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National Electric Mobility Roadmap in Ghana

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This National Electric Mobility Roadmap seeks to provide the implementation roadmap for guiding the deployment and scale-up of electric mobility in Ghana. The Roadmap was drafted by the authors based on EV targets that form the basis of the roadmap provided by the Ministry of Transport.

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Abbreviations and acronyms

BAU	Business-As-Usual
BRRI	Building and Road Research Institute
BPA	Bui Power Authority
BRT	Bus Rapid Transit
CAPEX	Capital Expenditure
CPESD	Coordinated Programme of Economic and Social Development Policies
DUR	Department of Urban Roads
DVLA	Driver and Vehicle License Authority
EPA	Environmental Protection Agency
EC	Energy Commission
ECG	Electricity Company of Ghana
GHG	Greenhouse Gas
GRA	Ghana Revenue Authority
GSA	Ghana Standards Authority
GTTC	Government Technical Training Centre
EVs	Electric Vehicles
ICEVs	Internal Combustion Engine Vehicles
ISTC	Intercity State Transport Company
MESTI	Ministry of Environment, Science, Technology and Innovation
MMDAs	Metropolitan, Municipal and District Assemblies
MTTD	Motor Transport and Traffic Department
MMTL	Metro Mass Transit Limited
MoEn	Ministry of Environment
MOT	Ministry of Transport
MoTI	Ministry of Trade and Industry
MOF	Ministry of Finance
NDC	Nationally Determined Commitments
NRSA	National Road Safety Authority
OEMS	Original Equipment Manufacturers
OPEX	Operating Expenditure
PURC	Public Utilities Regulatory Commission
TVET	Technical and Vocational Education and Training
VAT	Value Added Tax
VRA	Volta River Authority

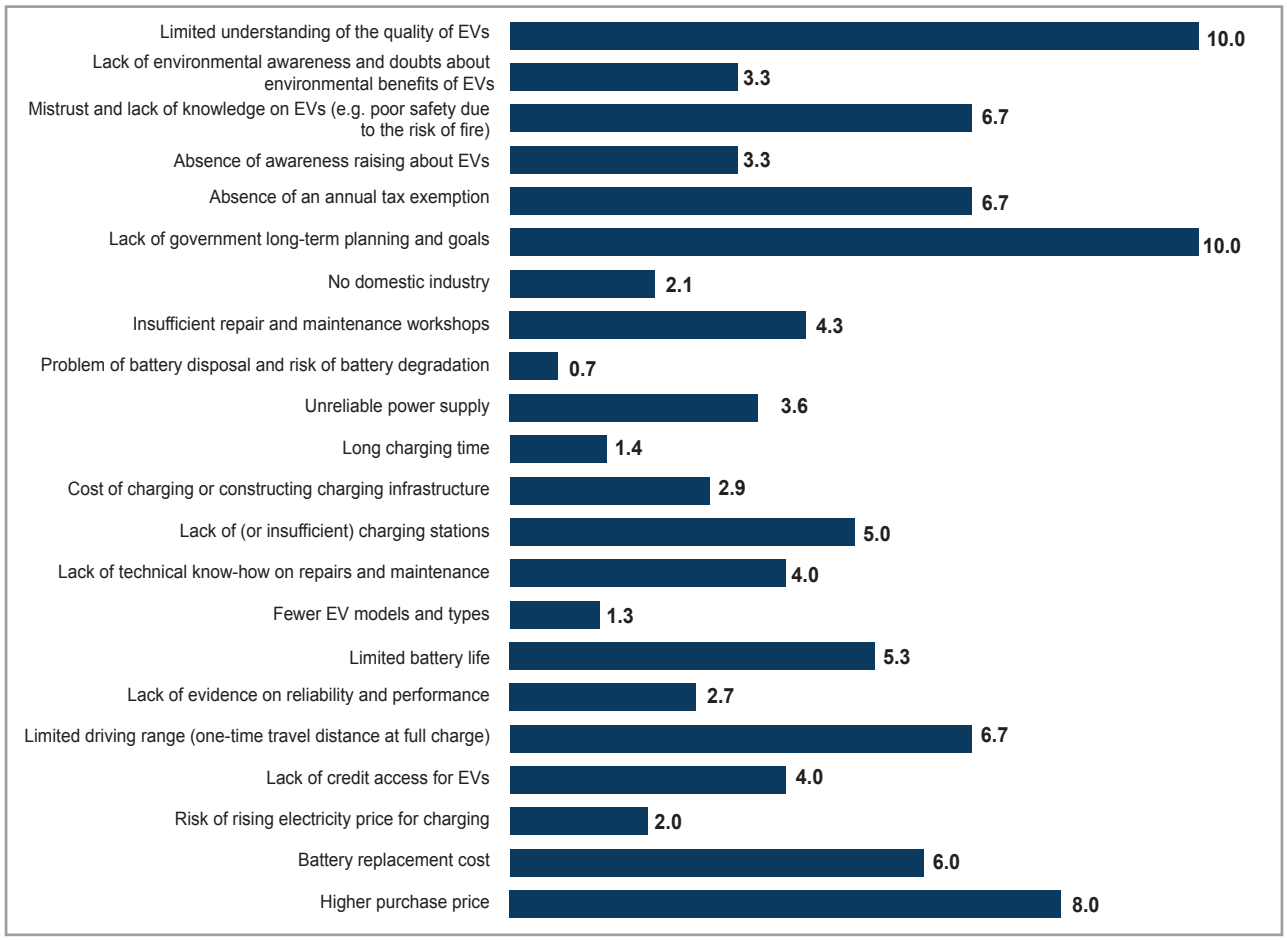
Executive Summary

Ghana is currently at the crossroads of planning and implementing sustainable mass transit solutions to deal with growing congestion, poor air quality, and global warming. As a fast-growing economy in sub-Saharan Africa, Ghana's transport sector contributes to 47.7% of energy-related emissions. The Greenhouse Gas (GHG) emissions are projected to reach 74 MtCO2e by 2050 in the Business-As-Usual (BAU) scenario compared to around 43 MtCO2e in 2016. The voluntary commitments will bring down the emissions by around 15% by 2030 but will be unable to stop the upward trend in growth of GHG emissions.

The government intends to reduce the emissions from the transport sector by improving mass public transportation and the efficiency of vehicles and promoting alternative vehicle technologies, including electric vehicles (EVs). However, Ghana's e-mobility agenda would have to be delivered through a range of supportive government policies, private sector partnerships, and strategic investments from international development partners. This will help address barriers and provide the necessary resources required to accelerate the adoption of EVs.

The barrier analysis identified twenty-two (22) barriers that inhibit the uptake of EVs in Ghana. (Figure ES1).

Figure ES1: Overall ranking of EV barriers in Ghana



This CTCN technical assistance is helping the Ghanaian Government develop an e-Mobility policy framework, e-Mobility policy roadmap and e-buses market feasibility assessment. This report presents the e-Mobility Policy Roadmap, developed under the guidance of the Ministry of Transport and in consultation with key stakeholders in Ghana.

The Ministry of Transport has proposed various targets for the deployment and diffusion of e-cars and e-buses. The per cent EV mix and the corresponding quantity of e-cars and e-buses in the short, medium- and long-term periods have been illustrated in Figures ES2 and ES3.

These ambitious targets are determined by the expected benefits and cost information provided. The Total Cost of Ownership (TCO) models was designed to assess the complete financial cost involved in procuring and operating e-cars and e-buses, including vehicle specifications, operating expenses and capital expenses.

Prioritised policy measures identified during the preparation of the National Electric Mobility Policy and Market Readiness Framework for Ghana were first defined in a more specific and elaborate manner to clarify what is needed to operationalise them. The budget estimate and institutions and key actors required to implement the prioritised policy measures were identified in consultation with stakeholders. The report proposes a comprehensive set of enablers and measures to address the barriers and accelerate EV uptake in Ghana.

Figure ES2: National e-bus targets

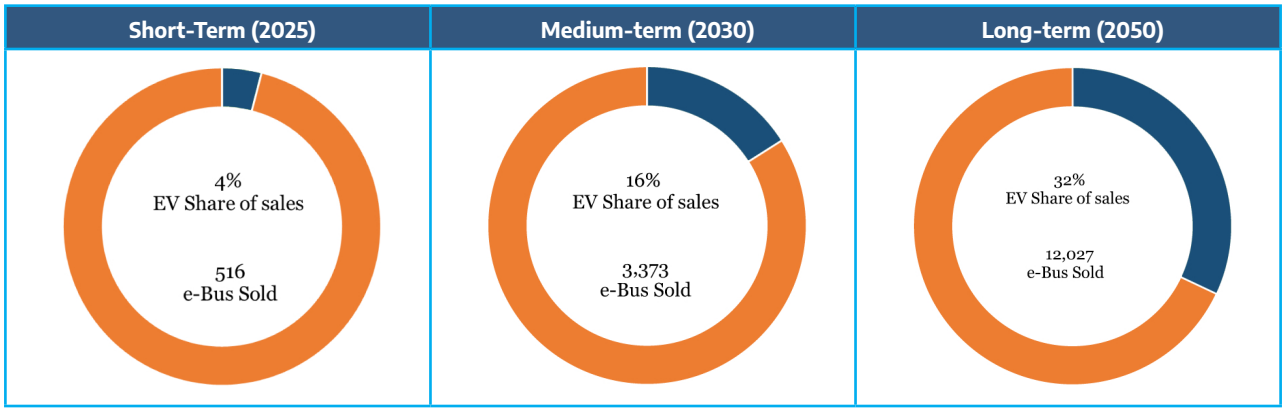
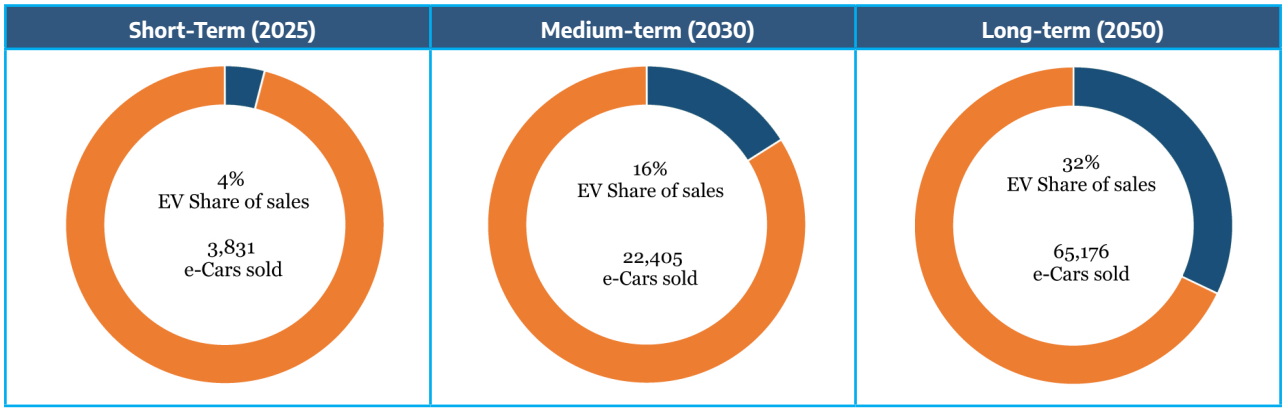


Figure ES3: National e-car targets



1. Introduction

1.1 Background

Ghana is one of the fast-growing economies in sub-Saharan Africa, and despite the steady economic growth, climate change poses a threat to future growth and development. The transport sector contributes to 47.7% of energy-related emissions. The Greenhouse Gas (GHG) emissions are projected to reach 74 MtCO2e by 2050 in the Business-As-Usual (BAU) scenario compared to around 43 MtCO2e in 2016. Ghana's voluntary Nationally Determined Commitments (NDC) will cut down emissions by approximately 15% by 2030, although this will be unable to stop the upward trend in the growth of GHG emissions.

