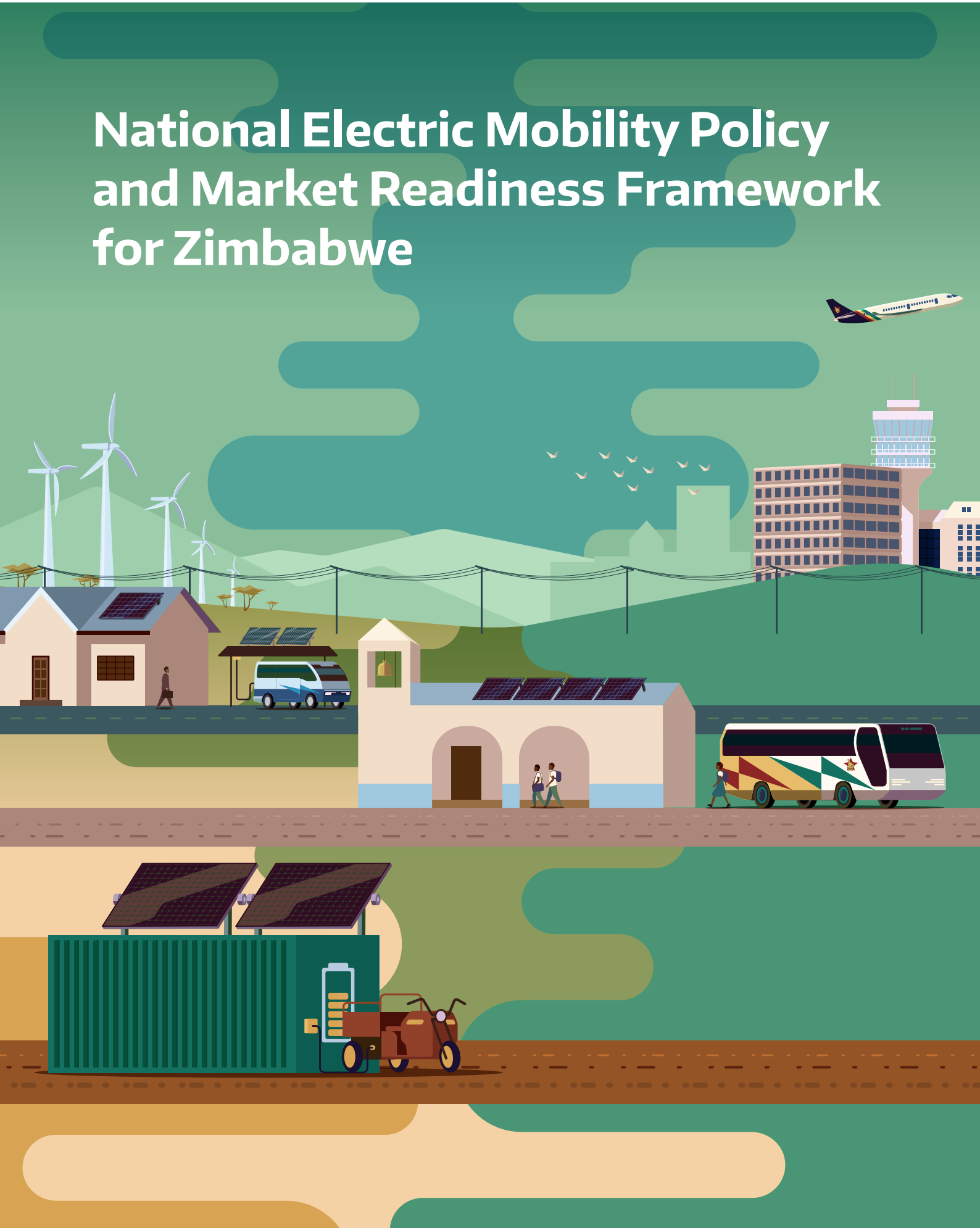
ZIMBABWE

National Electric Mobility Policy and Market Readiness Framework for Zimbabwe



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PUBLISHED: April 2022
ISBN: 978-87-93458-13-0
FRONTPAGE ILLUSTRATION: Barry Maitland-Stuart/Garage East

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Abbreviations

ADB	Asian Development Bank
AFDB	African Development Bank
BAU	Business As Usual
BEV	Battery Electric Vehicle
BMW	Bayerische Motoren Werke (Automobile company)
BYD	Build Your Dreams
CAFE	Corporate Average Fuel Economy
CAPEX	Capital Expenditure
CKD	Completely knocked-down Kits
CMED	Central Mechanical Equipment Department
COP	Conference of the Parties
CTCN	Climate Technology Centre and Network
CVR	Central Vehicle Registry
DC	Direct Current
DDF	District Development Fund
DISCOM	Distribution Company
DOR	Department of Roads
DRE	Decentralised Renewable Energy
EMA	Environmental Management Agency
EURO	Name of European Emission standards
EV	Electric Vehicle
GHG	Green House Gas
ICE	Internal Combustion Engine
ICEV	Internal Combustion Engine Vehicle
ICT	Information Communication Technology
IDBZ	Infrastructure Development Bank of Zimbabwe
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IPT	Intermediate Public Transport
LCV	Light Commercial Vehicles
LDV	Light Duty Vehicles
LEDS	Low Emission Development Strategy
LPG	Liquid Petroleum Gas
MACC	Marginal Abatement Cost Curve
MFA	Mobility For Africa
MIAZ	Motor Industry Association of Zimbabwe
MOEPD	Ministry of Energy and Power Development
MOTID	Ministry of Transport and Infrastructure Development
MSME	Micro, Small & Medium Enterprises
MU	Million Units
MW	Megawatt
NAMACO	National Manpower Advisory Council
NDC	Nationally Determined Contribution
NDS	National Development Strategy
NGO	Non-Governmental Organization
NMT	Non-Motorised Transport
OEM	Original Equipment Manufacturer
OPEX	Operational Expenditure
PT	Public Transport
PV	Photovoltaic
RDC	Rural District Councils
REAZ	Renewable Energy Association of Zimbabwe
REF	Rural Electrification Fund
RFP	Request for Proposal
RMT	Road Motor transportation
SA	South Africa
SADC	Southern African Development Community
SAZ	Standards Association of Zimbabwe
SDG	Sustainable Development Goals
SIRDC	Scientific and Industrial Research and Development Centre
SME	Small and Medium Enterprises
SUV	Sport utility vehicle
TCO	Total Cost of Ownership
TDM	Transport Development and Management
TERI	The Energy and Resources Institute
TSCZ	Traffic Safety Council of Zimbabwe
TSP	Transitional Stabilisation Programme
TSPM	Total suspended particulate matter
UMFA	University of Manitoba Faculty Association
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
USA	United States of America
USD	United States Dollars
VAT	Value Added Tax
VID	Vehicle Inspection Department
WHO	World Health Organization
ZB	Zimbank
ZERA	Zimbabwe Energy Regulatory Authority
ZESA	Zimbabwe Electricity Supply Authority
ZETDC	Zimbabwe Electricity Transmission and Distribution Company
ZIMRA	Zimbabwe Revenue Authority
ZINARA	Zimbabwe National Road Administration
ZRP	Zimbabwe Republic Police
ZUPCO	Zimbabwe United Passenger Company

Acknowledgements

The National Electric Mobility Policy and Market Readiness Framework development process involved a robust stakeholder consultation process from the inception workshop in 2020 to the validation workshop in 2022. In developing the policy framework, key stakeholders consulted were from the three key priority sectors of climate, energy, and transport. They ranged from the government ministries, non-governmental organisations, private sector, academic and research institutions, development partners, and local community members.

We are grateful for the contributions made by the government ministries, various governmental institutions, NGOs, experts and others who contributed in various ways to the development of the policy framework.

We are particularly grateful to the Project Steering Committee for providing guidance and support to the project. We are especially thankful to Ms Salome Maheya from the Ministry of Energy and Power Development and Ms Virginia Mawere from the Ministry of Transport and Infrastructure Development for valuable inputs and support to the project. Ms Munashe Mukonoweshuro, the project focal point at the Ministry of Environment, Climate, Tourism and Hospitality Industry provided inputs and coordinated the project with ministries, organised meetings with key stakeholders, and coordinated inputs from them. Her keen interest in the project and unstinting support has been key to the successful conclusion of the project. We profusely thank her for that. We also thank Shanar Tabrizi and Lisa Sundberg for providing comments as gender experts. CTCN provided funding to the project.

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Foreword

Climate change is a global development challenge which is impacting socio-economic well-being and development in all countries. Zimbabwe has seen increased frequency and magnitude of prolonged dry spells, droughts, tropical cyclones, and violent storms over the past two decades. This has been further exacerbated by the increase in importation of second-hand internal combustion vehicles and increase in purchase of private vehicles which contribute a significant amount to national greenhouse gas (GHG) emissions.

Zimbabwe as a Party to the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement, is committed to reduce its greenhouse gas (GHG) emissions across all sectors including the energy sector as reflected in its Nationally Determined Contribution (NDC). The transport sector as one of the high emitting sectors offers the opportunity to reduce GHG emissions and contribute to meeting the NDC commitments. Guided by the country's Vision 2030 through which the country seeks to have an upper middle-income society by the year 2030, economic activity and associated consumption levels are expected to increase. The Government is putting in place policies and regulatory measures to ensure that the envisaged growth is less carbon intense.

Zimbabwe's Long-term Low Greenhouse Gas Emission Development Strategy (2020-2050) commits to implementation of renewable energy and energy efficiency initiatives, low carbon transport systems and sustainable industrial development among others. Therefore, there is a need to improve public transport, scale up non-motorized transport and transition to cleaner, more efficient modes of transport on the roads. Increased public transport will also lead to increased mobility for low-income populations.

The introduction of electric mobility to Zimbabwe can help the nation transition her transport sector to a low emitting one, and at the same time contribute to economic development. Supporting the electric evolution will contribute directly to achieving progress on Sustainable Development Goal (SDG) 13 on climate action, SDG 3 on good health and well-being, SDG 7 on affordable and clean energy, SDG 12 on responsible production and consumption and indirectly to achieving SDG 8 on sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all.

It is within this context that Zimbabwe presents its National Electric Mobility Policy and Market Readiness Framework. The Policy Framework will assist in introduction of electric mobility in Zimbabwe and address various barriers to its scale up.

The Government of Zimbabwe expresses its gratitude to the Climate Technology Centre and Network (CTCN) and UNEP-CCC for availing the technical support to develop the National Electric Mobility Policy Market Readiness Framework. Last but not least, the Government acknowledges consulting firms Mobility for Africa Trust and pManifold.

Ministry Environment, Climate, Tourism and Hospitality Industry
Republic of Zimbabwe

Executive Summary

Zimbabwe's National Electric Mobility Policy and Market Readiness Framework

Introduction

At the Paris Climate Conference (COP21) in December 2015, Parties to the United Nations Framework Convention on Climate Change (UNFCCC) reached an agreement to avoid dangerous climate change by limiting global warming to well below 2°C and pursuing efforts to limit it to 1.5°C. Following the Agreement, countries submitted their Nationally Determined Contributions (NDCs). Zimbabwe has committed, as part of its NDC to reduce its emissions 40% below the projected business as usual (BAU) emissions per capita by 2030 and develop a low carbon development pathway.

The transport sector is a major contributor to greenhouse gas (GHG) emissions in Zimbabwe with a 22% share in her total GHG emission. With the vehicle fleet doubling every 10 years, it is also facing other issues including a lack of adequate infrastructure to meet demand, congestion and air quality deterioration in cities. The Government of Zimbabwe, therefore, initiated the development of an Electric Vehicle Policy Framework and Roadmap, with support from the Climate Technology Centre and Network (CTCN). The initiative will help Zimbabwe shift to a low carbon pathway in transport and also address air quality and congestion issues. Thus, the project is in line with Zimbabwe's National Development Strategy 1 (NDS1), which encompasses several strategies to promote clean and efficient transport and support infrastructure. It is also in line with Zimbabwe's strategy to reduce GHG emissions from the transport sector as included in various policy and strategy documents such as the National Climate Change Response Strategy (2015), National Climate Policy (2017), National Transport Master Plan (2018), Renewable Energy Policy (2019), Vision 2030 (2019)[1] and Low Emission Development Strategy Strategy 2020-2050 (2019), and also aligned to Zimbabwe's commitments to UNFCCC to reduce emissions through her Nationally Determined Contributions.

Globally, the electrification of the transport sector is progressing with the car market reaching 10 million vehicles in 2020, representing a 1% stock share. Several governments supported electric cars through fiscal and other incentives and electric cars are slowly becoming competitive in some countries (IEA, 2021). The average driving range of new battery electric vehicles (BEVs) has also been increasing, reaching 350 kms in 2020. The sale of the electric light commercial vehicle (LCV) and buses also increased but totals are still low. China dominates the electric bus market and in Europe, electric bus registrations reached 4% of all new bus registrations in 2020.

Urban Passenger Transport sector in Zimbabwe

The population of Zimbabwe is approximately 14.9 million (Worldbank, 2020) with the urban population accounting for 32.24% of the total population. Urbanization is increasing in Zimbabwe and with that demand for urban services has outstripped the supply of key services, including transport services. More than 90% of the cars and light duty vehicles (LDVs) imported in Zimbabwe are pre-used vehicles with an average age of 11 years. Zimbabwe United Passenger Company (ZUPCO), a company with a majority government holding, runs the buses but declined from 1995 onwards, especially after 1999 liberalization when the private sector became the dominant player. But this led to fragmented and scattered public transportation with kombis[2] and pirate taxis becoming the prominent and most common modes of public transportation with limited use of buses. However, public transport in Zimbabwe is under the process of re-organisation with ZUPCO taking the lead role and independent operations of kombis being phased out.

1 This Vision is anchored on re-engagement with the Global Community, private sector-led rapid growth and development as well as enhanced domestic and foreign investment as encapsulated by the mantra "Zimbabwe is open for business".

2 Kombi is 15-to-16-seater mini bus used as one of the public transport modes in Zimbabwe. It is run by private as well as public operators.

Projected demand estimates in vehicle kilometres for transport from various regions in Zimbabwe for various modes in 2032 indicate the highest demand for commuter omnibus, followed by motor car and motorcycle, ZUPCO buses, and emergency taxis at 8818, 4409, 3307 and 2425 thousand vehicle- kms respectively.

In 2017, emissions from the transport sector account for 22% and it is the second-largest source of emissions after electricity generation. Emissions from transport are forecasted to rise significantly as demand for vehicles and transport services increases with economic growth, particularly for passenger cars. GHG mitigation measures identified in Zimbabwe's Low Emissions Development Strategy 2020-2050 (LEDS) (2020) include low carbon transport with mitigation primarily contributed through a combination of fuel savings and the use of alternative and low carbon fuels and electric and hydrogen-fuelled vehicles. The air quality in Zimbabwe is considered moderately unsafe. Pollution in urban areas from transport is of concern reflected in Zimbabwe's Transport Master Plan 2018, and LEDS (2020).

Electric Mobility Priorities in Zimbabwe

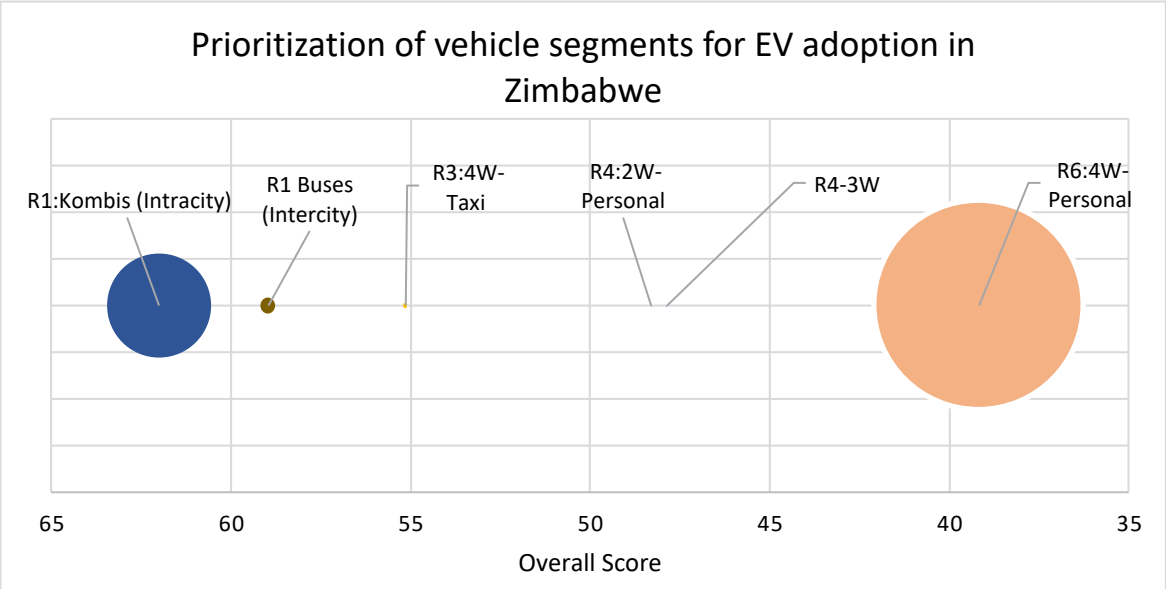
There are a variety of vehicles in use in the transport sector of Zimbabwe including buses, kombis, four-wheeler taxis, personal vehicles, two-wheelers and three-wheelers. Prioritization of vehicle segments can help policymakers to target a segment for implementation of e-mobility where resources can be deployed, and policies and efforts can be focussed. It can thus help phase-wise transition to e-mobility as the lessons learnt in one segment can be successfully transferred to other segments in the country.

Both quantitative and qualitative data were used to prioritise vehicle segments in Zimbabwe for e-mobility adoption. The methodology included identifying criteria for prioritization, assigning weights to criteria and scoring[3], aggregating scores, and sensitivity analysis to check the impact of change in assumption about important parameters on prioritization results. The weights were estimated based on consultations with the local experts' team and interactions with different government stakeholders and validated through stakeholders' meetings and presentations to the project steering committee.

The final prioritisation ranking of vehicles segments is shown in Figure 1 together with their relative estimated GHG mitigation potential (assuming 100% electric vehicles (EVs) in 2020 in the segment) indicated by the size of the bubble.

3 Stakeholders' involvement is essential in identifying criteria, assigning weights and scoring.

FIGURE 1. Prioritisation matrix for vehicle segments



Note:
1. Bubble size represents GHG mitigation potential and 'R' represents Rank.
2. The term "kombi" has been retained in the discussions that follow but it should be considered substituted by "intracity buses" since these buses are expected to be used for intracity transport under ZUPCO licensing.

Sensitivity analysis was carried out for changes in assumed values of the parameters, the vehicle adoption rate for electrification, and the government's share in total investment (in EVs and charging Infrastructure) but the top rankings did not change.

Barriers and enabling measures for the prioritised EVs

The value chain of the EVs from vehicle production to vehicle disposal (see Figure 2) has been considered for the barrier analysis. The barrier analysis was used to identify strategies and policies (also referred to as "enabling measures") to overcome the identified barriers for large scale deployment of EVs in the country.

FIGURE 2. Value chain of vehicles (ICEVs and EVs) across the lifecycle

The barriers and enabling measures to large scale deployment of EVs in Zimbabwe were discussed in a stakeholders' workshop. Identified barriers and related enabling measures have been categorised and included in Table 1.

