E-TRANS - ELECTRIC MOBILITY AND TRANSITION IN NIGERIA:

STRATEGY AND IMPLEMENTATION

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Enabling Infrastructure Investment
MOLO
ESMAP
Energy Sector Management Assistance Program

Component 1
Strategy and Implementation

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List of Acronyms

AbuTrans	Abuja Transport Initiative
AC	Air Conditioning
AC	Alternating Current
ACOMORAN	Amalgamated Commercial Tricycle and Motorcycle Owners, Repairers and Riders Association of Nigeria
AQI	Air Quality Index
BAU	Business as Usual
BC	Black Carbon
BEB	Battery Electric Bus
BMS	Battery Management System
BNEF	Bloomberg New Energy Finance
BRN	Bus Route Network Lagos
BRT	Bus Rapid Transit
BYD	Build Your Dreams (a Chinese EV manufacturer)
CapEx	Capital Expenditure
CAPM	Capital Asset Pricing Model
CBN	Central Bank of Nigeria
CKD	Complete knock-down
CMB	CMB = CAIO Mercedes Benz
CNG	Compressed Natural Gas
CO2	Carbon dioxide
COP 26	2021 United Nations Climate Change Conference
COVID 19	Coronavirus
CPKM	Cost per Km
DC	Direct Current
DisCo	Distribution Companies
DOC	diesel oxidation catalyst
DOD	Depth of Discharge
DPF	Diesel Particulate Filters (DPFs
E2W	Electric two-wheeler
E3W	Electric three-wheeler
E-bike	Electric powered bicycle
E-bus	Electric bus
ECN	Transmission Company of Nigeria
ECOWAS	Economic Community of West African States
E-mobility	Electric mobility
EOL	End-of-life
EPKM	Earnings per km
ESG	Environmental and Social Governance practices
ESIA	Environmental and Social Impact Assessment
ESMAP	Energy Sector Management Assistance Program
EV	Electric Vehicles
FCT	Federal Capital Territory
FDRD	Federal Department of Rural Development of FMARD
FEPA	Federal Environmental Protection Agency
FMARD	Federal Ministry of Agriculture and Rural Development
FRSC	Federal Road Safety Commission
FS	Feasibility Study
GCAP	Green City Action Plan

GDP	Gross Domestic Product
GENCOS	Generation Companies
GHG	Greenhouse Gas
GNI	Gross National Income
GoN	Government of Nigeria
GW	Gigawatt
GWh	Gigawatt-hour
HDI	Human Development Index
ICE	Internal Combustion Engine
IEA	International Energy Agency
IFC	International Finance Corporation
IKEDC	Ikeja Power Distribution Company (Lagos State)
IMT	Intermediate modes of transport
IPCC	Inter-Governmental Panel on Climate Change
IRENA	International Renewable Energy Agency
Keke	motorcycle taxis and the tricycle taxis
kWh	Kilowatt hour
LAMATA	Lagos Metropolitan Area Transport Authority
LFP	lithium iron phosphate
LGA	Local Government Area
LMIC	Lower Middle Income Country
LPG	Liquified Petroleum Gas
LSSTMP	Lagos State Strategic Transport Master Plan
LTO	Lithium titanium oxide
MAA	Moving Annual Average
Main	UoA Main Campus
Mini	UoA Mini Campus
MOF	Ministry of Finance
MoLo	Mobility and Logistics
MPR	money policy rate
MW	Megawatt
MW /GW	Megawatt/Gigawatt
NAAQ	Nigerian National Ambient Air Quality
NACTMORA	National Commercial Tricycle and Motorcycle Riders Association
NAIDP	New Automotive Industry Development Plan
NAMA	Nationally Appropriate Mitigation Action
NAPEP	National Poverty Eradication Programme
NCCPRS	National Climate Change Policy and Response Strategy
NCV	Net Calorific Value
NDC	Nationally Determined Contribution
NEMSA	Nigerian Electricity Management Services Agency
NEP	National Development Plan for Electric Mobility
NERC	Nigerian Electricity Regulatory Commission
NGN	Nigerian Naira
NIPP	National Integrated Power Project
NIS	National Industrial Standard for clean fuels
NMC	lithium nickel manganese cobalt oxide
NOx	Nitrous Oxide pollutants
ODS	Ozone Depleting Substances
OEM	Original Equipment Manufacture
Okada	Motorcycle Taxi

OpEx	Operational Expenditure
PHEV	plug-in hybrid electric vehicles
PIU	Project Implementation Unit
PLR	prime lending rate
PM	Particulate Matter
PM2.5	Particulate Matter less than 2.5 micrometres in width
PPIAF	Public-Private Infrastructure Advisory Facility
PPP	Public-Private Partnership
PV	photo-voltaic
RAAMP	Rural Access and Agricultural Marketing Project
REA	Rural Electrification Agency
REEV	range extended electric vehicles
RMI	Rocky Mountain Institute
SKD	Semi-knock down
SMEs	Small and medium-sized enterprises
SOC	State of Charge
SON	Standards Organisation of Nigeria
SOX	Sulphur Oxides
SSATP	Sub-Saharan African Transport Policy Programme
STPV	solar rooftop photovoltaic system
SWOT	SWOT AnalysIs: Strengths Weakness Opportunities Threats
TBS	Tafawa Balewa Square (Stadium)
TCN	Transmission Company of Nigeria
TCO	Total Cost of Ownership
TL	Team Leader
ToR	Terms of Reference
TTW	Tank-to-Wheel
UITP	International Association of Public Transport
UK FCO	UK Foreign and Commonwealth Office
UNEP	United Nations Environmental Programmes
UNFCCC	United Nations Framework on Climate Change Convention
UoA	University of Abuja
USABC	The U.S. Advanced Battery Consortium (USABC)
USD	United States Dollar
USEPA	United States Environmental Protection Agency
VGF	Viability Gap Funding
VOC	Vehicle Operating Cost
WACC	Weighted Average Cost of Capital
WB	World Bank
WHO	World Health Organization
WTT	Well-to-Tank
WTW	Well-to-Wheel

1. Executive Summary

The objective of the study is to facilitate dialogue on urban and rural clean energy e-Mobility strategies that reduce air pollution, greenhouse gas emissions and health and economic impacts of mobility in Nigeria

This project contains four components, where components 2 and 3 have sub-components A and B:

Component 1: Final Report on Nigeria Clean Energy e-Mobility Strategy and Regulatory Framework.
Component 2A Lagos E-Bus Field Study.
Component 2B: Urban Mass Transit E-mobility Report Kaduna, Kano, Ibadan and Abuja.
Component 3A: Rural E-mobility.
Component 3B: University of Abuja e-Mobility; and
Component 4: Private Sector Engagement in E-mobility in Nigeria

Component 1: Final Report on Nigeria Clean Energy e-Mobility Strategy and Regulatory Framework

Nigeria devotes significant funds – in excess of US$ 10 billion in the current year - to subsidise transportation but, unfortunately, this funding serves precisely to discourage the development of e-mobility. The subsidisation of petrol discourages the take-up of alternative vehicles such as electric minibuses, two-wheelers (E2W) and three-wheelers (E3W). The two options available are: to introduce more subsidies, which negate the impact of those applied to petrol; or to reduce petrol subsidies to increase the attractiveness of e-vehicles. In the current climate, the first option is likely to be unaffordable.

Regulations to enact policies will also need to be developed, mostly at federal level, adapting the tax regime and permission framework for importing new and used vehicles, and instating new framework drawing from international experience as for safe storage, recycling and disposal of batteries and e-waste associated with e-vehicles.

The long-term vision calls for:

- expansive adoption of mass transit system such as the Rail and Bus Rapid Transport (BRT) to reduce the number of commuter vehicles on the road and curb emissions and encouraging the acquisition and use of zero-emission vehicles such as electric cars and buses.
- Development of a matching electromobility strategy and Roadmap that should focus on buses at federal level, that ties with other relevant strategies and policies and provides the enabling environment for more local action. A National Electromobility Strategy will provide a roadmap to achieve electrification targets, BEV penetration.

A national strategy champion should now step forward, whose role needs to extend to procuring funds, both for the establishment of institutions as well as the implementation of the e-mobility strategy itself.

Policy proposals covering several cities – not just Lagos – will require policy and initiative development at the highest level of government and a federally-led approach should improve efficiency and reduce the costs of asset procurement.

For further development of E-mobility for Nigeria – as justified on macroeconomic, environmental and health grounds - dialogue in the integrated environment/transport/electricity sectors should continue but this dialogue needs to be undertaken along with specific actions to improve Nigeria's trading (imports, exports), fiscal (taxation/subsidies) and monetary (exchange rate) policies.

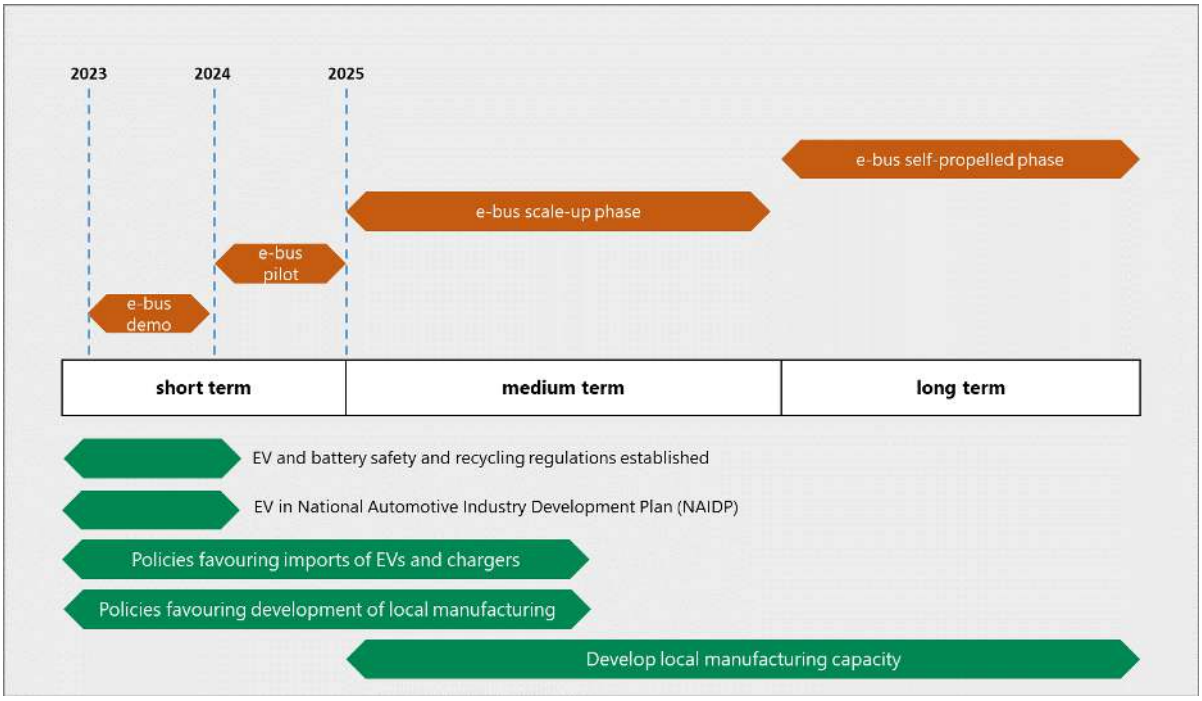

Figure 1-1: Roadmap for Electrification of E-Buses in Lagos with Policies benefitting E-Mobility also in other Sectors

Component 2A Lagos E-Bus Field Study
Component 2B: Urban Mass Transit E-mobility Report Kaduna, Kano, Ibadan and Abuja

Among the actions proposed for achieving the **Nigeria Energy Compact** ambition for the transport sector include funding pilot assessment studies and identifying suitable technology. A key technological option to consider for reduced emissions in the transport sector is the adoption of e-mobility. Any reductions in greenhouse gas emissions from transforming the bus fleet to e-buses with zero tailpipe emissions **will contribute towards achieving Nigeria's emission reduction commitments.**

The introduction of E-buses should be facilitated by:

- subsidies and financing solutions that account for the high upfront costs
- the electricity should come from renewables where possible
- the level of involvement of the private sector should be decided at the outset and then operators should be encouraged to e-bus transport
- standards for chargers and vehicles should be introduced
- regulations on battery recycling and re-use should be introduced

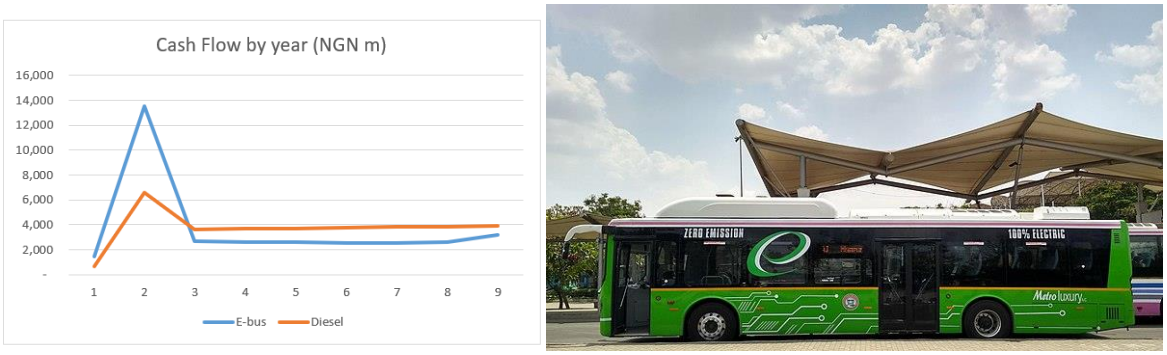

Figure 1-2: Comparison of current E-bus and Diesel bus cash flows along BRT corridors in Lagos (left) and an example of a typical standard 12.0 m E-bus (right)

A phased E-bus rollout plan for Lagos along BRT Corridors is recommended: based on monitoring and evaluation of trials and demonstration projects to prove that the e-mobility arrangement and energy source is financially viable before moving towards a more widespread roll-out. The large e-buses to be used in the Lagos pilot project are expected to be charged through charging stations powered by the national grid and/or decentralized power generation facilities. The power demand for the e-buses, given their size and use intensity for urban public transport, would require reliable and high-capacity grid charging facilities, with only partial utilisation of renewable (solar) energy (at depots) suggested.

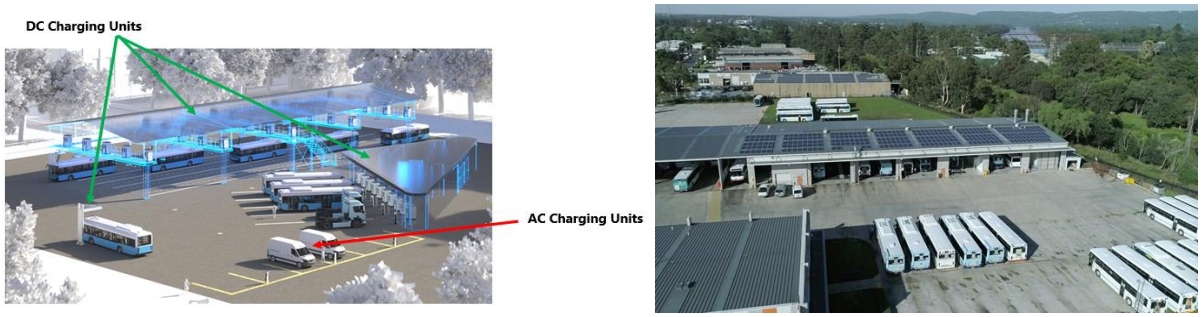

Figure 1-3: Depot charging and roof top solar charging examples

Table 1-1: 4-phase road map for E-bus rollout in Lagos

Phase	Phase 1	Phase 2	Phase 3	Phase 4
Year	2023	2024	2025-26	Beyond 2026
# of buses	5-10	50-100	100-500	500 -2000
Passengers Allowed	Passenger should be in the E-bus to test the demand factor	Yes	Yes	Yes
Route Selection	Select 2 or 3 routes	Operate out of 2-3 depots with 30-40 buses along 2-3 select routes	Discuss with LAMATA-Identify complete electrification of Depots	Discuss with LAMATA

Phase	Phase 1	Phase 2	Phase 3	Phase 4
Year	2023	2024	2025-26	Beyond 2026
# of buses	5-10	50-100	100-500	500 -2000
Bus Type	9m and 12m	12m and 9m	12m, 9m, 7.5m and 6m	12m, 9m, 7.5m and 6m
Battery Capacity	>200 kWh	135-400 kWh	135-400 kWh	135-400 kWh
Battery Chemistry	LFP or NMC	LFP or NMC	LFP, LTO-LFP, NMC	Existing + New
Charging location	At Depots	At Depots	At Depots + Opportunity Charging	At Depots + Opportunity Charging
Charging standard	Manufacturers choice with inter-operability	Manufacturers choice with inter-operability	Manufacturers choice with inter-operability	Manufacturers choice with inter-operability
Charger Type	Charge Power as per OEM	Charge Power: Slow and Fast Charger	Charge Power: Slow and Fast Charger	Charge Power: Slow and Fast Charger
Range	150 km-200 km	200 km-300 km	200 km-300 km	200 km-300 km
Power Consumption	<1.3 kWh/Km	<1.3 kWh/Km	<1.3 kWh/Km	<1.3 kWh/Km

Urban e-mobility trials will focus first on Lagos, and later in Ibadan, Kaduna, and Kano and Abuja. In these latter cities, the first step should be to set up an agency like LAMATA after carrying out a review of roles and scope across existing relevant bureaus and agencies to ensure unique assignment of functions and to avoid agencies overruling one another. Agencies need to be fully established and have sufficient capacity to re-plan (in Abuja), plan (in Kano) or implement (in Kaduna and Ibadan) public transport services

Component 3A: Rural E-mobility

Challenges of Rural Mobility[1]: Where transport services exist, they are often very expensive and overcrowded. When roads are in poor condition vehicles are frequently delayed and may fail to arrive at all, particularly in the rainy season. Access to services constitutes a major challenge in lightly populated areas. Empirical and anecdotal evidence suggests that women (as well as children) in Africa (including Nigeria) shoulder disproportionate household transport responsibilities. The gender-related mobility differences in rural transport appear particularly problematic, as limited access for women and girls is further accentuated by restrictions such as the age-long traditional subordinate role that confines them to the households.

Rural E-mobility trials are expected to be piloted through the World Bank's Rural Access and Agricultural Marketing Project (RAAMP). Rural e-mobility trials will focus on adoption of e-2wheelers (Okada) and e-3wheelers (Keke) initially in areas of relatively high rural per capita income. The current subsidy for petroleum fuel affects the slow electric mobility adoption in Nigeria. These small vehicles are expected to be charged using photovoltaic (PV) powered mini grids, as this would both promote renewable energy

[1] The World Bank has been helping Nigeria in tackling rural access and mobility for over a decade. RAAMP is scheduled to close in end-June 2026. The project document specifically mentioned to try out e-vehicle option to help increase rural mobility.

implementation as well as overcome the obstacle of limited national grid power access in most of rural Nigeria. Development of PV-based mini-grids could capitalize on the governance framework of REA that has established large number of them. On balance, it appears too early to develop a full strategy on rural electromobility since such important trials need to be prepared first, and lessons learned.

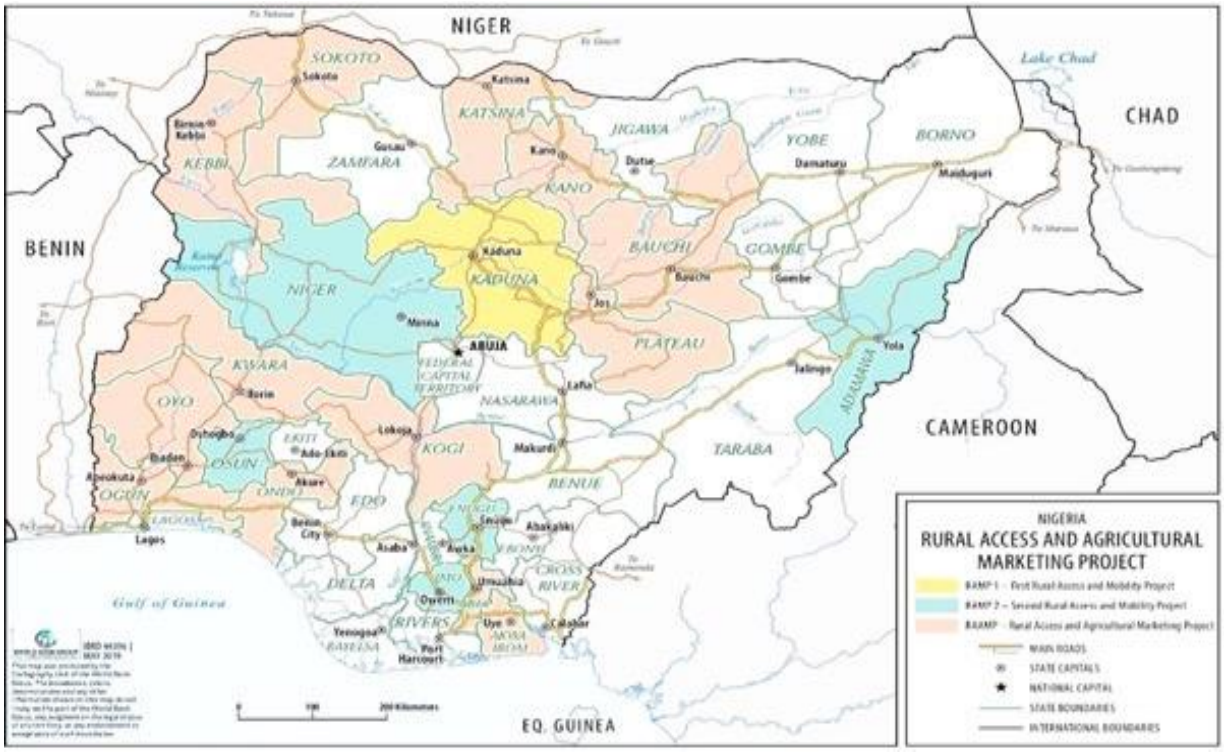

Figure 1-4: Phases of the World Bank Supported RAAM Project

Limited and Erratic underlying Power Supply poses challenges for e-mobility: Nigeria has the largest energy access deficit of any country in the world with 85 million Nigerians lacking access to grid electricity. This figure equates to 43% of the population. Geographic coverage by the distribution network is limited with much of rural Nigeria excluded from access to the network. Nine out of the eleven distribution networks experience power deficits (due to generation and transmission constraints) and thus do not meet power demand within their distribution markets.

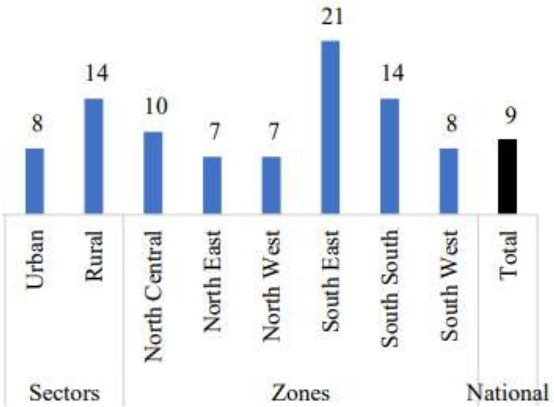

Figure 1-5: Median number of electric power outages over a 7-day period in Nigeria

Most power generation plants operate well below their installed capacity - less than 5,000MW is generated out of over 13,000MW of installed capacity. Maintenance issues and equipment breakdowns limit and disrupt power generation. End users including industry, commerce and households suffer from the shortfall of electric power generation, resulting in most acquiring decentralized power sources (primarily diesel and gas generators) to cover the gaps in supply[2]. An outcome of the grid power availability limitations is that around **86% of companies in Nigeria own or share a generator providing 48% of their electricity demand and 80% of Nigerians rely on decentralized diesel generators, solar inverters or other alternative sources of power to meet their electricity needs**. Millions of decentralized diesel generators with a total generation capacity of 8 to 14 Gigawatts is estimated to be installed in Nigeria, which has economic and environmental impacts (e.g. noise, fuel leakages and pollutant emissions).

The policy and regulatory analysis points to trials of e-mobility along with wider rural energy projects like mini grids (such by MAX in Ogun State, where certified drivers with e-motorbikes provided transport of people to nearby hubs and markets as well as transport of goods that could fit on a motorcycle. The motorcycles were charged utilizing surplus PV energy from mini grids as a means to power batteries)

Introduction of e2w and e3w should be connected to:

- the efforts supported by the Rural Electrification Agency (REA) to have mini-grids built and in operation
- EV facility and services deployment (charging, renting, leasing) along with mini-grid development would help achieving the power demand to obtain mini-grid profitability as well as providing a pre-condition to the advancement of the EV transport market
- special electricity tariffs for EV charging should be considered
- standards are required for (rural) vehicles, chargers, and batteries to ensure interoperability of charging infrastructure (including communications) and second-hand market for vehicles
- research programs on e-vehicles suitable for rural areas should be set-up.