Ghana plans to address climate change and local environmental challenges through multiple strategies, including limiting the import of older vehicles, increasing the number of trips by public transportation by 10% in the four major cities, and electrification of vehicles. However, the adoption and uptake of e-mobility have been slow. Ghana's e-mobility agenda would have to be delivered through government-supportive policies, private sector partnerships, and investments from international development partners. Policy interventions are critical to the penetration and adoption of e-mobility and can potentially drive other related development in the urban transport landscape. Being a developing country with limited resources, it is imperative to direct investment in a direction which delivers the highest benefits and value for money.

This CTCN technical assistance is helping the Ghanaian Government develop an e-Mobility policy framework, e-Mobility policy roadmap and e-buses market feasibility assessment. This report presents the e-Mobility Policy Roadmap, developed under the guidance of the Ministry of Transport and in consultation with key stakeholders in Ghana.

1.2 Supporting existing policies

Ghana's commitment to tackle climate change has been articulated in several recent medium-term development policy frameworks. This includes Agenda for Jobs: Creating Prosperity and Equal Opportunity for All, 2018-2021; the National Climate Change Policy; and the Coordinated Programme of Economic and Social Development Policies (CPESD), 2017-2024. These policies seek to reduce the transport sector's emissions by improving the efficiency and effectiveness of road transport infrastructure and services and increasing the proportion of renewable energy in the national energy supply mix.

1.3 E-Mobility Policy Framework

The EV Roadmap is based on a detailed assessment of EVs in Ghana, potential barriers to EVs adoption and enabling measures to overcome these barriers. This thorough assessment is available as a separate document titled "National Electric Mobility Policy and Market Readiness Framework for Ghana". Some key outputs of this report that shape the roadmap preparation are provided below:

Prioritisation

In Ghana, there are different modes of transport used for travel, and some of these modes are public, whereas some are personal. In the prioritisation exercise, stakeholders preferred electrification of public transport over private. In the case of public transport, Ghanaian stakeholders prioritised electric buses, as shown in Table 1 below, to improve intra-city and intercity passenger transport services in Ghana. Among personal means of transport, the e-car was prioritised by Ghanaian stakeholders for their day-to-day mobility needs (Table 1).

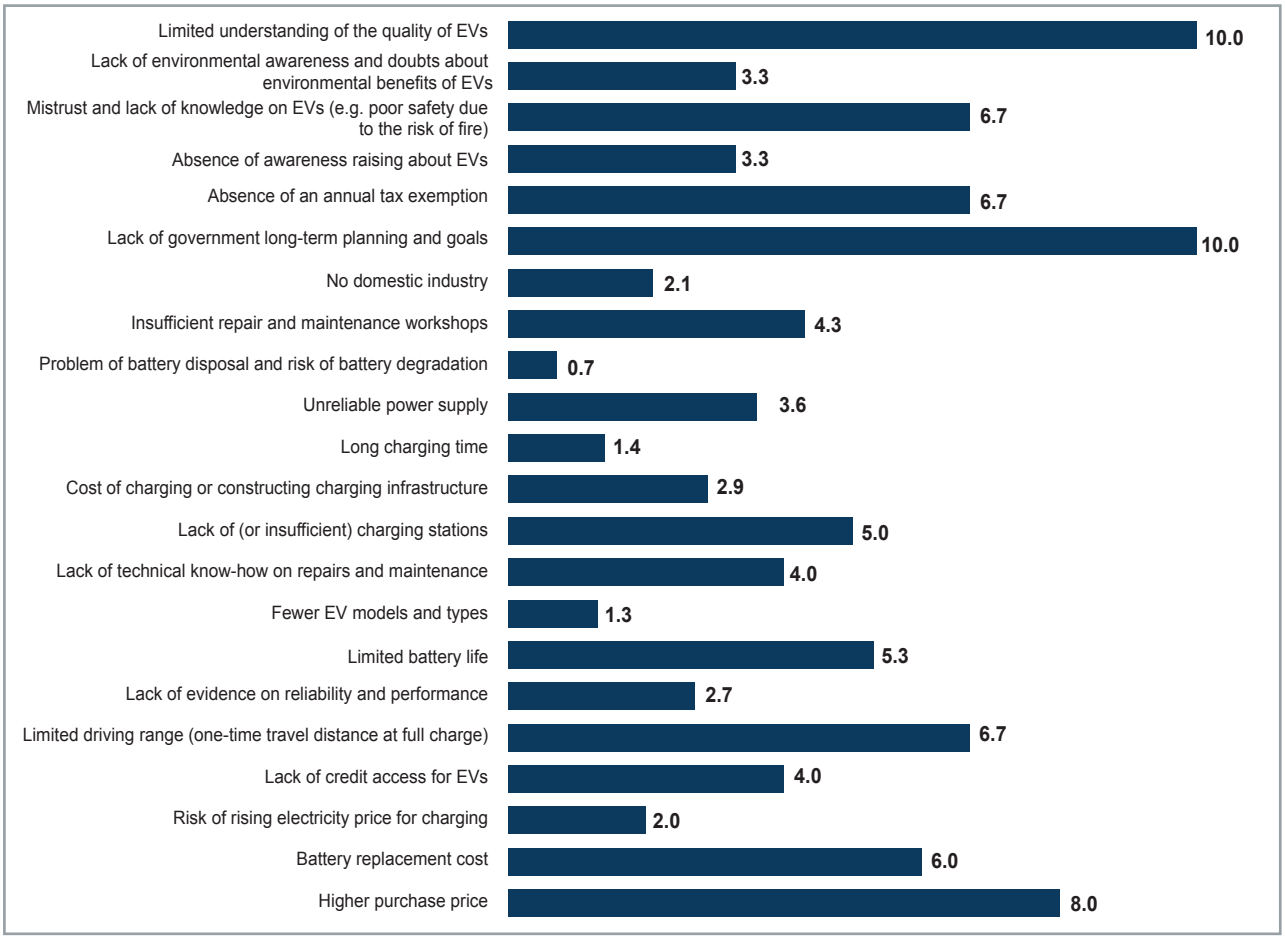
Barrier analysis and enabling framework

A total of twenty-two barriers were identified through a mixed-methods approach, involving a questionnaire survey and expert interviews with stakeholders and the general public. These barriers inhibit the uptake of EVs in Ghana. These barriers were subsequently classified under five key categories ranked in the following descending order: economic and financial, infrastructural, technical,

Table 1: Prioritisation of different transport modes

Type	Modes	Overall Score
Public	**Bus**	*70.11*
	4W-Taxi	69.71
	Trotro	65.08
Private	**Car**	*55.64*
	2W-Personal	49.55
	3W-Personal	47.24

Figure 1: Overall ranking of EV barriers in Ghana



policy and social barriers. The ranking of the identified barriers is shown in Figure 1.

Economic and financial barriers

The most significant barrier is the economic and financial barriers against EV diffusion in Ghana. The purchase price of EVs is relatively high in Ghana, which is primarily attributed to the high import duties, vehicle tax, undifferentiated HS codes etc. Other economic factors, such as battery replacement cost, charging installation cost, and access to credit, are considered disadvantageous to EVs' acceptance. The policy framework report identified four economic barriers that can potentially inhibit EV adoption in Ghana. They include:

- Higher Purchase Price
- Battery Replacement Cost
- Higher Electricity Price for Charging
- Lack of Credit Access for EVs

Infrastructural barriers

Infrastructural barriers were ranked as the second most important barrier. Given that EVs are a relatively new technology, EV manufacturers, private businesses, transport operators, and users are unlikely to invest in EVs unless the supporting infrastructure for charging exists. This implies that the absence of sufficient infrastructure creates a negative network externality for EV uptake and deployment. Below is a list of the vital infrastructure-related barriers identified:

- Long Charging Time
- Lack of Charging Stations
- Unreliable Power Supply
- Lack of Repair and Maintenance Workshops
- No Domestic Industry

Technical barriers

Technical barriers were ranked as the third most crucial barrier category. The lack of standardisation, limited availability, inadequate model choices, and performance issues are important factors for the acceptance and diffusion of EVs. Since EVs are relatively new technologies compared to internal combustion engine vehicles (ICEVs), their quality can be compromised by technical constraints at the manufacturing stage. The critical technical barriers identified for Ghana are:

- Limited Range (One-Time Travel Distance at Full Charge)
- Lack of Evidence on Reliability and Performance
- Limited Battery Life
- Fewer EV Models

Policy, regulatory and institutional barriers

Policy barriers were ranked as the fourth most important barrier category. Various stakeholders consider the absence of a long-term policy framework for EVs as a key concern. Any proposed policy framework should be consultative and inclusive of all relevant stakeholders, including policymakers, manufacturers, users, transport operators, and other related institutions. For instance, purchase subsidies alone may not be enough to increase EV adoption without an effective policy package that incorporates adequate infrastructure, operational framework etc., and political will. The policy framework report identified three key policy barriers against the uptake of EVs in Ghana. They include:

- Lack of Long-Term Planning and Goals
- Absence of an Annual Tax Exemption Policy
- Absence of Awareness Creation about EVs

Social barriers

Social barriers were considered the least important, as the stakeholders considered these barriers to be less critical than the other challenges. Given that EVs are new to Ghana, concerns relating to social barriers, including awareness, safety etc., cannot be overlooked. Social factors, particularly consumer understanding of the attributes of EVs, are recognised as an essential consideration for EV users. The communication of related information is crucial in this regard. Social barriers may pose obstacles equivalent to technical factors concerning the adoption of EVs.

- Lack of Knowledge of EVs
- Limited Understanding of the Quality and Safety of EVs
- Lack of Environmental Awareness about EVs

Measures to address barriers to EV adoption

The barriers identified and categorised have significant implications for the Government, EV manufacturers, transport operators, users, and other related stakeholders interested in the introduction of EVs and exploring solutions to navigate the barriers that militate against EV adoption and use in Ghana.

The report proposes a long list of measures to address the obstacles and accelerate EV uptake in Ghana. It is crucial to address the measures concurrently to ensure successful EV deployment. Thus, the end goal must be to adopt an all-inclusive and integrated approach rather than focusing on a specific barrier.

Economic and financial measures

The Government needs to provide different financial incentives to create a competitive market for EVs. Notably, purchase waivers and subsidies would offer a competitive edge to EVs over ICEVs. The economic barriers will be addressed, to a certain extent, through such incentives. Key fiscal measures and economic instruments include:

- Tax waivers and tax holidays for fully electric vehicles: should be rolled out progressively.
- Special electricity (energy) tariff for EV vehicles. This can include a differentiated and subsidised tariff system for EV charging (e.g., from 8 pm to 6 am)
- Affordable electricity price for charging EVs
- Sale of Carbon surpluses arising from EV adoption on carbon market platforms

Infrastructural measures

Stakeholders believe that the construction of the relevant infrastructure, such as charging stations and repair maintenance workshops, should be undertaken by the Government, private sector and vehicle manufacturers. Thus, the Government should work closely with the relevant stakeholders to facilitate the development and maintenance of the required infrastructure, including charging, battery handling, etc. The Government's intervention and partnerships with the private sector toward infrastructure creation are crucial to overcoming barriers and promoting EV diffusion. The following enablers should be considered:

- Installation of private (home) charging systems
- Installation of multiple public charging points to be sited at fuel filling stations, parking spaces, street-side parking lots, office parks, service stations and depots.
- Installation of inter-city charging points
- Contraflow bus lanes: EV buses can use the opposite direction of the surrounding streets during peak hours to promote scheduled bus services and minimise traffic.
- Exclusive and dedicated bus lanes: as part of the bus rapid transit (BRT) system in the long term to support efficient, reliable and sustainable transport.
- Fast chargers, connectors, and charging systems: should be made available.
- Backup power systems for charging stations to deal with power outages.
- Battery swapping, recycling and end-of-life disposal systems

Technical measures

Experts and stakeholders continue to doubt the technical performance of EVs and the expertise required to repair and maintain EVs. They emphasised the need for the technical issues to be resolved to encourage people's willingness and uptake of EVs in Ghana.

