Baseline Report on the Transport Fuel Economy and Electric Mobility in São Tomé and Príncipe

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Abbreviations

AFAP	Agência Fiduciária de Administração de Projectos (Autonomous body)
AFOLU	Agriculture, Forestry, and Other Land Use
ANP	Agência Nacional de Petróleo (National Oil Agency)
B2B	Business-to-business
B2C	Business-to-consumer
BAU	Business As Usual
BEV	Battery Electric Vehicle
BUR	Biennial Update Report
CAGR	Compound Annual Growth Rate
CAREERS	Central African Centre for Renewable Energy and Energy Efficiency
CIEM	Centro Industrial Electromecânico (Mechanical Center)
CNG	Compressed Natural Gas
COE	Centre of Excellence
COVID	Corona Virus Disease of 2019
DGAAC	General Directorate of Environment and Climate Action
DGRNE	General Directorate for Natural Resources and Energy
DISCOM	Distribution Companies
DNP	National Planning Directorate
EE	Energy Efficiency
EMAE	Empresa de Agua e Electricidade
ENCO	National Oil and Fuel Company
EOL	End Of Life
ERPSSP	Economic Reform and Power Sector Support Program
ETISP	Energy Transition and Institutional Support Program
EU	European Union
EV	Electric Vehicle
GCF	Green Climate Fund
GEF	Global Environment Facility
GFDRR	Global Facility for Disaster Reduction and Recovery
GHG	Green House Gases
GOP	Great Options Plan
GST	Goods and Services Tax
GW	Giga Watt
HEV	Hybrid Electric Vehicle
HH	Households
ICEV	Internal Combustion Engine Vehicle
ICT	Information and Communication Technology
IEA	International Energy Agency

INPEIG	Gender Equality Institute
INTT	Land Transport Directorate
IRENA	International Renewable Energy Agency
KW	Kilo Watt
LDC	Least Developed Country
LEAP	Long-range Energy Alternatives Planning model
LED	Light Emitting Diode
LPG	Liquified Petroleum Gas
MHP	Mini Hydropower Plants
MIRN	Ministry of Infrastructure and Natural Resources
MPFEA	Ministry of Planning, Finance, and Blue Economy
MRV	Measurement, Reporting, and Verification
MW	Mega Watt
NDA	National Designated Authority
NDC	Nationally Determined Contributions
NDP	National Development Plan
NEEAP	National Energy Efficiency Action Plan
NREAP	National Renewable Energy Action Plan
OEM	Original Equipment Manufacturer
PHEV	Plug-in Hybrid Electric Vehicle
RAP	Autonomous Region of Príncipe
RDSTP	Democratic Republic of São Tomé and Príncipe
RE	Renewable Energy
SDG	Sustainable Development Goals
SEFA	Sustainable Energy Fund for Africa
SIDS	Small Island Developing Countries
SRIOOT	Secretária Regional de Infraestruturas (Regional Infrastructure Secretary)
STP	São Tomé and Príncipe
TCO	Total Cost of Ownership
TNC	Third National Communication
TOU	Time-Of-Use
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention for Climate Change
UNIDO	United Nations Industrial Development Organisation
USD	United States Dollar
VAT	Value Added Tax
VNR	Voluntary National Review
WB	World Bank

2 Introduction

This document presents a fuel economy and electric mobility (e-Mobility) baseline report of land transport in Sao Tomé and Príncipe (STP) under the contract – *Consultancy Services for the Development of a standard and compliance framework for low-emission transport and an electric mobility roadmap for São Tomé and Príncipe*- established between the United Nations Industrial Development Organization (UNIDO) in partnership with the General Directorate for Natural Resources and Energy (DGRNE) of the Ministry of Infrastructure and Natural Resources (MIRN, former MOPIRNA) and the National Designated Authority (NDA) at the Ministry of Planning, Finance and Blue Economy (MPFEA) being implemented under the GCF readiness project "Building institutional capacity for a renewable energy (RE) and energy efficiency (EE) investment program for São Tomé and Principe".

The project underscores the need to provide and strengthen policies and regulations regarding low-carbon transport in STP. With this assignment, UNIDO and the Central African Centre for Renewable Energy and Energy Efficiency (CEREEAC) are supporting the Government of STP to improve the policy, regulatory, and practical framework for the land transport fuel economy and low-emission vehicle uptake, including electric and hybrid vehicles.

2.1 Background

The Democratic Republic of STP is a small island developing state (SIDS) off the coast of central Africa with a population of 225,00 people [1]. It is made up of two islands, located in the Gulf of Guinea at 0º 25'N latitude and 6º 20'E longitude, about 380 km west of the coast of the African Continent. The islands occupy an area of 1,001 km² and consist of the larger island Sao Tomé the smaller island Príncipe, and several tiny islets. Sao Tomé (area of 859 km^2) is about 6 times larger and four times more densely populated than Príncipe (142 km^2). Both Island share a national government, which is elected every four years. Due to the special status of the Príncipe as an Autonomous Region, there is also a regional government and regional president in Príncipe.

Generally, STP is known to be highly vulnerable to the impacts of climate change and faces development challenges stemming from structural vulnerabilities such as its geographic isolation, the small size of the national market, and dependence on imports, which affect its capacity to manage environmental and economic shocks.

STP signed the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, ratified on October 27, 1999, and became a full member of the Convention. In its first biennial update report to the UNFCCC in 2022, STP reaffirmed its commitment to reducing greenhouse gas (GHG) emissions by 109 kT-CO_{2eq}, which corresponds to an emission reduction of 27% by 2030 [2]. The prioritized mitigation measures include

- Increase in the share of renewable energy (RE)
- Reduction of losses in the network and improvement of energy efficiency (EE)
- Reduction of carbon intensity in mobility

The transport sector is the second largest contributor to emissions after the energy sector. In terms of carbon dioxide emissions, the energy industry sectors are the biggest emitters accounting for 48% followed by transport with 43% and residential with 9% [3].

The transport sector plays a fundamental role in the socio-economic development of any country, as it ensures the mobility of people and goods, thus allowing exchanges and commercial exchanges between peoples. Furthermore, the country is volcanic in origin and, therefore, has a predominantly hilly and steep geography.

As a SIDS, STP is also part of the list of the least developed countries where two-thirds of the population is considered poor and suffers from the high cost of insularity, including transportation. The high cost of fuel imports reduces the prospects for mobilizing more internal and external development finance [4].

The country imports 100% of its oil and half of its food. As a result, inflation rose to 17.9% in 2022 from 8.1% in 2021, on the back of the enduring COVID-19 pandemic effect [5]. In 2018, the energy consumption of the road sector was estimated to be 11,188.26 TEP (Equivalent ton of oil). The results of GHG calculation for the road sector in 2018 was 34.3Gg of CO_{2eq} which far exceeds aviation (3.83Gg of CO_{2eq}) and maritime (7.02Gg of CO_{2eq}) transport (*Figure 1)* [2].

The land transport sub-sector is considered the second largest consumer of fossil fuels and contributes 33% of overall GHG emissions resulting from its massive energy use of fossil fuels. Land transport consumes gasoline, in addition to diesel (gasoil) and lubricants. According to the National Energy Efficiency Action Plan, the transport sector, particularly the land transport subcategory, is considered the second largest consumer, with 80% of gasoline and 17% of gasoil, as percentages of overall consumption, and has a major role to achieving decarbonization in STP.

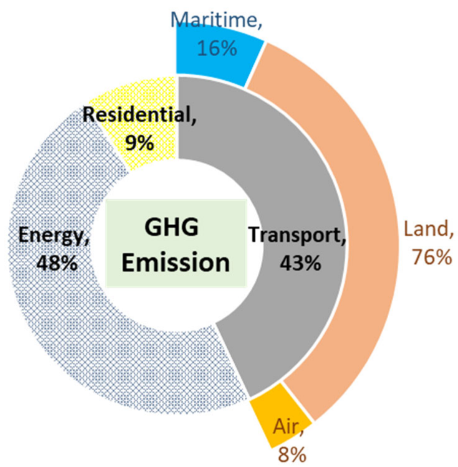


Figure 1 GHG Emissions from the Transport Sector (2018)

As of today, the country has imports of used vehicles. The absence of an age limit on imported vehicles, complete reliance on imported fuel, and the lack of fuel and vehicle standards are some of the challenges in the transport sector in STP, as in many other African countries. Additionally, the country has electric vehicles (EVs) in a very nascent stage, with only 16 EVs on the road (1

Tesla 4Ws and 15 e-Cycles). The lack of an operational system for the regular and mandatory inspection of vehicles makes it difficult to take stock of vehicles in circulation at STP [6].

To decrease oil consumption in the land transport sector and move towards a low-emission development path, the formulation of this baseline report is imperative to promptly evaluate and tackle the prevailing challenges in fuel economy and the emerging e-Mobility sector in STP. This aims to guide the nation toward a sustainable and efficient transportation future.

2.2 Objectives

In response to the growing imperatives of sustainable transportation and the unique challenges faced by STP, the baseline reports for both Fuel Economy and e-Mobility are crafted with overarching objectives.

From the foregoing and with the necessity of a **fuel economy improvement roadmap** in view, the objectives of this fuel economy baseline report are to:

- To undertake a detailed characterization of the current vehicle fleet in STP, including an analysis of vehicle types, categories, and ownership patterns
- To review vehicle imports into the country by considering age, origin, fuel economy, category, and ownership by gender
- To review the supply of automotive fuels, considering aspects such as types of fuels, their quality, and the sources of these fuels
- To review vehicle and related fuel-efficiency-related policies, standards, and infrastructure, including the distribution network and accessibility
- To identify potential opportunities and strategies for enhancing fuel economy, including recommendations for the adoption of cleaner fuels, technological advancements, and policy interventions.

This report seeks to characterize the type of vehicles imported into STP from 2017 to 2023. It analyses their categories, ages, source countries, powertrain, fuel economy, ownership, and use cases. Another objective is to analyze the supply of automotive fuels and their quality and make projections until 2040. Per the results of the mission study mission to STP should also enable a review of vehicle-related policies, standards, and infrastructure.

Considering the emerging importance of e-Mobility in STP, the objectives of the **e-Mobility Baseline Report** are to provide a foundational understanding of the current status and prospects of electric transportation. The specific objectives include:

- To assess the current e-Mobility Landscape including existing EV fleet, charging infrastructure, supply chain, EV players (demand & supply side) and policies, etc.
- To examine EV demand and supply, considering user awareness, potential barriers to adoption, production and import capacity, etc.
- To evaluate economic feasibility (TCO analysis) to assess the competitiveness of EVs in comparison to conventional vehicles, and prioritize vehicle segments for EV adoption

- To identify barriers across the EV value chain, covering aspects from vehicle production to scrappage and disposal
- To formulate a comprehensive roadmap outlining policy measures to overcome identified barriers, including fiscal and non-fiscal incentives, regulatory frameworks, and infrastructure development

By addressing these objectives, both the Fuel Economy and e-Mobility Baseline Reports aim to provide an in-depth understanding of the current landscape, key challenges, and strategic opportunities for advancing sustainable and efficient transportation in STP.

2.3 Methodology

To develop the Fuel economy Standards & compliance framework and e-Mobility regulations, the following steps are involved as shown in ***Error! Reference source not found.***:

1) *As-Is Land Transport assessment*
    a. Fuel Economy Assessment: Aims to gain insights into existing practices in fuel and vehicle imports, emphasizing the alignment between regulations and actual practices, through stakeholder consultations and site visits.
    b. e-Mobility baseline assessment: Involves a thorough examination of EV regulations, policies, and best practices to lay the foundation for the development of a robust e-Mobility roadmap.

2) *Development of Fuel economy and e-Mobility Roadmap*
    a. Fuel Economy Roadmap: Aims to identify barriers and opportunities aligning to unique needs and challenges of STP to incorporate into the roadmap.
    b. e-Mobility Roadmap: Aims to define clear EV targets and policy measures for both the demand and supply sides and formulate a roadmap that will serve as a strategic guide for STP's long-term vision in e-Mobility.

3) *Training and Capacity building*
    a. Aims to establish EV training centers and a dedicated Industry-Academia EV Center of Excellence to enhance skills and knowledge in the field of EVs.

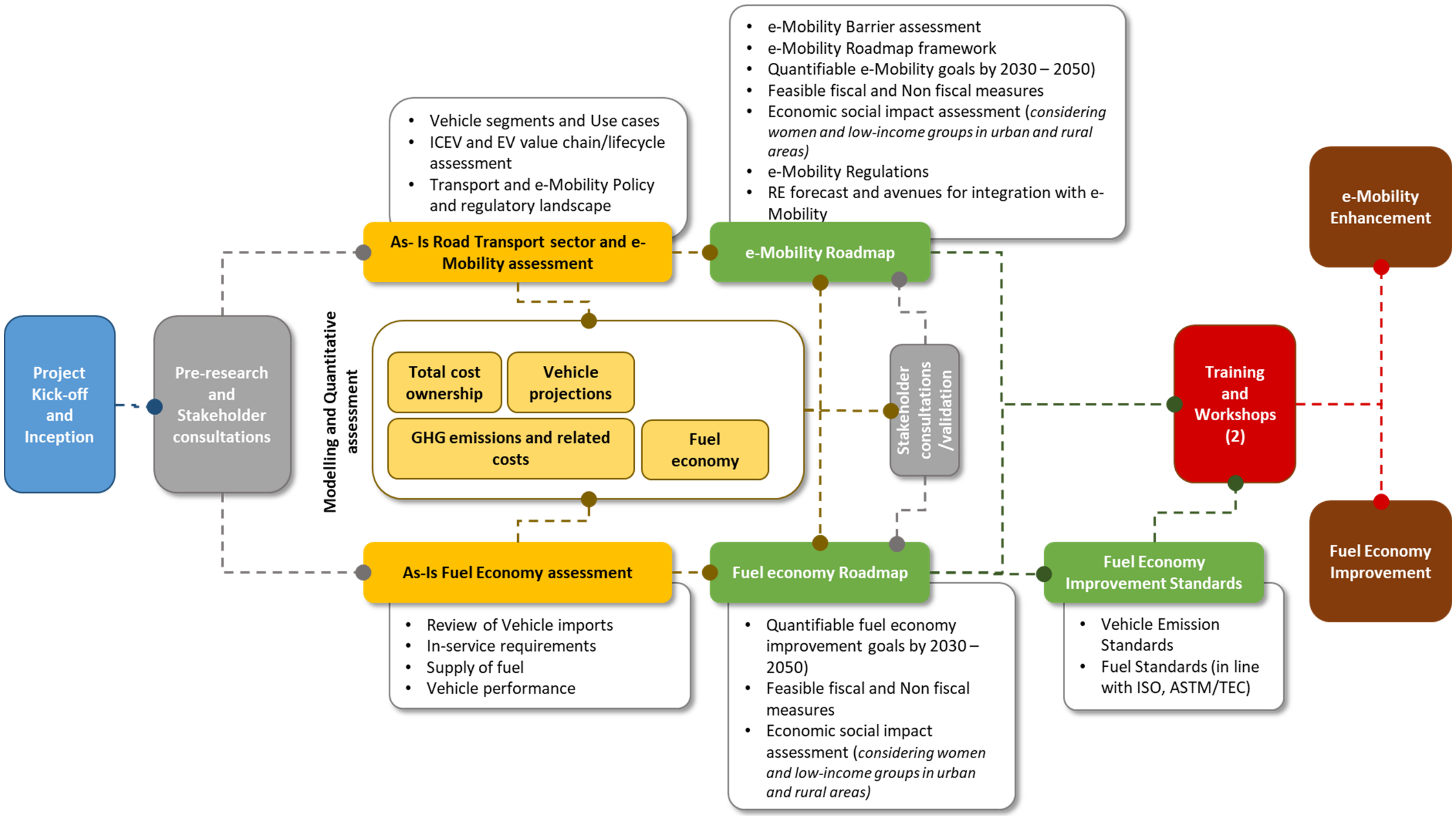


Figure 2 Methodology to develop Fuel economy and e-Mobility Regulatory Framework

The National Institute of Land Transport provided vehicle import statistics for every year since 2017. Vehicle ownership data by gender and by use was also obtained from the recordings in the record books provided by the institute. The manual recording of data by the institute meant that details of the over 9,000 vehicles recorded for this period would have taken months to obtain.

The vehicle identification numbers (VIN) of all the vehicles were obtained and decoded to obtain information on vehicle category, model, model year (age), source country, fuel type, and fuel economy. The source country and age enabled the conclusion on the vehicle standards. Data on vehicles in use from 2010 to 2016 was obtained from publications of the World Health Organisation and OICA [7]. Together with the data obtained from 2017 to 2023, the vehicles in use by 2040 were projected using the LEAP model.

Fuel supply data was provided by the National Oil and Fuel Company (ENCO). Estimation of fuel quality was done based on publication on fuel quality by the Global Fuel Economy Initiative and the United Nations Environmental Program [8]. The sulphur contents of countries that STP buys its fuel from gave an idea of the quality of fuel. Further confirmation of fuel quality was done based on the survey of mechanics, individuals, and the new vehicle dealership, CIEM. Visits to several other key sector entities enabled the determination of existing fuel-related policies, standards, and infrastructure.

In conclusion, the LEAP projection model has been instrumental in shaping the forward projection of e-Mobility, leveraging vehicle import statistics, ownership data, and VIN decoding to facilitate a comprehensive understanding of the vehicle landscape. Subsequent steps, including target setting and barrier analysis across the value chain, have been informed by this data-driven approach. Additionally, extensive consultations with key stakeholders have enriched the e-Mobility assessment in a subsequent section.

3 Key Sector Entities and Policies

3.1 Key Sector Entities

This baseline study represents a very important step for the transition to more fuel-efficient vehicles, low-carbon fuels, and e-Mobility in STP. The engagement with various stakeholders is critical for the success of this study as shown in *Figure 3*.

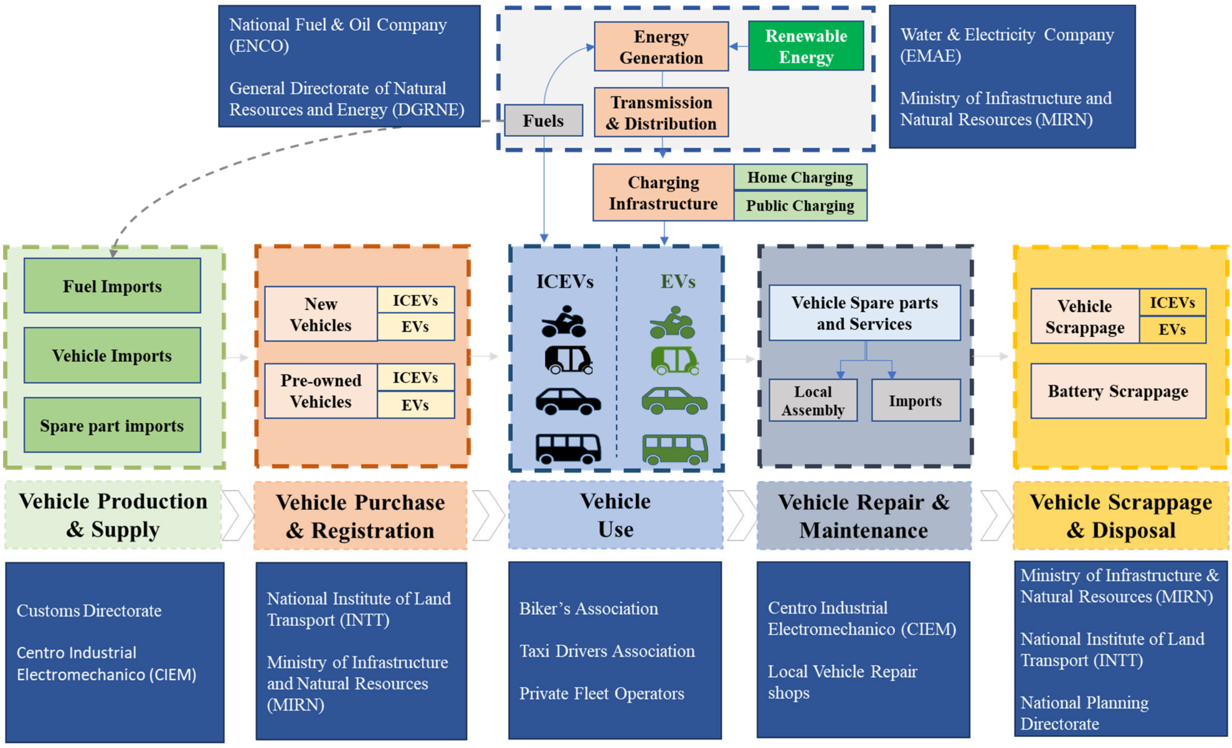


Figure 3 Authorities regulating fuel and vehicles across different life cycle stages

The table below outlines the relevance of key sector entities to the fuel economy and e-Mobility assessments as presented in *Table 1*.

