

User Needs Assessment – City Report

City: *Kigali*

Project SOLUTIONS+

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This document complements the User Needs Assessment Guideline.

https://drive.google.com/file/d/12F3_C5g0doKrdDYdzgLQKFHj1c8VLbqV/view?usp=sharing

1 Approach

The User Needs Assessment was carried out in the months of November and December 2020 and in January 2021. The assessment was carried out in line with the concept that was provided by the SOLUTIONS+ project as described in Deliverable D 1.3, in order to harmonize the assessment approaches over the demo cities that are part of the project. As primary method interviews with key stakeholders were carried out and the results and findings of these are presented below.

The following team carried out the assessment:

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The first list of stakeholders was prepared by DTU using earlier SOL+ submissions and using documents available on the internet. Stakeholders were grouped into public/paratransit companies, national, regional and local authorities, passengers and individual travellers, service providers, OEMs, associations, importers and exporters, academic and research organizations, and finally foundations and funders. Other city partners (ITDP, UEMI, and UNEP) vetted the first draft list of stakeholders. This included editing the contact list and also adding a significant number of new contacts. From the large list of stakeholders, some select stakeholders were contacted either by email or by phone calls by local city partners ITDP and UEMI.

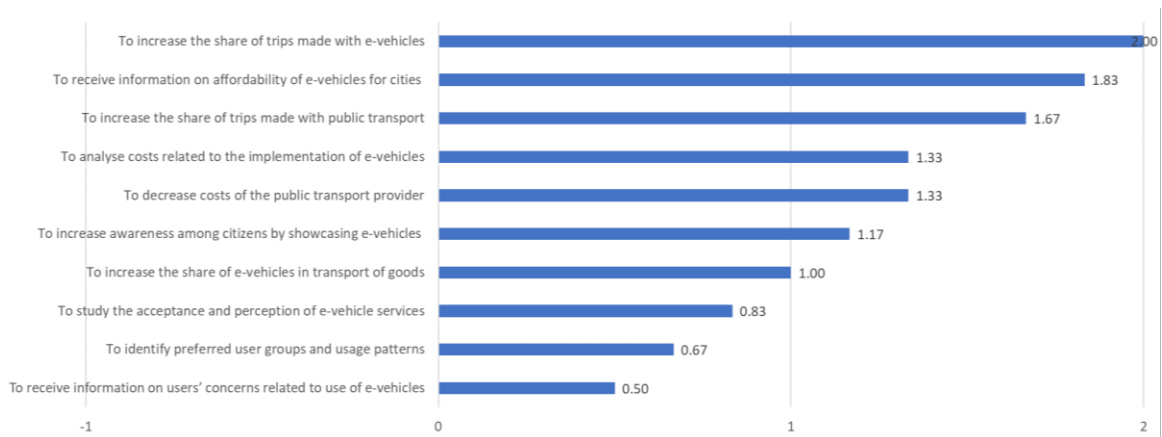
The email sent to the stakeholders included an offline version of the survey form was shared along with the questions for the interview. After an extensive follow-up, nine stakeholder interviews were possible. At least two members of the city team participate in most of the interviews.

Stakeholder groups	Stakeholder	Abbreviation	Method (Interview, Survey, KPI)	Date
Public/Para Transport Companies	JALI Transport (RFTC)	PT1	Interview + KPI	30-Nov-20
National / Regional / Local Authorities	Rwanda Utilities and Regulatory Authority (RURA)	G1	Interview + KPI	01-Dec-20
Service providers (Private and small- scale operators, also informal, energy companies)	Ampersand (motor-cycle taxis) (S1)	S1	Interview + KPI	11-Nov-20
	Gura Ride (e-bicycles) (S2)	S2	Interview + KPI	12-Nov-20
OEMs (i.e. vehicle companies, maintenance)	Volkswagen Mobility Solutions Rwanda (O1)	O1	Interview + KPI	20-Nov-20
Associations	Fédération Rwandaise des Conducteurs des Taxi Motos(FERWACOTAMO) (T1)	T1	Interview + KPI	11-Dec-20
Academia/ Research	University of Rwanda(A1)	A1	Interview + KPI	26-Nov-20
Foundation/Funders	Shell Foundation (F1)	F1	Interview + KPI	25-Nov-20
	GGGI(F2)	F2	Interview + KPI	16-Dec-20

2 Results – Survey

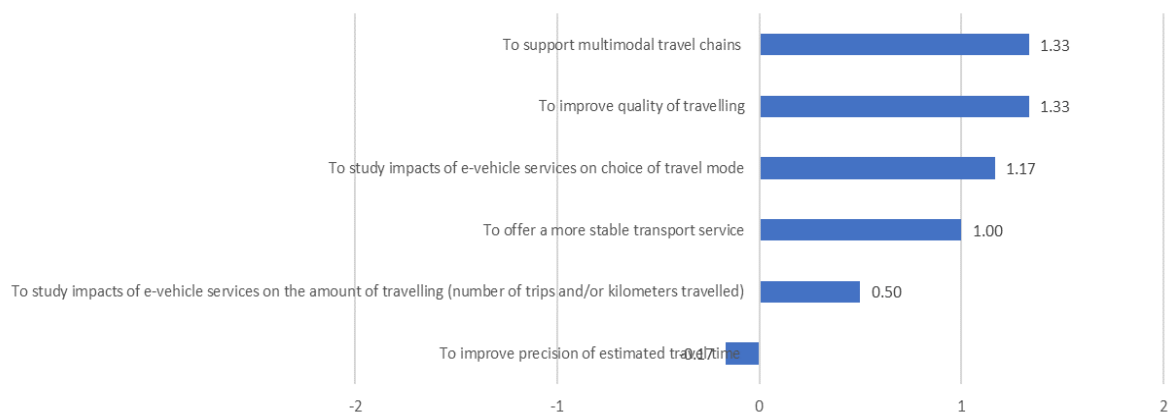
This section outlines the most important findings of the online survey. We received four responses: one from university staff, one from an OEM company, one from a foundation and one from the governmental organization. Respondents were asked to evaluate the importance of the city. The following aspects, using a scale from -2 (not important at all) to +2 (very important). Even though the number of responses is low (6) to present any statistically significant quantitative analysis, we have presented the data as initial analysis and will be updated as more responses will come in.