Component 3B: University of Abuja e-Mobility

Developing E-Mobility expertise at the University of Abuja: The potential options for in-campus transport at the University of Abuja were outlined proposing a conceptual network and a phased implementation for the routes, allowing for the testing of e-buses and e-minibuses, capitalizing on the new internal road being built, and reorganizing the role of buses and kekes within the campus. Data needed to take the conceptual design to a more concrete one with the indication of the frequency/timetable and of the bus size, were not available. E- mobility charging requires approximately 6% of the overall present UoA power demand, the entire profile defines the energy share available for the charging of the E-buses which represent a 1000 kWh.

[2] The World Bank has an extensive program in place over many years to support the Nigerian electricity sector. Currently, it is implementing the NG Electricity Transmission Assistance Project, Nigeria Electrification Project and North Core/Do resale Nord Regional Power Interconnector Project. Pipeline operation includes Power Sector Recovery Program for Results and the Distribution Sector Recovery Program for Results.

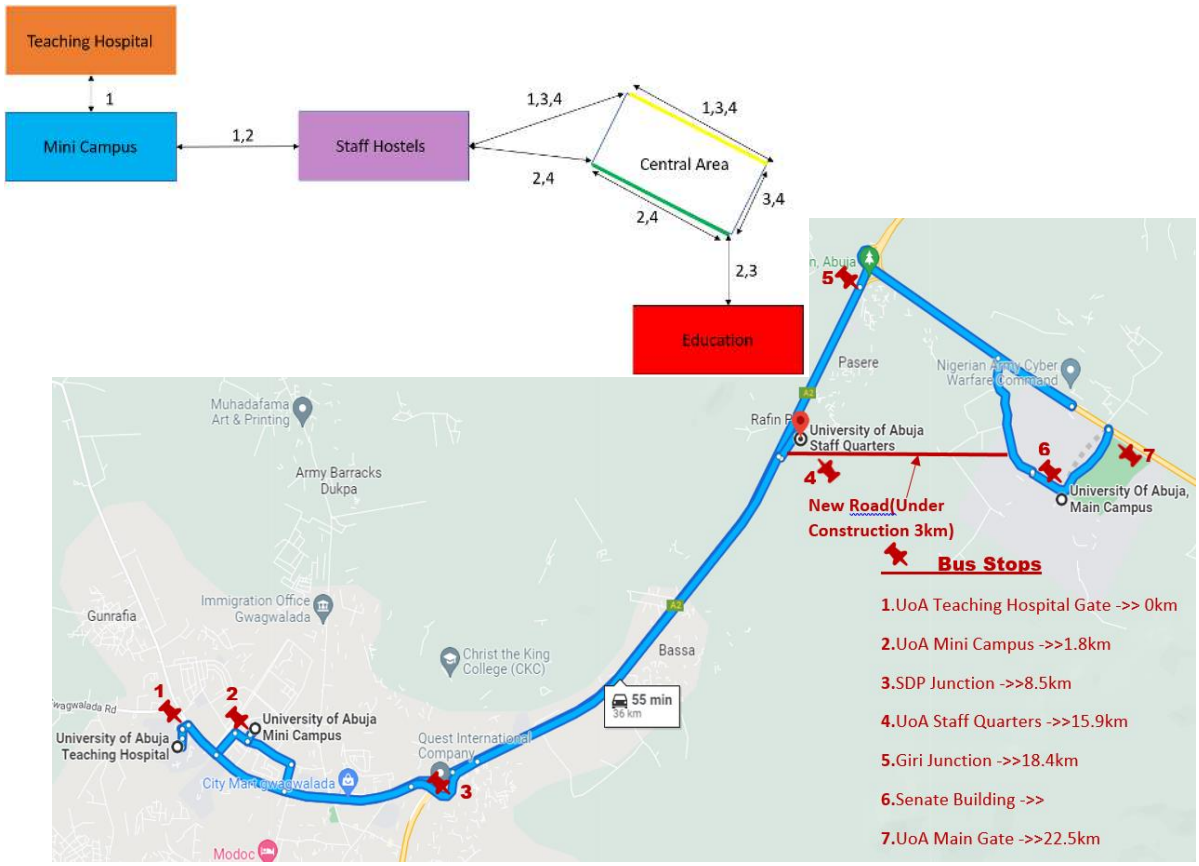

Figure 1-6: Four proposed bus lines

The daily energy requirements for each line are dependent on size of bus as detailed below. The estimated daily energy cost of running the e-busses is approximately NGN 52,000 for the first trial phase if energy is procured from the grid. The use of auxiliary diesel generation would make this cost considerably higher.

Table 1-2: Estimated daily energy costs of e-buses for pilot phase

Line	Vehicle type	No. of buses	Vehicle seating capacity (persons)	Trips/ day	Total seating capacity (persons)	km/ tour	kWh/ km	Energy per return trip	kWh/ day	Total daily cost (NGN)*
Line 1	Midi-bus	2	23	10	460	36.0	0.7	25.2	504	30,744
Line 2	Midi-bus	0	23	10	0	40.6	0.7	28.4	0	0
Line 3	Minibus	0	15	10	0	18.6	0.5	9.3	0	0
Line 4	Minibus	3	15	20	450	11.6	0.5	5.8	348	21,228
Total		5		50	910				852	51,972

*Assumption: *Grid power costs NGN 61 per kWh.* *Source: Consultant's estimates.*

Component 4: Private Sector Engagement in E-mobility in Nigeria

The private sector has a critical role to play in demand creation, supply and facilitation towards electric mobility in Nigeria and government needs to engage it. The National Automotive Industry Development Plan (NAIDP) to promote local production of vehicles and components should be extended with incentives to the EV sector.

The private sector is an actor for e-buses and rural mobility and the study indicated that planning of public transport systems and choice of incentives should ensure financial viability and bankability of projects.

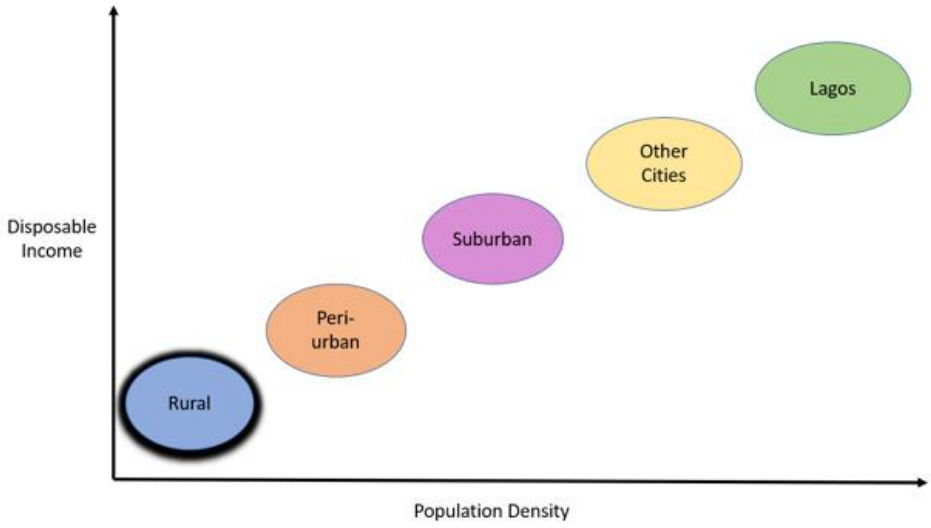

Figure 1-7: Viability Continuum of EV Projects in Nigeria

According to the World Bank 'Doing Business 2020' report, Nigeria is perceived to be a less business-friendly country than, for example, Ghana due to the high costs incurred in complying with import and export procedures.

Table 1-3: Ease of Doing Business in Nigeria: Specifics of Cross Border Trading:

		Ghana	Benin	Togo	Cameroon	Nigeria
Import Border Compliance	Hours	80	82	168	271	242
Import Border Compliance	USD	553	599	612	1407	1077
Import Document Compliance	Hours	36	59	180	163	120
Import Document Compliance	USD	474	110	252	849	564
Export Border Compliance	Hours	108	78	67	202	128
Export Border Compliance	USD	490	354	163	983	786
Export Document Compliance	Hours	89	48	11	66	74
Export Document Compliance	USD	155	80	25	306	250

The Study underlines that there is a strong need to bring in financing structures for the entire value chain including the infrastructure that cannot be addressed using public finances alone and suggests new

sources of debt such as bonds could be used to smoothen the budgetary spending required to get e-vehicles uptake started. The private sector should be engaged to bring in funds for instance by fostering the growth of Consumer Financing for EV loans. However, given inflation levels in Nigeria, the significant decrease in the NGN-USD parallel market exchange rate and the widening disparity between the official and parallel rates, the risk pertaining to the acquisition of loans has heightened.

In addition, the following is recommended:

- the taxation regime conditions procurement options for e-buses (purchase of leasing)
- models of PPP schemes should be explored for charging stations, also for public transport
- public funds for mini-grids may not suffice, the private sector could step in with the utilization factor of facilities increased by EV charging
- a quality business environment is required as well as simpler cross-border trade procedures
- the existing National Automotive Industry Development Plan (NAIDP) should further include EV establishment and production
- Short- and medium-term fiscal support to the EV
- demand side incentives for EVs like vehicle subsidy, exemption from registration and road tax, lowered tax on sale would help uptake
- battery recycling by the private sector should be encouraged by a promotional policy.

2. Component 1: Final Report on Nigeria Clean Energy e-Mobility Strategy and Regulatory Framework

2.1 Introduction

2.1.1 Objective

The objective of this study is to facilitate dialogue on urban and rural clean energy e-Mobility strategies that reduce air pollution, greenhouse gas emissions and health and economic impacts of mobility in Nigeria. In the short term, there are significant costs to be incurred on both the energy and transport side, but there are longer term benefits in terms of cleaner air, a healthier and therefore more productive population.

There are undoubtedly challenges to the introduction of an e-mobility strategy for Nigeria. However, there are also opportunities to be garnered, in addition to the environmental and health benefits, such lower requirements in refined oil products for mobility. A local production of vehicles for rural use would fit with the intention to revive the automotive industry. E-mobility would be a way to increase the possibility to travel of the population, including the rural dwellers.

The Terms of Reference (ToR) form the basis for the consultancy team to analyze options for Nigeria's potential future engagement with e-Mobility in several areas including strategy and regulatory framework for integrated e- Mobility, Lagos e-Mobility, rural e- Mobility and optimum private sector participation in the e-Mobility provisions and operations.

2.1.2 Project Scope and Funding

The consultancy is being funded by three trust fund sources:

- Energy Sector Management Assistance Program (ESMAP),
- Mobility and Logistics (MoLo) and
- Public-Private Infrastructure Advisory Facility (PPIAF).

These different funding sources comprise an integrated package of support from different arms of the World Bank Group.

2.1.3 Preceding Phase of Component 1: the Briefing Paper

The Briefing Paper outlined the literature review on current urban/rural mobility related strategy and regulatory regime in Nigeria and included the potential options for sustainable clean energy e-Mobility strategy and regulatory framework.

The report encompassed the clean energy e-Mobility strategy context review, needs assessment and preliminary scoping; review of clean energy and e-Mobility regulatory requirements.

The Briefing Paper was addressed to senior transport and energy policy advisors at the World Bank.

2.1.4 Terms of Reference for Component 1 Final Report

Tasks to be carried out under this component include:

Final report on Nigeria Clean Energy e-Mobility Strategy and Regulatory Framework. This includes sustainable federal e-Mobility strategy and EV and PV-powered charging stations regulatory framework based on the feedback received from the Stakeholder meetings and Workshops.

The report is comprehensive and elaborates the content of the Briefing Paper, following the same structure and format.

The Final Report includes a Road Map for Urban E-Mobility (Lagos: Ebuses[3]). The Final Report also includes a **Template** for sustainable urban e-Mobility strategy and regulations that will be deployed at the state level. The example of Lagos (E-buses) is provided.

This Final Report summarizes the current predominantly research-based phase of the Consultants work throughout the six-month assignment (April – end October 2022).

2.1.5 E-mobility

E-mobility is a general term for the development of electric-powered drivetrains designed to shift vehicle design away from the use of fossil fuels and carbon gas emissions. E-Mobility "comprises all street vehicles that are powered by an electric motor and primarily get their energy from the power grid – in other words: can be recharged externally. This includes purely electric vehicles, vehicles with a combination of electric motor and a small combustion engine (range extended electric vehicles – REEV[4]) and hybrid vehicles that can be recharged via the power grid (plug-in hybrid electric vehicles – PHEV[5])."[6]

A "so-called systemic approach also includes the energy supply side as well as the charging and traffic infrastructure in its definition of electric mobility, since those components are interconnected and together, they lead to sustainable mobility. One thing all definitions have in common is the narrow interpretation of the term electric vehicles, which is based on the idea of electricity as "fuel." This was chosen with good reason; when you consider the entire energy chain, only electricity offers efficiency advantages and – as long as it comes from renewable sources – a significant reduction of CO2-emissions"[7] as well as reductions in local pollution reduction (SOx, NOx, PM).

It is this reduction in emissions which has been the primary motivator for developing an e-mobility strategy. In the short term, there are significant costs to be incurred on both the energy and transport side of the equation (bolstering the electricity supply network, subsidizing relatively expensive vehicles) but there are longer term benefits in terms of cleaner air, a healthier and therefore more productive population.

[3] *Based on the Final Report for Component 2A: Lagos E-mobility Field Study (E-buses)*
[4] *battery-powered vehicles with an additional small combustion engine and generator are called range extenders. The combustion engine only starts to generate additional electricity for the battery. In contrast to the hybrid drive, however, it does not drive the vehicle directly. E-REV stands for Electrical Vehicle with Range Extender.*
[5] *https://etrr.springeropen.com/articles/10.1007/s12544-011-0064-3*
[6] https://www.erneuerbar-mobil.de/en/node/970
[7] https://www.erneuerbar-mobil.de/en/node/970

2.1.6 Potential Challenges and Opportunities from E-mobility

There are undoubtedly challenges to the introduction of an e-mobility strategy for Nigeria. Institutional challenges are discussed in later sections of this paper and being a democracy, persuading the population of the benefits of e-mobility will require a long-term effort. Weaning the population off subsidized petrol could be viewed as one of Nigeria's greatest challenges.

We cannot emphasize enough the importance of rebalancing incentives away from fossil fuel subsidies toward those intended to encourage uptake of e-vehicle use (grants towards vehicle purchase, lower energy tariffs for e-vehicle battery charging) but we also appreciate how perceived reductions in benefits (i.e. lower subsidies) can lead to unrest and riots in countries where such subsidies are prevalent.

However, there are also opportunities to be garnered; in addition to the environmental and health benefits that would flow from a reduction in air pollution, other benefits which can be expected include a lower requirement in refined oil products for mobility, which, in turn, would improve the balance of payments and government budget.

E-mobility could add to the business model of off-grid systems provided it is not at the detriment of other uses, therefore benefitting the case for PV as local source of energy at rural locations.

In terms of transport, e-vehicles have simpler engines and powertrains that ICE ones which results in simpler and less expensive maintenance of vehicles. A local production of vehicles for rural use would fit with the intention to revive the automotive industry currently under examination by the government and would simplify and reducing the costs of sourcing parts.

More generally, once the appropriate vehicles are identified, e-mobility would be a means to increase the possibility to travel of the population, including the rural dwellers, since it would fit with the current emphasis of funds on e-vehicles and climate change.

2.1.7 Vehicles in Scope

2.1.7.1 Lagos (Urban E-mobility)

The main vehicle in scope in urban areas of Nigeria would be the E-bus. An example of a standard 12.0 m E-bus is provided in the Figure below. For the purposes of the Study, a range of large bus lengths is likely to be considered, possibly to include midi-buses.

Figure 2-1: Urban E-vehicles in Scope: ZEB in Bangalore, India
Source: By LoveofZ - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=77575873

Figure 2-2: Midi-bus
Source: E- minibus for max 25 person https://www.karsan.com/nl/jest-electric-hoogtepunten

2.1.7.2 Rural E-mobility

The main vehicles in scope in rural areas of Nigeria would be the motorcycle taxis and the tricycle taxis (Bajaj). Examples of a standard Okada and a standard Keke are provided in the Figures below.

Figure 2-3: Rural E-vehicles in Scope: Motorcycle Taxi (Okada)
Source: World Bank SSATP: Policies for Sustainable Accessibility and Mobility in Urban Areas of Nigeria

Figure 2-4: Rural E-vehicles in Scope: Tricycle Taxi (Keke)
Source: World Bank SSATP: Policies for Sustainable Accessibility and Mobility in Urban Areas of Nigeria

2.1.8 Report Structure

The Final Report is the final study deliverable for Component 1. The Briefing Paper has earlier formed a summary of this Final Report (**Consolidated Report, Volume 1)** which is structured as follows:

1. Introduction.
2. Literature review on mobility strategy and regulatory regime in Nigeria.
3. Survey of international experience in initiating e-Mobility development in a LMIC context.
4. Potential options for sustainable clean energy e-Mobility strategy.
5. Potential options for sustainable clean energy e-Mobility regulatory framework.
6. Clean energy e-Mobility strategy context review needs assessment and preliminary scoping.
7. Initial Review of clean energy and e-Mobility regulatory requirements.
8. The Distinction between Federal and State Policies.
9. Abstraction of Relevant Policy and Regulatory Summaries from Components C2, C3 and C4.
10. Component 1 Framework and development of Templates; and
11. Development of Federal and State Templates for Urban E-mobility (E-buses)

2.2 Literature Review on Mobility Strategy and Regulatory Regime in Nigeria

This Chapter looks at Federal and State level and concerns the policy and regulations on Climate Change (including the recent Climate Change Act that sets a net zero target for the 2050-2070 timeframe and the Nationally Determined Contributions submitted in 2021 that leverage on the planned growth of public transport provision), Energy (the set of acts that led to the energy sector reform and the current set-up, the arrangements at state level), transport (at state level with the reforms that led to the emergence of LAMATA in Lagos, the Bus Reform Initiative, the draft transport policy document by the Lagos State Ministry of Transport, the state-integrated public transport plan for Kano that the press mentioned in 2020, the Draft Green Paper for the Kaduna State Transport Policy, the work towards updating transport planning in the FCT).

2.2.1 Environment and Climate Change

2.2.1.1 Review of Laws and Plans about Relevant Transport and Mobility Plans and Policies at the Federal level

The year 2021 saw several updates to the institutional and planning framework on Climate change in Nigeria. At COP26, President Buhari committed to net zero emissions by 2060 and in November 2021 he signed the Climate Change Act that sets a net zero target for the 2050-2070 timeframe. The Climate Change Act requires the government to develop National Climate Change Action Plan and to set five-year carbon budgets. The Climate Change Act provides for a National Council on Climate Change, led by the President, that is tasked with guidance on the implementation of the National Climate Change Action plan while the Federal Ministry of Environment administers a Climate Change Fund.

Further, in June 2021 Nigeria issued its National Climate Change Programmes covering the 2021-2030 period, that do not refer to the new framework described above since it spurs from the National Climate Change Policy (NCCP) that was approved together with the Programmes. Details of the National Climate Change Programmes are not available. This Policy replaces the National Climate Change Policy Response and Strategy (NCCPRS), passed in 2012.

Still in 2021, Nigeria adopted its Energy Transition Plan aiming for net-zero emissions, details of this plan are not yet available.

In 2021 Nigeria also submitted to the United Nations Framework Convention on Climate Change an update to its Nationally Determined Contributions, updating the previous ones from 2017, confirming the unconditional target to reduce emissions 20% below business as usual (BAU) and increased the conditional target to reduce emissions from 45% below BAU to 47% by 2030. The NDC include actions on the energy and transport sectors, but these documents are not publicly available. In particular, the transport sector is noted as generating 21% of the country's CHG emissions as of 2018. Actions on the transport sector include:

- 100,000 extra buses by 2030
- BRT accounting for over 22% of pax-km by 2030
- 25% of trucks and buses using CNG by 2030
- All vehicles meet the Euro III emission limits by 2030 and Euro IV by 2030

in December 2021 Nigeria also submitted its 2050 Long-term Vision to the UNFCCC which is intended to set out the path to decarbonization. The 2050 Long-term Vision is consistent with the NDC just submitted but does not reflect the Climate Change Act.

Recent Plans with effects on Climate Change and Environment comprise also the Medium-Term National Development Plan 2021-2025, intended to implement the Climate Change Act, that follows the Economic Recovery and Growth Plan for 2017-2020 issued in 2017 in response the recession due to low oil-prices, including initiative such as the Great Green Wall Initiative and the issuance of green bonds.

2.2.1.2 Review of Laws and Plans about Relevant Transport and Mobility Plans and Policies at the State Level: Lagos State

2.2.1.2.1 Strategic Transport Master Plan and Travel Demand Model to Cover the Mega City Region

The Strategic Transport Master Plan for the Lagos Mega City Region, released in 2014, stressed the need to consider that Lagos is built around the Lagos Lagoon and climate change may lead to raising water level and therefor flooding followed by migration of the population away from the coastal area. Additionally, there may be saltwater intrusion into fresh water sources. Provisions within the plan aim at reducing CHG emission from particles. In particular, the plan aims at:

- Reducing 2009 reference emission by 30% at the 2030 horizon, thanks to the improvements to the transport system and the offer of public transport foreseen by the plan
- Reducing further emission by 30% between 2022 and 2052 due to additional public transport and new technologies for propulsion.

The focus on vehicular emission follows form the findings of the Lagos Air quality Monitoring Study, delivered in 2008, that found traffic emissions responsible for 43% of Lagos air pollution. The study also noted that vehicles in Lagos account for half of GHG transport emissions in Nigeria. This should be read recalling that increasing numbers of vehicles are being registered in Lagos, which is afflicted by persistent congestion. Further in 2009 the average car in Lagos was at Euro 2 which dated back to 1996.

2.2.1.2.2 The Lagos State Government Development Plan 2012-2025

The Lagos State Government Development released in 2013 had mentioned the dangers of extreme weather events such as heavy rainfall and storms along with floods. Measures foreseen by the plan were not focused on transport: they were aiming at flood response and included:

- flood early warning
- Preparation of Stormwater Drainage Master Plans

However, the plan aimed also at preserving roads' functionality and indicated that slab drains in major roads should be discouraged or demolished.

2.2.1.2.3 The Lagos Five-Year Climate Action Plan 2020-2025

This plan aims for zero carbon in 2050 and includes the following actions on transport:

- Expansion of the BRT network
- Transit oriented development via spatial planning
- Encouragement of the uptake of low emission vehicles

As well as the following actions on energy

- PV solar system on all schools, hospitals and municipal buildings
- Promote energy storage technologies and incentivize the deployment of micro-grids in areas not served by the grid

2.2.2 Energy, Electricity Supply and Renewables

2.2.2.1 Review of Laws and Plans about Relevant Energy, Electricity Supply and Renewables at the Federal Level

Main acts and plans concerning the energy sector at federal level include:

- The set of acts that led to the energy sector reform
- National Renewable Energy Master Plan (REMP) of 2012
- Nigeria Electrification Programme (NEP)
- Rural Electrification Strategy and Implementation Plan (RESIP) of 2016
- Sustainable Energy for All Action Agenda of 2016
- NERC Mini-Grid Regulation 2016
- Feed-in Tariff for Renewable Energy Sourced Electricity

2.2.2.2 The Set of Acts that Led to the Energy Sector Reform

The current set-up of the energy sector is the result of a path of reforms set-off by the National Electric Power Policy (NEPP) of 2001, issued after an energy crisis. The NEPP looked at moving from a vertically integrated public system, represented by the National Electric Power Authority (NEPA), to a liberalized and privatized market for electricity attracting several actors to cover different roles. The legal foundation for the change came with the Electric Power Sector Reform Act of 2005, from which followed the transfer of NEPA's assents and then the split between 18 different companies responsible for generation, transmission, and distribution. At the same time, the regulatory authority NERC was established. Power trade now occurs via the Transitional Electricity Market (TEM) operational since 2015 and is bound by contracts. The Electric Power Sector Reform Act of 2005 also established the Rural Electrification Agency an financed its activities with the aim of expand electrification of rural areas.

2.2.2.3 National Renewable Energy Master Plan (REMP) of 2012

2012 saw the update of the Renewable Energy Master Plan (REMP) that sets the targets of 23% of renewable energy in the electricity mix by 2025 and 36% in 2030 starting from a 13% (mostly hydroelectric) in 2015.

The targets are to be attained with a massive increase in generated power and by diversifying sources that would include hydro, solar PV, wind, biomass and solar thermal technologies.
In parallel the REMP aims for a significant improvement in electricity access in both rural and urban areas, from 42% in 2015 to 75% by 2025.

The REMP also includes a policy of incentives for renewable energy waiving import duties for renewable energy and, foreseeing in the future, customs duty exemptions for, capital incentives and preferential loans for renewable energy appliances.

2.2.2.4 Nigeria Electrification Programme (NEP)

The NEP aims to involve the private sector in providing electricity access to rural communities through solar hybrid mini grids and standalone off grid solutions coupled with a result-based finance scheme. Further the NEP aims at providing reliable electricity supply to selected universities with the aim to have the as starting points of between services to the surrounding communities.

A couple of examples of the NEP actions currently ongoing:

- The minimum subsidy tender, funded by the WB, whereby mini grid developers compete on a technical proposal and on the price (the minimum subsidy requirement) to build, own, and operate solar hybrid mini grids. Successful proposers are provided the minimum subsidies required.
- The technical Assistance and Capacity Building, funded by the WB, provides both technical capacity building, project management and financing for project implementation of off-grid facilities.