Table 1 Relevant stakeholders for the fuel economy and e-Mobility baseline

Relevant Stakeholder	Description	Relevance to the Fuel Industry	Relevance to e-Mobility
Public Agencies			
AGER (Autoridade Geral de Regulação)	Regulates the telecommunications, postal, water and electricity sectors.	Might involve regulation and oversight of various aspects related to fuel distribution, and consumption such as Licensing and Permits, Price Regulation, Quality Standards, Safety Regulations, etc.	Would regulate aspects such as the installation, operation, and safety standards of charging points, as well as any related equipment or infrastructure necessary for the functioning of e-mobility services.
Directorate General for	Design, promote, and evaluate strategic policies	Oversees RE and EE in the electricity	Would be influential in shaping policies

Relevant Stakeholder	Description	Relevance to the Fuel Industry	Relevance to e-Mobility
Natural Resources and Energy (DGRNE)	on water, energy, and geological resources. It has the added responsibility of compiling data on electricity production and mobile combustion as in transport.	sector. Key for assessing the impact of alternative fuels and efficiency measures on energy consumption.	related to EV adoption and assessing the energy requirements for charging infrastructure.
Directorate General for the Environment (DGA)	Responsible for the coordination of the environmental actions, and the definition and execution of the State's policy on the environment.	Coordinates environmental actions and defines and executes the state's environmental policy. It is vital for assessing the environmental impact of fuel consumption and emissions.	Essential in formulating policies and regulations to promote sustainable and environmentally friendly practices in the transition to e-Mobility.
Water and Electricity Company (EMAE)	Provides public services for the production, transmission, and distribution of electricity and the collection, adduction, conservation, and distribution of water, including the maintenance of its infrastructures and networks for the transmission and distribution of water and electricity.	NA	Critical for planning and implementing electric charging infrastructure, as well as understanding the energy demands and impacts of EV charging on the existing power grid.
National Oil Agency (ANP)	Regulate, supervise, control, and promote the activities of the oil and gas industry.	Regulates, supervises, controls, and promotes oil and gas industry activities. Cooperation is crucial for assessing the environmental impact of traditional fuel consumption.	Relevant in developing policies for the reduction of fossil fuel use, promoting EVs, and ensuring a smooth transition to cleaner transportation.
National Fuel and Oil Company (ENCO)	Mainly dedicated to the import wholesale and retail marketing of petroleum products.	Manages and distributes fuel. Relevant for fuel import data, pricing, and understanding the	Contribute insights into fueling challenges, infrastructure readiness, and

Relevant Stakeholder	Description	Relevance to the Fuel Industry	Relevance to e-Mobility
		existing fuel market dynamics.	potential collaborations for e-Mobility projects.
Customs Directorate (DA)	Mandated to collect tax and duties.	Understand tax implications on fuel imports and vehicle purchases.	Relevant in developing policies and regulations related to customs and duties for EVs, fostering a favorable environment for e-Mobility adoption.
National Institute of Land Transport (INTT)	Mandated to register, and test vehicles. They are also mandated to authorize a change of vehicle ownership.	Coordinates, legislates, and monitors road safety. Relevant for understanding the vehicle fleet, road conditions, and overall impact on fuel efficiency.	Critical in the development of e-Mobility policies, regulations, and infrastructure, including charging station locations and safety considerations.
Private Sectors			
Centro Industrial Electromecanico (CIEM)	Sales agent and representative for Toyota.	Responsible for selling and maintaining vehicles. Key for insights into existing vehicle technologies, maintenance practices, and market dynamics.	would be significant in the promotion of EVs, including sales, maintenance, and potential collaborations with EV manufacturers.
HBD Príncipe Island	Sustainable ecotourism and agroforestry company, dedicated to the conservation of Príncipe Island, a precious UNESCO Biosphere Reserve.	Major vehicle fleet owners, especially in the Príncipe region. Relevant for assessing the impact of tourism-related transportation on fuel consumption.	Could be a key stakeholder in promoting e-Mobility for sustainable tourism, potentially leading the adoption of EVs in their fleet.
Belo Monte	Elegant heritage hotel, renovated and furnished in classical Portuguese style. They offer numerous excursions and expeditions to explore the unique nature and culture of Príncipe	Major fleet owner with potential influence on vehicle choices and usage patterns. Relevant for understanding the impact of hospitality	A potential leader in adopting EVs for hotel-related transportation needs, setting an example for sustainability in the hospitality industry.

Relevant Stakeholder	Description	Relevance to the Fuel Industry	Relevance to e-Mobility
	including guided tours by 4x4 vehicle or quad bike.	services on local transportation.	
Other Stakeholders			
Mechanics and Taxi Operators Associations	Informal mechanics are responsible for the day-to-day repair, servicing, and maintenance of the vehicle fleet. Taxi associations including motorcycle taxis, minivan taxis, and saloon 4W-Comemrcial, taxis operated mainly in Sao Tome.	Significant in assessing the operational and fueling requirements of the existing vehicle fleet.	Crucial for understanding the potential adoption, challenges, and preferences of taxi operators regarding EVs.

The Directorate General of Natural Resources and Energy (DGRNE) was the first point of contact during the mission visit. It was responsible for facilitating stakeholder meetings with the other agencies. Its responsibility to the design, promotion, and evaluation of strategic policies on energy with a view to sustainable development was relevant to the baseline studies.

The National Fuel and Oil Company was incorporated as a Limited Liability Company on 08/07/1998 through Decree No. 60/97 of 15 December, under the name of ENCO, SARL. It has 4 gas stations (3 in São Tomé and 1 in Príncipe Island). The Angolan oil company Sonangol is the largest shareholder of the Sao Tome Fuel and Oil Company called ENCO. ENCO was contacted during the baseline study for historical fuel pricing, mandate, and fuel quality data.

Starting in March 2022, ENCO had to reduce the supply of fuel to the Water and Electricity Company (EMAE) by 56% due to the default in the payment of accumulated debts [9]. The government says it does not update the electricity company's tariffs to avoid social upheaval. Another reason is that many state institutions in the country do not pay their energy tariffs. The Government has reported that the electricity company does not pay its debts to the fuel company, because the electricity tariff that prevails in the country is incompatible with the cost of producing thermal energy. The World Bank recommended years ago that EMAE should increase its tariff by 108% [10]. To avoid a general collapse, the ENCO company reduced the supply of diesel to the electricity company, EMAE, which in turn began to rationalize the supply of electricity to the population resulting in recurrent blackouts on both islands.

The General Directorate of the Environment is responsible for the coordination of the country's environmental actions, its definition, and execution of the State's policy on the environment following Article 24(b) of Decree No. 2/2007. Their work is to contribute to the sustainable development of STP, based on high standards of protection and enhancement of environmental systems and integrated approaches to public policies. This is done through policies and management plans, environmental monitoring and assessment, implementation of climate adaptation and vulnerability projects, awareness campaigns, and information and communication of citizens on the environment.

The private sector was consulted on this project including Centro Industrial Electromecanico (CIEM), HBD Príncipe Island, and Belo Monte. The CIEM are the sole distributors and sales representatives for Toyota, Lexus, and Daihatsu vehicles in STP. They have the biggest market share in new vehicle sales at STP. Their customers include the government of STP, HBD Príncipe Island, Belo Monte, and others. Both HBD Príncipe Island and Belo Monte are the two biggest vehicle fleet owners in the Island of Príncipe hence the reason for making them stakeholders in this project. Both companies pride themselves in sustainable tourism and have been known to invest in EVs for tourism in the past. Other stakeholders include informal mechanics, taxi groups and private owners.

3.2 Policy Context

STP archipelago by its size, geographical location, morphological features, and insularity is exposed to various hazards arising from both environmental factors and human activities. Henceforth, various action plans and policies have been drafted for the country since 2004 to address climate change, enhance EE, and revolutionize the transportation sector as shown in *Figure 4*.

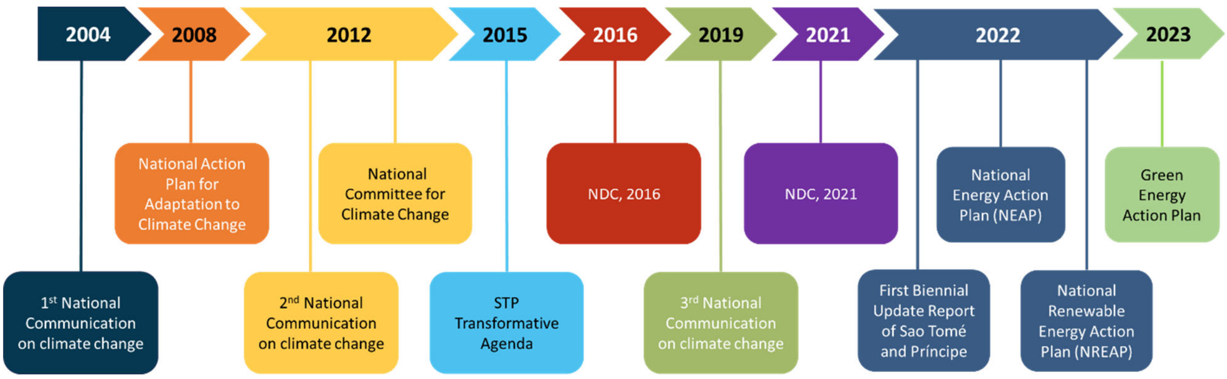


Figure 4 Evolution of Action plan and Policies towards Climate Change

To comprehend the policies and objectives in existence at STP, several policy documents were reviewed as highlighted in *Table 2,* aiming at mitigating climate impacts, promoting RE, and fostering a sustainable and efficient transport infrastructure. More efficient taxis will take the place of 500 gasoline and 500 diesel taxis, according to the Third National Communication of Sao Tomé and Príncipe (MOPIRNA, 2019). Taking into account that STP has gasoline taxis that are up to 50 years old, this is a very good concept. A few of these taxis are not fit for use on the road and are not in good shape. Images of a normal gasoline cab and a diesel taxi, respectively, captured in October 2023 in Sao Tomé are displayed in *Figure 5* and *Figure 6*. Table 2 Policy and Action Plan Review.

<table>
<tr><th>#</th><th>Name of Report</th><th>Policy Measure</th></tr>
<tr><td>1</td><td>Green Energy Acceleration Plan (OIED, 2023)</td><td>
<table>
<tr><td rowspan="2">Electric Vehicles</td><td colspan="2">Basecase (2050) – On-road EV share</td><td colspan="2">Highcase (2050) – On-road EV share</td></tr>
<tr><td>%</td><td>#</td><td>%</td><td>#</td></tr>
<tr><td>Electric Light Vehicle</td><td>40%</td><td>10,000</td><td>60%</td><td>14,900</td></tr>
<tr><td>Electric Motorcycle</td><td>10%</td><td>2,000</td><td>40%</td><td>8,000</td></tr>
<tr><td>Electric Buses</td><td>5%</td><td>100</td><td>27%</td><td>500</td></tr>
<tr><td>Total EV</td><td>26%</td><td>12,100</td><td>50%</td><td>23,400</td></tr>
</table>
</td></tr>
<tr><td>2</td><td>National Energy Efficiency Action Plan (NEEAP) of Sao Tomé and Príncipe (UNIDO, 2022) [1]</td><td>• 10,000 electric light vehicles (2041-50)
• 2,000 electric motorcycles (2041-50)
• 100 electric buses (2041-50)
• 5,000 recharge points (2041-50)
• Taxation of emitting vehicles (2041-50)
• Creation of financial incentives and replacement of 1,000 gasoline or diesel taxis (500+500) with more efficient 4W (2041-50)</td></tr>
<tr><td>3</td><td>National Renewable Energy Action Plan (NREAP) of Sao Tomé and Príncipe (UNIDO, 2022) [1]</td><td>• Replace cars, motorcycles, and buses that currently burn diesel and gasoline with electric units by 2040</td></tr>
<tr><td>4</td><td>First Biennial Update Report of Sao Tomé and Príncipe (MIPN, 2022) [2]</td><td>• Introduction of 5,000 EVs to reduce 4.5 kt CO_2/year by 2030
• Introduction of 1,000 electric motorcycles to reduce 0.2 kt CO_2/year by 2030
• Introduction of 100 efficient public transport vehicles with 12 seats each to reduce 1.4 kt CO_2/year by 2030
• Installation of 2,000 charging stations by 2030</td></tr>
<tr><td>5</td><td>Updated National Determined Contributions (NDC, 2021) [3]</td><td>• Reduce GHG emission reduction to 27% by 2030</td></tr>
<tr><td>6</td><td>Third National Communication of Sao Tomé and Príncipe (MIRN, 2019) [4]</td><td>• Replacement of 500 gasoline taxis with more efficient vehicles
• Replacement of 500 diesel taxis with more efficient vehicles</td></tr>
<tr><td>7</td><td>STP 2030 Transformation Agenda (UNDP, 2015) [5]</td><td>Increase the percentage of RE injected into national electric grid:
• Baseline (2015): 5%
• Target (2021): 25%</td></tr>
</table>

In addition, the first biannual update of STP (2022) suggests that starting in 2030, there will be 5,000 electric 4W; 1,000 electric motorbikes; and 100 efficient public vehicles. Given how frequently motorcycles are used in STP for both private and public transit, more electric motorcycles should have been the goal than other vehicle categories. 10,000 electric light vehicles; 2,000 electric motorbikes; and 100 buses by 2041 are other goals of the National Energy Action Plan (2022). It also considers the taxation of emitting vehicles. Emission testing could have been done at the National Institute of Land Transport during annual periodic technical inspections. However, the institute is yet to require every vehicle to come for yearly testing. There is currently no equipment for this and there is a need to train personnel to do this.

Figure 5 Gasoline taxi parked for loading at Sao Tomé


Figure 6 Diesel taxi showing emissions as it climbs a hill

Proposed Projects by the Government

Updated NDC 2021 also holds the country's commitments towards the reduction of GHG emissions by 27% (109 kT-CO2eq) by various mitigation/and adaptation measures and an estimated total cost of around 150 million US dollars (Million USD) by 2030 [3] as mentioned in *Table 3*.

Table 3 Contribution measures with cost valuation and the respective contribution to GHG reduction

	Mitigation contributions	GHG Reduction ktCO2/yr	Investment Million USD	Status [Idea, planification phase, in-implementation]
1)	**Increase in Renewable Energies**	**63**	**117**	
1.1	Solar PV (30 MW)	26.6	30	In the implementation (Piloto of 0.5MW) Financing (2.5MW Guaranteed) Remaining MW without financing
1.2	Solar PV Residential (800x3kW)	1.9	3.6	n/a
1.3	Isolated Mini Hydro (13 MW)	25.2	71.5	n/a
1.4	Mini Hydro (13 MW)	3.2	4.5	n/a
1.5	Energy from biomass residues (2.5 MW)	6.1	7.4	n/a
2)	**Losses reduction and Energy efficiency**	**39.3**	**15.1**	
2.1	Efficient residential lighting (300,000 LEDs)	30.5	3.9	Ongoing since 2020. Launched in 2023.
2.1	Efficient public lighting	3.9	1.6	

Mitigation contributions		GHG Reduction ktCO2/yr	Investment Million USD	Status [Idea, planification phase, in-implementation]
	(10,000)			
2.3	Rehabilitation of the electric network to more efficiency to reduce losses (10GWh)	4.9	9.6	
3) Carbon intensity reduction in mobility		**6.0**	**18.6**	
3.1	EVs (5,000)	4.5	4.5	n/a
3.2	Electric motorcycles (1,000)	0.2	1.6	n/a
3.3	Public transport with 12 seats (100)	1.4	12.5	n/a
Total GHG reduced		**108.4**	**150.8**	

4 Fuel Economy Assessment

4.1 Characterization of Current Vehicle Fleet

4.1.1 General Vehicle Fleet

The National Institute of Land Transport is the only entity with the mandate to register vehicles in STP. The institute takes the registration details of all vehicles in both islands of Sao Tomé and Príncipe. All vehicles destined for the island of Príncipe are also registered in Sao Tomé.

Sao Tomé's transportation system is made up of a variety of vehicles that meet the transportation needs for every kind of situation in STP. Every day, four different kinds of taxis are utilized for transportation. The first type consists of gasoline-powered taxis that typically transport passengers from urban areas. A few of these cabs need to be replaced because they are in terrible shape. *Figure 7* shows some of these taxis which are mostly old models of Toyota Corolla.

Figure 7 Light-duty gasoline taxis at the town center of Sao Tomé

The second category of taxis consists of minivans, including vintage Toyota Hiace, Toyota LiteAce, and Mitsubishi L300 vehicles. *Figure 8* depicts a typical view of the minivans, which run primarily on diesel. Motorcycle taxis, which appear to make up the majority of the public transportation fleet, are the third type of transportation available. These are common on both islands of Sao Tomé and Príncipe. At Príncipe, they are the only visible means of public transit. The tri-car taxis, also known as 3W, make up the fourth category of taxis. In Sao Tomé, private transportation consists of a variety of vehicles. Due to the nature of the roads, the majority of private transportation in Príncipe consists of motorcycles, pick-ups, land cruisers, and other vehicles with off-road capability. Vehicle rental companies in Príncipe rent out mostly 4x4 vehicles. Additionally, non-governmental organizations and tourism businesses own buses on the island. Because of the conditions of the roads in Príncipe, 4W needs to have regular maintenance because of issues with their suspension and chassis.

Figure 8 Diesel minivan taxis at Sao Tomé

4.1.2 Vehicle Registration Statistics

The data on vehicles imported from 2017 to 2023 were obtained from the National Institute of Land Transport. *Figure 9* below shows the first time vehicle registration statistics within this period. About 1,314 and 1,281 units of vehicles were registered in 2017 and 2018 respectively. In 2019, the number of vehicles imported peaked at 1,754 units representing a 37% increase over 2018. However, in 2020 there was a sharp decrease in vehicles registered. Registered vehicles decreased by 41% in 2020 at the peak of the Covid 19 pandemic. The decline could be attributed to the Covid 19 pandemic which caused a major decline in vehicles worldwide in 2020. The International Energy Agency reported that Global car sales contracted by 14% in 2020 [11]. In 2021, registered vehicles increased but 2022 and 2023 indicate major declines. Vehicle registration in 2023 reduced by 27% compared to 2022. Globally used vehicle prices have gone up since 2022 due to less inventory caused by consumers who had delayed purchases due to the 2020 Covid pandemic. The auto market is still experiencing pent-up demand from drivers who had delayed buying new vehicles in 2020 but are now shopping around despite high costs [12].

Considering the historical data from 2017, every year an average of 1,300 vehicles are registered. Motorcycles made up about 40% of all vehicles registered between 2017 and 2023, compared to 60% of all other vehicles. Approximately 55.5% of registered vehicles are powered by gasoline, while 44.5% are powered by diesel engines. One Tesla Model 3 battery-electric vehicles were registered, even though data on new energy vehicles, such as electric automobiles, was negligible. About fifteen (15) electric go-karts were registered for tourism purposes in Principe by HBD.

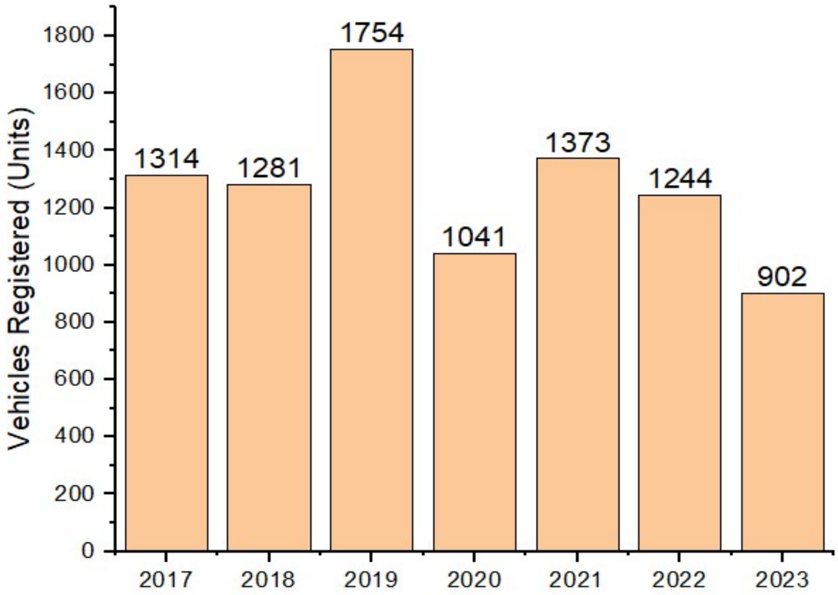


Figure 9 Number of vehicles registered between 2017 and 2023

Data released by the World Health Organization in 2016 and the Organisation Internationale des Constructeurs d'Automobiles (OICA) provided historical vehicle registrations and vehicles in use [7]. Future projections of vehicle registration were based on the model built in the LEAP software and upon historical growth rate. It is expected that by 2030, vehicle registration will be back to pre-pandemic levels. Owing to a growing population and rising GDP, at least 2,319 vehicles are predicted to be registered for the first time by 2040.

4.1.3 Vehicles in use

The historical and prospective vehicle stock forecasts are displayed in *Figure 10*. An estimated 40,713 vehicles across all categories will be registered by the end of 2023. This projection, assuming a 5% scrap rate, translates to 176 vehicles per 1000 people, which is rather high given that the average for Africa is 95 vehicles per 1000 people [13]. The vehicle stock is projected to reach at least 62,257 units by 2040. ***Error! Reference source not found.*** shows the share of vehicle stock projection by categories. Compared to light-duty vehicles (55%) and heavy-duty vehicles (5%), 2W and 3W make up 40% of the market.