City aims- Usage and user acceptance of e-vehicles



Regarding the usage and acceptance of e-vehicles, respondents rated the need to increase the share of trips made with e-vehicles with the highest score (score 2 out of 2). The need to analyse costs related to the implementation of e-vehicles and the need to receive information on affordability of e-vehicles for cities were the next most important factors (score of 1.83 out of 2). The respondents also considered the need to increase the share of e-vehicles in the transport of goods and need to increase the share of trips made using public transport with a high priority. The other factors rated above 1 (out of two) were the need to decrease the cost of public transport providers, the need to increase awareness among citizens by showcasing e-vehicles, and the need to increase share of e-vehicles in goods transport. Needs to increase awareness, receive information and to study acceptance and perception of e-vehicle services were considered necessary (with a score above zero) but comparatively less important.

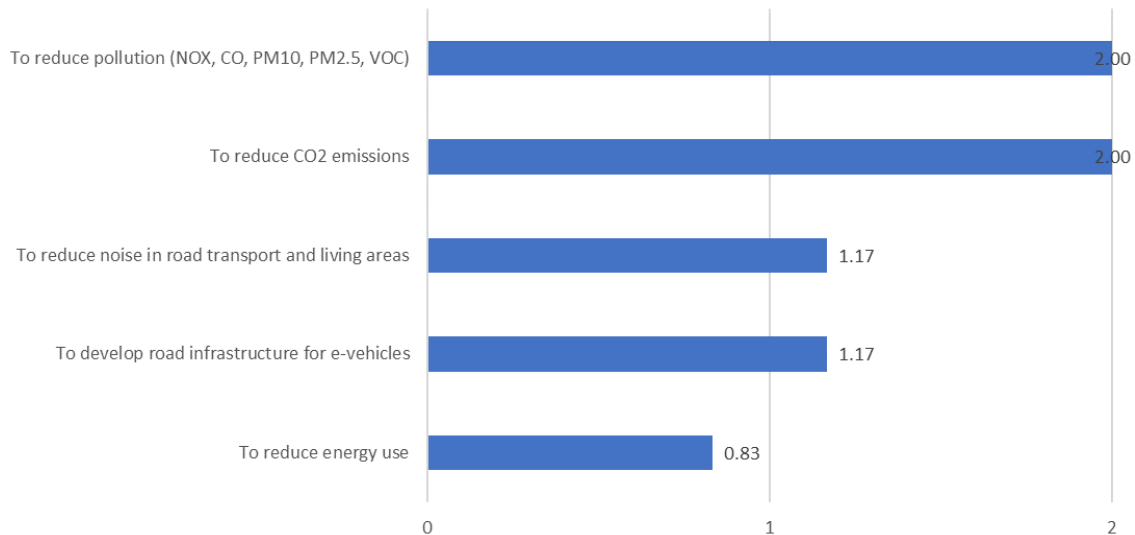
City aims: mobility patterns



The focus on the need to improve overall travel quality, multi-modality as identified in the question above – was confirmed in this question: supporting multimodal travel chains was considered most important (score: 1.33 out of 2)—the focus on multi-modality augers well with the demo project of e-motos and e-bikes in Kigali. The respondents also considered the need to improve quality of travelling equally important. The respondents also found the need to study the impacts of e-vehicles on travel mode choice as an important need (1.17 out of 2). Thus the focus for mobility patterns is to improve the quality of travel by providing the user options for multimodal transport and study the impact of e-vehicles on the choice of travel modes for better decision making.

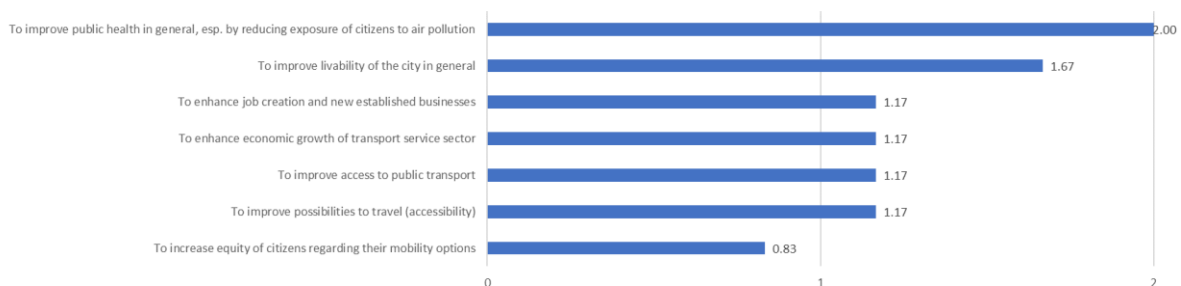
The respondents also considered the need to study the impacts of e-vehicles services on the amount of travelling and need to offer a more stable transport service as important (score of 0.50 out of 2). However, the need to improve the precision of estimated travel time was not considered necessary.