The key enablers could include:

- **Range:** EVs with a more extended range should be encouraged for long-distance travel.
- **Continuous training:** local auto-mechanics (fitters), electricians, garage operators (Certification of Garages)
- **Low carbon technology transfer:** local skills development (artisans, operators, garage operators). Training programmes should include women
- **Retrofitting of ICEVs to EVs:** needed expertise should be developed. Local start-ups should be identified and supported to reduce the final cost to the end-user.

Institutional framework, policy and regulatory measures

Stakeholders underlined the essence of the developed National E-mobility Policy and Market Framework in promoting and regulating EV use in Ghana. The Government is expected to implement a variety of policy instruments to encourage the uptake of EVs based on specific government plans and goals. This calls for a well-targeted policy roadmap that integrates economic (such as subsidies and tax exemption), technical (such as range, workshops and expertise) and infrastructural (charging systems and stations) considerations as well as awareness creation. Overall, we intimate that a policy mix is crucial for EV deployment and diffusion. Key components of the policy mix should include:

- **Review of the Harmonised System (HS) Customs code:** to facilitate proper estimation of import duties and related registration issues.
- **Standardisation, licensing and certification:** chargers, charging systems and charging installation.
- **Research and capacity development:** EV modules and curriculum development
- **Dealing with power outages:** Energy infrastructure and meter monitoring systems should be maintained and improved to minimise power cuts.
- **Renewable EV charging and battery storage energy system for energy security**
- **Close collaboration among partnering ministries and agencies**
- **Attract funding for promoting EV uptake**
- **The overaged vehicles importation** regime should be reviewed

Social measures

Consumer knowledge, experience, environmental considerations, and perceived quality of EVs influence consumers' decision to purchase EVs. The average potential user is likely to be uninformed about the advantages of using EVs and their quality and actual performance. Hence, it is recommended that information about EVs be publicly disseminated to heighten consumer understanding and awareness. Other key recommendations include:

- **Procuring, piloting and testing EVs** to ensure their quality, safety, performance, and reliability. Pilot with Intercity STC and MMT buses on selected corridors.
- **Buses could have roof-top solar charging systems** to enhance battery life for long-distance travel.
- **Adding EVs to government vehicle fleet:** ministries, departments and agencies.
- **Roadmap on EV awareness creation and campaigns:** should incorporate broad grassroots consultation and validation engagements. Information sharing about EVs should be done in multiple ways, including:
    - Easy-to-read leaflets, handouts, and brochures in English and the local dialects
    - Media engagements and advertisements: using radio, television, and social media

Policy measures prioritised for inclusion in the Roadmap

A ranking of policy measures under each category has been done in consultation with stakeholders. High priority measures have been prioritised based on stakeholders' inputs, as captured in Table 2. Safety concerns and gender inclusivity will be emphasised.

Table 2: Prioritised policy measures

Policy goal	Prioritised policy measures
Economic & fiscal measures	Affordable financing mechanisms, incentives and targeted subsidies
	Affordable and special electricity (energy) tariff for charging EVs
Infrastructural measures	Installation of intra-city and inter-city charging points
	Garages, maintenance workshops and training centres
	Traffic management: Contraflow bus lanes and dedicated bus lanes
Technical measures	More extended range and battery capacity
	Skills development, retrofitting of ICEVs, and low-carbon technology transfer
Institutional framework, policy and regulatory measures	Review of the Harmonised System (HS) Customs code
	Standardisation, licensing and certification of EVs and related components
	Research, capacity building, assembly and manufacturing
	Energy security/ renewable EV charging and battery storage facilities, recycling and end-of-life disposal systems
Social measures	Procuring, piloting and testing EVs
	Roadmap on EV awareness creation and campaigns
Local EV development measures to accelerate the uptake of EVs	Review and adapt the Ghana Automotive Development Policy for ICEVs to provide enabling environment for local start-ups
	Establish an assembling plant and ensure local content and automotive standards are enforced in the domestic industry

2. Roadmap for Public Transport Modes: Electric bus (e-bus)

2.1 Background

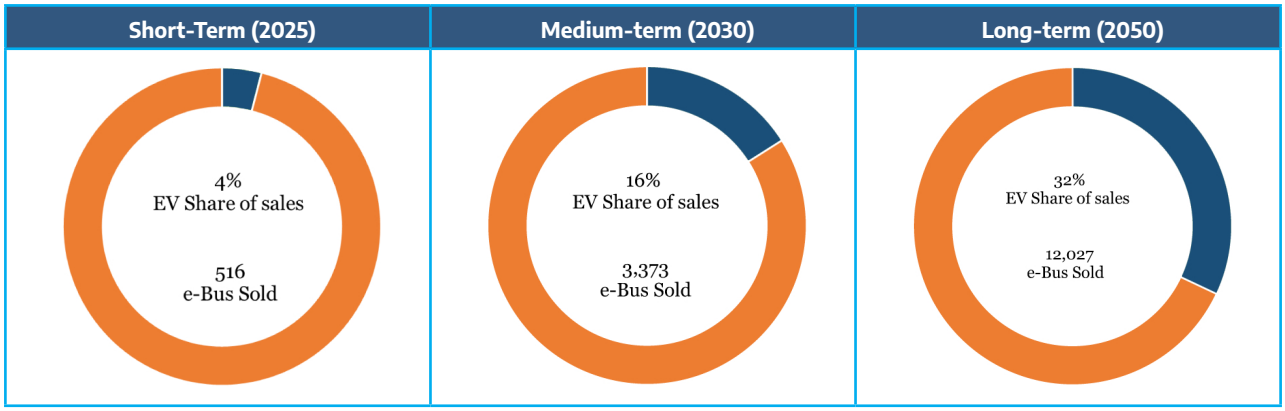
Ghana is at the crossroad of planning and implementing sustainable mass transit solutions. E-buses are one of the emerging technologies that offer opportunities to design an efficient transport system in terms of technology and fuel shift and economic incentives that can strongly contribute to economic transformation.

Electric buses have the potential to considerably promote sustainable mass and affordable transport, reduce noise and air pollution, improve public health, and contribute to reducing emissions and mitigating the impacts of climate change. Electric buses are expected to create viable economic benefits, including job creation, reduced trade deficits, reduced cost of oil imports etc. These benefits are expected to facilitate economic development and decarbonise the transport sector.

2.2 Ambition for e-Buses

The Ministry of Transport has proposed various targets for deployment and diffusion of the e-intracity bus technology. The per cent EV mix and the corresponding quantity of e-buses in the short-, medium- and long-term periods have been illustrated in Figure 2. These ambitious targets are determined by the expected benefits and cost information provided. Benefits, for example, could include socio-economic and environmental benefits such as GHG reductions, air quality, jobs, etc., from analysis done during the prioritisation in the policy framework report.

Figure 2: National e-bus targets



Box 1: Government's ongoing efforts

In light of the above, the government has committed to introducing one-thousand (1,000) electric buses and related charging and maintenance infrastructure for intra-city (40%) and intercity (60%) transport services within the short term period. The first phase involves the supply, operation and maintenance of five hundred (500) Complete Built Unit (CBU) electric buses for intra and intercity transport services which would be delivered in five (5) batches. The second phase involves the supply of five hundred (500) Semi-Knocked-Down (SKD) buses and assembly in Ghana in partnership with local assemblers.

Besides this policy direction, the Automotive Policy has been developed to provide the necessary framework for local assembly and manufacturing capacity for new passenger cars, SUVs, and light duty commercial vehicles. Ghana's commitment under the NDCs and the new transport policy emphasizes the decarbonisation of the transport sector and supports the formulation of long-term enabling framework to enhance the sustainability of the transport infrastructure and associated services for accelerated economic development in Ghana.

With the introduction of electric buses that are compliant with the Covid-19 safety protocols i.e., social distancing, temperature checks, and disinfection, the e-buses project seeks to modernize operations of the Intercity STC Coaches Limited (intercity) and the Metro Mass Transit Limited (intra-city).

This policy roadmap for e-buses presents a number of strategic, participatory transformational measures that will contribute to developing a modern, sustainable, forward-looking and results-driven transport and energy sector as well as climate-resilient and low carbon growth in Ghana.

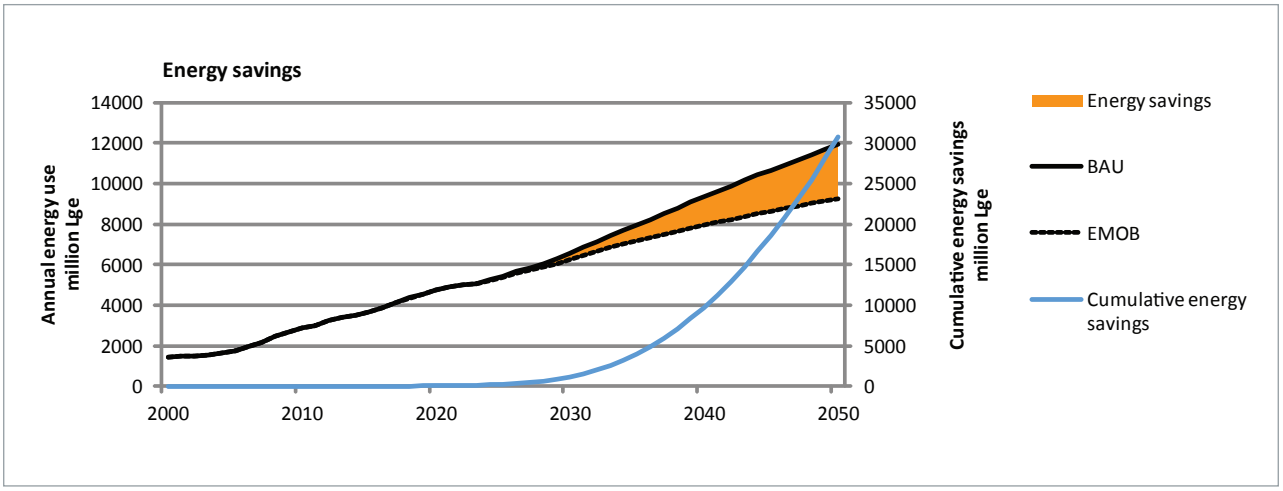
2.3 Impacts of e-Buses

Implementing the e-Bus targets will promote efficient transportation services and reduce transport-related emissions and pollution whilst creating job opportunities and further boosting the local manufacturing industry. The project is expected to provide eco-friendly, high performance, superior economy and cost-saving electric buses for efficient public transport.

Energy Savings

The e-Mob calculator analyses indicate that Ghana may enjoy tremendous benefits concerning fuel savings (Figure 3). The benefits are relatively small to start with. However, as the share of e-Buses increases, the fuel savings also increase, and the cumulative savings will be around 30 billion litres of gasoline-equivalent (Lge) over 2020-2050.

Figure 3: Projected fuel savings from e-Bus targets (2021-2050)



Climate Benefits

Since nearly all fuel used for vehicles currently is based on fossil fuels, fuel savings also translate into CO_2 mitigation (Figure 4). The cumulative CO_2 mitigation will be around 90 million tons of CO_2 over the period 2020-2050.

Environmental Benefits

In addition, the benefits accrued from a decarbonised bus system also result in cleaner air quality through reductions in emissions of Particulate Matter (Figure 5) and Nitrogen Oxides (Figure 6).

