversified picture across the reviewed sectors and cities. However, there are some common traits, which can be identified across the region, particularly in the context of the incentives which drive the development of e-mobility.

Firstly, the reference to the ecological gains framed more generally as climate change mitigation potential or concretely as reduction of air pollution, green city development is strong. Those factors were relevant for public sector representatives in Tanzania and across all analysed sectors in Kigali and Nairobi. While the narrative of tackling climate change was particularly prominent on the side of the public sector, international organisations and academia, operators in Kigali and Nairobi also mention this as relevant. Similarly, the reduction of dependency on petrol and shift to renewable energy sources produced at a national level was underscored as relevant for representatives of various sectors in these three cities. Alongside environmental gains, a significant proportion of representatives from start-ups, transport providers, international organisations, local authorities, particularly strongly in Kigali, Nairobi and Kisumu expect that the shift to e-mobility, while challenging, may reduce operational and maintenance costs of vehicles. This is especially the case for smaller vehicles (electric two and three-wheelers). These environmental and socio-economic expectations explain a high enthusiasm captured in Nairobi, where mobility electrification is regarded as a disruptive technology, qualified as a 'godsend' (international organization, January,

Nairobi), 'huge game changer' (public sector, January; NGO, February, Nairobi). Otherwise a patchwork of secondary heterogenous opportunities are diversely cited, including opportunities for job creation, active start-up scene and the private sector, absence of noise, renewal of urban planning practices, global drive for e-mobility, including international funding and support.

Yet, the range of barriers remains high. Contrary to incentives more commonalities can be identified across cities included in the study. Firstly and foremost some negative perceptions on EVs and lack of awareness concerning positive aspects of e-mobility is considered as a major issue, mainly from a public sector perspective. Representatives of the sector tend to consider transport operators and the general public as the ones who might be ill-informed in that regard. This is not universally confirmed on the side of operators who tend to see both challenges and potential opportunities linked with the transitioning process. As underscored by a start-up representative 'if people are not convinced that this product can work they will not come to buy your product. In the end you end with a huge investment which will not really materialize' (Start up, September, Kigali). Similarly, operators point out that 'we also have to see the advantage in using them, compared to what we have been using before. If there is cost effectiveness (...) we have to make a comparison to see what can come out of it' (Moto transport operators association, September, 2020, Kigali).

Linking up with this, significant attention in Kigali, Dar es Salaam and Nairobi was given to the issues related to bad road infrastructure and inaccessibility of specific areas of these cities. As pointed out by one of respondents in Kigali 'engine-motor can go everywhere in the country, even in the countryside, even on the bad roads but you have to compare now with this one (...) our drivers are not riding only on these paved roads they go also in this tiny roads, and they go even to very, very bad roads, so we have to do this survey if it can be very effective' (Moto transport operator, September, 2020). The ability to drive electric vehicles under similar conditions of challenging road infrastructure as well as with heavy weights transported (freight, passenger) was also questioned in Nairobi. Similar weight was given to potential issues related to the costs of deployment of a sufficient e-mobility charging infrastructure (charging and swapping stations) particularly strongly in Kigali and in Nairobi. In Dar es Salaam the issue of lack of land availability was only mentioned in the context of informal settlements, while the development of stations, in itself, was seen as an opportunity for the private sector. Overall the urban planning procedures regarding these stations seem inexistent or unclear, representing a planning void in which start-ups in Nairobi and Kigali navigate also by arranging those facilities by themselves. As mentioned by one start-up representative in Nairobi, 'I think for now it's too early and everyone is doing whatever they think is right' (…) 'there is no regulation around it and it's something that hasn't come up yet and considering how young the concept is. No one has thought about that because it's something that's going to crop up maybe in 3, 4 years from now' (Start up, Nairobi, December, 2020). While some discussions were taking place, for instance in Kigali in terms of allocation of land for stations, representatives of multiple sectors point out to insufficient development in this field.

Lastly, some more attention was given to the issues of electricity reliability, costs and access in Kigali and Nairobi as well as missing policies. On the top of those more universal problems, some local and sectoral issues were mentioned in different contexts. Kisumu is a particularly strong example here. While it is unlikely that issues of availability of charging stations are absent, or that there is no concern of high upfront investment for operators, the respondents focused mostly on the issues related strongly to 'secondary' status of the city, namely: availability of funding, political process and distance from the capital.