Several other programmes are available including a 'Results Based Financing for Productive Appliances & Equipment' programme and a further capacity building programmed financed by the AfDB.

2.2.2.5 National Renewable Energy and Energy Efficiency Policy (NREEEP) of 2015

This policy document summed up a number of previous master plans and policies noting the lack of a coherent framework for energy policy and remarking the need for renewable energy and energy efficiency action plan. The Federal Ministry of Power, that issued the policy, would develop an integrated resource plan to enact the NREEEP, including monitoring of implementation.

The Policy addressed renewable energy supply and utilization, renewable energy pricing and financing, legislation, regulation. and standards.

2.2.2.6 Rural Electrification Strategy and Implementation Plan (RESIP) of 2016

This plan follows from the goal about rural electrification set in 2011 by the National Electric Power Policy that aimed to increase access to electricity to 75% of the population by 2020 and to 90% of the population by 2020 including at least 10% of renewables in the energy mix by 2025.

The RESIP strands of work include:

- Urge distribution companies to achieve their grid extension targets
- Promote the development of mini grids by communities and private companies, considering that grids below 100 kW do not require permits
- Promote the development of stand-alone systems, aimed at hard-to-reach communities

The policy instruments to implement RESIP include:

- Setting cost reflective tariffs and supporting selected projects with grants towards CAPEX. To entice operators to provide rural electricity access they also have the possibility of setting tariffs out of the approved rural tariff as long as 60% of customers agree
- Promoting low cost and high-quality options for rural electrification with grants
- Supporting new entrants and local production of low-cost electrical equipment
- Supporting the entry of non-traditional operators by modifying power market rules so that public, private and cooperative companies may enter the market
- Promoting rural electrification projects to improve rural economic development

To implement the RESIP policy, the REA may use a rural electrification fund which may be accessed by interested parties on a competitive basis and current second call of the REF comprises a component dedicated to innovation which targets also solar-powered tricycles/motorcycles (component 1 subcomponent 3A).

2.2.2.7 Sustainable Energy for All Action Agenda of 2016

The Sustainable Energy for All Action Agenda is guided by UN SDG 7 and was issued in 2016 setting three targets for 2030:

- Energy access, with an increase in generation to 32,000MW and only 10% of Nigerian without energy access compared to 60% in 2015
- Energy efficiency, energy consuming sectors, including transport, should undergo energy audits and energy efficiency, compared to 2015 levels, was expected to increase by 20% in 2020 and by 50% in 2030.
- Renewable energy. 30% of the electricity mix must be of renewables by 2030 with 19% from hydro and 19% from solar

The Nigerian Energy Support Programme (NESP), funded by international donors, aims to foster private investments in the Nigerian Renewable Energy and Energy Efficiency Sector and to improve access to electricity for rural communities. It includes work on off-grid and on-grid access to electricity.

The Green Energy Investment Platform should also be mentioned among the elements providing access to electrification. This a one-stop platform for Renewable Energy and Energy Efficiency investments in Nigeria. It is operated by the Federal Ministry of Power (FMP), the Nigerian Investment Promotion Commission (NIPC) and the Rural Electrification Agency of Nigeria (REA) and developed with the support of the Nigerian Energy Support Programme (NESP).

2.2.2.8 NERC Mini-Grid Regulation 2016

This regulation concerns standalone or interconnected minigrids (multi-customer supply system of at most 1 MW) and aims to foster their development and avoid that promoters of isolated minigrids suffer depreciation if and when the national grid reached the area.

In case of isolated mini grids of up to 100 kW a permit to operate is not requited though they should register with NERC. Isolated minigrids of more than 100 kW and at most 1 MW power must have NERC permits to operate.

Interconnected minigrids need a permit to operate as well as a contract with the community they serve and the local DisCo.

In case of arrival of the national grid, isolated minigrids can become connected or be transferred to the DisCo for a compensation that is the residual value of the assets summed to the revenues of the latest years.

2.2.2.9 Feed-in Tariff for Renewable Energy Sourced Electricity

This regulation entered in force in 2016 and stipulated that DisCos must source at least 50% of the electricity form renewables, the remained being obtained from the state-owned Nigerian Bulk Electricity Trading Company. Electricity from plants up to 30 MW is directly integrated in the DisCos supplies, renewable energy form larger plants is assigned through a competitive process.

2.2.2.10 Nigeria Energy Transition Plan

We examined the Nigerian Energy Transition Plan, available at https://energytransition.gov.ng/, and suggest that the Plan could be made more robust with the following additions:

- provision of source and reference material for the analysis undertaken on the website.
- an implementation plan, including systems for monitoring and regular updating of a chart showing progress expected and actually made for each key element of the Plan; and
- what remedial measures can be taken if particular items are delayed in implementation or go over budget.

The inclusion of these three elements may improve the attractiveness of the Plan to potential investors and hence their willingness to invest.

2.2.2.11 Review of Governance Arrangements for Relevant Energy, Electricity Supply and Renewables at the Federal Level[8]

The Federal level policy making body is the Federal Ministry of Power whose responsibilities include policies and programme to develop the electricity sector, implementing renewable energy projects, coordinating activities of power sector, licensing in the power sector. Those and other activities in the responsibility of the ministry are implemented by six agencies

- Nigerian Electricity Regulatory Commission (NERC) - issues the regulations concerning renewables, the grid code (and feed-in tariffs) therefore it is of primary relevance when considering mini-grids, PV installations and special tariff
- Transmission Company of Nigeria (TCN) - builds, operates and maintains the electricity transmission and distribution network
- Nigerian Electricity Management Services Agency (NEMSA) - certifies contractors and testing equipment for compliance with current technical and safety regulations
- Rural Electrification Agency (REA) - is managing the electrification of rural Nigeria, which also affects the possibility to use e-vehicles in rural areas

[8] *This section is mostly based on the information provided on the websites of the stakeholders mentioned and on the publication: NESP (2015) The Nigerian Energy Sector authored by Intec*

- Nigerian Electricity Liability Management Company (NELMCO) - deals with liabilities following the power sector reform, the privatization of the sector, and the Power Holding Company of Nigeria divestment
- National Power Training Institute (NAPTIN) - provides capacity building for operators of the power sector.
- Nigeria Bulk Electricity Trader, owned by the federal government - administers the electricity pool of the Nigerian Electricity Supply Industry by buying power from generation companies and selling it to distribution companies.
- Standards Organisation of Nigeria (SON) - prepares standards and quality assurance systems

The ministry also convenes the Inter-ministerial Committee on Renewable Energy and Energy Efficiency (ICREEE) which was set up to further the Sustainable Energy for All agenda of the UN.

There is also the Presidential Task Force on Power to ensure coordination across public bodies for the implementation of the power reform following the 2005 Act. It fosters the involvement of private actors and plans and monitors projects concerning generation, transmission and distribution of electricity.

In parallel, the Energy Commission of Nigeria (ECN), resulting from agreements at ECOWAS level, started operation in 1989 and produces strategic plans and national policies in coordination with those of other ECOWAS countries, advise the federal and state governments about energy policy. The ECN has participated to the development of the National Energy Policy (NEP), the National Energy Masterplan (NEMP), Renewable Energy Masterplan (REMP), the National Energy Efficiency & Conservation Policy (NEECP).

The power sector is also affected by the policies and regulations of:

- The Federal Ministry of Environment, already mentioned in relation to transport, which fosters the use of renewable energy and the energy efficiency.
- The Federal Ministry of Science and Technology which manages energy statistics and has a department aiming at including renewable sin the energy mix

Main acts and plans concerning the energy sector at federal level include:

- National Electric Power Policy (NEPP) of 2001
- Electric Power Sector Reform (EPSR) Act of 2005
- Roadmap for Power Sector Reform of August 2010
- National Energy Efficiency Action Plans (NEEAP) (2015–2030)
- National Renewable Energy Master Plan (NREAP) of 2016
- Nigerian Electrification Programme (NEP), which aims to provide electricity access to rural communities through solar hybrid mini grids and standalone off grid solutions
- Energy Commission of Nigeria Act (ECN Act)
- Rural Electrification Strategy and Implementation Plan (RESIP) of 2016
- Sustainable Energy for All Action Agenda of 2016

2.2.2.12 Review of Governance Arrangements for Relevant Energy, Electricity Supply and Renewables at the State Level

The competencies concerning power are shared between the federal government and the state governments, with the latter active in power generation, and off-grid distribution. However, arrangements vary between states, and some are active in grid extensions. Of note is the removal of

electricity generation from the exclusive list, which gives the states opportunity to generate electricity on their own.

In the Federal Capital Territory comprising Abuja, the Federal Capital Development Authority (FCDA) develops distribution expansion plans and builds new sections of the distribution network.
The Lagos state acts on power through its Ministry of Energy and Mineral Resources that aims to develop sustainable energy and exploit natural resources. The Ministry elaborates and develops power planning, works with the office of PPP to implement private investment options, and coordinates and supervises independent power projects.

2.2.2.13 Review of Laws and Plans about Relevant Energy, Electricity Supply and Renewables at the State Level

The base provision for states issue laws concerning power generation, transmission and distribution as well as the possibility to set up agencies for promotion or management of power station is in the 1999 Constitution.

2.2.2.13.1 Lagos State

Lagos state has a Ministry of Energy & Mineral Resources whose role includes energy and network developments, enacted via its implementing agency Lagos State Electricity Board (LSEB). The LSEB was established in 1980 and focuses on maximizing power supply through independent power projects (IPP), reach areas not linked by the federal grid, establish domestic power stations (it commissioned four stations in 2011-2015), improve public lighting and water facilities. IPP are implements with PPPs and Lagos state has its Office of Public-Private Partnerships since 2011.

The need for state action stems from the state receiving only about 1GW (whereas 9 are required) for 12 hours a day at most for a large population that is increasing further while the LSEB- estimated that a potential of 15 GW of alternative power is located in the state.

A recent major power planning exercise, the Lagos state Electric Policy of 2021, noted the latter points, argued for the role of the state in power law, and underlined the need for off-grid electrification in the state. The plan indicates that a local electricity market may be attained provided some critical aspects are addressed, for example, an enabling constitutional and legal framework, an integrated resource plan, an autonomous regulatory body, competitive and transparent procurement of generation, a bankable commercial framework, an Independent System Operator, generation, transmission and distribution players along with Federal and State Government support. The Lagos state Electric Policy then advocates the importance of off-grid solutions to provide electricity to the part of the population that is not served and articulates the steps necessary to implement the electricity policy which includes the need for a relevant state authority.

In May 2022 Lagos state announced its Off-Grid Electrification Strategy and Action Plan developed with assistance from the Africa Clean Energy Technical Assistance Facility (ACE-TAF). The document focuses on off-grid solar, but it is not available at the time of writing.

2.2.2.13.2 Kaduna State

The Kaduna state Infrastructure Master Plan 2018-2050 noted that the power distribution network is inadequate especially in rural areas and even urban connected locations suffer from supply interruptions. The plan aimed to:

- provide electricity to all major towns by 2020.
- provide electricity to all primary health centres.
- create a mini-grid framework for deployment of renewable energy in rural and semi-urban areas.
- deploy off-grid solar energy infrastructure in rural and in remote areas.

2.2.3 Urban Mobility (Transport) Lagos

2.2.3.1 Review of Laws And Plans about Relevant Transport and Mobility Plans and Policies at the Federal level

Policies (including drafts) and plans affecting transport and mobility at federal level comprise:

- The bill establishing the National Transport Commission of 2015
- The draft National Transport Policy of Nigeria
- The New Automotive Industry Development Plan (NAIDP)
- The act establishing the Federal Road Safety Corps of 2007
- The National Road Traffic Regulations of 2004
- The Act establishing the Federal Road Maintenance Agency of 2002
- The Nigerian Urban and Regional Planning Act of 1992
- The decree establishing the Nigerian Institute of Transport Technology of 1986 and the follow up Act of 2004

2.2.3.1.1 Bill Establishing the National Transport Commission

The bill establishing the National Transport Commission, an independent authority with the task of implementing the National Transport Policy of the Federal Ministry of Transportation. When approved by the President, tt would be also responsible for public transport in the states.

2.2.3.1.2 Draft National Transport Policy of Nigeria

The draft National Transport Policy of Nigeria, submitted to the Ministry of Transport in 2017 but not yet ratified, aims at a sustainable and integrated transport system that supports the social and economic development of the Country, aiding state and local authorities with the creation or strengthening of local institutions able to develop urban and rural transport, technology improvements and modernization of infrastructure, and at the development of mechanisms to finance transport infrastructure. Further, the draft Policy fosters the involvement of the private sector in the transport area from the provision of infrastructure to the operation of services.

2.2.3.1.3 The New Automotive Industry Development Plan (NAIDP)

The New Automotive Industry Development Plan (NAIDP) established in 2014 that aimed at promoting the local automotive sector, after the public sector had disengaged from it, and increased the import duties for secondhand vehicles.

2.2.3.1.4 Standards Organisation of Nigeria (SON)

A further federal agency whose activities affect the transport sector is the Standards Organisation of Nigeria (SON) that prepares standards and quality assurance systems.

2.2.3.2 Review of Governance Arrangements at the State level

Governance arrangements at State and local level vary depending on local conditions but each state has ministries responsible for implementing federal policies and, in particular, Ministry of Transport collaborating with the Federal Ministry of Transport and the federal agencies.

SSATP (2021), discussing urban transport policies, notes that the present legal basis is not sufficient for local governments to transform and improve local mobility and especially secondary urban areas are unable to design and implement policies. It also notes that the coordination to solve transportation issues is weak because of overlapping remits.

2.2.3.2.1 Federal Capital Territory (Abuja)

The Federal Capital Territory Administration has directly set up a transport company to provide public transport: the Abuja Urban Mass Transit Company (AUMTCO). There are unsolved several other problems related to transport and road maintenance.

2.2.3.2.2 Lagos State

In the Lagos State, the Ministry of Transportation is responsible for the transport sector in the state which is consists mostly of the Lagos Metropolitan Area. The Ministry of Transportation has a remit that spans policies for all transport modes, including public transport, provide road infrastructure and overseeing agencies acting on transport:

- The Lagos Metropolitan Area Transport Authority (LAMATA) that has the responsibility of reforming the transport system.
- The Motor Vehicle Administration Agency (MVAA) dedicated to vehicle licensing and registration.

In more detail, the mission of LAMATA is very broad and comprises public transport, urban rail, metro, water transport and non-motorised transport as well as construction and maintenance of main roads. LAMATA acts as planning, implementing, contracting and regulating body for transport. LAMATA planned BRT routes (for a total of 14 routes, the first one in operation since 2008) to be run by private operators, and the franchising of the bus network comprising 485 routes. In this framework private operators provide vehicles and operations whereas the state, via LAMATA, provides terminals, stops and other infrastructures as well as telematics, for instance making possible the use of pre-paid cards to pay for travel (the Cowry card). The first metro line is currently in construction. The reorganization of

public transport in Lagos is guided by two documents developed by LAMATA: the Lagos State Strategic Transport Master Plan (LSSTMP) and the Bus Route Network (BRN) document.

2.2.3.2.3 Kano State

In Kano state, where Kano the second largest city of the country is located, state level governance of transport involves two ministries and their implementing agencies:

- The Ministry of Housing and Transport, with the
  - Kano Road Traffic Agency (KAROTA)
- The Ministry of Work and Infrastructural Development, with the following agencies:
  - Kano Road Maintenance Agency (KARMA)
  - Kano Urban Planning and Development Agency

Additionally in 2021, the Kano state Executive Council set up a committed dedicated to establishing Strategic Metropolitan Transport Master Plan for the metropolis of Kano. Among the elements expected from the plan are the routes of the buses -including BRT lines-, the integration with rail, the location and design of the stops and an exploration of the options for financing the system.

2.2.3.2.4 Kaduna State

In Kaduna State, where Kaduna city is located, state level governance of transport involves:

- Ministry of Works, Housing and Transport with the following agencies:
  - Kaduna State Transport Regulatory Authority (KADSTRA)
  - Kaduna line (a bus and minibus company owned by the State)
  - Kaduna Roads Agency
  - Kaduna State Traffic and Environmental Law Enforcement Agency (KASTLEA)
  - Kaduna State Urban Planning and Development Authority

2.2.3.2.5 Oyo State

In the Oyo State, whose capital city is Ibadan, state level governance of transport involves:

- The Ministry of Lands, Housing and Urban Development
- The Ministry of Works and Transport with the
  - Oyo State Road Maintenance Agency (OYSROMA)
  - Oyo State Road Traffic Management Authority (OYRTMA)

2.2.3.3 Review of Laws and Plans about Relevant Transport and Mobility Plans and Policies and Governance Arrangements at the State Level (Lagos State)

Laws Policies and Plans Affecting Transport and Mobility at State Level comprise of:

- the LAMATA bill of 2002
- the Lagos State Government Development Plan 2012-2025
- the Lagos State Strategic Transport Master Plan (LSSTMP) which provides for the development of the Mass Transit System and for the introduction of walking and cycling facilities to promote non-motorised transport
- the Lagos non-motorised transport policy

- the Bus Reform Initiative
- the draft transport policy document by the State Ministry of Transport

The Strategic Transport Master Plan for the Lagos Mega City Region was issued in 2014 to review the previous master plan that would cover Lagos City (but not the greater Lagos area) and to extend the horizons for action to 2032 in three steps: 2017, 2022, 2032. The plan included the indication of actions with timelines comprising all surface transport modes.

The final list of public transport projects is reported in the following Table.

Table 2-1: The Final List of Public Transport Projects

FINAL LIST OF LAND TRANSPORTATION PROJECTS	
13 original STMP Projects (BRT, LRT)	
Oworonshoki to Apapa (BRT)	Red line Marina - Agbado(LRT)
Berger to Iyana Isolo through Ikotun (BRT)	Green line Marina – Ajah (LRT)
Maryland – Otta (BRT)	Yellow line Otta/MMA - Iddo (LRT)
Berger – CMS (BRT)	Purple Line LASU-Redeem (LRT)
Berger to Local Airport (BRT)	Brown Mile 12 – Marina (LRT)
Mile 12 – Ikorodu (BRT)	Blue TBS – Okokomaiko (LRT)
CMS-Okokomaiko-Ijaniki (BRT)	
2 new public transportation projects currently envisaged by Lagos State (Cable Car, Monorail)	
Lagos State Cable Car	Victoria Island Monorail
22 new projects for private and public transportation (Road, BRT, LRT, Cable Car)	
Lagos Outer Ring Road: Ojo – Apapa (Road)	Ijede – Isawo through Ikorodu (BRT)
Lagos Outer Ring Road: Ikorodu – Lekki through 4th Mainland Bridge (Road)	New corridor along Lekki's Green corridor (BRT)
Lagos Outer Ring Road: Ojo – Alagbado (Road)	Okun – Aja – Ikorodu Roundabout through 4th Mainland Bridge (BRT)
Lagos Outer Ring Road: Lekki – V.I / Apapa (Road)	New corridor along Lekki's new Lagoon Road (BRT)
Lagos Outer Ring Road: Alagbado – Ikorodu (Road)	Majidun/Ipakodo – Shagamu through Ikorodu (BRT)
Owode – Otta (by-pass) – Itele - Lagos-Abeokuta Road (Road)	Ikorodu Roundabout – Epe through Agbowa (BRT)
Agbara – Sokoto Road – Shagamu (Road)	New corridor along Lekki's new coastal road (BRT)
Shagamu - Ijebu Ode – Lekki Airport / FTZ (Road)	Red line – extension to Ifo (LRT)
Trade Fair – Ikotun (through Ijedodo Road) (Road)	Green line – extension to Lekki Airport, FTZ (LRT)
Badagry – Seme (Expressway) (Road)	Purple Line – extension to Shagamu (LRT)
Badagry – Seme (North) (Road)	Lagos State Cable Car: Extension of the Apapa leg to Ipaja and Alimosho

Source: Strategic Transport Master Plan for the Lagos Mega City Region

Included in the masterplan are four sector related plans:

- The Freight Transportation Plan
- The Non-Motorised Transport Plan
- The Road Safety Plan
- The Climate Change Plan

The Strategic Transport Master Plan also included an analysis of the institutional framework governing transport in Lagos and, in particular, of LAMATA. The following Figure reports the governance structure proposed by the 2014 Strategic Transport Master Plan.

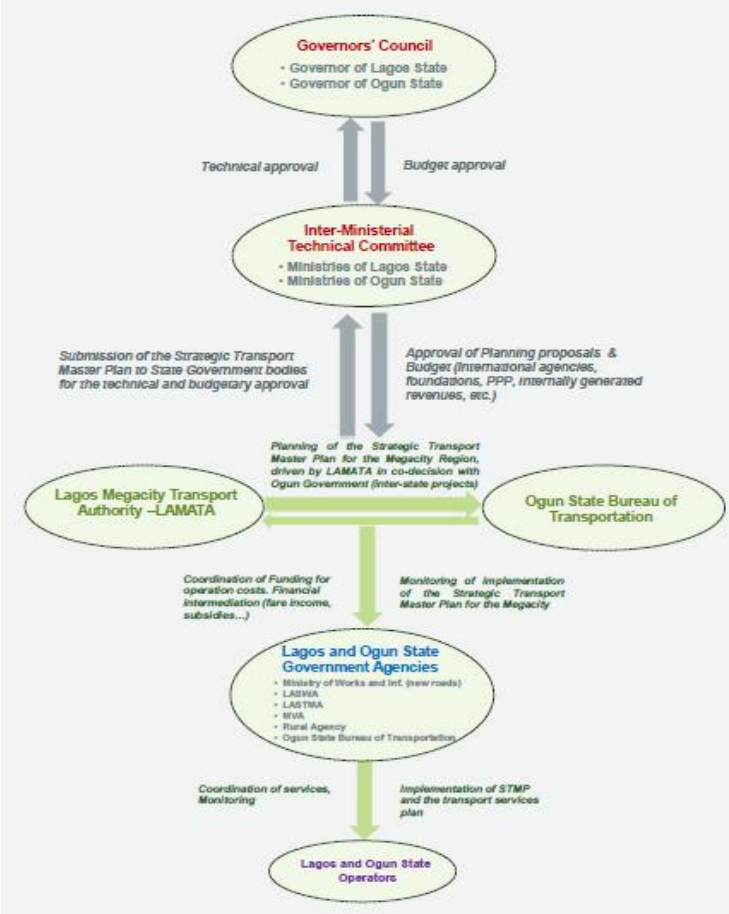

Figure 2-5: Governance Structure Proposed by the 2014 Strategic Transport Master Plan
Source: Strategic Transport Master Plan for the Lagos Mega City Region

The Lagos non-motorised transport policy was issued in 2018 by the Lagos State Ministry of Transportation and LAMATA following the most recent mobility planning principle, focusing on people rather than vehicles, and aiming to promote walking and cycling in connection to public transport. The Bus Reform Initiative.

The Bus reform initiative started in 2017 and designed to last until 2019, aims at replacing minibuses with last mile vehicles, with a marked increase in quality and safety for services, also thanks to drivers'

training. A total of 5,000 last mile vehicles and midi-buses were planned for introduction. The reform also includes development of:

- Infrastructure: completion of BRT corridors, bus shelters, depots, and road junctions.
- Operations: with 60 routes assigned to private bus operators, including performance monitoring
- Digitization: transport information and smart ticketing

As of 2019, 500 last mile vehicles and 300 midi buses had been procured (Otunola et al., 2019).
This Transport policy document for Lagos builds on the previous 2019 Draft Transport Policy and provides for:

- Road Network Operation and Management
- Private Cars
- **Adoption of Electric Vehicles and Autonomous Vehicles**
- Bus Rapid Transit, Bus and Minibus (Danfo)
- Yellow Taxis and E-Hailed Taxi Services
- Rail Transportation
- Inland Water Transport
- Integration, Interchange & Transit Oriented Development
- Pedestrians, Last Mile and Non-Motorised Transport
- Policies to Support Vulnerable and Displaced Persons
- Vehicle Repair Facilities (“Mechanic Villages”)
- Urban Freight Transport: Goods Vehicles & Wet Cargoes
- Ports
- Pipelines
- Air Transport

For each section the plan takes stock of the current situation and problems and discusses several short/medium/long term recommendations. This section outlines the problems reported in the most relevant chapters and some of the following short-term recommendations.

The discussion on the adoption of **Electric Vehicles** and Autonomous Vehicles focuses on the first topic since it is deemed too early to discuss autonomous vehicles. The policy paper discusses the options for Lagos state to intervene or guide the uptake of electric vehicles, indicating that an effective roadmap can only be designed once firsts steps to foster EV diffusion are taken and evaluated. The draft policy also discusses the need to evaluate measures on equity terms, since private EVs are likely to be purchased by the most affluent part of the population.

