Discussion Paper: Minibus Electrification in Africa

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Content

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The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH is Germany's leading provider of international cooperation services. As a federally owned enterprise, it supports the German Government in achieving its goals in international cooperation for sustainable development.

This paper was prepared as part of the project Mobilize Net-Zero: Facilitating the Global Transport Transformation. Mobilize Net-Zero supports governments in their commitment to decarbonise transport by building international partnerships. By facilitating knowledge exchange and peer learning, and raising awareness among policymakers, the project aims to accelerate the transition to sustainable transport systems.

Mobilize Net-Zero's activities in Africa include developing and disseminating knowledge on paratransit reform and decarbonisation, and supporting the Government of Rwanda to assess the feasibility of electrifying public transport in satellite/secondary cities and intercity transport.

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Volvo Research and Educational Foundations (VREF)

The Volvo Research and Educational Foundations (VREF) is an independent entity that inspires, initiates and supports research and educational activities for the purpose of contributing to new ideas and solutions for developing sustainable and equitable mobility and access in cities. The overriding goal is to strengthen accessibility for all groups while at the same time radically reducing transport's negative local and global environmental impacts.

This paper and the related workshop are part of the Informal and Shared Mobility Programme in Low- and Middle-Income Countries (ISM) programme. It is one of four thematic programmes under the VREF's overarching 'Future Urban Transport (FUT) – How to Deal with Complexity' programme, the other three being Mobility and Access in African Cities (MAC), Walking as Mode of Transport (Walking) and Urban Freight (UF). With the ISM program VREF seeks to contribute to strengthening equity and sustainability in informal and shared transport systems by supporting research that creates new knowledge among scholars and stakeholders who govern, design and/or develop such systems.

In 2023 the ISM program initiated an International Research Programme led by the Columbia University Climate School's Centre for Sustainable Urban Development with research and non-governmental partners in South Africa, Ghana, India, Thailand, China Colombia, Costa Rica, the United States and the United Kingdom.

Furthermore, the ISM program commissioned regional studies on climate change and supports events and workshops to strengthen the research network and support next generation scholars.

Introduction

At a global scale, the transport sector contributes 16.2% of global greenhouse gas (GHG) emissions. The road transport sub-sector accounts for 11.9% of total GHG emissions, making it the single biggest emitting sub-sector. Three-fifths of this road transport-related GHG emissions come from the petrol and diesel burned by internal combustion engine (ICE) vehicles that transport passengers.[1] In addition, these vehicles also cause local health problems due to the particulate matter and other gases that they produce as a result of fuel combustion, and degrade both air and water quality due to the brake dust and tyre particles that they produce in their normal operations.[2]

Though at present total GHG emissions from the transport sector in Africa is only about 30% of that in Europe, with the largest urbanisation and population increases expected on this continent in the next decades compared to other world regions there is a pressing need to explore ways to decarbonise this sector in this region.[3,4]

There is a range of possible decarbonisation levers that are relevant to the transport sector, each with its own time horizon. In the medium to long term, urban development that integrates multi-modal mobility systems anchored around mass public transport is a comprehensive lever for change, but challenging to realise. Local governments can also combine densification with strictly enforced restrictions to limit sprawl, revisit development regulations to increase the mix of land uses, and plan cities that use space to enable sustainable development. However, in light of generally weak land use planning and development controls in Sub-Saharan African cities, more likely avenues for decarbonisation are investment in mass public transport and promoting its use over private motorised transport.

The de facto mode of mass public transport in most cities in the region is paratransit reliant on minibuses with seating capacities in the 15 to 35 passenger range.[5] Due to old fleets, poor maintenance practices and a typically small business size (often one to two vehicles per business), efficiency in the paratransit industry is a major challenge – including in terms of fuel use and emissions per passenger.

There is evidence across the region of three clusters of action aimed at addressing paratransit efficiency, amongst other aims, though all have to date had a limited geographic spread and local impact. Firstly, programmes to renew paratransit fleets at scale have been running in Dakar, Senegal and nationally in South Africa for nearly two decades. At the outset both programmes had the aim of consolidating paratransit ownership, though this was only retained as component of the roll-out in Dakar.

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[1] Our World in Data, (2020) Sector by sector: where do global greenhouse gas emissions come from?, https://ourworldindata.org/ghg-emissions-by-sector

[2] https://www.thedrive.com/news/tire-dust-makes-up-the-majority-of-ocean-microplastics-study-finds

[3] Our World in Data, (2020) Breakdown of carbon dioxide, methane and nitrous oxide emissions by sector, https://ourworldindata.org/ghg-emissions-by-sector

[4] UN Habitat, (2022) World Cities Report 2022: envisaging the future of cities, Nairobi: UN Habitat

[5] Behrens, R, McCormick, D, and Mfinanga, D, (eds.), (2016), Paratransit in African cities: operations, regulation and reform, Oxon: Routledge

In the second instance, ambitions to displace or absorb paratransit operations through the introduction of new bus rapid transit or conventional bus services have for the most part not been realised. The most notable, if moderate, achievement on this front has been in South African cities, where bus rapid transit is predominantly operated by former minibus operators that were consolidated into companies. However, even in these cities the modal share of the new bus services is minor compared to that of minibuses.

A third thrust to shore up efficiency as well as service quality has been paratransit business reorganisation and ownership consolidation, with a view to operators' eventual participation in contracted public transport services provision. There has been notable work done in Kampala in this regard, with similar processes under development in Maputo and Pretoria. Again, such processes are not widespread.

With a greater focus directly on decoupling vehicles from a reliance on petrol and diesel fuels, in recent years a transition to low-emission vehicles has been gaining much momentum, supported by significant political will and often public sector subsidies. Electric vehicles (EVs) have taken centre stage as the technology of choice for this shift, with EVs being especially prevalent in High Income Countries (HICs), notably in the Nordic region.[6]

This adoption at a large scale has contributed in part to the dramatic fall in battery prices over the last decade, with many vehicle manufacturers now having committed to electrifying their full range.[7] Moreover, led by aggressive e-bus growth in China that has since spread to other world regions, e-buses are surpassing the growth of every other EV segment globally.[8]

While still in its early stages, these developments suggest that the electrification of public transport could contribute to an inclusive rollout of e-mobility in mass transport services in Africa, providing opportunity for several aspects of public transport to be improved. Aside from emissions, these can include the passenger experience, travel cost, operating cost, road and passenger safety, working conditions and the inclusion of marginalised groups.

Though operator consolidation remains a major challenge, it is encouraging to note that development finance institutions (DFIs) are increasingly broadening their focus to include fleet renewal and exploration of electrification of public transport services, targeting many of these issues and specifically in the bus segment. At the same time, research institutions and private sector entities are working at small or localised scales to do the same in terms of minibuses, notably in South Africa but also in some countries in East and West Africa.

Against this background, in this paper we explore how current fossil fuel-powered minibus fleets in African cities can be replaced with electric minibuses, or e-minibuses, moving from the current experimental scale to roll-out at the city or national level. The paper was developed alongside a workshop on minibus electrification in Africa that was hosted by GIZ and VREF in Kigali on 11-13 June 2024, attended by researchers, private sector practitioners and decision-makers with an interest in e-minibuses. This paper was prepared as a resource

[6] https://www.weforum.org/agenda/2021/02/electric-vehicles-europe-percentage-sales/

[7] https://www.bbc.co.uk/news/business-57253947

[8] https://www.bbc.com/future/article/20231206-climate-change-how-chinas-electric-vehicle-revolution-began-with-buses

to inform the workshop, while also serving to reflect on key lessons that emerged from the presentations and discussions at the event.

In the next section of the paper we put forward a set of propositions describing how e-minibus projects may unfold in reality, including what some of the pitfalls and opportunities may be in undertaking such projects. In the subsequent section we propose an e-minibus pre-project evaluation framework. It highlights critical factors that need to be considered in setting up, scaling up and investing in an e-minibus project. In the last section of the paper we capture important experiences on levers for and challenges to change which were flagged during the workshop, both in terms of those that are specific to particular countries and those that have wider relevance in the African context.

Propositions on minibus electrification

There is no precedent of full-scale implementation of e-minibuses (e-MBs) in Africa, though there is clearly interest in the topic as demonstrated by an increasing number of pilot-scale or experimental projects. At the same time, a shift to e-MBs is a complex undertaking, and does not only comprise the replacement of one kind of vehicle with another, but also implies far-reaching changes to the structure of the operator industry to how vehicles are managed and run. There are thus several current and potential obstacles that may prevent the shift from being feasible.

In this part of the paper, we put forward a set of eight propositions that aim to project how the shift to e-MBs might unfold in the coming years, drawing on experiences with these existing projects and noting current and potential enabling factors and hurdles. Our propositions touch on topics that include paratransit industry structure, energy efficiency, data collection, finance matters, private sector development, inclusion. and capacity building.

Proposition 1. The relevance and viability of e-MBs must be informed by the long-term visions for mobility systems and capacities of African countries and cities to reform public transportation.

In many African countries, the electrification and decarbonisation of minibuses will take place in contexts that are already defined by wide-ranging developments in public transportation. The nature, direction and speed of these changes vary greatly between countries, and within them. Paratransit services are, and will remain, subject to varying degrees of public interventions and reform, which can be roughly divided into the following categories:

- **Mapping and diagnosis** of the current system
- **Corporatisation** of operators (consolidation of the industry into few operating companies)
- **Rationalisation** of the network (planning competences assumed by (local) transport authorities, including monitoring)
- **Professionalisation** of the workforce (capacity building to drivers as well as management instances of newly established companies)
- **Formalisation** of working relationships (introduction of employment contracts with corresponding benefits and guarantees)
- **Contractualisation** of services (between public transport authority and operators, ideally to introduce competition for the market, vehicle and service standards, ticketing systems, schedules, number of vehicles per route/area, number stops, etc.)
- **Integration** with other public transport services (usually Bus Rapid Transit (BRT), as system operators or feeder services)

- **Renewal** of the fleet (accompanied usually through scrapping programmes and financial and tax incentives)

The degree of formality of minibus services in a broad sense will greatly influence not only the capacities of operators to shift to e-mobility, but also the instruments and support needed by governments to facilitate this transition, as we will argue in the following propositions.