Figure 4: Projected CO_2 savings from e-Bus targets (2021-2050)

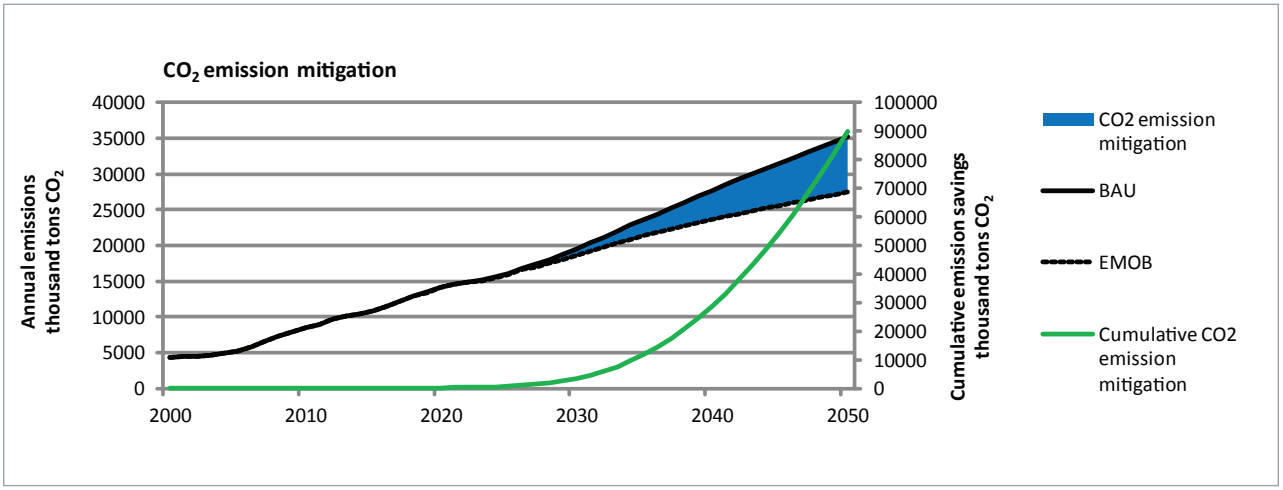


Figure 5: Projected PM savings from e-Bus targets (2021-2050)

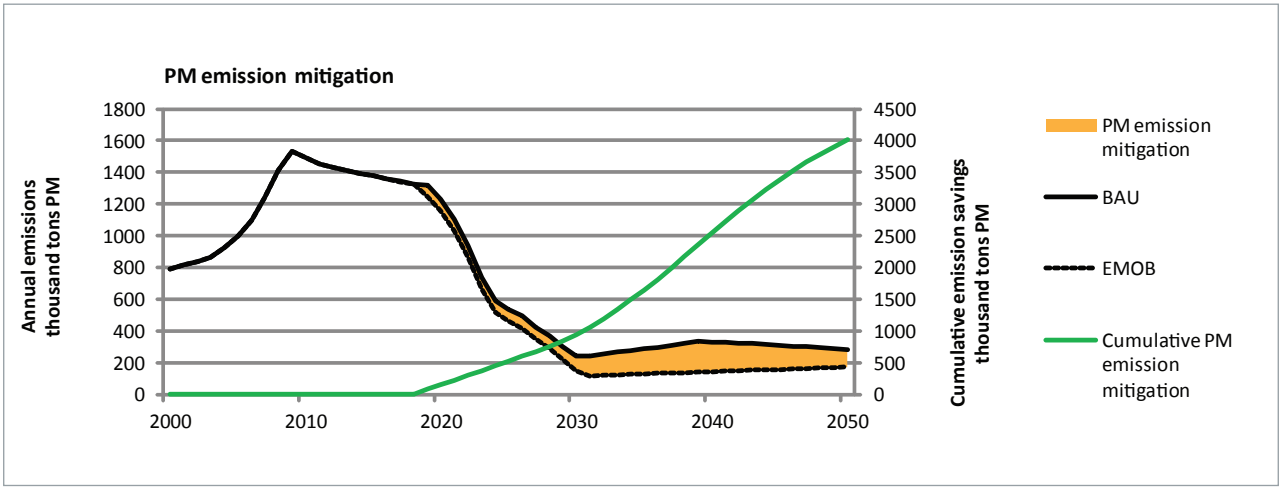
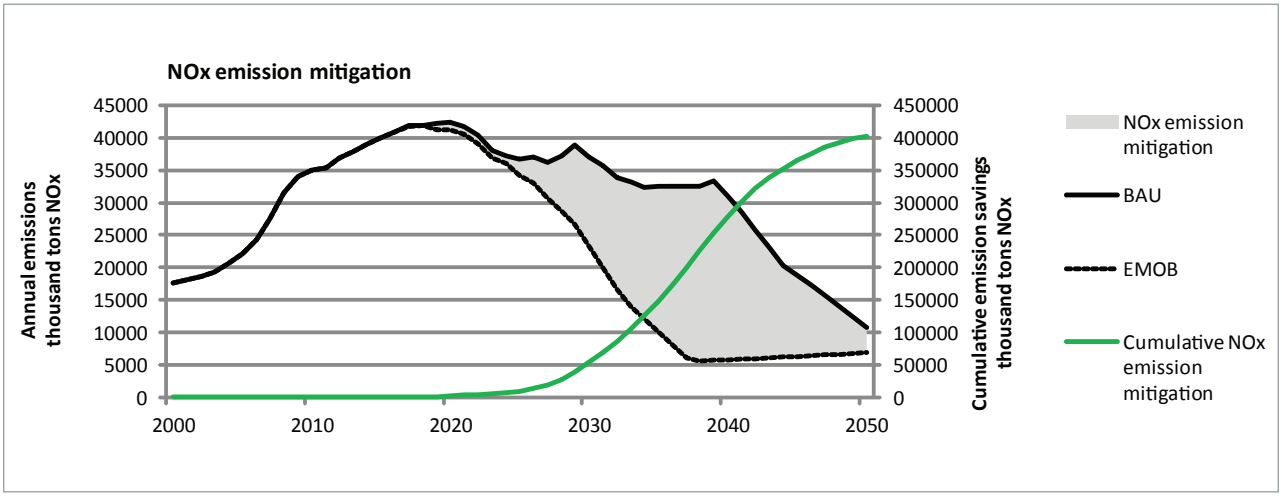


Figure 6: Projected NOx savings from e-Bus targets (2021-2050)



2.4 Resources required

To create an enabling environment that will facilitate the uptake of electric buses by private and public bus operators, economic and financial incentives as well as infrastructures for charging would be needed. Since EV Buses will compete with diesel buses, all the resource requirements consider diesel buses as the base case technology. Since the investments, operating costs and revenues will happen over the lifetime of a bus, a Total Cost of Ownership (TCO) model was built to assess the complete financial cost involved in procuring and operating e-buses vis-à-vis diesel-powered buses. The TCO considered Capital Expenditure (CAPEX) parameters such as the capital cost of buses, batteries and charging infrastructure costs. Also, the Operational Expenditure (OPEX) parameters like fuel/electricity, maintenance, and insurance costs were included. The TCO model is provided in Appendix 1, including vehicle specifications (Figure A1), OPEX (Figure A2) and CAPEX (Figure A3).

The OPEX of an e-bus is estimated to be USD 12,788. This figure is approximately 23% cheaper relative to the running cost of a diesel bus (see Figure A2). Meanwhile, as shown in Figure A3, the initial CAPEX of an e-bus, estimated at USD 353,850, is 44 % more expensive (EV Premium) than an imported diesel bus. The initial capital cost has been identified as a major bane for the adoption of e-buses all over world. However favourable market forces and improvements in battery technology, the EV Premium is expected to drop from 44% for the base year of 2020 to 20% in 2025 and 6% by 2030 compared to the 2020 diesel bus price. Thus, e-bus won't achieve price parity with a diesel buses till 2030 (See Figure 7).

Fiscal incentives are envisaged to speed up e-bus uptake on the Ghanaian market and to help attain the Government's ambition of 16% e-bus mix by 2030. The fiscal incentives that can be provided include subsidies on battery costs, import duty exemption, lower VAT, exemption of vehicle registration and licensing fee, subsidy on setting up charging infrastructures or a subssubsidisedctricity tariff. In the first presentation of the Roadmap to Stakeholders, all of these subsidies/ incentives in some measure were considered. However, the feedback was to simplify and present one consolidated scenario. It was proposed by the Ministry of Transport to only look into import duties and VAT on e-bus imports. The suggestion was to take zero rates for import duty and VAT for e Buses. TCO analysis revealed that a zero rate would reduce capital costs of e-buses well below diesel buses (at their 2020 price). Therefore price parity can be achieved at a much level of duty and VAT exemptions. Giving a zero rate would result in more than USD 250 million revenue losses by 2030 (Figure A5).

Figure 7: E-bus to diesel bus price parity outlook (Blue Color eBus and in Orange is Diesel Bus)

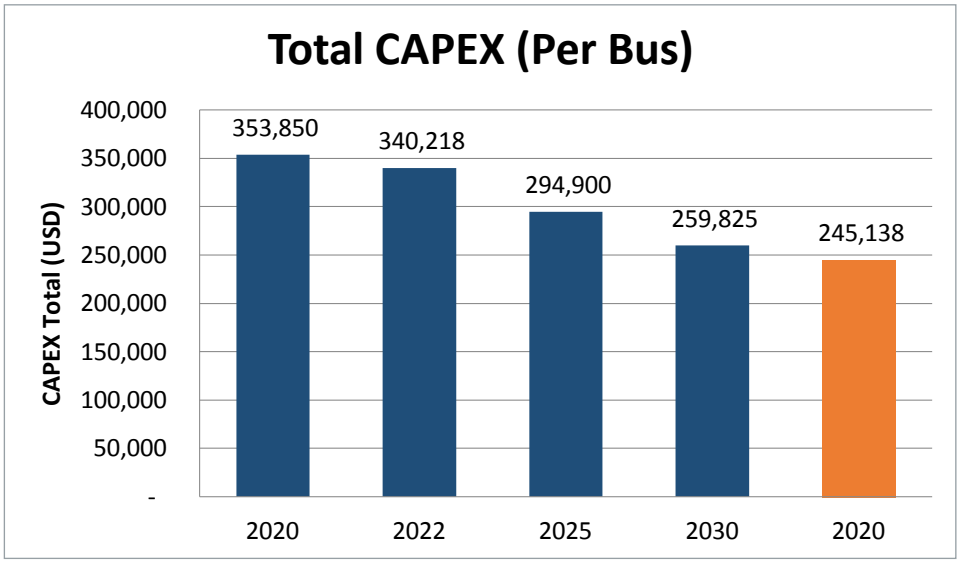
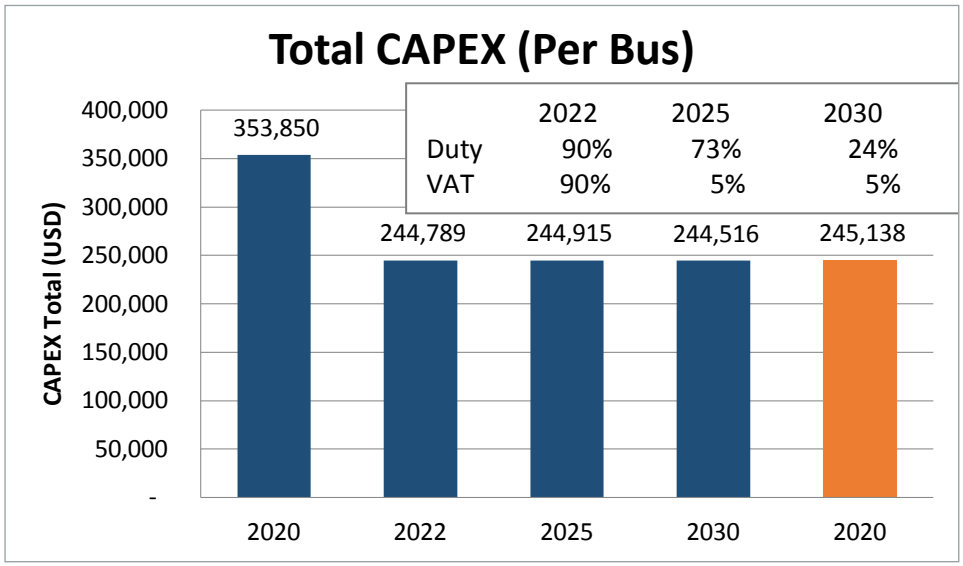