The recommendations over the short-term include:

- Deployment of a charging station network, at government facilities and if possible, at parking lots and shopping malls with mandate to include charging stations for new developments. The charging station network is indicated as the base prerequisite for the remainder of the actions to promote EVs
- Setting standards following standards established abroad, considering that one e-car is already being built on Nigeria (the Hyundai Kona) and that some EVs may be imported second-hand vehicles
- **Identify e-bus corridors where new e-buses should be introduced and agree with operators a timetable for their introduction and the construction of depot and roadside facilities as well as vehicle maintenance operations and standards**
- Establish training programmes for mechanics and drivers working on e-vehicles of all types

- Set up a facility to collects used batteries looking at their treatment and disposal downstream, be it in Lagos or elsewhere
- Develop an app to locate charging points and service facilities

The policy paper also notes that financial incentives (e.g., import dues) are set at Federal level and Lagos State could lobby the federal government about them but also that it cannot act on its own without causing unwanted effects, such as vehicles purchased in Lagos State due to incentives but used elsewhere in Nigeria.

Additionally, the paper expresses concern about the performance of e-vehicles with the poor state of the local roads and their surfaces.

The discussion on public transport including bus rapid transit, bus and minibus (danfos) stresses the problems due to lack of vehicle maintenance (particularly for smaller vehicles but also for the BRT fleet), poor road state (including along the BRT routes), congestion and pollution. The draft policy call for a reform of the Danfo services since they are typically old and poorly maintained, with safety and comfort problems for passengers and, constituting the largest fleet, they contribute to congestion and pollution. There has been the intention to phase them out, but more recent indications are for transforming them into feeder vehicles for larger buses. The BRT is not performing as it could, due to poorly maintained buses, violation of reserved lanes and lack of electricity at the stations where telematics services should inform passengers of the next arrivals.

The discussion leads to the following immediate and short-term recommendations:

- Improve Vehicle Maintenance Standards (immediate) requiring roadworthiness certification for danfos, that at present may operate without it
- Roadway repairs (immediate) to ensure that roads used by large numbers of buses are in good state
- Driver Training and Competence for all Danfo drivers (immediate) to improve safety and service
- Continue bus fleet expansion (immediate) with more large buses (molue) and last mile minibuses
- Adopt electric vehicles on BRT Corridors (short-term), where suited
- Tighten Emissions Standards on Vehicles (short-term) to move forward from the current requirement of Euro IV vehicles to less-polluting buses
- Expand e-ticketing to buses other than the BRT (short-term) where it has been implemented. Other buses are paid cash by users and the policy intend to standardize payments across the system (in the longer term including a rebate for transfers, to encourage feeder-trunk transfer)

As regards the Motorcycle taxis (Okada) and tricycle taxis (Keke). the draft policy takes the view that while they are still working, they should be limited only to local councils where the local government authorizes them, and they should be subject to licenses and road safety requirements.

2.2.4 Urban Mobility (Transport) in Three Other Cities

At Federal level the same laws and plans reviewed for the Lagos case apply to other cities.

Regulations and plans at state and local level have been included below as far as available at the time of writing this report.

SSATP (2021), discussing urban transport policies, notes that the present legal basis is not sufficient for local governments to transform and improve local mobility and especially secondary urban areas are unable to design and implement policies. It also notes that the coordination to solve transportation issues is weak because of overlapping remits. The three other cities referred to in the ToR are Ibadan, Kano and Kaduna. It is noted that they do not have a well-structured transport structure like Lagos and they have distinctive transport structures and varying degrees of approved urban transport masterplans.

January 2016 saw the release of the Draft Green Paper for the Kaduna State Transport Policy. The policy aims to correct this situation by providing public transport and non-motorised transport.

The Kaduna state Infrastructure Master Plan 2018-2050 notes that many roads in the state need to be paved and maintained to become all season roads, that are accessible –at the time of preparing the plan- to half of the population. The plan foresees road rehabilitations carried out by the specially established Kaduna State Roads Agency (KADRA). It also discusses the establishment of the Kaduna State Transport Authority (KASTA) taking over from various agencies with overlapping roles.

2.2.5 Rural Mobility (Transport)

2.2.5.1 Review of Laws and Plans about Relevant Transport and Mobility Plans and Policies at the State Level

At present this study has only had access to draft policy papers from which the critical issues are the poor state of rural roads and difficult with sustaining maintenance.

2.2.5.1.1 Lagos State

The draft transport policy document by the State Ministry of Transport identifies poor rural accessibility among the key issues related to the road network, along with inadequate design and construction and therefore aims to provide efficient rural-urban road transport facilities and services. As part of the on-going reforms the Lagos bus operator introduces first and last mile buses (7-11 passengers, locally assembled) deployed also to link rural communities and urban areas.

2.2.5.1.2 Kaduna State

The Draft Green Paper for the Kaduna State Transport Policy released in 2016 noted the importance of the several transport modes used in rural transport bicycles, animal transport, tractors, pickups, trucks, and buses as well as the critical issue that roads are in poor conditions and several communities do not have all season access. However, the green paper acknowledges the support of the RAMP program for upgrading, rehabilitate or maintain roads.

2.2.6 Private Sector Financing

2.2.6.1 Current Strategy

We are yet to see EV push in Africa in general and Nigeria which is due to many factors including the high cost of EVs compared to not just the new ICE based Vehicles but the secondhand ICE Vehicles. About 40% of the world's export of used vehicles are imported into Africa. Nigeria's import of used vehicles is almost 80-90% of all the imported vehicles. With no Government policy targeted towards

banning the imports of such vehicles like what Cape Verde has done (an end to imports of used vehicles by 2035) or compulsory phasing out of vehicles beyond a certain age like India (10 years for diesel and 15 years for petrol vehicles) along with incentives or promotional finance for large scale adoption of EVs, the future of EVs in Nigeria does not look very promising. Added to the challenges are the infrastructure challenges in terms of charging infrastructure leading to range anxiety issues, bad quality of roads, unreliable electricity supply and dilapidated electricity network.

One of the biggest challenges is upfront cost of EVs. For example[9], an electric car would cost around N24 Million (starting price of a Hyundai Kona in Abuja) which is more than 10 times the average annual salary of a Nigerian. Accordingly, despite the falling battery costs, lower maintenance cost of an EV and the resultant promise of greater savings over the lifetime of the vehicle, an average Nigerian is unlikely to buy an EV.

According to the latest data made available by the National Bureau for Statistics in 2018, there were a total of 11.8 million vehicles in Nigeria. Of this number, 39% (4.6 million) were privately owned, 56% (6.7 million) were commercial vehicles, 1.1% (135,000) were government vehicles and 0.4% (5,834) were owned by diplomats. Nigeria has one of the smallest per-capita car ownership (34.9 per 1000 Nigerians – 2017) and a large population depends on buses, mini-buses, taxis and motorcycles. Therefore, these modes of transportation are better suited for electrification which is also good for the Power Distribution Companies which can plan their capacity in a phased manner.

On February 2021, the NADDC, Nigeria in collaboration with the Stallion Group unveiled the first locally made electric car, Hyundai Kona. In February 2021, the director of the National Automotive Design and Development Council stated the goal is that by 2025, 30% of passenger cars driven in the country will be electric powered. The Federal Government has indicated reduction in import duties on imported vehicles from 35% to 5% due to the rising cost of transportation which needs to be harnessed to gather the much-needed momentum for EVs. However, the Government and Investors must constantly support the EV Eco-system so that there is increased uptake and the players involved can scale up their operations to meet the increased demand of EVs.

Another example is the Nigerian based Jet Motor Company which has launched the first locally made JET EV fully electric vehicle, with a $9Mn raise. It launched its first electric cargo van, JET EV in partnership with GIG Logistics, Nigeria. Despite the challenges of high cost of entry and unreliable power supply, the Company has gone ahead and has targeted fleet operators, schools and governments. It meets the deficit power through a generator presently. However, with more partners joining in, it is building charging stations for its partners. The Company has a long-term goal of adding more partners and get funding from the Venture Capitalists to build solar or wind powered charging stations. On the policy front, the company feels that despite its great ideas, it needs conducive policy framework that incentivizes making the vehicles easily accessible and funding to back its plans. While the company at present is focused on the mass transportation, it plans to enter the passenger vehicles and innovate in the battery swapping technology space.

As per Mr. Chidi Ajaere, Chairman, GIG Group, who founded Jet Motor Company, the Company is looking for funding from VCs and Angel Investors with a similar mindset and interest in the renewable energy space. In his words "*Our plan for expansion is to rapidly get the right funding and literally plant charging stations across African cities and African highways, making it easier for both individuals and corporations to adopt the EV because they are more likely to buy an EV if they know they can have access to charging stations".*

[9] *Electric Cars are out of scope of public transport E-mobility.*

2.2.6.2 Regulatory Regime

At present the policy framework is being developed. With a conducive Policy and Regulatory regime, Nigeria, with its large population, low per capita vehicle ownership and the consequent opportunities in the Electric Mobility, can attract some of the large players and investors from US, Europe, Middle East and Asia.

2.3 Survey of International Experience in Initiating E-Mobility in a LMIC Context

This Chapter discusses the interest and the limitations of drawing from international experience and recalls the lessons learnt from experiences in other countries such as Indonesia, India, Vietnam. The survey allows to note that successful strategies typically share several characters: focus primarily on larger e-vehicles, concern urban areas, use adequate access to a power supply, wealthier countries or regions are more likely to adopt e-vehicles, government a establish a regulatory regime and provide appropriate incentives and penalties to foster the adoption of e-vehicles. As input to action in Nigeria the survey calls for a clarification of roles, relevant legal and fiscal frameworks, commitment to Investment, use of a part of petrol subsidies for electric mobility, attraction of foreign investment, a national push for the establishment of domestic production.

2.3.1 Challenges of Undertaking Comparisons

Although not explicitly mentioned in the Terms of Reference, we have assumed that the objective of identifying and assessing experience elsewhere is to determine the applicability of such experiences to Nigeria. There have been two major obstacles in pursuing this objective:

- In Africa in particular, the majority of cases encountered have been e-bus trials which have only started within the last few months; and
- For the cases we have encountered, the quantitative aspects thereof could only be applied with significant degrees of caution and extensive analysis of each case to ensure that experiences outside Nigeria could be used as benchmarks for our study.

As a starting point, let us assume that the core objectives of developing and implementing an e-mobility strategy are a cleaner environment and a reduction in the reliance of fossil fuels (particularly petrol and diesel). In any given country, we would expect the largest impact will be felt in urban areas. The table below provides a sample of countries and the proportion of their populations that lives in urban areas.

Table 2-2: A Sample of Countries and the Proportion of Their Urban Population

	percUrbanPop	pop2022 (000s)
Botswana	70	2,441
South Africa	67	60,756
Angola	66	35,027
China	61	1,448,471
Cameroon	57	27,912
Ghana	57	32,395
Nigeria	52	216,747
Senegal	48	17,654
Egypt	42	106,157
Sierra Leone	42	8,306
Guinea	36	13,866
Tanzania	35	63,299
India	34	1,406,632
Kenya	28	56,215
Uganda	25	48,433
Malawi	17	20,181
Niger	16	26,084

Source : https://worldpopulationreview.com/country-rankings/most-urbanized-countries

Support for the likelihood of e-mobility case studies being focused in urban areas is illustrated by the case of Nigeria, which is middle-ranking in Africa in terms of the extent of urbanization. Data for the top ten metropolitan areas in Nigeria is provided in the Table below.

Table 2-3: Data for the Top Ten Metropolitan Areas in Nigeria

Rank	City	State	Population	Area (km²)	Density (/km²)
1	Lagos	Lagos	12,830,000	1,425	9,000
2	Onitsha	Anambra	7,425,000	1,965	3,800
3	Kano	Kano	3,680,000	251	14,600
4	Ibadan	Oyo	2,910,000	466	6,200
5	Uyo	Akwa Ibom	1,990,000	729	2,700
6	Port Harcourt	Rivers	1,865,000	158	11,800
7	Nsukka	Enugu	1,735,000	645	2,700
8	Abuja	FCT	1,580,000	225	7,000
9	Benin City	Edo	1,355,000	228	5,900
10	Aba	Abia	1,215,000	91	13,400
Top 10			36,585,000	6,183	5,917
Nigeria			186,000,000	923,769	
% Top Ten			19.7%	0.7%	

Source: "World Urban Areas" study, Demographia (2016)

Note that some 20% of the population is contained within under 1% of Nigeria's area.

2.3.2 Availability of Resources

A further, reasonable assumption concerns the availability of funds and other resources to implement an e-mobility strategy. Whilst city governments will have the heft to develop urban strategies which are specific to their own area, rural e-mobility strategies are more likely to be determined at national or state level. From a transportation viewpoint, the difference between urban and rural e-mobility strategies concerns the size of vehicles considered. Urban strategies, for example, will discuss e-buses but rural versions are more likely to consider smaller and cheaper modes of transportation.

In either case, the focus is on the development of strategy (including the selection of a business model) followed by the selection of appropriate vehicle types and sizes to implement this strategy. Our approach will therefore be to concentrate on geography (cities, rural regions) rather than vehicle type.

2.3.3 Specific Factors Hindering Quantitative Benchmarking

For international comparison, we have considered:

- The GDP per capita of the country (or region) used in the comparison.
- Accessibility to urban and rural electricity; and
- The relationship between the price of fuel per litre and electricity per KWh.

The Table below shows the countries used in the initial search for E-mobility cases comparable to Nigeria. Electricity coverage figures are for 2019.

Table 2-4: Countries Used in the Initial Search for E-Mobility Cases Comparable to Nigeria

	Electricity Coverage			GDPC	Relative Energy price
	Rural	Urban	Total	$	c per KWh/$ per litre
India	97	100	98	6,504	5.30
Indonesia	98	100	99	12,073	8.79
Kenya	62	91	70	4,578	18.38
Nigeria	26	84	55	5,186	15.89
Rwanda	26	93	38	2,214	18.95
Tanzania	19	73	38	2,780	8.05
Vietnam	99	100	99	8,650	6.74
Zimbabwe	20	85	41	3,537	2.00

Sources : https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD?locations=TD
https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=TD https://www.globalpetrolprices.com/

The Rwanda figures for electricity coverage require updating, however; according to the Rwanda Energy Group[10], 70% of households had access to electricity, split roughly 50% via the grid and 20% off-grid. As a general rule, we would expect e-mobility to be more prevalent in countries where:

- GDP per capita is higher (the ability to buy and maintain goods).
- Access to electricity supply is greater; and
- The price of electricity is relatively lower than the price of fuel (petrol or diesel).

If we examine the last column of the table above, it is evident that Zimbabwe has a very low price of electricity compared to that of fuel. Also note that, notwithstanding Nigeria's petrol subsidies and subsidy-free electricity supply, the ratio is not as high as in other African countries.
India is a country which will feature in the review, given the country's experience with e-mobility. However, it is necessary to be cautious over the application of the Indian experience to Nigeria due to the significant disparity within India of wealth; the table below shows the average net domestic product for India and the five wealthiest and poorest states.

[10] *https://www.reg.rw/what-we-do/access/#:~:text=To%20date%2C%2068.17%25%20of%20Rwandan,is%20100%25%20access%20by%202024.*

Table 2-5: The Average Net Domestic Product for India and the Five Wealthiest and Poorest States

Rank	State/Union territory	NSDP Per capita
1	Goa	US$25,044
2	Sikkim	US$19,543
3	Delhi	US$19,974
4	Chandigarh	US$17,990
5	Haryana	US$12,904
28	Meghalaya	US$4,865
29	Manipur	US$3,824
30	Jharkhand	US$4,154
31	Uttar Pradesh	US$3,635
32	Bihar	US$2,395
—	**India**	**US$7,333**

Source : https://en.wikipedia.org/wiki/List_of_Indian_states_and_union_territories_by_GDP_per_capita

As the table demonstrates, within India there is a significant variation between states, with the wealthiest being 8-10 times as wealthy as the poorest. For case studies, therefore, we will be specific about the states in which specific projects have been implemented.

2.3.4 E-mobility Case Studies

2.3.4.1 Availability

Several E-mobility Case Studies are presented in **Annex 1**: Indonesia (Annex 1.1), Vietnam (Annex 1.2), and in the City of Pune, India (Annex 1.3). Specific Case Studies for E2Wheelers and E-buses are presented in Annex 1.4: Nigeria and Annex 1.5 for India and Other Cities, respectively.

During our search for case studies, we observed that there is a certain hierarchy which predicts the availability of strategies which have been successfully implemented:

- Larger e-vehicles have been put into service more successfully than smaller ones. As a result, there are many more cases available for buses than for, say, two- and three-wheeled vehicles.
- Correlated with the first point is the level of impact. We would expect, *a priori*, for the impact of electric vehicles to be greater in the case of urban settings than rural ones and the availability of cases does seem to bear this out.
- Adequate access to a power supply (on- or off-grid).
- Given the investment cost, wealthier countries or regions are more likely to adopt e-vehicles; and

- More effective governments will establish a regulatory regime and provide appropriate incentives and penalties to foster the adoption of e-vehicles.

For each case, presented, we will make observations on the above criteria to enable a more robust comparison with Nigeria. Due to the fast-moving nature of this market (very much in the early growth phase and subject to significant technological innovations), we will focus on cases no earlier than 2020.

2.3.4.2 Selection Criteria

There are many cases which, whilst initially appearing promising, have not been selected including those where:

- Trials or pilot study which do not appear to have been extended; and
- Useful cases for which information is inadequate.

A further necessary condition for inclusion of a case study is that it has been well-documented.

2.3.4.3 Costs

Within a country, we would expect costs to be comparable, as projects will usually operate under the same regulatory and fiscal regimes. However, for comparing projects across borders, we feel that it is important to highlight the pitfalls involved in compared costs between countries.

2.3.4.3.1 Exchange Rates

Exchange rates are the most difficult obstacle when undertaking international comparisons. For example, within Africa, 14 countries use the CFA Franc, which is the Euro in all but name (it was last devalued in 1994, having remained fixed against the French Franc for 46 years previously and since 1994). In Nigeria, the official exchange rate is significantly lower than that in the parallel market which introduces distortions into price and cost comparisons.

2.3.4.3.2 Incentives and Disincentives

Incentives for the acquisition of e-vehicles include subsidies to fund their purchase, the provision of public vehicle charging stations and an electricity tariff which enables e-vehicle owners to charge their vehicles at a cheap rate (often overnight). By contrast, the main disincentive is a subsidy for fuel and/or diesel, which reduces the likelihood of switching to electric vehicles. For each case study, we will need to consider how the approach to incentives and disincentives differs from Nigeria.

2.3.4.3.3 Operational Efficiency of Buses

There are several variables which need to be considered here when comparing the effectiveness of buses on different networks. Most notable are:

- Number of bus-kms per day which is a function of congestion and route length.
- Efficiency of the maintenance regime, measured by the average availability of the fleet.
- Volume of ‘dead running’, particularly to and from the depot.

Each of these factors will have a direct bearing on the average operating and total cost per vehicle-km irrespective of the propulsion system used.

2.3.4.3.4 Direct and Indirect Costs

Whilst direct costs should be relatively straightforward to compare between countries (after taking account of differences in fuel and energy costs), indirect costs are likely to be more problematic. Examples of differences in indirect cost treatment include:

- Treatment of depreciation.
- Cost of land acquisition (for depots).
- Different import duty rates for vehicles and equipment., etc.

2.3.5 Strategy and Business Models

In contrast to the problems identified with comparing quantitative data, the ways in which strategy has been developed (and implemented) as well as business models used to develop e-vehicle systems elsewhere are more directly applicable to Nigeria. For example, formal public transportation in Lagos is already developed and implemented through a partnership of the public and private sectors. Similarly, as Nigeria has a developed private sector, we would expect various forms of private sector participation seen elsewhere (such as privately operating battery charging and swapping stations) to be applicable within Nigeria.

We have developed three case studies covering two countries (Indonesia, Vietnam) and a city (Pune, India). These case studies are provided in **Annex 1**. We have also developed a case study for Nigeria (which is also located in Annex 1.4) together with a review of international experience of E-bus development (particularly focused on India and China) which lays a foundation for work to be done under Component 2 Urban Mobility (for E-buses in Lagos, Nigeria).

2.3.6 Lessons Drawn from International Experience on E-mobility

Our evaluation of international experience, in addition to our judgement on the case studies presented, leads us to draw the following lessons which we would expect to apply to Nigeria.

2.3.6.1 Clarification of roles

An e-vehicle strategy requires activity from several branches of government in addition to any private sector involvement. For Nigeria, the relevant Ministries and agencies include as a minimum:

- Rural Electrification (availability of power supply).
- Transport (regulation of the e-vehicles, project planning); and
- Finance (development of incentives to acquire e-vehicles, special customs tariffs for imports, etc.)

A legal framework will need to be in place at national, regional and/or local level and the laws generated at various levels of government will need to be compatible to provide an internal consistency to the framework.

The legal and fiscal frameworks which need to be developed will require a coordinated approach and appropriate mechanisms for this co-ordination to occur, such as an inter-Ministerial Steering Group. Please note that lack of co-ordination was highlighted as an obstacle in Indonesia.

2.3.6.2 Commitment to Investment

For an e-vehicle strategy, there is a mismatch between financial costs and benefits. In particular, costs involve significant up-front expenditure but the benefits of lower pollution, improved health and hence less illness and death take many years to see the light of day. There is a significant funding requirement necessary at the early stages of the project and, in the case of Nigeria, the immediate financial benefit is a reduction in fuel imports (assuming, of course, that batteries are charged using clean energy).

For Nigeria, a potential source of funding is petrol subsidies, now projected to approach US$ 10 billion for 2022[11]. If these subsidies were, for example, reduced by just 5% (which should not cause significant political fallout), this would provide US$ 500 million for e-vehicle projects.

2.3.7 Experience of Private Sector Participation in E-mobility in LMIC's: India

2.3.7.1 All Vehicles

The sale of Electric Vehicles across India during the Financial Year 2019-20 was around 295,000 (152,000 two-wheelers, 140,680 three-wheelers and 2,810 four-wheelers) while sales during the Financial Year 2021-22 was around 238,000 (143,840 two-wheelers, 88,380 three-wheelers and 5,910 four-wheelers).

As of March, the data from Vahan4 Portal showed that India has about 1,076,420 electric vehicles.

Ministry of Heavy Industries launched the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles in India (FAME India) Scheme in 2015 to promote adoption of electric/ hybrid vehicles in the country. At present, Phase-II of FAME India Scheme is being implemented for a period of 5 years with effect from April 1, 2019 with a total budgetary support of Rs. 10,000 crores (about 1.2 billion USD). This phase focusses on supporting electrification of public & shared transportation and aims to support, through subsidies, 7090 e-Buses, 500,000 e-3 Wheelers, 55000 e-4 Wheeler Passenger Cars and 1 million e-2 Wheelers."[12]

"The Government (of India) approved the Production Linked Incentive (PLI) Scheme for Automobile and Auto Component Industry in India for enhancing India's Manufacturing Capabilities for Advanced Automotive Products (AAT) with a budgetary outlay of Rs 25,938 crore (about 3 billion USD).[13]"
The PLI scheme includes manufacturing of Advanced Chemistry Cell, in May 2021, with the aim to control the prices of batteries and as a result, decrease the prices of EVs. For Auto components, a PLI scheme was launched on September 15, 2021.

[11] https://www.reuters.com/world/africa/nigeria-expects-fuel-subsidy-could-cost-96-bln-2022-oil-prices-rise-2022-04-09/

[12] https://legalitysimplified.com/2022/10/05/ministry-of-heavy-industry-issues-circular-on-implementation-of-api-based-on-line-data-transfer-for-fame-ii/

[13] https://pib.gov.in/PressReleasePage.aspx?PRID=1806077#:~:text=The%20Government%20approved%20the%20Production,outlay%20of%20%E2%82%B925%2C938%20crore.

The GST on EVs has also been reduced from 12 per cent to the current 5 per cent. On the charging stations, the GST has been reduced from 18 to 5 per cent.

"The Ministry of Road Transport and Highways (MoRTH) announced that battery-operated vehicles will be given green license plates and be exempted from permit requirements."[14] "MoRTH issued a notification advising states to waive road tax on EVs, which in turn will help reduce the initial cost of EVs"[15], as per the statement issued by the Ministry.

2.3.7.2 Electric Scooters and Motorcycles

India's ICE Vehicles Market is dominated by two-wheeler segment with a sale share of as high as 80%. Naturally, therefore, the penetration of EVs in this segment is expected to bring good results.

The Union Transport Minister, in the first week of May, stated that the current number of electric scooters was around 1.2 million which, by December end, is likely to go up to 4 million and in the next two years to around 30 million. In the electric scooter space, there are about 250 start-ups working.

According to a KPMG and CII report titled '**Shifting Gears'**, the light mobility segments of 2/3-wheelers and commercial cars will be leading electric mobility in India by 2030. Keeping in view the fuel economy, prices and financing options, Electric two-wheelers, with many start-ups offering different ranges of products, attractive price and ownership models, are expected to have 25%-35% penetration by 2030. This development is similar to that in China, where electric bikes and scooters laid the foundation for growth.

2.3.7.2.1 Leading Players in the Electric Scooter Market in 2021

The leading players in the Electric Scooter Market include Hero Electric, Okinawa Autotech, Ather Energy, Ampere Vehicles, Purenergy, Bajaj, TVS, Yo Bykes, Eeve, Battre, M2GO, Rowwet, Techno Electra and Ujaas.