The single most important factor determining the viability of minibus electrification, however, will be whether minibuses in particular, and paratransit in general, will still have a place in the long-term (political) visions and plans of governments for public transportation. On one hand, such services represent the most important, and in many contexts the only, form of public transport in Africa, and are enjoying growing recognition, and perhaps even legitimacy, in the eyes of some public authorities. On the other hand, significant investments and efforts are being directed towards the introduction of mass transit systems, especially bus rapid transit (BRT), as well as high-occupancy vehicles better suited to supply the ever-growing African cities and the consequent growing transportation needs (and expectations) of urban populations. However, reliance on and recognition of minibus systems and the introduction of new higher occupancy vehicles and systems need not be separate undertakings. There is certainly scope to invest substantially in public transport efficiency improvements. This could start with existing minibus systems to include fleet and vehicle right-sizing, coupled with dedicated roadway, passenger and operational infrastructure, which in turn could produce more effective mass transport services.

The future of public transport in Africa is therefore uncertain, and may become even more diverse as it already is. For minibuses, at least three scenarios are possible:

Scenario 1: the industry will retain its current organisational and operational form, characterised by varying degrees of informality and fragmentation. This will most probably be the case in smaller cities and rural areas, where demand for public transport will remain relatively low, as well as the capacities, both institutional and financial, of local governments to envision and introduce significant changes to the current status quo. In this scenario, minibus electrification should become highly relevant from a policy perspective. In these contexts we expect to encounter the oldest, most polluting and road-unworthy vehicles, as well as the least financially and organisationally capable operators. This is the end of the value chain. This is, also, the most challenging scenario with the least conducive environment for minibus electrification.

The transition to electric mobility will depend on the development of second-hand vehicle markets, i.e. the availability of cost-efficient electric minibuses therein, and more important on the ability of operators to make the transition. Whether and when second-hand electric minibuses will or should enter Africa is uncertain and highly questionable, and several regulatory aspects should be seriously taken into consideration in order to guarantee safe operations and maintenance of batteries, as well as their proper disposal, recycling or repurposing. Whether the private sector can make the transition to electric minibuses will be informed by their ability to achieve the necessary degree of organisation to facilitate investments in fleet renewal and (collective) charging infrastructure and to introduce

attractive business models for electric minibus operations, largely in the absence of public intervention.

Policies and regulations should focus on improving the enabling environment for the provision of public (paratransit) services, such as encouraging consolidation of the industry (or at the minimum organisation in associations) and introducing or adapting regulatory frameworks to improve operational conditions. In the short term, government support should prioritise fleet modernisation with less old ICE vehicles, potentially new or second-hand, to deal with the acute problem of very old minibus fleets that arrive imported as goods vehicles and are converted locally for passenger use. The role of national (and where they exist, regional or state) governments is key, due to limited capacities of local authorities in general. Electric minibuses could be piloted as part of this, but uptake at scale may not be feasible in the short and medium term.

Scenario 2: paratransit will be integrated into better planned and regulated public transport networks and will shift to a better organised and consolidated industry, particularly in major cities. Under this scenario, investment in electric minibuses will be financially feasible, but so will be the introduction of higher-occupancy vehicles. The latter may not only be mandated by public transport authorities, but conventional buses will become more attractive for consolidated operators and more convenient for passengers in urban areas with high demand. The role of minibuses may be reduced to servicing feeder routes and areas with lower passenger volumes, making the case of electric minibuses a viable climate policy for governments under specific circumstances.

The greatest challenge and priority for public authorities should not be to electrify public transport fleets, but to design the right enabling environments for public transport operations to thrive. This should include planning for public transport systems that properly define the roles of the multiple public transport services; identifying the segments of the network that should be serviced by different types of vehicles (e.g. high-occupancy buses along main or trunk lines and minibuses in feeder areas); implementing contractual arrangements that facilitate competition for the market, incentivise fleet electrification, and allow (to the greatest extent possible) profitable operations; subsidizing, whenever necessary, public transport operations; introducing scheduled services and passenger information systems to increase convenience and accessibility for users; among others.

Minibus electrification should not be pursued as a standalone policy objective. Instead, it should be integrated into larger public transport reforms highlighted above. But first and foremost, cities should have a clear long-term plan and vision for the role of paratransit in general, and minibuses in particular, within the entire mobility ecosystem. To support minibus electrification, governments should focus on consolidating the industry and developing contractual models suitable for e-MB operations, including electrification mandates. These can be complemented with financial incentives for fleet modernisation and charging infrastructure, preferential treatment of electric minibus operators in tender processes and development of regulations for electric vehicle charging and grid integration.

Scenario 3: inefficient and (politically) unattractive minibus services will eventually be phased out as governments seek full formalisation of public transport. This may take place in the capitals and largest cities of Africa, accompanied by large-scale investments in mass-transit systems, especially bus rapid transit (BRT). Minibuses may still play a very limited role in specific niche areas not covered by the formal public transport network, and may remain informal in nature.

In this scenario, government efforts will be mostly directed at leading investments in BRT infrastructure, expansion of the bus fleet and its eventual electrification. Negotiated integration of incumbent (paratransit) operators should be a political priority to guarantee a just transition to formality and to reduce opposition to the planned reforms. To avoid repeating the vicious cycle of deteriorating publicly-led public transport and the subsequent rise of paratransit services due to the neoliberal reforms of the 1980s and 1990s, governments should firmly commit to supporting (i.e. subsidising) public transport operations backed by the necessary long-term financial commitments, contractual arrangements, business models and public-private partnerships. As in earlier decades, however, such operating subsidies may not be financially viable even if they are politically attractive.

Minibus electrification may not have a significant role to play whenever government policies and plans aim at fully replacing paratransit services with formal public transport systems. This does not mean that minibuses will entirely disappear from the public transport landscape. It is much more likely that many of these vehicles will be relocated to other regions within the same countries, e.g. rural areas and smaller cities, as in the first scenario. Phase-out programmes can have a positive environmental impact if properly planned and enforced. For example, retired minibuses in capital cities may be younger and in better condition than in less favoured urban and rural areas. Until the right conditions for minibus electrification develop in the areas covered by the first scenario, governments can support the modernisation of the minibus fleet by implementing scrapping schemes for the oldest minibuses, to be replaced by more modern variants phased out under the third scenario. If implemented in the long term, such scrapping and replacement programmes can pave the way for full electrification of the minibus fleet by regulating the entire value chain. In other words, the full electrification of public transport in scenarios 2 and 3 will inevitably lead to the eventual electrification of public transport in scenario 1 through a continuous process of replacement and renewal.

In order to accelerate the decarbonisation process, countries can introduce bans on ICE minibuses or maximum age requirements for minibus imports. However, such drastic policies need to be complemented by additional measures to avoid the risk of jeopardizing the public transport sector in the absence of viable alternative operational and business models for incumbent operators. Import restrictions and bans may thus become politically attractive, socially acceptable and operationally non-threatening in the medium to long term, once the e-mobility industry in Africa is mature enough and the minibus industry has reached the necessary level of formalisation and consolidation.

Proposition 2. Investment in e-MBs supports increased public transport system efficiency and brings about GHG and other emissions reductions

Minibus electrification can bring substantial benefits to the environment, urban populations (not only public transport users), and also to the pockets of operators. The most evident and well-known benefits are not specific to minibuses, but to electric mobility in general: cleaner air and GHG emissions reductions. Nonetheless, minibus electrification and decarbonisation should be at the top of the agenda of governments compared to other modes of transportation for a variety of reasons.

First, the relatively old age of the minibus fleets across African countries represents a real problem for both governments, citizens, and operators alike. These vehicles are not only very polluting and in many cases road-unworthy, representing thus a health and safety hazard, but they are also expensive to maintain. The organisational logic of minibus operations, based on the target system, creates an incentive to neglect maintenance to reduce operational costs, albeit reducing the overall useful life of the vehicle. For instance, investing in maintenance beyond minimum repairs would translate to a lower salary or longer working hours for drivers, who in most cases already work extremely long hours and struggle to make ends meet. Electric minibuses would reduce operational costs through reduced maintenance needs. If powered with a clean electricity grid, they could also contribute to greater predictability of operating costs related to fuel price volatility, though at the same the impact on tax revenue on such reduced fossil fuel sales should be considered.

Secondly, due to the (still) very low motorisation rates in most African countries, minibus fleets make up a significant proportion of the total vehicle fleet in many contexts. As a result, the relative contribution of electrifying minibuses to sectoral GHG emission reductions and air quality improvements should be equally substantial. Currently, the greatest problem is the lack of data to substantiate these claims. Such data gaps also act as an important barrier to mobilizing climate finance, an instrument that should play a key role to enable the transition to electric minibuses, as we shall argue in the next propositions.

As one of the main modes of (public) transport in many cities, electrification of minibuses can lead to more efficient operations and more attractive services that could potentially counter against a shift to private cars. The strategic placement of charging stations can take advantage of current operational features. The fill-and-go system, where minibus operators wait for long periods (sometimes several hours) for their vehicles to be filled with passengers to depart from stations, could provide an opportunity to introduce opportunity charging during off-peak hours, thereby reducing the burden on the grid.

The electrification of minibuses in a business-as-usual scenario, i.e. without significant changes to current operational and organisational conditions, may be possible under certain conditions, but this will require innovative solutions and experimentation different from those currently implemented for traditional and formal bus services. Support from governments and development organisations will be needed to carry out the necessary technical, financial and environmental assessments to electrify existing networks and

measure the potential for greenhouse gas reductions. The electrification of minibuses represents a major opportunity for route optimisation, potentially without the need for major reforms to current systems, but data will be needed. Electric minibuses can be equipped with data collection systems that allow operators to track routes, energy consumption and driver behaviour. This data can be used to optimise routes, improve driver training and facilitate access to finance. This will require first and foremost a great degree of awareness raising, capacity building and political ownership and negotiations. As of now, research and pilotin in South Africa suggest that retrofitting can be a technically and economically viable approach to electrification, making use of existing fleets and encouraging local industry development.

Proposition 3. Closing the data gap on current operations is a prerequisite to planning for electrification and assessing the overall impact of electric minibuses compared to their ICE competitors.