City aims: city environment



Concerning the city environment, the need to reduce pollution (NOx, CO, PM10, PM2.5, VOC) and reduce CO2 emissions were rated very important (rating between 2 of 2). The next most important consideration was developing infrastructure for e-vehicles and reducing noise on the road. Reducing energy consumption was also considered relevant, although with lower ratings (<1).

City aims: quality of life in the city



For the city's quality of life, the contribution of reduced air pollution in improving public health was considered very important (score of 2 out of 2). Likewise, the second most important aspect was improving liveability in the city (1.67 out of 2) and third need to enhance job creation and new established business. Thus stakeholder suggests that quality of life in Kigali can improve if the air is clean, there are more and better job options, and overall livability is good. The need to improve the transport system (increase the possibility to travel, better public transport and improve the transport sector's economic growth) was also considered necessary (score of 1 out of 2).

Implementation and obstacles, limitations and barriers

Regarding the implementation (questions 12-17), the most important findings are:

- (6 / 6) respondents rated transport of people and (4/6) rated last and first-mile connectivity as the most relevant use case for Kigali's e-mobility solution auguring well with the demo projects.
- city centre (5/6) and Suburban areas (3/6) and the were identified as the locations where the e-vehicles most likely to be used.
- Main target groups of e-vehicles in Kigali are 'all citizens' (5/6) One out of six respondents also mentioned each commuter, students and younger people as target groups.
- E-vehicles may be used most for commuting (6/6), followed by trips related to shopping (4/6) school trips (4/6), leisure(4/6) and other job-related trips (3/6) .
- For transport of goods, e-vehicles are most likely to be used by city (5/6), they by shops (4/6), city and small and medium private companies (4/6), followed by other entrepreneurs, large companies, other public actors and other entrepreneur (3/6).
- Most respondents suggested that e-vehicles should be operated by private service operators (6/6) and to a lesser extent by the city (2/6) and other public service operators (1/6).
- The most challenging factors for successfully implementing the e-mobility solution were: lack of money or financial resources and investment in infrastructure (5/6). Some respondents also felt that lack of maintenance service (4/6), lack of enabling policies and e-vehicle components (2/6). One out of six stakeholders felt the lack of acceptance of e-vehicles among stakeholders/users and low acceptance of e-vehicles as important challenges concerning successful implementation of e-mobility solutions.

3 Results – Expert Interviews

In this section, please report about the findings from the interviews. Interviews should be carried out based on the interview guideline. Please report per topic about the findings, if so please also indicate possible differing opinions, strong common views.

A total of 9 interviews were carried out and included service providers ((e-motos),(e-bikes)), moto-taxis federation, public transport operator, original equipment provider(OEM), foundation (F1, F2), national regulatory authority and university. In all a breadth of stakeholders was covered.

3.1 Aims of the city and Expectations of Stake-holders

Challenges to be addressed by e-mobility

Reduce air pollution, vehicle emission and affect human health

All interviewed stakeholders highlighted the environmental advantages of e-mobility, especially in reducing air and noise pollution. Interview E-bikes service provider identified a plurality of goals pursued via e-mobility, including reduced carbon emissions, reduced air pollution, the introduction of innovative mobility options such as e-bikes, and fuel reduction imports. The interviewee from the moto-taxis federation also believes that e-mobility and more specifically e-motorcycles will bring many advantages. These include improved air quality and reduction of CO₂ emission from the ICE motorcycle engines. The representative from foundation-F1 stated that the pollution level of current motorcycles is not controlled and the introduction of e-mobility in the city centre and peri-urban areas would

improve air quality. The interviewee from the public transport operator also stated that the introduction of e-buses would help in the decarbonization of transport in Kigali. The interviewee from the national regulatory authority mentioned that e-mobility in Rwanda will help the country reduce imports of old vehicles that harm the environment and help the country avoid being a dumping site for old vehicles. The respondent feels that most developed countries are shifting from internal combustion engine (ICE) vehicles to EVs, so the authorities intend to act as soon as possible so that Rwanda does not lag with old ICE vehicles.

Long term vision for sustainable transport (e-mobility)

Decrease fossil fuel import

Rwanda imports all its petroleum products via Kenya. There is also an electricity surplus in Rwanda, and more than half of the total electricity is sourced from hydro and solar power sources. There is also a push to increase the share of renewable electricity. Thus, most stakeholders also opined that the introduction of e-mobility solutions in Kigali would reduce fossil fuel imports. National regulatory authority interviewee felt that EVs' adoption would reduce dependence on imported fuel. The E-bikes service provider also supported the introduction of innovative mobility options such as e-bikes and reduced fuel imports. The interviewee from the national regulatory authority mentioned that e-mobility would help the transport sector increase its dependence on locally produced energy rather than imported fuel.

Lower operating cost and increased comfort

It is expected that the introduction of e-mobility will reduce the operating cost and also increase comfort levels. The cost is likely to fall, as most stakeholders, including the interviewee from national regulatory authority, feel that e-mobility will increase electricity demand, spurring local production, and reducing tariffs. With increased electricity demand, Rwanda has moved away from dependence on heavy fuel oil power plants to new sources of electric supply and have also negotiated better tariffs with power producers. This is only going to get better as the demand for electricity increases in future. The interviewee from the moto-taxis federation stated that electric motor-cycles are better in terms of speed and comfort as compared to ICE motor-cycles and the interviewee is hopeful that the uptake of the new technology will be high. The interviewee from moto-taxis federation also mentioned that current study with Ampersand and REM showed lower cost (700 Rwf / swamped battery/ 60-70km) compared to fuel cost per litre (960 Rwf/litre/ 50km).

How can SOL+ support

The interviewee from the e-motos service provider identified three types of support that SOLUTIONS+ could bring in, including financial support to deploy additional EVs and financial support to extend the driver typology, from men only to women and lastly material support from the SOLUTIONS+ expert network (e.g. Valeo powertrains).