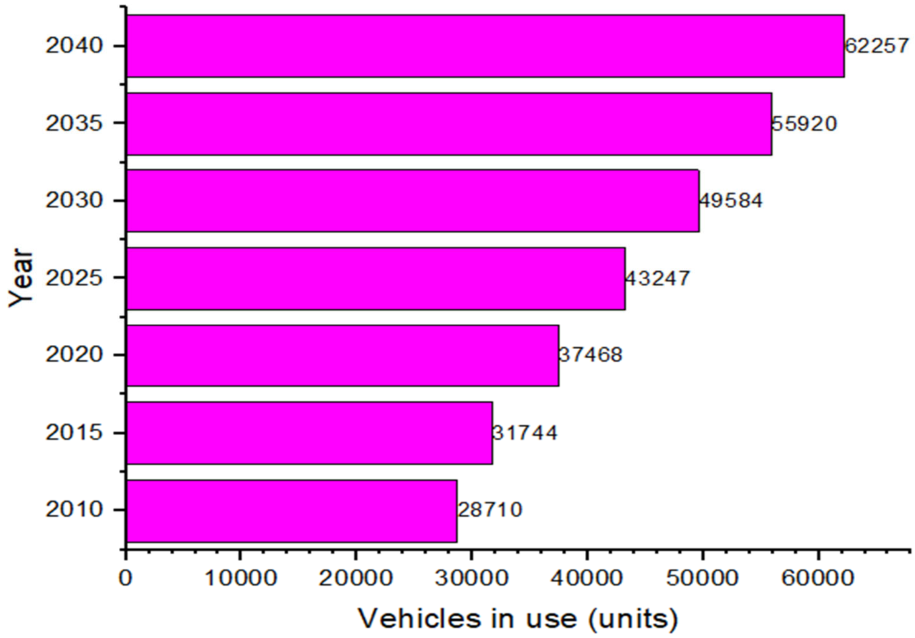


Figure 10 Vehicle stock projections

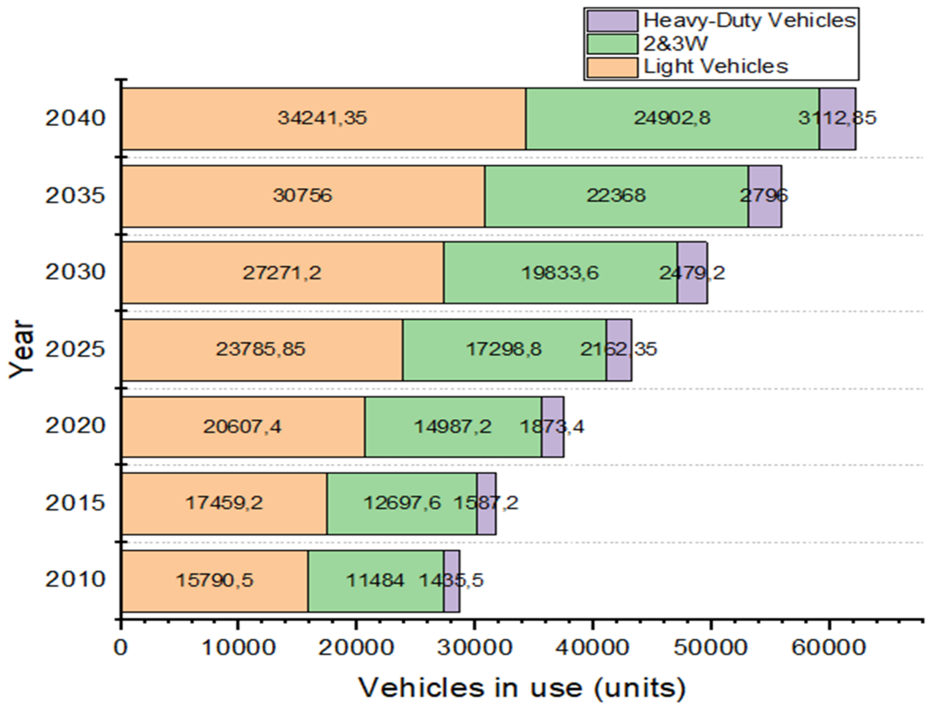


Figure 11 Vehicle stock projections by category

4.1.4 Vehicle Age Profile

The average age of vehicles imported at the time of registration was estimated based on the model year. *Figure 12* displays the average age of cars by type. The results are only accurate for vehicles registered from 2017 to 2023. At the time of registration, motorcycles had the highest average age, which was 31 years. For both light and medium-duty vehicles, the average age was 22 years while the average age of all vehicles was 25 years. As *Figure 13* illustrates, this is extremely high when compared to other African nations. Vehicles that are advanced in age are cheaper to afford.

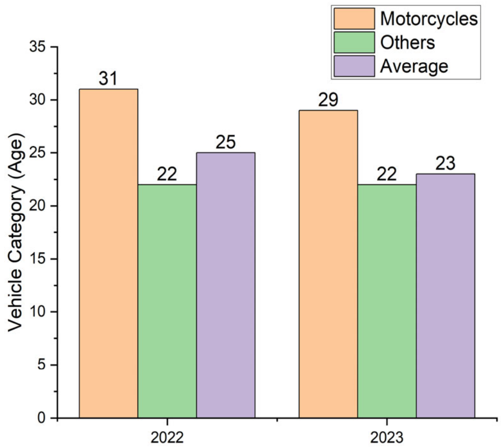


Figure 12 Average age of vehicles at the time of registration

The vehicle identification numbers collected during the baseline study on commercial vehicles suggest that the average age of all vehicles in service may be as high as 50 years, even though this could not be determined. There aren't any age limitations on cars brought into STP, according to information from the Customs Directorate. Most nations with lower vehicle ages, like Ghana and Kenya, have age import limitations on used car imports.

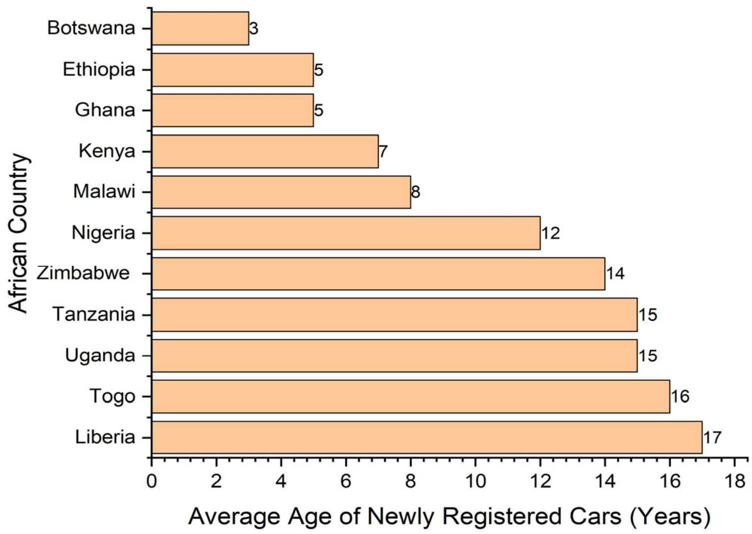


Figure 13 Average age of newly registered cars in Africa

4.2 Review of Vehicle Imports

4.2.1 Source Countries

The countries from which the vehicles and motorbikes are imported are displayed in *Figure 14* and *Figure 15*, respectively. New cars provided by CIEM made up only 3.6% of the imported cars. The majority of cars imported between 2017 and 2023 were from China, South Africa, Germany, France, Portugal, and Japan. According to Figure 10, over 56% of automobiles are imported from Japan with the majority being Toyota types such as the Corolla, Landcruiser, RAV 4, and Hiace, as well as a small number of Nissan and Suzuki vehicles. About 7.5% were imported from Germany comprising Mercedes Benz, BMW, VW, Audi, and Ford models. About 6.5% of cars were imported from France comprising used vehicle models of Peugeot, Renault, Citroen, and Eagle. Used vehicles comprising mostly of Mitsubishi Canter, and Honda HRV were imported from Portugal. They represent 6.5% of the vehicles imported from 2017 to 2023. All vehicles imported from South Africa were new vehicles imported by CIEM. They were mostly models of Toyota such as Hilux and Fortuner averaging 1 to 5 years of age at the time of registration. Vehicles imported from South Africa were 5% of the vehicle fleet imported within this period. Another 5% of vehicles were imported from China. The countries from which these vehicles were imported suggest adequate standards were in place. South Africa complies with European vehicle regulations because it has been exporting the majority of its new cars to Europe for many years.

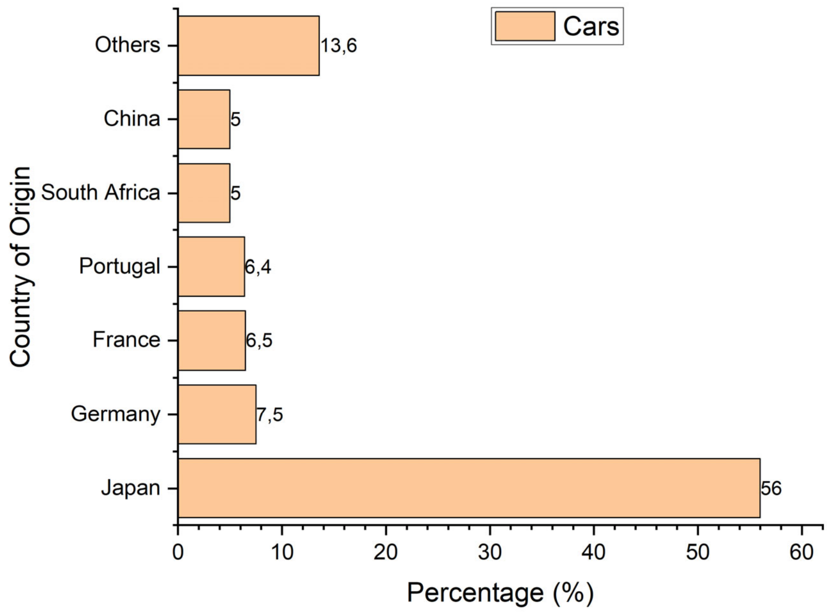


Figure 14 Countries from which cars were imported

In *Figure 15*, the countries from which motorcycles were imported are shown. Almost 90% of motorcycles imported came from China and had an average life of 30 years at the time of registration. The major motorcycle models include Sanya, MCT, Yinghao, Wuyang, Qingqi, Dayang, DAF, Fiver, and many others. About 8.3%, 1.8%, and 0.6% of motorcycles imported came from Europe, Japan, and India respectively.

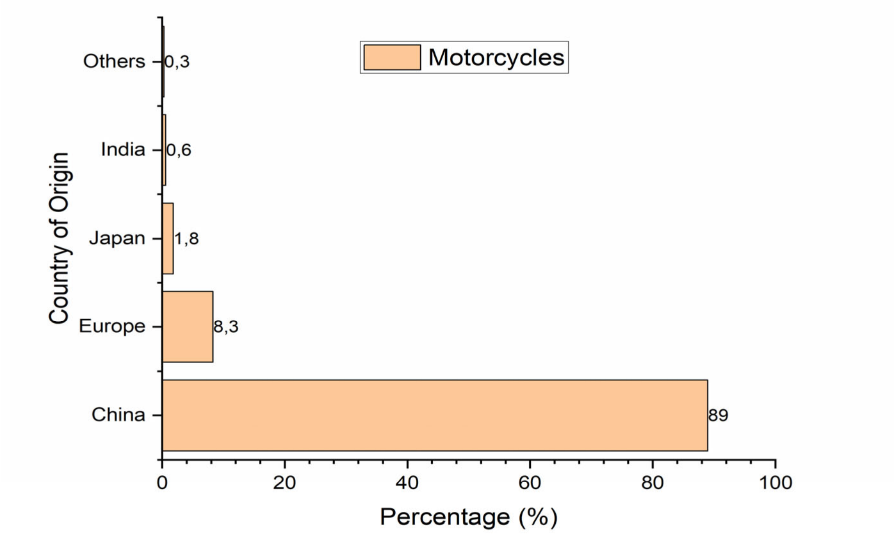


Figure 15 Countries from which motorcycles were imported from 2017 to 2023

4.2.2 Vehicle Standards

One of the key objectives of this project is to develop regulations and standards for vehicles entering STP. It was necessary to determine the homologation standards the imported vehicles were subjected to from their countries of origin. Especially since STP is a net importer of vehicles like almost all other countries in Africa. These vehicles' countries of origin already indicate they have been subjected to homologation and therefore meet international standards. The age of the vehicles also points to exactly which standards they passed before being allowed to be sold in the country of origin. The most popular and followed vehicle standards in the world are the Japanese, European and North American standards.

Figure 16 shows the model year brackets of cars imported from 2017 to 2022. The majority (29%) of the cars imported were manufactured between the year 2000 to 2004. Another, 18.3% were manufactured between 1996 to 1999. About 13.8% fell between the years 2005 and 2008. Another 13% were newer and fell between the years 2014 to 2023. Roughly 10%t of the cars were produced before 1992 when there were lax international regulations governing automobiles.

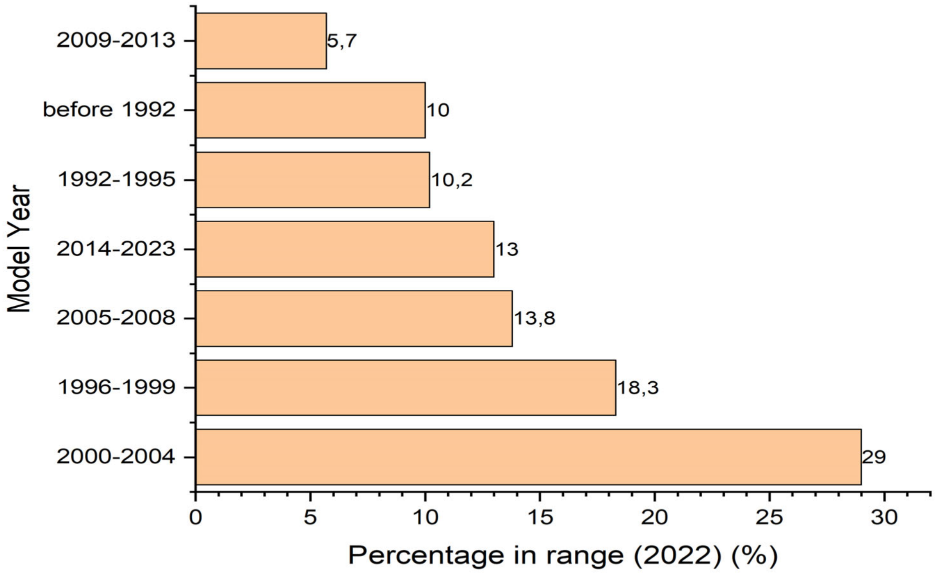


Figure 16 Model year brackets of cars imported from 2017 to 2022

Figure 17 presents links the vehicle age to their homologation standards. Most of the vehicles imported are in the bracket of Euro 3, whose implementation in Europe started in the year 2000 and ended in 2004. Vehicles in this category require Euro 3 fuel, whose specifications have been discussed in the next sections. Similarly, the next majority fall in the bracket of Euro 2 standard vehicles requiring Euro 2 fuel. About 13.8% of the vehicles imported were in the Euro 4 bracket. The new vehicles imported require either Euro 6 or Euro 5 fuel. This represents 13% and 5.7% respectively. Thus 18.7% of registered vehicles require Euro V fuel quality or better while 32.5% require Euro IV fuel or better. The majority of the vehicles (61.5%) require Euro 3 fuel or better.

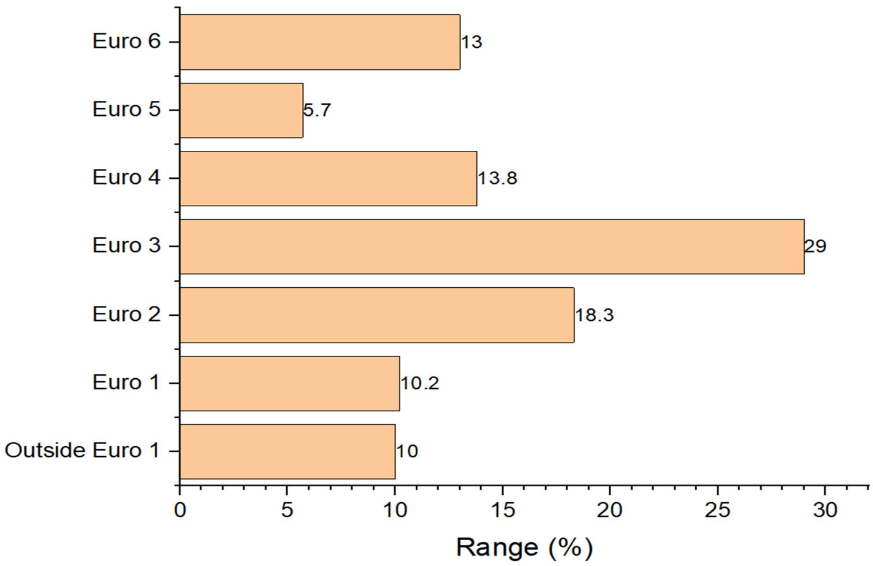


Figure 17 Euro Standard of the cars imported from 2017 to 2022

4.2.3 Vehicle Use

The use cases of the STP-registered vehicles from 2017 to 2023 were categorized as shown in *Figure 18*. Consistently, vehicles used for private purposes remain above 85% while commercial vehicle applications average 6.5%. On average, about 3.6% of the vehicles were new and sold by CIEM to companies and government agencies.

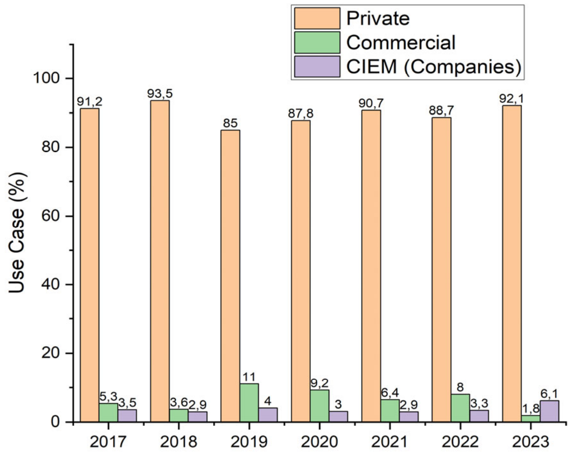


Figure 18 Use Case of vehicles registered from 2017 to 2023

The baseline data gathering also examined private car ownership by gender to gather gender-sensitive data, as presented in *Figure 19* and *Figure 20*. The average private vehicle ownership for females since 2017 is 20%.

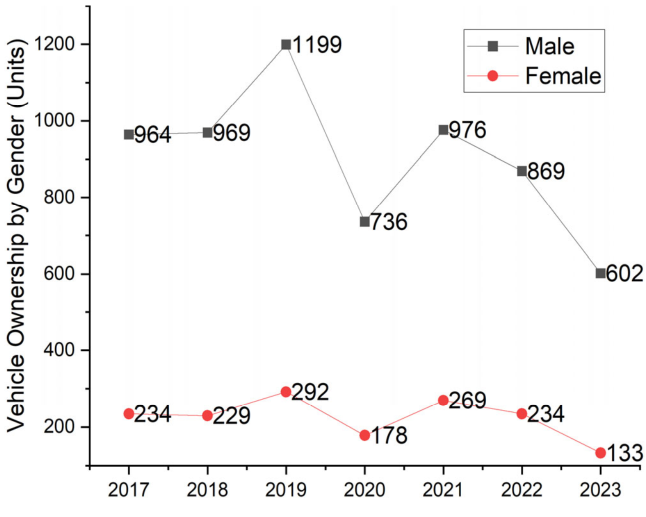


Figure 19 Private vehicle ownership by gender from 2017 to 2023

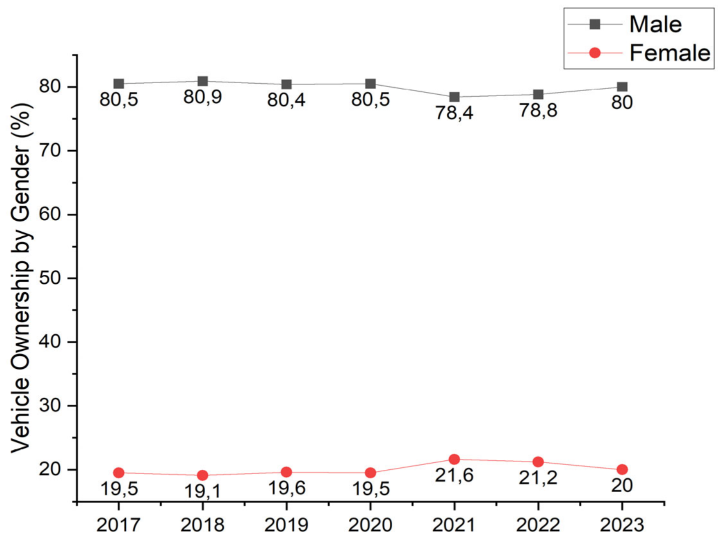


Figure 20 Percentage of private vehicle ownership by gender

4.2.4 Fuel Economy

The average fuel efficiency of newly registered cars in the global south has been improving since 2005. The average figure in 2019 stands at 7.1 L/100 km from 8.4 Lge/100 km in 2005 [8]. The average rate of progress has been 1.3% over the past 14 years. In Japan, where most vehicles in STP are imported from, fuel economy measures are in force. The average fuel economy for motorcycles in STP is estimated at 4.13 L/100 km for 2022 and 4.8 L/100 km in 2023 as seen from *Figure 21*. For other vehicles such as cars and heavy-duty vehicles, the fuel economy in 2022 was 9.9 L/100 km which decreased to 8.4 L/100 km in 2023. This exceeds the world average of 7.1 L/100km but compares well to other African countries as shown in *Figure 22*.

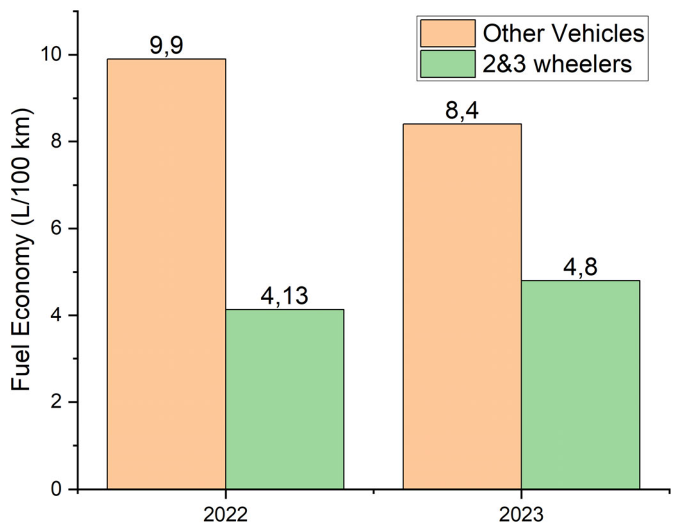


Figure 21 Average fuel economy for vehicle categories

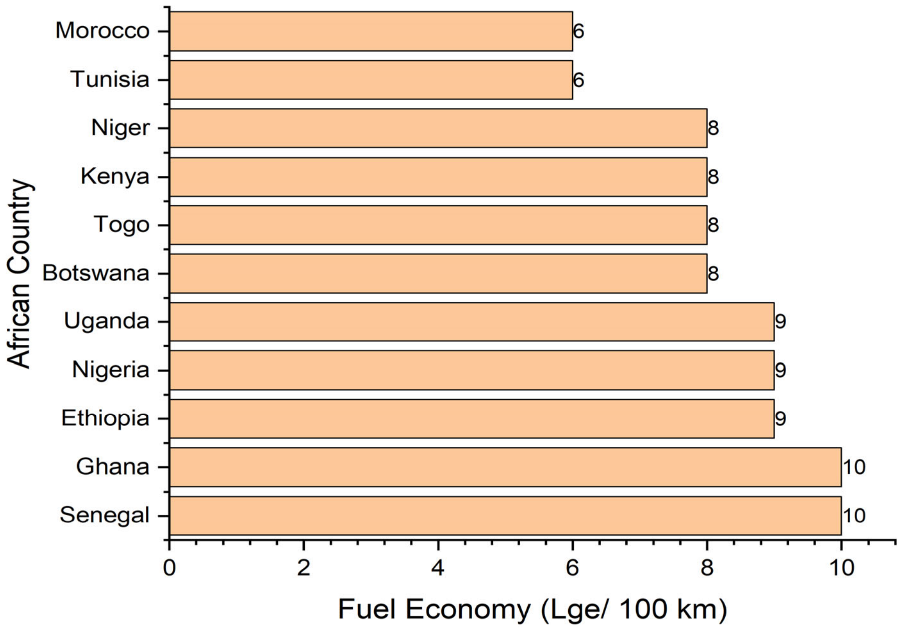


Figure 22 Average fuel economy for some African Countries

About 55.5% of imported cars were powered by gasoline, compared to 44.5% that ran on diesel. In finding the fuel economy of each powertrain it was noticed that the contribution of diesel vehicles to the fuel economy is much higher than that of gasoline. *Figure 23* shows the contribution of fuel economy for both powertrains. The average diesel powertrain fuel consumption in 2022 was 11 L/100 km which declined to 9 L/100 km in 2023. Gasoline fuel economy remained close to 8 L/km for both years considered.