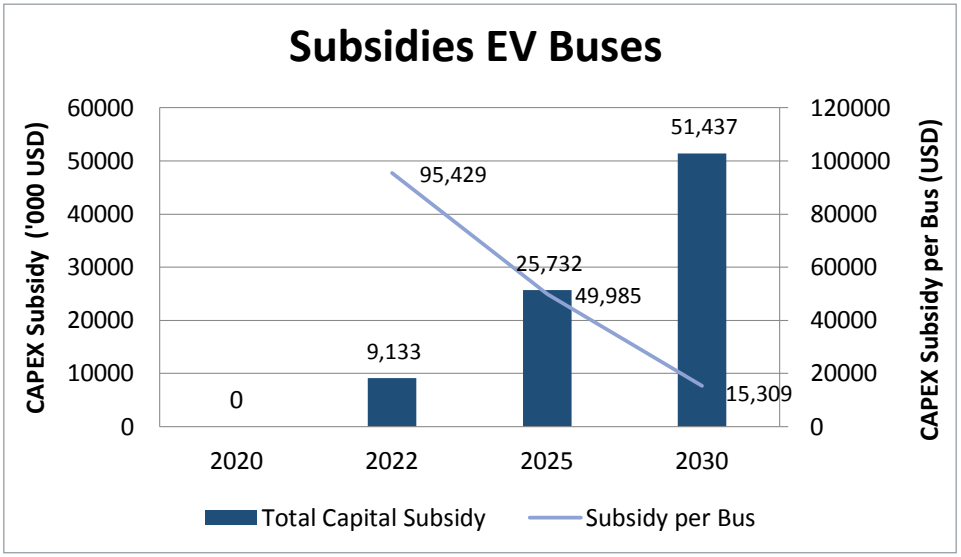
Figure 8: Graduated Import duty and VAT waivers: CAPEX of eBus in Blue and diesel bus in Orange



Therefore varying import duty and VAT waivers are needed over time with the sole consideration of achieving price parity with a diesel bus. For instance, at a 90% waiver on import duties and VAT for the period 2021-2025, the CAPEX of an e-bus is expected to reduce to USD 244,789, which is lower than an equivalent diesel bus is priced at USD 245,138 (in 2020). Figure 8 provides further details on import duties and VAT waivers and their effect on e-bus CAPEX over the years.

The cost implication of graduated import duty and VAT waivers to the Government is shown in Figure 9, . Itan be seen that Government's revenue 'losses' will amount to USD 9.1 million in 2022 and increase to about USD 51 million by 2030. However, the subsidy per bus from the waivers will decline from around USD 95,000 in 2022 to around USD 15,000 in 2030.

Figure 9: The 'cost' implication (revenue loss) for the Government



3. Roadmap for Personal Vehicles: Electric Cars (e-cars)

3.1 Ambition for the e-Cars

The per cent EV mix and the corresponding quantity of e-cars which are expected to be sold in Ghana in the short-, medium- and long-term periods have been illustrated in Figure 10.

3.2 Impacts of e-Cars

Energy Savings

The e-Mob calculator analyses show that the ambition to switch to e-cars will generate positive impacts, including fuel savings (Figure 11). The benefits are relatively small to start with. However, as the share of the e-Cars increases, the fuel savings also increases, and the cumulative savings will be around 100 million litres of gasoline-equivalent (Lge) over 2020-2050. (Figure 11).

Figure 10: National e-car targets

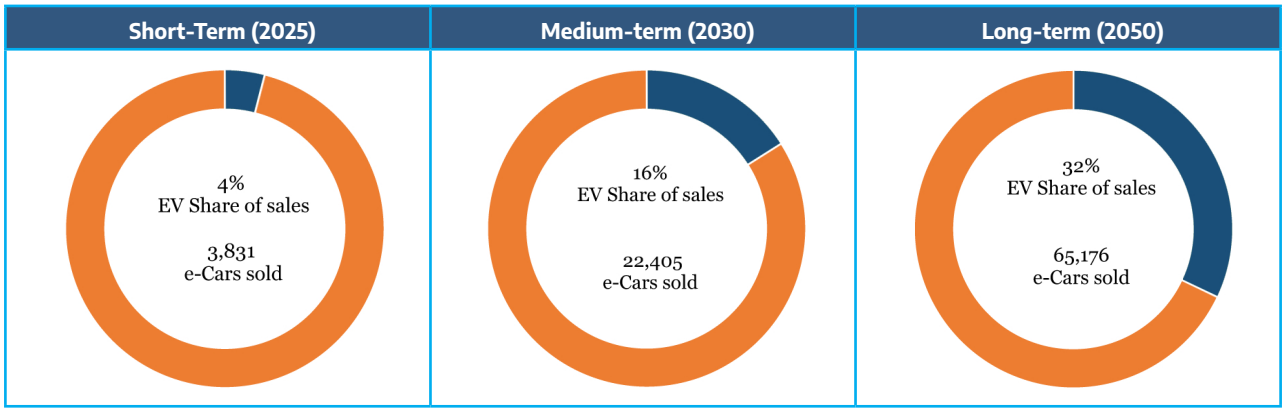
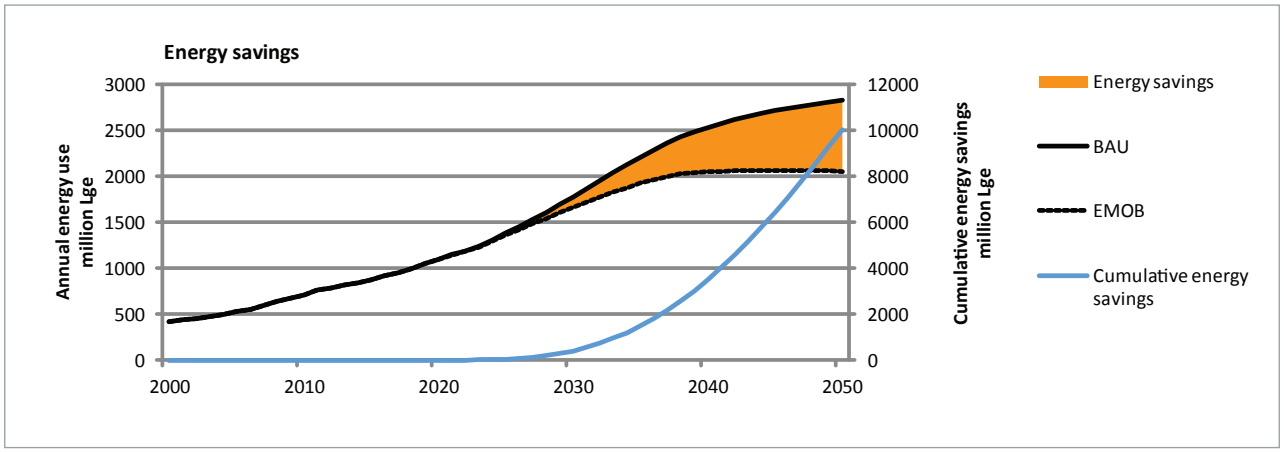


Figure 11: Projected fuel savings from e-Cars (2021-2050)



Climate Savings

Since nearly all fuel used for vehicles currently is based on fossil fuels, fuel savings also translate into CO_2 mitigation (Figure 12). The cumulative CO_2 mitigation will be around 27 million tons of CO_2 over the period 2020-2050.

Environmental Benefits

e-Cars have zero tailpipe emissions, and therefore e Cars will result in cleaner air quality through reductions in emissions of Particulate Matter (Figure 13) and Nitrogen oxide (Figure 14). However, the drops are lower since, in the BAU itself, more stringent emission standards are considered.

Figure 12: Projected CO_2 savings from e-Cars (2021-2050)

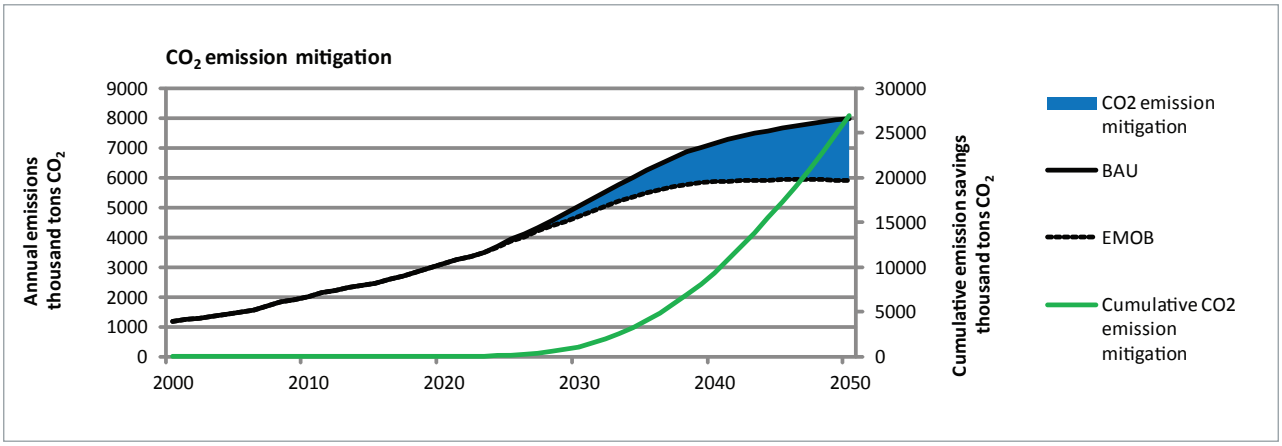


Figure 13: Projected PM savings from e-Cars (2021-2050)

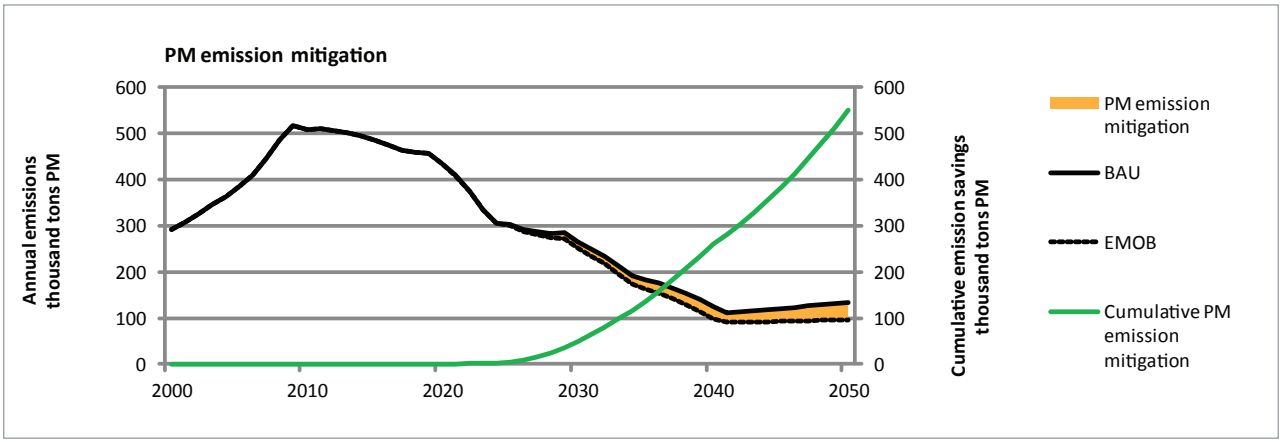
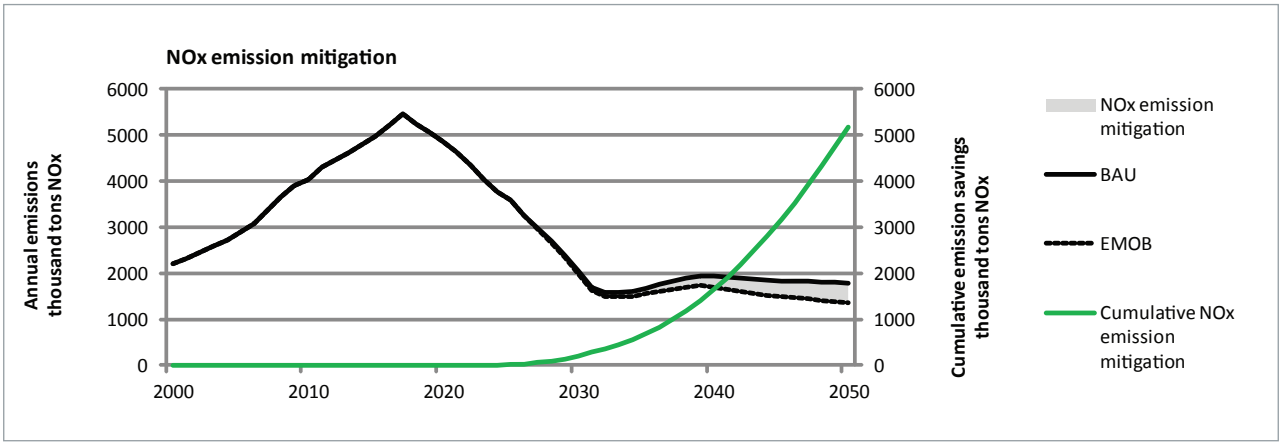