2.3.7.2.2 Players in the Electric Motorcycle Market

While the Indian two-wheeler is dominated by motorcycles with nearly 60% share, electric scooters have gained 90% of the electric scooter market. While there are more than 15 known companies of different size and volume, only a few companies are into motorcycles, such as, Revolt Motors, Tork Motorcycles, Evolet India, WardWizard and Ultraviolette Automotive.

2.3.7.3 Electric Three Wheelers

As per the data from Vahan Dashboard, electric three-wheelers registered almost 100% sales growth in FY 2021-22 with a share of about 46% in the segment. Electric three-wheelers recorded sales of 1,77,874 units over 88,391 units sold in FY 2020-21 fueled by intra city logistics requirements of ecommerce, growth in retail market, last mile connectivity for middle and lower classes, rising fuel prices and a general shift towards sustainable mobility.

[14] https://www.ndtv.com/india-news/lok-sabha-over-13-lakh-electric-vehicles-in-use-in-india-centre-in-lok-sabha-3174500

[15] https://emobilityplus.com/2022/07/20/2877-electric-vehicle-charging-stations-sanctioned-under-fame-ii-in-68-cities-across-25-states-uts/

Keeping in view the fuel economy, prices and financing options offered in this segment, the three-wheeler adoption is expected to be around 65%-70% by 2030, as per the KPMG and CII report. The leading players include Mahindra & Mahindra, Piaggio Vehicles, Euler Motors, Kinetic Green and Atul Motors

2.3.7.4 Electric Cars

The four-wheeler market segment is yet to see the EVs penetration, the present level being less than 0.1%. The total number of electric cars sold in India in 2021 was 14,800 which is low but was triple that of 2020 as per the report of the Federation of Automobile Dealers Association (FADA). While promising, the existing lower number is attributed to many factors such as limited models/products, high initial costs, insufficient and unreliable battery promise causing range anxiety, lower than expected performance and a lack of wide-spread charging eco-system. After Electric Bikes, Scooters and Intra City transport buses segment, the next segment that is likely to have high penetration is fleet cabs, and then others. The reach of electric cars in the personal mobility segment is expected to be only 10%-15% by 2030, as per the report. However, electric cars for ridesharing and taxis may see traction of 20%-30% by 2030, as per the report. However, for that to happen, the gaps outlined above need to be filled. The leading players and models of Electric Cars are Tata Motors (Nexon EV and Tigor EV), Mahindra & Mahindra (eVerito, e2o plus, eSupro, Treo & eAlfa mini), Hyundai (Kona Electric), MG (ZS EV), Honda (PHEV), Porsche (Porsche Taycan), BMW (Mini Cooper SE, iX), Jaguar Land Rover (Jaguar I-Pace), BYD (E6), Audi (e-tron & RS e-tron GT) and Strom Motors (R3).

2.3.7.5 E-Buses

India with its large population, congestion and traffic faces a huge challenge to have a public transportation which can cater to everyone. With concerns about climate, global warming and pollution, a move towards sustainable transportation particularly E-Buses has been made in India. In 2014, the first E-Bus was launched in Bengaluru and later in Delhi, Mumbai and Pune. Today, electric buses can also be seen plying in small towns and semi-urban regions. From viability perspective, Intra-city transport buses are also ripe for EV adoption.

The growth and demand for E-Buses has attracted many large-scale manufacturer including OlectraK9 Electric Bus by Olectra Greentech, BYD K9 by BYD Company Limited, Tata Ultra 9/9 Electric AC Bus by Tata Motors, Ashok Leyland Versa EV Electric Bus, JBM Ecolife Electric Bus by JBM Mo tors, SkyPark Electric Bus by Deccan Auto Limited, Eichers Skyline Pro by Eichers Motor Limited, Solaris Urbino 15 LE Electric Bus by Solaris Bus & Coach SA,,Zhongtong Electric Bus LCK6122EVG by Zhongtong Bus and Holding Company Limited and PMI – Photon Regio and Urban Electric Buses.

2.3.7.6 Charging Infrastructure

India has over 1 million electric vehicles and about 1742 charging stations out of which around 940 public EV Chargers are in nine big cities with a population of more than 4 million (Ahmedabad, Bengaluru, Chennai, Delhi, Hyderabad, Kolkata, Mumbai, Pune and Surat). The Government owned three fuel companies have also committed to set up 22000 EV Charging stations in prominent cities and on National Highways across the country out of which these companies have so far installed 900 EV charging stations.

The Government has determined that at least one charging station should be available in a 3 Sq. km Grid. Other guidelines include an affordable tariff for public EV charging stations and enabling the EV owners to charge their vehicles at the homes or businesses using the existing power connections. Keeping in view the high contribution of land cost in charging tariff, a revenue sharing model has also been proposed for land use to make public charging stations financially viable from the Operator's perspective along with timelines for timely electricity connection for faster roll out.

The Indian Automobile Industry is up for exciting times where the EVs will act like a big game changer with two-wheeler and three-wheeler playing a dominant role in terms of EV adoption followed by E-Buses and Passenger Taxies. However, India has a lot to do in terms of availability of charging infrastructure, create battery capacities to drive down the prices, carry out mass level awareness programs regarding why people should adopt EVs and finally, a sound grass root level financing system for both urban and rural customers.

The Government has provided the policy push such as FAME, PLI for manufacturing of Advance Chemistry Cell and Auto Components, reduced GST, waiver of Road Tax, green license plates, exemption from permits etc. due to which several established private automobile companies and start-ups are coming out with innovative product, services and business models. As per data from Tracxn, there are about 486 EV Start-ups in India with several State Governments also contributing to the EV Start-ups through their own policies and initiatives which has resulted in some of the leading start-ups like Ather Energy, Yulu, Tork, Euler, Emote, Revolt, Ultraviolette, Strom, Orxa, Emflux, Okinawa and Ola.

India, with its 28 States and 9 Union Territories, has a vast rural area. However, the existing vehicle manufacturers and financers have established their own network which can be leveraged. This is subject to many factors including the lower costs of EVs, driven by lowered battery and components costs reaching close to the cost of the traditional vehicles and the charging infrastructure also reaching in the rural areas through mutually beneficial business models thereby reducing the range anxiety. Here, the role of the State Governments has been defined to create an enabling EV policy. As at the end of January 2022, 16 States and Union Territories have issued their EV policies that include subsidy for two-wheelers and cars, waiver of registration fees and road tax, creating charging stations, etc. After from these, the State of Karnataka offers even more concessions and subsidies for component and battery manufacturing, battery swapping and EV charging enterprises.

2.4 Potential Options for Sustainable Energy E-Mobility Strategy

This Chapter discusses the Potential Options for Sustainable Energy e-Mobility Strategy with reference to the applications for the BRT in Lagos, for the e-bus service at the University of Abuja, for rural areas. The chapter includes a detailed indication of the barriers to be addressed, dividing between 'hard' barriers, primarily technologically driven; and 'soft' barriers, comprising management, human and financial issues.

The key drivers of the sustainable e-mobility strategy are:

i) to support the modal shift to a lower carbon transport mode (particularly for public transport) and
ii) to assist to reduce air pollution, greenhouse gas emissions and improve health and economic impacts of mobility in Nigeria

The strategy encompasses both Urban E-mobility (principally E-buses for Lagos and Abuja) as well as Rural E-mobility (principally E2W's and E3W's in rural areas of Nigeria).

2.4.1 Integrated Solutions

In developing E-mobility throughout Nigeria, the technology mix includes the following relevant components that need to be studied in detail when considering, for instance:

- the selection of the routes and depots for an E-bus demonstration project on a Priority BRT Corridor in Lagos,
- the design and development of an inter-campus E-bus service at the University of Abuja,
- the design and development of transport e-mobility in rural areas of Nigeria.

"Technology aspects look at the battery technology, charging stations and infrastructure, as well as electrical supply and the grid impact."[16]

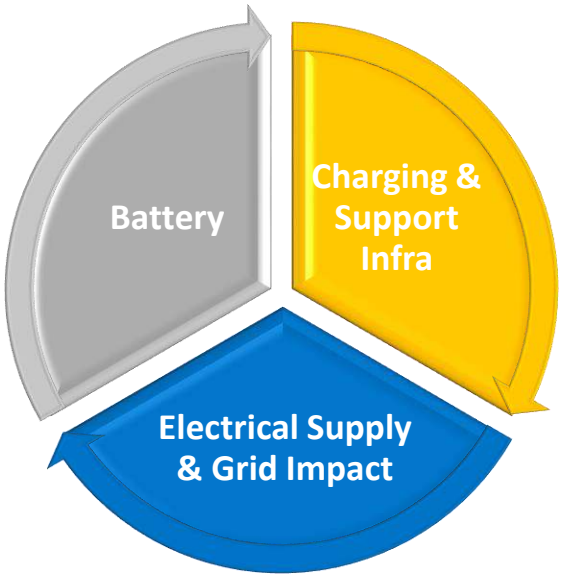

Figure 2-6: Components of E-Vehicle Technology
Source: "Electric Bus Technology and Infrastructure Planning Report", Sept. 2020, GFA/HEAT GmbH, published by C40 Cities Finance Facility and GIZ, p. 16

2.4.2 Study Approach

2.4.2.1 E-bus Demonstration Projects

Compared to diesel/CNG-powered buses, e-buses are based on a technology that is still evolving rapidly has a direct transformational impact on operations. Battery e-buses' introduction requires a paradigm shift in city bus operations and city governments and operators are still learning the world over. Therefore, the technical and economic feasibility of e-bus projects primarily focuses on understanding technology and route selection and the resulting economic benefits.

[16] "Electric Bus Technology and Infrastructure Planning Report", Sept. 2020, GFA/HEAT GmbH, published by C40 Cities Finance Facility and GIZ, p. 16

It is noted that PV charging infrastructure for urban E-buses is generally insufficient/ not applicable however PV may be utilized at E-bus Depots for ancillary building electrical support, etc.

2.4.2.2 Small-scale Rural E-mobility Demonstration Projects

Likewise, the development of E2W's and E3Ws involve fast-evolving technology as compared to Diesel/CNG powered vehicles, which directly also impacts operational aspects. Worldwide, both local authorities and operators are also still in a learning phase and the use of battery powered small-scale vehicles in rural areas buses is a paradigm shift, particularly given the potential of new PV powered mini grids as a source of clean energy for rural passenger transport operations.

2.4.3 Summary of Barriers to be Addressed

The Table below presents the barriers we have encountered in Nigeria, or which have been derived from our assessment of case studies of e-vehicle introduction. We have classified the barriers into two types:

- 'hard', primarily technologically driven; and
- 'soft', comprising management, human and financial issues.

The Table below also provides our views on whether each barrier is best tackled by the private or public sectors or possibly a joint effort between the two. Finally, for all barriers which are either perceived or real (for example, range anxiety), we propose an assessment of how to overcome each barrier.

Table 2-6: The Barriers to be Addressed

Type of Barrier	Barrier	To be addressed by Government/ Private Sector	Strategy/Initiative
Technical	Driving Range	Private	Current technologies allow high driving range and lesser charging time which will further improve as battery types and technologies advance with higher energy density
	Charging Time	Private	
	Battery Technologies and efficiency	Private	
	Standards	Government	Much work has already happened across the world that needs to be studied and reviewed along with the standards and safety aspects already prevailing for conventional vehicle to assess the best fit for Nigeria
	Safety	Government	
	Environmental concerns	Government	• Compulsory phasing out of vehicles beyond a certain age • Mandatory switch of Government vehicles to EVs • Green Cess/Tax/Certificate imposition on new conventional vehicle purchase

Type of Barrier	Barrier	To be addressed by Government/ Private Sector	Strategy/Initiative
Infrastructure	Roads	Government & Private	Roads improvement by Government under their budget or through PPP Models
	Dedicated Lanes	Government	BRT for E-Buses and/or dedicated lanes for Electric 4/3/2 Wheelers
	Charging Infrastructure	Government & Private	Commitment of Government Budget or Faster Cost Recovery and Financing Models for Private Sector to create charging stations at convenient locations
	Battery Recycling/Swapping	Government & Private	• Regulatory/Promotional Policy to encourage battery recycling by private sector • Regulatory Policy for 2/3 Wheelers to be sold without batteries by standardization of battery slots or additional battery slots • Battery Swapping Start-ups with business models for cost recovery that can be funded by VCs/Angel Investors/Institutions
	Grid/RE/Storage Availability	Private	• Private Sector engagement to set up RE and Storage based charging stations with or without grid connection • Timely improvement of distribution line and transformer capacity to accommodate setting up of charging stations
Policy/ Regulatory	Research & Development	Government & Private	• Investments in R&D by Governments Institutions and Private Sector in a collaborative manner • Engaging Private Sector to investigate and deliberate on the demand and supply incentives, retrofit kits, etc.
	Boosting manufacturing of EVs/Components	Government	• Promote local assembly of EVs with imported products with phased increase in local sourcing • Incentivize production of EVs, Battery, Chargers, Other Components e.g. Production Link Incentive schemes for Advance Chemistry Cell for Batteries and for Components announced in India
	Taxation of vehicles and components	Government	Lower Excise/VAT etc. on EVs/Components to bring the overall cost of the EVs/Infrastructure
	Subsidies/Incentives to Consumers	Government	• Lower or No Tax on Sales, • Cash subsidy for switching,

Type of Barrier	Barrier	To be addressed by Government/ Private Sector	Strategy/Initiative
			• Exemption from Registration & Road Tax, • No Toll, • Allowing entry of only EVs in certain areas etc.
	Subsidies on Fossil Fuels	Government	• Phased abolition of fuel subsidy, • Levy of green tax on fuel
	Phasing out of old vehicles	Government	All existing Petrol and Diesel Cars to be phased out after certain years, say 15/10 years
	Prohibition/Increased Duty on imported vehicles	Government	• Reducing imports by increasing import duty on second-hand cars and • Phased prohibition of import of second-hand petrol/diesel vehicle and permission to import EVs
	Electricity Policy for home/ public charging	Government	• Incentivize home charging by considering personal vehicle charging at domestic tariff • Compulsory provisioning of chargers in all group housing and estates • Compulsory provisioning of charging in all new residential/commercial building • Engaging Private Sector to set up the chargers on innovative revenue sharing models in partnership with the building owners/societies/ estates
Management and Finance	Consumer Awareness & Perception	Government & Private	• Utility, Safety, Range Anxiety, Charging Infrastructure availability, Initial Vs Total Cost of Ownership • Offer Rental options for customers to test the vehicles before they can decide to switch
	High Capital Cost	Government & Private	• With advent of new technologies in power train and batteries along with increase in volume, the cost is likely to come down • Demand side Incentives like Vehicle Subsidy, exemption from Registration and Road Tax, lowered Tax on Sale will help in reduction • Supply side production linked incentives and lower taxes on manufacture of EVs/ Components will help in reduction • Government budget for replacing its own fleets will generate volumes to

Type of Barrier	Barrier	To be addressed by Government/ Private Sector	Strategy/Initiative
			bring down the costs
	Financing Options	Private	• Auto loans, leasing and rental models on convenient terms, affordable interest and availability without credit score subject to due diligence on customers • Financing of EV Fleet Companies offering subscriptions (mobility as a service) and ownership models e.g. Uber, Bolt, etc. • Green financing models from Multilateral and Donor Agencies working in the ESG space to facilitate Electric Vehicle (EV) expansion or setting/expanding infrastructure, battery technologies, IT/IoT innovations,
	Vehicle Servicing	Private	• Engaging existing private players as well as start-ups to ensure timely and convenient servicing
	Trained Manpower	Private	• Tie up with institutions like NAPTIN
	Scarcity of raw material for batteries	Government	• To make available national resources for utilization by Private Sector players • Take up with other countries and join hands for making the battery raw material available
	Quality and reliability of DisCo Electricity supply		• At a transformer and line level, charging station does not impose any burden but if required, timely availability of connection and required capacity of transformer & line; Private DisCos in Nigeria actually gain in terms of adding paying commercial customers. • For big charging stations with multiple types and number of charges, fast and slow, timely connection and network upgrade by DisCos after conducting the required load and demand studies

The table above provides some elements which overlap with two or more components, but we will develop options by component in the following sections.

2.4.4 Main Options for Component 1

The first set of obstacles to overcome is to develop a compatible and consistent legal and economic framework upon which to develop the rollout of e-vehicles.

In the case of Nigeria, its status as a LMIC (weak institutions in part) and its federal structure (establishing and developing compatible policy at federal and state levels) suggest particular challenges, in particular:

- Defining and coordinating roles between federal authorities.
- between federal and state authorities.
- co-ordination with the private sector; and
- developing appropriate incentives for the latter's participation; communication of policies with the population.

The potential options for component 1 (policy) are the outlined dividing them among regulation (phasing out of older vehicles, requiring DisCos to provide a cheaper overnight tariff for e-vehicles charging), taxation (as imposing extra duties on certain imported vehicles), subsidies, investment (including a business-friendly framework).

The policy options below are divided into four key areas viz: Regulation, Taxation, Subsidies and Investment.

2.4.4.1 Regulation

In addition to design and safety regulations, which should be relatively straightforward, a policy framework will need to encourage the acquisition of e-vehicles but simultaneously take steps to remove more polluting vehicles from the road.

Whilst financial regulations are discussed in the next two sections, more direct laws such as phasing out older (more polluting) vehicles could be established, along with more stringent rules for importuning vehicles which do not meet certain standards.

A policy encouraging R&D in the sector by public sector entities such as parastatals and universities, alongside private sector participation should not only improve the adoption of e-vehicles through improved performance but act as a strong signal from government regarding to intentions to actively promote e-mobility.

On the energy side, government can enact laws regarding the provision of charging points in new building developments and adopt a law requiring DisCos to provide a cheaper overnight tariff primarily for use of e-vehicles charging.

2.4.4.2 Taxation

Taxation is an important aspect of policy. Whilst taxation is often a means to raise revenue, imposing a tax can also act as a serious statement of intent by a government to discourage certain actions and may not necessarily gain much net revenue for a government. An example in this case would be imposing extra duties on certain imported vehicles rather than an outright ban (a higher tax may also be more politically palatable than a ban).

2.4.4.3 Subsidy

At present, subsidy policy actively discourages and transition to e-vehicles due to the levels of subsidy provided by petrol. The projected subsidy of NGN 4 trillion[17] for 2022 represents almost 5.5% of Nigeria's entire GDP of 2021[18] (NGN 73 trillion). By contrast, the fossil fuel subsidy for Indonesia represents just 0.5% of the country's GDP.

If an increasing proportion of the fossil fuel subsidy were transferred to the subsidization of electricity (which is zero at present), the fiscal policy would then align more closely with the environmental and energy policies of the government.

2.4.4.4 Investment

The government can develop a business-friendly framework to invest in the e-vehicle sector, including vehicles and components. This framework could include exemptions of standard regulations and taxes which are currently levied on manufacturing investment.

2.4.5 Main Options for Component 2: Urban E-mobility/E-buses

The potential options for component 2 (urban transport in Lagos) including piloting e-buses, first, consult and engage stakeholders, select appropriate routes (as part of a technical feasibility study), ensure that fiscal incentives are in place, design infrastructure in advance, plan effective maintenance, understand e-vehicle market offer to avoid customization, allow new actors and models (such as leasing of buses by energy companies).

[17] *https://www.premiumtimesng.com/news/top-news/524987-world-bank-urges-nigeria-to-rethink-fuel-subsidy-multiple-exchange-rates.html*
[18] *https://nairametrics.com/2022/02/17/nigerias-gdp-grows-by-3-4-in-2021-fastest-rate-in-7-years/*

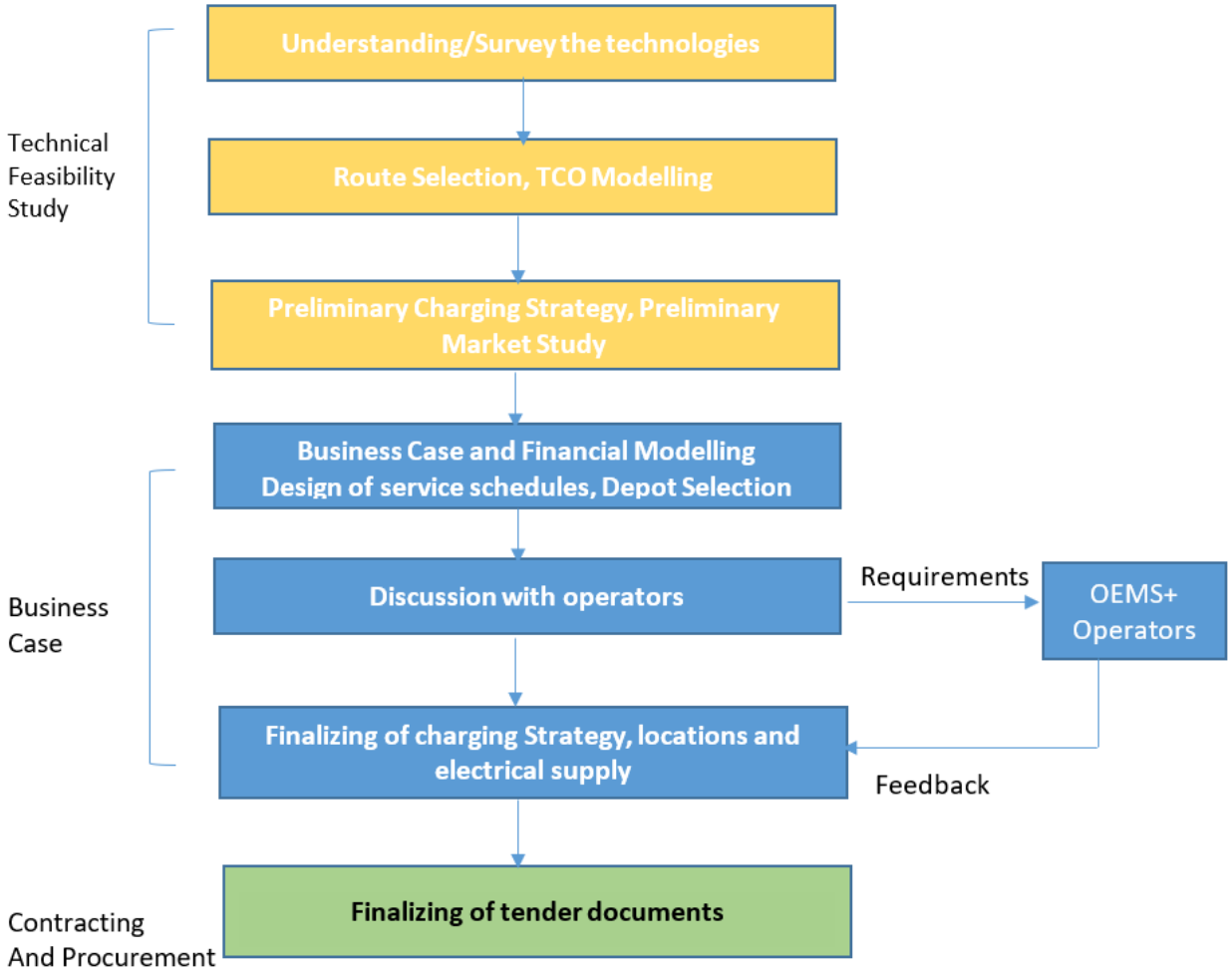

Figure 2-7: Component 2: Approach for E-bus Adoption and Deployment in Lagos
Source: Consultant Team

Energy demand is both a design and an exogenous factor. It is the results of which vehicles are introduced, where and for which uses, and when they are charged. For instance, the choice of e-buses, battery capacity and charging strategy determines the energy demand for the introduction of e-buses. Managed charging (by the charging station (at depot or terminus) may control the demand on the grid. For instance, typically buses charging at a depot are not charged together in the same way but power is distributed over time and buses to avoid exceeding subscribed power. Overnight slow charging as well as mid-day charging options may be optimal.

2.4.6 Main Options for Component 3A Rural Transport

The work potential options for component 3A rural transport noted the trial of rural e2W's undertaken in Nigeria (by MAX) that utilize surplus PV energy from mini grids as a means to power batteries. It remarks that e3W's where average occupancy is higher, and fares can be shared are likely most suited. However, Electricity access in Nigeria is poor and rural areas remain unconnected. Solar Photovoltaic (PV) technologies are a solution and EV charging should complement other uses. Development of PV-based mini-grids could capitalize on the governance framework of REA that has established large number of them.

2.4.7 Main Options for Component 3B University of Abuja Support

The present University of Abuja inter-Campus bus service has insufficient capacity and flexibility to meet current demand. Additionally, there is no service for the teaching hospital (requiring a lengthy walk to the Mini campus to catch a bus), the main drop-off point is inconvenient as it is on Airport Road rather than inside the Main Campus itself, and the trips within Main are satisfactory if leaving the *Keke* terminus but less so if a return journey to the main entrance is needed. Further, serving the Education buildings (Institute and Faculty) is particularly challenging, given their distance from the central area of Main (approximately 3km).

The potential options for component 3B in-campus transport at the University of Abuja were outlined proposing a conceptual network and a phased implementation for the routes, allowing for the testing of e-buses, capitalizing on the new internal road being built, and reorganizing the role of buses and Keke within the campus. OD data that were not available are required to take the conceptual design to a more concrete one with the indication of the frequency/timetable and of the bus size.