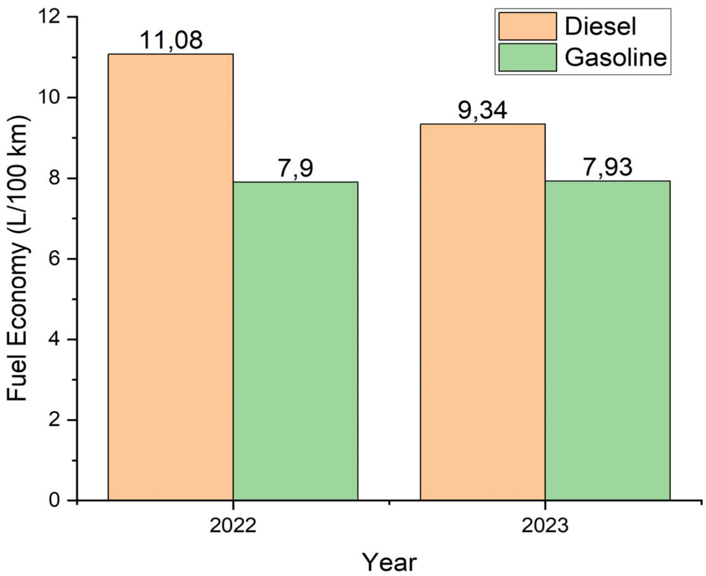


Figure 23 Fuel economy of diesel and gasoline powertrains

4.3 Review of the Supply of Automotive Fuels

4.3.1 Current and short-term forecasts

Figure 24 shows the trend of current fuel supply to STP for gasoline and diesel from 2012 to 2022. About 10 million liters (about 2641720 gal) of gasoline fuel are imported annually compared to 34.5 million liters (about 9113934 gal) of diesel. Annually, there was an average increase in consumption of around 230,000 and 560,000 liters for gasoline and diesel respectively.

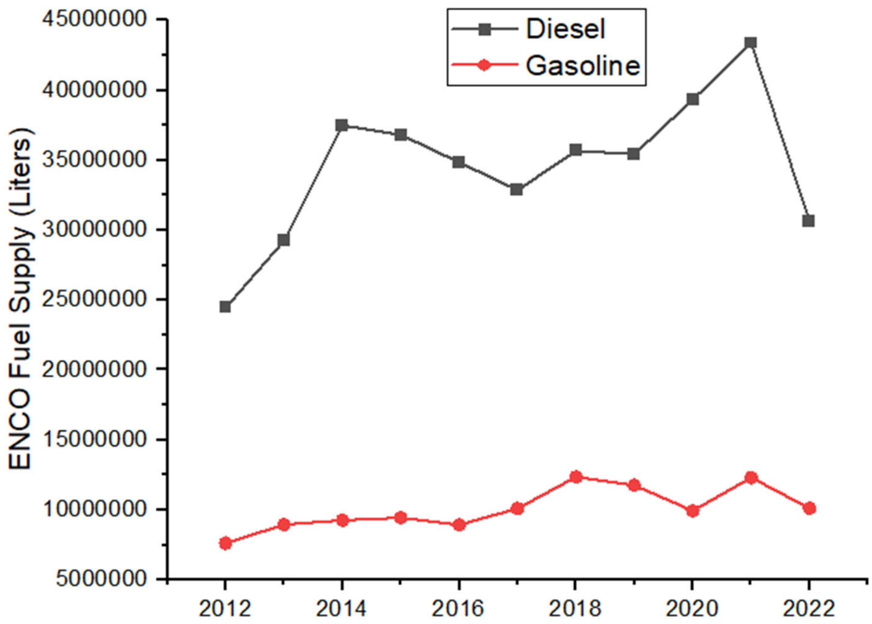


Figure 24 Fuel supply by ENCO from 2012 to 2022

Diesel fuel is used for both automotive purposes and for powering the thermoelectric power plants in STP. Gasoline fuels also have many other applications apart from road vehicles such as non-mobile machinery applications and fishing vessels. In the STP National Energy Efficiency Action Plan, it was estimated that 17% and 80% of all diesel and gasoline fuels respectively are used for automotive purposes. In *Figure 25* is an estimation of the quantity as an indication of fuel consumption. The presentation highlights historical data from 2012 to 2022 while projections from 2023 were made based on the actual data. Gasoline consumption for automotive purposes is about 181,000 liters per year compared to 95,000 liters for diesel. By 2040 due to growing vehicle ownership and vehicle use, gasoline and diesel consumption is expected to reach 11.35 million liters and 6.9 million liters respectively per year.

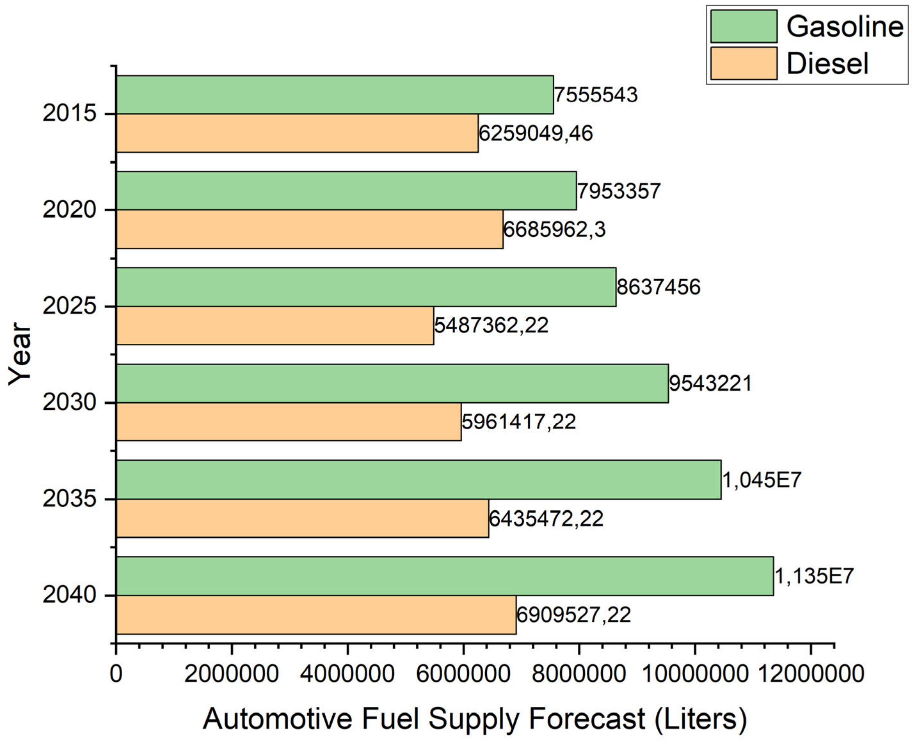


Figure 25 Historical and future projections for Automotive fuels

4.4 Fuel Supply and Quality

4.4.1 Sources of Fuel Supply

Countries that supply gasoline to STP are shown in *Figure 26*. In 2019, about 77.5% of gasoline to STP was supplied from Angola. The rest (22.5%) was supplied from Nigeria. Angola's supply margin increased to 80.6% but the rest (19.4%) was supplied by Togo while the supply from Nigeria ceased entirely in 2020. By 2021 Togo's supply margin had increased to 43.8% while Angola's supply reduced to 56.2% but increased to 67.3% in 2023. Angola and Togo remain the major suppliers of gasoline to STP.

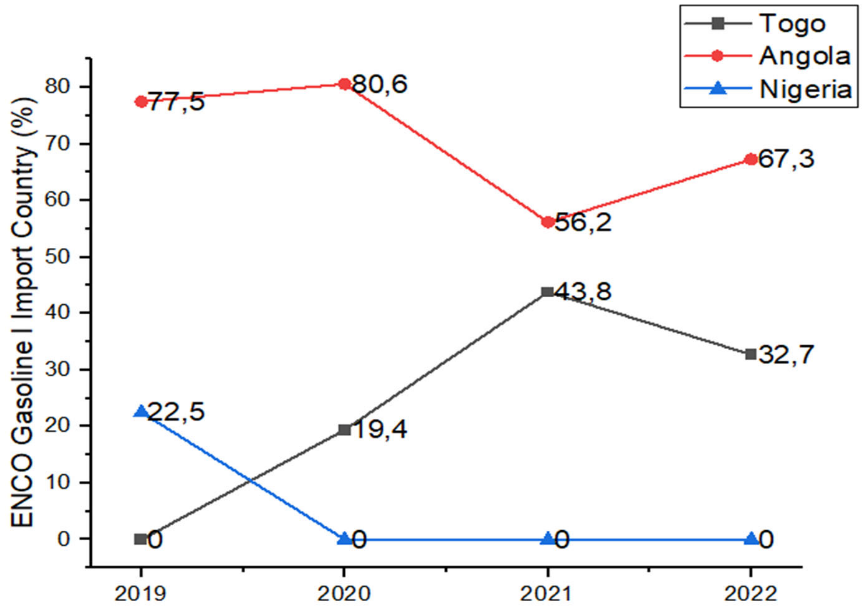


Figure 26 Countries that supply gasoline to STP from 2019 to 2022

Figure 27 shows countries from which diesel fuel was imported between 2019 to 2022. In 2019, about 79.5% of the entire diesel came from Angola and 20.5% came from Nigeria. Togo began its supply in 2020 with a share of 53.8% compared to Angola's reduced share of 46.2%. In 2022, Togo's share in diesel supply increased to 50.5%

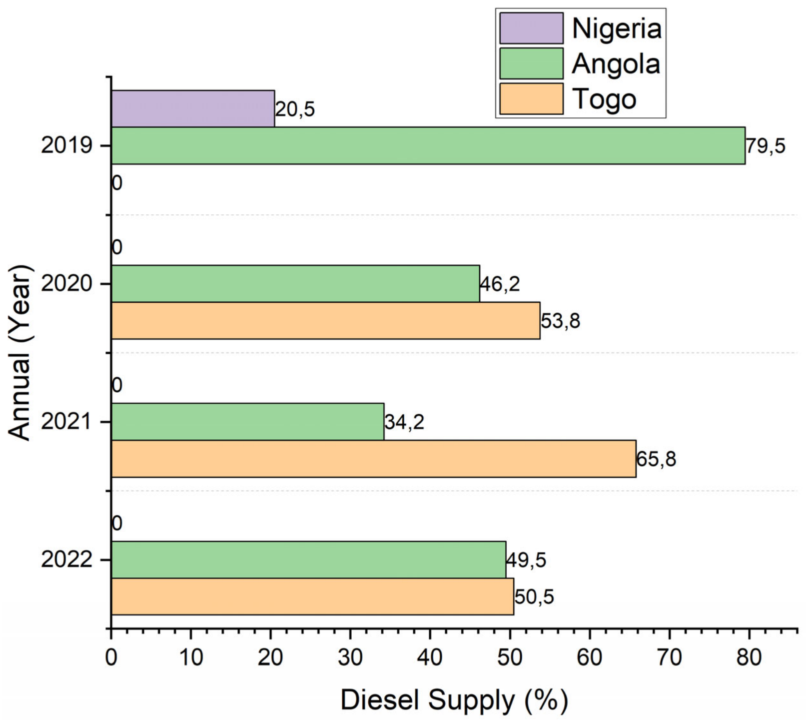


Figure 27 Countries that supplied diesel to STP from 2019 to 2022

Fuel prices in STP have been historically high compared to many other African countries. As of December 2023, diesel fuel per liter was selling at 35 Dobras in Sao Tomé and 37 Dobras in Príncipe. Gasoline fuel sold at 37 Dobras in Sao Tomé and 39 Dobras in Príncipe. The historical fuel prices in Sao Tomé as provided by ENCO are shown in *Figure 28*. *Figure 29* compares the fuel price per liter in other African countries within the same period.

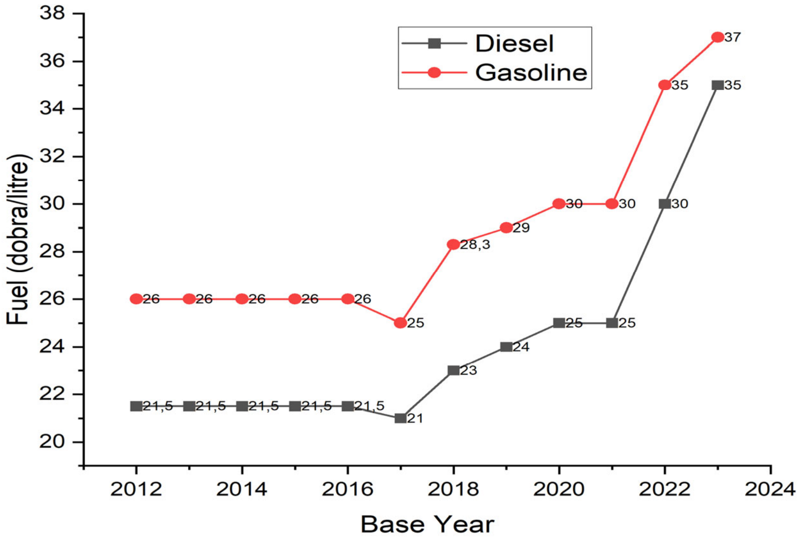


Figure 28 Historical fuel prices in Sao Tomé

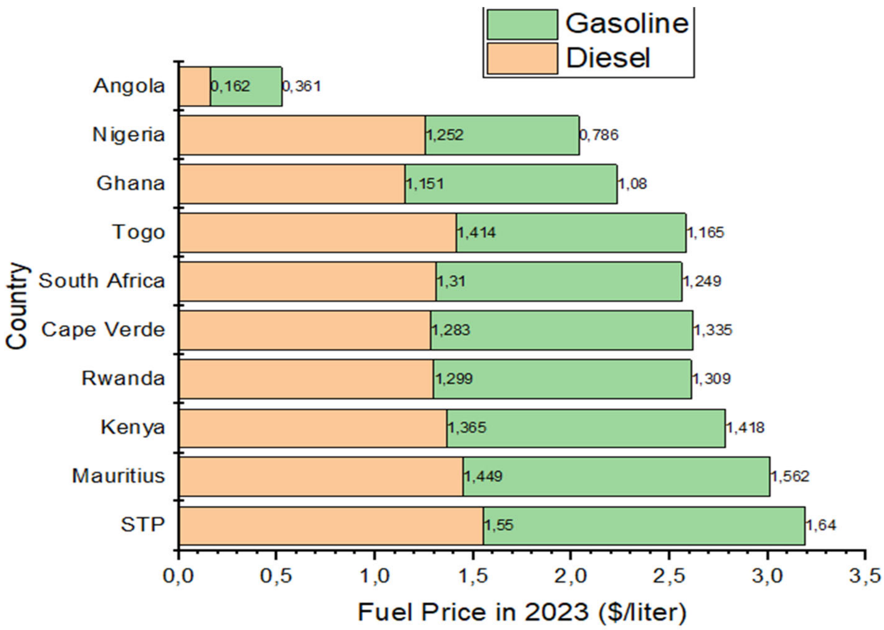


Figure 29 Fuel prices in African countries in 2023

4.4.2 Fuel Quality

Fuel quality remains an issue in many African countries. As part of this project, it was necessary to determine the quality and types of automotive fuel in STP. The island of Sao Tomé has three fuel stations by ENCO while the island of Príncipe has only one fuel station solely owned by ENCO. Only one grade of gasoline and diesel is sold in all the fuel stations. Considering that the countries that export fuel to STP themselves have major issues with fuel quality, it is easy to predict that there are major issues with fuel quality in STP. *Figure 30* shows the Sulphur levels of fuels in some African countries. According to the Global Fuel Economy Initiative (GFEI) and the United Nations Environment Programme (UNEP), the Sulphur content of fuels from Angola reaches 2000 ppm for diesel and 1500 ppm for gasoline [8]. Similarly, some of Togo and Nigeria's fuels even exceed the recommendations of Euro 1 and are not appropriate for vehicles made after 1990.

The conclusion of the survey of mechanics used vehicles, and new vehicles further confirms the need to improve fuel quality in STP. About 70% of all vehicles that frequent the mechanic shops are diesel-fueled vehicles. The mechanics the team interacted with also reported major issues with spark plugs for gasoline engines and injectors for diesel engines as symptoms of fuel quality. In 2023, Ghana also had a similar situation where motorists experienced jerking of their vehicles after buying gasoline from certain fuel stations. This resulted in damaged spark plugs. The Ghana National Petroleum Authority attributed this to the high magnesium content in some fuels sold on the market [14].

Considering that about 60% of STP-registered vehicles between 2017 and 2023 require Euro 3 fuel or better, there is a need to improve fuel quality in STP. It is worth mentioning that fuels from Mauritius, Kenya, and Rwanda fall under Euro 4 for diesel and Euro 3 for gasoline.

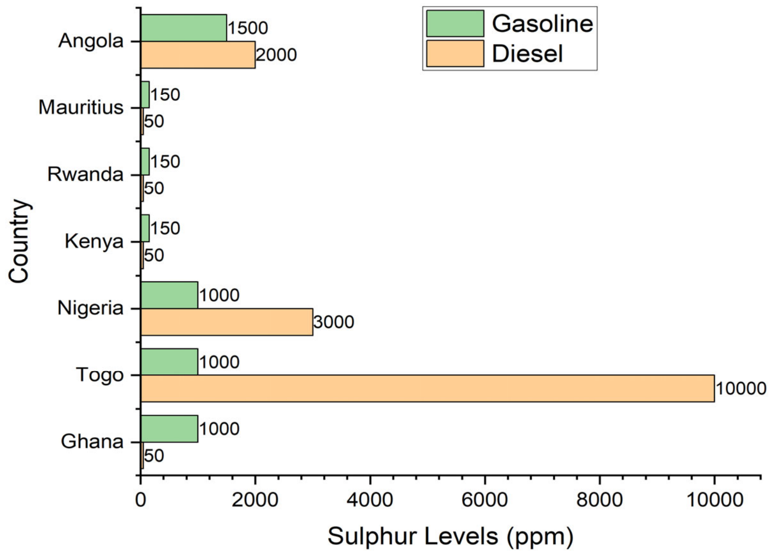


Figure 30 Sulphur levels of fuels in some African countries [8]

4.5 Review of Existing Vehicle-Related Policies, Standards, and Infrastructure

The STP ensures vehicle registration for all vehicles that have no previous registration in the country. Registration for both islands of Sao Tomé and the smaller island Príncipe is done dutifully at the National Institute of Land Transport of Sao Tomé. The island of Príncipe has the jurisdiction to conduct driving tests to issue licenses from the main island (Sao Tomé) but does not do vehicle registration.

Although the main island is required to conduct vehicle testing and registration, it does not currently have the necessary equipment. It does visual inspection of vehicles during registration, but vehicles are hardly refused registration. Basic equipment for testing conventional brakes, headlamps, and emissions is not available. There are no standard documents to follow for regular vehicle testing and emissions. The institute reiterates that it has the mandate to do annual vehicle inspections to determine roadworthiness of vehicles, but this is not done. Vehicles are only required at the institute for a one-time registration and in some cases change of ownership. The institute notes that to begin the yearly periodic technical inspection of cars, the skill set of its resource staff will need to be improved.

It was confirmed at the customs directorate that there are no age restrictions on the import of vehicles. This explains why the average age of vehicles during registration is very high. However, the customs fee structure indicates that vehicles over the age of 5 years pay about 5% to 15% more on import duty. There are new incentives for new energy vehicles, but this does not differentiate the types. All EVs including all hybrids within 5 years of age are duty-free and require no import duty. There are no incentives for other fuel-efficient vehicles with lower fuel economy.

The customs directorate mentions that it has started the digitization of its data, but this is at an early stage. The National Institute of land transport records its information manually and therefore finds it difficult to provide national data on vehicle information. Neither the Institute of Land Transport nor the customs directorate do not synchronize their data.

In recent years, all fuel to STP has been imported from Nigeria, Angola, and Togo. These three countries also import their fuel from other European countries before exporting to STP. Making the price of fuel in STP very high. There is only one grade of fuel sold in STP. Considering the quality of fuel from Nigeria, Angola, and Togo, this fuel supply is within Euro 1 or worse. More than 63% of vehicles in STP require Euro 4 fuel or better. This presents issues with frequent vehicle maintenance which has been reiterated by both roadside mechanics and dealerships in the survey that was conducted. ENCO mentions that there are currently no national fuel standards as of 2023. The issue is also compounded by the fact that there is no nationally recognized body to formulate standards, ensure implementation, and monitor all other bodies. In essence, there are no labs to test fuels or any other product to protect consumers. In the absence of a standards body, all new standards will need another regulation from parliament to make them legally binding.

5 E-Mobility Assessment

Within e-Mobility, the two pivotal components—vehicles and energy supply—constitute the focal points of analysis. Having previously addressed the intricacies of vehicles in the fuel economy assessment section, this chapter focuses on various facets of energy assessment, setting for a comprehensive evaluation of the broader e-Mobility ecosystem in STP. Subsequently, it will cover suitability and prioitisation for e-Mobility, barrier analysis across the value chain, and recommendation for e-Mobility adoption in STP.