Figure 14: Projected NOx savings (2021-2050)

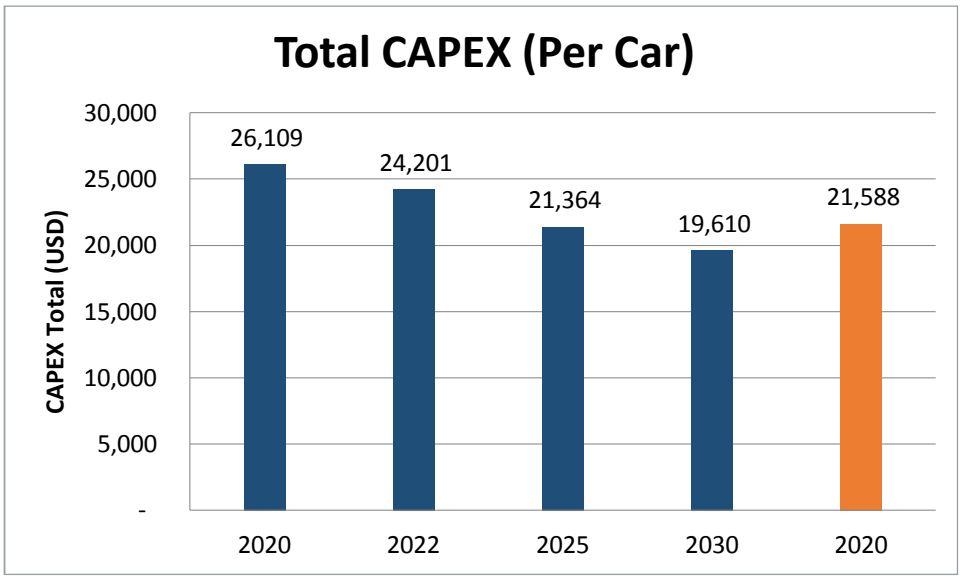


3.3 Resources required

The TCO model is provided in Appendix 3, including vehicle specifications (Figure A6), OPEX (Figure A7) and CAPEX (Figure A8). The OPEX of an e-car was estimated at USD 462. This makes the e-car about 41% cheaper compared to an ICEV (see Figure A7). Meanwhile, as shown in Figure A8, the initial CAPEX of an e-car, estimated at USD 26,109, is 21% more expensive than that of an imported ICEV.

As explained earlier, the CAPEX of EVs is projected to drop as pack-level battery cost drops from an estimated USD 137 to USD 71 per kWh between 2020 and 2050. According to Mauler[1] et al. (2021), the expected drop in EV CAPEX is due to economies of scale, incremental improvements in cell chemistry and engineering potentials in battery management. Thus, we expect the CAPEX of an e-car to drop, and the EV premium, around 21% in 2020 (see Figure A8), will come down to 12% in 2022. By 2025, the e-car will achieve price parity with the ICEV even without Government's fiscal interventions (See Figure 15).

Figure 15: E-car to ICEV price parity outlook (Blue Color e Car and in Orange is Petrol Car)



1 Mauler, L., Duffner, F., Zeier, W.G., & Leker, J. (2021). Battery cost forecasting: a review of methods and results with an outlook to 2050. Energy & Environmental Science, 14 (4712), 1-28. DOI: 10.1039/d1ee01530c

This notwithstanding, and to expedite the e-car transition, some waivers (40% duty and 30% VAT between 2021 and 2025, for instance) are needed to achieve price parity with conventional cars (See Figure 15). The revenue 'loss' implication associated with the proposed waivers is shown in Figure 16. The waivers will be around USD 1.9 million in 2022 and decrease to less than USD 1 million by 2025. However, the subsidy per e-car will decline from around USD 2,000 in 2022 to around USD 215 in 2025. Beyond 2025, further duty and VAT exemptions are not required.

3.4 Electricity Demand

The case for EVs in Ghana is primarily premised on the fact that excess electricity in the grid can be used to charge EVs. Therefore, the electricity demand will be due to targets for e-Buses and e-Cars are shown in Figure 18. The surplus electricity in 2020 was 1743 Gwh, which is more than the total demand for electricity in 2025. However, by 2030 the transition to EVs will soak up Ghana's current excess electricity.

Figure 16: Graduated Import duty and VAT waiver: CAPEX of e Car in blue and petrol car in Orange

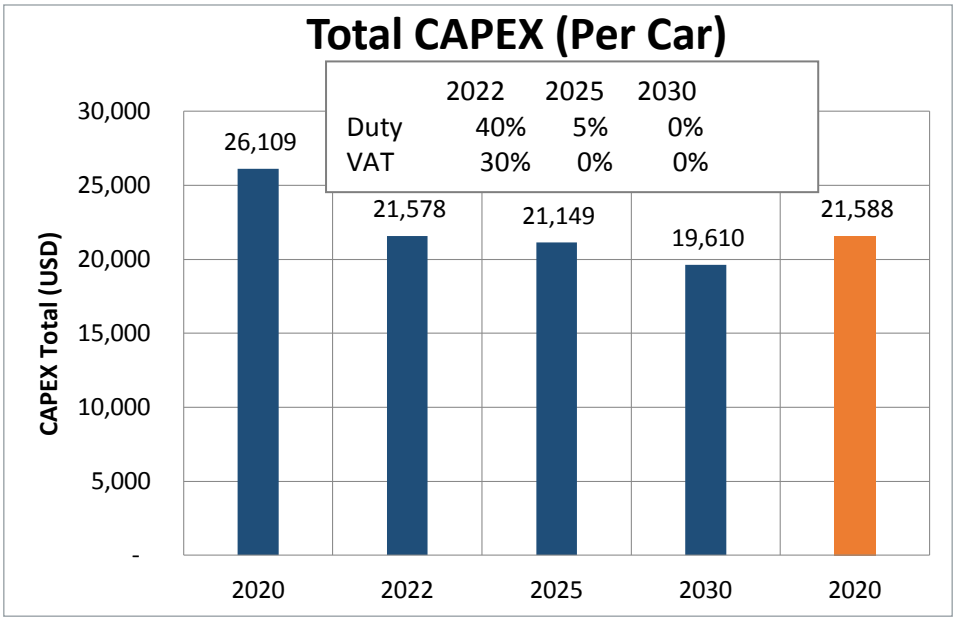


Figure 17: The 'cost' implication (revenue loss) for Government

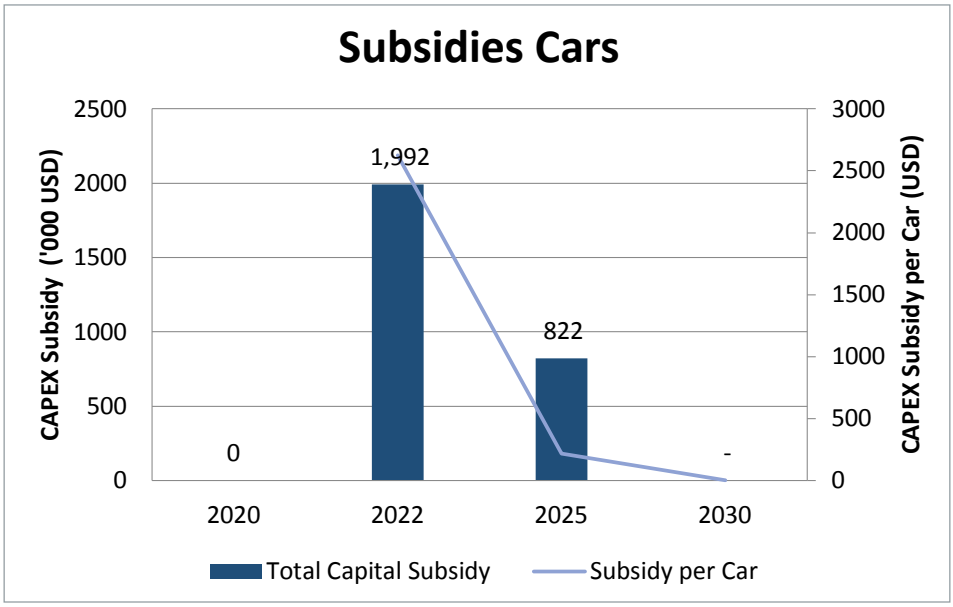
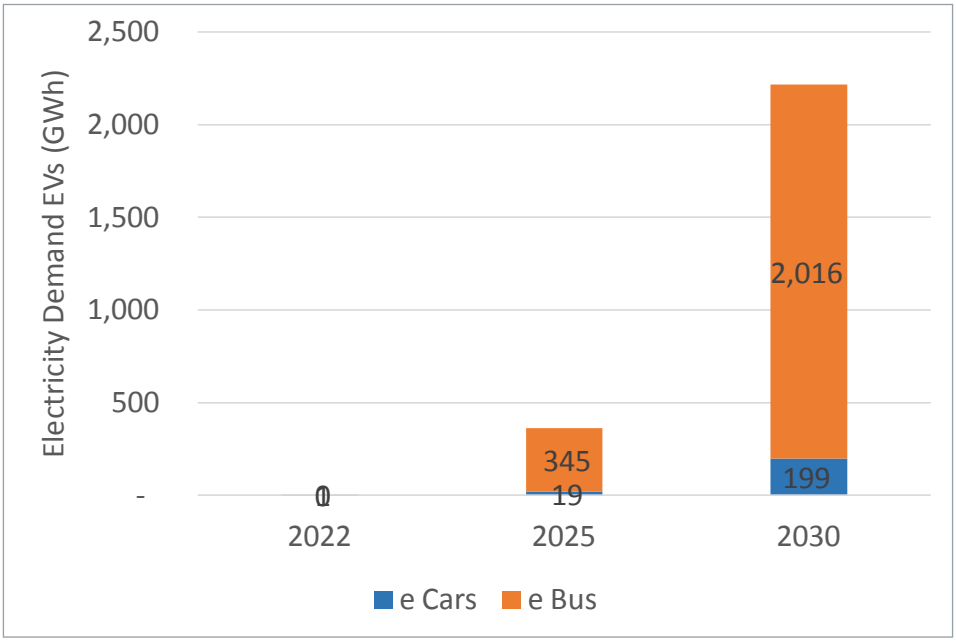


Figure 18: Projected electricity demand from EVs



4. Policy Roadmap for Electric Vehicles

4.1 Description of prioritised policy measures

Prioritised policy measures identified during the preparation of the National Electric Mobility Policy and Market Readiness Framework for Ghana were defined in a more specific and elaborate manner to clarify what is needed to operationalise them (Refer to Table 3).