We do not know nearly enough about the functioning of paratransit systems. Practices and data availability varies greatly across and within countries. Three major barriers to accessing data are the varying degrees of informality of minibus operations, their fragmented nature, and the different ownership models that one may encounter. Any attempt to promote the electrification of minibuses is thus likely to fail unless there is a dramatic change in the relationship between public authorities and the paratransit sector. Accepting the essential role of these services and engaging them through negotiations will not be enough. Governments should see operators as potential partners and try to build the necessary trust to forge long-lasting relationships. Envisioning and planning public transport and the role of paratransit within it is a first step. Trust and recognition will be needed to facilitate the exchange of information and data, but also to legitimise government support for these services in the transition to electric mobility. The problem of fragmentation can be solved through engagement with existing associations or, whenever possible, through consolidation of the industry.

To promote minibus electrification, different types of data will be needed for different purposes:

Assess the viability of electrifying current minibus routes: Although in theory minibuses operate as bus-like services with fixed routes, it is well documented that drivers usually use their assigned routes flexibly in order to maximise patronage. The length of routes also varies considerably depending on the areas served. Differentiated assessments will therefore be required.Some of the most important data required to assess the viability of electrifying minibus routes include 1) average daily distance travelled to determine the battery range required; 2) route topography, as information on elevation changes along routes will help to assess potential limitations or range reductions; 3) passenger load fluctuations, driving behaviour as well as the number of stops for a more accurate estimation of energy consumption. Understanding current operating conditions will allow

both operators and governments to identify routes with the greatest potential for electrification and plan network changes where necessary.

Assess the GHG emissions reduction potential: Electric minibuses offer significant environmental benefits, but quantifying these benefits requires data on current emissions. This includes 1) average vehicle kilometres travelled (annual distance) to estimate annual fuel consumption and emissions for ICE vehicles; 2) carbon content of fuel consumed (gasoline or diesel); 3) average fuel consumption per vehicle type to compare fuel efficiency of existing minibuses with the estimated energy consumption of electric minibuses; 4) carbon intensity of the electricity grid, as regions with a high dependence on fossil fuels for electricity generation will see lower emissions reductions from electric minibuses.

Compare the Total Cost of Ownership (TCO) of electric compared to ICE minibuses: A well-known financial barrier to the purchase of electric buses in general is the higher capital expenditure of electric vehicles compared to ICE equivalents. In the context of minibus electrification, this factor may be even more problematic as the majority of minibuses in Africa are second-hand imports. As used electric vehicle markets are not yet developed, new electric minibuses will compete with much cheaper used minibuses in the short to medium term. On the positive side, electrification of the minibus fleet can lead to significant reductions in operating costs. However, this does not solve the problem of higher capital costs for electric minibuses, which needs to be addressed with (significant) financial support to operators. In order to fully understand the potential efficiency gains and the need for (financial) support, the following data are required: 1) Purchase price of new electric vs. new and used ICE minibuses to calculate the initial investment required; 2) average energy consumption and price of energy by source (fuel vs. electricity); 3) maintenance costs; 4) battery replacement costs; 5) investment in charging infrastructure if operators are to bear the costs themselves; 6) other operational expenditures commonly encountered in minibus operations, such as fines, bribes, fees to associations, conductors, callers, stages, etc.

Assess the potential impact on public transport fares and revenues: Electrification can have both negative and positive impacts on fares and revenues for minibus operations. Cost reductions, which could potentially lead to a decrease in fare levels, may result from lower operating costs, improved efficiency, as well as eventual government incentives. Subsidies to offset the incremental upfront costs of electric minibuses can help operators maintain current fare structures despite potential loan repayments for electric vehicles. Cost increases, on the other hand, may be caused by upfront vehicle costs, even in the presence of incentives, as well as battery replacement costs and investments in charging infrastructure. Depending on the regulatory frameworks in place, public transport authorities may regulate fare changes proposed by operators based on electrification costs. For this purpose, a comprehensive analysis of the impact of electrification is required. Important data to be considered includes 1) historical fare structures and their relationship to operating costs; 2) passenger demand elasticity, especially responsiveness to fare changes and willingness / ability to pay a premium for improved services; and 3) financial and fiscal capacities of governments to subsidise electric minibuses. The bottom line is that the potential economic benefits of electrification should be shared by both operators and users.

Proposition 4. Substantial finance will be needed in the short- and medium-term to accelerate the transition to electric minibuses.

The electrification and decarbonisation of minibuses are crucial steps towards a cleaner future. However, several challenges need to be addressed to ensure that the transition is in line with governments' and international decarbonisation commitments, and in particular set timeframes. In addition to accelerating this process, increasing access to financing mechanisms could also ensure a more equitable transition by reducing the wide disparities in the capabilities of operators and public institutions, as we discussed in the first proposition. In effect, a key hurdle that must be overcome is the weakness of capital markets in most African countries, which limit local financial institutions' ability to provide loans to finance the acquisition even of individual vehicles.

The role of finance, and providing access to finance, in accelerating or even kick-starting this process is therefore essential for several reasons.

Bridging the financial gap and supporting a just transition: Climate finance can help fill the financial gap by providing the necessary grants and loan guarantees to make electric minibuses a viable alternative to the current second-hand market. This support can be particularly impactful if it is targeted at the weakest links (i.e. the most fragmented and informal segments), who struggle the most with traditional financing options. Accessing such finance is, however, not straightforward, and thus it should not be seen as a panacea. Nonetheless, without substantial finance, the transition is likely to be slow and uneven, potentially benefiting only larger, better-resourced operators. This could exacerbate the gap not only between operators, but also between regions (see scenarios in the first proposition).

De-risking charging infrastructure: As fragmentation and informality are particularly detrimental to collective action, it can be expected that investing in collective charging infrastructure will be even more challenging than purchasing electric vehicles. Climate finance can incentivise private investment in charging infrastructure by mitigating risks, supporting pilot projects, and enabling external actors to enter the market through innovative business models. Without climate finance, therefore, the development of a comprehensive charging network may be slow or even prevented, limiting the range and convenience of electric minibuses and ultimately discouraging wider adoption.

Aligning with governments' and international decarbonisation commitments: Climate finance will be needed to ensure that the decarbonisation of the paratransit sector is consistent with the need to reduce emissions to combat climate change and meet African countries' climate targets. Just as conventional bus systems have received support from international and governmental institutions in several countries, such as the provision of grants to cover the incremental costs of electric buses, minibus operators will need the same kind of support, if not more. Not only are minibus operators in a much more precarious financial and organisational situation than conventional public transport operators, but the capacity of many (local) governments to support the paratransit sector is equally limited. Without climate finance, slower electrification rates will translate into

slower emissions reductions, hindering progress towards climate change mitigation goals and limiting the ability of the minibus sector to realise its decarbonisation potential.

In order to facilitate access to finance – whether such finance is oriented towards climate change considerations or otherwise – governments need to recognise the role of paratransit in reducing GHG emissions in the transport sector. Differentiated policies, measures and targets exclusively for minibus electrification should be included in countries' Nationally Determined Contributions (NDCs) and low-carbon strategies, and harmonised with sectoral policies and electrification programmes. As a minimum, governments can conduct status quo assessments of current minibus fleets and estimate their potential to reduce emissions, and play a facilitating role between operators and climate finance institutions by providing the necessary leadership and enabling frameworks. Governments can also offer loan guarantees or other risk mitigation instruments to leverage private sector investment and complement climate finance, thereby fostering replication and scalability.

Proposition 5. Operator consolidation is a prerequisite for minibus electrification to be feasible, along with business set-up finance and competition management mechanisms.

The main challenges facing the paratransit sector, and minibus operators in particular, are not technical, but rather political/regulatory, organisational and financial in nature. They are closely linked and are a recurring factor throughout this paper. Fragmentation and informality result in weak financial capacity of operators and significant barriers to access finance. In addition, there is a lack of data and enabling legal and regulatory frameworks needed to improve the efficiency, reliability, and profitability of these systems and to increase the appetite of private financial institutions to invest in the sector. Membership in associations and reform measures, in particular industry consolidation supported by improved contractual frameworks, have proved effective in facilitating fleet renewal.

Transitioning Africa’s minibus sector towards electric vehicles requires thus a paradigm shift from a fragmented, informal industry dominated by ‘competition within the market’, to a consolidated and well-regulated sector characterised by ‘competition for the market’.

Introducing competition for the market and improved regulatory frameworks: The shift from 'competition in the market' to 'competition for the market' involves operators competing for government contracts to operate specific routes or zones. In regulatory environments characterised by varying degrees of informality, minibus operations tend to operate either in the complete absence of regulation, i.e. in a completely open market, or under licensing arrangements limited to the granting of operating rights, usually linked to a single vehicle, without any significant performance, service quality or vehicle specifications. To facilitate the introduction of electric minibus operations, regulatory frameworks must thus shift to more sophisticated and ambitious models, such as concessions, franchises and ultimately public transport contracts.

Many African governments are seeking to formalise the minibus sector through improved contractual arrangements and should continue to do so. In such existing and future cases,

the electrification of minibuses should be considered in the design of contracts in order to introduce mandates and incentives that can facilitate the transition by minibus operators. These could include quotas for e-MBs in operators' fleets, reductions in the electricity tariff paid for charging, exclusive access to the most profitable routes or areas, scrapping allowances for old vehicles, tax breaks on import duties or value-added tax for e-MBs and spare parts, longer contractual durations, among others.

Where governments have the institutional and financial capacity to set up a comprehensive public transport contracting regime, service contracts could be tested that incorporate the risk allocation affordances of both gross and net cost contracts. Potentially resulting hybrid net or hybrid gross cost contract should balance demand, revenue, capital expenditure and operating expenditure risks between the authority and the operator. Guaranteed profitability or subsidisation of public transport could be politically appealing and could make private sector financing more viable, thereby reducing reliance on climate and development finance in the long run, but equally exposes the authority financially for an extended period of time.

However, it is much more likely that the majority of African cities will struggle, at least in the short and medium term, with limited capacity to introduce the most comprehensive types of public transport contracts. In reform processes characterised by a transition from informal to better regulated systems, franchising and concessioning models may therefore be recommended as intermediate steps, as "both match the territorial and self-deterministic nature of paratransit operations, and leave the relationship between individual paratransit businesses and their route associations largely untouched" (Jennings and Behrens 2017, p. 17). In other words, concessioning and franchising can improve operational conditions and profitability by introducing competition for the market, without the need of full formalisation and/or consolidation.