Based on data available, conversations with the University's Transport Unit and the development of a new road, currently underway, between the staff hostels (Rafa Pa) and the Senate Building, a system comprising four e-bus lines was put forward:

- Line 1: Teaching Hospital-Mini-Staff Hostels-Management Sciences-New Boys Hostel
- Line 2: Mini-Staff Hostels-Engineering-Arts-Education
- Line 3: Staff Hostels-Management Sciences-Arts-Education
- Line 4: Staff Hostels-Management Sciences-Arts-Staff Hostels

This network will obviate the requirement for significant walking between bus stops and final destinations and significantly improve passenger experience. Lines 3 and 4 should run to a regular timetable (e.g. 2 buses per hour) to improve the variability of waiting times currently incurred by using the *Keke* services for many journeys.

The analysis led to estimating that, for the trial levels of e-bus provision proposed, the demand on energy equates to 6% of the University's daily average energy demand.

Keke demand will decline because of these services but the impact on employment and earnings of these drivers can be mitigated by employing these drivers in the new bus services and by repositioning the *Keke* service into a more modern, 'on demand' service. This new *Keke* service will offer a higher level of service than *Keke* drivers – or indeed, the intra Main bus services – will be able to offer.

The route network should be developed in stages, with the main focus initially on the design of a pilot trial for route nos. 1 and 4. If demand to and from the Education buildings is significant, line 3 could be substituted for line 4. Upon completion of a successful pilot period of one year, the scheme could be expanded to include the procurement of larger (12m) buses for lines 1 and 2. Dimensioning of buses was not possible at this stage due to lack of data on demand of passengers at peak time (origins and destinations). However, those should be sought to determine bus size and frequency at time of final design.

2.4.8 Main Options for Component 4 Private Sector Contribution

The discussion on the options for Component 4 'Private Sector Contribution underlines that there is a strong need to bring in financing structures for the entire value chain including the infrastructure that cannot be addressed using public finances alone and suggests new sources of debt such as bonds (which should be naira denominated) could be used to smoothen the budgetary spending required to get e-vehicles uptake started. The private sector should be engaged to bring in funds for instance by fostering the growth of Consumer Financing for EV loans.
The strategy options should focus on policies that promote EVs, help in setting up infrastructure, incentivize EV manufacturers to produce EVs and encourage end customers to switch to EVs.

2.5 Potential Options for Sustainable Clean Energy E-Mobility Regulatory Framework

This Chapter explores the Potential Options for Sustainable Clean Energy e-Mobility Regulatory Framework. The following sections outline possible support measures for e-mobility development focusing on e-buses and charging systems, e2w and e3w for use in rural areas including charging facilities off the national grid, and to involve the private sector in the development of e-mobility.

Supporting Annexes are presented in **Annex 1** as follows: in Annex 1.6: Power Generation and Demand in Urban Areas of Nigeria, in Annex 1.7: Power for Rural Areas of Nigeria, and in Annex 1.8: details of the Carbon intensity of the existing grid in Nigeria.

2.5.1 Main Options for Component 2

Potential regulatory options to be explored to enable the development of the work under Component 2 should overcome current barriers faced by e-bus development in Lagos and build on the capacity of LAMATA to plan transport infrastructure and services, coordinate its delivery, and engage with stakeholders able to affect projects at different levels.

In particular barriers faced when designing e-buses introduction and possible solutions include:

2.5.1.1 CAPEX of Buses and CAPEX of Chargers

E-buses are known for their affordable Total Costs of Ownership but those refer to the whole lifetime of the assets and leave the operators or the transport authority with the stumbling block of the high initial expenditure for the new buses and for the charging systems. The latter include chargers and systems to control the in the depot or, in case of opportunity charging, at select locations along the lines. Possible solutions that can be explored are:

- Direct financing of CAPEX from donors such as development banks
- Financing of CAPEX from development banks in the form of loans to spread expenditures along the lifetime of the asset and align them with revenues. In this case conditions should be defined.
- Leasing of e-buses and charging systems from specialized operators that may include e-bus manufacturers or power companies. The first solution is applied in India and includes full maintenance, thus dispending the operators from it, which should be an advantage

especially when e-bus uptake is only at the beginning. The second type of solution is applied in Latin America at several locations.

LAMATA should be empowered to either directly negotiate the financing and the implementation of the e-bus programme, with buses remaining in the states' property irrespective of the developments with the operators, or to coordinate the acquisition process to ensure minimum quality standards are met. In either case a capacity building programme as to the contractual options and the lessons learned from the several experiences worldwide would be beneficial to both LAMATA and the operators. The role of LAMATA could include providing model contracts for bus purchase or leasing so that provisions are comprehensive and reflect international experiences and, later, local ones.

2.5.1.2 Vehicle and Equipment Availability

To support introduction of e-buses and charging appliances waiving import duties could be considered as well as linking to the New Automotive Industry Development Plan to develop an e-bus ecosystem in Lagos and providing incentives, as funding tax waivers, for e-bus assembly or production in the country (an example that can be used as a starting point for discussion is the FAME II program of India).

2.5.1.3 Reliability of the Grid

This is a critical issue that could be overcome on the one hand with grid extensions and upgrades. Since this is an on-going effort aimed at satisfying the needs of other services and homes, a parallel strand of work could aim at developing off-grid supply systems able to store energy from PV (at depots) and to supply it reliably at night, in case of buses charged overnight, or at locations along the route (such as end of lines) in case of opportunity charged buses. The general issue of grid reliability is linked to the current problems with malfunctioning of the BRT telematics system (providing information to travelers) due to power interruptions. Competitive bidding to obtain funding/loans for off-grid solutions at end of lines against a performance-based contract could provide for opportunity charging and be set-up, considering also wider uses such as customers near the bus charging location since the system would be provided with storage and would not be used at night. Similarly, funding/loans (for instance part capex funding, part loans) against performance contracts could be set up to involve the private sector in providing off-grid solutions for depots.

2.5.1.4 Standards

E-buses would be imported at the beginning, and batteries will need decommissioning some years after delivery (at present approximately 8 years). Regulations ensuring interoperability of vehicles, chargers and batteries should be put in place as well as regulations on battery decommissioning and related responsibility. Interoperability of vehicles and charges is ensured, in the first instance, by selecting a standard for their interfaces (currently there are three alternative standards for these).

2.5.1.5 Maintenance Capacity and Availability of Parts for Maintenance

Maintenance has been signaled as an issue with current BRT vehicles and may become even more so with e-vehicles whose parts cannot be sourced locally. A training system for technicians, with a set minimum syllabus, could be set up as a foundation course to the training that e-bus manufacturers are typically asked to deliver along with the vehicles. Availability of parts for maintenance could be ensured

with appropriate performance contracts, considering routine and corrective maintenance. As mentioned above model contracts provisions would be beneficial base lines to ensure operators are supported throughout the lifetime of the assets (e-buses, chargers, control systems) and proper functioning is ensured.

2.5.1.6 Battery Decommissioning

A regulation should be put in place generally for e-vehicles and for the whole federal state concerning who is responsible for battery disposal after decommissioning. Manufacturers are setting up their own systems with batteries tested and re-worked for a second life as storage facilities. If storage facilities are set up locally, the regulations should indicate who is responsible for disposing of the batteries and how, with the clear indication of the channels available, unless the manufacturer of the e-vehicles takes full responsibility for withdrawing and disposing correctly of them.

Parallel efforts, concerning public transport as a whole, should improve traffic management and ensure reserved lanes are not used by other vehicles.

In the case of Ibadan, Kano, Kaduna, the path should start with the development of an appropriate legal basis to set-up a transport agency like LAMATA, which would take up the role of public transport planner and regulator. The Kaduna state appears to have such an agency in place although its actual operational capacity should be clarified. Once the planning of the e-buses route(s) becomes defined steps like those outlined for Lagos could be taken to favour the involvement of the private sector, develop local capacity, and ensure performance of the e-bus systems, in coordination with the remainder of the network.

Setting up the agencies should be carried out after a review of roles and scope across existing relevant bureaus and agencies to ensure unique assignment of functions and avoid agencies overruling one another.

2.5.2 Main Options for Component 3

Options for Component 3 Rural Transport could build on the established governance system of the REA and the methods for the implementation of the Rural Development Strategy, which includes support programmes with competitive bidding for financing of off-grid power systems.

Introduction of e-vehicles (2wheelers and 3 wheelers in rural areas) faces issues such as:

- Availability of vehicles
- Electricity access
- CAPEX of off-grid power systems and of vehicles
- Capacity and parts for maintenance

The work in this project reviewed suitable electric vehicles but several could only be sourced abroad. This suggests a twofold strategy, as with the e-buses: on the one hand favoring import of e2w and e2w in the short-medium term (reducing or waiving duties), and on the other hand foster and support local production in the long-term. A useful example for the first type of initiative could be the FAME projects, also in that supported vehicles should be approved (importers would apply for inclusion in a list of supported vehicles, that must satisfy minimum feature requirements). The second stream of work could leverage small local manufacturers since e2w and e3w are much simpler than corresponding ICE models. There could be a program supporting larger companies as long as they build or assemble locally

vehicles complying with minima requirements and on the other hand there could be CAPEX support for small workshops assembling building vehicles. The latter action could be directed to small companies in the rural areas to obtain a network of dealers able to provide parts. REA should be empowered to manage those processes.

The efforts of REA for the development of mini-grids by the private sector in rural areas have led to a large number of them in place and functioning. Regulatory action should include rural e-mobility in that stream of financing. Support could include soft financing for e2w and e3w Including training on maintenance with recognition of trained technicians. Financing type could relate to e-vehicles intended for commercial use (transport of people and goods) with support towards soft loans or lease to own solutions possibly directly via the vehicle leasing company.

An additional stream of dedicated financing CAPEX could target to facilities to provide e-vehicles for rent and battery swapping.

Supply of parts may end-up being an issue and thus limiting the effects of any other support measure in the long term. Supporting local production and workshops as mentioned above is one solution. Another solution would be to have measures towards maintenance and parts availability for dealers/companies bidding for support towards lease-to-own scheme for individuals and small local groups.

2.5.3 Main Options for Component 4

Options for component 4 include involving the private sector in the e-bus deployment as provider of financial solutions, lessor of e-buses and possibly charging equipment, provider of e-buses as a service, developer of PV generation facilities, manufacturer or assembler of buses and chargers, local party specialized in the maintenance of e-buses.

For rural transport, the private sector could be involved as provider of financial solutions for the purchase of e2w and e3w, vendor of e2w and e3w sold with third party financial support, developer of mini or microgrids with facilities for charging and renting or leasing e2w/e3w for commercial use, provider of platforms for rural transport services, local manufacturer of e2w and e3w suitable for rural usage.

Additionally for the wider adoption of electric vehicles (e2w and e3w) the contribution of the private sector could be fostered for Charging infrastructure, grid expansion and energy storage.

Following a preliminary planning of charging infrastructure, the private sector could be invited to provide charging and battery swapping facilities possibly linked to vehicle rental to qualified drivers. Private sector could be interested with special electricity tariffs and soft loans or interest free loans towards CAPEX. When coupled with PV generation and storage the charging station or battery swapping station could be supported with special feed-in tariff with a cap to the energy diverted from EV charging.
Standards for chargers and swappable batteries should be set first.

2.6 Sustainable Energy E-Mobility Strategy Context Review, Needs Assessment and Scoping

This Chapter covers Sustainable Energy E-Mobility Strategy Context Review, Needs Assessment and Scoping and stresses the need for a strategy champion whose role needs to extend to procuring funds, both for the establishment of institutions as well as the implementation of the e-mobility strategy itself.

2.6.1 Sustainable Energy e-Mobility Strategy Context

The context and need assessment for the Clean Energy e-Mobility Strategy will require consideration of multiple factors that could impact uptake of e-Mobility in the urban and rural environments. Financial support will be critical. The preliminary scope for engaging the private sector in the strategy implementation may include the following:

Table 2-7: Potential Scope for involving the Private Sector in E-mobility development in Nigeria

Role	Demand	Supply	Facilitation
Key	• Individual /State Bus Owners • Fleet owners (Cab/Passenger Transport/ logistics)	• OEMs/ EVSE/ Battery Manufacturers/ Suppliers • Service Stations	
Primary	• Real Estate/Landowners • Institutions owners/ Housing societies/ estates	• Charging Infrastructure/ Battery Swapping Players (including engaging the fuel companies to provide for EV charging stations) • DisCo/ RE/ GenCo • EV Ancillary Units	• Funding Institutions/ VC/ PEs • Training Manpower
Secondary	• Mall/ Commercial buildings/ Supermarket/ Stores/ Offices		• MAN • NACCIMA

Source: Consultant Team

2.6.2 E-mobility Strategy Critical Success Factors

Based on our analysis, we are able to provide some limited insight into the factors which are necessary conditions for success in implementing an e-mobility strategy. The three factors below are presented:

1. **E-mobility 'Champion' –** are the people who are able to communicate the strategy downwards through the ranks of stakeholders and have the confidence of people above them. In the case of Pune, the steering group responsible for the strategy includes the Municipal Commissioner, the Chair/Managing Director of the bus company and various senior engineers.
2. **Finance -** The role of champion needs to extend to the availability of procuring funds, both for the establishment of institutions as well as the implementation of the e-mobility strategy itself preferably ring-fenced to ensure that implementation is not disrupted due to a funding shortfall. For example, Pune has a City EV fund under the municipal corporation to financially support the implementation local projects and activities, including potential viability gap funding.
3. **Benchmarking and Targets -** It is extremely difficult to undertake international benchmarking, due to different sets of legislation, government structures, taxation levels, incentives provided for e-vehicles, etc. By undertaking domestic comparisons only, the obstacles listed in this section effectively disappear and comparisons on cost, operational efficiency, etc. are much more meaningful. The targets themselves need to be realistic but challenging and, above all,

developed in co-operation with as wide a range of stakeholders as necessary and reviewed annually to understand the reasons for the underperformance, if any.

2.6.3 Scoping

2.6.3.1 Targeted Demographics for Urban E-mobility in Lagos

The development of E-buses along priority corridors will serve the urban population living within the zone of influence of the BRT routes.

2.6.3.2 Scoping for Urban E-mobility in Lagos: E-buses (Component 2)

The current state of accessibility and mobility in Nigeria is specific to each urban area. Lagos, is the largest metropolitan area in Nigeria and has the most developed public transport system, including an extensive BRT network upon which an E-bus demonstration project can be based.

The ToR refers to the requirement to establish the financial, economic, and environmental costs of the introduction of different types of e-buses and PV-powered charging stations[19] (based on capacity) in Lagos.

It is considered important to outline the basis for the electrification at the outset. A detailed road map for electrification needs to be implemented, ideally at the city level. This road map should consider measures that will help to overcome challenges related to the adoption of E-buses. E-buses are a fast-evolving "technology as compared to Diesel/CNG buses, which directly impacts operational aspects. Both authorities and operators are still in a learning phase and the use of battery buses is a paradigm shift in city bus operations. Any project and phasing structure must take into consideration the technical and operational challenges that come with the introduction of E-buses."[20] The technical feasibility should focus on understanding the technologies and route selection. Business case phase will develop different scenarios and finalize the charging strategies followed by contracting and procurement. "The technology aspects look at the battery technology, charging stations and infrastructure, as well as electrical supply and the grid impact."[21]

Some of the key questions that need to be answered for introducing E-buses into city operations in Lagos pertain to the estimated range of battery, impact of route and operational characteristics on bus energy consumption and the range of E-buses, routes to be electrified first, place and time of charging of E-buses, electrical power consumption and the impact on the grid and existence of support infrastructure required at the depots to support the PV charging of E-buses. Multiple battery sizes ranging from 135 kWh to 324 kWh have been deployed in different cities across the world. The dominant battery chemistry that has been used have been LFP and NMC. The following guidelines should be followed in the E-bus transitioning[22]:

- All routes need to be redesigned taking into consideration, range, charging infrastructure, and space and power availability, etc.

[19] PV power at Bus Termini can be used for buildings and lighting but is usually insufficient in terms of capacity to fuel E-bus chargers.

[20] „Electric Bus Technology and Infrastructure Planning Report", Sept. 2020, GFA/HEAT GmbH, published by C40 Cities Finance Facility and GIZ, p. 62

[21] Dito, p. 16

[22] Based on: „Electric Bus Technology and Infrastructure Planning Report", Sept. 2020, GFA/HEAT GmbH, published by C40 Cities Finance Facility and GIZ, p. 55

- Route specific analysis is required to understand the exact charging strategy and bus battery requirement.
- There are issues related to battery and bus de-gradation. The Lagos government should ensure proper contracting terms and conditions to engage with manufacturers for replacing the buses and batteries.
- A battery replacement clause is a must in the requirement (when battery goes below 80% efficiency) due to issues related to" Battery Degradation.
- The charging infrastructure should be inter-operable. This could pose a problem if there are different variants of buses used in future.
- The bus operator needs to be selected first, so that the charging infrastructure company understands which charger to install.

2.6.3.3 Scoping for Urban E-mobility in Ibadan, Kano and Kaduna (Component 2)

Each urban area is a particular case, with its specific territorial and socioeconomic reality, its specific transport system and subsystems, its institutional and regulatory framework, and with the transformations it is facing – in a controlled manner). Therefore, the order and the degree of priority with which urban E-bus E-mobility recommendations must be applied depend – partially at least – on the situation and the dynamics that are specific to each urban area. Due to unreliable electrical supplies in northern parts of Nigeria, the scope for E-bus demonstration projects may be lower there.

2.6.3.4 Scoping for E-mobility Assistance to the University of Abuja

UoA comprises 1,800 hectares. This size is split between the Main and Mini campuses, which are 22km apart. Initial investigations suggested that the bulk of the area, unsurprisingly, is within the Main campus.

Our research into E-mobility therefore needed to take account of two distinct sets of flows:

- Point to point, between the Main campus entrance and the Mini campus (bus); and
- More personal transport within the Main campus (3W, vans, etc.).

Data provided or sourced by the Consultant's team include a representation of the area, the organisation and pricing of the current services by bus and Keke along with the challenges that arise in the current situation: the limitations and lack of flexibility of the services, the lack of service for the teaching hospital, walking requirement at Main's drop-off point, which is out of the campus, the difficulties with trips within Main and with the return journey. Information a new road currently being built between Rafa Pa (the staff hostels) and Main Campus that will reduce the transport distance between Mini and Main by around 2km.

University of Abuja transport officials advised that at peak periods of the year (such as at Examinations) the volume of passengers would be high, thereby meriting the appraisal of some form of intercampus public Transport (E-bus) system. They also indicated that 2wheelers have been banned from use on campus on safety grounds.

However, the information concerning origin-destination flows at peak times was not available: the network of services can be developed as a concept, but a more precise dimensioning of buses and timetables could not be obtained.

2.6.3.5 Scoping for Rural Transport- E-2W's , E3W's etc.

A beginning has already been made with the launch of 10 electric motorcycles for rural and per-urban communities in Nigeria in April 2022 by the Federal Government, manufactured by MAX Nigeria. The Pilot Project is part of the Nigerian Energy Support Program funded by EU and German Federal Ministry for Economic Cooperation and Development. These motorcycles have been deployed in Gbamu Gbamu mini grid solar community in Ogun State to take care of transport of good and agriculture produce, a critical step for the socio-economic development of rural and peri-urban communities. The project is aimed at showcasing the opportunities for electric mobility synergized with solar mini-grid project and the impact brought to these communities along with benefits cutting across economic and environments aspects for both the community and the mini-grid developers.

MAX tested operation of e2w in rural areas in Gbamu Gbamu, Ogun State with two certified drivers providing transport of people to nearby hubs and markets as well as transport of goods that could fit on a motorcycle. The motorcycles were charged using excess electricity from a minigrid facility.

Currently MAX is moving into EVs along the same lines of business therefore providing vehicles with financing to trained drivers for deliveries and taxi service with motorcycles and e-three wheelers. Max is also planning to provide its own charging points and swapping stations.

2.6.3.6 Scoping for Private Sector Participation

The private sector has a critical role to play in demand creation, supply, and facilitation towards electric mobility in Nigeria and government needs to engage it. The National Automotive Industry Development Plan (NAIDP) to promote local production of vehicles and components should be extended with incentives to the EV sector.

In rural areas the private sector should be engaged to provide the vehicles most suited to the environments (two/three wheelers, minibuses) on financially viable models (ownership/lease/rental finance) along with conveniently accessible charging infrastructure.

2.7 Initial Review of Sustainable Energy and e-Mobility Regulatory Requirements

This Chapter covers the Initial Review of Sustainable Energy and e-Mobility regulatory requirements as well as the organizational structure for the generation, transmission distribution and sale of power, the legislation for renewable energies and the e-mobility regulatory requirements. The research has been expanded and refined in Components 2, 3 and 4.

2.7.1 Organisational Structure for the Generation, Transmission Distribution and Sale of Power

Electric power produced by the generation companies is transmitted to the distribution companies through the transmission network of TCN and delivered to the consumers.

There are four basic power generation options for electrical power generation:[23]

1. Grid-connected: the electricity generated is evacuated on the Transmission Company of Nigeria (TCN) grid.
2. Embedded: electricity that is directly evacuated through a distribution system which is connected to a transmission network operated by a System Operations Licensee.
3. Captive: the generation of off-grid electricity that is entirely consumed by the generator itself and has an installed capacity exceeding 1 MW, with no upper limit.
4. Off-grid (including mini-grids): small scale (up to 1 MW) electricity generation to a single or limited number of customers.

The transmission network is under the control of the government-owned entity TCN. TCN has licenses for the following activities:

- Transmission service provider for the maintenance and operation of the transmission infrastructure
- System operator for system operations and administration of the wholesale electricity market under its functions, and as a market operator.

TCN executes grid connection agreements with generation companies and transmission use of systems agreements with distribution companies.

The electricity distribution is handled by 11 distribution companies. Each distribution company may hold a dual license for distribution and trading; the distribution license entitles it to construct, operate and maintain a distribution network, installation and maintenance of meters, revenue billing, collection, among others.

The following government agencies are involved in the regulation:

- Nigerian Electricity Regulatory Commission (NERC) https://nerc.gov.ng/
- Nigeria Bulk Electricity Trading Company (NBET) https://nbet.com.ng/
- National Environmental Standards and Regulations Enforcement Agency (NESREA) https://www.nesrea.gov.ng/
- Federal Ministry of Power, Works and Housing https://worksandhousing.gov.ng/
- Nigerian Electricity Management Services Authority (NEMSA) https://www.nemsa.gov.ng/
- Energy Commission of Nigeria: https://www.nigatom.org.ng/
- Federal Ministry of Water Resources: https: // wateresources.ng
- Federal Ministry of Environment: https: // ead.gov.ng/
- National Environmental Standards and Regulations Enforcement Agency (NESREA), https://www.nesrea.gov.ng/

NERC as the market regulator has a central role in the overall process through licensing of new companies, authorizing exploitation, giving concessions, and regulating the prices and pricing policies.

The Nigerian Bulk Electricity Trader (NBET) is at a crossroads for the power transactions between Gencos and Discos. Generation companies can sell electricity to the bulk trader, Nigeria Bulk Electricity Trading Company (NBET), distribution companies and eligible customers. For on-grid electric power and ancillary services, NBET enters a power purchase agreement for bulk procurement from the generation companies and resale to the distribution companies through a vesting contract.

[23] *Solar Report Nigeria, Netherlands Enterprise Agency 2021, p. 14*

2.7.2 Policies of Connection of Electricity Generation to the Transmission Grid

Generation companies connect to the transmission grid subject to the Grid Code. The Code contains the day-today management operating procedures and principles governing the development, maintenance and operation of an effective, well-coordinated and economic transmission system for the electricity sector.

2.7.3 Policy or Legislation for Renewable Energies

Renewable energy is derived from natural processes that are regenerative over short periods of time and cannot be depleted. The most common renewable energy resources are biomass, geothermal, hydropower, solar, and wind.

Several policies have been developed over the years which have enhanced government's pursuit of renewable energy as an additional means to solve the electricity challenge the country faces. Some of the policies are:

- Electric Power Sector Reform Act 2005 - the Act provides the legal and regulatory framework for the sector. It is the principal law for the regulation of the sector.
- Roadmap for Power Sector Reform 2013, renewable energy target of 18 % of all electricity generated 2025, and 20 % by 2030 – Share of Solar 500 MW
- National Renewable Energy and Energy Efficiency Policy
- National Renewable Energy Action Plan
- Rural Electrification Strategy and Implementation Plan

2.7.4 E- Mobility Regulatory Requirements

The following regulatory requirements may be characterized and could be put forward for discussion as part of this Component's work:

- Standards for (rural) vehicles, chargers, and batteries to ensure interoperability of charging infrastructure (including communications) and second-hand market for vehicles
- Incentives and tax waivers for imports of e-buses and chargers, e2w, e3w and chargers
- Incentives to foster local production and assembly (subsidies, low-interest or interest-free loans) to increase availability of vehicles and parts
- Set up and endow research programs on e-vehicles suitable for rural areas
- Incentives to exploit PV and storage for bus charging (also by third operators, such as power companies) to obviate issues with grid reliability
- Measures to support purchase for commercial operations in rural areas, to foster uptake of e2w and e3w for transport of people and goods with grants or interest free or soft loans issued directly to the customers or via vendors
- Incentives to couple off-grid PV generation and charging/battery swapping, for both rural areas (in the first instance) and urban areas
- Mandated phased conversion of the bus fleets serving the main axes, especially linked to vehicles' obsolescence, to start the change towards e-buses where transport conditions are better
- Procurement guidelines for bus fleet concerning both vehicles and charging systems

2.8 Distinction between Federal and State Policies

Regulations and policies towards the uptake of e-vehicles may have different scope for several reasons (such as: remit of issuing authority, different relevance of policy to action areas) and must therefore be carefully designed and targeted. This chapter elaborates the point by providing schematics to gauge the appropriate scope of regulations and policies and the rationale for choosing a scope or another. The point is further illustrated by providing examples of policies and regulations pertaining to road transport and energy.