5.1 Vehicle Segmentation for e-Mobility

The Government of STP classifies various vehicle types into three major categories: motorcycles, light vehicles, and heavy vehicles. However, there is no proper clarification on the specific vehicle modes included in such classifications. Segmenting these vehicle types into different modes such as 2W, 3W, 4W, Buses, and Trucks, with further differentiations for private and commercial usage, holds profound importance for e-Mobility assessment. As each mode exhibits distinct operational characteristics, including daily distance traveled, travel patterns, idle time, etc., and addressing the specific needs of each segment is pivotal to ensure the development of optimized battery solutions and charging technology.

Based on observations during the mission visit and stakeholder consultations, the three categories mentioned above are further elaborated in *Table 4*. The vehicle categories are also subdivided based on prevalent use cases in the country. For example, 2W and 4W are used for private use and as taxis.

Table 4 Vehicle Categorisation

As per the Country's vehicle categorization	Sub-categorization as per use-cases
Motorcycles	2W – Personal
	2W – Commercial
	3W – Commercial
Light Vehicles	4W – Personal
	4W – Commercial
Heavy Vehicles	Buses
	Trucks

The modal share of 2023 based on the categories as specified by the Institute of Land Transport (INTT) indicates most light vehicles (55%) followed by motorcycles (40%) and heavy vehicles (5%) as shown in

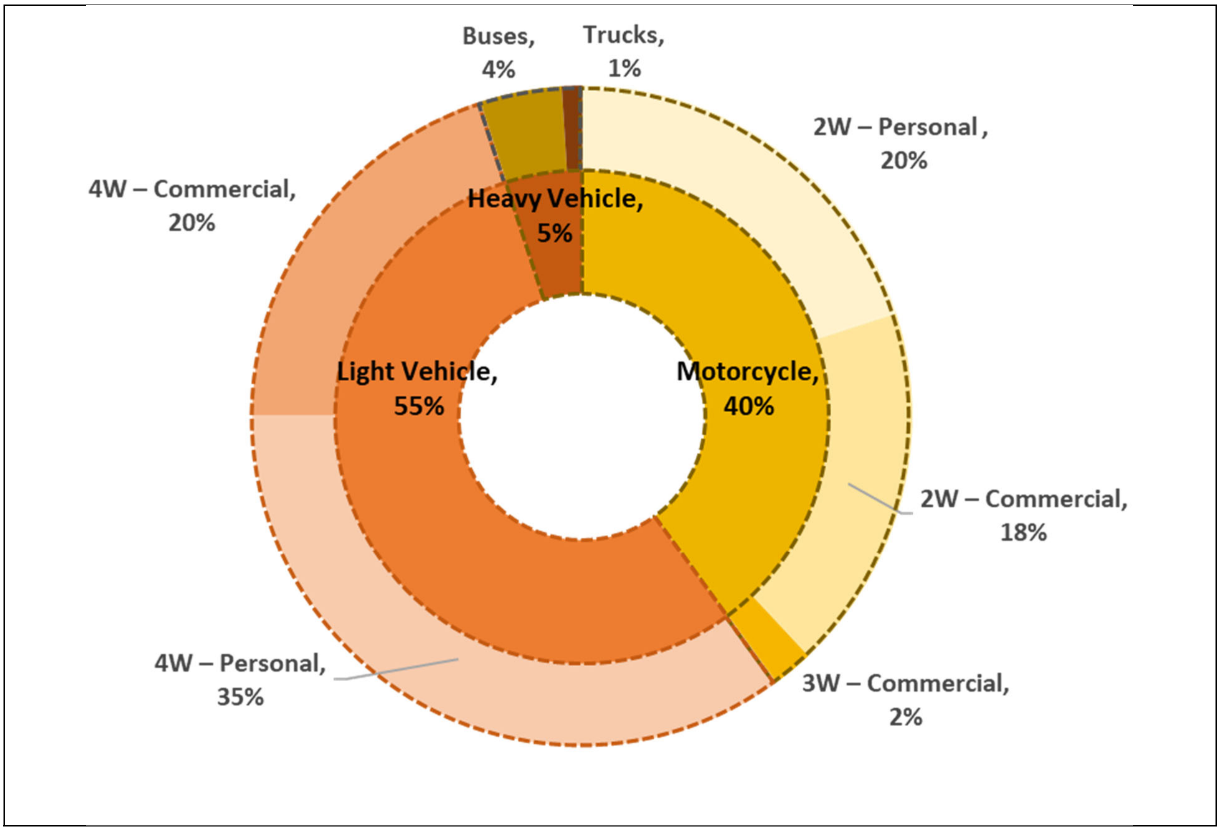


Figure 31**Error! Reference source not found.**.

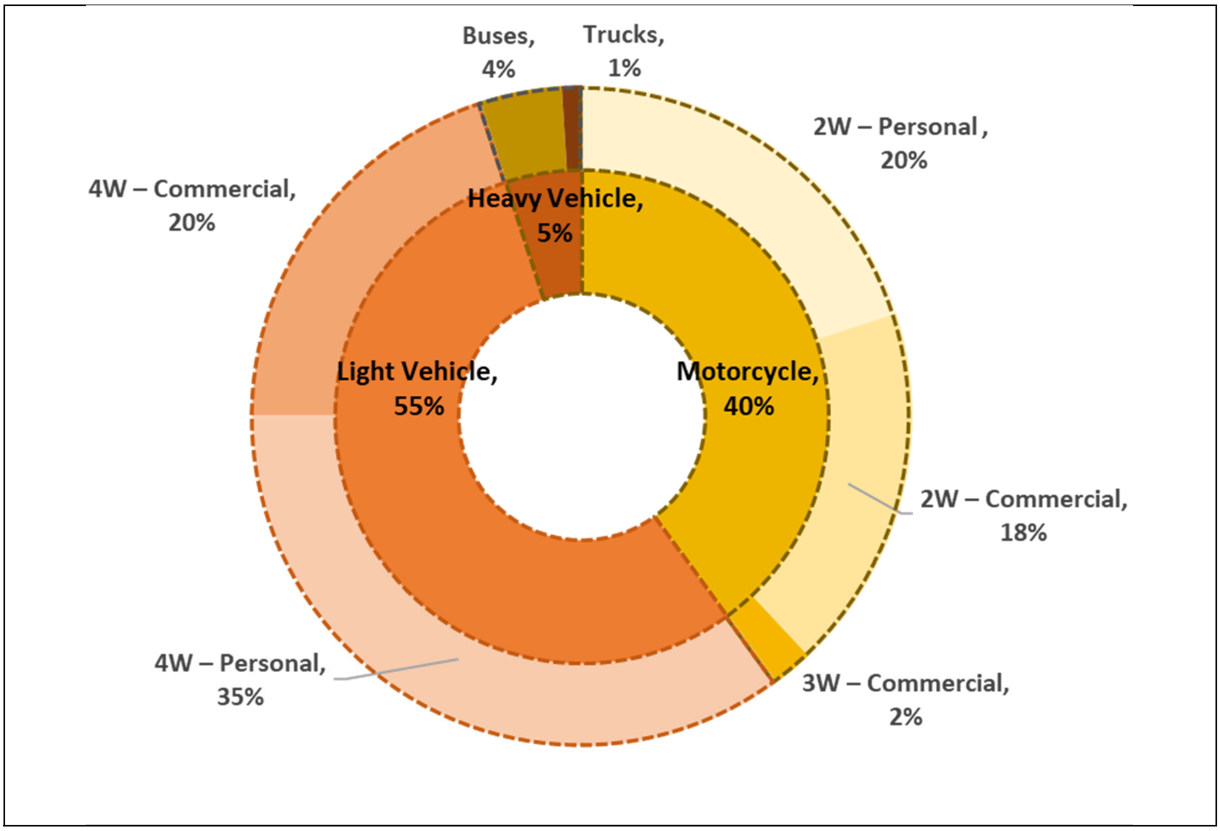


Figure 31 Modal Share

The vehicle categorization, as illustrated in

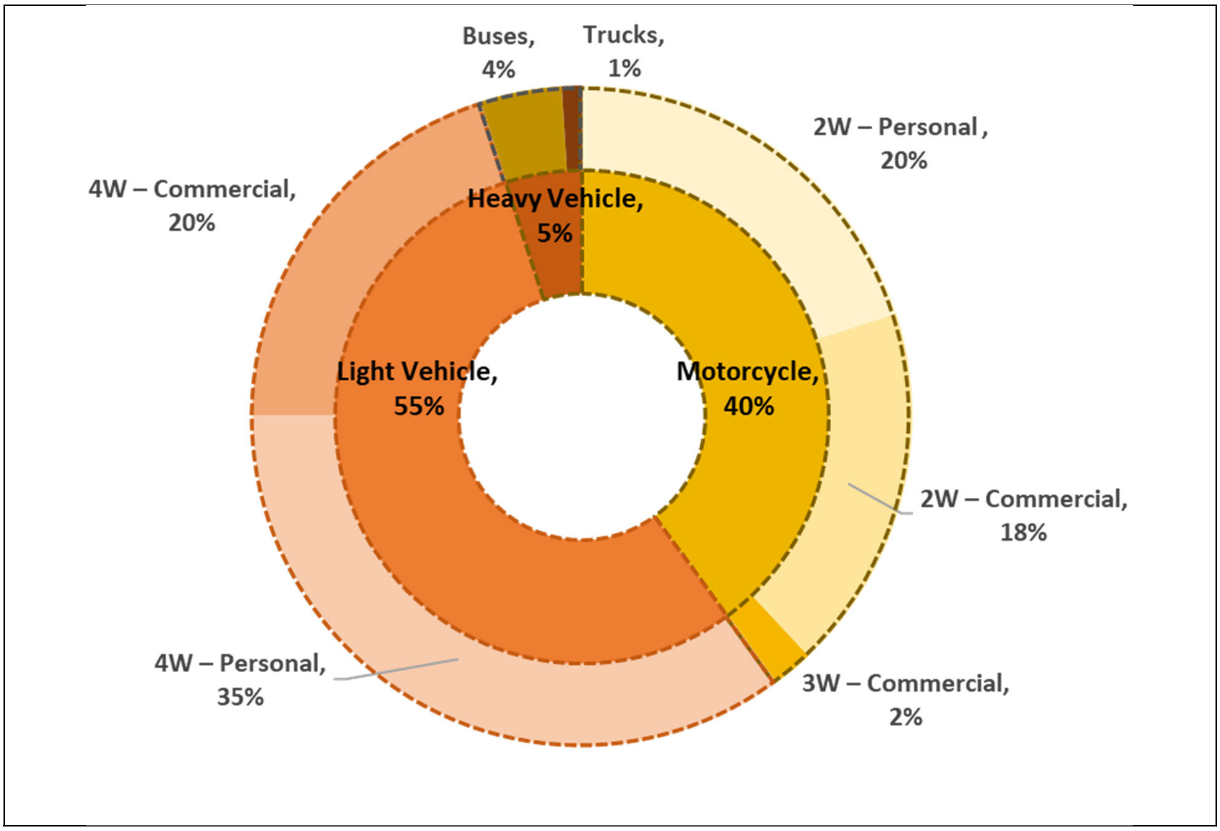


Figure 31 by the consultant, provides a clear breakdown of vehicle use cases and their stock distribution indicating 4W – Personal-use has a maximum share (35%), followed by 2W – Personal (20%) and other vehicle categories.

The operational characteristics of these segments based on stakeholder consultations are provided in *Table 5* below.

Table 5 Vehicle segment-wise Operational Characteristics

Sr. No.	Vehicle Segment	Use case	Vehicle Stock (2022)	% of Vehicle stock	Average Distance traveled per day (km)	Operational days
1	2W 	Personal	7,991	20%	20	330
2	2W 	Commercial	7,192	18%	35	365

Sr. No.	Vehicle Segment	Use case	Vehicle Stock (2022)	% of Vehicle stock	Average Distance traveled per day (km)	Operational days
3	3W  	Commercial	799	2%	50	300
4	4W 	Personal	13,984	35%	25	300
5	4W 	Commercial	7,991	20%	60	300
6	Buses 	Public	1,398	3.5%	80	330
7	Trucks	Freight	599	1.5%	200	300

5.2 Review of Electricity Network

In the context of embracing EVs, understanding and optimizing the electricity network becomes imperative for seamless charging, grid stability, and the successful coexistence of ICEV and EV. This assessment involves a review of electricity generation, transmission & and distribution and final consumption.

5.2.1 Electricity Generation

The electricity production sector in STP faces significant challenges, resulting in a high deficit state. Currently, the country requires 31 MW of power to meet basic operating needs, but it produces only 15 MW [6]. A report by Castália Advisory Group (2010) highlights that 30% of the energy production park is inoperative, and much of it is obsolete. This poor performance was due to successive postponements in the scheduled maintenance and curative maintenance processes of generator sets in all Plants throughout the year, largely due to the necessary financial unavailability, since manufacturers and/or representatives of brands require advance payments or letters of credit to prepare pieces, not being so little, phased payments are allowed.

As of 2021, the total power installed in the interconnected network was 39 MW, corresponding to 2.0 MW from one hydroelectric plant (Contador) and the remaining 37 MW from diesel-based thermoelectric plants (São Tomé, Santo Amaro 1, Santo Amaro 2, Santo Amaro 3, and Bobô-Forro 1) operated by EMAE [6] as shown in *Figure 32*. Details about characteristics of the plants, level of installed and guaranteed power, with power indicated in kW and the production expressed in kWh in *Annexure 7.1*.

Figure 32 Total Installed Capacity of STP

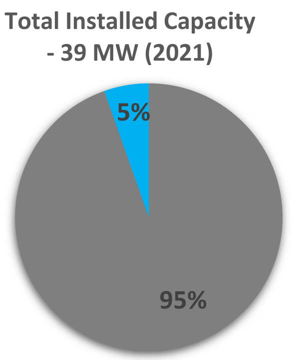
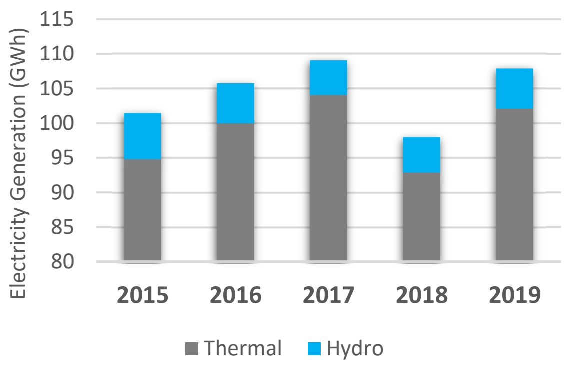


Figure 33 Year-wise Electricity Generation in STP



The renewable action plan outlines a target to achieve a minimum of 72% RE participation in STP's electricity matrix by 2030 [1], maintaining this level until 2050 in terms of installed capacity, as illustrated in ***Error! Reference source not found.***. It indicates the projected year-wise installed capacity from thermal diesel plants and RE sources. Out of the 72% RE, it is proposed that 18% will be obtained from hydropower plants, 49% from solar plants, and the remaining 5% from biomass power plants. If the proposed projects stay on track, the installed capacity is projected to be 69 MW from RE sources and the remaining 27 MW from thermal diesel plants in 2030. The share of RE sources in installed capacity is expected to increase exponentially to 112 MW by 2050, accompanied by a reduction of installed capacity from thermal diesel plants to 17 MW.

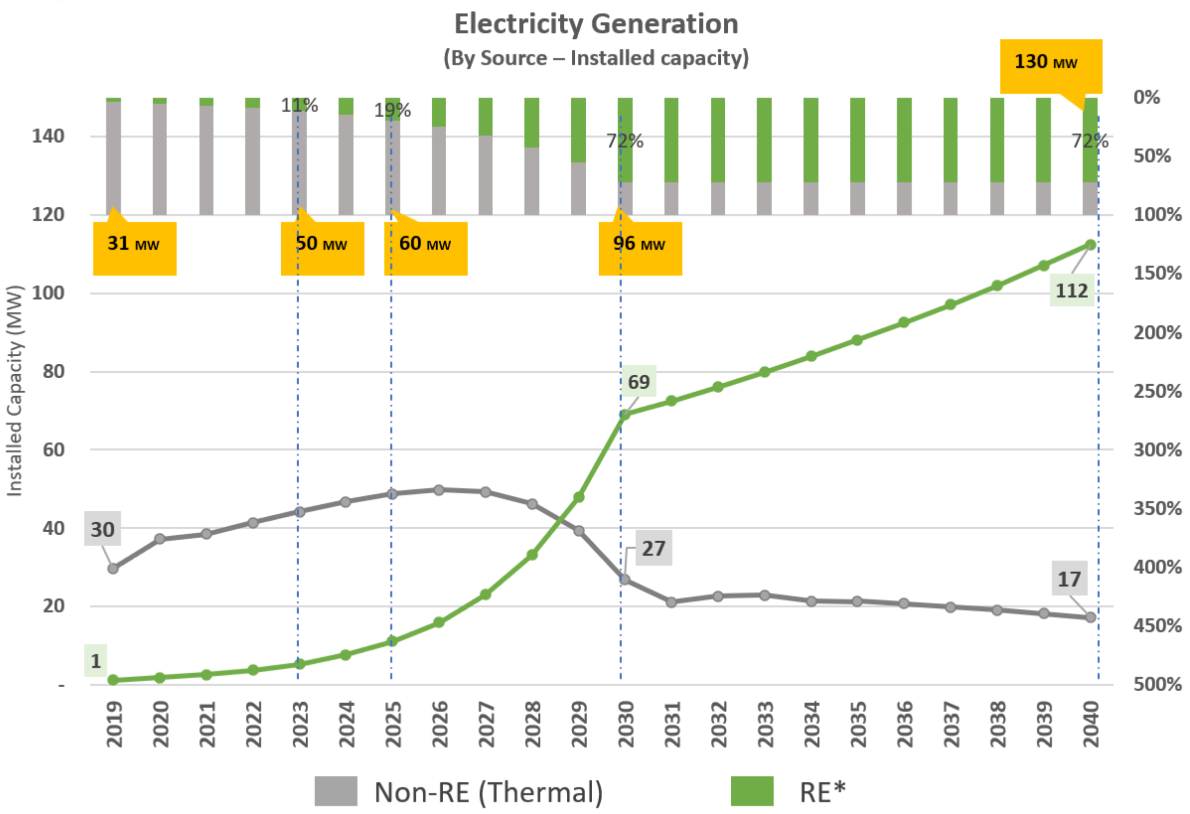


Figure 34 Renewable Energy Penetration Targets

5.2.2 Electricity Transmission & Distribution

The nation also faces difficulties due to an antiquated transmission and distribution system, a power generation mix heavily dependent on pricey diesel, and inadequate management. The total grid losses are around 35%, of which 14% are technical[1] and 21% commercial[2] as per the information collected to prepare the GHG Inventory in June 2021 [6]. These losses are very high and associated with inadequacies in the transmission and distribution networks, along with theft and fraud in the use of electricity, despite the interventions of gradual requalification of the low voltage distribution network and household branches and the creation of a Loss Office, which leads to the conclusion that the losses are commercial nature and unreliable statistical data.

It is crucial to emphasize that, at the production level, the proportion of losses persists until improvement projects in the transport network are completed and distributed. This should be accompanied by actions to combat energy theft and electrical fraud. EMAE's efforts to develop fraud detection and dismantle clandestine connections are insufficient on their own, as continuous responses from offenders are expected. Establishing multiple partnerships with key institutions becomes essential to curb energy and water theft effectively and to penalize offenders more efficiently. This collaborative approach will pave the way for noticeable improvements in performance at this level, aimed at combating illicit consumption and eliminating clandestine connections.

5.2.3 Electricity Consumption

In 2021, the majority of electricity consumption was attributed to residential customers, accounting for just over half (57%) of the total volume of electricity consumed, which corresponds to 38,267,256 kWh [6]. The remaining volume of electricity was consumed by the State Central Administration, Local authorities, Regional Administration of Príncipe, and autonomous State institutions, for which around 16.07% of the volume of electricity consumed was allocated, corresponding to 10,806,103 kWh. All industrial, commercial, services, and other non-domestic customers, consumed only 27% of the total volume of electricity consumed as shown in *Figure 35*. Details of electricity consumption by type of customer is provided in *Annexure 7.2*.

[1] Technical losses are the losses that occur within the distribution network due to the cables, overhead lines, transformers, and other substation equipment that we use to transfer electricity.

[2] Any illegal consumption of electrical energy, which is not correctly metered, billed, and revenue collected, causes commercial losses to the utilities.

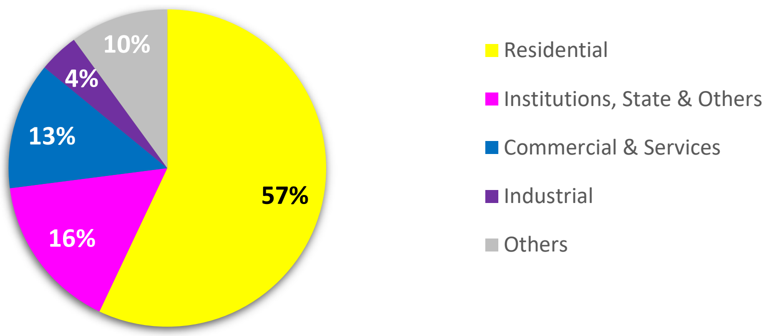


Figure 35 Energy Consumption by Consumer Category (2021)

5.3 Review of E-Mobility Ecosystem

In the global context, EVs stand out as a promising solution for mitigating GHG emissions from the transportation sector and aligning with international commitments to reduce reliance on fossil fuel-based vehicles. The transition to EVs presents a monumental challenge, especially for nations like STP, heavily reliant on vehicle imports. Overcoming hurdles such as technology costs, diverse technology options, capacity building, infrastructure development, and financial requisites is paramount. This chapter delves into a comprehensive assessment of e-Mobility in STP, covering policy evaluation, demand-side dynamics, and supply-side intricacies.

5.3.1 EV Policy Assessment

In evaluating the EV policy landscape of STP, it is discernible that the nation has manifested commendable commitment through various policy measures, which are aiming for EV adoption as described in *Section 3.1 3.1Key Sector Entities*. Policies like Green Energy Acceleration Plan (OIED, 2023), National Energy Efficiency Action Plan (UNIDO, 2022), and others have delineated specific targets for EV integration within the country. However, a critical observation reveals a notable inconsistency in the target-setting approach across different policies, signifying a potential gap in achieving a harmonized trajectory for EV adoption.