TABLE 1. Barriers and potential policy measures for large scale deployment of EVs in Zimbabwe

Barrier category	Barriers	Potential enabling measures/policies
Economic and Financial Barriers	High purchase price of EVs and batteries	**EV end-user purchase subsidy**: Encourage end-consumers for EVs adoption through subsidising different types of EVs that meets quality and safety standards. The capital subsidy can be linked to battery size and vehicle performance and should be capped.
		EV end-user interest subsidy: Develop mechanisms to allow easy and lower interest rates of financing for EVs (including, any interest subsidy from the government)
		Exemption of import duties on EVs: Exempt import duties on EVs (new, pre-owned and retrofits) that meet defined quality and safety standardsc
		Exemption of import duties on EV sub-systems and raw materials: Exempt import duties on EVs raw materials (e.g. cells), sub-systems (EV batteries, chargers, motors etc.) and CKD kits for 5 years until the local ecosystem is developed
		Exemption / reduction in sales tax: Exempt or reduce sales tax on EVs for the first few years until the right market development and price parity with ICEs is reached. Align EV sales tax (from original equipment manufacturers (OEMs)/ dealers to end consumers) to input raw material taxes paid by the OEMs for appropriate working capital management by OEMs
		Exemption/ reduction of registration fees and taxes for EVs: Exempt or reduce registration fees, one-time taxes and recurring taxes on EVs (as per revised vehicle classification) for 3 years until the appropriate market development and price parity is reached
		Exemption/ reduction of repeat taxes for EVs: Exempt or reduce the repeat taxes (registration renewal and licensing) on EVs for the first 3 years and gradually increase thereafter until EVs are rightly established

Barrier category	Barriers	Potential enabling measures/policies
Market Barriers	Lack of local supply chain for EV manufacturing and related services	**Incentives for local assembly/manufacture of EVs and their components**: The measures to make EVs competitive and create demand have been covered in the economic and financial measures, policy and regulatory measures, and other measures. Alternate / complementary measures can also be considered from the supply-side that include fiscal incentives (Capital/ interest/ tax subsidies) for local assembly and manufacturing of EVs and their sub-systems & components (including local value added of mining raw materials use in EVs). The incentives could be considered for manufacturers as well as for dealers.
		EV technology R&D: Another supply-side measure is to encourage start-ups across the EV value chain through R&D grants/funds and the right incubation support for production, skill and capacity building, including for; · Battery manufacturing, assembly and supply · Charging equipment manufacturing/ assembly and supply · Electric motors
		EV awareness program for dealers: Increased awareness programs to assist consumers to know and appreciate EVs
Policy and Regulatory Barriers	Lack of vehicle standards	**Vehicle emission standards (new & pre-owned ICE vehicles)**: Develop/adopt and enforce vehicle emission standards for new and pre-owned vehicles, compatible with upgraded fuel standards (EURO4) (for imports and local production; and for first-time registration and repeat use)
		EV safety standards (new & pre-owned EVs): Adopt relevant global quality and safety standards (with customisation) for different types of EVs (new, pre-owned and retrofits), advanced EV battery technologies (no Lead), charging technologies, EVs and chargers' inter-connection and their inter-operability, chargers and grid interconnection and communication, security against theft and end-consumer communications including vehicle to Load/ Home/Grid standards
	Lack of scrappage policy	**Zimbabwean EV mandates for OEMs**: Develop a Zimbabwean EV mandate for automotive OEMs to manufacture EVs (minimum percentage of total vehicle production to be defined). One mechanism for this can be through Corporate Average Fuel Efficiency standards (CAFE) and regulate average g/km CO2 across OEM production portfolio. CAFE can be first rolled out for cars, as it has the highest mode share in Zimbabwe.
		Vehicle scrappage/re-use mandates: **1. ICEs**: Establish a scrappage mandate for different ICE vehicle types and curb the use of vehicles after the end of (20 years) life. Other mechanisms could be, allowing vehicles to retrofit (with fitness test) to EVs. **2. EVs**: Establish scrappage/re-use mandate for different EV types and curb the use of vehicles after the end of (20 years) life.
		3. Battery recycle and re-use guidelines: Develop Lithium Battery recycle - re-use guidelines covering collection, storage, transportation and recycling of waste batteries (for suppliers, manufacturers and consumers)

Barrier category	Barriers	Potential enabling measures/policies
Infrastructure and technical barriers	Lack of charging infrastructure	**EV Charging infrastructure subsidies and Incentives**: Encourage industry and distribution company participation through attractive fiscal incentives (capital/ interest/ tax/ electricity subsidies) on the set-up of EV charging stations and services. Allow distribution companies to capitalise on the cost of setting and running minimum public charging stations (until the market gets developed)
		EV charging tariff revision: Introduce preferential electricity tariffs for EV charging providers for them to access cheaper electricity. Also, introduce time of use (TOU) tariffs at night in the residential and commercial buildings to encourage overnight charging when there is low demand to reduce strain on the current grid infrastructure (together with 100% smart meter deployment)
		EV public charging infrastructure guidelines: Develop guidelines for public charging infrastructure for the right selection of fast charging options and the right interoperability. Encourage home and office charging of EVs and facilitate easier new connection or existing sanctioned load revision. This will reduce dependence on public charging infrastructure and waiting time. Install more charging stations to minimize waiting time, where needed.
	Poor access to electricity	**EV home and office charging infrastructure guidelines**: Develop new building codes and guidelines for setting up appropriate charging infrastructure (especially for multi-storied residentials and in offices). Include EV charging provision in new building plans.
	Lack of automotive skills	**Encourage expansion of electricity infrastructure**: **1.** Drive government and private investments in national grid expansion **2**. Encourage (Decentralised Renewable Energy - DRE) mini-grids (by government and private players) to integrate EVs (including plug-in charging and swap batteries). Allow easy and lower interest rate of financing for DREs **3**. Revise the electricity tariffs across different utility sectors and encourage competitive prices across nations
		Acceleration of power sector reforms: Accelerate development of electricity grid network, power generation production capacity for 100% connections and 24x7 power for all
		Automobile and EV technology training and skill development: Develop guidelines for OEMs and dealers to partner with local institutions and build strong training and certification skill programs to build local expertise with EVs assemble, innovate, repairs & services, retrofitting, driving, etc.
Awareness / Information	Lack of promotional and facilitation measures for new (clean/ low emission) technology	**EV adoption mandate for government departments**: Mandate various government departments to purchase EVs only for their new fleet procurement and/or leasing. This can be made 100% or gradual increase from 50% to 100% in 2-3 years
		EV bulk procurement mandate for government departments: Give mandate to one government department to organise bulk procurement of EVs for aggregated demand from government and private offices

Barrier category	Barriers	Potential enabling measures/policies
		EV adoption targets: Set EV targets for different fleet applications (2Ws, 3Ws, cars and buses) for new EVs procurement, gradually reaching 100% of the new purchase in the next 5-10 years
		Revision of vehicle classification: Revise existing vehicle classification system (separate for passenger and freight transport and distinguishing commercial versus private use) to rightly fit different types of EVs (and any other future vehicle technology)
		EV awareness program for users (individual, fleet): Design and conduct repeat public awareness programs on EVs benefits and support from government and local ecosystem, targeting fleet and individual/private users
		Supporting EV pilots: Encourage EV pilots through funding, subsidising, incubation support for purchase, research and implementation including different use cases of EVs (shared fleet and individual use cases)
		EV awareness program for automobile Industry OEMs and Suppliers: increased awareness programs to assist ICE manufacturers to gradually shift to EVs (vehicle and its components) production and supply.
		Single window clearance for EVs registration and licensing: Single window clearance system for vehicle registration and licensing (aligned with new and clear vehicle classification system)

Important note: It is important to note that this is a list of barriers and potential policy measures, and only a few policy measures in each category may need to be taken. Policy measures relevant to achieving the targets need to be selected from this list based on their costs and benefits, and stakeholders' consultations. The selected policy measures and targets, along with their resource requirements are included in the roadmap, which is a separate document.

Opportunities for EV adoption in Zimbabwe

The opportunities for EV adoption in Zimbabwe include the following.

1. Micro-mobility- which refers to alternatives to current (petrol) two-wheelers and three-wheelers that could be e-bikes and e-tricycles, and last-mile connectivity, which can be through a combination of micro-mobility and e-buses. There is also a huge potential to service rural populations with e-tricycles that can contribute to increased agricultural productivity and access to social services.

2. Intermediate public transport where taxis and Mushikashika[4] are converted to e-taxis.

3. Public transport, where both kombis and buses are replaced by e-buses.

4. Other fleet operations can be converted to e-mode. These include fleets in the mining sector, government vehicle fleets managed by Central Mechanical and Equipment Department (CMED), and utility company (i.e. ZESA) fleets. Bulk procurement models could be adopted to reduce the cost of e-vehicles.

5. Onsite renewable power generation can be used to electrify fleets wherever feasible, in the mining sector for example.

The potential for battery manufacturing should also be explored since Zimbabwe produces the raw materials required for batteries.

4 mushikashikas, are informally run taxis that serve as last-mile connectivity.

1. Introduction

1.1. Country Overview

1.1.1. Transport Sector

The transport sector in Zimbabwe comprises four sub-sectors: road, rail, aviation and inland water. The Ministry of Transport and Infrastructure Development (MoTID), the administrative authority responsible for the formulation of national transport and infrastructure policies, ensures that the transport sector complies with the relevant national and international standards and meets safety requirements. The Ministry is supported by various departments, local authorities and parastatals including Zimbabwe National Road Administrations (ZINARA), National Railways of Zimbabwe (NRZ) and the Civil Aviation Authority of Zimbabwe (CAAZ) (AfDB, 2019).

In the late 1990s, the road transport sector was deregulated as part of economic reform programmes to increase private sector participation (AfDB, 2019). This led to the termination of the Zimbabwe United Passenger Company's (ZUPCO) monopoly on urban transportation leading to the introduction of other players. As such urban passenger transport is dominated by kombis for public passenger transport.

Concerning rural transport, a mix of large buses and kombis service this sector for passenger transport. These services cover rural, intercity and regional public bus markets. Within the rural areas, trips are generally short and hence there is no harmonised system in place. Scotch carts, bicycles and wheelbarrows are the dominant types of transport for rural communities.

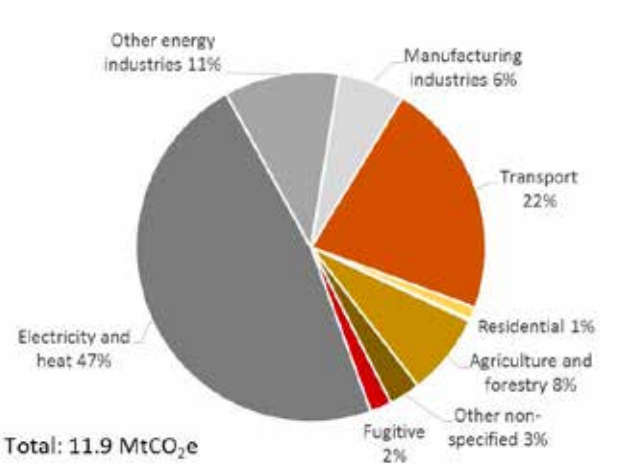
There are several challenges for road transport in Zimbabwe due to (i) the high rate of motorization, with the vehicle fleet doubling every 10 years, (ii) the level of reconditioned cars imported from industrialized countries, and (iii) the contribution of GHG emissions from transport, mainly from direct combustion of fossil fuels and CO2. Nearly 97% of transportation GHG emissions come through direct combustion of fossil fuels, with the remainder being hydro-fluoro-carbons emitted from vehicle air conditioners and refrigerated transport.

1.1.2. GHG Emissions from the Transport Sector

Energy use in power generation, transport, manufacturing industry and agriculture accounts for the largest share of national GHG emissions. Emissions totalled around 11.9 MtCO2e in 2015, of which CO2 accounted for over 99%. The energy sector is the largest contributor to GHG emissions. Diesel, coal and liquefied petroleum gas (LPG) fuel use in other sectors such as industry, commercial, institutional, residential and agriculture accounted for the remaining emissions.

Emissions from the transport sector account for 22% of energy sector emissions (LEDS-GoZ, 2020) the second-largest source of emissions after electricity generation. The transport sector emissions mainly come from gasoline and diesel use in road vehicles, as shown in Figure 1.1.

FIGURE 1.1 CO2 emission from energy sector 2015



Source: Zimbabwe Long-term Low Greenhouse Gas Emission Development Strategy (2020-2050).

1.1.3. Zimbabwe's Low Emissions Development Strategy

Zimbabwe's Low Emissions Development Strategy 2020-2050 (2020) indicates that total emissions are expected to increase significantly over the coming decades, rising to around 26.5 and 37.5 MtCO2e in 2030 and 2050, respectively. The fastest growth and overall contribution are expected to come from power generation, in particular with the official planned expansion of thermal power generation over the coming decade. Emissions from transport are also forecast to rise significantly as demand for vehicles and transport services increases with economic growth, particularly for passenger cars.

1.1.3.1. GHG Mitigation Potential for the Transport Sector

Low carbon transport contributes the largest share of mitigation potential after renewable electricity generation. The mitigation is mainly through a combination of fuel savings and the use of alternative and low carbon fuels and vehicles. Mitigation measures identified in Zimbabwe's LEDS 2020 for the transport sector highlight road transport as a key intervention area and are described in Table 1.1.

TABLE 1.1. Mitigation measures identified in LEDS-GoZ (2020)

GHG Mitigation measures for the Transport sector	Description	MACC (In USD/tCO2e)	Accumulated Investment Need up to 2030 (In M USD)
Local biofuel production	Reducing fossil fuel components in the energy mix through blending.	-0.92	299.70
Fuel economy policy.	Reduction in gasoline and diesel consumption	-1000.83	510.87
Electric and hydrogen-fuelled vehicles	Reduction of gasoline and diesel demand by Internal Combustion Engines (ICE) vehicles through the uptake of electric and hydrogen vehicles.	12.00	NA.
Public transport (modal shift).	Reduced carbon intensity of travel system by shifting away from passenger car use to modern buses and non-motorised transport (NMT).	17.71	367.37

The GHG mitigation measures for the transport sector signify the need for a shift to clean transportation modes, i.e., electric and hydrogen-fuelled vehicles and a modal shift to public transport from private ownership.

1.1.3.2. Role of Renewable Energy in E-mobility

GHG emission reductions from e-mobility depends on the carbon intensity of the electricity. Though e-mobility may reduce local pollution, GHG mitigation from e-mobility assumes that electricity used by electrical vehicles is from relatively clean sources, which is also evident from the mitigation measures identified in LEDS (Table 1.1). Zimbabwe's National Renewable Energy Policy brought out in 2019 aims to have 16.5% of the total generation capacity (excluding large hydro) from renewable sources by 2025. This increases to 26.5% by 2030. The development of electric mobility in Zimbabwe that uses centrally produced electricity, therefore, should lead to emissions reduction in line with the decreased carbon intensity of the national grid. In cases where decentralized renewable energy is used to power electric vehicles, GHG emissions could be eliminated. This would, however, require examining the feasibility of the development of decentralised renewable electricity and local grids.

1.2. The Paris Agreement

In 2015, Parties to the United Nations Framework Convention on Climate Change (UNFCCC) endorsed the Paris Agreement on Climate Change. The Agreement sets out a framework to avoid dangerous climate change by limiting global warming to well below 2°C and pursuing efforts to limit it to 1.5°C. It also aims to strengthen countries' ability to deal with the impacts of climate change and support them in their efforts to foster climate resilience and low-carbon development pathways.

Parties to the Paris Agreement are obligated to put forward their best efforts through Nationally Determined Contributions (NDCs) which highlight targets to reduce greenhouse gas (GHG) emissions and pursue efforts to adapt to the impacts of climate change. Zimbabwe as a Party to the UNFCCC signed and ratified the Paris Agreement on Climate Change in 2015. As part of its obligation, Zimbabwe submitted its revised Nationally Determined Contribution (NDC) setting a target to reduce its greenhouse gas emissions across the economy by 40% below the projected business as usual (BAU) scenario by the year 2030.

1.3. Transport and Sustainable Development Goals (SDG)

There are several SDG targets directly linked to sustainable transport, including SDG 3 on health (reduced pollution and increased road safety), SDG 7 on energy, SDG 8 on decent work and economic growth, SDG 9 on resilient infrastructure, SDG 11 on sustainable cities (access to transport and expanded public transport), and SDG 12 on sustainable consumption and production.

Electric mobility, as one of the sustainable transport options, can help achieve many of these SDG targets and coupling electric mobility with renewable energy can further help in decarbonising the transport sector (SDG 7; increased share of renewables). It can help eliminate tailpipe emissions and thereby contribute to tackling air pollution and related health effects (SDG Target 3).

EV manufacturing can also help create jobs, encourage entrepreneurship and development and growth of micro, small and medium enterprises (MSMEs) (SDG Target 8). It can promote inclusive industrialization and integration of SMEs in value chains and markets (SDG Target 9), efficient use of resources and reduce waste generation by recycling batteries and ending fossil fuel subsidies (SDG target 12).

1.4. Zimbabwe's Policy and Regulatory Framework

Zimbabwe's National Development Strategy 1: 2021-2025 (NDS1, 2020) builds on the nation's Transitional Stabilisation Programme (TSP) and is the first 5-year Medium-term Plan aimed at ensuring high, accelerated, inclusive and sustainable economic growth as well as socio-economic transformation and development as the nation moves towards an upper middle-income society, as stated in its Vision 2030. The Strategy identifies 14 priority areas, one of which is Transport, Infrastructure & Utilities. The NDS1 highlights several strategies; i) promote road transport services, ii) promote high quality and efficient transport for both rural and urban areas, iii) develop and rehabilitate supporting infrastructure, iv) develop local industry and supply chain by leveraging minerals and available natural resources, v) produce locally and provide employment opportunities, vi) improve access to power and promote renewable energy sources and their use.

The specific targets indicated in NDS1 include, i) 60% local bus production by 2025 (NDS1, 2020; page 97) which is likely to reduce import bill by 44% and increase employment by more than 4500; ii) reduce road accidents and fatalities by 25% per annum; iii) increase power supply capacity to 3,467 MW and access to electricity by 54% by 2025; iv) increase road network in good condition to 24,500 km by 2025 (NDS1, 2020; page 121).

Zimbabwe's National Climate Policy (2017) commits to "accelerating mitigation measures by adopting and developing low carbon development pathways" through adopting gender-sensitive green technologies and strengthening gender considerations into green programming. The Policy, in addition, commits to ensuring mitigation strategies that are socially inclusive through actions such as promoting gender-responsive climate programming and implementation

of climate-related policies, strategies and actions, and promoting climate-smart technologies that are user friendly for children, youths, women, people living with disabilities and vulnerable or disadvantaged groups.

Transport is seen by the Government of Zimbabwe as an enabler for other sectors. Urban sprawl, particularly in Harare and Bulawayo, has resulted in increased commute distances for citizens. The National Climate Change Response Strategy (2015) describes how the major challenges for the road transport sector include the rate of motorization and the quality of fuel. The traffic is increasing rapidly with the vehicle fleet doubling every 10 years. Under its Physical and Social Infrastructure pillar, it committed to introducing a transport policy framework that encourages the use of low carbon transport, such as electric vehicles, and the integration of climate resilience into transport planning and Infrastructure development.

In 2018, Zimbabwe completed its Transport Master Plan with a prioritized list of short-term, medium-term and long-term transport sector investments. Zimbabwe acknowledged that its transport systems should be developed to be compatible with environmental concerns, for example by reducing pollution in urban areas.

Building on the country's revised NDC, Zimbabwe's long term Low Emission Development Strategy (LEDS) follows an economy-wide approach guiding emissions reductions over the period 2020-2050. This introduced a low carbon transport package as part of its LEDS strategy within the energy sector highlighting the reduction in gasoline and diesel consumption, adoption of electric and hydrogen vehicles, modal shift to mass public transportation and development of e-charging infrastructure.

1.5. Transport Sector Institutional Structure

The Ministry of Transport and Infrastructure Development (MoTID) is responsible for (i) formulation of transport and infrastructure policies (ii) planning, design, construction and maintenance of road and rail networks, (iii) ensuring compliance with national and international standards (for example, the SADC transport protocol), and (iv) approving, monitoring, and evaluating the implementation of turnaround strategies[5].

The key departments under MoTID responsible for road transport and relevant activities including vehicle registrations, road infrastructure development etc. are as follows:

- Central Vehicle Registry (CVR) is a department under the Transport Management Division and is a sister department to the Vehicle Inspectorate Department (VID) and Road Motor Transportation (RMT). It was created by the Government of Zimbabwe to facilitate and regulate national and cross border traffic flow in a manner that optimizes mobility and accessibility.

- Vehicle Inspectorate Department (VID) is responsible for vehicle inspections, driver licensing, road and infrastructure preservation and road safety through the implementation of policies, strategies, and standards.

- Road Motor transportation (RMT) authorises an operator to run public transport service.

- Information Communication Technology (ICT) is responsible for the management of information communication technology solutions for enhancing efficiency in the provision of service within the Ministry and its stakeholders.