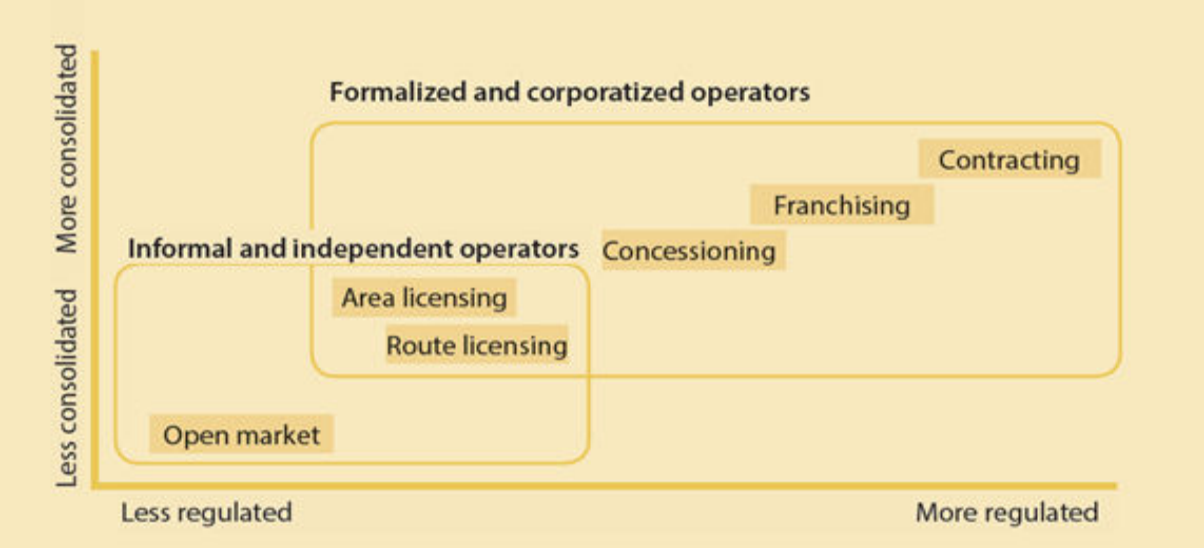

Figure 1: The regulatory framework informs both the degree of informality and organisation of the paratransit industry[9]

[9] Jennings, G, Behrens, R (2017), The case for investing in paratransit strategies for regulation and reform, Volvo Research and Educational Foundations (VREF), May 2017

Shifting from a fragmented to a consolidated industry: Consolidation into a few (or more) professionally managed public transport operators goes hand in hand with an improved regulatory framework. As mentioned above, the fragmentation of operators is a major obstacle to accessing finance and operating on terms favourable to both operators and passengers. Membership in associations (also called cooperatives or unions) has proved successful in addressing the first factor, as they can provide loans and other financial services to their members, which can be used to modernise the fleet. However, these organisations are not very good at improving their members' operating conditions and therefore not very successful at improving their profitability. Although associations are a mechanism for collective action in the informal transport sector, the oversupply of vehicles and competition in the market (even between members) is a common dynamic observed on many paratransit routes.

A key factor in explaining this paradoxical situation is the mismatch between the interests of the different stakeholders within the associations themselves: since the power and success of an association is measured to a large extent by the number of its members, it has an incentive to always increase this number. On the other hand, the main interest of the operators (at least the drivers, who bear all the operational risks under the target system) is to limit the number of vehicles on their routes in order to reduce competition. Under these circumstances, even a rationalisation of the network without full consolidation and formalisation may be at odds with the management of an association.

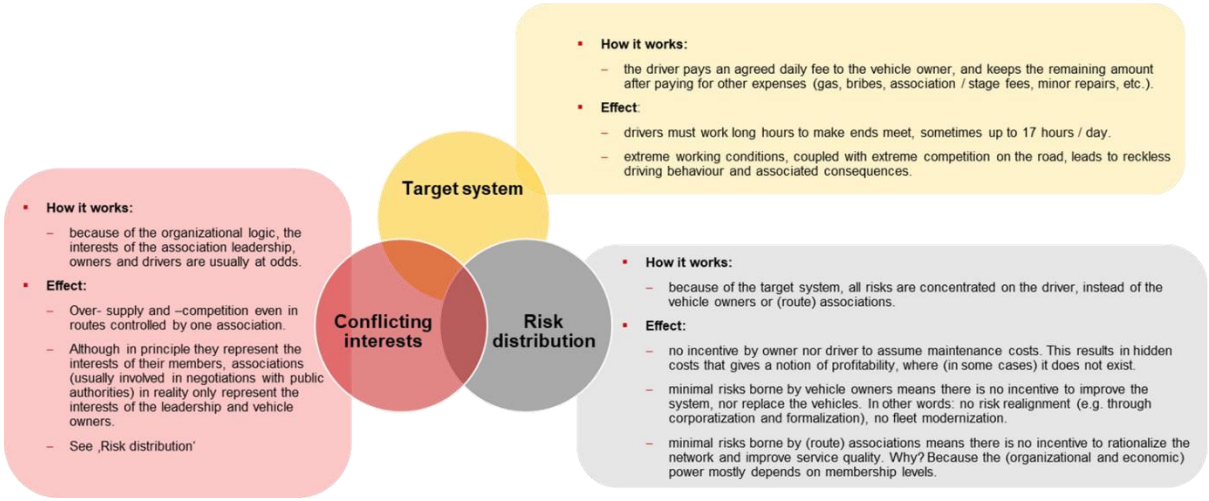

Figure 2: Three key factors behind paratransit's inefficiencies and negative externalities[10]

Not only do associations (especially in the context of the target system, i.e. in the absence of a formal employment relationship between driver and vehicle owner) pose a challenge to improved planning and operation of minibus services, but they could also act as a barrier to the introduction of innovative business models for electric minibuses, especially those that separate fleet ownership and operation in different hands. The "pay-as-you-drive" leasing model, where a company that owns the fleet and the charging infrastructure leases

[10] By the authors

its buses to operators for a fixed payment based on the number of kilometres driven, may not be feasible for minibus electrification in the absence of professional companies for the following reasons: 1) associations may have the legal status or experience to negotiate bulk contracts for their members; 2) vehicle owners, who often represent the power base of the associations (and not the minibus drivers), would lose their business based on the target system; and 3) the leasing company may be reluctant to offer its services to semi-informal organisations with opaque ownership and operating models.

In the context of the electrification of minibuses, the first priority should be to support the transition of the industry from associations to formal public transport companies. Given the constraints that both public authorities and operators face in making such drastic changes, associations should play a key role in enabling the introduction of electric vehicles. In the context of fleet modernisation programmes, governments can provide preferential access to financial incentives (such as grants and loan guarantees) for those associations that commit to purchasing electric vehicles. Capacity building programmes can also improve the management skills of associations to encourage them to invest in and operate charging infrastructure. Governments can also work with associations to negotiate bulk contracts with OEMs to reduce the cost of electric minibuses for a large number of operators.

Proposition 6. A shift to e-MBs will require rapid private sector development and participation to supply the needed technologies and services.

The current minibus market in Africa is almost entirely dependent on used ICE imports from outside the region. This is a major challenge for the introduction of electric minibuses on the continent, and stifles local industrial development. The lack of used electric minibuses also means that, under current circumstances, new electric models entering the market would necessarily compete with much older and more polluting but cheaper vehicles, making electric minibuses inaccessible to the vast majority of operators. All things being equal and assuming that minibuses are exported to Africa when they are at least five years old or older, we could potentially see the development of an initial used electric minibus market in the medium term, but only on a large scale in the long term.

It is unclear whether minibus electrification can develop within the existing value chains that at present rely so heavily on used vehicle importation. Compared to the current system, several issues will become highly relevant, without which minibus electrification may not be feasible, and for which the private sector will play a central role.

Firstly, the charging infrastructure needs to be developed at a pace that is compatible with the introduction of electric minibus fleets. We have argued in previous proposals that infrastructure development is a new and additional investment. The capital and expertise required is largely not available to the majority of operators. Associations could play a role in bridging this gap, as could the private sector through the introduction of new services. For example, the provision of charging infrastructure could be outsourced to third parties, creating new and attractive business models while reducing the risk and (otherwise prohibitive) investment requirements for operators. A starting point could be to leverage

the infrastructure already used by the sector. This could be the case for owners and operators of fuel stations, garages and car washes who provide collective overnight parking for many minibuses. To facilitate opportunity charging, charging stations could also be placed at bus parks and other stops used by operators for breaks or under the fill-and-go system.

Second, the knowledge, services and infrastructure for battery supply and management need to be built from the ground. Batteries will have a significant impact on operational costs, as well as safety. To ensure that second-hand vehicle markets are a viable option for electric minibuses, appropriate testing methods and regulations need to be developed and enforced to ensure that imported used batteries are in an acceptable condition. Unexpected battery failure or reduced range due to a lack of monitoring and testing can significantly increase operating costs for operators and discourage wider adoption. This will become even more important as electric minibuses move down the value chain, eventually ending up in the hands of the most informal segments of the sector before being scrapped, recycled or reused.

It will be equally important to build the capacity and knowledge of operators and service providers to work safely with high-voltage systems. This will be challenging in the context of informality, where the relationship between drivers and vehicle owners is defined by the target system, i.e. in the absence of a formal employment relationship, and where some maintenance functions are also carried out by informal providers. Associations should once again play a key role in mobilizing and facilitating access to capacity building opportunities for their members. Governments, however, have a key role to play in the early stages of the transition by providing access to training for both existing operators and technicians, and implementing widespread awareness raising campaigns. The challenge of scalability can be mitigated by first identifying a few associations and their service providers that show a willingness to purchase electric vehicles. Nevertheless, in the long term, informality may be the most important challenge in dealing with batteries.