The Green Energy Acceleration Plan (GEAP) outlines Scenario-wise targets (Basecase & Highcase) for on-road EV shares by 2050, encompassing electric light vehicles, motorcycles, and buses. The National Energy Efficiency Action Plan sets the target for 2041-50 which is similar to the base scenario of GEAP with a change in the target year. This inconsistency in target setting could pose challenges in standardizing and streamlining the overarching vision for EV adoption.

Henceforth, concerted effort to harmonize and streamline targets will contribute to a more effective and coordinated approach in realizing the envisioned future of sustainable e-Mobility in STP. *Table 6* delves into the present status of EV policies in STP and potential areas for development.

Table 6 EV policies in STP and potential areas for development

<table>
<tr><th>Parameters</th><th>Existing EV Policy Measures in STP</th><th>Gaps identified</th></tr>
<tr><td colspan="3">Demand Side</td></tr>
<tr><td>Fiscal incentives</td><td></td><td></td></tr>
<tr><td>Segment-wise Purchase Subsidy</td><td>Not available</td><td>Lack of EV purchase incentives (across vehicle categories) and awareness of EV technology</td></tr>
<tr><td>Registration Fees / Charges Exemption</td><td>Not available</td><td>No separate insurance charges structure for EVs</td></tr>
<tr><td>Tax Exemption</td><td><table><tr><th>Taxes</th><th>ICEV</th><th>EV</th><th>HEV</th></tr><tr><td>Custom Duty</td><td>25%</td><td>0%</td><td>0%</td></tr><tr><td>VAT</td><td>15%</td><td>0%</td><td>0%</td></tr></table></td><td>As compared to the taxes on ICEVs, EVs have been exempted from heavy customs duty charges and VAT. However, non-differentiated tax incentives for new and pre-owned BEVs (including hybrid).</td></tr>
<tr><td>Transport Tax Exemption</td><td>0.81% of the vehicle market price for ICEV and xEV</td><td>Non-differentiated transport tax for ICEV and xEV</td></tr>
<tr><td>EV Preferential Parking</td><td>No parking policy</td><td>No preferential parking policy for EV</td></tr>
<tr><td colspan="3">Supply Side</td></tr>
<tr><td>Fiscal incentives</td><td></td><td></td></tr>
<tr><td>Public Charging Infra</td><td>Not available</td><td>No visibility of EVs on the road resulting in no charging infrastructure providers</td></tr>
<tr><td>EV dealers/infrastructure providers</td><td>The presence of only 2 vehicle dealer
• CIEM
• CFAO</td><td>Both do not sell EVs due to their high market prices</td></tr>
<tr><td>Establishment of EV charging standards</td><td>No clear charging standard for AC and DC charging will help build standardized charging infrastructure across the country, which in turn will attract users to shift to xEVs</td><td></td></tr>
<tr><td>Land subsidy</td><td>Not available</td><td>No separate land categorisation for the installation of public charging stations</td></tr>
<tr><td>Electricity Tariff</td><td>Tariffs applied in STP are the same for any source of energy production, regardless of whether it is thermal or hydro. Not updated since 2007</td><td>No separate electricity tariff for EV charging</td></tr>
<tr><td>Maintenance Capability</td><td>Not available</td><td>Absence of necessary equipment and other infrastructure, inspection procedures, and qualified/trained manpower in the inspection centre</td></tr>
<tr><td>Battery Recycling and Re-Use</td><td>Environmental Law no. 10/9, 1999 highlights the basic principles for waste management</td><td>But does not have clear mechanisms to drive the collection of all xEV batteries and other xEV components and their safe disposal</td></tr>
<tr><td>Old vehicle Scrapping Mechanism</td><td>No stricter norms for discouraging the use of age-old vehicles (ICEV, hybrid, EV)</td><td>Lack of end-of-life definition, differentiated green cess on polluting vehicles, and retrofitment of ICEVs into EVs</td></tr>
</table>

Limited presence or possibly at an initial stage of policies related to EV import and supply quality, vehicle homologation, battery/charging infrastructure standards, electricity access and reliability, in-use EV maintenance and inspection, and end-of-life and scrappage.

5.3.2 EV Demand-side Assessment

The demand-side analysis of e-Mobility considers various aspects related to the demand for EVs and their equipment to drive the growth of EVs. The current status of demand-side analysis of e-Mobility is presented in *Table 7* below.

Table 7 Demand-side Analysis of e-Mobility in STP

Aspects	Current Status

EVs	• EVs are in a nascent stage
	• 16 EVs on the road [7]
	  o 1 Tesla e-4W (imported from Portugal)
	  o 15 e-GoKarts (4W with lead-acid batteries)

Chargers	• No Public Charging Stations
	  o 1 Level-2 (3.6 kW) Home Charging for 1 Tesla e-4W
	  o Level-1 charging for 15 e-GoKarts used in HBD Príncipe Island, directly charged from the socket
	• No separate EV charging electricity tariff exists

It becomes evident that while fiscal incentives exist to encourage EV adoption as shown in the table, a critical evaluation reveals certain gaps and areas of prioritization that merit attention. As there are non-differentiated tax incentives for new and pre-owned vehicle. This does not encourage the purchase of new vehicle over pre-owned. The tax structure should be designed in a manner that prioritizes BEVs over hybrids, and hybrids over ICEVs.

In conclusion, STP's commitment to fiscal incentives for EVs is commendable. However, addressing the identified gaps in prioritization between new EVs and hybrids, coupled with the integration of comprehensive policy measures, will contribute to a more robust and holistic demand-side strategy.

HBD Príncipe Island is a sustainable eco-tourism and agro-forestry company that collaborates with the Government of STP and island communities to conserve Príncipe Island. It also holds the distinction of being the single largest owner of a vehicle fleet in Principe. They exclusively acquire new vehicles through CIEM and CFAO, including models such as Toyota Hilux, Mitsubishi L200, Suzuki, and Coaster buses.

The company undertook a **pilot project** introducing electric go-karts for transporting food to Sundy Beach. These **electric go-karts** operated on **lead-acid batteries**. However, the actual range fell short of the advertised range due to the hilly terrain and nature of the road. The charging duration proved impractical for their business, and challenges arose from using a dirty grid and unreliable electricity for running these EVs. Generators had to be employed at times to charge the go-karts, and there were difficulties with maintenance and the availability of spare parts. The project faced these challenges and ultimately failed after just six months.

Given the challenges encountered in this project, HBD recommends prioritizing public vehicle fleets, hybrids, and a green grid over any further e-Mobility plans.

5.3.3 EV Supply side Assessment

It considers various aspects of the production/import of EVs and their equipment to support the use of EVs, as well as economic growth. STP has traditionally been highly dependent on other countries for the import of vehicles, spare parts, as well as the fuel required to operate them. This is also the case with EVs and related components, including batteries, chargers, electronics, and others, and there is no strong ecosystem established as of now. The current status of the supply-side analysis of e-Mobility is presented in *Table 8* below.

Table 8 Supply-side analysis of e-Mobility in STP

Aspects	Current Status
Supply chain development for EVs	• Limited OEMs, suppliers, and market (2 vehicle dealers - CIEM and CFAO)
Regulations and control	• No regulatory framework, standards, or code of conduct • No regulations around vehicle disposal • No robust regulations, infrastructure, and appropriate systems for battery disposal
Infrastructure and Operations	• No charging & grid infrastructure • No clear plan of action
Technical expertise and Awareness	• No right set of technical knowledge and capabilities at the individual, and organizational levels for both Public and Private entities

The forthcoming *Section 5.6.1 Global Best Practices in E-Mobility* will delve into a global benchmark analysis, providing insights into diverse EV policy frameworks from various countries. This comparative study aims to extract valuable lessons and specific policy options applicable to STP. This will serve as a foundation for formulating effective and comprehensive EV policies for the nation, enhancing its sustainable mobility ecosystem.

5.3.4 Drivers for EV Growth

As the global community intensifies efforts to address climate change and reduce dependence on traditional energy sources, the adoption of EVs emerges not only as a necessity but as an opportunity for STP to position itself as a forward-thinking and progressive nation committed to shaping a sustainable tomorrow. Key drivers contributing to the growth of EVs (as shown in *Figure 36*) are:

- **Environmental Benefits**: EV has zero tailpipe emissions, contributing to the reduction of GHG like CO2. In alignment to STPs scenario, which is mostly fossil-fuel based, all vehicle segment except e-Bus seems to be more cleaner than its ICE counterpart as shown in table below. For e.g., e-2W are 70% more cleaner than its ICE counterpart, as ICE vehicle emits 90 gms/veh-km and its electric substitutes only 70 gms/veh-kms.

For ICE Powertrain	Input Fuel in Diesel Tank	Fuel Efficiency	Distance Travel	Emissions per Veh-km
	Litre	*km/Litre*	*km*	*kgCO2/Veh-km*
2W	50	35	1750	0.09
3W	50	25	1250	0.13
4W	50	20	1000	0.16
Bus	50	5	250	0.65

For Electric Powertrain	Input Fuel in Diesel Gen	Diesel Gen Efficiency	Electricity Generation	Charging Efficiency	Output Electricity Generated	EV Efficiency	Distance Travel	Emissions per Veh-km
	Litre	*kWh/litre*	*kWh*	*%*	*kWh*	*km/kWh*	*km*	*kgCO2/Veh-km*
2W	50	3.5	175	90%	157.5	52	8190	0.02
3W	50	3.5	175	90%	157.5	10	1575	0.10
4W	50	3.5	175	90%	157.5	9	1418	0.11
Bus	50	3.5	175	90%	157.5	1.5	236	0.69

Mitigated GHG Emission from ICE vs EV (kgCO2/Veh-km)	
2W	0.07
3W	0.03
4W	0.05
Bus	-0.04

- **Lower operation cost**: The running cost of an EV is significantly lower than ICEV. For e.g., e-4W is significantly lower operational cost (~50%) than ICE-4W.

- **Reduced Foreign Import Bill:** Shifting to EVs will reduce transport related fossil fuel consumptions. With country's improving RE in the Grid, this will also lead to reduction of net fossil fuel import into the country.
- **Local Value Chain Development**: EV might offer a fair chance to develop local assembly, retrofit opportunities, broader battery-related business, and foster the energy access industry.
- **Job Creation**: EV industry presents opportunities for job additions (preferably green jobs), spanning EV local assembly, retrofitting, research, development, and maintenance, contributing to overall economic growth.
- **National Commitment**: Embracing EVs, reflects a commitment to sustainable and environmentally friendly practices, aligning with national goals and global environmental targets. Strong policy support, facilitation, and incentives outlay can drive the growth of EVs by the government
- **Economics of Scale for Grid**: EVs, by adding a new load to the grid, provide an opportunity to scale the economy for the power grid. This increased load can incentivize upgrades, making the grid more robust and efficient, , leading to reduced cost per unit
- **Harnessing RE Potential:** Possess significant Solar, Hydro and biomass potential, offering a RE source that can contribute to the energy mix providing a cleaner source for powering EV

Figure 36 Drivers for EV Growth

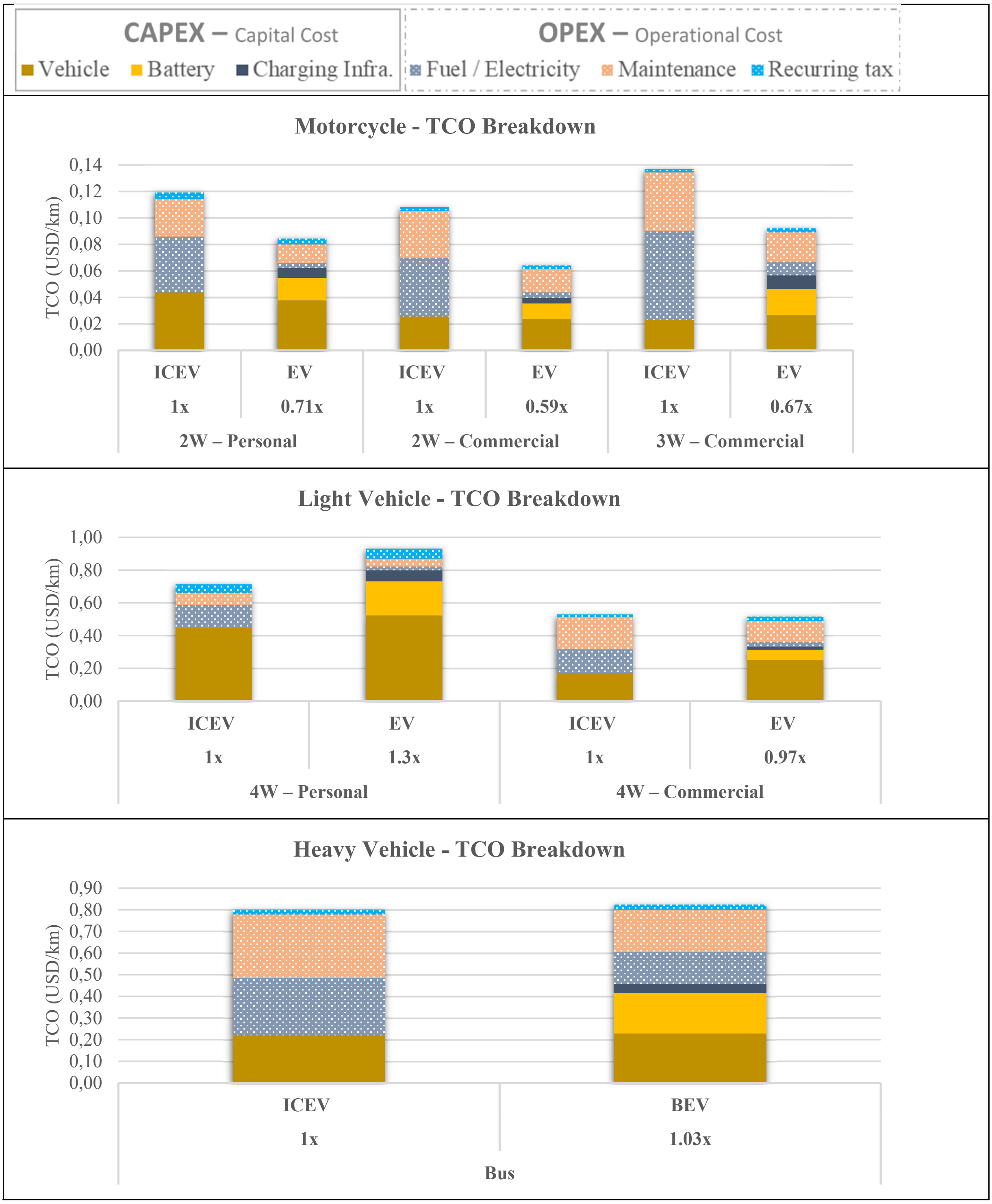
5.4 Suitability and Prioritisation for E-Mobility

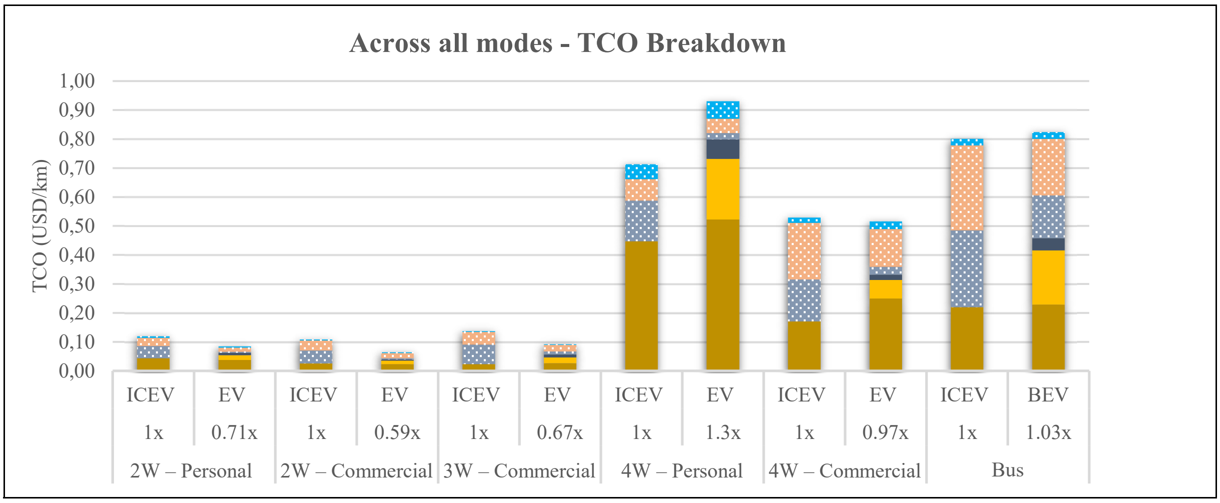
The transport sector in STP encompasses a variety of vehicles, including 2W – Personal, 2W – Commercial, 3W, 4W – Personal, 4W – Commercial, and Buses. While the aspiration is to transition to e-Mobility in both urban and rural areas across all segments, not all e-Mobility modes are economically viable at present. Given the limited availability of resources, constrained access to technology, infrastructure requirements for charging, and implementation capacity, it becomes crucial to prioritize vehicle segments and plan the phased transition to e-Mobility. Prioritization allows policymakers to focus efforts and resources on specific segments, facilitating a more effective transition to e-mobility. This targeted approach enhances the probability of success and quickens the learning curve compared to spreading resources across multiple segments.

5.4.1 TCO Suitability for e-Mobility

This study has developed a total cost of ownership (TCO) comparison for ICE and EV models for the STP, considering the lifetime costs of purchase and operation on a per kilometre basis. In the TCO analysis, it is found that motorcycles and 4W – Commercial in Light vehicles are cost competitive over a full lifecycle, whereas 4W – Personal in the Light vehicle segment and buses in heavy vehicle segment have higher TCO costs and are not cost competitive as shown in *Figure 37*. Nevertheless, operator interviews found outstanding barriers in terms of concerns around battery replacement costs, financing, range anxiety, and after-sales maintenance issues (such as spare part supply chain and warranty issues).

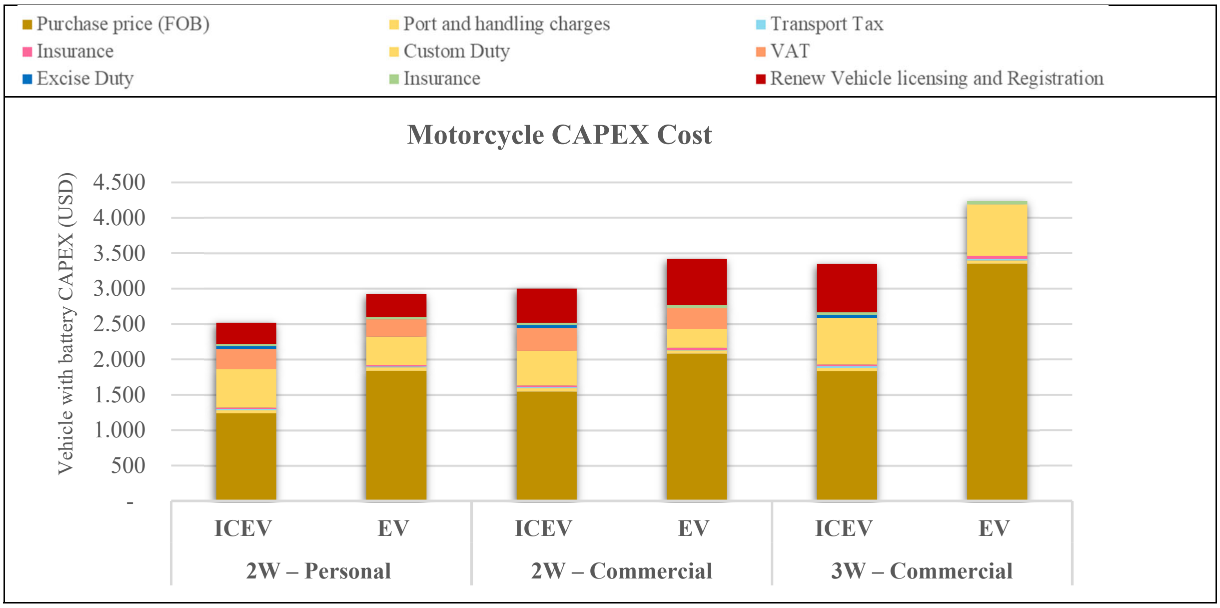
Figure 37 Vehicle segment wise TCO Breakdown