Table 3: Policy initiatives of the prioritised policy measures

Policy Goal	Policy initiative	Remarks
Improve economic & fiscal measures to accelerate the uptake of EVs	Introduce tax waivers and tax holidays for full EVs (over a specified period after which re-imposition is encouraged), e.g., Import Duty, VAT exemptions	Only Import Duty and VAT were considered
	Implement particular electricity (energy) tariff for EVs (i.e., differentiated and subsidised tariff system for EV charging (e.g. from 8 pm to 6 am)	This was taken off based on feedback on the Draft Roadmap during the stakeholder workshop in Jan 2022
Develop and expand infrastructural measures to support the deployment of EVs	Promote accessible fast chargers for home charging, multiple intra-city public charging points (at fuel filling stations, parking spaces, street-side parking lots, office parks, service stations and depots) and inter-city charging points on national highways and significant rest stops	
	Adoption of contraflow bus priority lanes on existing urban roads for peak hour travels where dedicated BRT lane is not possible.	
	Promote battery swapping, recycling and end-of-life disposal systems	
Accelerate improvements in technical measures to facilitate efficiency in the uptake of EVs	Encourage more extended-range EVs, especially for long-distance travel.	
	Develop local skills (artisans, garage operators, etc.), certify garages and promote low carbon technology transfer.	
	Encourage the retrofitting of ICEVs to EVs and develop needed expertise. Local start-ups like Arke Global Technologies in Accra and others should be identified and scaled up	
Develop institutional framework, policy and regulatory measures to drive and promote the use of EVs	Review of the Harmonised System (HS) Customs code (for the proper estimation of import duties and related issues of registration)	
	Standardisation, licensing and certification of EVs and related components (regulation of chargers, charging systems and installation)	
	Promote energy security through the promotion of renewable EV charging and battery storage facilities	
	Ensure close collaboration among partnering ministries and agencies (e.g., MOT, MOF, EC and EPA) in promoting the transition to green technologies.	

Policy Goal	Policy initiative	Remarks
Develop and scale up social measures to promote the use of EVs	Facilitate the procurement, piloting and testing of EVs to ensure their quality, safety, performance, and reliability (e.g., piloting with MMTL/STC and Ayalolo on selected corridors for inter-city and intra-city journeys, respectively).	
	Facilitate and promote the addition of EVs to government vehicle fleet to increase acceptability and publicity of EVs	
	Implement a roadmap for EV awareness creation and campaigns Produce easy-to-read leaflets, handouts, brochures; aggressive media campaigns to improve knowledge on EVs	
Promote local EV development measures to accelerate the uptake of EVs	Review and adapt the Ghana Automotive Development Policy for ICEVs to provide enabling environment for local start-ups like Kantanka Automobile's *Amoanimaa* EV and other multinational companies that are already into manufacturing or local assembling	
	Establish an assembling plant and ensure local content and automotive standards are enforced in the domestic industry	

4.2 Institutions responsible for the implementation of prioritised policy measures in the roadmap

Institutions and other actors required to implement the prioritised policy measures are identified in consultation with stakeholders. The role of each institution is also described, as shown in Table 4.

Table 4: Policy goal and measures and the responsible institutions

Policy Goal	Policy initiative	Responsible Institutions
Improve economic & fiscal measures to accelerate the uptake of EVs	Introduce tax waivers and tax holidays for full EVs (over a specified period after which re-imposition is encouraged)	Ministry of Finance (MOF) to collaborate with Ghana Revenue Authority (GRA), Ministry of Trade and Industry (MOTI), Ministry of Transport (MOT), Ministry of Energy (MoEn), and the Energy Commission (EC)
	Implement special electricity (energy) tariff for EVs (i.e., differentiated and subsidised tariff system for EV charging (e.g. from 8 pm to 6 am)	MoEn to collaborate with the Electricity Company of Ghana (ECG), Public Utilities and Regulatory Commission (PURC), EC

Policy Goal	Policy initiative	Responsible Institutions
Develop institutional framework, policy and regulatory measures to drive and promote the use of EVs	Review of the Harmonised System (HS) Customs code (for proper estimation of import duties, and related issues of registration)	GRA (Customs) to collaborate with MOT, MOF, and Drivers and Vehicle Licensing Authority (DVLA)
	Standardisation, licensing and certification of EVs and related components (regulation of chargers, charging systems and installation)	Ghana Standards Authority (GSA) to collaborate with MOT, MoEn, EC, DVLA, Volta River Authority (VRA) and ECG
	Promote energy security through the promotion of renewable EV charging and battery storage facilities	EC to collaborate with MoEn, PURC, Environment Protection Agency (EPA), MOF, GRA
	Ensure close collaboration among partnering ministries and agencies (e.g., MOT, MOF, EC and EPA) in promoting the transition to green technologies.	MOT to collaborate with MoEn, Ministry of Environment, Science, Technology and Innovation (MESTI), MOTI, MOF, EC, EPA, ECG, VRA, Bui Power Authority (BPA), PURC, Building and Road Research Institute (BRRI), Government Technical Training Centre (GTTC), Metro Mass Transit Limited (MMTL), Intercity State Transport Company (ISTC), Oil Marketing Companies (OMCs)
Develop and expand infrastructural measures to support the deployment of EVs	Promote accessible fast chargers for home charging, multiple intra-city public charging points (at fuel filling stations, parking spaces, street-side parking lots, office parks, service stations and depots in safe sites), and inter-city charging points national highways and major rest stops	EC, MOT and MoEn to collaborate with ECG, PURC, Original equipment manufacturer (OEMS) OMCs, Ministry of Works and Housing (MOWH), Private Estate Developers, Tourism Board, Vehicle Manufactures/ Assemblers
	Adoption of contraflow bus priority lanes on existing urban roads for peak hour travels where dedicated BRT lane is not possible	Ministry of Roads and Highways (MRH) to collaborate with MOT, Department of Urban Roads (DUR), Metropolitan, Municipal and District Assemblies (MMDAs), Motor Traffic and Transport Department (MTTD), National Road Safety Authority (NRSA)
	Encourage the installation of backup power systems for charging stations for overnight charging and to deal with power outages	MoEn to collaborate with EC, MOF, GRA, GSA
	Promote battery swapping, recycling and end-of-life disposal systems	EC to collaborate with EPA, MESTI, MOWS, MOF, GRA, GSA
Accelerate improvements in technical measures to facilitate efficiency in the uptake of EVs	Encourage longer-range EVs, especially for long-distance travels	MOT to collaborate with MOTI, GRA, OEMS, Vehicle Manufactures/ Assemblers
	Develop local skills (artisans, garage operators, etc.), certify garages and promote low carbon technology transfer	NRSA and DVLA to collaborate with EC, MOT, Technical and Vocational Educational Training (TVET), Association of Garages, OEMS, GSA, DVLA
	Encourage the retrofitting of ICEVs to EVs and develop needed expertise. Local start-ups like Arke Global Technologies in Accra, and others should be identified and scaled up	DVLA to collaborate with NRSA, GSA, Association of Private Garages, Spare Parts Dealers Association

Policy Goal	Policy initiative	Responsible Institutions
Develop and scale up social measures to promote the use of EVs	Facilitate the procurement, piloting and testing of EVs to ensure their quality, safety, performance, and reliability (e.g., piloting with MMTL/STC and Ayalolo on selected corridors for inter-city and intra-city journeys, respectively).	MOT to collaborate with MOF, EC, MoEn, ISTC, MMTL, MMDAs, DVLA, NRSA, DPs, Bilateral/ Multilateral Funding Agencies
	Facilitate and promote the addition of EVs to government vehicle fleet to increase acceptability and publicity of EVs	Chief of Staff (COS) to collaborate with MOT, MoEn, EC, MOTI, ECG
	Implement a roadmap for EV awareness creation and campaigns Produce easy-to-read leaflets, handouts, and brochures; aggressive media campaigns to improve knowledge of EVs	MOT to collaborate with Ministry of Information (MOI), DVLA, NRSA, EC, MoEn, ECG, MESTI, EPA
Promote local EV development measures to accelerate the uptake of EVs	Review and adapt the Ghana Automotive Development Policy for ICEVs to provide enabling environment for local start-ups like Kantanka Automobile's *Amoanimaa* EV and other multinational companies that are already into manufacturing or local assembling	MOTI to collaborate with MOT, GSA, OEMS, Vehicle Assemblers, NRSA, DVLA, Academia
	Establish an assembling plant and ensure local content and automotive standards are enforced in the domestic industry	MOTI and MOT to collaborate with GSA, DVLA, OEMS, DLVA, NRSA, EC, MoEn, MOF, ECG
	Ensure local content and automotive standards are enforced in the domestic industry	MOTI to collaborate with DVLA, GSA, EC, MoEn,

4.3 Scheduling and sequencing of policy measures

The sequence and timing of each prioritised policy measure have been provided in the Roadmap Overview Table based on inputs from stakeholders.

4.4 Estimation of resources needed for policy measures

Estimation of cost of policy measures

An estimate of how much it would cost to implement import duty reductions and VAT reductions has been done for e-Buses and e-Cars in Section 2.4. and 2.5, respectively. However, the remaining policy measures will be provided by the Policy Implementation Committee. The rest of the policy measures do not entail any revenue loss for the Government and will only entail costs in drafting the policies.

Estimation of capacity building needs

Capacity building needs to carry out policy measures provided by the Policy Implementation Committee.

4.5 Management Planning

The Government of Ghana will establish an inter-ministerial committee to coordinate the implementation of the e-mobility policy and market framework. This will ensure that the interests of the various ministries, departments, and agencies are well represented and catered for. This will include the finance, resources, infrastructure, personnel capacity

building and skill development, enabling environment, etc. The committee will comprise all relevant stakeholders involved in policy, regulation and implementation. Possible management planning challenges include:

i) Institutional conflict during the work of the inter-ministerial implementation committee

ii) Lack of inter-agency coordination to monitor the progress of the implementation of the policy

4.6 Roadmap overview table

POLICY GOAL	POLICY INITIATIVE	ESTIMATED BUDGET	RESPONSIBLE INSTITUTIONS		TIMELINES				
		US $	Lead	Collaborating	2022	2023	2025	2030	2035
Improve economic & fiscal measures to accelerate uptake of EVs	Reduce Import Duty and VAT on e-Buses	2022 – 13 Million 2025 - 32 Million 2030 – 51 Million	MOF	GRA, MOTI, MOT, MoEn, EC					
	Reduce Import Duty and VAT on eCars	2022 – 2 Million 2025 – 1 Million 2030 - Nil	MOF	GRA, MOTI, MOT, MoEn, EC					
Develop institutional framework, policy and regulatory measures to drive and promote the use of EVs	Review of the Harmonised System (HS) Customs code (for the proper estimation of import duties and related issues of registration)		GRA-Customs	MOT, MOF, DVLA					
	Standardisation, licensing and certification of EVs and related components (regulation of chargers, charging systems and installation)		GSA	MOT, EC, DVLA, MOE, VRA, ECG					
	Promote energy security through the promotion of renewable EV charging and battery storage facilities		EC	MoEn, PURC, EPA, MOF, GRA					
	Ensure close collaboration among partnering ministries and agencies (e.g., MOT, MOF, EC and EPA) in promoting the transition to green technologies.		MOT	MoEn, MOF, EC, EPA, ECG, VRA, MESTI, MOTI, BPA, PURC, BRRI, GTTC, MMTL, ISTC, OMCs					
Develop and expand infrastructural measures to support the deployment of EVs	Promote accessible fast chargers for home charging, multiple intra-city public charging points (at fuel filling stations, parking spaces, street-side parking lots, office parks, service stations and depots) and inter-city charging points on national highways and major rest stops		EC	MoEn, ECG, PURC, OEMS					
	Adoption of contraflow bus priority lanes on existing urban roads for peak hour travels where dedicated BRT lane is not possible		MRH	MOT, DUR, MMDAs, MTTD, NRSA					
	Encourage the installation of backup power systems for charging stations for overnight charging and to deal with power outages		MoEn	EC, MOF, GRA, GSA					
	Promote battery swapping, recycling and end-of-life disposal systems		EC	EPA, MESTI, MOWS, MOF, GRA, GSA					