When analysing the interrelationship between different sectors and their role in promoting e-mobility, a relatively clear picture can be drawn. In spite of quite early stages of policy formulation, public authorities on a national level identify the development of incentives and the creation of a conducive environment in terms of

formulation of the legal and regulatory framework as their natural role. However, this self-positioning concerns a broader shift of policy environment into sustainability pathways, rather than championing e-mobility specifically. They position the private sector as their main counterpart, though this category includes mostly business people and the start-up scene. In fact, the latter may be considered as the key drivers of change who put pressure on public sector stakeholders in various arenas of advancement for the mainstreaming of e-mobility (perhaps with lower influence in Dar es Salaam where the pace of the start-ups in the sector is still slow). While they eagerly engage in partnership with city and governmental counterparts, they remain critical regarding some aspects of the existing institutional frameworks. As mentioned by one of the start ups representatives in Tanzania - the issue of limited capacity and lack of technical support provided to e-mobility start-ups is noticeable. Even in Kigali where the government pushes for various eco-friendly policies, the start-ups representatives notice that some policies are missing and there are some bureaucratic barriers which need to be overcome. In spite of these issues an active cooperation is flourishing in different constellations of actors, particularly between international NGOs, academia, industry and start-ups, for instance within international programmes promoting e-mobility such as the EU-funded project SOLUTIONSplus, which aims to facilitate the co-development of innovative e-mobility solutions among local and international actors.

The role and positioning of operators, para-transit and individual 'informal' actors is more ambiguous. At the current stage, involving those in e-mobility transitions has not been positioned as a priority. For instance in Kigali where the policy environment is the most advanced, the public representatives mention that 'we have not yet engaged them in a sufficient way, but we do it little by little because it requires some conducive environment, we have been working on policies' (public sector, September 2020, Kigali). Similarly the necessity of high upfront investment is acknowledged. Challenges linked to transitioning, especially in linkage to the Corona pandemic are mentioned: 'with COVID 19 there is a tremendous amount of stress that has been put on the resources, that means busses and other things' (start up, September 2020). Occasionally, as in the case of Kisumu, public sector representatives believe that operators also feel included in better communication with the government. Conversely, they also believe the operators need to transform their organisational model to be ready to operate effectively. This perception is shared by one of the representatives of the public sector in Kigali: 'the other issue is bus operators sometimes claiming they are not getting their benefit (..). But of course we are trying to see how we can assist them not only incentivizing them in terms of money but giving them some non physical interventions to help them out to get (...) their benefits but also improve their way of doing business (public sector, September,2020).

The ambiguity in the positioning of transport providers is also reflected in the opinions of the sector's representatives about e-mobility. High upfront costs for transitioning to electric vehicles are well acknowledged. Balancing higher upfront investment costs with lower operational and maintenance costs is more frequently mentioned for smaller vehicles (comparatively smaller investments resulting from a smaller battery size), especially when drivers are themselves owners and when combined with innovative business models (vehicle lease-to-own, rental of the battery, pay-as-you-go schemes). For buses or minibuses, this could be more challenging, considering higher investment costs and the decoupling between owners and drivers, responsible for fuel expenses in Kenya for instance.

In addition, a fear of job losses exists in the matatu segment in Kenya, strongly emphasized by the interviewee representing transport workers (TWU interview, May 2020). This was explicitly framed within current tensions around BRT implementation. Electric buses were seen as a threat and replacement of current matatus and their culture, linked with a reduction in the number of workers. The interviewee was not aware of current projects to convert existing buses with an electric powertrain (retrofit), instead of bringing in new electric buses. Dynamics of e-mobility acceptance (as well as implementation and cost characteristics) therefore appear as differing between modes.

Finally, some hypothetical benefits are "mode-specific », in the sense that they relate to current challenges faced by these modes. For instance, in Nairobi a cashless payment in the minibus segment is envisioned by transport workers in the wake of electrification, while e-mobility projects could possibly improve boda boda road safety records via slower EVs or driving training programmes.

7. Discussion and conclusions

The three East-African countries at study have initiated steps of a transition towards transport electrification, yet at different paces and taking diverging approaches in terms of sequential order (targets, policies, standards, incentives). Overall, they are still at an early stage of policy formulation, and detailed policies are still in the making. Projects, mostly privately led by small companies, are burgeoning in Kigali, Nairobi and Kisumu, albeit with limited fleets or at stages of prototyping and piloting.