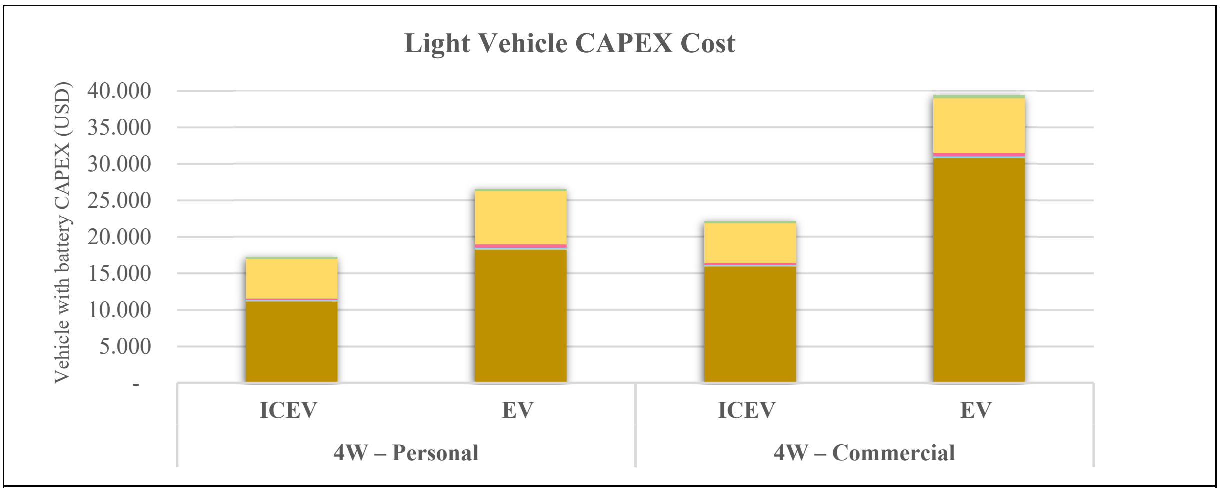


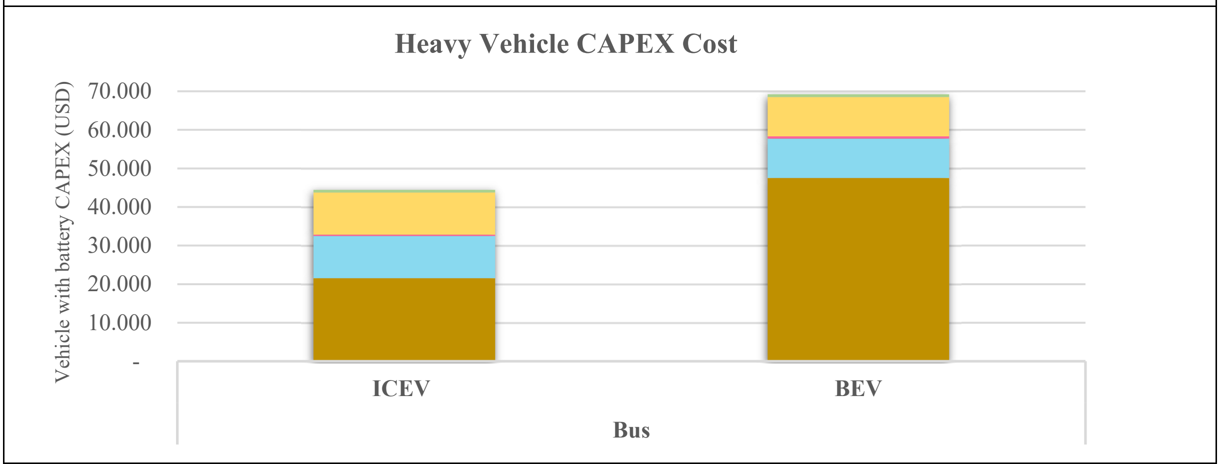


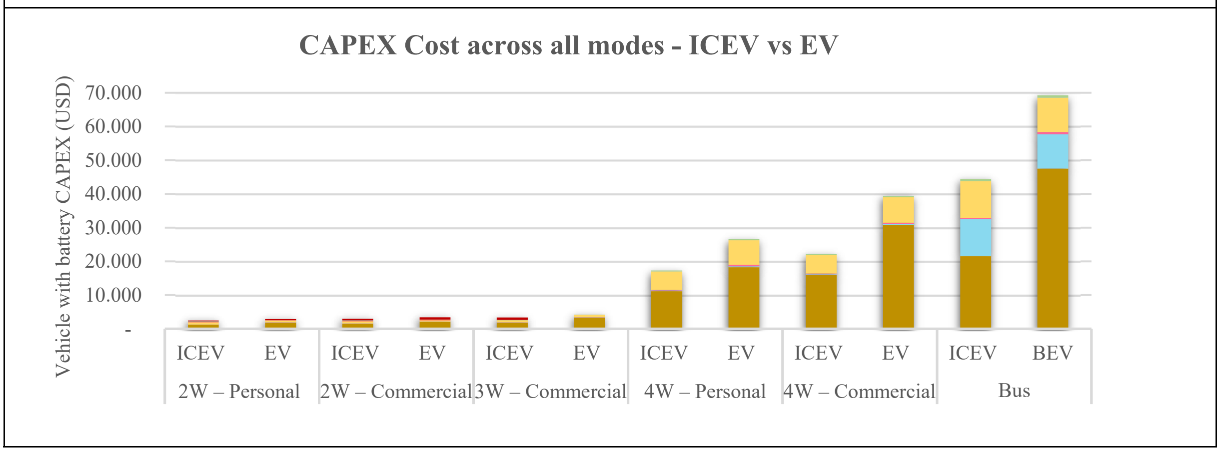
However, upfront purchase costs of vehicles remain to be the biggest hurdle especially seen in the TCO estimates of this study as shown in *Figure 38*. There is a huge disparity especially for buses and the EV counterpart. As found through consultations and participation in government forums, the STP government remains averse to providing fiscal incentives that would reduce disparity and contribute to more attractive EV investments.

Figure 38 Vehicle segment-wise CAPEX cost









5.4.2 Prioritisation Framework

The criteria used to prioritise e-Mobility across different vehicle segments broadly consists of the following 3 categories as shown in *Table 9:*

1. **Technology Costs**: Includes capital and operational cost of the EVs.

2. **Benefits**: Includes economic, social, local pollution reduction, and climate benefits.
3. **Local Context**: In this, specific criteria important in the STP context were considered. The key criteria were usage characteristics, supporting ecosystem, research and development, and acceptability to local stakeholders.

Table 9 Prioritisation criteria for EV adoption in different vehicle segments

Criteria	Sub-criteria	
Costs	**Capital expenditure**	• EVs investment requirements • Charging infrastructure investment requirements
	Operational expenditure	• Electricity costs
Benefits	**Economic benefits**	• Total cost of ownership (TCO) • Fuel savings
	Social benefits	• Job creation opportunities • Quality of life and equity considering ease of movement, connection opportunities, social cohesion, and overall well-being from economic benefits • Gender equality considering ease of drivability and opportunities for women and differently-abled in transport
	Emission reduction benefits	• Air pollution reduction potential • GHG reduction potential
Local Context	**Usage characteristics**	• On-road vehicle stock • Vehicle trip length • Fuel consumption per passenger-km • Easiness of EV Charging
	Supporting ecosystem	• Local availability of EV models • Local post-sales services & spare parts availability • Local assembly & supply potential for EV models & components • EVs R&D and technical skills
	Governmental support	• Government preference

5.4.3 Prioritisation Results

A prioritisation ranking of vehicle segments were carried for identified criteria and sub-criterion, based on consultations with local experts team and interactions with different government stakeholders (MIRN, INTT, ENCO, CIEM, and others) to align them with sectoral policies and strategies. Detailed assessment of identified criteria and calculation of prioritisation ranking is shown in *Annexure 7.3.*

The results reflect high priority for shared vehicle segments namely Buses and 4W – Commercial and low priority for 'private' vehicle segments namely, 4W – Personal and 2W. Further insights for individual vehicle segment levels are explained as follows:

1. **Buses**: e-Buses have the lowest energy consumption per passenger/kilometre, higher social & and environmental benefit, and government willingness to promote them. The buses therefore also emerge as one of the priority options for electrification.
2. **4W – Commercial**: They function as an intermediate mode of shared mobility, often a utility vehicle used for intracity freight and are considerably preferred locally, have longer usage in terms of kilometers traveled and since operational costs of e-vehicles are lower, they can compete with ICEVs with lower financial support (and earlier, when the cost of technology falls) than 4W – Personal. Considering the average trip length, and potential range per recharge (i.e., around 70-80 kms), the e-4W – Commercial is also a good candidate for electrification after buses.
3. **3W**: Although 3Ws have the potential to serve as a quick, accessible, and compact mode of services, 3W has a small market and moderate GHG mitigation potential impact and limited socio-economic benefits. As with 2W, the e-3W segment can also be adopted through local initiatives, NGOs, right financing programs and others.
4. **2W- Commercial**: They have a huge and growing market and moderate GHG mitigation potential impact, and, their daily travel requirement makes it economically feasible for early adoption than 2W Personal.
5. **2W – Personal**: The numbers of 2W – Personal in STP are comparable to 4W and therefore hold much potential for GHG reductions, one of the important objectives of electrification. and, 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.
6. **4W – Personal**: The 4W segment has a moderate potential to reduce GHG emissions if converted to EVs. Considering the high volume of 4Ws and resource constraints (market, supply chain finance and others), this segment may not be an immediate candidate for electrification in STP. 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 the road, which is expected to create demand from private vehicle segments and help grow and establish the EV market in the country.

5.4.4 Gender and Intersectionality

Gender disparities and safety concerns have been integral aspects, impacting both vehicle ownership and preferences. Historical data reveals fluctuations in female vehicle ownership, with 20% as the average since 2017, however, their presence in after-sales service/mechanics is almost negligible.

EVs are often considered more user-friendly, with simpler maintenance requirements, making them potentially easier for women to adopt. The novel ecosystem of e-Mobility presents a chance to create a more inclusive and accessible vehicle ownership experience.

This e-Mobility transition also necessitates the development of a new skill set for vehicle maintenance. This presents an opportunity to bridge the gender gap in the traditionally male-dominated field of automotive maintenance. Therefore, targeted training programs can empower women to actively participate in the maintenance of electric vehicles, creating a more diverse and inclusive workforce.

Beyond vehicle maintenance, there is a significant role for women in the charging infrastructure of EVs. Henceforth, encouraging female participation at every level of the e-Mobility value chain will not only help the country to align with environmental goals but also serve as a catalyst for social change.

5.5 Barrier Analysis Across Value Chain

5.5.1 e-Mobility lifecycle framework

Based on the above assessments of policy, regulation, demand, and supply considerations, this section reviews the barriers across the e-Mobility value chain in STP. The entire value chain of the EVs from vehicle production to vehicle disposal (*Figure 39*) 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; large-scale deployment of EVs in the country.

The value chain of vehicles that applies to both ICEVa and EVs is mapped across production, purchase and registration, vehicle use, repairs and maintenance, and final vehicle scrappage and disposal, as shown in *Figure 39*.

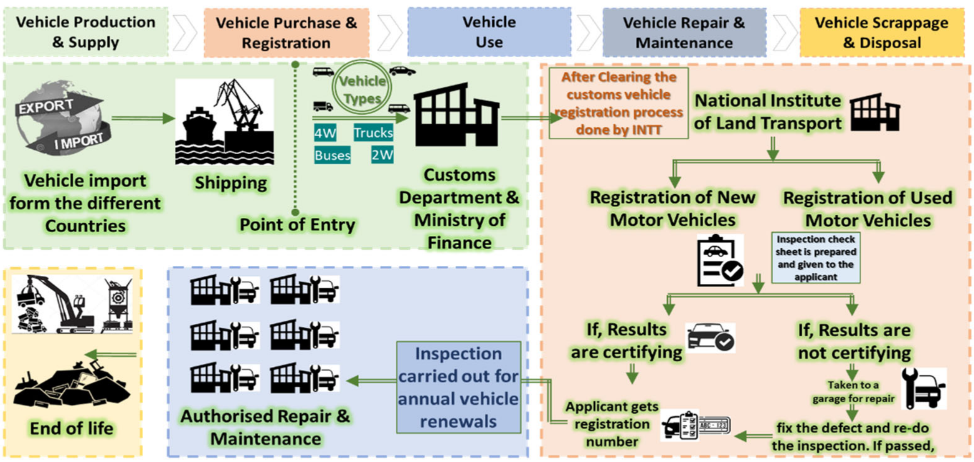


Figure 39 Value chain of vehicles (ICEVs and EVs) across the lifecycle

5.5.2 Barrier Analysis

Vehicle Supply

Vehicle supply landscape in STP face several significant barriers, hindering the development of a robust automotive industry. These challenges primarily revolve around the absence of local skilled capabilities, the dominance of imported vehicles, especially those with considerable age, etc.

- **Lack of Skillset**: The mobility in STP is dependent on imported vehicles (98% of imports from Japan, China, Germany, France, and Portugal). This leads to a limited skillset of local EV assembly, retrofitting, etc. creating a significant barrier to the establishment of both ICEV and EV ecosystem.
- **Import of pre-owned vehicles**: Predominant import of pre-owned vehicles, with an average age of 22 years, often lower in cost, dominate the market, creating strong competition for comparatively high-priced EVs.
- **Absence of Standards and Regulations for EVs**: Absence of well-defined standards for the import and assembly of vehicles, along with specific regulations for EVs, as well as for battery and charging poses a significant challenge related to the quality, reliability, and performance of EVs post-purchase.

Vehicle Purchase and Registration

Vehicle purchase and registration in STP encounter several barriers, impacting the adoption of EVs and creating challenges for both consumers and policymakers.

- **Limited Differential Tariffs and Incentives:** EVs have lower operational costs while their upfront purchase costs are very high compared to the ICEVs. In addition to this, high import duties and the absence of subsidies and financing options for EV purchases in countries have affected the end-user adoption of EVs at large. The government of STP has recently implemented incentives for EVs starting from 1st November 2023, where HEVs that are five years and below are exempted from VAT (which is 15% for ICEV). However, it is non-differentiated especially for new vs. used EVs, and clear incentives favoring EVs over other alternative technologies, could significantly enhance the attractiveness of EVs in the market.
- **Absence of Clear Vehicle Classification and Registration**: While EVs have been granted favorable policies such as tax exemptions and fee waivers, the absence of a clear classification system and segmentation for various vehicle types (2W, 3W, 4W) and their intended usage (private vs. commercial) limits the potential for segment-wise incentives and policies. This hinders the promotion of a more targeted approach to drive EV adoption based on specific needs and preferences.
- **Low Awareness and Limited Availability of EV Dealers**: Low demand for EVs, coupled with the scarcity of dealerships specializing in EVs, contributes to a lack of awareness and understanding among potential buyers.

- **Lack of Standardized Inspection Procedures**: There is absence of standard procedures for periodic vehicle inspections in ICEV also, which adversely affects the health checks and roadworthiness assessments. A standardized inspection protocol is crucial to ensuring the longevity and performance of ICEv and EVs both.

Vehicle Use

The use phase of EVs in STP encounters several barriers, spanning from inadequate power infrastructure to low adoption rates.

- **Limited Access to Electricity:** Low access to electricity is a critical barrier, especially in rural areas. The lack of widespread access hampers the adoption of EVs, particularly in regions where grid connectivity is limited.
- **Energy Infrastructure and Reliability**: Reliability of the power infrastructure is a major concern, with frequent power cuts posing a challenge to uninterrupted EV charging. In the future, increased load due to EVs, without corresponding upgrades to the grid capacity, could exacerbate power cuts, impacting both EV users and the general populace.
- **High Electricity Tariff**: High cost of electricity may discourage the adoption of EVs, particularly in STP, where electricity production is dominated by diesel sources, especially when compared to Africa, hindering the transition to a cleaner and more sustainable energy ecosystem.
- **Insufficient EV Charging Infrastructure**: Lack of clear standards, long charging times and insufficient charging infra hinders the widespread utilization of EVs, highlighting the need for scalable and accessible charging solutions.
- **Apprehension and Lack of Awareness**: Apprehension among vehicle users regarding the new EV technology contributes to low adoption rates.

Vehicle Repairs and Maintenance

- **Insufficient x-EV** (like hybrid) **Experience**: Unlike some other African countries experiencing a transition to hybrids, STP lacks a significant hybrid vehicle presence, means that mechanics may not be equipped to handle the unique challenges posed by larger EV batteries (electronic systems and battery handling). With the advent of EVs, there will be significant need for upskilling mechanics to handle sophisticated electronics and larger battery systems.
- **Inadequate After-Sales Infrastructure**: Limited after-sales ecosystem and repair & maintenance skills.

Vehicle Scrappage and Disposal

- **Lack of End-of-Life Guidelines**: Absence of specific guidelines for scrapping and re-using old ICE vehicles hinders the sustainable disposal of these vehicles. Similar guidelines are required for EVs as the used EV market begins to emerge, ensuring proper procedures for their disposal.
- **Sustainable Battery Disposal**: EVs come equipped with batteries, and their disposal requires specific attention due to environmental concerns. Guidelines for sustainable battery disposal, in compliance with the Environmental Waste Management act, need to be established to mitigate potential environmental risks.
- **Limited Awareness and Infrastructure**: Insufficient infrastructure for organized scrappage processes poses a challenge in the effective implementation of responsible disposal practices.
- **Economic Utilization of Battery Components**: Batteries in EVs consist of disposable and reusable components, presenting an economic opportunity for battery re-use and re-purposing if managed efficiently. A lack of awareness and mechanisms for extracting value from battery components may result in missed economic opportunities.

These barriers were grouped under eight categories that included Economic and Financial barriers, Technological barriers, Institutional barriers, Infrastructure barriers, Social barriers, Market barriers, Regulatory and Policy barriers as shown in *Table 10*.

Table 10 Barriers to large-scale deployment of EVs in STP

Barrier category	Barriers	Barriers components
Economic and Financial Barriers	High purchase price of EVs and batteries	• High price of EV, 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 SKD/CKD kits for local assembly are high, the same as on ICE vehicles.
Market al Barriers	Lack of local supply chain for EV local assembly 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. Un-defined EV Standards: No defined EVs, batteries and charging standards (for new, pre-owned and retrofits)

Barrier category	Barriers	Barriers components
	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
	Lack of automotive skills	• Lack of automotive skills: Overall lack of automotive skills including retrofitting (mostly in 2W and commercial – 3W/4W) and repairs and maintenance of EVs
Awareness / information	Lack of promotional and facilitation measures for new (clean/low emission) technology	• Lack of awareness of new clean/low-emission technologies • EV Technology Apprehension

5.6 E-Mobility Policy Measures

This section delves into the formulation of policy measures for STP leveraging international learnings to outline policy pathways that can pave the way for a robust and environmentally conscious e-Mobility future in STP.

5.6.1 Global Best Practices in E-Mobility

To develop an e-Mobility Roadmap for a country, it is important to understand its key aspects from best practices across the globe. Thus, the best practices are selected from three typologies of countries such as **Progressive countries, African countries,** and **SIDS countries,** for their leadership in e-Mobility within their regions. These diverse countries offer valuable insights into successful EV policy frameworks, informing STP unique approach as a SIDS. Comparative assessment of EV policy measures for selected countries are shown in

Table 11.

Table 11 Summary of EV Policy Measures

Parameters	Progressive Countries		African Countries		SIDS Countries	
	China	EU	Mauritius	Rwanda	Fiji	Barbados
Demand Side						
Fiscal Incentives	✓	✓	✓	✓		
Segment-wise Purchase Subsidy		✓	✓		✓	
Registration Fees/ Chargers	✓	✓		✓	✓	
Tax Exemption	✓	✓	✓	✓	✓	✓
Home/ Work Charging Infra	✓	✓				
Preferential Parking	✓	✓	✓	✓		
Stricter emission standards/ high taxes	✓	✓				
Supply Side						
Fiscal Incentives	✓	✓	✓	✓	✓	✓
EV Manufacturers	✓	✓	✓			✓
Public Charging Infra	✓	✓	✓		✓	
Tax incentives to vehicle dealer				✓		✓
Establishment of charging standards						✓
Electricity Tariff				✓		
Land subsidy				✓		
ZEV Mandate	✓	✓	✓			
Approval of ICE to EV retrofitting (& homologation)	✓	✓				
Battery Recycling and Re-Use			✓			
Old vehicle Scrapping Mechanism	✓	✓			✓	

By examining the experiences of countries such as China, EU, Mauritius, Rwanda, Fiji, and Barbados, this section aim to glean insights into the various approaches, policies, and frameworks that have propelled the growth of e-Mobility in diverse global contexts as shown in

Table 11.

China stands as a global leader in the transition to EVs, given its position as the largest car market globally. In 2022, an impressive 22% of passenger vehicles sold in China were all-electric, totaling 4.4 million sales – surpassing the rest of the world combined. This success is attributed to China's robust support for EVs, significantly contributing to the reduction of battery costs on a global scale. Notably, eight out of the top ten EV models sold in China are produced by Chinese companies, and China has ventured into exporting EVs globally [8].

European Union (EU) has achieved considerable progress in e-Mobility, with 21.6% of new car registrations being EVs in 2022, totaling close to two million registrations. The growth trend continues, with a steady increase in the number of new e-Car registrations over the years. BEVs accounted for 12.2% of total new car registrations in 2022, with PHEVs representing 9.4% [9].

Mauritius recognizes the impact of the transport sector on energy consumption (77.8% of the total energy consumed), prompting a transition towards greener transportation. Currently, the country has approximately 100 EVs and 300 PHEVs, with PHEVs representing 5% of the conventional car fleet [10].

Rwanda, concerned about air quality and rising fuel import bills, aims to foster an integrated, safe, clean, and affordable multi-modal transport system. At present, there are 632 e-motos, 80 ICE bikes retrofitted, 124 PHEV cars, 20 e-golfs, 130 domestic charging stations, and 33 public charging stations operational. Rwanda aims to convert the vehicle stock to EVs by 2030 (motorcycles: 30%, cars: 8%, buses: 20%, mini and micro-buses: 25%) [11].

Fiji as a SIDS, recognizes its vulnerability to climate change and aims for ambitious and rapid action to address GHG emissions. The country targets 100% electrification of the transport sector by 2030, emphasizing the shift from Euro 4 to Euro 5 emissions standards [12].

Barbados, serves as a strong example that is working towards sustainable energy independence as it is one of the thirteen SIDS to fully ratify the Paris Climate Agreement. It intends to achieve a reduction of GHG emissions of 40% by 2030, for which they have targeted 100% RE and 100% electrification of bus and government fleet. To date, they have deployed over 40 charging points, of which 34 are publicly accessible and the remainder located in the car parks of businesses.