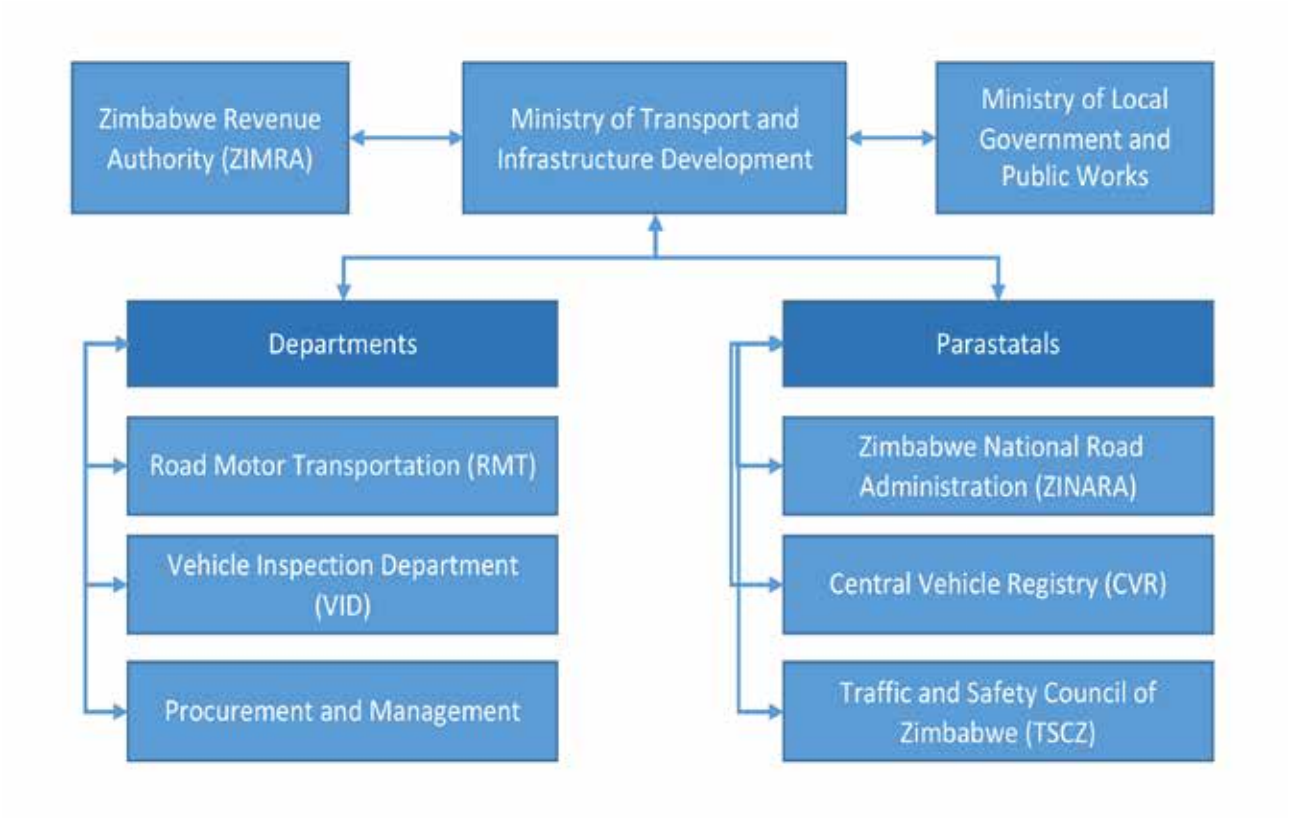
- Department of Roads (DOR) is responsible for planning, design, supervision and maintenance of world-class standard road infrastructure.

- Other departments of MoTID are Strategic Policy Planning Monitoring and Evaluation, Transport Development and Management (TDM), and Procurement Management Unit (PMU), the last two responsible for the management and procurement respectively.

The institutional relationships for the road sector entities are shown in Figure 1.2.

5 retrieved from http://www.transcom.gov.zw/

FIGURE 1.2 Road sector - Instituional framework (AFDB, 2019)



Zimbabwe Revenue Authority (ZIMRA): is responsible for collecting revenue, facilitating trade and travel, advising the government on fiscal and economic matters and protecting civil society.

Zimbabwe National Road Agency (ZINARA): is responsible for vehicle licensing, tolling and toll collections, cross border movement (ZIMRA, DOR, Zimbabwe Republic Police (ZRP), and various ministries are also involved in cross border movement). ZINARA only collects road transit fees for the Road Fund it administers as directed by the MoTID through the DOR. Responsibilities also include fuel levies, bridge toll collection, disbursement of finance for periodic and routine maintenance. Development of roads is not their mandate as they are not an authority.

Ministry of Local Government and Public Works: is the central body governing the local governments of Towns/ Cities in Zimbabwe. It has an important role to play as the license to run public transportation in a city has to be issued by the local government of the respective city.

2. Passenger Transport Sector in Zimbabwe: An Overview

2.1. Urban Passenger Transport Demand

Zimbabwe has undergone several socio-economic and political changes over the last four decades. The urban areas have been significantly transformed as a result of these changes as well as the rapid urbanisation over the past years. With an annual urbanisation rate of 4.3% per annum, Zimbabwe, like most of the countries in the global south, is experiencing rapid urbanisation (Government of Zimbabwe, 2015). The population of Zimbabwe is approximately 14.9 million (Worldbank, 2020) and the urban population is 32.24% of the total population. Harare is the capital of Zimbabwe and has the highest population growth as compared to the other cities. However, rapid urban growth continues in the other cities and towns as well, as shown in Table 2.1.

The City of Harare has a current population of 1.9 million people with a population density of 2,179 persons/sq.km, including the contiguous settlements that account for approximately 16% of the total country population. In the last two decades, the city of Harare has grown both in terms of area as well as population. Many new suburbs have been created as land has been converted and rezoned from agricultural to residential. This has meant that the city now covers a large geographical area with commuter distances having grown substantially and new residential developments that now require transport. Due to lack of reliable transport and often long distances to get to kombis or buses from homes in these new areas, many people seek to invest in their vehicles which has dramatically resulted in the growing demand for second-hand cars. This has also led to an increase in demand for fuel and a lot more traffic on main roads that has increased wear and tear and congestion.

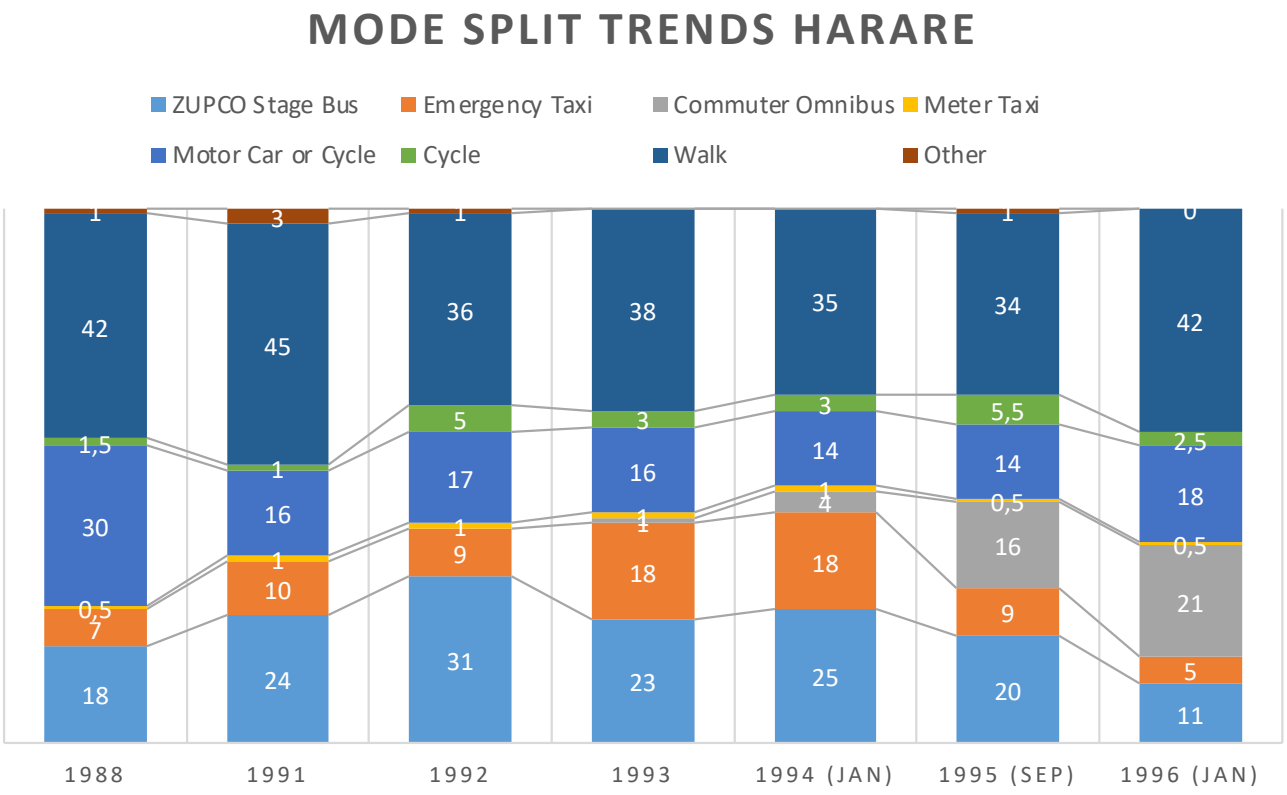
TABLE 2.1 Population for selected towns and cities in Zimbabwe

Town/City	1982 Census	1992 Census	2002 Census	2012 Census	2022#	2032#	2042#
Zimbabwe	7,958,239	10,900,511	11,954,293	13,115,149	14,862,927	16,565,428	18,167,829
Harare	656,011	1,189,103	1,444,534	1,485,231	1,699,505	2,009,812	2,248,123
Bulawayo	413,814	621,742	676,787	653,337	747,595	832,402	902,318
Chitungwiza	172,556	274,912	321,782	356,840	408,322	472,920	528,266
Mutare	69,621	131,367	170,106	187,621	214,689	258,598	293,237
Gweru	78,918	128,037	141,260	157,865	180,641	207,326	230,654
Kwekwe	47,607	75,425	93,072	100,900	123,633	141,385	159,138
Kadoma	44,613	67,750	76,173	92,469	105,809	121,496	136,207
Masvingo	30,523	51,743	69,993	87,886	100,566	121,011	138,634
Chinhoyi	24,322	43,054	56,794	77,929	89,171	107,626	124,083

Source: Zimbabwe National Statistics Agency (2013, 2018) # Estimates

As a travel behaviour study on Harare indicates, the majority of trips are made for work purposes (38%), followed by trips made for educational purposes (21%), shopping (~14%), with leisure and other social trips such as visiting friends and relatives constituting around 15% of trips. A greater proportion of trips by women tend to be local, short, and principally for shopping (72% of shopping trips are made by women). Men undertake the majority of work trips (68%) and travel longer distances than women and thus tend to dominate most modes of transport except metered taxis (Mbara and Maunder, 1997). Mbara and Maunder (1997) found that the average trip number in Harare was 1.56 trips per capita. The average trip number per capita in high-income households was 1.91 compared to 1.49 for low-income households.

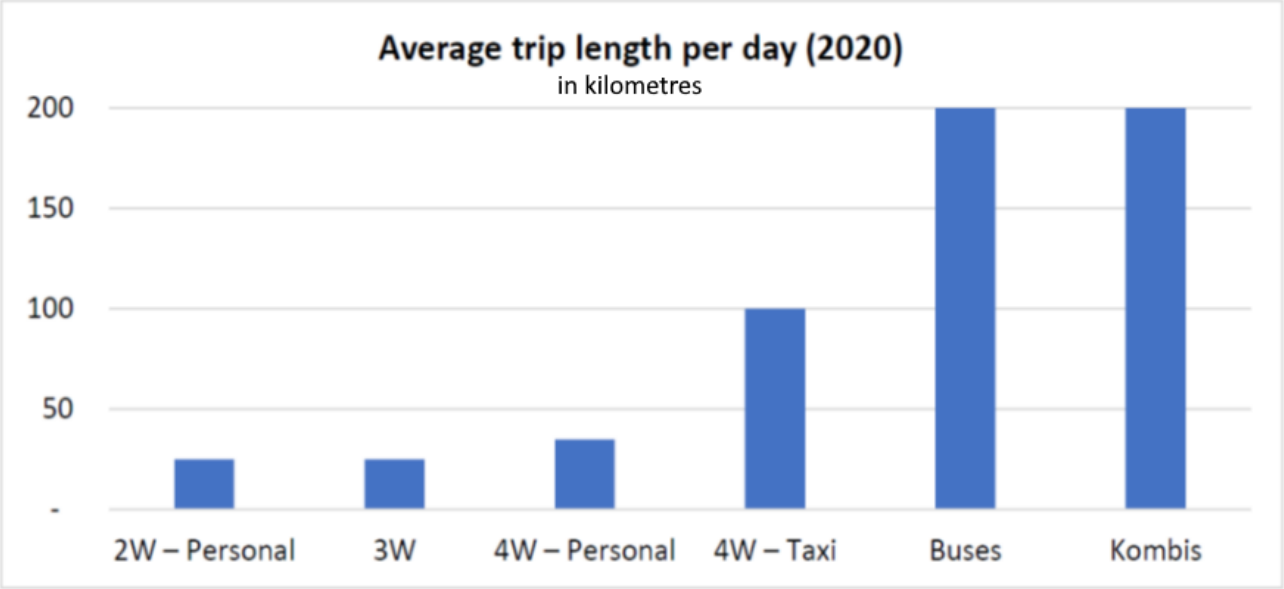
FIGURE 2.1 Mode Split Trends (Home Interview Surveys - 1988-1992, 1993-1996)



As can be expected, the trip length varies with the travel mode, longer trips are made using motorised modes of transport and on bicycles and short trips are made by walking. However, as walking and bicycle are dominant modes of transport (as can be seen from Figure 2.1) majority of the trips made in Harare were less than 5 kilometres, 80% of trips were less than 15 kilometres, and only 6% of trips were higher than 25 kilometres (Mbara and Maunder 1997). From the data in Figure 2.1, it is also apparent that there has been a significant increase in the use of commuter buses, and the Zimbabwe United Passenger Company (ZUPCO) State buses have also had a relatively high share. ZUPCO is a public transport governing authority in Zimbabwe. Even though the ZUPCO has the government majority shareholding (51%), it had shown a significant decline after 1995, and there was a further decline after 1999 due to the liberalisation of the public transport sector by the government which allowed private players to own and operate privately owned public vehicles where many buses run out of their economic life.

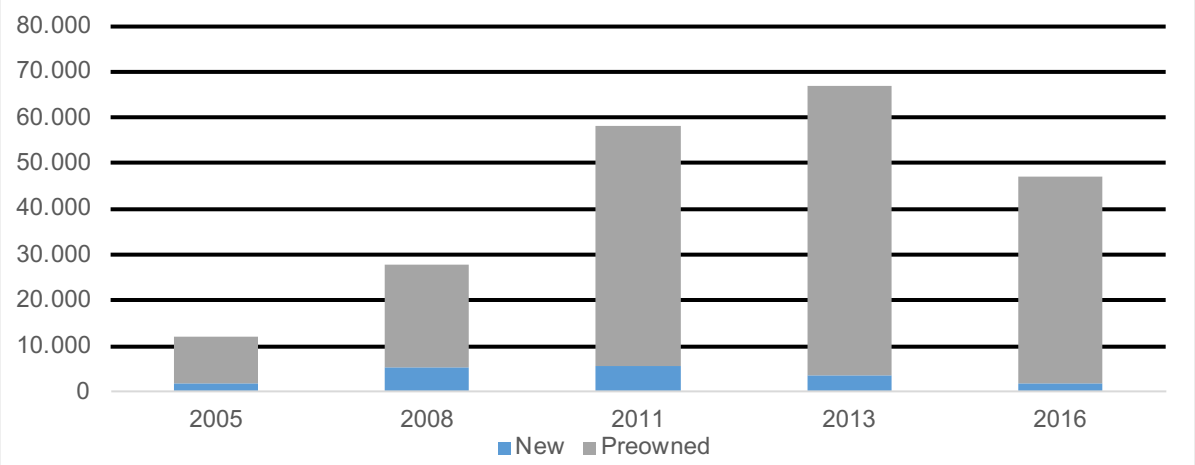
Since 2006-07, second-hand (10-15 years) saloon cars have been imported from Japan via Durban at the cost of about US$2,000 to US$4,000. These cars are being used as taxis, with their numbers increasing by over 10% annually. More recently, the burgeoning number of commuter buses/kombis and taxis have saturated the market and congested the streets. Worsening congestion and declining safety and security have increased demand by users for a new and efficient service run by conventional, fixed route, fixed schedule bus companies in partnership with local authorities. Figure 2.2 shows the average trip lengths (kilometre travelled per day) by various modes in Zimbabwe, which are more or less in line with what has been observed for Harare.

FIGURE 2.2 Average Trip Rates in Zimbabwe



A study on the fuel economy of light-duty vehicles (LDVs) in Zimbabwe highlights that in 2016 annual registrations of LDVs (maximum net mass of 2,300 kg) were 54,593. 96.2% (ZERA, 2017) of these registrations were of pre-owned (second-hand) vehicles. Figure 2.3 shows that the trend of registration of pre-owned vehicles has become pre-dominant in Zimbabwe. This supports the trend of import of second-hand vehicles in Zimbabwe.

FIGURE 2.3 LDVs New vs pre-owned vehicle registration Trend (ZERA, 2017



Trends of vehicle registration and their stock highlight the dependency on cars, SUVs, and pick-up vans. However, as mentioned earlier, a very large portion of the population in Zimbabwe does not have access to motorised vehicles. Other modes of passenger transport are also significant in Zimbabwe's context.

Private transportation

a. **Two-wheelers and Three-wheelers** occupy the smallest place in the vehicle stock of the country and are not used for public transport but primarily for deliveries.

b. **Cars, SUVs, and Pickup vans** are the most used mode in Zimbabwe. Most of them are imported due to affordable prices with an average age of 11 years. They are classified under Class 1 (1-2300kg) as per Central Vehicle Registry (CVR).

Public transportation

Public transport in Zimbabwe is under the process of re-organisation after 20 years of liberalisation which resulted in a scattered, fragmented, and unorganised phase. Kombis[6] and Pirate taxis dominated by private operators are the prominent and most common modes of public transportation while the use of private buses is limited.

c. **Kombis** are the most common mode of public transport with a seating capacity of 15-18 along with 25–39-seater omnibuses that run-on fixed routes. More than ten thousand families are currently relying on the income generated by operating kombis.

d. **Pirate taxis locally referred to as mushikashikas**, are informally run taxis that serve as last-mile connectivity. Its use in rural areas becomes important where the connectivity and accessibility are poor. Given no specific route and fare, they run the service with flexibility and act as last-mile mode.

e. **Buses** in Zimbabwe are typically large buses carrying approximately 39 (and above) passengers. There are several applications of buses such as public transport providing inter-city, intra-city, regional, rural, cross-border services and there uses such as Hospital, school, office buses.

As stated earlier, in the absence of ZUPCO for the last twenty years, private omnibus kombi players were the main public transport providers in the country. The absence of ZUPCO allowed the private bus and kombi operators market to flourish but their quality of service was poor, and fairs were high. The government had been trying to phase out kombis and private buses due to these reasons and the disorganization and chaos they caused. The revival of ZUPCO buses at affordable prices due to the Covid-19 pandemic was an opportunity for the government to further control kombis, and mushikashikas besides efforts to control the spread of the Covid virus. Since the year 2020, ZUPCO resumed operations, and the focus shifted to delivering quality service and affordable public transportation to people.

At present, ZUPCO is operating 1,000 omnibuses and 770 other buses. ZUPCO provides passenger transport service for 10 intracity (urban) routes, connects rural areas, regional (intercity), and provides cross border service (ZUPCO, a). ZUPCO presently operates more than 272 buses (Bulawayo 24-News, 2020), some of which are sourced from private sector players using its franchise. The current fleet of ZUPCO buses is not sufficient to support the demand, where the waiting time in some cases is an hour or more for buses. ZUPCO also focuses on aggregating kombis to provide a convenient and affordable mode of transport while reducing fares ten times that of private kombi operators charge. This is creating conflict between private kombi operators and ZUPCO due to the large shift of ridership to ZUPCO due to affordable service; hence the struggle is to accommodate each other. For this, ZUPCO has already started partnering with private kombi operators through a subsidy mechanism to run the service at lower fares.

The government has since banned kombis from operating and have encouraged private mini and large bus owners to enter into contracts with ZUPCO. The motive behind this initiative was to bring organization to the whole system and improve public transport management.

Various types of vehicles used for passenger transport in Zimbabwe are given in Table 2.2.

6 Kombi is 15-to-16-seater mini bus used as one of the Public Transport modes in Zimbabwe. It is run by private as well as public operators.

TABLE 2.2 Different vehicle segments (Use cases) in passenger road transport system in Zimbabwe

Mode of Passenger transport	Categorisation	Vehicle Stock No. (2020)	Share of vehicle stock	Characteristics	Challenges	Opportunities
2W – Personal 	**Owner**: Private **Purpose**: Non-commercial **Capacity**: 1-2	45,653	3.81%	• Negligible use for daily commute • New and pre-owned import • Limited and small market • Convenient mode as last-mile connectivity	• Negligible use for daily commute • Second-hand imports • Limited and small market	• Flexible and convenient mode for mobility • Less maintenance • Less parking space requirement • Affordable
3W – Passenger 	**Owner**: Private **Purpose**: Commercial **Capacity**:3-4	3,652	0.3%	• Convenient mode as last-mile connectivity • New models for rural commuters • Limited and small market		
4W – Personal 	**Owner**: Private **Purpose**: Non-commercial **Capacity**: 5	1,042,826	87.04%	• High private ownership and dependency on cars	• Second-hand imports with an average age of 11 years • High pollution and maintenance • lower efficiency	• Convenient mode as public transport inadequate maintenance • Easy availability and relatively inexpensive
4W – Taxi (Shuttles, Mushikashika, Vayas) 	**Owner**: Private **Purpose**: Commercial **Capacity**: 7-8	26,755	2.23%	**Mushikashika (Informal taxi)** • Many unorganised players • No fixed routes • No fixed fares • Mostly pre-owned imports • Usually worn out with no O&M plans **Vaya (Formal taxi)** • No fixed routes • Fixed fares • Their use as metered taxis is preferred by women due to the safety of door-to-door service	**Mushikashika** • Second-hand imports with an average age of 11 years • High pollution and maintenance • Lower efficiencies • Mushikashikas are run informally • No fixed routes • No fixed fares	**Mushikashika** • Affordable to common people • Accessible and convenient • Easily available in the market • Preferred by rural commuters **Vaya**: • Accessible and convenient • Easily available in the market • Preferred by Women from a safety perspective
Buses (Intercity buses run by Government/ ZUPCO and private operators) 	**Owner**: Public/ Private **Purpose**: Commercial **Capacity**: 25-75	10,319	0.86%	• Revival of ZUPCO • Legally the sole public transporter for inner-city • Aggregating the public transport service to provide affordable public transportation	• Poor service (Vehicle, frequency, routes, infrastructure)	• Revival of ZUPCO • Aggregating the public transport service to provide affordable public transportation
Kombis (Intracity buses, Vans, Pick-up Vans) 	**Owner**: Public / Private **Purpose**: Com-mercial **Capacity**: 15-18	68,866	5.75%	• Many unorganised players running kombis • Occupy large space for parking • Responsible for urban centres congestion in Zimbabwe	• Illegally run kombis are more than legally run kombis • Occupy large space for parking • Responsible for urban centres congestion in Zimbabwe	• Most used public transport • A significant source of revenue to public transport • Opportunity to regularise and formalise as an official mode of transport to stop illegal services and improve quality of passenger transport • More reliable than any other mode of transport due to the number of kombis available
Total		**1,198,071**	**100%**			

Note: 2W, 3W and 4W refer to 2 wheelers, 3 wheelers and 4 wheelers respectively.