The interviewee from e-bikes service provider had a broader range of expectations towards the SOLUTIONS+ project. They expect that the SOL+ project will increase EVs' visibility, translating into easier adoption of e-bikes in the long run.

The project also will support policymaking on sustainable mobility (e.g., bike lanes integrated with the planned BRT system) and lastly bring in financial and technical support for e-mobility providers, not only for demonstration action but also to scale-up.

The foundation-F2 Interviewee identified three roles for SOLUTIONS+: improved coordination between the multiple e-mobility projects and stakeholders, improving the image of non-motorized transport via the support to e-bikes, and facilitating access to funding.

The moto-taxi federation interviewee observed that current e-motorcycles under demonstration by Ampersand and REM were found to require less maintenance than regular ICE motor-cycles. Nevertheless, the respondent expects SOLUTIONS+ project to bring advanced solutions to ease maintenance of e-motorcycles, for instance, via an e-motorcycle demonstrator and training to local maintenance operators at local stations and garages. Further areas of support could include training in business operations and road safety.

Electric vehicle type and use cases

The interviewee from public transport operator showed ample willingness to comply with government guidelines on transport regulation, in general, including on electric mobility and has the impression that the process of promoting electric mobility will result in an attractive business for environmentally friendly public transport service. The stakeholder also sensed that e-buses would contribute a lot to environmental decarbonization. The bus operator is ready to comply with all the current and upcoming regulations about e-mobility.

The e-motos service provider interviewee believes that e-mobility solution will be mainly used by former (male) ICE moto drivers, but they intend to broaden the use to new female drivers. The solutions will be mainly used for passenger transport. Transport of goods and deliveries is a growing segment but is considered to have less potential in Kigali when compared with other East African cities with a bigger population or more congestion. In Kigali, today the motos provide a lot of door-to-door service, however in the long run interviewee from e-motos service provider sees most of the solution as a feeder to BRT or MRT services.

The interviewee from e-bikes service provider expects a variety of uses, including commuters, youth (students) targeted with a special tariff, but also partnerships with businesses, organizations of events and sports activities. They also see the e-mobility solution as a feeder to upcoming BRT services. An interviewee from the foundation-F2 stated that Rwanda is seen as a cycling country, similarly to the interviewee from ebikes service provider. This interviewee also feels that e-mobility will reduce air and noise pollution. Given that Kigali's topography is difficult for conventional bicycles, e-bikes could increase bicycles' use.

The interviewee from foundation-F1 mentioned about the range of e-mobility solutions that have been deployed. The interviewee also said that Volkswagen (VW) and Siemens are engaged in the four-wheel vehicle space, including charging. Two-wheelers are taking off quickly, and there are providers like Ampersand, Orion, Savi. In the case of two-wheelers, both fixed batteries and battery swapping (single /double battery) are being considered. E-rickshaws and e-buses are also attractive e-mobility options. Likewise, e-matatu is also an interesting e-mobility solution, mainly based on retrofitting.

The stakeholder interviewed from university feels that the Government of Rwanda is very positive about implementing e-mobility solutions; therefore there is a very good chance that many residents of Kigali will use e-mobility solutions in the coming ten years. The interviewee feels that it is likely that e-mobility solutions will come in the form of public transport e-buses, motor-cycles, and moto-taxis. The private car could also come as a Volkswagen is working on encouraging e-mobility in Rwanda.

The geographic coverage for e-mobility solutions

In terms of geographical coverage, the e-motos service provider feels that it will be mostly used peri-urban and in the city's central areas. Data from their vehicles tracked in the last two years (circa one million km driven) indicate that most of the motor-cycle traffic is within a 12 km radius from the city centre. Drivers travel an average of 165 km a day as they move around the city to look for customers (no staging system as in Kenya). The interviewee from foundation-F2 also feels that e-motos are a solution for both city centre and peri-urban areas.

E-bikes service provider thinks that the solution will be mostly used in the city centre. He also sees the use of e-vehicles in some suburban areas and around all dock stations located in the vicinity to bus stops. The interviewee from university opines that the initial use of e-mobility solutions will mainly be in urban areas. E-motos service provider indicates that it is a low-hanging fruit in urban areas, as the concentration of vehicles is higher. Like interviewee from university, Interviewee from OEM observes that E-mobility solutions will mainly be used in urban areas, mainly for the transport infrastructure and electricity infrastructure (grid requirements).

As a solution to provide electric infrastructure in a rural area, the Interviewee from OEM feels that off-grid solution might not be a preferred option in Rwanda as there is an electric surplus in Rwanda and therefore, governments might not be very keen to promote off-grid solutions. For e-mobility shared-mobility solutions are likely to work in Rwanda. Shared mobility solutions are already there, and it needs to be seen how these can be translated into e-mobility solutions. OEM interviewee felt that motor-cycles are not a long term sustainable solution as these are not all-weather, not geared toward use by all users (especially women), and not safe as they are subject to many road accidents. The interviewee from moto-taxis federation expects that the range of batteries will improve and e-motos will be able to operate for more than 100 km range to suit the hilly terrain of Kigali and Rwanda, especially in the peri-urban areas of Kigali.

While considering that e-motos will be deployed in both urban and peri-urban areas, foundation-F2 interviewee stressed the need to improve bicycles in peri-urban areas, used for cargo and as bicycle-taxis, via electric mobility.

3.2 Regulation

Existing Regulation

E-Mobility policy

There is no e-mobility policy nor are specific regulations in place yet. The public transport operator interviewee confirmed that it was not aware of any available e-mobility regulation, policy, or guidelines.