Second-hand markets are not the only solution for electrifying the minibus sector in Africa. Two additional alternatives are also possible:

Retrofitting of existing minibus fleets: Although retrofitting has been successfully tested in minibuses, the technology is not yet ready for the mass market. This would require, amongst others, substantial investment to develop the needed industrial base with its supply chains (notably for battery cells and motors, whether imported or locally produced) and people with the appropriate technical skills. In the medium to long term, this model could become an attractive alternative to the second-hand market, especially for used minibuses that are not too old and/or incompatible with electric conversion. This approach is promising as it makes use of the existing fleet and infrastructure, thus reducing the need for new manufacturing infrastructure and waste generation. Retrofitting could potentially become more financially accessible and therefore attractive to informal operators with limited resources, allowing them to participate in the electrification process. Currently, the main challenge is the relatively high cost compared to other alternatives and the lack of a regulatory framework that could facilitate their standardisation and uptake.

Governments can support the development of retrofitting as a viable technology and business model by providing grants or subsidies to offset the cost of retrofitting minibuses; developing certification schemes for retrofit kits and companies to ensure safety and performance standards; establishing technical standards and regulations for retrofitting; and implementing capacity building programmes for mechanics on how to properly retrofit and maintain retrofitted minibuses.

Development of a local electric minibus industry: Certainly the most ambitious scenario, a local industry would not only result in significant job creation, but would also encourage the development of local technological innovations tailored to African conditions and needs, especially those specific to the paratransit minibus sector. Reduced dependence on import markets could potentially reduce costs and encourage the development of local value chains. This scenario may be highly unlikely unless the challenges of informality, inappropriate business models and organisational structures, uncertain demand and lack of infrastructure, as well as the shortage of skilled workers in electric vehicle technology across the continent are addressed in parallel and in an integrated manner.

The development of a local industry could be seen as a long-term strategy within specific countries or clusters of countries, complementing other initiatives such as retrofitting and importing electric minibuses. Economic policies and financial incentives could be targeted at this specific industry, such as tax breaks, subsidies and low-interest loans for investments in local assembly and manufacturing; prioritising locally assembled electric minibuses where governments are directly involved in minibus electrification; funding research and development initiatives focused on electric minibuses; developing standards and regulations for locally manufactured vehicles, etc. Equally important, governments should prioritise the development of a battery recycling industry and design the necessary regulatory frameworks to enable the recycling, reuse and disposal of batteries in a sustainable manner.

Proposition 7. A shift to e-MBs can create opportunities for the greater inclusion of vulnerable, marginalised and minority groups in society.

The reliance on technology and energy importation from other world regions for the existing ICE minibus industry in the great majority of African countries works against local industrial development and job creation. Nonetheless, such reliance does not remove the need for local services to provide and maintain such minibuses and related (fossil fuel) energy systems. Indeed, there are usually extensive local networks of service providers that cater to vehicle repair, maintenance and cleaning needs, as well as to parts supply and fuel distribution. Such providers might often work in as informal or fragmented a manner as the operators that they support, in particular in keeping vehicles in working order, and thus might easily be overlooked despite being essential to minibus operations.

A shift to electrification can unlock opportunities for regional, national and local industrialisation, which in turn create employment opportunities that previously did not exist. This can be both in vehicle and energy systems production (such as bodywork,

battery pack, or solar PV panel assembly) and in the support services for such systems (including, for example, maintenance of electronic and electric parts, or in recycling battery components). In the near to medium term e-MBs are unlikely to supplant their ICE equivalents, and thus the employment spurred by electrification would in all likelihood not replace existing jobs but rather provide additional ones – albeit requiring more advanced skills. Care should nonetheless be taken that existing service and support jobs related ICE minibuses are not curtailed, or if so, that affected people have access to training programmes. With jobs already being scarce, it should not be assumed that they can be accommodated elsewhere in the formal or informal economy.

Unemployment is a massive – and increasingly urban – issue in most African countries, impacted by ballooning young populations, urbanisation and relatively small economies. Further let down by poor basic education systems, young people in Africa are effectively one of the largest vulnerable and marginalised groups in society whether viewed in local or in global terms. Paratransit is already a large employer, and industrialisation linked to electrification can further bolster the positive economic and employment contributions of this crucial mode of public transport.

Another group of people in the paratransit system that are often marginalised are vehicle drivers, especially so where the paratransit representative organisations focus on owners rather than drivers. Crew on board vehicles, usually conductors and/or touts, are in an even more precarious labour situation than drivers. Both these groups can be exploited in existing paratransit operations, being dependent on the number of hours they work and daily income generated by their vehicles after the fuel bill and owner's income are settled. While e-MBs may reduce operating expenditure, it should not be assumed that such gains will accrue in whole or in part to drivers and crew. Moreover, daily operations of e-MBs will likely be different and require more sophisticated skills, and require more considered operational planning that lends itself to work shifts – all of which could motivate for introducing improved working conditions and perhaps extending to labour agreements. To better understand the potential impact of minibus electrification on employment, Labour Impact Assessments[11] are useful tools that should be utilized by practitioners and decision-makers, especially in the context of concrete (future) electrification programmes and modernization schemes.

The main source of revenue in the paratransit system is the fares that passengers pay – making passengers a essential part of such systems. However, despite being the financial foundation of the system and the largest stakeholder group in terms of numbers,

[11] Relevant examples of Labour Impact Assessments include the following:

Djah, A, Spooner, D, and Gráinne, C. (2023), Abidjan Bus Rapid Transit And Metro: Labour Impact Assessment Research Report.

Sakho, P, Spooner, D, Bouna Timéra, M, Diongue, M, (2020), Dakar Bus Rapid Transit: Labour Impact Assessment Research Report, Global Labour Institute.

Spooner, D, Mwanika,J M, Natamba, S and Manga, E, (2020). Kampala Bus Rapid Transit Report: Understanding Kampala's Paratransit Market Structure, GLI/AFD

Spooner, D, (2019). Bus Rapid Transit (BRT) and the Formalisation of Informal Public Transport – A Trade Union Negotiating Guide

voices from this group are often not very evident in debates and decisions around paratransit service improvement. Passengers as a collective are also a vulnerable group – at the level of the household as they tend to be from poorer or peripheral segments of society, and at the mobility level because they may well be dependent on using paratransit to make their daily living. If anything, a shift to electrification should be used to strengthen minibus reliability and service coverage, and alleviate the cost burden especially on the poorest users of such services.

In each city of part of a city, different vulnerable, marginalised or minority groups might be found, with different political imperatives and social norms. Minibus electrification can be used to start or restart conversations on the (greater) inclusion of such groups in society in a locally relevant manner. The above examples of groups that can be included or benefit from a shift to electrification are just that: examples. It may be that in a particular setting there are policy or social norms mandating the inclusion of these and other groups, be they women, people with disabilities, the elderly, ethnic or religious minorities, and the like. Our intention here is not to dictate which groups should be included, but rather to flag that electrification can provide a platform for social inclusion. Who is targeted and how it is done is a conversation that must be driven local and in the local context.

Proposition 8. The shift to e-MBs must be designed so that local stakeholders drive the process and have the capacity to sustain it.

The shift to electric mobility is driven to a large degree by international and regional institutions, notably those in the development finance and NGO sectors. However, for electrification to be sustainable and appropriate at the country and city levels in Africa, local stakeholders will have to be involved in designing, and ultimately take ownership of, the change process. In the case of a shift to e-MBs, these local stakeholders include, but are not limited to: owners, vehicle crew, technicians, administrators and their representative organisations in the operator industry; current and prospective passengers; vehicle and parts suppliers; energy suppliers; financial service businesses; government departments and agencies; educational and research institutions; and civil society organisations.

For the shift to be carried through, understanding the current capacities of these stakeholders to conceptualise and drive change, and to address any gaps in these capacities, needs to be a core part of the agenda (and budget) of international or regional e-MB programmes. Three areas of action are proposed in terms of understanding and building such capacity.

Local capacity analysis and capacity building: Government officials and people in the operating industry are likely to be key drivers and/or partners in a shift to e-MBs; government in terms of developing and implementing supporting policy, plans, and regulations, and operators in terms of accommodating the business and operational changes that will come with a shift from ICE to electric vehicles. It is important that the full systems impact of the e-MB shift is discussed with these core stakeholders, along with the

capacities that they will need to design, implement and manage the shift. Subsequently, it will be critical to assess whether they, collectively, have these capacities - e.g. technical, managerial or process skills - and to develop suitable capacity building activities or programmes that address identified gaps. Such activities or programmes may include professional development courses, apprenticeship programmes, series of topical dialogues or debates, and site visits, amongst many others.

Investment in regional/local academic and research capacity: Universities and similar research institutions serve both as repositories and disseminators of international and local knowledge, and in so doing can build, share and keep institutional memory across several topics and/or projects. However, many cities in Africa do not have a university, and where these institutions exist locally, it is frequently the case that they do not have staff focussed on or experienced in a topic as specialised as public transport or minibus electrification. There may, nonetheless, be departments or units with these institutions that do have expertise on different aspects the e-MB system - for example in terms of electrical engineering, the political economy, or financial management, which could respond partially to identified capacity needs. It is possible that these capacities in universities or research institutions at the regional level could together provide a comprehensive "knowledge offer." This offer could include undertaking and documenting research, setting up and facilitating courses or workshops, and training students who could be the next generation of academic or decision-makers.

Cross-continental and cross-regional exchange: There is a diversity of experimentation with electrification in the passenger, public transport and paratransit sectors in Africa. This experimentation is furthermore taking place in settings with different urban development, operating sector, vehicle supply, passenger demand and other patterns and dynamics. Moreover, there are experimental or pilot projects that are advanced to the extent that they demonstrate what is possible in light of local opportunities and constraints. Such projects can form the basis for cross-Africa and cross-regional exchanges. It is no longer necessary for operators or government officials to visit cities in the global North to observe electric buses - it is possible to do so in East, West or Southern Africa and to do so in the familiar territory where paratransit operations are the norm (and where consistent electricity supply is not necessarily the norm). Facilitated exchanges that delve into industrial, operational, financial, political and other intricacies of e-MBs or public transport electrification can play an essential part in sharing knowledge and experiences across cities, and thus support build capacity.