Demand estimates in vehicle kilometres for transport from various regions in Zimbabwe for various modes of transport are given in Table 2.3

TABLE 2.3 Vehicle Kilometre ('000) demand estimates

Town/City	Vehicle kilometre ('000) demand estimates/mode year 2032							
	ZUPCO Stage Bus	Emergency Taxi	Commuter Omnibus	Meter Taxi	Motor Car or Cycle	Cycle	Walk	Walk
Zimbabwe	3,307	2,425	8,818	110	4,409	882	8,818	220
Harare	401	294	1070	13	535	107	1,070	27
Bulawayo	166	122	443	6	222	44	443	11
Chitungwiza	94	69	252	3	126	25	252	6
Mutare	52	38	138	2	69	14	138	3
Gweru	41	30	110	1	55	11	110	3
Kwekwe	28	21	75	1	38	8	75	2
Kadoma	24	18	65	1	32	6	65	2
Masvingo	24	18	64	1	32	6	64	2
Chinhoyi	21	16	57	1	29	6	57	1
Marondera	17	13	46	1	23	5	46	1

The projections use population forecast, mode share trends, and trip rate/person/day to derive the projected numbers. The projected numbers suggest that the urge to own a private automobile will drive a multi-fold increase in the use of private automobiles. But, as there will still be a huge population that will not be able to afford private automobiles, especially women, Zimbabwe will have most personal travel using commuter omnibus/kombis. Table 2.3 given above explains the national and local distribution of thousand kilometres travelled per year by different modes. The kilometres travelled by walking are equal to that of vehicle kilometres travelled by commuter omnibus. Given that walk trips are short distances than omnibus trips, walking trips have the largest share in total trips.

Women are disproportionately impacted by lack of transport. They are found to be the group with some of the most diverse transit needs, given that they often work part-time, study, volunteer, or have carer responsibilities that all need to be managed within a given day. Those who are elderly or live with a disability also face challenges in accessing basic services due to their reliance on public transport, which often has trouble meeting transit schedules because of their fixed-route model. This means that keeping to necessary appointments or acquiring last-minute essentials comes with great difficulty for these social groups.

Women's non-formal employment patterns result in non-radial, dispersed travel routes either served through lower-volume (higher priced) routes or via multiple routes requiring transfers (and payment of multiple fares). These exacerbate women's accessibility, costs, and safety challenges in transport resulting in women on average paying more than men (on a per-kilometre basis).

2.2. Rural Passenger Transport Demand

Zimbabwe's economy is highly dependent on the agriculture sector which provides livelihoods to approximately 70% of the population, contributes 15% -20% of GDP and 40% of exports and supplies and 63% of agro-industrial raw materials (Bulawayo 24-News, 2019). The sector is important in employment generation, economic growth, reduction of poverty as well as food and nutrition security.

Zimbabwe's agricultural sector is predominantly smallholder-led with over a million communal farmers relying on rain-fed agriculture and close to 70% of them making a livelihood on less than 2 hectares of land. Since land reform in 2001, there are now an additional 200,0000 small scale farmers which have had a dramatic impact on the country's transport needs as rural populations have shifted from living in communal areas into commercial areas where they have more land yet are far more spread out increasing their demand of transport. This has resulted in demand for rural feeder roads and for roads to be created where there was none before.

Rural farmers are often far away from main transport roads and suffer huge costs in both time and finances to get their goods to the market. A lack of transport infrastructure is hindering the development of agriculture in Sub-Saharan Africa and more than half of the untapped potential for cultivation in the region is located more than 6 hours away from a major market (Berg Claudia et al., 2019).

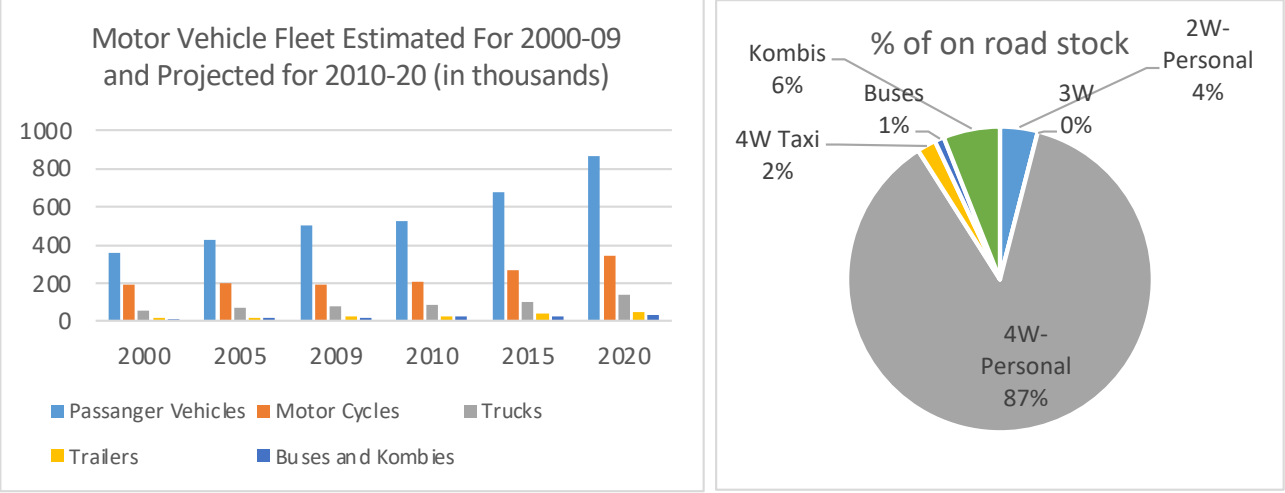
Transport in rural areas is very costly to use, not only because of slow travel times due to the poor state of roads, but because of 'non- physical' transport costs related to delays, poor competition in the transport industry leading to higher prices, and corruption (Berg Claudia et al., 2019). The literature on transport and development shows that roads can have a very important impact on agriculture and rural development more generally. The main channel is by improving access to markets for agricultural produce. More reliable transport and rural roads can boost commercial agriculture, participation in markets, and improve access to services.

The burden of inaccessibility and reduced mobility is borne disproportionately by women and children. Distances to access to water, energy, fuelwood and transportation overburdens rural women, constrains their time, and mobility, therefore limiting their access to resources, markets, and services, de facto limiting their productivity.

2.3. Vehicle Population: Historical Trends

Figure 2.4 shows the growth of motor vehicles in Zimbabwe over the years; Zimbabwe National Road Administration (ZINARA) states that the country's vehicle population in 2014 stood at 1.2 million (The-Herald, 2021). As can be seen from Figure 2.4, most vehicles are passenger vehicles, and there has been a considerable increase in passenger vehicles over the years. Figure 2.4 also shows the percentage of on-road vehicle stock, which indicates that a large portion of the vehicle stock on the road is 4W-personal automobiles. The passenger car ownership in Zimbabwe is around 90 cars per 1000 people (NationMaster, 2014). While the wealthy can afford private vehicles, which account for less than 10% of the total population, this also explains why there is heavy reliance on the commuter omnibus and walking.

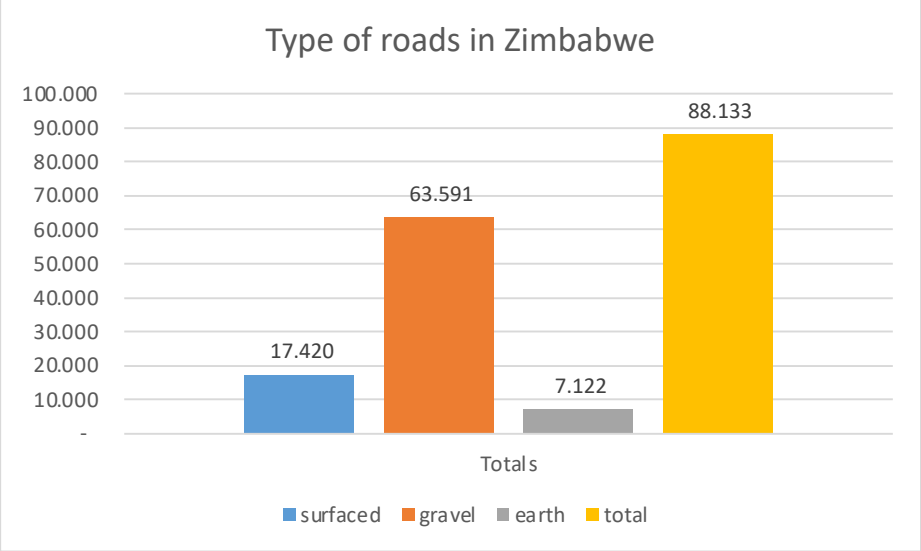
FIGURE 2.4 Vehicle stock in Zimbabwe



The poor are dependent on public transport or non-motorised transport. However, as shown in Figure 2.1, the supply of public transport vehicles is very small, and therefore not able to meet the demand. As a result, a large section of the population is forced to use non-motorised transport modes to access activity locations. This makes it difficult for the neighbourhoods located on the periphery of the city as they may not be close enough to walk, and public transport may not be available (Escamilla, Calhoun et al. 2019).

In terms of connectivity and accessibility, Zimbabwe's road network consists of 950,000 km of roads (Figure 2.5). Only 17,420 km are surfaced, with 9,256 km representing State Roads and highways under the Ministry of Transport and Infrastructure Development's Department of Roads and 8,164 km under the urban authorities. The bulk of the roads are gravel roads of 63,591 km which fall under the jurisdiction of the Rural District Councils (RDCs) and District Development Fund. A further 7,122 km are earth roads mostly under the RDCs. Thus, the paths and roads may be of poor quality, without provision for pedestrians or cyclists and thus dangerous (Pirie, 2013). The challenge is worse for the poor, who may then be forced to walk for longer distances, as indicated in the case of Nairobi, Kenya, where the poor, especially women, cannot afford transport fares. Hence, they have to walk to the nearest health facilities (Escamilla, Calhoun et al. 2019). This is also the possible reason why ZUPCO provides transport at a very subsidised rate.

FIGURE 2.5 Zimbabwe roads type by classification and length (kms)



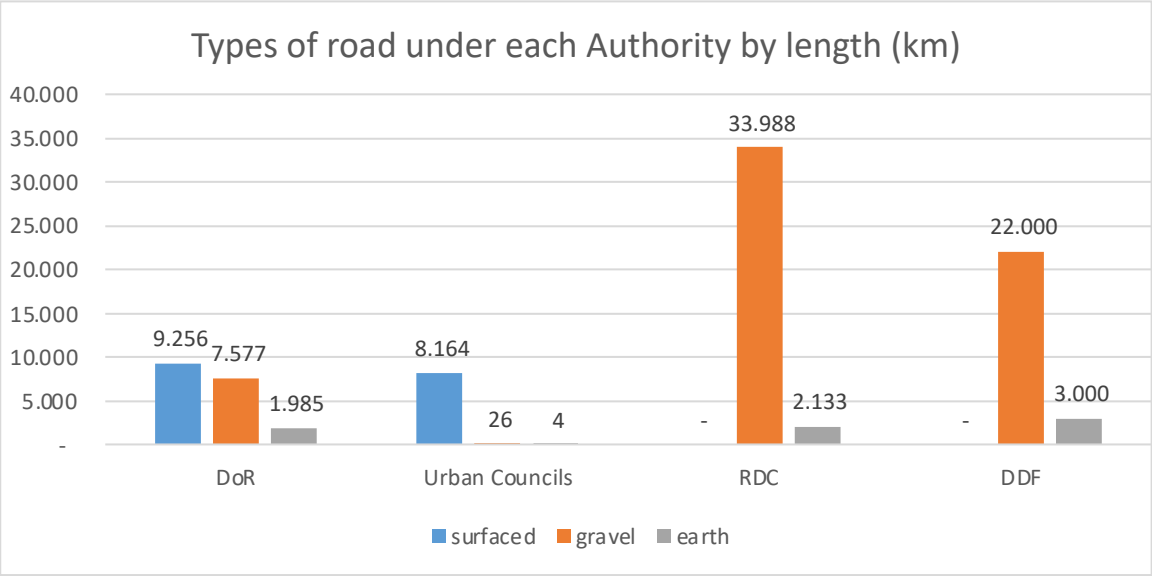
The road network, in terms of trunk roads, primary, secondary and tertiary roads as classified by the Road Acts of 2002 in Zimbabwe is shown in Table 2.4 and different types of roads managed by various authorities given in Fig 2.6

TABLE 2.4 Road network categories in Zimbabwe

Road Class	Function
Regional trunk roads	These roads are 3,391 km in length and link the country with its Southern African neighbours.
Primary roads	Contributing 8% of the road network these roads link regional roads to urban centres or urban centres to each other as otherwise classified within the Roads Act.
Secondary roads	Connect regional, primary, tertiary and urban roads, industrial and mining centres, tourist attractions and minor border posts to each other
Tertiary roads	Connect schools, health centres, dip trunks and other service facilities within a rural district council; connect and provide access to secondary, primary and regional roads within and outside a rural district council area.

According to the Zimbabwe Infrastructure Report (AfDB, 2019), the transport sector in Zimbabwe comprises five modes: road, rail, aviation, inland water, and pipeline transport.

FIGURE 2.6 Different types of roads under each authority (in Kms)



According to the Zimbabwe Infrastructure report (AFDB, 2019), the road network is maintained through a funding framework that includes:

- Fuel levies
- Overloading and abnormal fees
- Heavy vehicle surcharge
- Transit fees
- Vehicle licensing fees; and
- Transport services

In the late 1990s, the road transport sector was deregulated as part of economic reform programmes to increase private sector participation (AfDB, 2019). This led to the termination of the Zimbabwe United Passenger Company's (ZUPCO) monopoly on urban transportation leading to the introduction of other players such as kombis for public passenger transport dominate urban passenger transport.

Concerning rural transport, a mixture of large buses and kombis service this sector for passenger transport. These services cover rural, intercity and regional public bus services. Within the rural areas, trips are generally short and hence there is no harmonised system in place. Scotch carts, bicycles and wheelbarrows are the dominant types of transport for rural communities.

2.4. Air Quality in Harare

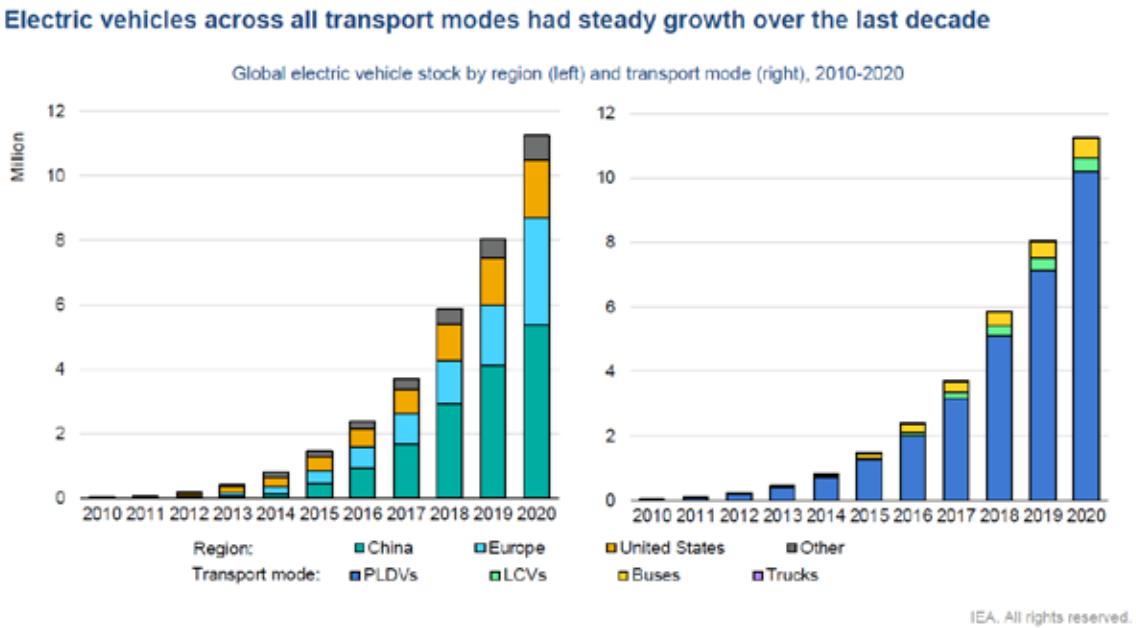
As per the World Health Organization's (WHO) guidelines, the air quality in Zimbabwe is considered moderately unsafe. However, the most recent data indicates the country's annual mean concentration of PM2.5 is 22 µg/m3 which exceeds the recommended maximum of 10 µg/m3. Contributors to poor air quality in Zimbabwe include the mining, cement, and steel industries, fertilizer manufacturing, vehicle emissions, and waste burning. Available data indicates that Harare has consistently high levels of air pollution (IAMAT, a).

In a study in Harare (Mujuru et. al., 2012) four pollutants (SO_2, NO_2, Pb, and total suspended particulate matter (TSPM)) were monitored at eight different sites scattered throughout the city for three months (July, August and September). During the sampling period, all these pollutants were found to be above the air quality guidelines provided by WHO, with SO_2 and particulate matter levels being of particular concern. High ambient air concentrations of SO_2 and particulate matter were ascribed mainly to vehicles and industrial operations near the sampling sites. There are not many studies on air pollution from the transport sector in Zimbabwe (LEDS-GoZ, 2020), however, the concern is reflected in Zimbabwe's Transport Master Plan (2018) which requires that transport systems should be developed considering Zimbabwe's environmental concerns, which includes reducing pollution in urban areas (LEDS-GoZ, 2020).

3. Electric Mobility Priorities in Zimbabwe

The global electric car market has been experiencing rapid growth for more than a decade now and reached 10 million vehicles in 2020, which was a 43% increase over 2019 and represented a 1% stock share. About 3 million new electric cars were registered globally in 2020. Two-thirds of the stock was that of battery electric vehicles (BEVs). Several governments supported electric cars through fiscal and other incentives and electric cars are slowly becoming competitive in some countries (IEA, 2021). Figure 3.1 shows the growth of the different types of electric vehicles and growth in different regions.

FIGURE 3.1 Growth of electric vehicles across regions and transport modes



Notes: PLDVs = passenger light-duty vehicles. LCVs = light-commercial vehicles. Electric vehicles include battery electric and plug-in hybrid electric vehicles. Europe includes EU27, Norway, Iceland, Switzerland and United Kingdom. Other includes Australia, Brazil, Canada, Chile, India, Japan, Korea, Malaysia, Mexico, New Zealand, South Africa and Thailand.

Sources: IEA analysis based on country submissions, complemented by ACEA (2021); CAAM (2021); EAFO (2021); EV Volumes (2021) and Marklines (2021).

The major contributors to the growth of the electric vehicle market in 2020 were Europe, China and the US with China having the largest fleet of electric cars at 4.5 million despite the slowdown due to the Covid-19 pandemic. In Europe, the electric car market doubled despite a contraction in the car market due to the pandemic. European policy on CO_2 emissions standards and subsidy schemes by several governments led to this increase in electric car sales.