Despite the current absence of policies, several stakeholders highlight the strong governmental support on e-mobility. The OEM interviewee stated that there is a push from a supportive government towards e-mobility, but the situation arising from the COVID -19 pandemic has led to delays in policy formulation. The moto-taxi federation interviewee also mentioned that, even though there are no written regulations, there is a verbal agreement to adapt and shift to e-moto taxi as per a request from the President's speech during a youth forum. The foundation-F2 interviewee stated that Rwanda's government is putting pressure on the national Ministry of Infrastructure MININFRA, the key focal point for e-mobility, to deliver supporting policies.

According to several interviewees, E-mobility policies are being prepared and are currently at a draft stage, with much ongoing speculation over their content, number (one or several documents) and the schedule for adoption (foundation-F2 interviewee, OEM interviewee, e-motos service provider interviewee). Stakeholders are eager to see these policies adopted; there is a hope that they will be all-encompassing and will come with bold measures. The university interviewee said that a national transport policy is at an advanced stage, and the government needs to approve it to adopt a regulation related to e-mobility. The interviewee from e-motos service provider mentioned a draft e-mobility policy prepared by MININFRA, pending Cabinet approval. According to him/her, this policy would provide financial incentives as well as non-fiscal ones such as the possibility for EVs to use bus lanes, free license plates, and special green license plates for EVs. Generally speaking, the national regulatory authority's interviewee mentioned that the government is ready to provide related regulations.

Several studies are ongoing alongside the ongoing preparation of policies, including from the startups themselves looking at how the e-mobility solution is best provided in Kigali. The interviewee from university also felt that the present challenge is the newness of the e-mobility technology, leading all stakeholders to learn along the way while upscaling. He mentioned that studies have also been a commission that will look at what is required to support Rwanda's e-mobility. For instance, the Global Green Growth Institute office in Rwanda just finalized a study on electric buses, including the identification of 3 lines, length, depot charging, the total cost of ownership, and grid impact.

Further information regarding policies on power tariffs and regulation of charging infrastructure are provided below in subsection 2.3 (Obstacles, limitations, barriers).

Implementation issues

The interviewee from university and the foundation-F1 Interviewee felt that the policy landscape is very dynamic, and there is a need for testing policies before they are implemented at large scale. The foundation-F1 interviewee suggests creating a regulatory sandbox, mentioning previous application of this approach by the Shell Foundation in Hyderabad, India (note from the team: sandboxes are frameworks set up by a regulator that allows FinTech startups and other innovators to conduct live experiments in a controlled environment under a regulator's supervision). Like these two interviewees, the OEM interviewee also feels that there is a general lack of knowledge of what policy will work and what will not work. Policies will have to consider that solutions may need to be differentiated for

various vehicle types. For example, a good solution for a two-wheeler might not work as well for cars. In addition, the e-motos service provider (e-motos) also warns against standards that would be too prescriptive since they could have unintended consequences as R&D is still ongoing.

An example of companies' testing and iteration process was given by the interviewee from moto-taxi federation interviewee, working with REM (and possibly Ampersand in the future) to study e-motos. The first batch of batteries of REM (currently having 150 e-motorcycles, 70 operating) failed as their capacity were below about 40km per one swapped battery, which led REM to buy other batteries that enable covering about 60km before recharging.

Lastly, the foundation-F2 interviewee stated that there is little coordination of the many different projects and suggested having regular meetings between e-mobility stakeholders to avoid overlaps.

3.3 Obstacles, limitations, barriers

Main barriers towards adoption of e-mobility solutions in Kigali

Charging infrastructure and standards

Charging stations. The public transport operator interviewee stated that the lack of charging facilities and increased charging time could be a limitation. Currently, the bus operator gives four hours of layover time when the buses are maintained, washed, and refuelled. If the operator were to add charging to these four hours, the business could be affected by the high duration of charging compared to refuelling. According to him, many charging depots will be required, and the need for additional space will be required. This interviewee stressed that Rwanda is a hilly country, which would require more electricity and induce high charging costs for e-buses. The moto-taxi federation interviewee also raised concerns about charging infrastructure and mentioned that more charging stations would be required for e-moto taxi implementation. The charging process should not take more time. It currently takes 2 to 3 minutes with battery swapping options. Battery swapping and scale-up of charging infrastructure is needed. In general, the foundation-F2 interviewee suggested incentivizing the provision of charging infrastructure via policies. For instance, the building code can be modified to mandate charging at public buildings).

Standards. The e-motos service provider mentioned the absence of charging standards. However, they could deploy charging stations without facing legal challenges, cooperating with the Rwanda Energy Group (REG) on the location of charging points. Yet, the interviewee felt that the absence of regulation could lead to safety issues as competitors intend to establish charging points at petrol stations without assessing the risks associated with the proximity to combustible fuel.

The national regulatory authority interviewee mentioned that there is currently no clear masterplan, guideline, regulation related to the installation and operation of electrical charging stations for e-mobility. RURA regulates the fuel stations and has the mandate to regulate both station installation and operation. So far bus terminals and depots are owned by private operators.

In general, the interviewee from university also found charging infrastructure as a significant barrier. The OEM interviewee felt that a policy will be needed on how the new charging infrastructure will be provided, including what happens to the existing fuels station.

Financial resources/ Upfront cost

Challenge of access to finance. The e-motos service provider felt that there is a need for capital to be invested in e-mobility, but that private investments in e-mobility in the region are still limited as compared with other sectors, such as solar energy. The technology investment community in the region is seen as particularly conservative, with very high financial expectations put on companies. The foundation-F1 interviewee stated that access to finance (debt and equity) is a barrier. The foundation is working with enterprises such as JALI Transport to provide asset financing and finance companies to provide guarantees that reduce risks. Access to funding was also considered one of the most significant barriers by the foundation-F2 interviewee. This interviewee stressed that there are interested investors for electric cars, but none for electric buses given a too high price tag for domestic funding sources.