We recommend that capacity building to support a shift to e-MBs is included as an integral part of any project or process of this nature. This will include identifying: the involved stakeholders - and ideally key individuals within stakeholder groups - that can drive the process; the capacities that they need to have to envision, plan and implement the shift; and gaps that exist in terms of these needed capacities. An important subsequent step will be to design a comprehensive capacity building programme that draws on, but equally develops, capacity in local or regional universities and research institutions so as to establish a local knowledge base, and to complement this with facilitated cross-continental and cross-regional knowledge exchange events. In planning and undertaking such a capacity building programme, it will be essential that it has sufficient budget - and here the

expertise in and resourcing by international and regional development organisations and NGOs can be an important enabling factor.

e-Minibus pre-project evaluation framework

The introduction of e-minibuses (e-MBs) does not comprise only the replacement of ICE fleets with their electric equivalents. The shift to e-MBs is a complex process that is located in a complex system setting: there are several actors, components and areas of work in different sectors of society that will be impacted by or play a role in the shift to electric vehicles.

In this part of the paper we propose four guiding questions to unpack how e-MB introduction fits into this systems context, with reference to the parts of this system. This can serve as a framework to guide project preparation for the roll-out of e-MBs at scale in a step-by-step manner.

Question 1: Are the conditions present that motivate for and support a paratransit minibus electrification project?

A paratransit minibus electrification project is not inserted into a vacuum. In the location of implementation, there is likely to be paratransit or other public transport services and operators that already serve passengers. It may also be desirable, or essential, that a paratransit electrification project contributes to environmental and social outcomes that affect the site of implementation. We pose four questions to consider in this regard.

Is the minibus paratransit industry a dominant or growing part of the mobility system in a given location?

Though paratransit minibuses accommodate the bulk of motorised passenger trips in many cities, they do not exist in isolation. An e-MB project needs to take due consideration of other modes of transport both motorised and non-motorised, so that it contributes to an integrated multi-modal transport system. This can include aspects such as fare, schedule, passenger information and interchange integration across routes and modes, as well as planning into the near and further future for a shift from e-MBs to e-buses where passenger demand and urban growth justifies it.

What are the environmental issues to which a paratransit minibus electrification project would respond?

Desired environmental outcomes are likely to centre on a reduction in the quantity of harmful gases that are emitted, and which contribute to the global greenhouse effect as well as to local air quality problems. The gains should not only be framed in terms of minibus tailpipe emissions, but also in terms of emissions produced during energy generation and distribution.

Aside from gaseous outputs, electric vehicles present a mixed bag when it comes to other forms of waste that also need to be accounted for in the desired outcomes. While the vehicles do not need liquid fuels or engine oil, the batteries are a potential source of pollutants and contribute to a greater vehicle weight, which in turn can increase the volume of brake dust and tyre particles that are produce compared to an ICE equivalent.

What are the social aims to which a paratransit minibuses electrification project would contribute?

There are several societal outcomes that can be set in an e-MB project, some of which might be a direct result of electrification and others that could be co-benefits. Fleet renewal could result in vehicles having improved safety equipment, in turn improving passenger and road safety. Electrification can be used as a catalyst to reduce reliance on importation, thus increasing local industry, employment and opportunities for the inclusion of marginalised or minority groups. People with disabilities could also benefit from improved accessibility through better vehicle design; however, this is likely feasible only in cases where current minibus fleets are replaced with higher-capacity vehicles due to the design limitations of minibuses and incentives to maximize space utilization by operators.

Public transport infrastructure improvements aside from those needed directly for electrification could also be packaged into an e-MB project. As part of such a package, facilities could be refurbished or newly built to improve passenger safety and comfort. Another example is that dedicated rights-of-way could be introduced to increase vehicle efficiency and travel time, in turn translating to cost and time savings that serve both current ICE and a future electric fleet.

Is the organisational structure of the paratransit industry consolidated, notably in terms of vehicle ownership or coordination of operations?

Besides enabling environmental and societal outcomes to be met, an e-MB project must include sensible business outcomes as part of its economic contribution. Paratransit operators are in business to create income and draw profit; a proposed project ultimately has to demonstrate how it benefits their bottom line. At the same time, the paratransit industry in any given city tends to comprise a very large number of small businesses.

For an e-MB fleet project to be feasible, it is likely that business ownership needs to be consolidated into a smaller number of contractible entities, through a facilitated process. The current vehicle and fleet may also be inefficient in serving passengers. An electrification project provides an opportunity to right-size the vehicles and fleet, but doing so will impact on jobs as well as on the ownership structure.

Question 2: What are the ideal or feasible options for introducing electric vehicles in the paratransit industry?

In a shift to e-MBs, the current system in terms of the vehicle fleet, the fossil fuel and electric energy system, and available or needed public transport infrastructure needs to be considered as a package. This infrastructure includes the maintenance, depot, refuelling and passenger interface facilities on which the vehicles rely, as well as the roadways (or rights-of-way) to which vehicles have or will have access as this impacts on efficiency.

All of these system components will together inform what the ideal options could be for minibus fleet electrification within a given location. They may also provide an indication of whether electrification and/or another energy system, such as battery-diesel hybrid vehicles or renewable fuels might be a more appropriate path to follow. There may also be

limitations that prevent the ideal option to be introduced. In such cases identifying the best feasible options will be the next step.

Is the ideal vehicle and fleet size configurations for the paratransit industry to efficiently serve existing and projected passenger demand substantially different to the current situation?

The e-MB options that are investigated must respond to the operational needs and the structure of the operating industry, while at the same time ensuring that current passengers are not left stranded. This means, amongst others, that the fleet configuration in terms of vehicle number and capacity must be considered in relation to what is offered to passengers at present, that route distances are achievable and if not that charging points are set up along the routes, that there is sufficient recharging capacity at the depots and termini, and that drivers are capable of – or provided the needed support to – operate the new vehicles.

It may also be desirable to shift from a fill-and-go system that results in erratic vehicle frequencies to a scheduled service pattern service, that allows for sufficient vehicle recharging times and for the management of potentially reduced travel distances per charge. This, in turn, may motivate for a different fleet configuration, e.g. larger vehicles that have larger battery capacities, or smaller vehicles in cases where there is low passenger demand.

Are local supply chains in place to provide an electric version of the ideal vehicle and fleet configuration and charging facilities, and to ensure their maintenance and end-of-life disposal?

The supply chains through which the fleet, energy systems and public transport infrastructure are supplied to the site of implementation must be taken into account. It is, for example, important to ensure that the chosen fleet and charging technologies are locally available or, if electricity is or will be sourced from renewable sources, that there is a local supply chain for equipment installation and maintenance to ensure consistent supply.

Moreover, the vehicle and energy system life cycle and end-of-life arrangements are also essential factors to be considered. The battery represents a valuable concentration of minerals that can be reused whole or in part, which will require handling by trained personnel. Care should be taken that the new system does not produce more waste than the old overall, during manufacturing or disposal – again this applies in particular to the battery.

Do current policies and regulations allow for the introduction of the ideal electric vehicle and charging facilities in the paratransit sector?

National and local policies and regulations may furthermore impact on the availability, choice and cost of vehicles, energy systems and public transport infrastructure. Such policies and regulations could, for instance: direct or limit where public transport facilities may be located; how electricity is generated, priced and supplied; impose taxes that impact vehicle, battery, energy generation and charging equipment acquisition costs; or make it mandatory to establish local assembly facilities.

If it is not possible to pursue the ideal option, then what is the most feasible option or options?

The previous three questions can be answered more or less in isolation, allowing for the identification of an ideal e-MB option respectively according to fleet configuration, supply chains and policies and regulations. However, it is possible – or indeed likely – that the ideal option is not the same in response to all three questions at the same time. This means that there is, in fact, no single ideal option. In this case, it will be necessary to pose all three questions at the same time, and finding the feasible option or set of options that respond to all of these questions to the greatest extent possible.

What changes will need to be made to operations and infrastructure to accommodate a shift to the ideal/feasible paratransit electric vehicle?

It is possible that the ideal or feasible e-MB option is different in the vehicle's configuration, fleet size and operational characteristics. Amongst others, this might mean that route lengths or operating hours may need to change, that passenger loading bays are not long or wide enough, that there is a need for larger or differently configured storage or maintenance areas, and the like. The ideal or feasible vehicle fleet exists as a function of the operations and infrastructure – and if the latter two are not also ideal or feasible, they will need to be modified or provided from scratch to enable the new fleet to function properly.

Question 3: Is there a business case for the ideal/feasible electric paratransit fleets and infrastructure?

Overall, the investment scenarios will be different for each country, city and part of a city, or indeed rural area, and will depend on which parties are involved in funding it, in implementing it, and in running operations. In order to account for these contextual specificities and the local as well as broader risks involved, it is advisable to make allowance for and draw on the expertise of professionals who have local – or at least regional – experience in working with paratransit. It is essential to bring knowledge into a project on the financial, business, legal and political dynamics specific to this industry, as these dynamics are part of what will make a shift to-minibuses feasible or not.

What are the costs and revenues generated by current paratransit minibus operations, and what will these be if such operations are shifted to the ideal or feasible electric vehicle fleet?

A comprehensive business case for the feasible or ideal e-MB option (or options) will be the next step in enabling a project's outcomes to be realised. Not only will this demonstrate the financial impacts – or preferably benefits – to involved operators, but it will also enable government, finance or development partners to quantify their funding and financial commitments over a time horizon that can be a decade or more.

The starting point for drawing up investment scenarios is identifying the costs incurred and revenue generated by the existing business and comparing these with the projected costs and revenue after a shift to e-MBs for the same business unit or area. As with outcomes, these costs and revenue relate not only to the fleet, but also to energy supply and the

needed public transport infrastructure. In cases especially where development partners are involved, a project's environmental or social outcomes may override to some extent the purely financial or funding aspects of a project. However, even in such cases, from the operators' point of view it will always be important to be able to demonstrate what the impact of the shift to e-MBs will be on their profit.

The main – or only – source of revenue is usually passenger fares, while operating costs can be separated into two categories. The first is variable costs, which includes what tends to be largest expense for a public transport business, i.e. fuel or energy, as well as the cost of service and maintenance items. The second category is fixed costs, which covers stable or recurring items such as salaries, licensing, insurances, facility rental and loan repayments.

What are the key risks and fluctuations that impact on this comparison that need to be mitigated?