The electric mobility market is in a nascent stage in Africa. South Africa (SA) established the national uYilo e-Mobility Programme in 2013 to enable, facilitate and mobilise electric vehicle mobility in South Africa. The uYilo Kick Start fund offers to fund the e-mobility project in South Africa. Projects on battery systems, charging solutions, motors, inverters, and remote monitoring systems have been funded. Some high-end global e-vehicles brands such as BMW, Volvo. Mini Cooper etc. are available and more choice is expected to be available in future. About 1400 plug-in EVs had been sold in the country by June 2021 and 300 charging stations were established. In many counties in Africa such as Uganda, Rwanda, Kigali and Kenya focus is on electric two and three-wheelers and buses. In Kampala, for example, Ugandan start-up Zembo offers electric motorcycles to local boda boda riders and recharges batteries in its solar stations. In Kenya, electric motor-taxi start-up Stimaboda provides a network of charging stations to moto-taxi drivers. UNEP is engaged in Kenya and Uganda in e-motorcycle demonstration projects as a part of the UNEP global e-mobility programme, and in Kigali in an EU funded project with other partners. A Kenyan-Swedish start-up, Opibus, introduced the first all-locally designed and developed electric bus in January 2022 in Kenya.

Worldwide, about 370 electric car models were available in 2020, a 40% increase from 2019. China had the maximum number of models. The average driving range of new BEVs has also been increasing, reaching 350 kms in 2020. The sale of the electric light commercial vehicle (LCV) also increased in Europe, but total LCV stock was below half-million in 2020. Bus registrations also increased with China dominating the electric bus market with 78,000 new vehicles in 2020. Local policies to curb pollution were the driving force in China for electric buses. In Europe, electric bus registrations (at 2,100) reached 4% of all new bus registrations in 2020 and most of this seems to be due to municipal level policies. (IEA, 2021).

In terms of consumer segments and trends in gender-differentiated user behaviour, it has been found that men use and own electric cars more often than women in Europe and the Nordics (Sovacool et al, 2019). In the U.S., women account for 25% of all new electric car purchases (Fuels Institute, 2021). Similar trends are observed in most countries with electric vehicles. However, this often correlates with statistics on fossil fuel car ownership by gender. In China, for example, car ownership for men is 70.4% compared to 29.6% for women (Statista, 2016) and men use less public transport compared to women. Among women, key concerns for electric vehicles are often related to economy and safety. For men, maintenance costs and mechanic availability are important factors. Meanwhile, women have stronger preferences for the environmentally friendly or safety factors of vehicles such as electric cars (Sovacool et al, 2019). For example, women in the U.S. are more open to buying an electric car in the future compared to men, in the face of global warming as a driver to their purchase decision (MacInnis & Krosnick, 2020). Yet, marketing of electric vehicles is traditionally directed towards men, marking a missed opportunity in terms of scaling up electric vehicles globally through wider consumer awareness and buy-in for the technology.

3.2. Prioritisation of Electric Vehicle Segments in Zimbabwe

There are a variety of vehicles in use in the transport sector of Zimbabwe including buses, kombis, four-wheeler taxis and personal vehicles, two-wheelers and three-wheelers. Though, aspiration may be the transition to e-mobility in urban as well as rural areas in all segments, not all e-mobility modes are economically viable at present. In addition, considering the limited availability of resources, limited access to technology, infrastructure requirements for charging, and implementation capacity, it is important to prioritize the vehicle segments and plan the phase-wise e-mobility transition. Often diffusion of new technologies requires a focussed approach and deployment of substantial resources in the beginning phases. Due to the low capacity and the uniqueness of the markets, countries require the development of their own approach for the adoption of e-vehicles. Prioritization can help

policymakers to target a segment for implementation of appropriate e-mobility mode where resources can be deployed, and policies and efforts can be focussed to facilitate the transition to e-mobility. This in turn will lead to quick learning and increased probability of success compared to the allocation of resources across several segments. The lessons learnt in one segment can be successfully transferred to other segments in the country.

3.3. Methodology for Prioritisation

Both quantitative and qualitative data were used to prioritise vehicle segments in Zimbabwe for e-mobility adoption. The vehicle segments considered for prioritization in Zimbabwe include buses, kombis, four-wheeler taxis and private cars, three-wheelers taxis and two-wheelers (private).

The methodology to prioritize these vehicle segments included the following.

1. Identifying criteria for prioritization of vehicle segments
2. Weighting and scoring on identified criteria by stakeholders
3. Aggregating prioritization scores and results
4. Sensitivity analysis

The final e-mobility roadmap will include priority vehicle segment, resource requirements and policy measures for their adoption in phases for gradual scale-up in the country.

3.3.1. Identifying Criteria for Prioritisation of Vehicle Segments

The criteria used to prioritise e-mobility across different vehicle segments broadly consists of the following 3 categories:

- Technology Costs: This includes investment (capital expenditure) on EVs (or retrofit equipment, in case of retrofitted EVs), and operational cost of the EVs. Only electricity (fuel) costs were considered in operational costs for EVs; maintenance costs were not considered in these costs.
- Benefits: The benefits were divided into four categories; economic, social, local pollution reduction, and climate benefits.
- Local Context: In this, specific criteria important in the Zimbabwe context were considered. The key criteria were usage characteristics, supporting ecosystem, research and development, and acceptability to local stakeholders.

The criteria used for prioritization within these categories are given in Table 3.1. A detailed list of criteria with an explanation of each criterion is given in Annexure-I.

TABLE 3.1 Criteria for EVs adoption in different vehicle segments

Criteria. No	Level 1	Level 2	Level 3	Estimation method
C-1	Costs	Capital Expenditure (CAPEX)	EVs investment requirements	CAPEX requirement is indicated for 100% substitution by new EVs in 2020 for each vehicle segment[7]
C-2			Charging infrastructure investment requirements	CAPEX requirement is indicated for public charging infrastructure for the 100% EVs (in 2020) in the vehicle segment
C-3		Operational Expenditure (OPEX)	Electricity costs	Electricity costs are indicated for running EVs for the 100% EVs (in 2020) in the vehicle segment (Consumption in kWh*cost/kWh)
C-4	Bene-fits	Economic benefits	Total cost of ownership (TCO)	The ratio of TCO of a new EV to an ICE (existing technology) vehicle in the vehicle segment
C-5			ICE vehicle to EV retrofit potential	The ratio of TCO of a retrofitted EV to a new EV in the vehicle segment
C-6			Fuel savings	Fuel-saving potential with 100% EVs (in 2020) in the vehicle segment
C-7		Social benefits	Job creation opportunities	Estimated number of jobs for charging stations and EVs maintenance with 100% EVs (in 2020) in the vehicle segment
C-8			Quality of life and equity	Ease of movement, connection opportunities, social cohesion, and overall well-being from economic benefits
C-9			Gender equality	Ease of drivability and opportunities for women and differently-abled in transport
C-10		Local pollution reduction benefits	Air pollution reduction potential	% Particulate matter (PM) reduction with 100% EVs (in 2020) in the vehicle segment
C-11		Climate benefits	GHG reduction potential	% GHG emission reduction with100% EVs (in 2020) in the vehicle segment
C-12	Local Context	Usage Characteristics	On-road vehicle stock	Vehicle stock (%) of the segment
C-13			Vehicle trip length	Avg. trip length per year (km) in the segment
C-14			Fuel consumption per passenger-km	Fuel efficiency per passenger km (litre/pax-km) in the segment
C-15			Easiness of EV Charging	Dependency on shared public charging infrastructure of the EVs in the segment (excluding dedicated chargers[8])
C-16		Supporting Ecosystem	Local availability of EV models	Number of local EV dealer-ships
C-17			Local post-sales services & spare parts availability	Existing local ecosystem; availability for ICE vehicles repair and maintenance
C-18			Local assembly & supply potential for EV models & components	Potential of supporting locally assembled EV models & component industry
C-19			EVs R&D and technical skills	Number of academic institutions and corporates doing R&D in EVs
C-20			Quality of road and accessibility	Navigability on roads of varying qualities (qualitative judgment)
C-21		Governmental support	Government preference	The willingness of the government to provide fiscal incentives
C-22				The willingness of the gov-ernment to provide non-fiscal incentives and technical support

7 100% substitution is an assumption made for comparison purposes.
8 Investment assumed private for dedicated chargers.

A prioritization matrix was developed containing various criteria where weights were assigned to each criterion. The weights were estimated based on consultations with local experts team and interactions with different government stakeholders (i.e. Ministry of Transport and Infrastructure Development, Ministry of Energy and Power Development, Ministry of Environment, Climate, Tourism and Hospitality Industry, and Ministry of Finance and Economic Development) to align them with NDS1 and sectoral policies and strategies, and finally validated through stakeholders meetings and presentation to the project steering committee.

For each EV segment, scores were given on different criteria, in case of some criteria using quantitative data, (such as costs, GHG reduction potential etc.) and qualitative (such as gender equity, quality of life etc.) in case of others. The qualitative criteria were ranked by stakeholders for each segment, with rank 1 as the highest priority and rank 6 as the lowest. Both quantitative scores and qualitative ranks were normalised on a scale of 0-100, giving individual scores out of 100 for each criterion in each segment. The scores were thereafter multiplied with their weights (for each criterion in each segment) to get an overall score for each vehicle segment. The option with the highest overall score was considered the most preferable option.

The prioritisation matrix indicating criteria, their weights and individual scores in each vehicle segment, and overall score of each segment across the criteria is given in Table 3.2. Overall ranks were derived from the overall score. It may, however, be noted that due to various assumptions about weights and qualitative assessment of several criteria by stakeholders, small differences in overall score should be neglected in the final ranking. The overall ranking of vehicle segments reflects that. The detailed data and calculations are given in Annex 2.

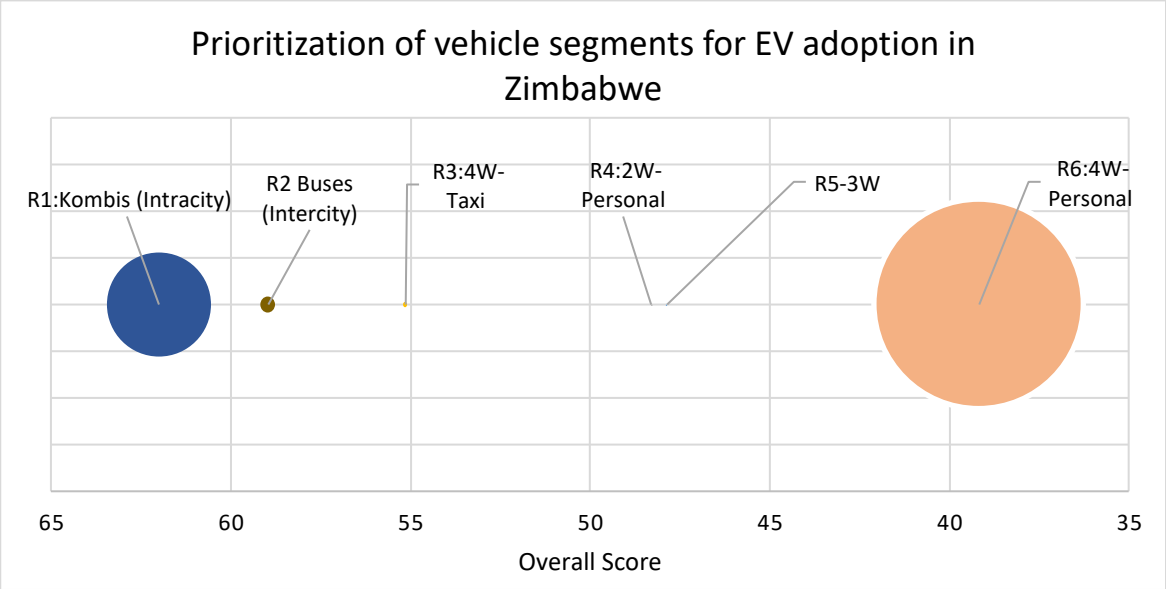
TABLE 3.2 Prioritisation matrix for all vehicle segments

Prioritisation matrix for EVs adoption in Zimbabwe								Individual Score (0-100)					
Criteria	Criteria			Weightage									
Criteria. No	Level 1 (L1)	Level 2 (L2)	Level 3 (L3)	L1	L2	L3	Overall	2W-Personal	3W	4W-Personal	4W-Taxi	Buses (Intercity)	Kombis (Intracity)
C-1	Cost	CAPEX	EVs investment requirement	30%	70%	70%	15%	100	100	0	100	97	83
C-2			Charging infrastructure investment requirement			30%	6%	99	100	0	100	80	92
C-3		OPEX	Electricity consumption		30%	100%	9%	99	100	0	93	53	22
C-4	Benefits	Economic	Total cost of Ownership	40%	30%	30%	4%	100	75	58	58	26	0
C-5			Retrofit potential			20%	2%	34	56	92	100	0	12
C-6			Fuel Saving			50%	6%	1	0	100	7	14	38
C-7		Social	Job creation		20%	33%	3%	0	20	60	40	80	100
C-8			Quality of life and equity			33%	3%	40	20	0	60	100	80
C-9			Gender Equality			33%	3%	40	20	0	60	100	80
C-10		Environmental	Air pollution reduction potential		15%	100%	6%	4	0	77	5	15	100
C-11		Climate	GHG reduction potential		35%	100%	14%	0	0	100	2	7	49
C-12	Local Context		On-Road vehicle stock	30%	30%	25%	2%	4	0	100	2	1	6
C-13		Usage Characteristics	Vehicle trip length			25%	2%	0	0	6	43	100	100
C-14			Fuel eff. /pax-km			25%	2%	65	43	0	76	100	89
C-15			Easiness of EV Charging			25%	2%	100	60	40	0	80	20
C-16		Supporting Ecosystem	Local availability of EV models		25%	15%	1%	80	60	100	100	20	40
C-17			Local post-sales services & spare parts availability			20%	2%	80	80	100	100	60	60
C-18			Local assembly of EV models & components			25%	2%	80	100	20	20	40	60
C-19			EVs R&D and Technical skills			25%	2%	20	40	80	80	100	60
C-20			Quality of road and accessibility			15%	1%	100	0	80	60	20	40
C-21		Local stakeholders' acceptance	Government's preference		45%	70%	9%	20	40	0	60	100	80
C-22						30%	4%	20	40	0	60	100	80
Overall Score								48.3	47.9	39.2	55.2	59	60.5
Overall Rank								4	5	6	3	2	1

3.3.3. Prioritisation Results

The final prioritisation ranking of vehicles segments is shown in Figure 3.2 together with their relative estimated GHG mitigation potential (assuming 100% EVs in 2020 in the segment) indicated by the size of the bubble.

FIGURE 3.2 Prioritisation matrix for vehicle segments



Note: Bubble size represents GHG mitigation potential & 'R' represents Rank.

The results reflect high priority for 'shared mobility segments namely, kombis, buses and 4W-taxis and low priority for 'private' vehicle segments namely, 4W-personal and 2-wheelers. Further insights for individual vehicle segment levels are explained as follows.

- Intracity Buses (Kombis) (Rank-1): With high GHG mitigation potential and based on current developments in ZUPCO's revival as a nodal agency to provide public (mass) transportation in Zimbabwe, kombis emerged as one of the priority mass transport options for electrification. Kombis included intracity buses, vans, pick-up vans, etc. Since kombis were the most common and preferred public transport mode with medium passenger carrying capacity and had easy accessibility, they had a good potential for success in electrification. Since kombis have been banned and ZUPCO has started partnering with kombi operators to run the services, the demand for kombi intracity bus services will shift to the ZUPCO operated intracity public services through private mini-bus and large bus owners. Intracity buses, therefore, have been ranked as 1. The term "kombi" has been retained in the discussions that follow but it should be considered substituted by "intracity buses".

- Intercity Buses (Rank-1): Since the difference in scores between intercity buses and kombis is insignificant, both are ranked as 1. Intercity buses have the lowest fuel consumption per passenger/kilometre, higher social & environmental benefits and government willingness to promote them. The buses therefore also emerge as one of the priority options for electrification.

- 4W-Taxi (Rank-3): Taxis function as an intermediate mode of shared mobility and are considerably preferred locally. 4W-taxis have longer usage in terms of kilometres travelled and since operational costs of e-vehicles are lower, they can compete with ICEVs with lower financial support (and become viable earlier, when the cost of technology falls) than private cars. Considering the average trip

length, potential range per recharge (i.e., around 50-60 kms), and local availability of the spare parts and EV models, the electric 4W-taxi is also a good candidate for electrification after buses and kombis.

- 2W-Personal (Rank-4): The numbers of personal two-wheelers in Zimbabwe are quite limited and therefore, do not hold much potential for GHG reductions, one of the important objectives of electrification. However, e-2Ws can be relatively easily adopted through local initiatives, NGOs, right financing programs and others, without requiring substantial investment in charging infrastructure, as options for home and office charging, and battery swapping may require only limited investment and are easy to implement. Experience from implementation can also be helpful for some other segments.

- 3W (Rank-4): Score close to 2W-Personal and hence given same rank. Although 3Ws have the potential to serve as a quick, accessible, and compact mode for paratransit services, 3W have a small market and moderate GHG mitigation potential impact and limited socio-economic benefits. As with two-wheelers, the e-3W segment can also be adopted through local initiatives, NGOs, and right financing programs with a priority in rural areas where there is no transport and fuel is not available.

- 4W-Personal (Rank-6): 4W segment has a high potential to reduce GHG emissions if converted to EVs. Considering the high volume of 4Ws and resource constraints (market, supply chain and finance and others), this segment may not be an immediate candidate for electrification in Zimbabwe. However, with experience building up in several countries and the availability of technology relatively easy, it can be added to the portfolio as soon as resources become available.

Investment in public charging infrastructure will increase the visibility of EVs on road, which is expected to create demand from private vehicle segments and help grow and establish the EV market in the country.

3.3.4. Sensitivity Analysis

Criteria weights taken in this study for the base case scenario are given in the columns L1, L2 and L3 of Table 3.3. These were validated by the stakeholders in a workshop as well as presented in the project steering committee meeting.

Sensitivity analysis was done for changes in the assumed values of the following parameters.

i) The vehicle adoption rate for electrification was changed for each vehicle segment, and

ii) The government's share in total investment (in EVs, charging Infrastructure) was changed.

Sensitivity analysis is important to find out how the results change with change in assumed values of important parameters. Values of these parameters were initially based on discussions with stakeholders. The values of these parameters determine the values of criteria such as CAPEX, air pollution and GHG reductions, which have high weightage in the prioritization matrix. Therefore, these were considered important for sensitivity analysis. The variations considered for scenarios are summarised in Table 3.3.

TABLE 3.3 Variation in parameters for sensitivity analysis

Parameters	Vehicle Stock	Government's investment
Scenario 1 (Optimistic)	All vehicles achieve a high adoption rate. Private vehicles= 100%, Public vehicles = 100%	Doubling the share of the government investment (%) compared to the base case
Scenario 2 (Base)	Public vehicles adoption rate is higher than Private vehicles. Private vehicles= 30%, Public vehicles = 50%	Share of government investment given in Annexure-II for each segment (based on stakeholders' consultation) on government capacity for investment
Scenario 3 (Pessimistic)	Private vehicles' adoption rate is higher than public vehicles. Private vehicles = 20%, Public vehicles= 10%	Share of government investment reduced by 50% across all segments

Note: Public vehicles include Buses, Kombis, 4W-Taxi, and 3W. Private vehicles include 2W-Personal, and 4W- Personal.

3.3.5 Gender Analysis

Gender equality was included as one of the criteria in the vehicle prioritization matrix, and it focused on 'drivability' for women and differently-abled to make transport easier and allow greater socio-economic opportunities across genders. Vehicle segments were ranked qualitatively on this aspect of gender equality potential. The final prioritization ranking for various vehicles across the matrix aligned well with high scoring and weighting results for the gender equality criteria. Buses and kombis were deemed to enhance ease of mobility and socio-economic participation in society. As women benefit more from shared vehicle segments compared to privately owned vehicles according to the scoring, no major disadvantages are expected for women concerning the ranking of intracity kombis and intercity buses highest on the priority list. This is specifically the case in urban centres, which is an important segment to prioritize considering the use of motorized transport and an urbanization rate of 4.3% per annum in Zimbabwe. In rural areas, the use of public transport is rather infrequent and the bulk (86%) of trips take place within 4 km around the village. Due to unequal gender relations of power, men's travel and transport needs take priority over women which often limits women's access to intermediate means of transport further (Tichagwa, 2000).

It is worth noting additional factors which could have been considered in the scoring of gender equality with regard to accessibility (in terms of cost, connectivity, and social norms), job creation and safety. However, the results of such analysis in the matrix are expected to mainly support the already prioritized vehicle segments. For example, shared vehicles such as buses and kombis are more accessible to marginalized customer segments, including women, from a cost perspective. The increase in mobility can bring access to new employment opportunities for women and youth, as well as improved time management leading to decreased domestic burden.

Formalized buses can offer child-friendly modes of transport for mothers, who are most often in charge of their mobility. In terms of connectivity, with ZUPCO's plans to formalize the sector, there are good opportunities to plan for gender-sensitive transport routes and schedules which increase access to schools, medical centres, and markets. Buses can also bring more opportunities relative to private alternatives for job creation as women are more likely to be employed as drivers for public buses. ZUPCO already reports half of their bus driver fleet being women (Matiashe, 2020) and with the government being in a position to apply staffing policies and rules it is more likely to achieve gender equality in the public transport workforce compared to private transport modes and infrastructure.