Upfront investment cost for buses. The public transport operator interviewee identified a financial challenge as the urban bus transport sector is only financed by private transport operators and lacks government subsidies, while the transport service has to be affordable (note from the team: not fully accurate as the government pledged to start subsidizing bus service so that operators would keep their fares at pre-COVID levels). This private bus operator has no plan to shift from ICE buses to e-buses unless the government policy requests them to do so. The national regulatory authority interviewee observed that financial challenges might affect the development of e-mobility if these solutions are on board soon before post-Covid-19 economic recovery. For instance, public transport operator companies are young, and some are still in payback periods of the previous investment and improvement. Due to financial problems brought by Covid-19, public operators are still under desirable qualification in terms of fleet size as traffic demand is still growing. These could not initiate the risk of an additional loan.

Upfront investment cost for moto-taxis. On the moto-taxi side, the moto-taxis federation interviewee feels that to run e-moto taxi business profitably, the upfront cost of e-motorcycles will have to be reduced and affordable for motor-cycle drivers, who prefer to own a motor-cycle rather than leasing it. The high cost of motor-cycles would be a barrier, and many motor-cycle riders will need a loan to own e-motorcycles. The financial option offered by Ampersand currently the most frequently selected among ICE moto-taxi drivers is lease-to-own (see below Impacts on business models).

Upfront investment cost for cars. The OEM interviewee said that for cars, the most significant barrier is the cost barrier, especially in an unsubsidized market in Africa, which might inhibit cars' use as a private means of transport. Therefore, this could happen mostly through companies for mobility solutions like shared fleets.

Electricity tariffs

Several interviewees felt that the high electricity tariffs are a substantial barrier (Interviewee from foundation-F1, Foundation-F2, e-motos service provider, and e-bikes service provider). The e-motos

service provider hopes that the new e-mobility policy prepared by MININFRA (pending Cabinet approval) will tackle this significant barrier. Currently, the high electricity tariffs would be the most significant challenge to financial viability (stated by both service providers 1 and 2. Note from the team: \$0.277/KWh in Rwanda versus a global average \$0.15 according to Ampersand's information from April 2020), followed by the value added taxes on EV charging services (note from the team: no figure on current VAT level; at the 25.02.20 February workshop, the e-moto company Ampersand requested VAT exemption on EV charging stations, and a reduction of the VAT reimbursement period from the current 9 months or more to 30 days). The foundation-F1 interviewee stressed that power tariffs need to be attractive, similar to industrial tariffs.

According to both service providers, this would have been resolved through the draft policy pending approval. Similarly, the interviewee from moto-taxi federation expressed confidence, stating that this issue is under government consideration and that the cost will be regulated. According to this Interviewee, even with currently high tariffs, the shift to electricity is still financially attractive (lower costs with Ampersand and REM of 700 Rwf/swapped battery/60-70km, as compared to fuel costs (960 Rwf/litre/50km). The foundation-F2 Interviewee was less confident on this aspect being included in the draft policy (persisting uncertainty on the content).

Supply Chain and Importation

The interviewee from e-motos service provider observed that the Covid-19 pandemic resulted in delays and disrupted supply chains. Quality issues are also faced with supply chains and products from China, although incremental improvements have been achieved. In the long run, the provider intends to shift towards working with ICE moto OEM partners. The university interviewee also observes that as EVs is a new technology, switching from ICE engines to EVs will need many changes in the value chain.

Regarding import policies, the national authority's interviewee observed that there are currently no particular regulations and guidelines on how EVs will be imported.

A barrier of high import duties seems to have been partially resolved according to the e-motos service provider and e-bikes service provider. Both Service Providers received tax exemptions, e-motos service provider got it on the second batch of vehicles. The E-bikes service provider specified that the Rwanda Development Board issued tax waivers (RDB) (no detail was provided on which tax, or if was full or partial exemption). Issues regarding paperwork and internal arrangements between various ministries and departments were faced; it is not fully clear if this has been completely cleared now.

The issue could still remain for buses, as the public transport operator interviewee points out that ICE buses are imported with tax exemption (no tax paid to import bus). Regarding e-bikes, the foundation-F2 interviewee indicates that parts for EVs are prohibitive due to taxes, especially for e-bikes. However, this information may be outdated as from 2018, and the e-bikes service provider did not mention this issue.

EV adaptation to topography. The national authority's interviewee pointed out the necessity of pre-assessment on the adaptability of EVs to Rwanda topography. This concern of operations in hilly terrains was expressed by several interviewees.

Lack of technical expertise. The public transport operator interviewee is concerned about the availability of skills and knowledge to support the new technology. He observed that the operators do not have experience with e-buses, charging systems, and e-vehicle maintenance. On the moto-taxi side, the federation identified the need to provide training to local maintenance operators.

Safety. Interviewee Service Provider A (e-motos) alerts on quality and safety issues, criticizing competitors for importing vehicles from India not respecting the Bharat emission standards and possibly neglecting safety considerations when establishing charging points at petrol stations regarding proximity with combustible fuel.

General: insufficiencies of public transport infrastructure of services. The national authority's interviewee mentioned that private operators mainly own public transport depots and terminals, and they are not controlled or regulated by the government. RURA has provided a license of one more year to the current bus operators while planning for the second-generation public transport contracts. Governments need to put some facilities like dedicated bus lanes to enhance a well scheduled public transport system in the second generation contracts. The interviewee highlighted the current challenges of the transport operation. Those are dedicated bus lanes included in planning documents but not yet implemented, appropriate transport fares that reflect different road conditions (paved, gravel, and earth roads), and transport fares suitable for both passengers and transport operators.