Indeed, as the analysis of incentives and barriers revealed, a growing number of private stakeholders are looking at meeting the decarbonization needs identified by public authorities, international organisations, donors and NGOs, combined with air pollution reduction, while exploring potential benefits from lower operational and maintenance costs of EVs. Yet, a set of financial and technical barriers persist as high upfront investment costs in vehicles and infrastructure constrain the uptake of such private initiatives, combined with persisting interrogations on the capacity of EVs to provide similar uses, compared to current fossil-fuel vehicles in terms of road conditions, carried weight, range and speeds.

As an emerging phenomenon with little maturity, the question of acceptability among transport operators remains at an early stage, requiring further analysis over time. This study found out that operators and their representative associations are limitedly recognized as major players in the transition, far behind new e-mobility players (start-ups) and public authorities, mostly national ones. Similarly, in the nascent policy sphere on electric mobility, the role of the sector is not, or not truly recognised. While public authorities and start-ups are exchanging on policies, technical feasibility and incentives, transport operators and their representatives stated not to be truly involved in e-mobility policy talks with public authorities yet. Some start-ups entered in contact with drivers and representative associations in order to collect data on transport patterns, especially on the two-wheeler segment, but not all of them.

In the light of the above, the capacity of initiated transitions to fully account for the needs of transport providers remains an open question. This is especially the case for buses and minibuses which provide mobility services for a considerable share of urban dwellers in the four cities at study, and where high investment costs will be needed to shift to electric mobility. Early tensions could be felt with the transport union in Kenya, interpreting electric mobility transitions in the light of current issues encountered with the BRT system implementation. Overall, a challenge of constrained financial resources is identified in the context of the Covid pandemic. The question of acceptability versus potential future oppositions and events of public contestation in the like of the modernization programme for jeepneys in the Philippines[69], remains open.

Hence, this analysis of the early stages of electric mobility developments and currently (subject to rapid change) governance traits lead us to identify three gaps which should be adequately addressed by policymakers and revolving organisations (international, non-government, academia).

Firstly, this analysis identifies the need for significant further research to lead and calls for continuous study of electric mobility in the region, looking at it on a more granular level and distinguishing between transport modes and vehicles. As discussed, effects of electrification seem likely to vary between vehicle types as investment costs vary, linked with the size of the battery and the vehicle, as well as technical characteristics. The additional layer of electrification comes on top of already different operational patterns, making the case for dissociated analysis.

Secondly, looking at current loopholes in the involvement of stakeholders in electric mobility, a principle of transparency of decisions and policy formulation should be set, allowing for structured engagement from the transport sector. Consultation of transport providers should be the minimal step, while public authorities ought to aim for co-production schemes enabling taking on board needs and expectations from transport providers. This is paramount for the success of electric mobility transitions, especially when identifying organizational and financial models which could ease the transition and alleviate investment constraints for transport providers (for instance, leasing or rental models, pay-as-you-go, etc.). The potential for progressive solutions where transport providers play a crucial role may be higher than expected by the main gatekeepers facilitating the electric mobility transitions. However, from public sector perspectives cooperating with on the ground players may seem risky not only because of their expected resistance but, in some context, engagement in politicised arenas or perception of being messy and uncontrollable. Bridging this divide emerges as a crucial step in truly mainstreaming the positive role of electric mobility both in transportation and climate change mitigation but also in an inclusive transitioning process.

Thirdly, urban planning is a further dimension currently omitted in e-mobility as revealed during interviews, creating uncertainties and leading to *bricolage* practices from stakeholders. Yet, this has significant impacts, for instance on availability - location of charging infrastructure, safety of location at fuel stations, etc. Similarly, on the ground actors, such as operators and start-ups see an urgent need to demonstrate that electric vehicles can operate in weakly developed parts of the local cities. In addition, this raises the question of the impact of electrification on transport systems, as neglecting urban planning may result in rebound effects and missed opportunities, such as the potential improvement of connectivity between transport modes via well-designed electric charging spots. Limited to absent involvement of transport providers further misses the opportunity to leverage electric mobility transitions to review planning practices, mostly ignoring informal to semi-formal transport services and infrastructure in planning, to the exception of Kigali. The possibility to integrate transit stops and waiting points into planning via the transition to electric mobility is not informed or not much discussed at this point.

In conclusion, this research calls for stakeholders to look at implementing *inclusive* electric mobility, based on modalities that include transport providers, potentially include redistributive effects benefiting them, and address their financial constraints.

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