It is worth noting that many women rely on public transport to meet their mobility needs. However, a fear of violence and harassment on public transport limits their accessibility. Thus, mitigation efforts to encourage a modal shift to public transport should integrate a gender perspective and consider law enforcement, safety measures, as well as policy-oriented advocacy engaging authorities at local and national levels to prevent and reduce gender-based harassment and violence in public transportation for the protection of women and girls.

From a safety perspective, women prefer more private alternatives such as metered taxis with their door-to-door service over shared vehicles, due to the heightened risk of violence and sexual harassment on public transport. As the higher cost means private cars and metered taxis are not an alternative for many women, safety must be taken into account when developing Zimbabwe's public electric mobility sector policies and law enforcement for the protection of women and girls. Women and men's different needs must also be considered during design and planning for safe routes by reviewing boarding and seating systems, safety and lighting at pick-up and drop-off stops and understanding women's specific needs in terms of the routes they travel and which times during the day.

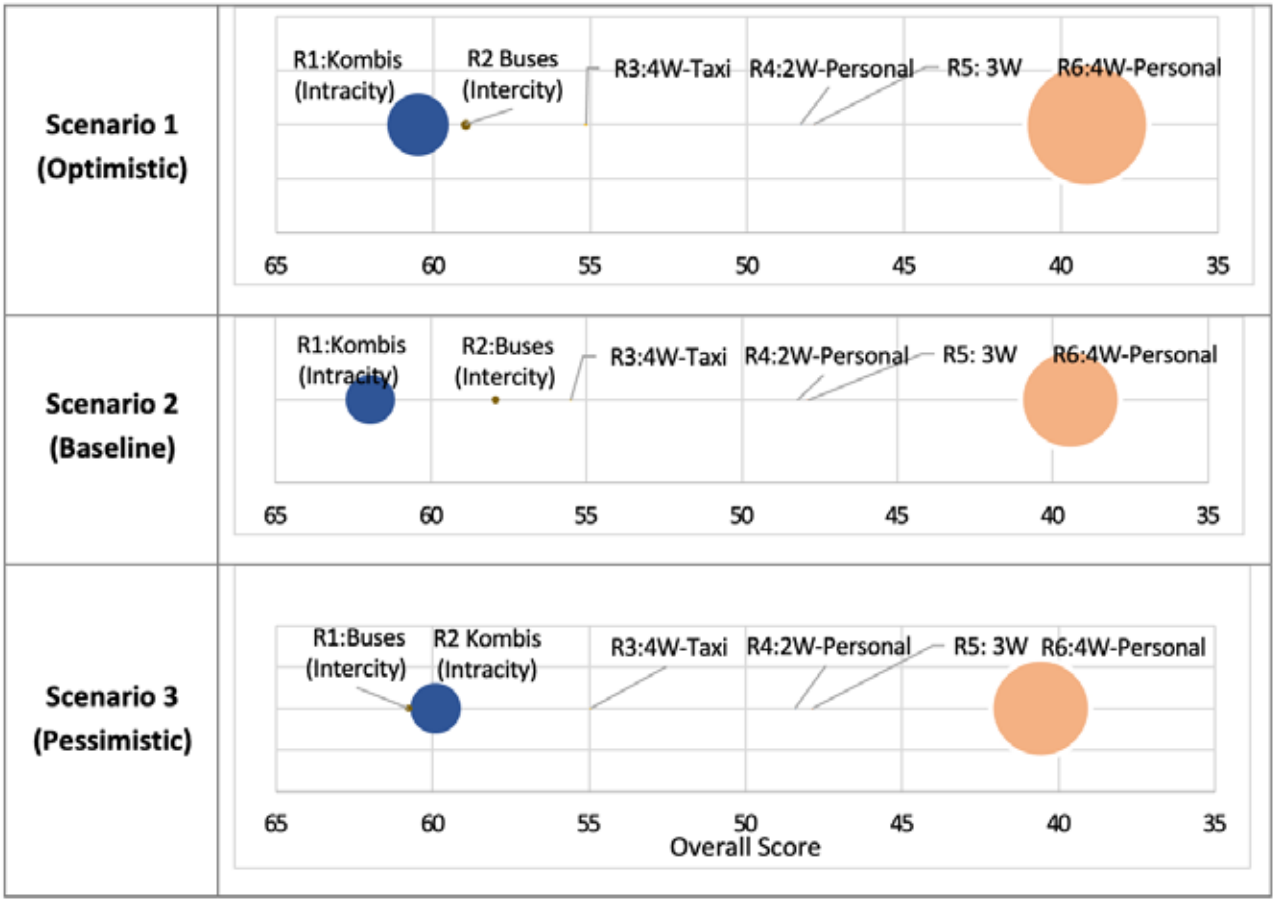
3.3.6. Results

The impacts of changes in the parameters (as given in Table 3.3) on the prioritization results are indicated in Table 3.4 and Figure 3.3.

TABLE 3.4 Scores across vehicle segments in the scenarios

Overall Score		2W – Personal	3W	4W – Personal	4W – Taxi	Buses (Intercity)	Kombis (Intracity)
Scenario 1 (Optimistic)	Score	48.4	47.8	39.2	55.2	59	60.5
	Rank	4	5	6	3	2	1
Scenario 2 (Baseline)	Score	48.2	47.8	39.4	55.5	57.9	62
	Rank	4	5	6	3	2	1
Scenario 3 (Pessimistic)	Score	48.4	47.8	40.6	55	60.8	59.9
	Rank	4	5	6	3	1	2

FIGURE 3.3 Results from scenario analysis



The results indicate that top rankings do not change with variations in parameters. Thus, kombis and buses retain their first rank for electrification. The high priority for public vehicles is due to their high potential to reduce GHG emissions through shared mobility and governmental priority, who owns approximately 70% of fleet shares through ZUPCO.

4. Barriers and enabling measures for the prioritised EVs

4.1. Methodology for Barrier Analysis

Barrier analysis in the context of EVs here refers to the analysis of market conditions for the prioritized EVs and the identification of barriers in their large-scale deployment. The entire value chain of the EVs from vehicle production to vehicle disposal (see Figure 4.1) has been considered for the barrier analysis. The barrier analysis helps identify strategies and policies, also referred to as "enabling measures" to overcome the identified barriers, which, in turn, can help attain the objective of large scale deployment of EVs in the country.

The value chain of vehicles that applies to both internal combustion engine vehicles (ICEVs) and EVs is mapped across production, purchase and registration, vehicle use, repairs and maintenance, and final vehicle scrappage and disposal, as shown in figure 4.1.

FIGURE 4.1 Value chain of vehicles (ICEVs and EVs) across the lifecycle

The barriers were identified in consultation with local experts and stakeholders, including government, industry, NGOs and others. The process followed for the stakeholders' consultation is shown in Box 4.1. The barriers were grouped under eight categories that included Economic and Financial barriers (E), Technological barriers (T), Institutional barriers (I), Infrastructure barriers (Inf), Social barriers (S), Market barriers (M), Regulatory barriers (R) and Policy barriers (P). The policies benchmarked from global best practices were discussed with local experts and stakeholders and thereafter mapped to appropriate barriers to developing the first potential policy framework for e-mobility adoption and growth in Zimbabwe. Subsequently, cost benefits for identified policy interventions were estimated and combined with other parameters to select optimal policies for inclusion in the final e-mobility roadmap for Zimbabwe.

Box 4.1: Stakeholder consultation process

Two types of stakeholder consultations were conducted: 1) Individual stakeholder consultations and 2) Group consultations.

The process included three steps as follows:

Step 1: A comprehensive list of stakeholders was made. It included stakeholders from various ministries, private sector (OEMs, Dealers), financing institutions, academic institutions, civil society/unions and industry associations.

Step 2: Questionnaires were prepared for individual stakeholders. The questions were related to the existing situation of transport and energy sector, issues, and their take on EV uptake (barriers and policies).

Step 3: Stakeholders consultation Interviews and workshop

a. Individual consultations: All the listed stakeholders were approached through formal communication and calendar invitation for consultations were sent. The questionnaires were used, and consultations were done on-line.

b. Group Consultations: Group consultations were carried out in a workshop. with 24 participants from the ministries, transport, energy and industry sectors. The group consultations were aimed at vetting the passenger vehicle segments prioritisation and driving the discussion towards identifying barriers to EVs and possible policy recommendations for Zimbabwe.

4.2. Barrier Analysis

Barriers have been discussed in this section across the vehicle value chain. First, the value chain has been discussed with barriers at various stages and it is followed by categorization of various barriers. The barriers have been categorised since it helps optimize measures to address them. Often, a measure can help address several barriers in a category, thus avoiding the need for multiple measures.

4.2.1. Barriers for EVs in the Vehicle Value Chain in Zimbabwe

Barriers across the vehicle value chain have been discussed in this section for Zimbabwe.

4.2.1.1. Vehicle Production and Supply

The Automobile industry in Zimbabwe has witnessed a rapid decline in the local manufacturing /assembly segments and has negligible indigenous manufacturing in place. For example, in the 1990's one of the local vehicle assembly plants, Willowvale Motors produced an average of 9,000 vehicles per annum. High production costs and prices of vehicles due to devaluation and inflation during 1997 to 2008 and increased competition from cheap pre-owned vehicles imports resulted in a continued decline in production to less than 1,000 units per year. As a result, mobility in Zimbabwe is now primarily dependent on imported vehicles with 98% imports from Japan, Europe, the USA, and South Africa. Of these imports, a large part of vehicles is pre-owned with an average age of 11 years, due to a lack of national performance standards and quality control, and emissions standards for these ICE vehicles. The Government of Zimbabwe has recently moved to ban the imports of used vehicles that are older than 10 years under the Control of Goods (Import and Export) (Commerce) (Amendment) Regulations, 2021 (No.9). However, the overall local investment appetite is low, and the skillset is limited, leading to a lack of manufacturing capacity both for ICEVs and EVs.

The cheap prices of pre-owned vehicles compared to new vehicles is the major reason for their customer purchase preference and popularity in the market. For EVs, there are no defined standards on import, manufacturing, assembly, as well as for battery and charging in Zimbabwe, which may lead to quality and reliability issues after purchase.

4.2.1.2. Vehicle Purchase and Registration

EVs have lower operational costs while their upfront purchase costs are very high compared to the ICEVs[9] . In addition to this, high import duties and the absence of subsidies and financing options for EVs purchase in countries have affected the end-user adoption of EVs at large.

ICEVs imported and registered in Zimbabwe are subject to about 25% import duty, 14.5 % VAT and, 35% surtax (if a vehicle is older than 5 years); and the same taxes are being imposed on EVs. Given the high purchase cost of EVs and import duties, currently, the demand is low and hence there are very few EV dealers in Zimbabwe.

9 Based on total cost of ownership (TCO) analysis done for passenger vehicles

Taxation Structure:

i. CIF = Purchase price (FOB)+ Freight Value + Other Charges

ii. VDP = CIF + Other charges (on landed price)

iii. Import Duty – Calculated as % of VDP

iv. VTP = VDP+ Import Duty

v. VAT – Calculated as % of VTP

vi. Surtax – Calculated as % of VDP

vii. Total Tax = Duty + VAT + Surtax

The vehicle classification system currently used for registration is based on ICE vehicle weight, engine displacement and capacity of the factory manufacturing vehicles (factory rated capacity) etc. which leads to overlaps as well as a lack of clarity in categorization, including difficulty in distinguishing passenger and freight vehicles. This also makes it difficult to accommodate EVs in the current classification system for registration. As ZIMRA, ZINARA and CVR follow different processes and classification for record-keeping, it leads to a non-uniform database and ambiguity in classification. There is no 'zero-emission vehicles' classification which has been used in many countries to promote EVs along with targets, and EV friendly policies.

The kombi and bus operators (fleet owners as well as individuals) need to follow multiple processes including registration, licencing, and permits (if applicable) at multiple widows to legally run their fleet/bus for commercial passengers' transport. They incur multiple fees and taxes making it a high-cost operation for the fleet operators.

The shared passenger transport sector (Public and Intermediate Public Transport - IPT) has witnessed a lot of changes in the last twenty years with the formalisation and in-formalisation of the sector in Zimbabwe. As a result, there is a lack of - standard fleet purchase, demand aggregation and operational business models in Public Transport (PT) and Intermediate Public Transport (IPT) sectors, which focus on reducing Capex (Capital Expenditure), Opex (Operational Expenditure) and overall lifecycle cost of operations and enhancing service levels. This signifies the need for piloting and adopting global and regional best practices suitable to the local context for fleet operations focusing on service delivery and profitability.

4.2.1.3. Vehicle Use

The electric vehicle market is still at a nascent stage in Zimbabwe with a handful of EVs, mostly pre-owned and imported. The vehicle efficiency, range, charging time, and quality of batteries in the vehicles are some crucial elements but not validated before EVs are imported. These are also not monitored during on-road use of vehicles due to the absence of EV standards and quality assurance mechanisms across the EV value chain.

The EV market is also underdeveloped due to limited local assembly/ manufacturing, dealerships, and research and development (R&D[10]) facilities. As a result, there are very few use cases across different vehicle segments. The areas for individual and fleet usage of EVs need to be explored and piloted (both for personal and commercial purposes) as they will help drive improvements across the EV supply chain, including improving supplies, quality (product and service) and performance. This signifies the need to promote R&D, which may help develop assembly/ manufacturing facilities and dealerships.

The EV technology is new for Zimbabwe and there is apprehension among vehicle users to adopt it. The lack of visible public charging infrastructure in Zimbabwe adds to the user apprehension on the adoption of EVs. A lack of EV public charging infrastructure, charging standards and long charging time, all leading to lower utilization of EVs are currently some crucial issues. Most EV charging for personal vehicles is happening globally at home, which could also be an option in Zimbabwe. However, its scalability for high EVs penetration is unexplored.

Other important challenges include the low access to electricity and availability of grid infrastructure (grid access estimated 40-45% (MoEPD, 2021). Approximately 14,000 kms of network worth USD 2 billion is required to be developed for the distribution of electricity nationwide. The energy sector lacks investments (public and private) and customer service by Power Distribution Companies (DISCOMs) (REF, 2021).

10 R&D includes the research in e-mobility, product development, design, safety, product quality; various academic and industrial trainings; support on indigenous manufacturing and development of e-mobility etc.

In addition, the low cost of electricity adds to the viability issues and bankability of new investments in the power sector. Despite having targets, Zimbabwe has a very low penetration of renewable energy in the power sector due to inflationary pressure and fear of losses in long term investments. Cheap electricity tariffs that can be as low as US 3 cents per kWh for industrial segments reduce the competitiveness of renewable energy sources, negatively impacting project viability.

4.2.1.4. Vehicle Repairs and Maintenance

One of the major challenges in the automobile sector in Zimbabwe is the limited local capacity and skills for manufacturing as well as repair and maintenance (R&M) of vehicles. There are no standard procedures for periodic vehicle inspection for health checks and roadworthiness. The repair and maintenance facilities including vehicle workshops are not up to the mark to ensure the quality of R&M services. The challenge arises due to the lack of adequate disposable income of vehicle owners as well as service providers to pay for these processes and set up the facilities and the lack of overall automotive skills. This affects the lifecycle costs of vehicles, normally the cost of R&M accounts for 21% of the total cost of ownership in vehicles but for a pre-owned vehicle it is 43% of the total cost of ownership[11].

4.2.1.5. Vehicle Scrappage and Disposal

Vehicles scrappage and disposal is an essential part of the value chain of the vehicles from the perspective of waste management as well as phasing out inefficient and old fleets from vehicle stock. Old ICE vehicles are being scrapped in Zimbabwe, however, there are no guidelines for their scrappage and re-use ensuring their disposal sustainably. Similarly, for EVs, as the used vehicle market is emerging, guidelines for vehicle disposal are needed. EVs come with batteries which are a prominent part of an EV. Apart from the vehicle body, the battery also has disposable as well as reusable parts and their proper usage can help the economy.

4.2.2. Barriers Categorisation for EVs in Zimbabwe

The barriers to large scale deployment of EVs in Zimbabwe were discussed through stakeholder engagement. A list of stakeholders who were consulted and attended the workshop is given in Annexure-III. Barriers were categorised into the following five categories.

(i) Economic and financial barriers: include both a lack of economic or financial viability and access to available and affordable finance to buy an EV or retrofit an ICE vehicle

(ii) Policy, regulatory and institutional barriers: can be a policy or regulation which may be dis-favourable to the technology that needs to be deployed. An import ban, tedious procedure or high taxes to import the technology for example.

(iii) Technical and Infrastructural barriers: new technologies often require skilled personnel as well as infrastructure, the absence of which can be an obstacle in its deployment.

(iv) Awareness/information barriers: new technologies usually face this barrier. There is neither full information available about the technology in a country nor stakeholders are even aware of steps that are being taken for the promotion of the technology in the country.

(v) Other barriers: other barriers can be country-specific or technology-specific. Safety for example can be an issue in some cases.

Barriers were considered at two levels. Level 1 indicates the barrier at a higher level while at Level 2 it is decomposed into its various dimensions, also referred to as components. All the above categories of barriers are included in Table 4.1.

11 The percentages of repair and maintenance cost is based on TCO Analysis for Passenger vehicles conducted for this study.

TABLE 4.1. Barriers to large-scale deployment of EVs in Zimbabwe

Barrier category	Barriers	Barriers components
Economic and Financial Barriers	High purchase price of EVs and batteries	The high price of EV: Prices of new EVs are very high compared to pre-owned ICE vehicles' prices.
		The high price of batteries and other spare parts of EVs. Batteries may need replacement after some years, but the price of batteries is also very high. Import duties on EVs, spare parts and CKD kits are high, the same as on ICE vehicles.
Market Barriers	Lack of local supply chain for EV manufacturing and related services	High level of pre-owned ICE vehicles at cheap prices makes EVs uncompetitive
		Very few EV dealers due to low EV demand and a lack of EV awareness among dealers
Policy and regulatory barriers	Lack of vehicle standards	Un-defined ICE Standards: No defined ICE vehicle standards (ageing, engine size, safety, emissions etc.), leading to cheap ~98% high polluting pre-owned (and long-aged) vehicles entering into the country (Most of the current ICEs are in-compatible with EURO 4 fuel standards adopted in the country)
		Un-defined EV Standards: No defined EVs, batteries and charging standards (for new, pre-owned and retrofits)
	Lack of Scrappage Policy	No vehicle scrappages policy for ICEs
Infrastructure and technical barriers	Lack of charging infrastructure	Limited public charging infrastructure: This leads to a lack of confidence in EVs for planning various trips
		Long waiting time for charging
		Inadequate home and office charging network: No guidelines for home and office charging from the power distribution company
	Poor access to electricity	Low access to the grid and poor power quality: (80% and 20% electricity connections to urban and rural respectively)
	Lack of automotive skills	Lack of automotive skills: Overall lack of automotive skills including retrofitting and repairs and maintenance of EVs
Awareness / information	Lack of promotional and facilitation measures for new (clean/low emission) technology	A lack of awareness of new clean/low-emission technologies
		EV Technology Apprehension

4.3. Enabling Measures for a Market Readiness Framework for EVs in Zimbabwe

Enabling measures refers to the development of strategies and policies that help create an enabling environment to address the barriers. The enabling environment denotes the entire range of institutional, regulatory and political framework conditions that are conducive to promoting and facilitating the transfer and diffusion of technologies (TERI, 2003). The country-specific circumstances that include existing market and technological conditions, institutions, resources and practices are considered, which can be subject to changes in response to government actions. The policy measures may target both; supply-side and demand-side aspects of the transfer and diffusion of technologies. As already mentioned, various barriers and enabling measures/policies were discussed through stakeholder engagement. A list of potential enabling measures/policies based on the stakeholders' responses in the workshop is given in Table 4.2.