In order to develop investment scenarios, it will be necessary to understand and, where possible, manage risks and fluctuations in revenue and costs. From a revenue point of view, the greatest risk is fluctuations in passenger demand, which can vary from day to day or periodically, be impacted by service quality and availability, or be subject to irregular events such as traffic crashes, social movements or the weather. In relation to costs, the main risks and uncertainties are fuel price variations, changes in interest rates and new vehicle availability and prices, all of which might also be impacted by currency exchange rate fluctuation.

If the shift to electrification is projected to result in capital shortfalls for the fleet and new infrastructure, how will these be funded or financed?

It is likely that a significant capital injection will be instrumental to fund the new fleet and infrastructure, and that this will be required early on in the project. There are several potential sources for such capital, be it in the form of funding (i.e. without the need for repayment) or financing (i.e. a loan), or a combination of both. There may be several organisations providing these funds, including international or regional development institutions, international or local private financial institutions, government entities, and/or the current fleet or infrastructure owners themselves.

There is no set recipe for how and from where such capital shortfalls should be funded of financed. Project stakeholders will need to make decisions guided by capital availability, repayment conditions, interest rates, repayment terms, and other factors to arrive at what the final funding and/or finance package will be.

In addition, it will be crucial to have a good understanding of local capital markets. These tend to be poorly developed in most African countries, severely constraining the potential for lending locally to fund systemic paratransit electrification, and often even just to finance individual vehicle replacement. This is likely to increase the need for regional or international development finance, which in turn will require business consolidation in the paratransit industry to provide the scale needed for such investments.

If the shift is projected to result in operating cost shortfalls or surpluses, how will these be funded or distributed, respectively?

While there is likely to be a capital shortfall in an e-MB project, there may be either an operating cost shortfall or a surplus that results from it. Shortfalls may, for example, arise due to inefficient operations of the new fleet such due to poor driving behaviour or if the vehicle were inappropriate to the operating conditions. Surpluses, on the other hand, may result from reduced maintenance costs of electric vehicles compared to the ICE equivalents, or a better match of the fleet to passenger demand compared with the replaced fleet.

The assumption may be that the government should foot the bill for operating cost shortfalls, or if the contrary, operators may naturally assume that any surpluses should accrue to them. However, government – whether national, regionals/state or local – may well not have the financial resources to perpetually fund what will in effect be an operating subsidy. Operators, for their part, may not have the mechanisms or experience in place to distribute surpluses amongst themselves. Neither of these assumptions necessarily hold water. Instead, informed decisions aligning expectations, risk, managerial capacity and other considerations will need to make, in all likelihood done through concerted negotiation by all parties involved.

Question 4: How will the shift to paratransit electrification happen?

There are many actors and spread across several sectors who will be involved in a project that introduces e-MBs. They will include i) those involved in supplying vehicles, energy systems and public transport infrastructure and related technologies, ii) those who develop and administer policy and regulations relating to the vehicle fleet, energy system and public transport infrastructure, and iii) those who do and will operate, maintain and dispose of such vehicles, energy systems and infrastructure.

Which local, national and/or international actors will be involved in a shift to electric paratransit operations?

An e-MB project should be expected to have a high degree of institutional complexity. It is likely to include stakeholders from national and local government, the paratransit industry, global or local vehicle manufacturing, the electricity sector, and private or development finance agencies. Besides such actors, a project will also include, or should ideally task itself with including, non-government organisations (NGOs), civil society representative groups and academic or research institutions who can, for example, provide broader societal perspectives, contribute expert knowledge gained in other settings, or serve as institutional memory. There may furthermore be local initiatives or experiments focussed on e-MBs that can provide data or share lessons that can inform a full-scale project.

There is no one answer to who is or should be involved. A useful step in this regard will be to undertake stakeholder mapping, and to update this map on a regular basis.

What will be the roles for each of these actors, do these roles align with their existing capacities, and how will capacity gaps be addressed?

The different actors in an e-MB project may play different roles at different stages of the project, but not all will be equally well prepared for these roles. Understanding existing capacities, and addressing capacity gaps, will feed into the success of such a project. The participation of suitably equipped and experienced funders or financiers will in all probability be fundamental to the success of an e-MB project, as their involvement often serves as the initial catalyst for change.

Paratransit owners and drivers will need to respond to the changes that a shift to e-MBs will bring to their businesses, e.g. owners jointly owning and managing a business or drivers needing to learn how to handle a heavier vehicle and not being able to refuel whenever convenient. It will similarly be important to support local and national government officials in planning for and overseeing a new type of operations and operational structure that e-MBs will introduce, likely at a gradual and then accelerating pace. If there are local initiatives they may be able to provide information or share their experience to inform such activities aimed at building government and industry capacity.

The role that NGOs and universities can play in collecting and sharing qualitative and quantitative knowledge between actors, sectors and countries can also be a key enabler in addressing the capacity gaps that the operator and government partners are likely to encounter. Moreover, the views of passengers can go unheeded as a project's focus turns towards addressing technical challenges that might seem more urgent that meeting originally planned social outcomes. Civil society partners can play a role in bring balance in this regard.

A capacity building programme for all those involved – on a per-sector basis – can be an important part of a successful project. The design of such a programme should be done in an inclusive manner, and ideally be led by the core project partners working with trusted knowledge and training partners organisations and skilled learning/dialogue facilitators.

Who will facilitate dialogue between the actors and/or take ownership of the project to ensure its aims are achieved?

There will be several stakeholder groups in an e-MB project, and a large number of individuals who make up these groups. Mediating between all the individual opinions and positions will be a challenging task over a substantial period of time. This role will in all probability best be facilitated by an independent person or team, or at least one which is not part of one of the main project stakeholders.

In the same manner as the needed financial or legal advice should draw on suitable professionals, the facilitating party should be one that is experienced in the task of mediating complex projects. The decision – and budget – to appoint such a person or team from the outset can make a crucial difference to the success of the project, not least because conflicts will arise and will need to be resolved on an ongoing basis. The stakes are high in an e-MB project.

While a process facilitator will play a critical mediating role, the ownership of the project will lie with the local stakeholders – government, operators, labour, passengers, civil society. A project office and project steering committee, representing technically competent and/or respected representatives from these different groups, can be an essential step in having a locus in the project to take ownership of the project. As with the facilitator appointment, setting up such an office or committee should not be left to chance, but rather form an integral part of the early stages of setting up a project and be budgeted for appropriately.

Perspectives on e-minibuses from practice

There is exploration and experimentation with e-minibuses in several African countries. Such processes are at different stages of development, be it still on the drawing board, in the early preparation stages, or being tested at a small scale. In this part of the paper, we summarise presentations that were made during the regional exchange in June 2024 from a selection of such countries and projects. We also add commentary in relation to challenges to and levers for change that these projects highlight in terms of a potential shift to minibus electrification at a larger scale.

These perspectives are not intended to provide an exhaustive inventory of all e-MB projects across all countries, nor to provide a systematic review of what works and what does not. Rather, this section of the paper is intended to illustrate the diversity of approaches currently being taken to developing, testing or supplying e-MBs, in order to spur further investigation and discussion.

Country perspectives

Ethiopia

The country's capital, Addis Ababa, hosts a fleet of 12.162 paratransit vehicles, comprising 4.275 blue minibuses, 7.438 minibuses not in blue livery and 449 larger midibuses. Together these vehicles transport around 60% of daily public transport passengers. Though owned by individuals, these vehicles' fares and routes are set by the Addis Ababa Transport Bureau. Further government intervention and reform in this industry include service and technology improvements, route rationalisation, fleet renewal and fleet standardisation.

Ethiopia is relatively advanced in Africa in terms of supporting local electric vehicle production and adoption. In 2021 a national electric mobility development plan with a 10-year time horizon was launched, with the aim of having 500.000 light electric vehicles and 5.000 large electric buses at the end of this period. In 2023 a ban on the importation of non-electric vehicles followed.

There have also been notable efforts to establish local EV assembly facilities, mostly reliant on imported components and aided by tax exemptions. Besides setting up facilities to build electric three-wheelers, more recently e-MBs have also started to be produced locally. More than 200 e-MBs, 35 midibuses and 100 large buses have been assembled since 2023, with 20 of the e-MBs and 2 large buses operating on selected routes in the capital. Operational data is being collected, notably to address a knowledge gap on the total cost of ownership of EVs compared to their ICE equivalents.

Kenya

The largest fleet of paratransit minibuses in the country is that in Nairobi, with an estimated 15.000 vehicles ranging in capacity from 14 to 52 seats. The results of a passenger satisfaction survey with these services, presented by the Nairobi Metropolitan Area Transport Authority (NaMATA), indicated that respondents were most satisfied with their

frequency, coverage and connectivity, and least satisfied with facility cleanliness and fares. NaMATA also highlighted that, in the results of another public satisfaction survey this time among vulnerable road users (including women, elderly people, children, and people with disabilities), respondents indicated dissatisfaction also with fares and facilities, as well as vehicle interiors, safety of operations and interactions with the on-board crews.

While not all the issues raised in the surveys can be addressed in a shift to e-MBs, potential operating cost savings from electrification could be passed on to passengers through lowered fares, while newer vehicles could respond to safety and interior comfort concerns. BasiGO, an assembler and financier of small e-buses in Nairobi, appears to have targeted individual paratransit owners as well as the Savings and Credit Cooperatives (SACCOs) to which they belong. Through the provision of such these e-buses, with a distance-based battery leasing model and the outright purchase or lease of the vehicle, their model could address passenger concerns. However, the number of locally assembled vehicles (from imported parts) is still small. The company does see opportunity elsewhere in the region, having expanded its lease-based offering to Rwanda.

There are several projects underway in the metropolitan area that could lay the groundwork for further experimentation with, or implementation at a larger scale of, e-MBs. For several years a BRT network has been in planning, with the manner in which existing paratransit would be integrated not yet fully defined. Profiling passenger demand on the major corridors provides input not only into such planning, but also into the development of an Integrated Public Transport Route Network Plan. A Sustainable Urban Mobility Plan is furthermore in preparation, as well as work to institutionalise learning on e-mobility in local teaching and learning offerings.

South Africa

Despite a well-developed vehicle assembly industry, there are currently no electric minibuses on the market in the country. Other hurdles to minibus electrification include frequent scheduled electricity cuts, an ailing electricity grid, limited charging infrastructure, and potential negative impacts on government revenue from reduced fossil fuel sales and job losses in the automotive industry.