More disputed: grid capacity. The public transport operator interviewee had concerns about electricity availability and felt that more electricity would be required for e-buses while other electricity-dependent services such as industries and residential are also growing. Nevertheless, this opinion was not shared by the foundation-F2 interviewee (foundation having done a recent study on electric buses), stating that its grid analysis showed that grid capacity was not an issue, except for large charging depots for buses in certain areas of the city. The interviewee stressed that electricity is in surplus, though electricity distribution is not equitable. The REG would be transparent in terms of grid analysis. The e-motos service provider indicates that even in the scenario of 100,000 e-motorcycles in the country, there would be enough additional capacity in the grid (surplus between 60 to 75 mW on installed capacity). Extra demand at peak times in the evening would not be a problem by the time e-mobility reaches grid scale as new power plants will be open in the next 2 to 3 years.

More disputed: knowledge and awareness on EVs. The public transport interviewee PT1 mentioned that as this technology is new, there is no information about e-buses, which are not yet operating in Rwanda. Yet, the operator states to be aware of how environmentally friendly it is, contributing to the green city and decarbonization of air in Kigali. The university's Interviewee A felt that there could also be behavioural barriers because people's mindset set to traditional ICE vehicles, making the switch to EVs difficult. However, the moto-taxi federation interviewee felt that there were no such issues regarding user acceptance. Both service providers e-motos and e-bikes did not either identify such issues, the latter (e-bikes) strongly emphasizing very positive feedback and enthusiasm from Kigali residents.

Gender Parity. Interviewee e-motos service provider saw barriers for bringing women as drivers, about the lack of an inclusive driving curriculum, lack of sensitization of driving instructors, and cultural barriers.

Not an issue anymore: vehicles registration. Interviewee from e-bikes service provider said that, initially, the vehicle registration system only saw the possibility of registering ICE vehicles (for instance,

an indication of CC requested). Interviewee e-motos service provider (e-motos) states that this issue has been resolved. E-motos are registered with RURA.

Interpretation of interviews: the main challenges with regard to SOL+ project implementation

As the policy environment seems to evolve rapidly with an expected policy on e-mobility, some of the main barriers could be lifted in the near future, such as high electricity tariffs. The political support for e-mobility solutions is a further facilitating factor, having led to flexible resolution of issues (e.g. importation duties) in the past.

Yet, some context elements could turn as challenges for the implementation of the SOL+ demonstration action, such as the lack of coordination between initiatives and the absence of clarity on the involvement of the city authorities, as opposed to Mininfra. For the upscaling phase of the Kigali demonstration action, access to finance seems a persisting hurdle which should be addressed early, in coordination with other stakeholders. Generally, it seems that e-motos and e-bikes are well supported and with some positive results already (e-motos), while the amount of hurdles and uncertainties faced by electric buses seems much higher, especially on the financial side. Lastly, the lack of technical knowledge and of information on pertinent policies does not appear as a barrier, but as an opportunity for SOL+ to fill a gap and answer well-expressed needs.

3.4 Sustainability of the e-Mobility solutions to be implemented

E-mobility is seen as a part of strategies for improving public transport and parking in Kigali according to interviewee from university, and therefore the interviewee believes that these solutions will improve urban mobility. Most stakeholders indicated the need for strong Government support for e-mobility. However, there are good hints from the discussion with interviewees from university, OEM, and others that the government will come up with strong policy and regulations that will support e-mobility and charging infrastructures in Rwanda. The interviewee from university informed that the urban development plan is very supportive of transit-oriented development and this could lead to the densification of locations around bus stops, which will be a good support for public and shared transport modes like e-motos, e-bikes and e-buses that are proposed in this program.

The interviewee from foundation-F2 feels that the government works mostly on e-motos, followed by e-cars and e-buses, and not much on e-bikes. E-bikes were not included in their initial rollout strategy. The foundation also opines that focus on e-bikes, especially in peri-urban areas, will impact the lowest income groups and mobility will be good to save on maintenance costs for smaller vehicles, more challenging to have economic opportunities with e-buses given the Capex. eMobility as an excellent opportunity for transport hubs, to improve connectivity and to address challenges of steep terrains

3.5 Impact on existing business models

Most stakeholders were aware of impacts e-mobility will have on existing business models. We cover impacts on buses and motos that are currently used for public transport.

The interviewee from public transport operator said that since the public transport in Kigali is fully financed by the private operator, the operators currently own buses using internal combustion engines

and shift only when the government provides funding. Introduction of e buses was seen by the bus operator to be complemented by improvement in road conditions, better tariffs, and real-time information on schedules to improve economic returns for e-buses and can be deduced will be beneficial for the bus operators.

The e-motos are essentially converting the ICE motos into electric and interviewee with e-motos service provider (e-motos) stressed the positive impact of electric mobility on ICE moto drivers' revenues. The pricing structure is periodically reviewed, contingent on external factors such as electricity prices. This company offers three options to ease the transition for drivers: direct purchase (usually not selected by drivers), simple rental, and lease-to-own (most popular option). Batteries are rented to drivers.