TABLE 4.2. Potential enabling measures/policies to support large scale deployment of EVs in Zimbabwe

Enabling measure /policy category	Potential enabling measures/policies	Stakeholders responsible for the action
Economic and financial measures/policies	**EV end-user purchase subsidy**: Encourage end-consumers for EVs adoption through subsidising different types of EVs that meets quality and safety standards. The capital subsidy is to be linked to battery size and vehicle performance and should be capped. Depending on vehicle type, subsidy rates could also take into consideration the purchasing power of various segments of the population to avoid further exasperating inequalities in terms of transport access.	o Ministry of Finance and Economic Development o Banks and financiers o ZIMRA
	EV end-user interest subsidy: Develop mechanisms to enable fair and equal access to loans for men and women and allow easy and lower interest rates of financing for EVs (including, any interest subsidy from the government)	o Ministry of Finance and Economic Development o Banks and financiers
	Exemption of Import duties on EVs: Exempt import duties on EVs (new, pre-owned and retrofits) that meet defined quality and safety standards	o Ministry of Finance and Economic Development o ZIMRA o Motor Industry o Association of Zimbabwe (MIAZ)
	Exemption of Import duties on EV sub-systems and raw materials: Exempt import duties on EVs raw materials (e.g. cells), sub-systems (EV batteries, chargers, motors etc.), CKD kits for 5 years until the local ecosystem is developed	o Ministry of Finance and Economic Development o ZIMRA o MIAZ
	Exemption / reduction in sales tax: Exempt or reduce or exempt sales tax on EVs for the first few years until the right market development and price parity is reached. Align EV sales tax (from Original Equipment Manufacturers (OEMs)/dealers to end consumers) to input raw material taxes paid by the OEMs for appropriate working capital management by OEMs	o Ministry of Finance and Economic Development o ZIMRA
	Exemption/ reduction of registration fees and taxes for EVs: Exempt or reduce registration fees, one-time taxes and recurring taxes on EVs (as per revised vehicle classification) for 3 years until the appropriate market development and price parity is reached	o Ministry of Finance and Economic Development o ZIMRA o CVR
	Exemption/ reduction of repeat taxes for EVs: Exempt or reduce the repeat taxes (registration renewal and licensing) on EVs for the first 3 years and gradually increase thereafter until EVs are rightly established	o Ministry of Finance and Economic Development o ZIMRA
Market development measures	**Incentives for local assembly/manufacture of EVs and their components**: The measures to make EVs competitive and create demand have been covered in the economic and financial measures, policy and regulatory measures, and other measures. Alternate / complementary measures can also be considered from the supply-side that include fiscal incentives (Capital/ interest/ tax subsidies) for local assembly and manufacturing of EVs and their sub-systems & components (including local value add of mining raw materials use in EVs). The incentives could be considered for manufacturers as well as for dealers.	o Ministry of Finance and Economic Development o ZIMRA o MIAZ
	EV technology R&D: Another supply-side measure is to encourage start-ups across the EV value chain through R&D grants/funds and the right incubation support for production, skill and capacity building, including: · Battery manufacturing, assembly and supply · Charging equipment manufacturing/ assembly and supply · Electric motors	o Ministry of Higher and Tertiary Education, Innovation, Science and Technology Development o Ministry of Transport and Infrastructure Development o NAMACO o Government of Zimbabwe o SIRDC o ZERA
	EV awareness program for dealers: Increased awareness programs to assist consumers to know and appreciate EVs	o Automotive Industry association o EV enthusiasts and interest groups o Ministry of Energy and Power Development o Ministry of Transport and Infrastructure Development o Development Partners o Media

Enabling measure /policy category	Potential enabling measures/policies	Stakeholders responsible for the action
Policy and regulatory measures	**Vehicle emission standards (new & pre-owned ICE vehicles)**: Develop/ Adopt and enforce vehicle emission standards for new and pre-owned vehicles, compatible with upgraded fuel standards (EURO4) (for imports and local production; and for first-time registration and repeat use)	o Ministry of Energy and Power Development o Ministry of Transport and Infrastructure Development o Standards Association of Zimbabwe (SAZ) o Ministry of Environment, Climate, Tourism and Hospitality Industry
	EV safety standards (new & pre-owned EVs): Adopt relevant global quality and safety standards (with customisation) for different types of EVs (new, pre-owned and retrofits), advanced EV battery technologies (no Lead), charging technologies, EVs and chargers' inter-connection and their inter-operability, chargers and grid interconnection and communication, security against theft and end-consumer communications including vehicle to Load/Home/Grid standards	o Ministry of Transport and Infrastructure Development o Ministry of Environment, Climate, Tourism and Hospitality Industry o Ministry of Energy and Power Development o Standards Association of Zimbabwe (SAZ)
	Zimbabwean EV mandates for OEMs: Develop a Zimbabwean EV mandate for automotive OEMs to manufacture EVs (minimum percentage of total vehicle production to be defined). One mechanism for this can be through CAFE - Corporate Average Fuel Efficiency standards and regulate average g/km CO2 across OEM production portfolio. CAFE can be first rolled out for cars, as it has the highest mode share in Zimbabwe.	o Ministry of Transport and Infrastructure Development o Ministry of Energy and Power Development o Ministry of Industry and Commerce
	Vehicle scrappage/re-use mandates: **1. ICE**: Establish a scrappage mandate for different ICE vehicle types and curb the use of vehicles after the end of (20 years) life. Other mechanisms could be, allowing vehicles to retrofit (with fitness test) to EVs. **2. EVs**: Establish scrappage/re-use mandate for different EV types and curb the use of vehicles after the end of (20 years) life.	o Ministry of Transport and Infrastructure Development o ZINARA o Central Vehicle Registry (CVR) o Vehicle Inspectorate Department o Ministry of Environment, Climate, Tourism and Hospitality Industry o EMA
	Battery recycle and re-use guidelines: Develop Lithium Battery recycle - re-use guidelines covering collection, storage, transportation and recycling of waste batteries (for suppliers, manufacturers and consumers)	o Ministry of Transport and Infrastructure Development o Ministry of Energy and Power Development o Ministry of Mines and Mining Development o Ministry of Industry and Commerce o ZERA

Enabling measure /policy category	Potential enabling measures/policies	Stakeholders responsible for the action
Infrastructure-enabling policy measures	**EV charging infrastructure subsidies and incentives**: Encourage industry and distribution company participation through attractive fiscal incentives (capital/ interest/ tax/ electricity subsidies) on the set-up of EV charging stations and services. Allow distribution companies to capitalise on the cost of setting and running minimum public charging stations (until the market gets developed)	o Ministry of Finance and Economic Development o ZIMRA o Ministry of Local Government and Public Works
	EV charging tariff revision: Introduce preferential electricity tariffs for EV charging providers for them to access cheaper electricity. Also, introduce Time of Use tariffs at night in the residential and commercial buildings to encourage overnight charging when there is low demand to reduce strain on the current grid infrastructure (together with 100% smart meter deployment)	o Ministry of Finance and Economic Development o ZIMRA o Ministry of Energy and Power Development o ZERA
	EV public charging infrastructure guidelines: Develop guidelines for public charging infrastructure for the right selection of fast charging options and the right interoperability. Prepare/update National Transport plan and city-level master plan and development code inclusive of e-mobility development. Encourage home and office charging of EVs and facilitate easier new connection or existing sanctioned load revision. This will reduce dependence on public charging infrastructure and waiting time thereof. Install more charging stations to minimize waiting time, where needed.	o Ministry of Transport and Infrastructure Development o Ministry of Energy and Power Development o Ministry of Local Government and Public Works o Local Authorities o ZERA
	EV home and office charging infrastructure guidelines: Develop new Building codes and guidelines for setting up appropriate charging infrastructure (especially for multi-storied residential and in offices). Include EV charging provision in new building plans. Prepare/update National Transport plan and city-level master plan and development code inclusive of e-mobility development.	o Ministry of Transport and Infrastructure Development o Ministry of Energy and Power Development o Ministry of Local Government and Public Works o Ministry of National Housing and Social Amenities o Local Authorities o ZERA
	EV safety standards (infrastructure): Develop gender-sensitive safety measures and standards for hard and soft infrastructure relevant for shared mobility (including pick-up/drop-off spots, routes, and schedules).	o Ministry of Transport and Infrastructure Development o Ministry of Environment, Climate, Tourism and Hospitality Industry o Ministry of Women Affairs, Community, Small and Medium Enterprises Development o Standards Association of Zimbabwe (SAZ) o Ministry of Energy and Power Development
	Encourage expansion of electricity infrastructure: Drive government and private investments in national grid expansion Encourage (Decentralised Renewable Energy - DRE) mini-grids (by government and private players) to integrate EVs (including plug-in charging and swap batteries). Allow easy and lower interest rate of financing for DREs Revise the electricity tariffs across different utility sectors and encourage competitive prices across nations	o Ministry of Energy and Power Development o Ministry of Transport and Infrastructure Development o Ministry of Environment, Climate, Tourism and Hospitality Industry o ZERA o ZETDC

Enabling measure /policy category	Potential enabling measures/policies	Stakeholders responsible for the action
Infrastructure-enabling policy measures	**Acceleration of power sector reforms**: Accelerate development of electricity grid network, power generation production capacity for 100% connections and 24x7 power for all	o Ministry of Energy and Power Development o ZERA o Ministry of Finance and Economic Development o ZIMRA
	Automobile and EV technology training and skill development: Develop guidelines for OEMs and dealers to partner with local institutions and build strong training and certification skill programs to build local expertise with EVs assemble, innovate, repairs & services, retrofitting, driving, etc.	o Ministry of Transport and Infrastructure Development o Ministry of Energy and Power Development o ZERA o NAMACO, Ministry of Higher and Tertiary Education o TSCZ o Academia and Research Institutions
Information, awareness and promotional measures	**EV adoption mandate for government departments**: Mandate various government departments to purchase EVs only for their new fleet procurement and/or leasing. This can be made 100% or gradual increase from 50% to 100% in 2-3 years	o Office of the President and Cabinet o Government of Zimbabwe
	EV bulk procurement mandate for government departments: Give mandate to one government department to organise bulk procurement of EVs for aggregated demand from government and private offices	o Government of Zimbabwe
	EV adoption targets: Set EV targets for different fleet applications (2Ws, 3Ws, cars and buses) for new EVs procurement, gradually becoming 100% of the new purchase in the next 5-10 years	o Government of Zimbabwe
	Revision of vehicle classification: Revise existing vehicle classification system (separate for passenger and freight transport and distinguishing commercial versus private use) to rightly fit different types of EVs (and any other future vehicle technology)	o Ministry of Transport and Infrastructure Development o ZIMRA o CVR o VID
	EV awareness program for users (individual, fleet): Design and conduct repeat gender-sensitive public awareness programs on EVs benefits and support from government and local ecosystem, targeting fleet and individual/ private users	o Ministry of Transport and Infrastructure Development o Ministry of Higher and Tertiary Education, Innovations, Science and Technology Development o Ministry of Energy and Power Development o NAMACO o Govt of Zimbabwe o EV OEMs o ZERA o Traffic Safety Council of Zimbabwe (TSCZ) o Environmental Management Agency (EMA) o Dealers

Enabling measure /policy category	Potential enabling measures/policies	Stakeholders responsible for the action
Information, awareness and promotional measures	**Supporting EV pilots**: Encourage EV pilots through funding, subsidising, incubation support for purchase, research and implementation including different use cases of EVs (shared fleet and individual use cases)	o Ministry of Transport and Infrastructure Development o Ministry of Finance and Economic Development o Ministry of Environment, Climate, Tourism and Hospitality Industry, o Ministry of Energy and Power Development o Ministry of Higher and Tertiary Education, Innovations, Science and Technology Development
	EV awareness programme for automobile industry OEMs and suppliers: Increased awareness programs to assist ICE manufacturers to gradually shift to EVs (vehicle and its components) production and supply.	o Ministry of Transport and Infrastructure Development o Ministry of Environment, Climate, Tourism and Hospitality Industry, o Ministry of Energy and Power Development o Ministry of Information and Technology Services o Private sector (Automotive Industry)
	Single window clearance for EVs registration and licensing: Single window clearance system for vehicle registration and licensing (aligned with new and clear vehicle classification system)	o Ministry of Transport and Infrastructure Development o ZINARA o CVR o VID
Gender-sensitive measures	**Institutional measures**: Strengthen institutional capacity to advocate for rights, needs and priorities of women, youth, children, elderly and most vulnerable within transport and infrastructure development. Set target for the share of women trained and employed in the transport sector.[12]	o Ministry of Transport and Infrastructure Development o Ministry of Women Affairs, Community, Small and Medium Enterprises Development
	Capacity development: Increase capacity of service providers to identify, prevent and respond to gender-based violence and harassment on public transport. Develop training programmes for responding to incidents	o Ministry of Transport and Infrastructure Development o Ministry of Women Affairs, Community, Small and Medium Enterprises Development
	Public awareness: Strengthen public awareness and mobilize the community in promoting change in social behaviour among users of public transport through a public communications campaign. Develop partnerships with media outlets Develop promotional material and resources for public awareness campaigns	o Ministry of Transport and Infrastructure Development o Ministry of Environment, Climate, Tourism and Hospitality Industry, o Ministry of Energy and Power Development o Development Partners o Care Dealers

12 One of the important measures, "setting target for the share of women in decision making bodies and committees concerning public transportation" is included in the revised National Gender Policy of 2020.

4.4. Selection of Policies/Enabling Measures

It needs to be mentioned here that this is a list of potential measures and in some cases, a few of them in each category may only need to be selected for implementation. In the case of economic and financial measures, for example, the aim is to make EVs competitive with their counterpart ICE vehicles so that consumers find them attractive to purchase. This can be achieved through a mix of the following: (i) some of the incentives listed in the measures; (ii) some measures that discourage old and polluting ICE vehicles; and (iii) promotional measures. The cost of an alternate package of preferred measures should be worked out so that optimum and informed decision is taken.

5. Opportunities for EV Adoption

5.1. Micro-mobility

Last-mile connectivity and micro-mobility are essential as accessibility issues are prevailing in Zimbabwe. Poor last mile connectivity is responsible for loss of sense of security and safety for long-distance travellers, long walking distances and a lack of overall accessibility. With relatively lower prices and operational viability of micro-mobility modes, the alternatives to current ICEV two-wheelers and three-wheelers could be e-bikes (e-2Ws), e-tricycles (e-3Ws). These can address the accessibility and affordability issue to a large extent as their application is not only limited to personal travel but also caters the small commercial use including, small deliveries, transportation of agricultural harvest etc. The average commuting distance in Harare is 15km. This relatively short distance is ideal for a large cross-section of micro-mobility solutions. Ease of driving and less complex technology make EVs safer transport modes, especially for women in rural areas.

5.2. Intermediate Public Transportation

Current Intermediate public transport in Zimbabwe is fragmented and consists of more than half of informal taxis (Mushikashika). The operational cost of ICEVs is higher than that of EVs in this case and hence, 'e-taxis' with the right subsidies, incentives, and tax exemptions (to compensate for higher capital cost) can encourage operators/individuals to opt for emission-free taxis and run them at nominal operating costs.

5.3. Public Transportation

Government-owned Zimbabwe United Passenger Company (ZUPCO) operated public transport in Zimbabwe with a fleet of mostly 16-seater minibuses and their monopoly was terminated in 1993. After that, public transport has been quite fragmented in Zimbabwe with a few fleet operators, and individual operators of kombi as well as large buses.

The re-formation of ZUPCO and the decision to formalise the public transport sector in Zimbabwe again is an effort to revive Zimbabwe's public transport system. This provides an opportunity to introduce 'e-public transport' in Zimbabwe, which can be e-kombis or large e-buses. To increase EVs share in public transport will require piloting the fleet operations in major cities with financial and policy support.

5.4. Other fleet applications

Localised campus operations such as government offices, schools, mining industry fleet etc. could represent early low hanging fruit opportunities for electrification. Fleet managers at campus centric businesses are generally in a position to afford new electric vehicle models and have a periodic fleet replacement cycle that could be taken advantage of. They offer an opportunity for high volume orders, further incentivizing original equipment manufacturers and their dealers or franchises. Campus centric industries/institutions include the mining sector, universities and colleges, airports, the tourism sector and the farming and agricultural sector. Potential campus centric segments in Zimbabwe are indicated below.

5.4.1. Mining sector

Operations around large campuses form a critical constituency of the transport landscape. The most significant of these is the mining sector. Big mines in Zimbabwe generally have dedicated lines and special arrangements with the power utility to ensure guaranteed access to power which they pay for in USD.

5.4.2. Central Mechanical Equipment Department (CMED)

The CMED is a parastatal agency, wholly owned by the government under the Ministry of Transport and Infrastructure Development (MoTID). The company sources, services and maintains vehicle fleets for all government departments in Zimbabwe. The CMED has a subsidiary EASYGO, that offers vehicles for hire

and driver training on a commercial basis to members of the public, corporate and non-governmental organisations. In July 2020, the CMED issued an RFP for luxury electric vehicles to add to its fleet.

5.4.3. Zimbabwe Electricity Supply Authority (ZESA)

The ZESA board highlighted that it requires 2,600 vehicles to return to its optimal operating levels and to restore its 24-hour fault restore service. They intend to upgrade their fleet and include electric vehicles as part of their fleet replacement programs. ZESA would like to take the lead by utilising its 90 centres across the country to roll out electric charging points.

5.5. Creating synergies with power generation and EV operations

With Zimbabwe's new focus on renewable energy and growing investment in the independent generation of green energy, there is an opportunity to foster this sector and reduce dependency on imported fossil fuels.

The transition to electric mobility must be closely aligned to the increase in clean energy generation that makes rural and urban charging options feasible. Electric Mobility has the potential to increase the viability of renewable energy generation by increasing demand for productive use and also help absorb its variability.

Electric mobility has the potential to provide a new opportunity to utilities as utilities can play an important role in creating charging infrastructure. Also, electric mobility can provide an opportunity to use off-peak power during nights as vehicles can be charged during nights. New technology developments such as vehicle to grid (V2G) has potential for two-way flow electricity, vehicles acting as electricity storage, and feeding back electricity to the grid when needed. Adoption of electric mobility may however require expansion of the supply to meet the increasing demand as well as strengthening of the grid.

5.6. Onsite power generation and synergies with EV operations

Large mines such as Caledonia's Blanket mine 20 MW PV project are building large solar plants that are capable of providing up to 30% of their 24-hour energy consumption requirements. Several other firms including RioZim also plan to add as high as 75 MW of onsite solar generation capacity to power their mining campuses in Zimbabwe along with several other big mines that have announced plans to install large photovoltaic plants.

The mining sector is the largest consumer of electricity in Zimbabwe, policymakers, therefore, should continue to encourage local onsite generation by these players. With a significant fleet of vehicles for staff and operations in a campus model that is perfect for electrification, mining firms can unlock more value from their solar plants by powering electric vehicles. This would reduce operational costs and benefit from synergies of onsite generation from Solar PV and EVs. Unlocking the synergies between distributed energy generation and electric vehicles will help both sectors support each other. Private investments into generation as well as other private-public partnerships can bridge the current energy generation gap.

5.7. Potential for Battery Manufacturing

The Mining Industry in Zimbabwe accounts for 60% of the country's export and is responsible for the employment of 37,000 formal jobs and 200,000 artisanal and small-scale miners (Zimbabwe Chamber of Mines Annual Report, 2019). The Mining sector produces important raw materials required for battery manufacturing that include Nickel, Manganese, Phosphate, Lithium and Graphite amongst others. These can feed into indigenous battery manufacturing, which has a prospect to be an integral part of the EV supply chain in Zimbabwe. Other raw materials such as copper, which is an essential part of motor manufacturing, also create an opportunity for indigenous motor manufacturing in the EV supply chain. Zimbabwe can thus leverage its mining industry produce for EV battery manufacturing with the right technical support, skill development, R&D incubation and funding for the same.

5.8. Support from MoEPD for the establishment of Charging infrastructure

In September 2019, The Ministry of Energy and Power Development announced government support for the adoption of electric vehicles. It was also stated that the government's fuel retailing company will install charging stations at its fuel stations and along the country's major highways. This is an important development for EV adoption and dissemination in Zimbabwe.

5.9. Other opportunities

Zimbabwe can be a leader in SADC in leading the electric transport transition by being the hub for innovation and testing new technology for the African market, investing in new skills, and providing the right incentives for investment in manufacturing and adoption. It will require;

- Boosting capabilities of local and national authorities, public transport operators and entrepreneurs about innovative urban e-mobility solutions across various transport modes by informing them about tools to plan, assess, implement, and operate e-mobility solutions. The capabilities to develop policy, implement business models and operate e-mobility solutions are a vital step in the transition process towards sustainable mobility.

- Fostering the take-up of e-mobility innovations by businesses, start-ups, local, provincial and national government departments and transport operators by inspiring officials, operators, industry and businesses through peer-to-peer exchange on innovative e-mobility products and services. Implementing new policies, adopting new technologies or testing new business models can be inspired by peer-to-peer exchange.

- Strengthening policy and business collaboration by initiating partnerships between government departments and entrepreneurs and supporting the development of new e-mobility business models based on addressing the enormous demand for reliable, safe and efficient transport.

- Creating reference models for e-mobility innovation by implementing demonstration actions to test innovative e-mobility technologies and services, foster their replication and ensure their long-term sustainability.

6. Roadmap and Action Plan for Implementation

To guide Zimbabwe on this transition to green mobility, policies have been identified to address the barriers to the introduction and deployment of e-mobility in Zimbabwe. A policy measure may address one or more barriers and therefore most effective and appropriate policies may only need to be selected for implementation. For example, reduction in import duty, purchase subsidy, interest subsidy, decreased sales tax etc. all may help address economic barriers but only one or a combination of a few may be needed. Selection of policies along with targets, timelines, resource requirements and institutional responsibility will be included in the National Policy Roadmap, which is a separate document.