The country nonetheless has a legislative framework that could support a shift to EV in general and e-MBs in particular. This framework includes a national Public Transport Strategy, a National Development Plan and Infrastructure Development Act, a national Green Transport Strategy, and various national and local Climate Strategies and Action Plans.

Also in South Africa, Stellenbosch University has been building a hub of expertise on minibus electrification. The university partnered with a local engineering firm and was supported by the South African National Energy Development Institute (Sanedi) to convert a diesel paratransit minibus to be fully battery electric. This work was finished in 2024 in parallel to the importation of a fully built-up e-MB of the same size. Calculations suggest that the total cost of the converted minibus was half that of the purpose-built imported e-MB, reducing to less than a third if it could be done at scale, while the converted e-MB paid

off the price differential compared to ICE models in 30.000km due to substantial running cost savings.

Staff and students at the university have also undertaken extensive research to understand the context and potential of e-MBs. One of these studies compared e-MB operations with petrol and diesel equivalents, using a typical fuel station as one of the key units. Modelled effective range of an e-MB was 21-29% that of the ICE models, the electricity charge rate of 3km/min was much less than the fill rates of 444km/min for diesel and 333km/min for petrol. Critically a station fuel tank of 20m3 stored the equivalent of 224 000km in diesel and 168.000km in petrol, with a battery of the same volume only storing 16.000km.

Tanzania

Supported by the European Union, UN-Habitat and the Solutions+ project, the Dar es Salaam Institute of Technology (DIT) has led the design and assembly electric bicycles and three-wheelers, as well retrofitting an ICE three-wheeler with a battery. Much of this has relied on the importation of parts. However, to enhance local expertise and promote the use of local materials, DIT has also designed a 26-seater e-minibus to be used for on-campus transport, and with a maximum speed of 50km/h. While for the time being still on the drawing board and seeking increased financial support, the institute aims to develop and test a prototype and detail the manufacturing process in the course of 2024 and 2025.

The e-minibus project is supported by a National Framework for Deploying and Scaling up e-Mobility in Tanzania, which is spearheaded by the national Ministry of Education, Science and Technology, the Tanzania Commission for Science and Technology (COSTECH), and Siemens. COSTECH's objective is to drive innovation and technology development and transfer, and is the nationally designated government entity for topics related to climate change matters. This mandate is further supported by the Environment Division in the Vice President's Office, which is charged with sustainable environmental management and development.

Nigeria

Lagos State has a population of more than 20 million people, the bulk of which reside in the Lagos Metropolitan Area. On its own, this state constitutes the fifth-largest economy in Africa. The bulk of public transport is provided by about 50.000 minibuses licensed by the State Ministry of Transport, and organised under national road-transport workers' and employers' unions (NRTW and RTEAN, respectively). Residents also rely heavily on two- and three-wheelers.

There is an ongoing Bus Reform Initiative, which aims to enhance motorised and non-motorised trips from passengers' origin points to their final destinations. Under this initiative, in 2021 a fleet of 500 First and Last Mile (FLM) minibuses were introduced regulated by the Lagos Metropolitan Area Transport Authority (LAMATA), to improve access to standard bus, BRT rail and waterway services in Lagos. The state government with private investors is also working on expanding the FLM offer with 2.000 7- to 11-seater

minibuses on identified routes across different parts of the state. As part of the state-led component of the FLM initiative, two electric minibuses were deployed covering 80.000km over 160 days and carrying around 160.000 passengers, to test their viability.

At a national level, in May 2023 the government discontinued the local fuel subsidy, which over the course of a year has led to an increase of 300% in the retail cost of fuel. Besides significant transport cost escalations, the change resulted in worker strikes and social unrest. These developments have spurred interest in alternative energy sources, notably electricity and compressed natural gas (CNG) as Nigeria has abundant gas reserves and hydro-electric power. In response, the federal government encouraged the National University Commission (NUC) to engage its several dozen member institutions to explore opportunities for research on and the adoption of electric and CNG powered vehicles on their campuses. NUC, in turn, commissioned a study on the feasibility of these alternative energy vehicles in anticipation of government and private sector deployment to higher education institutions.

At present only seven of the 36 states have access to adequate electricity and CNG supply infrastructure, which limits the ability of some of the institutions to respond to the NUC request. Other hurdles that have been identified include vehicle procurement and supply, battery replacement and disposal costs, vehicle conversion costs, the absence of a viable business model, and the absence of suitable administrative and management structures. Nonetheless, there was sufficient interest from institutions to urge the NUC to move to invite expressions of interest from vehicle suppliers for testing, and to support a pilot phase of research to collect data on current campus mobility needs and how these might be addressed in the shift to EV and CNG vehicles.

Potential levers and challenges

Different stakeholders are involved and take the lead in e-MB projects, and these projects have different objectives that are not necessarily explicitly related to curtailing emissions. Universities are active role-players at present, not only in terms of research but also in developing and testing minibuses, as the above examples demonstrate. The aims of such university-driven projects vary, including pursuing the creation and dissemination of knowledge for the general public good, counteracting fossil fuel market upheavals caused by government policy decisions, and responding to public transport as well as campus mobility needs. In fact, some university campuses are small cities in themselves, with student and staff populations reaching 60 000 or more in some parts the continent, and thus campus transport services resemble small public transport systems in their own right.

Minibus electrification offers opportunities for the private sector, whether or not in partnership with universities and government agencies. This appears presently to be mostly focussed on e-MB vehicle design, supply and assembly, bringing together vehicle assemblers, engineering and technology firms, government development agencies and university staff and students together. However, the vehicle itself is only a small part of the system. The larger system, and at a larger scale, needs to be considered, such as wider industrialisation opportunities. These can include several parts of the e-MB system, including vehicle, battery, charging and electricity generation equipment and parts. It also

need not only be for new production, but can, for example, include the conversion of ICE vehicles to EVs, or battery reuse and recycling. In terms of supply chains, regional institutions, such as the East African Community (EAC), Southern African Development Community (SADC), Economic Community of East African States (ECOWAS), and recently formed African Association of Urban Mobility Authorities (AUMA) may play an enabling role through their coordinating and convening capacities.

e-MB explorations at different scales – whether for industrial, pilot or research purposes – require substantial funding and/or financing. While international and regional development finance and cooperation institutions have played an important part in spurring interest in electrification in public transport in Sub-Saharan Africa, minibus owners are also financiers in their own right. In the absence of local capital markets (with the exception of South Africa), owners typically fund vehicle acquisitions from their own resources, or by pooling with other owners often under the auspices of cooperatives, such as the SACCOs in Kenya, or in their representative associations.

Minibus owners are ultimately in business to generate income; to be in a position to demonstrate to them to that it will be worthwhile to change from ICE to e-MBs, it will be necessary to have data to prove that the shift will be financially beneficial to them. Enabling comparison with ICE operations and infrastructure will be reliant on much more widespread testing of e-MBs in local operating and market conditions to generate reliable data on their total cost of ownership. Household incomes, passenger fare affordability, energy prices, climatic, geographic and traffic conditions, labour costs, owner income expectations, and many other factors differ from city to city and country to country, making it difficult to generalise from one case to another. Whether the expectation is that owners or financial institution providing the resources to enable the shift, much more data is needed in order to develop a business case for minibus electrification.

Testing e-MBs in local conditions is complicated by the absence of supply chains for vehicles as well as for all of the components that make up an EV system. In some countries universities may be able to arrange tax and homologation exemptions for the importation of vehicles and equipment that can enable testing and the generation of local data, but this is not the same as having vehicle supply for public purposes and at the needed scale. More work needs to be done: to develop vehicle and component supply models; to develop the appropriate funding and financing models to make such supply models sustainable; and to take wider view of the market beyond primary or capital cities.

Ethiopia serves as an important example here. The country appears to have created the conditions for a comprehensive local electric vehicle industry to establish itself in just a few short years, and that is not just focussed on Addis Ababa. While this may not necessarily be replicable in other countries, studying the Ethiopian case in greater detail may yield important pointers on which enabling condition need to be present, or may need to be created, to achieve similar results elsewhere.

Closing remarks

The case for minibus electrification in Sub-Saharan Africa is not clear-cut, as we have aimed to make clear through the propositions, guiding questions and country perspectives that we have put forward in this discussion paper.

There is reason to be cautiously optimistic: there are now electric minibuses on the road in more than one country in the region, and not just at the experimental scale. The support from international financial institutions to enable the shift also seems to be there already, and growing. At the same time, there is a long way to go from these relatively early beginnings to seeing the large-scale adoption of e-minibuses across the many cities in which paratransit minibuses provide the main form of mass public transport, as well as the rural areas in which they also connect people.

Why electrify minibuses? Much more data is needed to answer with a conclusive “yes” or “no”. e-MBs may produce fewer greenhouse gas emissions than their petrol and diesel counterparts, but not necessarily so if the electricity that they run on is derived from burning fossil fuels. There are also further environmental – and infrastructural – implications related to the greater weight of electric vehicles compared to comparable ICE vehicles. Will battery packs be disposed of or reused in a responsible manner after their useful life onboard the vehicle? Systems that do not exist at present will need to be put in place for this to happen. From an energy supply point of view, it is not just a straightforward matter of installing charging points; electric grids will need to be strengthened substantially to cope with electric vehicles. All global and local parts of the transport, energy, land use and industrial system of which current minibuses form part will need to be considered in each place where a shift to electric minibuses is being contemplated.

Perhaps most important is to be conscious that minibuses provide livelihoods for many people. Not only do they do they bring large populations to work and school; they also generate income for vehicle owners and their families, as well as employment for drivers, on-board crew, service staff and the many other people working in the background to keep the paratransit industry running. A shift to e-MBs must be a just transition, for all these people too.

Paratransit services are and will remain an essential issue for sustainable transport and development in Africa. With the advent of e-mobility in the continent in general, and in the paratransit sector in particular (especially if we take into account the remarkable and very recent growth of electric 2-wheelers), electrification may now become a powerful lever or entry point for practitioners and decision-makers to introduce sustainable and inclusive reforms. The complexity of the sector, as well as its challenges, remind us however of the need for systematic and comprehensive approaches to sustainable improve these services for the benefit of public transport users and operators alike.

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