Table 12 Policy Measures of Global Best Practices in e-Mobility

	Targets	Demand-side Policy Measures	Supply-side Policy Measures
Progressive Countries	**China**		
	• 20% EV sales by 2025 • 20 million EV charging facilities by 2025	• Purchase subsidies and tax incentives • Charging Infrastructure subsidies • Driving and parking privileges • Public Bus policies	• Research, development, and tax subsidies • Sales targets for domestic auto manufacturers • Technology Development funds

<table>
<tr><th></th><th>Targets</th><th>Demand-side Policy Measures</th><th>Supply-side Policy Measures</th></tr>
<tr><td rowspan="2"></td><td colspan="3">European Union</td></tr>
<tr><td>CO2 Fleet Targets:
• 2025: Reduction targets for cars & vans - 15%
• 2030: Reduction targets
o Cars: 55%
o Vans: 50%</td><td>• Indirect consumer incentives such as preferential access to bus lanes
• Free or preferential parking
• Access to low-emission zones
• Free charging at public stations and road toll exemptions</td><td>• Financial support to the EV industry
• Public investments in charging infrastructure or subsidies for home chargers</td></tr>
<tr><td rowspan="4">African Countries</td><td colspan="3">Mauritius</td></tr>
<tr><td><table>
<tr><td rowspan="2">% share of e-4W sale</td><td colspan="3">EV Growth Scneario</td></tr>
<tr><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td>2020</td><td>1%</td><td>3%</td><td>5%</td></tr>
<tr><td>2025</td><td>5%</td><td>9%</td><td>18%</td></tr>
<tr><td>2030</td><td>10%</td><td>15%</td><td>30%</td></tr>
</table></td><td>• Phased approach and scaling of EV incentives by target groups:
o Taxi
o Corporate & govt</td><td>• Nation-wide open fast charging network
• National Battery Plan
• Building EV community
• Clean power for EVs
• Phase implementation of smart charging</td></tr>
<tr><td colspan="3">Rawanda</td></tr>
<tr><td>Conversion of vehicle stock to EV by 2030:
• Motorcycles: 30%
• Cars: 8%
• Buses: 20%
• Mini & micro-buses: 25%</td><td>• Zero VAT on EV-related equipment
• Exemption on import, excise duties and withholding tax of 5% at customs
• Preferential parking for EV
• Free license and authorization for commercial EVs</td><td>• Electricity tariff for charging stations to be capped at industry tariff
• Introduction of a carbon tax to discourage polluting vehicles
• Rent-free land for charging stations</td></tr>
<tr><td rowspan="4">SIDS</td><td colspan="3">Fiji</td></tr>
<tr><td>• Minimum 50% of fleet transition to electric by 2030
• Move from Euro 4 to Euro 5 emissions standard
• Reduce vehicle emission levels by 40%</td><td>• Zero duty on EVs, hybrid vehicles, LPG, CNG and solar-powered vehicles
• Zero duty on EV-related items, including solar and electrical charging stations, etc.</td><td>• Vehicle scrapping mechanism
• Vehicle efficiency improvements
• Adoption of EVs in public transport</td></tr>
<tr><td colspan="3">Barbados</td></tr>
<tr><td>• 100% reliance on RE.
• Carbon neutrality by 2030.
• 100% e-Bus and government fleets by 2030.</td><td>• Tax incentives to vehicle dealerships that provide training, encourage investment in required infrastructure with charging stations etc.
• Remove import duties on EVs.</td><td>• Encourage investment in EV infrastructures.
• Establish standards in charging and other RE infrastructure related to fuelling</td></tr>
</table>

5.6.2 Policy Options

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 13*.

Table 13 Potential enabling measures/policies to support large scale deployment of EVs in STP

	Barriers		Enablers
01	• Lack of local EV assembly and retrofitting skillset • Import of pre-owned vehicles with an average age of 22 years • Absence of standards and regulations for EVs	Vehicle Imports	• Investment in Capacity and Capability building • Development of clear standards and regulations for EVs • Policy support for quality, reliability, and performance of EVs
02	• Limited differential tariffs and incentives for EVs • Absence of clear vehicle classification and registration • Low awareness and limited availability of EV dealers • Lack of standardized inspection procedures	Vehicle Purchase & Registration	• Clear vehicle classification and segmentation system • Increased awareness and availability of EV dealerships
03	• Lower fuel emission standards and cost • Limited access to electricity and reliability • Absence of tariff differentiation • Insufficient EV charging infrastructure • Apprehension and lack of awareness	Vehicle Use	• Improved emission standards • Infrastructure development for widespread access to electricity • Upgrade power infrastructure to support increased EV load • Implementation of tariff differentiation for RE sources • Development of standardized & accessible charging solutions • Public awareness campaigns and educational programs
04	• Insufficient x-EV experience • Inadequate after-sales infrastructure	Vehicle Repairs & Maintenance	• Upskilling mechanics for handling EV complexities • Investment in local manufacturing capacity and R&M facilities
05	• Lack of end-of-life guidelines • Sustainable battery disposal • Limited awareness and infrastructure • Economic utilization of battery components	Vehicle Scrappage	• Establishment of specific guidelines for scrapping and re-using • Infrastructure development and awareness programs for responsible disposal • Mechanisms for extracting value from battery components

In conclusion, the global best practices in e-Mobility, gleaned from countries like China, the EU, Mauritius, Rwanda, Fiji, and Barbados, offer valuable insights for STP. While early incentives can spur market development, the focus on TCO parity emerges as a sustainable driver of adoption. Aligning with vehicle prioritisation, precise vehicle segmentation, and acknowledging STP's unique context, these policy measures set the stage. Further specificity, modeling, projections, and a comprehensive roadmap will be elaborated in the subsequent section of this report, delineating a strategic path for STP's e-Mobility future.

6 Recommendations

6.1 Fuel Economy

Based on findings of the baseline study the following is recommended

- There should be **age restrictions of at least 15 years on vehicles imported into STP**. This will automatically put used vehicles imported into the bracket of Euro 4 and/or Euro 5. Since there is no vehicle scrapping policy, this age restriction can only be achieved using the incremental tax regime where the tax for overage vehicles is enough deterrent.
- Prior to the implementation of any age restrictions on vehicles, it is to be ensured that the recommended fuels are available. **Two fuel grades of both gasoline and diesel could be made available** to serve both new and old vehicles at every fuelling station. At least one of these fuels for gasoline and diesel should be of Euro 4 quality or better.
- A **standards directorate or body should be formed with a legal mandate to manage standards**. Embracing the three pillars of Metrology, Standardisation and Conformity Assessment (Testing, Inspection and Certification). They will be required to provide the necessary assurance that goods and services are of acceptable quality. They will form technical committees of experts nationally and/or internationally to draft standards without the need to seek approval from parliament. They will have laboratories or certify private laboratories to test and monitor goods, products such as fuel, vehicle, food, drugs for conformance to these standards. Help can be sought from the Ghana Standards Authority, African Organisation for Standardisation (ARSO), Kenya Standards Bureau among others in setting up this body.
- Another intervention should be sought for the **national institute of land transport to be resourced with the necessary equipment** such as roller brake tester, diesel smoke meters, exhaust gas emission analysers, and headlamp beam testers. Their testers should be trained on this equipment to conduct annual periodic technical inspection for private vehicles. Technical inspection for commercial vehicles should be done every six months as done in countries such as Ghana, Nigeria, South Africa, Canada, and China.
- An intervention is required for the national institue of land transport to be trained on how to inspect and test new energy vehicles such as EV.
- Eventually, there must be a deterrent for vehicles that fail emissions tests.
- The institute of land transport should be assisted to digitize their data collection of vehicles. In the interim, excel sheets hosted online could be used to record vehicle data during registration. In the Longterm an online management system should be developed for both the Customs Directorate and the institute of land transport. There is a need for them to use the same database for easy reference and synchronization.
- **Customs Directorate officials should be trained** in how to identify and quantify new energy vehicles in preparation for any future tax incentives.
- An intervention should be sought to **replace old vehicles mostly used for commercial transport (taxi) with more energy efficient vehicles**. These vehicles (minivan and light-

duty taxis) travel longer miles and their replacement will significantly reduce the carbon footprint of STP.

- Data on new energy vehicles should be captured separately during vehicle registration.
- The **Island of Principe should be helped implement a public transportation system from the entire North to South**. The lack of a well-functioning transportation system (apart from motorcycle taxis) means that motorcycle taxis get to be expensive. Also, vehicle rental services have become dominant and expensive and out of reach of the locals. Currently there are too many vehicles on the island than its needed due to the lack of effective commercial transportation.
- Transport GHG should be regularly quantified and reported using the ISO 14064 standard or newer.

6.2 E-Mobility

Final Policy measures that are recommended towards sustainable and resilient e-Mobility serve as guideposts, aligning the nation's aspirations with global best practices. These are:

Target: Define clear and ambitious targets for EV adoption, encompassing various vehicle segments and charging infrastructure (public as well as home/office/captive charging). Establish specific timelines and milestones to track progress and ensure transparency in goal attainment.

Demand Side:

- **Revision of vehicle classification**: Implement a robust registration system that is segmented by vehicle type (2W, 3W, 4W), usage (personal vs. commercial), and distinct fuel sources. This will facilitate effective import duty framework, targeted incentive allocation and enable monitoring.
- **Differential vehicle taxation**: Implement a differentiated vehicle taxation system that distinguishes between pre-owned and new EVs, ICE vehicles, hybrids, and pure EVs. Our aim is to prioritize pure EVs in taxation to promote their preference over other vehicle types. This may include exemption of import duties on EVs, reduction in sales tax, reduction of registration fees and taxes, reduction of repeat taxes for EVs, and others.
- **EV end-user purchase subsidy**: Design fiscal incentives for each vehicle system, considering the results from TCO analysis (varying from 0.75x to 2.5x compared to ICEV) and varying purchase costs (from 1.5x to 3x compared to ICEV) and then gradually phasing them out as TCO parity is achieved. This will ensure a balanced approach to sustaining government revenues.
- **EV charging tariff revision**: Introduce preferential electricity tariffs for EV charging providers so them to access cheaper electricity. Also, introduce Time of 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)

- **Improvement in safety & serviceability of xEVs**: Develop and enforce safety & serviceability standards for new EVs and pre-owned EV imports, which should be followed by INTT, MIRN and customs department. This should have inclusion of mileage criterion for import of pre-owned vehicle, maintenance SLAs, etc.

Supply Side:

- **Incentives for local assembly 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 of light EVs and their sub-systems & components (including local value add of mining raw materials use in EVs).
- **Vehicle and Fuel 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 (EURO 4) (for imports and local assembly), in alignment with recommendations provided in *Section 6.1 Fuel Economy.*
- **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 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.
- **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.

Several policies have been identified to address a variety of barriers to the introduction and deployment of e-Mobility in STP. 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. The selection of policies along with targets, timelines, resource requirements, and institutional responsibility will be included in the roadmap, which will be a separate document.

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7 Annexure

7.1 Annexure 1: Characteristics of the Electricity exchanges in STP

Type	Central	Groups Generators	Entry node in service	Power installed (kW)	Productibility Guaranteed (kW)	Energy Produced (kWh)	Percentage (%)
S. Tome	S. Tome	ABC 3	1996	1,280	0	1,882,150	0.00%
		Caterpillar	2009	1,800	0	377,000	0.00%
		German 1	2001	1,450	853	6,537,111	58.84%
		German 3	2001	1,450	952	6,809,900	65.68%
	Subtotal S. Tome			**5,980**	**1,805**	**15,606,161**	**30.19%**
	STO. AMARO 1	HIMSEN #1	2010	1,701	1,211	2,483,070	71.17%
		HIMSEN #2	2010	1,701	1,034	8,206,610	60.76%
		HIMSEN #3	2010	1,701	1,061	6,881,080	62.37%
		HIMSEN #4	2010	1,701	1,099	7,133,320	64.62%
		HIMSEN #5	2010	1,701	1,092	8,489,820	64.22%
	Subtotal Santo Amaro 1			**8,505**	**5,497**	**33,193,900**	**64.6%**
	STO. AMARO 2	ABC#1	2016	2,000	0	0	0.00%
		ABC#2	2016	2,000	1,440	3,748,748	71.98%
		ABC#3	2016	2,000	1,258	5,054,422	62.91%
	Subtotal Santo Amaro 2			**6,000**	**2,698**	**8,803,170**	**45.0%**
	STO. AMARO 3	CAT no.1	Dec-19	1,800	1,228	7,124,020	68.24%
		CAT no.2	Dec-19	1,800	1,363	8,396,980	75.72%
		CAT no.3	June-20	1,800	1,360	4,582,200	0.00%
		CAT no.4	June-20	1,800	1,310	9,680,620	0.00%
		CAT no.5	June-20	1,800	1,355	8,748,780	0.00%
	Subtotal Santo Amaro 3			**9,000**	**6,616**	**38,532,600**	**73.5%**
	Bobo Forro 1	Group 9	2011	1,000	0	293,658	0.00%
	Subtotal Bobo Forro 1			**1,000**	**0**	**293,658**	**0.00%**
	BOBO-FORRO 2	Perkins#1	2015	1,636	0	0	0.00%
		Perkins#2	2015	1,636	0	130,290	0.00%
	Subtotal Bobo Forro 2			**3,272**	**0**	**130,290**	**0.00%**
	Interconnected Thermal Subtotal S. Tome			**32,784**	**16,616**	**96,559,779**	**50.7%**
	COUNTER	Turbine 1	1967	960	459	1,429,000	47.86%
	COUNTER	Turbine 2	1967	960	652	3,625,718	67.90%
	Subtotal Hydroelectric in S. Tome			**1,920**	**1,111**	**5,054,718**	**57.9%**
	Total Interconnected in S. Tome			34,704	17,727	101,614,497	51.08%
	Porto Alegre	Perhins	2015	500	145	449,935	29.00%
	Riberia Peixe	Deutz		400	40	117,680	10.00%
	Monte Mario	Perkins		140	32	89,728	22.86%
	Subtotal Isolated in S. Tome			**1040**	**217.00**	**657,343**	**20.9%**
	Total in S. Tome			35,744	17,944	102,271,840	50.2%
PRINCIPE	Electric Thermal Cater	Caterpillar 1	2014	700	393	748,698	56.09%
		Caterpillar 3	2019	700	381	3,111,754	54.46%
		Caterpillar 4	2014	700	0	124,075	0.00%
		Caterpillar 5	2014	700	351	2,341,522	50.15%
	Principe Thermal Subtotal			**2,800**	**1.125**	**6,326,049**	**40.2%**
	Total in Principe			**2,800**	**1.125**	**6,326,049**	**40.2%**
General Total in STP				**38,544**	**19,069**	**108,597,889**	**49.5%**

7.2 Annexure 2: Electricity consumption by type of customer (2021)

Customer Category	No. of customers	Consumption (kWh)	Invoicing		Percentage	
			Tariff	Value/Dbs	kWh	Revenue
Domestic Service	44,454	34,477,263	2.19	75,661,100	51.29%	27.27%
Commercial	2,952	8,708,095	3.84	33,439,085	12.95%	12.05%
Industrial	339	2,736,101	3.43	9,384,085	4.07%	3.38%
Central Administration State	635	9,661,490	9.87	94,514,823	14.37%	34.06%
Autonomous Institutions State	24	432,634	9.87	4,270,095	0.64%	1.54%
Public Companies	15	606,058	6.03	3,573,839	0.90%	1.29%
EMAE workers	341	703,222	1.00	700,890	1.05%	0.25%
Embassies and International	30	938,248	7.03	6,551,440	1.40%	2.36%
Organizations, Regional Administration	106	711,979	7.03	6,759,593	1.06%	2.45%
State Financing Institutions	35	1,283,450	7.03	8,948,766	1.91%	3.22%
Telecommunications	70	2,350,923	7.03	16,526,989	3.50%	5.96%
Companies Airlines	5	92,771	7.03	654,947	0.14%	0.24%
Private Bodies	306	853,777	3.84	3,278,504	1.27%	1.18%
Post-Payment Subtotal	**49,312**	**63,556,011**	**4.16**	**264,300,897**	**94.55%**	**95.25%**
Pre-payment System	3,235	3,086,771	3.09	9,551,824	4.59%	3.44%
Post and Pre-payment Subtotal	**52,547**	**66,642,782**	**4.11**	**273,852,721**	**99.14%**	**98.69%**
EMAE self-consumption	36	577,543	6.03	3,629,411	0.86%	1.31%
Grand Total	**52,583**	**67,220,325**	**4.13**	**277,482,132**	**100%**	**100%**

7.3 Annexure 3: Vehicle Prioritisation for e-Mobility Adoption

No	Level 1 (L1)		Level 3 (L3)	2W – Personal	2W – Commercial	3W	4W – Personal	4W – Commercial	Buses
1	Cost	CAPEX	EVs investment requirement	Low	Low	Low	Medium	Medium	High
2			Charging infrastructure investment requirement	Low	Low	Low	Medium	Medium	High
3		OPEX	Electricity consumption	Low	Low	Low	Medium	Medium	High
4	Benefits	Economic	Total cost of Ownership Parity	Low	Low	Low	High	Medium	Medium
6			Fuel Saving	Low	Low	Low	High	Medium	Medium
7		Social	Job creation	Low	Low	Medium	Medium	High	High
8			Quality of life and equity	Low	Low	Medium	Low	High	High
9			Gender Equality	Low	Low	Medium	Medium	High	High
10		Emission Reduction Benefit	Air pollution reduction potential	Low	Low	Medium	Medium	High	High
11			GHG reduction potential	Low	Low	Medium	Medium	High	High
12	Local Context	Usage Characteristics	On Road vehicle stock	Medium	Medium	Low	High	Medium	Low
13			Vehicle trip length	Low	Medium	Medium	Medium	High	High
14			Fuel efficiency/pax. km	Low	Medium	Medium	Low	High	High
15			Easiness of EV Charging	High	High	Medium	Medium	Low	Low
16		Supporting Ecosystem	Local available EV model	Low	Low	Low	Low	Low	Low
17			Local post sales services & spare parts availability	Low	Low	Low	Low	Low	Low

No	Level 1 (L1)		Level 3 (L3)	2W – Personal	2W – Commercial	3W	4W – Personal	4W – Commercial	Buses
18			Local assembly & supply potential of EV models	Low	Low	Low	Low	Low	Low
19			EVs R&D, Technical skills	Low	Low	Low	Low	Low	Low
21		Local stakeholder acceptance	Government's preference	Medium	Medium	Medium	Low	High	High
Overall Score				Medium	Medium	Medium	Low	High	High

7.4 Annexure 4: Details from Stakeholder Consultation during Mission Visit

Stakeholder's name		Notes
1	**Institute of Land Transport (INTT)**	• This department is responsible for **registration of vehicles**, provide number plates and licenses to people. • It is also supposed to carry out **periodic technical inspection of vehicles** but it's not carried out there. • The **condition** of two-wheelers here is good but **not with the taxis**. • The taxis are **painted yellow**. Saloon cars are used as taxis. • **Toyota and Corolla** are majorly used OEMs in STP. • Few vehicles are used as **Para-transit modes – Toyota Ace**. • Private vehicle fleet is new one. • **2W- Motorcycles** are used a lot. • The electricity grid is very dirty. It has a capacity of **15 MW**. • **95% of thermal electric plants** are powered by diesel. • There are **3 electric vehicles** in the country – (1-Tesla, 2-e-2W) • The electricity **supply is very fluctuating**. (goes on and off 10 times in 20 minutes). • Use of solar mini-grids seems better solution and that too only for 2W segments. • São Tomé has **hydro-capacity plans**. • This island is very small. So, it **does not require long range** for operations. • The travel from São Tomé to Príncipe is only by sea or air. • The **electrification rate** of Príncipe is 100% while for São Tomé is 73-74%. • There exists a huge human resources limitation, **no trained people**. • Country **doesn't have transport engineer** thus no one holds the responsibility to manage the transport concerns. • Voice of America is a foreign news agency and has a **huge vehicle fleet**. They manage their own vehicles, have their own fuel and even own mechanics.
2	**Customs Directorate**	• The country has recently developed a **new policy on incentives for BEVs** starting from Nov 1st. Under this policy, BEVs will pay half of out volume tax that they are required to pay. There will be no VAT for BEVs. • Hybrids- 5 years and below is **free of tax**, VAT, fees 5-7(5% Advolareom tax, VAT 15%). • There are **no age restrictions** on vehicles entering the country. Citizens can bring any vehicles into the country. • Citizens need **proper training and knowledge-sharing** sessions for the identification of EVs. • The directorate recommended prohibition on old vehicles entering the country.
3	**Visit to Príncipe**	• Principe is a very small island. Tentatively 40 mins ride by air from Sao Tome and 8 hours journey by sea. • There are wide routes with highly variable terrain.

Stakeholder's name		Notes
		• The roads here feel like climbing a mountain. • There is no commercial/public transport here. • There are no yellow taxis on road and there is no need of it as well because the stretch of the island is also very less. • Motorcycles are majorly used here. • Cars are only used by UNEP, UNDP, NGOs, GEF, UNIDO, etc. organisations. • Pick-ups and 4X4 are also preferred. • Motorcycle taxis are used. • People walk usually. • Principe is completely different from Sao Tome in terms of transport preferences thus need different interventions. • Directorate of Water and Electricity are different for Principe and Sao Tome. The one in Principe is called as Secretariat II. He also heads Land Transport department.
4	**National Oil and Fuel Company (ENCO)**	• There are **no national standards** for fuel. • There is **no fuel testing** in the country. • ENCO has the responsibility of importation, distribution and retail of fuel. • There is **no monitoring of fuel emissions** from vehicles. • It sells the fuel to energy company for the production of energy as 95% are diesel plants. • STP mostly imports fuel from **Angola and Nigeria**. • The country **does not have the capacity** to test the fuel quality.
5	**National Water and Energy Electricity (EMAE)**	• Its responsible for generation, distribution and transmission of electricity. • Principe does not depend on Sao Tome for electricity. • There is a market place for picking up motorcycles as motorcycle taxis. • Motorcycles seems expensive to local people. • There is no Public Transport in Principe. • The roads are bumpy with mountaineous terrain. • Toyota and Corolla are the most popular brands here. • CIEM is the official distributor of vehicles. Caterpillar generators are also sold here. • Principe has one fuel station.
6	**HBD**	• It is the single biggest fleet owner in Principe. • These vehicles are used for tourists transport purpose. • They also operate buses to pick workers from their homes to sites. • They recommended the need for commercial transport as the operational cost of motorcycles is high. • They had started electric go-carts to Sandy Beach. • It was used for carrying food to restaurants. • Unfortunately all the 15 go-carts were damaged within 6 months. • Another reason was mountainous terrain. • In terms of charging, Principe uses diesel plants which was not sustainable, energy is not reliable as generators were used to charge these go-carts. • HBD specializes in sustainability. • HBD is not interest in Electric Mobility anymore. • They are concerned about the EOL batteries and battery recycling.
7	**Biker's Association, Association of Taxi Drivers**	• Cost of new Motorcycle is 75000 Db. • Preowned motorcycle costs 40000 Db. • They require 5 litres per day fuel. • 50 Dobras is the average fare. • They charge 100 Db to reach Sandy Beach. • Few people were interested in EVs but rest were not. • Sanya is the preferred motorcycle there. • Kawasaki, Suzuki are the preferred OEMs.

Stakeholder's name		Notes
		• Sensitization and Education on EVs is much needed. • There are so many motorcycles greater than 20 years of age.