2.8.1 Scope of Regulations and Policies to Control and Favour the Uptake of E-Vehicles

Regulations and policies can be divided into federal and local. The reasons for the different scopes range from remit and appropriateness of the government level issuing them to the relevance of the subject matter, as mentioned in the following tables:

Table 2-8: Scope of Regulations and Instances of Rationale

Scope of regulations	Rationale for scope of regulations
Federal regulations	– Matter in Federal remit (e.g., import regulations, power transmission network) – Need for uniformity across states or internationally (e.g., safety and standards, both to account for best practice and to foster trade) – Need to avoid disparities across states (e.g., limits to age of imported vehicles)
Local regulations	– Matter in local remit (e.g.: establishment of local transport agency, funding of local public transport, local arrangements for electricity distribution) – Matter relevant only locally (e.g., traffic limitations on certain roads, electricity tariffs for public transport e-vehicles)

Table 2-9: Scope of Policies and Instances of Rationale

Scope of policies	Rationale for scope of policies
Federal policies	– Matter in Federal remit (e.g., climate change commitments and actions; overall development of an industrial and research sector, power distribution network planning, main electricity generation planning) – Matter affects the whole nation (e.g., federal transport plan ensuring connectivity between states; funding for projects in rural areas)
Local policies	– Matter relevant only the local area (e.g., metropolitan transport plan, ticketing/integrated ticketing and e-ticketing, fostering of certain power sources like PV with detailed plans and focused funding, training of tricycle operators in accordance with their associations/unions) – Financing is local and should not disperse nor create border effects (e.g. procurement of local transport services, subsidy to certain

	vehicles that would cause export of vehicles to another state or subsidy to a fuel that would attract drivers from an adjacent state)

In some cases, regulations and policies affecting the same items may be both federal and local. Of course, they should not contradict each other. Local regulations may get further in detail whereas local policies may supplement federal ones, for instance on funding local transport where local funding may add to the federal one or complement it (e.g. Federal transport funds go to LRT while the bus systems enjoy local subsidies for vehicles) or on power where federal planning concerns generation and transmission whereas local planning focuses on distribution and certain generation facilities.

2.8.2 Some Examples of Regulations and Appropriate Scope

The general treatment of policies and regulations illustrated in the following section is applied to the case of road transport and of energy in the following Table 8 and Table 9 where examples of regulations and policies, respectively, are placed at the appropriate level in the Nigerian case thus choosing between Federal and local level.

Table 2-10: Example of Regulations and Appropriate Scope

Scope of regulations	Example regulations
Federal regulations	– Road code – Regulations on types of vehicles and their standards – Regulations for battery labelling – Regulations for safe storage, recycling and disposal of batteries and e-waste associated with e-vehicles – Public and occupational health regulations concerning risks and safety measures for professionals maintaining, recycling and disposing of batteries – Insurance requirements – Limits to import of used vehicles, with progress timelines – Maximum age of vehicles for commercial use – Electricity sector codes – Base electricity tariffs – Feed-in regulations and tariffs – Electricity market oversight – Special electricity tariffs for public transport e-vehicles – Fuel emission and fuel efficiency standards for vehicles and generation sets – Air quality standards
Local regulations	– Fares – Licensing of public transport vehicles and operators and enforcement of code of conduct – Ban on certain type of vehicles (e.g., ban on motorcycles taxis) – Transition to EV for certain vehicles with progress timelines (e.g. BRT vehicles, tricycles) going along with financial support and capacity building policies – Reserved roads and reserved lanes or, conversely, ban for certain vehicles on certain roads

Scope of regulations	Example regulations
	– Restrictions on services by certain vehicles (e.g., service only within a certain area of the city) – Design of road space – Usage of spaces on roadsides

Table 2-11: Example of Policies and Appropriate Scope

Scope of policies	Example policies
Federal policies	– Tax waiver for e-vehicle imports – CapEx subsidies and tax cuts for the establishment of national assembly and production of e-vehicles (of certain characteristics) – Generation masterplan – Distribution masterplan – Subsidies for the development of minigrids in areas with no connection to the grid – CapEx subsidies and tax cuts for the establishment of local assembly and production of e-vehicles (of certain characteristics) – Special electricity tariffs for battery swapping facilities or for e-bus charging – Masterplan for deploying EV charging stations along major highways and concession provision
Local policies	– Funding towards the CapEx of public transport vehicles, sometimes meeting only the difference between the price of an ICE bus and that of an e-bus – Development of PV where more efficient – Subsidies towards electricity tariffs for battery swapping facilities or for e-bus charging – Power distribution infrastructure policies guiding development of infrastructure and supply of power to e-mobility charging sites – Urban Master Plans integrating e-mobility infrastructure (power infrastructure and charging spaces) – Uptake of EV in municipal fleets with development of charging stations that can also be (partly) open to the public – Development of air quality monitoring stations and regular reporting to the public on Air Quality Index

2.9 Components C2, C3 and C4: Abstraction of Relevant Policy and Regulatory Summaries

Following submission of the Briefing Paper to the World Bank, the Consultant Team has worked in parallel on all three main components. Summaries of the main policy and regulatory needs are described below, by Component[24].

[24] *As abstracted from the final C2A, C2b, C3A , C3B and C4 reports*

2.9.1 Component 2 Urban E-mobility - Summary of Main Policy and Regulatory Findings

Main policy and regulatory findings resulting from the work in Component 2 on the introduction of e-buses for public transport in Lagos and in the cities of Kano, Kaduna, Ibadan, Abuja are:

- Introduction of e-buses should be facilitated by subsidies and finance solutions that account for the high upfront costs. The financial analysis carried out for the case of Lagos, revealed that e-buses and diesel buses are financially equivalent once costs over their entire operational life are considered. The difference is made by the cash flow and by the high upfront costs of introducing e-buses due to the cost of the vehicles, of the chargers and of the new electric connections and arrangements in depots, including the installation of PV on the depots' roofs. The high upfront cost may be offset either by providing CAPEX subsidies or by having operators to look for financial products able to distribute it over the bus life (leases).
- Import or assemble e-buses at first and aim for local production later. At present e-buses would be most likely imported and so would be parts and chargers. The development of e-buses could be supported by the reduction of upfront costs related to import dues and taxes (that could be waived or reduced). In the longer term, however, policies should include incentives for local production that would shorten supply chains (also concerning parts, that should be sourced locally), and develop skills for e-mobility since at present there is lack of technicians and operators with skills relevant to EVs.
- The energy should come from renewables. The introduction of e-buses needs to be planned in conjunction with the power generation required. This can be sourced partly from PV on depot roofs, but other PV plants should be developed, if the aim of reducing emissions by using e-buses is to be attained.
- The level of involvement of the private sector should be decided at the outset and then operators should be enticed to e-bus transport. There are different roles that the private sector may have to get buses running. It should surely provide the vehicles, but it could also provide operations, or operations and maintenance and the contract provide services could be of the franchise type or a management contract. Which option is best should be clarified by transport agencies considering local experience.
- LAMATA should be in charge in Lagos, and the corresponding agencies in the other cities. Deploying e-bus services will entail a planning and coordination effort that require knowledge and experience, both technical and relational. Stakeholders' involvement during Lagos BRT development has been positive so similar methods should be employed to involve stakeholders for e-bus systems development. It is also important that agencies planning and overseeing the system have capacity to optimize the procurement of the systems (e.g. ability to evaluate supply conditions to issue tenders).
- In Kano, Kaduna, Ibadan transport agencies are at different level of development and authorities are typically taking LAMATA as an example. While they need to develop the same skill that LAMATA is providing in Lagos, their role should also be strengthened in terms of supporting replanning (in Abuja), planning (in Kano) or implementation (in Kaduna and Ibadan) of public transport services, with consistent multimodal plans and the capacity to implement the measures envisaged throughout the years. They should be able to effectively monitor the performance of the parties involved in the delivery of transport services.
- Standards for chargers and vehicles should be introduced, building on international experience and aiming for interoperability and a market of used vehicles. Standards should include connecting components, charging mode, communication between the vehicle and the charging infrastructure.
- Regulations on battery recycling and re-use should be introduced, defining who is responsible for withdrawing decommissioned batteries, and recycling by private sector should be

encouraged. However, for e-buses this should account for the dimension of the battery packs and for the fact that manufacturers are increasingly organizing themselves the withdrawal and reuse of batteries, also due to supply contracts that normally request the replacement of the batteries when they reach a set degradation.

The findings of the work on urban transport also underlined the need for linked measures targeting all vehicles and aiming at emission and pollution reduction such as:

- Compulsory phasing out of vehicles beyond a certain age.
- Reducing imports by increasing import duty on second-hand cars and motorcycles.
- Phased prohibition of import of second-hand petrol/diesel vehicles and permission to import EVs.
- Incentivize home charging by considering personal vehicle charging at domestic tariff.
- Compulsory provisioning of chargers in all group housing and estates.
- Compulsory provisioning of charging in all new residential/commercial building.
- Engaging Private Sector to set up the chargers on innovative revenue sharing models in partnership with the building owners/societies/ estates.
- Government budget for replacing its own fleets will generate volumes to bring down the costs.
- Auto loans, leasing and rental models on convenient terms, affordable interest, and availability without credit score subject to due diligence on customers.

The framework includes all the critical steps in needed for the deployment of e-buses

- Type of battery charging system based on the requirement of Transit agencies. This may include decision among mix of fast charging, opportunity charging, battery swapping, flash charging technology.
- Assessment on the energy requirements based on the number of buses being charged and locations for charging stations
- Extent of grid impact assessment for various charging scenarios
- Route network and operations planning in tandem with selected e-bus technology and its operating range.
- Connected loads needs at different locations and preparations for acquisition of the same
- Maintenance practices and crew scheduling

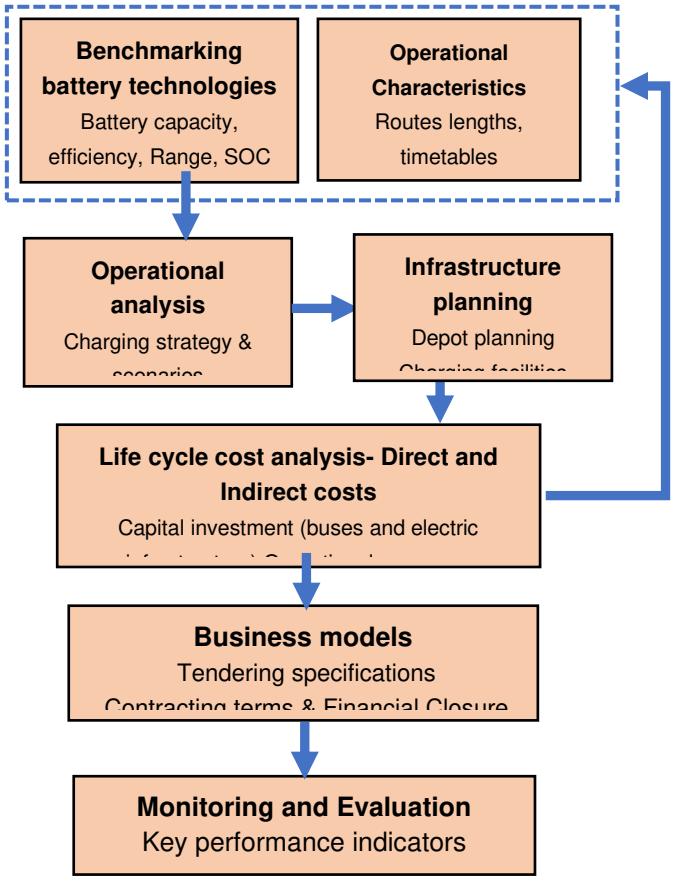

Figure 2-8: Framework for the Analysis for E-Bus Adoption and Deployment in Nigeria
Source: Consultant Team

2.9.2 Component 3 Rural E-mobility - Summary of Main Policy and Regulatory Findings

Main policy and regulatory findings from the work in Component 3 on rural e-mobility are:

- e-mobility should be introduced and trialed along with wider rural energy project like minigrids. Introduction of e2w and e3w in rural areas should therefore be connected to the efforts supported by the Rural Electrification Agency (REA) to have mini-grids built and in operation. Trials of e2w and e3w should be conducted in selected RAAMP areas.
- Promotion of minigrids in connections to EV charging facilities should be coordinated to obtain a network of charging points sufficient to enable people with EV in rural areas to move freely and have no issues with vehicles' ranges.
- Electric network reinforcement planning should account for EV charging stations and promotion of off-grid power solutions in connection with EV would serve the purpose of tackling the added loads that EVs would bring to the electric grid. This would lead to improved reliability of power and therefore to an element required by moto-taxi and tricycle drivers to switch to using EVs.
- EV facility and services deployment (charging, renting, leasing) along with mini-grid development would help achieving the power demand to obtain mini-grid profitability as well as providing a pre-condition to the advancement of the EV transport market.
- Special electricity tariffs for EV charging should be considered after discussion with the DisCo and the Regulator; the tariff could either be subsidized or cost reflective for the DisCo thereby

helping in bringing down the high technical and commercial losses and thereby improve their financial sustainability through assured collection from the charging stations.

- Imports and local sourcing of EVs should be pursued. Some or most e-vehicles could only be sourced abroad, at least in the short term. Policies should therefore favour import of e2w and e2w in the short-medium term (reducing or waiving duties), while fostering local assembly and production, to be attained in the longer term. Local assembly and production facilities will provide jobs and skilled labour (since skill to work on EVs are different than many of those relevant to ICE vehicles) as well as short value chains and, as part of them, ready availability of parts.
- Standards for (rural) vehicles, chargers, and batteries to ensure interoperability of charging infrastructure (including communications) and second-hand market for vehicles. Swappable battery standardization would allow the introduction of vehicles with swappable batteries that could be rented at charging kiosks.
- Battery regulations are required also to govern recycling and disposal. Regulations should be established for e-vehicles and batteries and for the whole federal state concerning who may re-purpose batteries and who is responsible for battery disposal after decommissioning and under which conditions they may be repurposed for stationary storage. Recently vehicle manufacturers are developing systems to withdraw decommissioned batteries, and regulations should account for the likely difficulty of tracking batteries at end of life in rural areas. Incentives for battery second life as storage, to support the grid and re-use batteries.
- Need of adequate and affordable financing for the entire value chain, including charging infrastructures, that cannot be addressed only as public expenditures. Financing could include:
    - Soft financing or lease to own solutions for e2w and e3w for commercial use, directly to the customers or via vendors.
    - Contributions towards CAPEX of facilities providing battery swapping and e-vehicles for rent.

  While the Federal Government's N200 Billion Vehicle Financing Scheme would help, the market needs financially sustainable models, both for the providers and the customers. Several banks (including microfinance) and start-ups provide auto loans. However, in general, there is a need to address the limitations due to tough credit criteria, high interest rates, cumbersome paperwork, collateral requirement (in case of microfinance banks).
- Provision of public transport at the University of Abuja (and other with similar transport requirements) could involve the private sector. Services could be franchised to private operators with the university retaining a monitoring role covering revenue, operating costs and operational performance. The private sector could provide transport services at the University of Abuja with the incorporation of Keke drivers into a co-operative or a more traditional sort of firm with the university retaining a safety regulator role.
- Promotion of a start-up system to bring in innovative EV ideas including financing solutions
- Set up and endow research programs on e-vehicles suitable for rural areas
- Policies, incentives and funding should target the engagement the private sector for:
    - Development of mini or microgrids with facilities for charging and renting or leasing e2w/e3w or batteries for commercial use
    - Charging infrastructure, grid expansion and energy storage
    - Manufacturing e2w and e3w suitable for rural usage (including R&D, assembly units, battery, chargers, capacity building services for training local manpower, other component & ancillary manufacturers)
    - As vendor of e2w and e3w sold with or without third party financial support
    - As provider of financial solutions for the purchase of e2w and e3w as a bank, non-banking finance company or Fintech start-up
    - As provider of platforms for rural transport services
    - As provider of ride hailing/sharing through smartphones for passengers and goods

- As provider of timely and convenient after sales repair and maintenance services
- As Venture Capitalist and/or Private Equity Player to support manufacturing, sales & distribution, financial services or platform service providers
- Fintech Start-ups for loan/lease to customers
- Auto loans, leasing and rental models on convenient terms, affordable interest and availability without credit score subject to due diligence on customers
- Financing of EV Fleet Companies offering subscriptions (mobility as a service) and ownership models e.g. Uber, Bolt, etc.

2.9.3 Component 4: Private Sector Involvement - Summary of Main Policy and Regulatory Findings

Main policy and regulatory findings about the involvement of the private sector in EV development in Nigeria resulting from the work in Component 4 are:

- Planning of public transport and choice of incentives should take in due account density of population in rural areas or patterns flows of people in urban areas to ensure financial viability and bankability of projects.
- Business cases for e-bus introduction should be realistic and carefully discussed to avoid deploying them when conditions are unsuitable as it has been the case for conventional buses in Abuja where financial issues of the state-owned operator are due to regulated fares which are insufficient to provide an adequate return for the operator and do not apply to all parties, to obstacles accessing foreign exchange, spare parts, insufficient technical maintenance capability; poor enforcement of licensing regulations for non-mainstream operators.
- Ways to have the private sector perform as expected should be in place. Whilst the current LAMATA franchise model is functioning, it cannot be described as efficient. Data provided by LAMATA show that less than 50% of the bus fleet on BRT routes 1 and 2 is operational and average waiting time on route 1 is more than double the programmed 15-minute headway. This is a serious concern because if an operator is unable to maintain a fleet for whatever reason including access to foreign exchange, lack of maintenance skills, etc., the introduction of e-buses will be an expensive failure.
- It should be expected that most e-vehicles in the early stages of EV development would be imported since there is only one local e2w manufacturer that achieved some scale, and the local Hyundai plant is able to manufacture e-cars but there is no local production of e3w and e-buses. Before an industry may be developed locally with targeted incentives, it should be expected that imports of e2w, e3w and e-buses would come from India and China.
- Procurement options for e-buses depend on the taxation regime. A determinant of whether outright sales or leasing is a better option will also depend on the taxation regime and whether one option provides significantly better tax benefits.
- The Rural Electrification Agency is looking to establish 10,000 mini grids but public funds may not suffice. The private sector could step in and operate sustainable mini grids by combining different products and services for the end customers. One of the ways to increase the utilization factor of such mini grids will be to supply to charging stations, by optimizing size and demand of the energy station, excess energy being used for charging EVs.
- Off-grid and Mini-grid operators should be encouraged to consider business models to set-up battery swapping and vehicle charging stations that would enable them to utilize their spare PV power from their existing capacity
- Electricity for EV charging should be supplied (by the DisCo or Private Merchant Plants) on special electricity tariff that are either subsided or cost reflective; the DisCo gets the opportunity

to change its customer mix and improves revenue collection thereby reducing the high technical and commercial losses and in turns its financial sustainability.

- Models of PPP schemes should be explored for charging stations and public transport.
- To attract foreign investors, it is crucial to have monetary and fiscal policies that stabilise the economy and provide them with assurance on prospects beyond the short term. This is particularly pertinent given the recent collapse of the Naira. A further issue needing sorting in this respect is the high costs and bureaucratic end finance market.
- A quality business environment would also require a greater implementation of processes online, such as greater use of digital signatures and full adoption of the Corporate Affairs Commission online platform and more extensive use by federal and state tax authorities of an online system.
- Need for simpler and faster procedures to obtain electricity supply connections. Nigeria performs particularly poorly in the number of procedures required to acquire a supply of electricity (seven) and it takes on average 110 days for supply to start after initial application. This is a one-off problem and cost, however, and should not be a particular impediment for a business establishing itself in Nigeria.
- Enhanced electricity generation capacity and improved electricity distribution network. Electricity supply is limited and there would be the dilemma of whether to priorities essential services or EVs. Power supply is irregular also for SMEs whereas reliable electricity supply is a precondition for business set-up and for EV deployment. The current government policy to establish Independent Power Plants (IPP) under PPPs should be further pursued but with increased efficacy unlike the multi-billion-naira Independent Power Plant (IPP) project in Kano State, which was scheduled to be commissioned in October 2020 is still incomplete after a nine-year project. Additionally, the distribution network is dilapidated and needs major investments to increase its capacity and reliability.
- Strongly improved reliability of electricity supply. Reliability of electricity supply is weak in comparison to some of Nigeria's neighbors. This is a serious concern for new and established businesses in the country.
- Simpler cross-border trade procedures. The ability to trade finished goods across borders without burdensome customs and excise procedures increases the market potential of an investment and consequently reduces risk.
- The existing National Automotive Industry Development Plan (NAIDP) should further include EV establishment and production considering particularly e-vehicles for rural use and e-buses. The NAIDP including EVs would help in the smooth transition to EV along with targets, regulations, guidelines, standards.
- Short- and medium-term fiscal support to the EV is required also to enable Nigerian entrepreneurs and start-ups to introduce innovative business models for charging infrastructure like in other countries.
- Supportive policies to foster local production of EVs could target e2w and e3w by small local manufacturers since they are relatively simpler to make than larger vehicles. Incentives could tackle CAPEX for small workshops assembling or building vehicles. Incentives for larger companies to assemble vehicles should have as requirement the use of at least a set fraction of locally produced parts.
- Demand side incentives for EVs like vehicle subsidy, exemption from registration and road tax, lowered tax on sale will help in reduction of costs linked to those vehicles and thus support uptake.
- A regulatory/promotional policy should be established to encourage battery recycling by the private sector.

2.10 Component 1 Framework and Development of Templates

This Chapter underscores how important it is to develop a National Electromobility Strategy that will roadmap to achieve electrification targets. Supporting policies by federal and state governments are then discussed with a detail of the government intervention for facilitating domestic production of EVs. The Federal regulatory framework is discussed mostly in its enabling role, especially as concerns urban buses, and to provide a strategic consistency to urban and rural action, with direct effect on the latter. State policy and regulatory framework are considered in terms of direct action on the transport system. The latter is discussed with reference to the Lagos state since role and competencies of state, local governments and their agencies are not always as clear cut elsewhere. However, regulatory frameworks developed for Lagos can be adapted by other cities.

2.10.1 Supporting Policies

Policies could include:

- economic stimulus for uptake for public transport
- economic stimulus for local production
- economic support for local research
- standards for charging stations (safety, plugs/interfaces)
- regulations about (li-ion) battery handling and disposal

Economic elements mentioned above can be deployed at state level (for instance: public transport may be of interest to some states only).

It is very important to develop a National Electromobility Strategy. The National Electromobility Strategy will offer a roadmap to achieve electrification targets through the following:

- Establishing the necessary regulations and standardization requirements of components that favour an efficient development of electromobility from the energy, environmental and mobility points of view
- Promoting the deployment of electric vehicles in the public transport system of the different cities of the country
- Supporting the research and development of electromobility and enhancing the formation of human capital
- Promoting the development of electromobility, generating new balances that allow the market to support itself
- Generating spaces for knowledge transfer and dissemination of information necessary for different actors to make decisions optimal with respect to electromobility

2.10.2 Potential Government Interventions

Government interventions could:

- Facilitate imports (short-medium term), this refers to both vehicles and chargers/related equipment. Waivers of taxes and duties would at the same time facilitate uptake of e-buses for urban transport (lowering CAPEX) and ease the financial burden on rural dwellers (for instance in case of lease to own arrangements or if the lower CAPEX is reflected in the tariffs to rent e2w or e3w by the day)
- Facilitate growth of local expertise and production (short to long term). Local expertise should grow in terms of

- technicians able to work/maintain vehicles (but this is linked to supply of vehicles and training by manufacturers)
- development of capacity for instance with university research staff and programmes possibly linked to setting up local manufacture of e-vehicles and parts.

2.10.3 Potential Federal and State Interventions to Facilitate Local EV Production

Facilitating local production could foresee:

- creating conditions to have plants of international companies in Nigeria (as it was before several disengaged in the past decades and as foreseen by the national automotive policy) for domestic sales and for regional exports; possible tax waivers or financial support should be linked to sourcing at last a set fraction of parts locally (as with the FAME programme in India)

- creating conditions for local entrepreneurs to set up manufacturing of e-vehicles. This could start with simpler vehicles (to build expertise) for local use such as e2w and e3w. If those are locally manufactured purchase costs should be lower than those of imports therefore resulting in increased affordability, and parts would not have to be imported. In the long term there could be a strategy to export vehicles, for instance, in the region. This is consistent with the automotive policy being discussed at government level.