POLICY GOAL	POLICY INITIATIVE	ESTIMATED BUDGET	RESPONSIBLE INSTITUTIONS		TIMELINES				
		US $	Lead	Collaborating	2022	2023	2025	2030	2035
Accelerate improvements in technical measures to facilitate efficiency in the uptake of EVs	Encourage longer-range EVs, especially for long-distance travels		MOT	MOTI, GRA, OEMS, Vehicle Manufactures/ Assemblers					
	Develop local skills (artisans, garage operators, etc.), certify garages and promote low carbon technology transfer		NRSA/ DVLA	EC, MOT, TVET, Association of Garages, OEMS, GSA, DVLA					
	Encourage the retrofitting of ICEVs to EVs and develop needed expertise. Local start-ups like Arke Global Technologies in Accra and others should be identified and scaled up		DVLA	NRSA, GSA, Association of Private Garages, Spare Parts Dealers Association,					
Develop and scale up social measures to promote the use of EVs	Facilitate the procurement, piloting and testing of EVs to ensure their quality, safety, performance, and reliability (e.g., piloting with MMTL/ STC and Ayalolo on selected corridors for inter-city and intra-city journeys, respectively).		MOT	MOF, EC, MoEn, ITSC, MMTL MMDAs, DVLA, NRSA, DPs, Multilateral Funding Agencies					
	Facilitate and promote the addition of EVs to government vehicle fleet to increase acceptability and publicity of EVs		COS	MOT, MoEn, EC, MOTI, ECG					
	Implement a roadmap for EV awareness creation and campaigns Produce easy-to-read leaflets, handouts, and brochures; aggressive media campaigns to improve knowledge of EVs	Completed	MOT	Ministry of Information, DVLA, NRSA, EC, MoEn, ECG, MESTI, EPA					
Promote local EV development measures to accelerate the uptake of EVs	Review and adapt the Ghana Automotive Development Policy for ICEVs to provide enabling environment for local start-ups like Kantanka Automobile's *Amoanimaa* EV and other multinational companies that are already into manufacturing or local assembling		MOTI	MOT, GSA, OEMS, Vehicle Assemblers, NRSA, DVLA, Academia					
	Establish an assembling plant and ensure local content and automotive standards are enforced in the domestic industry		MOTI/ MOT	DVLA, GSA, EC, MoEn, MOF					

Appendix

Appendix 1 TCO Model for Buses

Figure A1: Vehicle specification comparison

		
250 kWh-capacity Iron-Phosphate Battery	CAPACITY & DISPLACEMENT ENGINE	Turbocharger & intercooler, 6-cylinder,11.05 litre, Euro II Diesel
100.5 km/h	TOP SPEED	102 km/h
1.49 kWh/km	FUEL EFFICIENCY	0.35 litre/km
12,000 mm x 2,550 mm x 3,200 mm	DIMENSIONS	11,940 mm x 2,500 mm x 3,190 mm
18, 000 kg	WEIGHT KG	18, 000 kg
31 + 1	CARRYING CAPACITY	31 + 1

Figure A2: OPEX of an E-bus and a Diesel Bus

		
51,300 kms	Annual Vehicle-kms	51,300 kms
$ 10, 397	Electricity/Fuel Cost	$ 13, 646
$ 2,052	Maintenance Cost	$ 2,668
$ 339	Insurance & other costs	$ 339
$ 12,788	TOTAL	$ 16, 653

Figure A3: CAPEX of an E-bus and a Diesel Bus

$ 170,000	CIF	Purchase Price	$ 159,900
$ 54,250		Battery Cost	-
$ 4,500		Freight Cost	$ 4,500
$ 2,500		Cargo Clearance Fee	$ 2,500
$ 231,250	Total		$ 166, 900
$ 71,688	One-Time Taxation	Duty	$ 50,905
$ 37,867		VAT	$ 27,226
$ 108		Registration & License Fee	$ 108
$ 109,663	Total		$ 78,239
$ 12,938	Charging Infrastructure Cost		-
$ 353,850	TOTAL VEHICLE COST		$ 245,138
$ 108,712	Comparison	Extra EV Premium ($)	-
44%		Extra EV Premium (%)	-
31%	Total taxes on Vehicles (%)		32%

Appendix 2 Cost of Zero Rating Import Duties and VAT

Figure A4: Zero-rated waiver outlook on e-bus price parity with diesel bus

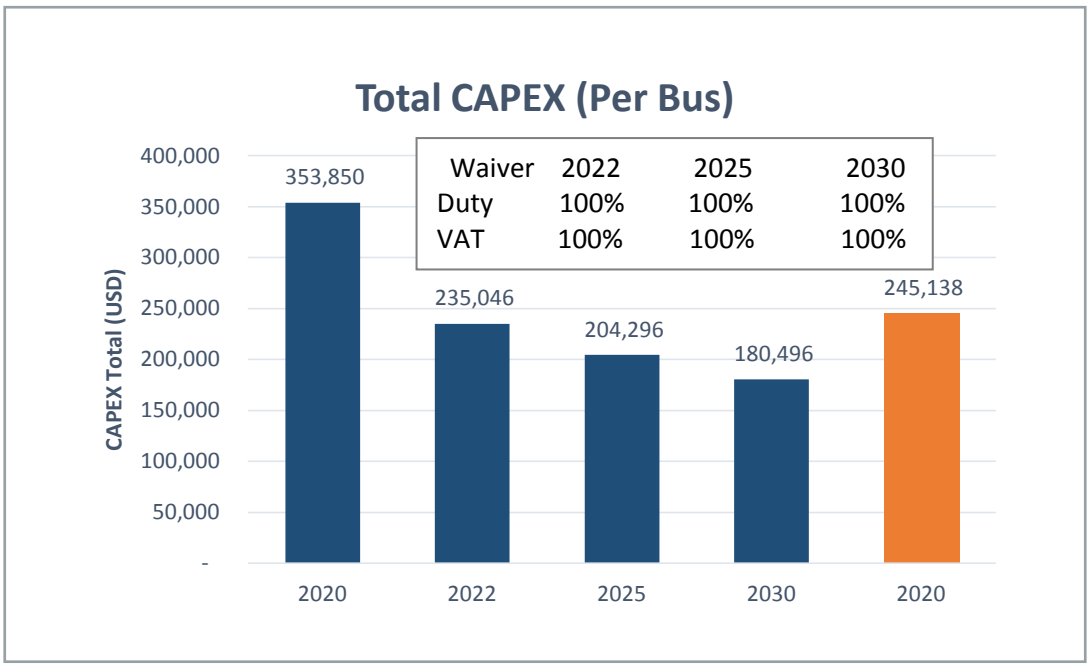
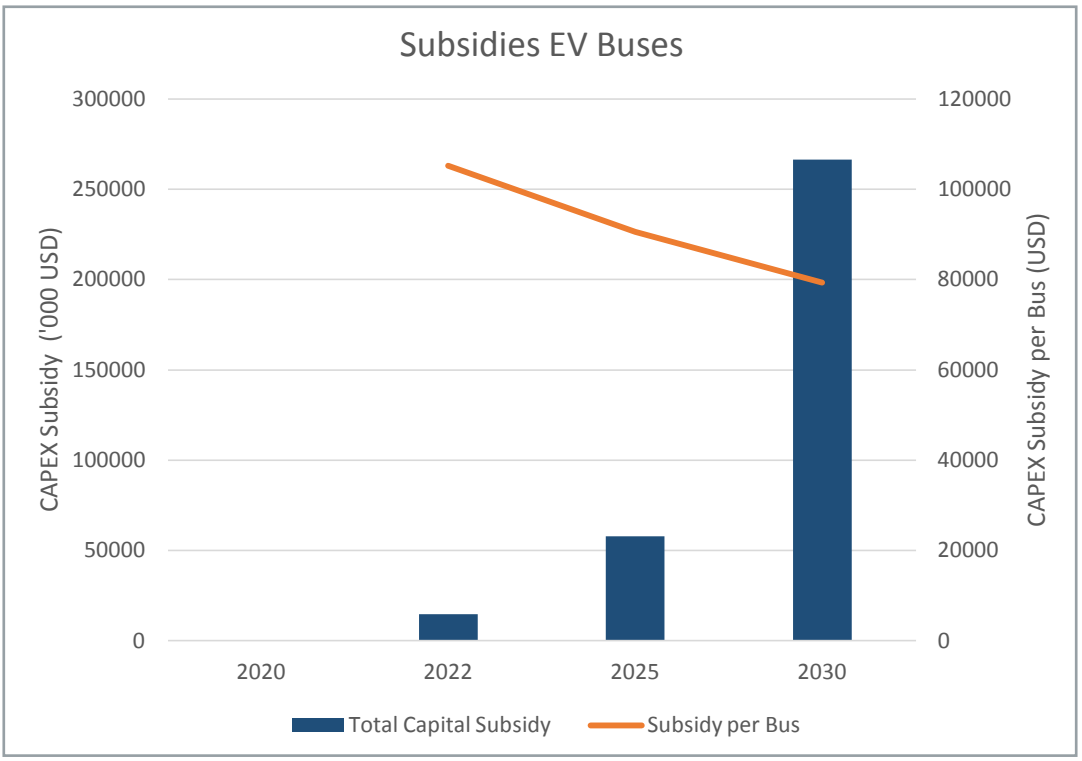
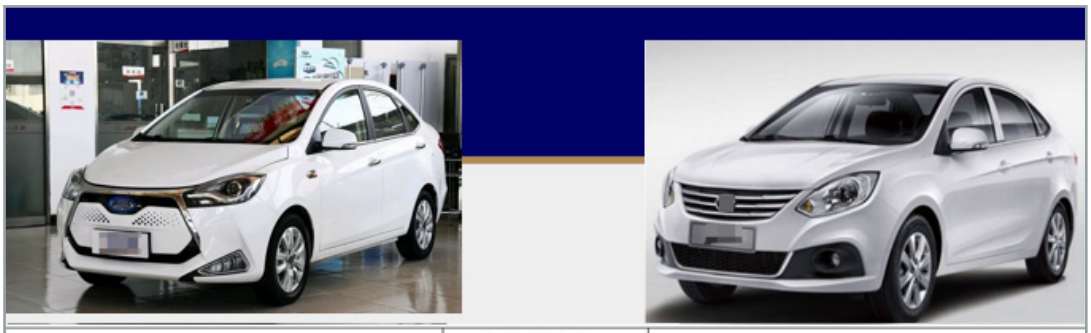


Figure A5: The 'cost' implication (revenue loss) for Government



Appendix 3 TCO Model for Cars

Figure A6: Vehicle specification comparison



35 kWh Lithium (NCA)	CAPACITY	1,499 CC gasoline
110 km/h	TOP SPEED	180 km/h
12 kWh/100 km	FUEL EFFICIENCY	4.0 litres/100 km
4,135mm x 1,750mm x 1,560mm	DIMENSIONS	4,435mm x 1,725mm x 1,505mm
1,495 kg	WEIGHT	1,110 kg
5	SEATING CAPACITY	5

Figure A7: The OPEX of an E-car and an ICEV

9,920 kms	Annual Vehicle-kms	9,920 kms
$ 162	Electricity/Fuel Cost	$ 302
$ 49.6	Maintenance Cost	$ 99
$ 250	Insurance & other costs	$ 384
$ 462	TOTAL	$ 785

Figure A8: The CAPEX of an E-car and an ICEV

$ 4,256	CIF	Purchase Price	$ 10,890
$ 7,595		Battery Cost	-
$ 1,200		Freight Cost	$ 1,200
$ 2,500		Cargo Clearance Fee	$ 2,500
$ 15,551			$ 14,590
$ 4,821	One-Time Taxation	Duty	$ 4,523
$ 2,546		VAT	$ 2,389
$ 86		Registration & License Fee	$ 86
$ 7,453	Total		$ 6,998
$ 3,105			-
$ 26,109	TOTAL VEHICLE COST		$ 21,588
$ 4,521	Comparison	Extra EV Premium ($)	-
21%		Extra EV Premium (%)	-
29%	Total Taxes on Vehicles (%)		32%