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8. Annexures

8.1. Annexure-I: List of identified criteria for prioritization

Criteria		Explanation
C-1	EV investment requirement	Measured as total CAPEX required for 100% conversion from ICEVs to EVs. It is quantitatively computed assuming 100% EVs in 2020 with lower total CAPEX ranked higher.
C-2	Charging infrastructure investment requirement	Measured as total CAPEX required to install public charging infrastructure, if 100% conversion from ICEVs to EVs happens. It is quantitatively computed assuming 100% EVs in 2020 with lower total CAPEX ranked higher.
C-3	Electricity consumption	Measured in terms of electricity requirement (MUs) for EV charging, if 100% conversion from ICEVs to EVs happens. It is quantitatively computed assuming 100% EVs in 2020 with lower total OPEX ranked higher.
C-4	The ratio of Total Cost of Ownership (TCO) of new EV to ICEV	One key barrier to EV adoption is high purchase cost. Total Cost of Ownership (TCO) provides a rational metric to compare total life cycle costs. EVs applications in Zimbabwe across the vehicle segments have lower TCO than their ICEV counterparts. The ratio of TCOs of new EV to ICEV is measured quantitatively with lower numbers ranked higher (indicating EVs will offer better TCO than ICEVs).
C-5	ICEV to EV Retrofit potential	Zimbabwe has greater than 90% import of pre-owned vehicles, and hence retrofit of ICEVs into EVs could play important role in driving EVs adoption. The ratio of TCOs of ICEV to EV retrofit and new EV is measured quantitatively with lower numbers ranked higher (indicating retrofit will offer better TCO than new EV).
C-6	Fuel savings	Zimbabwe has 100% fossil fuel imports, and this has a high impact on its foreign reserves. EVs adoption in different vehicle segments will allow the country to save fuel in passenger transport and reduce its import bill. Fuel savings are quantitatively computed assuming 100% EVs in 2020 with the higher contribution being ranked higher.
C-7	Job creation opportunities	Implementation of EVs will stimulate investments and activities in multiple value chains across sectors including automobiles, transport, energy and others. These investments will generate both direct and indirect jobs. Vehicle segments are ranked qualitatively on their job creation potential and explained further in Annexure-II: Calculation and Inputs for Prioritization Matrix Analysis.
C-8	Quality of life and equity	It refers to the ease of movement, connection opportunities, social cohesion, and emancipation. Vehicle segments are ranked qualitatively on their Quality of life and equity potential and explained further in Annexure-II.
C-9	Gender Equality	It focuses on women and differently-abled for making transport easier (on drivability) to allow greater socio-economic opportunities across genders. Vehicle segments are ranked qualitatively on the above-mentioned aspect of gender equality potential and explained further in Annexure-II.
C-10	Air pollution reduction potential	EVs adoption in different vehicle segments has substantial potential for GHG emission reduction. This is quantitatively computed assuming 100% EVs in 2020 with higher reduction potential being ranked higher.
C-11	GHG reduction potential	Measured in cumulative metric tonnes CO2e mitigated from 100% conversion of ICE to EV. GHG reduction potential is quantitatively computed assuming 100% EVs in 2020 with higher reduction potential being ranked higher.
C-12	On-Road Vehicle Stock	The existing vehicle stock of each vehicle segment will help us understand the cumulative number of vehicles registered and provide an insight into the most widespread type of vehicle used. This is quantitatively computed with higher vehicle stock being ranked higher.
C-13	Vehicle trip length	The average trip length per day will help understand the vehicle segment travelling longest distance as the EVs are better viable for vehicles with long average trip length. This is quantitatively computed with higher vehicle trip length being ranked higher.
C-14	Fuel consumption per passenger-km	Fuel consumption calculated per passenger kilometre depend strongly on vehicle occupancy and vehicle efficiency. It has been assessed for all vehicle segments and results found that 4W-personal has the highest fuel consumption per passenger-km and thus lowest efficiency. Therefore, ranked lowest among all other modes.
C-15	Easiness of EV Charging	Dependency on shared public charging infrastructure is also a parameter that will determine easiness for EV adoption. Higher the dependency on shared public charging infra (outside dedicated chargers), slower can be those EVs adoption as it may take time to build the right infrastructure. Vehicle segments are ranked qualitatively on their ease of charging with lower rank to those with high dependency on shared public chargers (and not a strong business case for dedicated chargers).
C-16	Local availability of EV models	Currently, there is limited EV penetration in Zimbabwe and the number of EV dealerships is a good indicator of the local availability of EV models. Vehicle segments are ranked qualitatively on the estimated number of existing local EV dealerships. The higher the dealership numbers, the higher will be its rank.
C-17	Local post-sales services & spare parts availability	The existing local ecosystem for ICEV repair and maintenance will allow building the right capacity to also service EVs in Zimbabwe. Vehicle segments are ranked qualitatively on existing local ecosystem availability for ICEVs and explained further in Annexure-II.
C-18	Local assembly & supply potential for EV models & components	There are close to no existing local assemblers/ manufacturers of EVs in Zimbabwe. There is however local industry in ICEVs and sub-systems including batteries, which has the potential to be transformed to support EVs. Vehicle segments are ranked qualitatively on their potential to support local EV assembly and manufacturing as further explained in Annexure-II.
C-19	EVs R&D and Technical skills	This parameter deals with local research and innovation on EV design, willingness to develop local technical capacity and opportunities on skills transfers of EV design and maintenance. Vehicle segments are ranked qualitatively on their above-mentioned aspect of research and innovation on EVs and explained further in Annexure-II.
C-20	Quality of road and accessibility	Evs' performance and vehicle efficiency are impacted by the quality of road infrastructure where they typically operate. Vehicle segments are ranked qualitatively based on their most-used road infrastructure quality and explained further in Annexure-II.
C-21	Government's preference to provide fiscal incentives	The government may have a different strategy to support different vehicle segments, given their utility and impact on the masses and government expenditure. Vehicle segments are ranked qualitatively on the willingness of the Government's preference to provide fiscal incentives and explained further in Annexure-II.
C-22	Government's preference to provide non-fiscal incentives	Vehicle segments are ranked qualitatively on the willingness of the government's preference to provide non-fiscal incentives and explained further in Annexure-II.

8.2 **Annexure-II:** Calculation and Inputs for Prioritization Matrix Analysis

Sr. No	Measurement	Reference	2W – Personal	3W	4W – Personal	4W – Taxi	Buses	Kombis
1	CAPEX for 100% new EVs (2020)							
A	Unit cost of EV (CAPEX in USD)	Local stakeholder	2,544	3,893	74,635	74,635	1,17,593	94,643
B	Vehicle stock (2020)	Estimated	45,653	3,652	10,42,826	26,755	10,319	68,866
C=AxB	CAPEX for 100% EVs (2020 in million USD)	Calculated	116	14	77,831	1,997	1,213	6,518
D	Government's investment (%)	Assumption	5%	2%	10%	0%	20%	20%
E=CxD	Government's investment (USD)	Calculated	6	0.3	7,783	-	243	1,304
	Normalize		100	100	-	100	96.88	83
2	CAPEX for 100% charging infrastructure (2020)							
	Type of charging		Slow Charging	Slow Charging	Slow Charging	Slow Charging	Fast Charging	Fast Charging
A	Unit cost of Charging Point (USD)	Secondary research, Indiamart	100	150	250	300	850	600
B	No. of Vehicles shared per charger	*Market Report on Electric Vehicle Charging, 2019, pManifold*	10	6	6	6	2	6
C	Vehicle stock (2020)	Estimated	45,653	3,652	10,42,826	26,755	10,319	68,866
D=(AxC)/B	CAPEX for charging infrastructure (million USD)	Calculated	0.5	0.1	43.5	1.3	4.4	6.9
E	Government's investment (%)	Assumption	5%	2%	10%	0%	20%	5%
F=CxD	Government's investment (USD)	Calculated	0	0	4	-	1	0
			99	100	-	100	80	92
3	Electricity requirement for 100% EV conversion (MUs)							
A	Average distance travelled per day (km)	Local stakeholder	25	25	35	100	200	200
B	Avg. Vehicle efficiency/ Range (km/kWh)	*Market Report on Electric Vehicle Charging, 2019, pManifold*	35	10	8.3	8.3	1.0	4.0
C	Unit cost of Electricity (USD/kWh)	Secondary research, ZESA	0.1	0.1	0.1	0.1	0.1	0.1
D	Vehicle stock (2020)	Estimated	45,653	3,652	10,42,826	26,755	10,319	68,866
E	Operational Days per year	Assumption	300	300	300	300	300	300
F=A/B	Electricity required per day per vehicle (kWh)	Calculated	0.7	2.5	4	12	200	50
G=CxDxExF	OPEX for EV conversion per year (million USD)	Calculated	1	0	132	10	62	103
	Normalize		99	100	-	93	53	22
4	Ratio of TCO new EV to ICEV							
A	TCO of ICE (USD/Km)	pManifold and MFA TCO Model	0.17	0.35	1.31	1.31	0.65	0.40
B	TCO of new EV (USD/Km)	pManifold and MFA TCO Model	0.09	0.28	1.30	1.30	0.87	0.65
C=B/A	Ratio of TCO new EV to ICE	Calculated	0.5	0.8	1.0	1.0	1.3	1.6
	Normalize		75	58	58	26	-	100
5	The ratio of TCO of retrofit to new EVs							
A	TCO of Retrofit (USD/Km)	pManifold and MFA TCO Model	0.1	0.2	0.9	0.9	0.9	0.6
B	TCO of new EV (USD/Km)	pManifold and MFA TCO Model	0.09	0.28	1.30	1.30	0.87	0.65
C=B/A	Ratio of TCO of retrofit to new EVs	Calculated	0.9	0.8	0.7	0.7	1.0	1.0
	Normalize		34	56	92	100	-	12
6	% Fuel saved							
A	Avg. Vehicle efficiency (km/litre)	Local stakeholder	46	16	10	10	4	10
B	Average distance travelled per day (km)	Local stakeholder	25	25	35	100	200	200
C	Operational Days per year	Assumption	300	300	300	300	300	300
D=1/A	Avg. Vehicle efficiency (litre/km)	Calculated	0.022	0.063	0.100	0.100	0.250	0.100
E	Vehicle stock (2020)	Estimated	45,653	3,652	10,42,826	26,755	10,319	68,866
F=BxCxDxE	Fuel Saved per Year (litre)	Calculated	7	2	1,095	80	155	413
	Normalize		1	-	100	7	14	38
7	Job creation opportunities							
	Nominal Scale	Local stakeholder	Very Low	Low	Moderate	Low Moderate	High	Very High
	Relative Rank		0	20	60	40	80	100
	Rationale		As it deals with private ownership, transition to electrification is expected to mean fewer jobs assembling in 2W and as EV has less O&M cost, auto repair shops will also be inactive.	3W is intermediate public transit, it has the opportunity to create operational jobs, repair and assembly jobs, but this will not have a construction-related job for charging infra as it can have home charging as well.	4W personal will rank third considering its yearly registration and existing stock. As it deals with private ownership, transition to electrification will bring jobs in EV assembly, battery supplier, auto repair shops etc with job losses in the existing sector.	3W and 4W are intermediate public transit and it has the opportunity to create operational jobs, repairing and assembly jobs, etc. But considering yearly registration and existing stock, 4W taxis will rank higher than 3W.	Buses will rank second highest after kombis considering their yearly registration and existing stock. Jobs will be created in the construction of charging infra, its maintenance, EV assembly and battery supplier, R&D section, operational staff, etc.	As Kombis registration is higher than other public transport modes, a high number of jobs will be created in the construction of charging infra, its maintenance, EV assembly and battery supplier, R&D section, operational staff, etc.
8	Quality of life and equity							
	Nominal Scale	Local stakeholder	Low Moderate	Low	Very Low	Moderate	Very High	High
	Relative Rank		40	20	0	60	100	80
	Rationale		Easy access to 2W and lower fuel consumption per pax-km ranked 2W higher than 4W.	As 3W has higher fuel consumption per pax-km, it is ranked lower than 4W-Taxi.	4W is not a sustainable mode of transport compared to other vehicle segments and is not affordable for low-income groups, Hence, it is ranked lower	Provide option for first/last mile connectivity and enhance ease of movement and connection opportunities	Improve access to sustainable transport and individual productivity, especially for people with low-income groups	Improve access to sustainable transport and individual productivity, especially for people with low- income groups
9	Gender Equality							
	Nominal Scale	Local stakeholder	Low Moderate	Low	Very Low	Moderate	Very High	High
	Relative Rank		40	20	0	60	100	80
	Rationale		2W has low ease of drivability for women and differently able and therefore ranked fourth	As it has a lower seating capacity than 4W Taxi and other public transport modes, it has been ranked lower than 4W-Taxi	4W has the lowest ease of drivability for women and is differently able compared to all other vehicle segments	As it has lower seating capacity than public transport mode, it has been ranked lower than Buses and Kombis	Increases opportunities for women and differently-abled in transport by enhancing the ease of mobility and socio-economic participation in society	Increases opportunities for women and differently-abled in transport by enhancing the ease of mobility and socio-economic participation in society

Sr. No	Measurement	Reference	2W – Personal	3W	4W – Personal	4W – Taxi	Buses	Kombis
10	Air pollution reduction potential							
A	PM emissions gasoline ICE (g/km)	UNEP EMOB	0.100	0.100	0.057	0.057	0.196	0.196
B	Average distance travelled per day (km)	Local stakeholder	25	25	35	100	200	200
C	Vehicle stock (2020)	Estimated	45,653	3,652	10,42,826	26,755	10,319	68,866
D	Operational Days per year	Assumption	300	300	300	300	300	300
E=AxBxCxD	Total PM emissions gasoline ICE/year (ton)	Calculated	34	3	624	46	121	810
	Normalize		4	-	77	5	15	100
11	GHG reduction potential (2020)							
	Total GHG mitigation potential (if 100% EV conversion happens)		24,192	21,213	9,607,611	2,22,016	7,03,665	4,696,053
	% GHG mitigation potential (2020)		0%	0%	63%	1%	5%	31%
	Normalize		0	-	100	2	7	49
12	On-road Vehicle stock (%)							
	2020 All Vehicle stock (Estimated)	Estimated	45,653	3,652	1,042,826	26,755	10,319	68,866
	Normalize		4	-	100	2	1	6
13	Avg. Trip length per day (km)							
	Average distance travelled per day (km)		25	25	35	100	200	200
	Normalize		-	-	6	43	100	100
14	Fuel efficiency per passenger-km							
A	Average Occupancy	Local Stakeholder	1	2	2	6	40	9
B	Average distance travelled per day (km)	Local Stakeholder	25	25	35	100	200	200
C	Vehicle stock (2020)	Estimated	45,653	3,652	10,42,826	26,755	10,319	68,866
D	Operational Days per year	Assumption	300	300	300	300	300	300
E=AxBxCxD	Passenger km (million-kms)	Calculated	342	55	21,899	4,816	24,766	37,188
F	Average distance travelled per day (km)	Local stakeholder	25	25	35	100	200	200
G	Avg. Vehicle efficiency (litre/km)	*Market Report on Electric Vehicle Charging, 2019, eManifold*	0.022	0.063	0.100	0.100	0.250	0.100
H=DxFxG	Fuel Saved per Year (litre)	Calculated	163	469	1,050	3,000	15,000	6,000
I=CxH	Fuel Consumption (million-litre)	Calculated	7	2	1,095	80	155	413
J=I/E	Fuel efficiency per passenger-km (litre/pax-km)	Calculated	0.02	0.03	0.05	0.02	0.01	0.01
	Normalize		65	43	-	76	100	89
15	Easiness of EV Charging							
	Nominal Scale	Local Stakeholder	Very High	Moderate	Low Moderate	Very Low	High	Low
	Normalize		100	60	40	0	80	20
	Rationale		Easily recharged at home	It can be charged at home or shared public charging infra as well	Because of higher vehicle stock, shared public charging infra requirement is high	Highly dependent on shared public charging infra, it has been ranked lowest	It has a dedicated public charging facility at the depot	Since it needs shared public charging infra, unorganised sector, it has been ranked second-lowest
16	Local availability of EV models							
	Nominal Scale	Local stakeholder	Moderate	High	Very High	Very High	Very Low	Low
	Normalize		80	60	100	100	20	40
	Rationale		BYD T3 is identified in the market	Hardly any EV model identified in the market	BYD launches EV in 4W segment	BYD launches EV in 4W segment	Not identified EV model	Not identified EV model
17	Local post-sales services & spare parts availability							
	Nominal Scale	Local stakeholder	Low	Very Low	Very High	Very High	Moderate	High
	Normalize		80	80	100	100	60	60
	Rationale		Immerging use, evidence of local maintenance capacity, ranked lowest	Immerging use, evidence of local maintenance capacity, ranked second lowest.	Well established existing ecosystem. High maintenance frequency provides for a well-established market for spares and service centres, ranked highest.	High maintenance frequency provides for a well-established market for spares and service centres, ranked 3rd due to stock.	Well established existing ecosystem. Availability of service centres ranked 4th.	Well established existing ecosystem. High market potential due to enhanced use and maintenance regimes, ranked 2nd highest
18	Local assembly & supply potential for EV models & components							
	Nominal Scale	Local stakeholder	Very Low	Low	Moderate	Moderate	High	Very High
	Normalize		80	100	20	20	40	60
	Rationale		No existing assembly facilities hence ranked lowest	No existing assembly facilities hence ranked second lowest	Existing car assembly plants can be easily turned into EV retrofit assembly plants	Existing car assembly plants can be easily turned into EV retrofit & assembly facilities	Existing coachbuilding facilities can be easily turned into EV assembly plants	Good market for EV assembly and retrofitting of batteries, used for business
19	EVs R&D and Technical skills							
	Nominal Scale	Local stakeholder	Very Low	Low	High	Low Moderate	Very High	Moderate
	Normalize		20	40	80	80	100	60
	Rationale		No proven and verifiable existing local efforts, adequate technical capacity, ranked lowest	No proven and verified existing local efforts ranked second lowest	Evidence of ongoing R&D efforts at research institutions in collaboration with private assembly units, proven technical capacity, ranked second-highest	Some evidence ongoing R&D efforts at research institutions in collaboration with private assembly units	Evidence of ongoing R&D efforts in collaboration with private assembly units ranked 1st according to proven efforts and adequate technical capacities	Evidence of ongoing R&D efforts at research institutions in collaboration with private assembly units ranked 3rd according to present efforts
20	Quality of road and accessibility							
	Nominal Scale	Local stakeholder	Very High	Very Low	High	Moderate	Low	Low Moderate
	Normalize		100	0	80	60	20	40
	Rationale		Ranked highest, easy to navigate all road terrains, ideal for all road conditions	Requires well-established road network with good clearance, ranked lowest	Ranked 2nd, can navigate all road terrains	Ranked 3rd, can navigate most road terrains	Requires well-established road network with good clearance, ranked second lowest	Ranked 2nd, can navigate most road terrains

Sr. No	Measurement	Reference	2W – Personal	3W	4W – Personal	4W – Taxi	Buses	Kombis
21	The willingness of the government to provide financial incentives and technical support							
	Nominal Scale	Local stakeholder	Low	Low Moderate	Very Low	Moderate	Very High	High
	Normalize		20	40	0	60	100	80
	Rationale		Govt not very willing to provide incentives for individual or private transportation	Semi-public, unregulated with mainly unregistered operators. Not much Govt support.	Govt not very willing to provide incentives for individual or private transportation	Govt willing to provide incentives for intermediate public transportation provided that they are registered	Ideal for mass public transportation, incentivised private sector participation. Well, supported with appropriate Govt policy, high carrying capacity ranked highest	Mass public transportation incentivised private sector participation. Ranked 2nd due to carrying capacity.

22	The willingness of the government to provide non-fiscal incentives and technical support							
	Nominal Scale	Local stakeholder	Low	Low Moderate	Very Low	Moderate	Very High	High
	Normalize		20	40	0	60	100	80
	Rationale		Govt not very willing to provide incentives for individual or private transportation	Semi-public, unregulated with mainly unregistered operators. Not much Govt support.	Govt not very willing to provide incentives for individual or private transportation	Govt willing to provide incentives for intermediate public transportation provided that they are registered	Govt is very willing to provide non-fiscal incentives for mass public transportation. Ranked highest due to their carrying capacity	Govt is very willing to provide non-fiscal incentives for mass public transportation. Ranked second highest due to their carrying capacity

8.3. **Annexure-III** List of Stakeholders (involved in stakeholder consultation workshop 1)

Name	Organisation / Government Dept
Gwinyai Rondozai	Ministry of Women Affairs
Neville Moyoweshumba	Ministry of Energy
Takunda Matembo	Solar Power Project Engineer
H. Chingosho	UMFA
I.Chiridza	MOEPD
Tendai Nyamaropa	ROUTEMAX
Elton T Chirinyu	LENTAWAY P/L
Samuel Zaranyika	ZERA
Remekedzai Kuhudza	Electric Drive Africa
Sosten Ziuku	MOEPD
Virginia Mawere	MoTID
Tafadzwa Nyasuta	Hyundai Zimbabwe
Isiah Nyakusendwa	REAZ
T Mudzingwa	ZERA
C Maseva	IDBZ
L Madiye	UZ Renewable Energy
D Mzimba	MOVED
L Nyemba	LENTAWAY P/L
N Katsvairo	GHACO
K Deke Chimuchere	BVD Zimbabwe
Pearl Musiri	BVD Zimbabwe
Shamiso Kangai	TPL on the go Delivery Services
J Zhou	CVR
Cm Nduku	CVR
Takudzwa Muza	Zimbabwe Power Coil
Cloudias T Woloza	Super Touch

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