- Set regulations (technical and safety standards) both for domestic use and interoperability and to ensure that local production is aligned with international standards and enable exports. Nigeria should introduce regulations on chargers and vehicles on the one hand to provide minimum safety standards and on the other to ensure that all vehicles can be charged at all locations (this is also a requirement for widening the choice of e-buses and for ensuring sustained use of e2w and e3w, without ‘artificial hurdles’ due to standards linked to vendor choices). Alignment with international regulations would ensure that imports (and later exports) can be used ‘off the shelf’.

2.10.4 Outline Road Map for E-mobility in Nigeria

The Road Map forms a key element of the Final Report. It is to be complied from the outputs from each of Components 2, 3 and 4. An example is provided in the figure below with reference to the introduction of e-buses in Lagos and the concurrent key policy actions to enable it at Federal level.

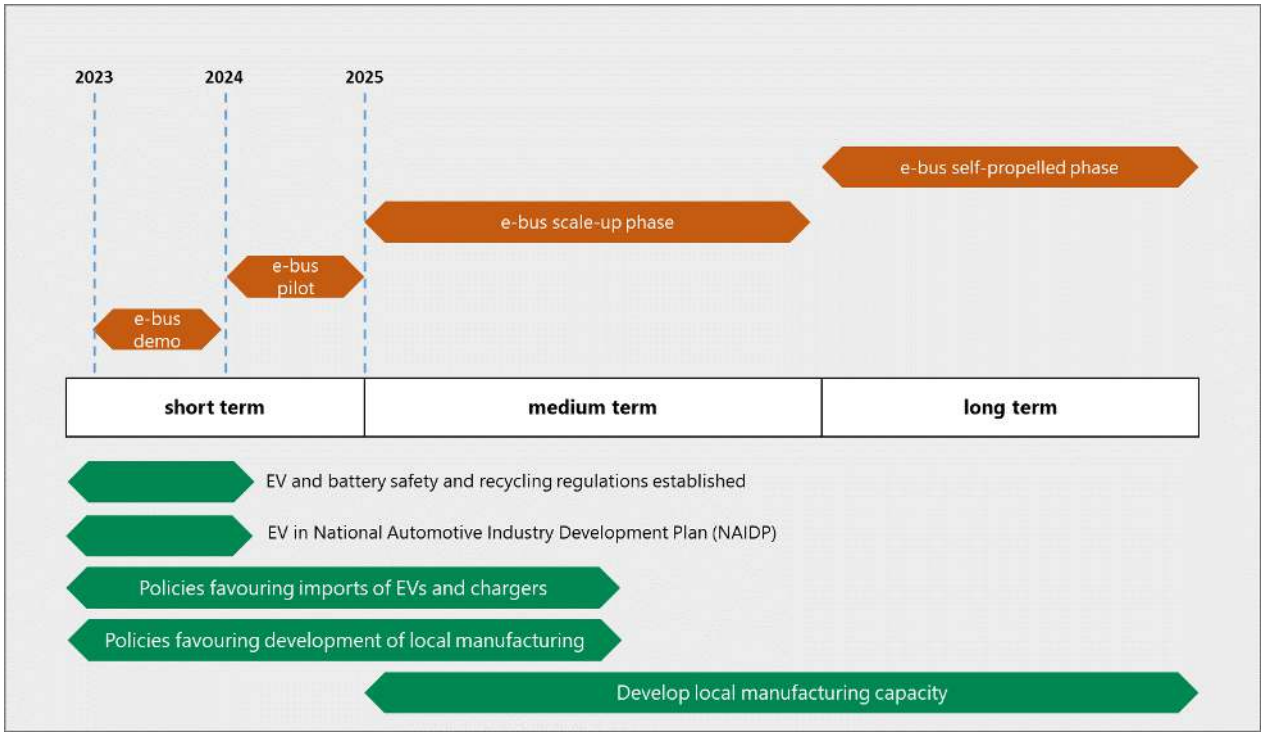

Figure 2-9: Example: Roadmap for Electrification of E-Buses In Lagos with Policies Benefitting E-Mobility also in other Sectors

Source: Consultant Team

The need for National Electromobility Strategy can be underscored considering that e-mobility is still evolving and so are availability of vehicles as well as locations of regional manufacturing centres. Additionally, e-mobility has effects across sectors, for instance in terms of power sourcing and usage (both delicate items, especially in Nigeria). Policy is required on the one hand to ensure consistency between power uses and availability, for instance leveraging on e-mobility charging to reduce overall costs of minigrids at rural locations, and on the other hand to coordinate industry efforts and see which role Nigeria could have in the medium term: for instance, importer and user, importer/manufacturer and user, importer/manufacturer and user/exporter.

Policy coordination is crucial with chargers that are a key element of uptake and could make the difference in uptake of e3w in urban settings (assuming they are charged at public chargers).

2.10.4.1 Stakeholder Workshops and Meetings

Presentations were prepared to present and discuss the strategy options and potential sustainable e-Mobility strategy, and potential regulatory regimes with selected key stakeholders. A series of phased Stakeholder Workshops/Meetings was held, in August and September 2022:

1. REA_UoA_RAAMP Workshop – 12th August 2022
2. LAMATA Workshop – 15th August 2022
3. C4 Private Sector Engagement – 15th September 2022

The workshop dedicated to the Rural Electrification Agency (REA) and the University of Abuja (UoA) was attended by participants form both institutions and from the World Bank. The main purpose was to

communicate the results of the studies concerning the introduction and use of electric vehicles in rural areas –and the potential role of REA to support off-grid facilities for EV charging- and the novel transport arrangements at the UoA using electric buses and electric tricycles. The workshop included discussion of rural mobility gaps, electricity access and requirements for electric vehicles, benefits and challenges of Okada (e-moto-taxis) and Keke (e-three wheelers) in rural areas. The discussion then focused on making the case for linking RAAMP (Rural Access and Agricultural Marketing Project) and RAMP II actions as well as building on the governance system of REA (Rural Electrification Agency) to develop e-mobility in Nigerian rural areas. The second part of the workshop concerned the re-organisation of public transport at the University of Abuja and the establishment of services run with electric vehicles, e-buses in particular. Preliminary figures were discussed followed by an indication of the steps better suited to move beyond a conceptual plan, stressing the importance of carrying out an origin destination survey.

The workshop on 15 August 2022 dedicated to e-buses and public transport in Lagos was attended by many experts of LAMATA and the MoT who discussed in detail with the Consultant's staff the several results obtained during the technical work and summarized in the C2 report. The content of the workshop ranged from providing an environmental assessment of the situation and issues in Lagos that warrants actions such as the introduction of the e-buses, to providing a technical feasibility assessment of their introduction, down to the detail of the early-analysis on the suitability of e-buses of different make for different routes. The workshop attendees were also introduced to the functioning and the results of the financial model developed to analyze and contrast ICE and electric buses in Lagos. Finally, they discussed the steps of a road map to introduce e-buses in the mega-city.

The final workshop was about the Private Sector Engagement in the deployment of e-mobility in Nigeria and was aimed at potential financing institutions. The leading content of the discussion were the results of the study carried out in C4 of this project. The presentation summarized those results looking at the current situation with mobility potential in cities and rural areas of Nigeria, the risks and obstacles as well as best practice to manage then such as the experience of MAX with motorcycles in a rural area powered off a mini grid. The private sector business models looking in detail at e-vehicles manufacturing, procurement and operations, considering separately the urban case, focused on e-buses, and the rural case where the issues of demand and affordability need to be tackled. Further, the consultant went on to discuss the incentives to entice the private sector in EV development in Nigeria and the needs related to the wider ease of doing business in the Country.

2.11 Development of Federal and State Templates for Urban E-mobility (E-buses)

At the present stage the most promising application of e-vehicles is with e-buses, particularly in Lagos where the presence of the BRT and, especially, the organisational set-up are at a stage that can actually be conducive for e-bus deployment. As recalled in the review of EV applications in LMIC, larger vehicles, notably e-buses, generally have larger chances of successful implementation.

Development of state templates for rural e-mobility is, instead, premature since important trials need to be prepared first and E2Ws, even though trialed in Nigeria, may not be recommended in rural areas where e3w seem to be more suitable. E2W could instead be of use in peri-urban areas. Given this situation the development of templates for rural e-mobility is left for later stage of EV uptake in Nigeria. However, the key conceptual points to develop are similar to those for urban mobility. This means there needs to be a vision underpinning the strategy and there must be objectives and targets than are best

coupled with objectives and targets of REA's rural electrification and of RAAMP II on rural accessibility so that the three streams of action complement one another.

2.11.1 Federal Template for Urban Emobility (E-buses)

The federal template for e-buses should consider an overarching vision for e-bus deployment in Nigeria, a set of objectives and targets and a set of actions each with owners and budget. Given the role of the Federal government and considering that the most likely first implementation of e-buses will be in Lagos, a federal template should on the one hand include enabling policies and regulations and on the other hand be refined once the Lagos' demonstration and pilot are finalized.

As in the case of Lagos, illustrated in the following section, the vision for the federal strategy template should not be developed in isolation and could appropriately link to other policies such as those on climate change and energy.

The following discussion is intended as a template therefore it suggests elements of a strategy enactment, but it is intentionally not exhaustive. An exhaustive strategy would require linking fully to other relevant policies and reach agreement at government level.

Objectives and targets may be divided in chapters such as:

- Tax and finances
- Power infrastructure and services
- Technical regulations
- Environmental and climate change regulations

Tax and finances objectives and targets could include the following:

- Revise import dues and taxation of EVs and equipment
  - Target: regulation in place
- Incentivize local production of EVs and parts
  - Target: inclusion of e-buses and e-rural transport vehicles in the National Automotive Industry Development Plan (NAIDP)
  - Target: incentives and subsidies towards CAPEX in place

Power infrastructure and services objectives and targets could include the following:

- Support development of rural power infrastructure along with EV charging/swappable battery charging
  - Target: incentives and governance to administer them in place (preferably as extension of REA remit)
- Discuss with DisCos and develop special electricity tariffs for EV charging
  - Target: overall agreement reached and tariffs for EV in place

Technical regulations objectives and targets could include the following:

- Provide battery usage and disposal regulations aligned with international best practice
  - Target: draft regulation drawing from international experience
  - Target: stakeholders' involvement and discussion of realistic role of the private sector
  - Target: regulations in place
- Provide standards to ensure interoperability and used-vehicles market
  - Target: review and weighting of options to maximize interoperability
  - Target: standards in place

Environmental and climate change regulations objectives and targets could include the following:

- Establish a regulation to enhance the climate change and environmental performance of road vehicles, that calls for appropriate maintenance and environmental standards (e.g. minimum standards for ICE vehicles, phasing out of more polluting vehicles))
  - Target: regulation in place

2.11.2 State Template for Urban Emobility (E-buses)

A template for the strategy for e-buses' introduction is developed in this section considering that deployment of e-bus systems is a means to an end rather than a goal by itself. The end is manyfold since the introduction of e-buses in Lagos contributes to:

- The improvement of the public transport system and therefore of the mobility of Lagosians
- The energy policy aiming at extending energy supply and making it more reliable
- The climate change strategy of Lagos State
- The improved air quality in Lagos

The e-bus strategy will therefore need to tie in with those related strategies since it contributes to their goals and, at the same time, depends on those. For instance, success of e-buses will depend on the availability of energy and on their integration in a functioning public transport system.

2.11.2.1 A Vision For the E-Bus Strategy for Lagos

A vision is normally set as an overarching guiding element when elaborating a strategy. It is also a non-technical way to share the end result sought with the strategy across stakeholders. In the present case the scope is narrower since the vision would refer to a specific action, the deployment of e-buses, that is encased and functional to the wider policies recalled in the introduction. Additionally, a phasing plan for e-buses in Lagos has been introduced because of Component 2. However, having an overarching statement of the arrival points remains useful and the vision therefore links wider objectives and the phasing plan, recalling them. A possible vision -provided by way of example- could be *e-buses integrate into Lagos BRT and are used on all suitable lines contributing to improved mobility for the people of Lagos and enhancing energy safety, environmental and climate change situation by being powered only by renewables*.

Such a sketch vision would be consistent with the Nationally Determined Contributions submitted to the United Nations Framework Convention on Climate Change by Nigeria in 2021 (see 2.2.1.2.3) that comprise actions such as:

- 100,000 extra buses by 2030
- BRT accounting for over 22% of pax-km by 2030

Also, the Lagos five-year climate action plan 2020-2025 (see 2.2.1.2.3) aims for zero carbon in 2050 achieved with the expansion of the BRT network and the uptake of low emission vehicles among many other measures.

Further that vision is coherent with the Strategic Transport Master Plan for the Lagos Mega City Region of 2014 (see 2.2.3.3) that includes a Climate Change Plan aiming to mitigate climate change effects

with the reduction of GHG emissions by 45% at the 2030 horizon and further reduction to 2052 due to implementation of effective public transport and progress in technologies.

The example vision indicated above is also consistent with the Draft transport policy document of 2019 by the Lagos State Ministry of Transport that recommends for the short-term to identify e-bus corridors where new e-buses should be introduced and agree with operators a timetable for their introduction and the construction of depot and roadside facilities as well as vehicle maintenance operations and standards. In fact, the same document recommends adopting in the short-term electric vehicles on BRT Corridors where suited (see 2.2.3.3). Additionally, the introduction of e-buses fits with the actions guided by the bus reform initiative that requires the completion of BRT corridors, bus shelters, depots, and road junctions (see 2.2.3.3).

Relying on renewables is consistent with the Lagos state Electric Policy that advocates the importance of off-grid solutions and the Lagos state Off-Grid Electrification Strategy and Action Plan issued in 2022 that, though not available at the time of writing, focuses on off-grid solar.

2.11.2.2 Objectives and Targets the E-Bus Strategy for Lagos

Objectives and targets descend from the vision but get into the details of the streams of work to attain it that are further detailed later by specific actions. Since a phasing plan is already established, the targets may concern the conditions to start the phases and the results that are sought from the phases. An exhaustive strategy would also require involvement in its discussion of the decision levels of all parties concerned.

Objectives and targets may be divided in chapters such as:

- Finance and governance
- Power infrastructure and services
- Transport infrastructure and services
- Technical regulations
- Environmental and climate change regulations
- Coordination

Finance and governance objectives and targets could include the following:

- Before phase 1 (before trial phase begins):
  - source funding for trial e-buses, depot equipment[25] and operations[26]
    - target: funding obtained and channeled to e-buses and equipment purchase and installation
- During phase 1 and before phase 2:
  - clarify and, if necessary, amend tax situation affecting choice of bus financing (leasing vs purchase)[27]
    - target: clear tax situation supporting e-bus adoption
  - Clarify how to involve private operators and the most suitable form of PPP[28]
    - target: definition of set-up(s) for the involvement of private operators
  - source funding for pilot e-buses, depot equipment and operation
    - target: funding secured

[25] This would include anything required to equip the depot as a charging station, including a grid connection and/or a PV installation
[26] This may involve policy and regulatory action in terms of import dues and tax waivers as well as CAPEX subsidies
[27] This may be in the remit of the federal government
[28] This may entail the introduction of new types of operators such as the utilities that, in Latin America, successfully expanded their role and act as lessors of chargers and e-buses to operators. It may therefore involve action from the Federal government

- During phase 2 and before phase 3:
  - Update costs and revenues in actual e-bus operations to refine further financial evaluation
    - target updated financial plan and understanding of actions it requires, and of the outlook it provides in terms of financing requirement or self-sufficiency of operations
  - Revise, if the necessary, the form of the private sector involvement
    - Target: confirm or amend the form of private sector involvement. If amendments are required, clarify which they should be, and which is a realistic path (actions, sequence and times) to amend the arrangements
  - Source funding for the next phase
    - Target: funding secured

Power infrastructure and services objectives and targets could include the following:

- Before phase 1 (before the demonstration phase begins):
  - Provide reliable power from renewables to charge e-buses at the depot location[29]
    - Target: connection to suitable renewable power source up and running (this may also be PV on depot roof) with maintenance arrangements in place
  - Ensure a safe working environment for all involved with e-buses
    - Target: depot staff and technicians as well as drivers pass relevant safety training (this target may be achieved only with electric equipment in place and trial e-buses delivered)[30]
- During phase 1 and before phase 2:
  - Provide reliable power from renewables to charge e-buses at the depot location
    - Target: 99% days of availability of power
    - Target: a minimum of 20% depot power sourced from renewable energy sources (tbc)
    - Target: maintenance team at work within 30 mins of alert
  - Provide reliable power from renewables to charge e-buses at all depot locations selected for the next phase
    - Target: connections to suitable renewable power source up and running with maintenance arrangements in place
  - Improve system understanding and operations
    - Target: data on electrical operation of buses/batteries and equipment collected in view of better understanding of design and maintenance parameters
- During phase 2 and before phase 3:

  Objectives and targets like those of the previous phase but larger in scope

Transport infrastructure and services objectives and targets could include the following:

- Before phase 1 (before trial phase begins):
  - Identify line, operator, and depot for trail and agree trail operations details
    - Target: operational arrangements finalized
  - Design e-bus system
    - Target: Requirements for sourcing buses and charging equipment finalized: e.g. technical requirements of e-buses ranging from seating capacity to minimum range and charging mode and standard; technical requirements of chargers and management system
  - Source e-bus system and training/maintenance

[29] This may require involvement of the regulator and the DisCo to obtain tariff targeted to e-bus charging.

[30] Public and occupational health regulations concerning risks and safety measures for professionals maintaining, recycling and disposing of e-vehicle batteries should be in the federal government remit, therefore action from the federal level is required as a prerequisite.

        - Target: tender/acquisition program for buses and chargers launched and completed with award to successful bidder/agreement to supply pilot buses and chargers
    - Deliver and install e-bus system and deliver training/maintenance
        - Target: tender/acquisition program for buses and chargers launched and completed with award to successful bidder/agreement to supply pilot buses and chargers as well as training/maintenance
        - Target: installation and successful test of chargers in depot, delivery and successful test of e-buses in depot, delivery of training, maintenance arrangements operational.
    - Design and implement required road schemes
        - Target: road schemes (e.g. traffic lights, reserved lanes, reorganization of use of road space by non-transport activities) designed and communicated to local communities
        - Target: road schemes (e.g. traffic lights, reserved lanes, reorganization of use of road space by non-transport activities) implemented
- During phase 1 and before phase 2:
    - Ensure availability of e-bus systems
        - Target: minimum availability of e-buses 95%[31]
        - Target: minimum availability of charging systems 98%
        - Target: maintenance team at work within 15 mins of alert
    - Improve system understanding and operations
        - Target: data on e-buses' performance, consumption, faults, and operations collected throughout the trial phase and analyzed. Lessons learnt accounted for in operations' practice.
        - Target: data on drivers and technicians feedback collected and analyzed Lessons learnt accounted for in operations' practice.
        - Target: data on e-buses' perception by travelers throughout the trail phase and analysis. Lessons learnt accounted for in operations' practice and used to plan next stage.
    - Identify lines, operators, and depots for phase 2 and agree operations details
        - Target: operational arrangements finalized
    - Design e-bus system
        - Target: Requirements for sourcing buses and charging equipment finalized: e.g. technical requirements of e-buses ranging from seating capacity to minimum range and charging mode and standard; technical requirements of chargers and management system
    - Source e-bus system and training/maintenance
        - Target: as for the previous phase but with scope suitably adjusted
    - Deliver and install e-bus system and deliver training/maintenance
        - Target: as for the previous phase but with scope suitably adjusted
    - Design and implement required road schemes
        - Target: as for the previous phase but with scope suitably adjusted
- During phase 2 and before phase 3 (during pilot and before scale-up begins):
    Objectives and targets are like those of the previous phase but the scale changes

Technical regulations objectives and targets would require action at federal level therefore they could be the content of a local/state level strategy. They are included here as their presence is essential to proceed properly. Technical regulations objectives and targets and could include the following:

[31] These targets are also likely to have an impact at an earlier stage, when they must be part of contractual agreements with suppliers of e-bus maintenance or charger maintenance

- Before phase 1 (before trial phase begins):
  - Establish battery treatment and storage regulation (this should be done a Federal level)
    - Target: regulation in place
  - Establish end of life battery regulation (this should be done a Federal level)
    - Target: regulation establishing what can or must be done with a decommissioned battery and who is responsible in place

  Since the time before trial begins is a very early stage and the batteries involved in the trial are a very limited number, the phase could more simply include temporary arrangements ensuring proper battery treatment according to international best practice. This should be clearly referred to in the agreements and contracts leading to the trial phase. However, should such a temporary arrangement be chosen while the buses are demonstrated, the regulation should be finalized and established at federal level.
- During phase 1 and before phase 2:
  - Establish charging and connection standards (may be also part of previous phase) (this should be done a Federal level)
    - Target: connections standards in place, also for charger vehicle communications
  - Establish end of life battery regulation (if not done at previous stage)
    - Target: regulation establishing what can or must be done with a decommissioned battery and who is responsible in place
- During phase 2 and before phase 3 (before scale-up begins):
  All necessary technical regulations should be in place before the beginning of phase 2

Environmental and climate change regulations objectives and targets could include the following:

- Before phase 1 (before trial phase begins):
  - This is too early a stage to look at specific and environmental and climate change regulations.
- During phase 1 (demonstration phase) and before phase 2:
  - This is too early a stage to look at specific and environmental and climate change regulations. However, data can be collected to feed development of future regulations.
- During phase 2 (pilot phase) and before phase 3:
  - Establish a regulation to enhance the climate change and environmental performance of road vehicles, targeted in particular to public transport, that calls for appropriate maintenance and environmental standards (e.g. minimum standards for ICE vehicles, phasing out of more polluting vehicles, phased introduction of less pollution buses, phased introduction of e-buses[32])
    - Target: regulation in place
- During phase 3 (scale-up) and during phase 4 (self-propelled phase):
  - Align local regulations to possible newer federal regulations[33]
    - Target: regulation in place

Coordination objectives and targets could include the following:

- Before phase 1 (before demonstration-trial phase begins):
  - Enable a single body (LAMATA in Lagos) to perform and coordinate activities related to e-buses
    - if required, enhancement of LAMATA role/technical capacity established (especially in terms of coordination with the energy sector)

[32] This could refer to number of e-buses or number of bus-km by e-buses
[33] In the case of Lagos, local actions and regulations are likely to be ice-breaking, with federal regulations shaped by the Lagosian experience

- Involve LAMATA in all relevant activities mentioned above concerning 'Finance and governance', 'Power infrastructure and services', Transport infrastructure and services', 'Technical regulations'
  - Target: LAMATA manages financing flows related to e-bus systems
  - Target: LAMATA carries out tendering/agreement for demonstration e-buses and chargers
  - Target: LAMATA monitors demonstration operations

- During phase 1 (demonstration) and before phase 2:
  - Further LAMATA's role to coordinate activities related to e-buses (if expansion of LAMATA's remits is required for its role to be effective in the next phases)
    - Target: Expansion of LAMATA's role in place
- During phase 2 (pilot) and before phase 3 (before scale-up begins):
  - All necessary coordination arrangements should be in place before the beginning of phase 2

Once the demonstration phase -and possibly also the pilot phase- is completed and deemed successful a parallel line of work could foster the local production of e-buses and chargers and should be included in the National Automotive Industry Development Plan.

2.11.2.3 Actions/Projects to Implement the E-Bus Strategy for Lagos

Each of the objectives and targets established to attain the vision can be reached by carrying out a set of activities that are the actions or projects mentioned here.

Defining each of the actions or project means also indicating a precise action plan where projects are described in detail, related to each other (precedence relationships), broken down in tasks and milestones that are useful to monitor the progress of the single projects, their effect on other projects and the overall advancement of the action plan. Key to success is a precise identification of role and responsibilities across stakeholders as well as budget and source of funding.

As this is a template an example of project is outlined below for clarification:

- Technical design of the e-bus system

The design of the e-bus system is required, with a different focus and scope, at each stage of the development, starting from the demonstration and pilot to the self-propelled phase.
The design requires starting from a feasibility study, as the one developed in component 2, extended to the availability of power at the charging points. It is therefore necessary to define:

- A set of candidate lines
- A set of likely ranges for the buses, given their required size (e.g. from passenger demand, current bus blocking)
- A set of candidate sites for the charging station (in the depot) with their power availability (including added reliable power that could be sourced very likely at night if buses are charged once a day)

A simulation of the buses along the candidate lines will provide the information required to finalize the selection of the characteristics of the buses, of the revised blocking, and of the charging points. The characteristics of the buses required can then be used as base requirements for their procurement. Alternatively, the study can be used as a detailed verification for the feasibility of operating the lines with e-buses and the procurement can be carried out by issuing a tender based on the specification of the lines. This is particularly useful to "learn" from the bids especially at the inception of e-bus introduction.

By providing surveys of the lines, climate information, and of requirements, the bidders are asked to design a supply of buses from their current offer and are asked to guarantee that the design of the bid is suitable to provide the service. In this case it is clearly crucial that tender documents contain precise information.

Information from actual bus operations will provide the means to refine the simulations and therefore the design at following stages of e-bus deployment.

The technical design, after stage 2 (pilot), will provide the elements to determine CAPEX and OPEX that, considered along with earnings, will enable the designers to outline a financial plan for the e-bus system lifetime which can then be used to compare options for their acquisition (such as leasing, outright purchase) and make the case for financing e-buses against economic benefits (e.g. lower environmental impact) with financing institutions as well as to contrast with actual cash flows during operations.