The interviewee from e-bikes service provider sees e-bikes (US \$0.22 (RWF200) every 30 minutes (can ride about 6-8 km)) as a cheaper alternative to moto-taxis (about 300/400 RWF, i.e., US \$0.30-0.40 for circa 1km). It particularly targets students, with 100 RWF (about 10 cents USD) for 30 minutes. Further details regarding its pricing policy were not communicated, and the difference in prices for the two types of bicycles is unclear. The interviewee from moto-taxi federation also mentioned that e-motorcycles under test in cooperation with Ampersand are on the good stage of profitability where for one swapped battery, moto-taxi driver pays 700 RWF and battery operates up to about 70km while for 1 litre of fuel costs 960 RWF/litre and operates for about 50km. The interviewee also believes that current motor riders will use e-motorcycles. The business will continue and shift from using ICE motorcycles to e-motorcycles. If the e-motorcycle cost will be affordable, high profit is expected as the e-motorcycle was previously found to have less cost in terms of maintenance and transport energy than regular motor-cycles that use fuel.

Interviewee national regulatory authority opines that e-mobility will change the existing business model as it will increase energy demand; the energy sector will get further developed. Vehicle maintenance business will shift from ICE vehicle maintenance to EV maintenance. Electronic transport fare collection system will need improvement and integration, and transport fuel energy-based business will shift to electricity dependence that is locally produced energy.

The interviewee from foundation-F2 finds it challenging to identify the impact on users and business models without addressing costs for owning and operating EVs. Spare parts for EVs are prohibitive due to taxes, especially for e-bikes. For e-bikes, it also relates to the way e-bikes are classified, resulting in higher custom duties. There is a need to incentivize the provision of charging infrastructure, work on recommendations on the building code to introduce charging at public buildings (green building minimum compliance standards)

3.6 Implications for Planning and Urban Development

Master Planning

The interviewee from university mentioned that the new master plan has e-mobility as one of its components. In Kigali when implementing e-mobility solutions, topography is an essential consideration. In the updated master plan, there are provisions for parking that prioritizes e-vehicles. The city of Kigali is also planning to locate charging stations without costs, where the government will

give the land for private operators to operate charging stations. Urban regulation will have to start planning for charging infrastructure.

Public Transport Planning

The interviewee from university mentioned that the World Bank also has a project for dedicated bus lanes, which EVs have a right to use. There are also plans to use e-buses for CHOGM 2021 to be held in Rwanda. There is a strong focus on the use of public transport and transit-oriented development. The master plan encourages high-density commercial+residential along mass rapid transit corridors. Transport Association A also mentions that parking spaces need to be increased, providing a moto-taxi riders station for passengers. The interviewee from OEM mentioned that In Africa, urbanization is not triggered by industrialization. Therefore cities experience a lot of cross commuting. This is unlike European cities, where it was possible to connect industrial areas with public transport in Rwanda, many people walk for about 20 minutes to access public transport. He feels that the e-mobility solution will have to be integrated mobility solutions, which solutions like e-shuttles, and other mobility solutions for the last mile connectivity all hinting towards a transit-oriented development

Infrastructure Planning

Interviewee from foundation-F1 felt that there is a need for an integrated approach. There is a need to understand consumer behaviour and needs for charging, tap and go buses (cashless system) can help in targeting e Buses with subsidies. Ride-hailing apps can help the boda industry reduce use of fuel. She also feels that data from e mobility can help in better urban planning. Interviewee from moto-taxi federation mentioned that the ongoing e-motorcycles operation is working in the limited space of Kigali due to few swamping stations. Therefore there is a need for urban plans to include these.

Interviewee from OEM states that in Kigali, Bus operators have challenges of narrow roads and some roads that are in poor condition (earth roads). Therefore the new urban plans could come up with improved roads to facilitate e-buses' smooth operation and operating up to their life expectancy and enhance an economic return.

Interviewee from e-motos service provider mentioned about the need to incorporate the additional spaced need for infrastructure needed for electricity distribution and charging in urban plans.

Parking

Interviewee OEM observes that parking function is vital for charging; therefore, in a city where there is very little space, parking management will also be essential. The interviewee was of the opinion that in Rwanda it is possible to use the parking places as charging stations.

Annexure 1:

List of Stakeholder Considered and Contacted

Stakeholders marked as green were considered and contacted. Stakeholders marked as blue were

Stakeholder groups	Stakeholder	
Public/Para Transport Companies	Kigali Bus Service (KBS)	
	JALI Transport (RFTC) (PT1)	Interview Survey and KP1 weighting
	Rwanda Interlink Transport Company (RITCO)	
	Royal Express	
National / Regional / Local Authorities	Ministry of Infrastructure	
	Rwanda Transport Development Authority (RTDA)	
	Rwanda Utilities and Regulatory Authority (RURA) (G1)	Interview Survey and KP1 weighting
	The city of Kigali	
	Rwanda Urban Development Program(RUDP)	
	REMA, Rwanda Environment Management Authority	
	Rwanda Standards Board	
Service providers (Private and small-scale operators, also informal, energy companies)	Gura Ride (e-bicycles) (S2)	Interview Survey and KP1 weighting
	Ampersand (motor-cycle taxis) (S1)	Interview Survey and KP1 weighting
	REM (Rwanda Electric Mobility)	
	Rwanda Energy Group	
OEMs (i.e. vehicle companies, maintenance)	Volkswagen Mobility Solutions Rwanda (O1)	Interview Survey and KP1 weighting
Associations	Fédération Rwandaise des Conducteurs des Taxi Motos(FERWACOTAMO) (T1)	Interview Survey
	Public Transport Association, ATPR	
Importers & exporters	Association of Manufacturers	
Academia/ Research	University of Rwanda(A1)	Interview Survey and KP1 weighting
	International Growth Centre (IGC)	
Foundation/Funders	GGGI(F2)	Interview Survey and KP1 weighting
	Shell Foundation (F1)	Interview Survey and KP1 weighting
	World Bank	