Tanzania EV Implementation Framework and Business Models

The United Republic of Tanzania
Ministry of Transport

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Acknowledgements

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Partners on the project:

Consultant:

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Abbreviations

AC	Alternating Current
BAU	Business-As-Usual
BEV	Battery Electric Vehicle
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditure
CPO	Charging Point Operator
COSTECH	Commission for Science and Technology
CTCN	Climate Technology Centre and Network
DC	Direct Current
EBIT	Earnings Before Interest and Taxes
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
E2E	End-to-End
EVCP	Electric Vehicle Charging Point
FCV	Fuel Cell Vehicle
IEA	International Energy Agency
IFI	International Financial Institutions
ICE	Internal Combustion Engine
kWh	Killo watt hour
MR	Motorization Rate
MSP	Mobility Service Provider
MtCO2e	Million tons of Carbon dioxide equivalent
NGO	Non-governmental Organization
OEM	Original Equipment Manufacturer
OPEX	Operational Expenditure
p.a.	Per annum
PHEV	Plug-in Hybrid Electric Vehicle
PPP	Public Private Partnership
SEERI	Siemens EV Ecosystem Readiness Framework
SPV	Special Purpose Vehicle
TANESCO	Tanzania Electric Supply Company Ltd
T&D	Transmission and Distribution
2W	Two Wheelers
3W	Three Wheelers
4W	Four Wheelers

1 Executive summary

1. Tanzania is positioning itself at the forefront of sustainable transportation through the development and scaling up of electric mobility (EV). In alignment with the Paris Agreement, which Tanzania ratified in 2018, the country is committed to reducing greenhouse gas emissions by 30-35% by 2030 relative to the Business-As-Usual scenario. The transport sector, identified as a priority for mitigation efforts, is central to achieving these targets.
2. The report outlines a comprehensive approach to **EV adoption**, focusing on establishing a consensus on emission targets and an EV ramp-up curve for various vehicle groups resulting into a implementation framework on national level but primarily on for the three target cities Dodoma, Dar es Salaam and Mwanza. The EV Implementation Framework is directly linked with the Market Assessment Report and the National EV Policy Framework. It complements the National EV Policy Framework as it shows how suggested policies could be translated into local actions on a short- mid- and long-term horizon. By 2050, more than 50% of new vehicle sales in Tanzania are projected to be fully or partially electric, driven by strategic, technical, and economic factors. The analysis anticipates significant growth in the nation's vehicle stock, with projections indicating that Tanzania's vehicle stock could reach 10 million by 2044, necessitating strategic planning for sustainable transportation infrastructure.
3. The transition to electric vehicles (EVs) in Tanzania requires a robust infrastructure, particularly in charging equipment. The report highlights the need for both private and public charging solutions, with a focus on the growing demand for electric two-wheelers and the necessary power generation capacity to support this transition. The **economic analysis** projects a substantial market volume for EVs, especially for four-wheelers and minibuses, driven by their higher costs and numbers.
4. The report presents several **business models** crucial for the successful deployment of EV infrastructure. Key roles such as Charging Point Operators (CPOs) and Mobility Service Providers (MSPs) are identified as essential players in this ecosystem. The financial viability of these roles is underscored, with detailed projections on the potential returns from public charging infrastructure.
5. Public-private partnerships (PPP) are highlighted as a strategic approach to fostering an e-charging ecosystem. Various models, including concessionaire agreements and joint ventures, are discussed, each with varying degrees of private sector involvement. These partnerships are crucial for scaling up infrastructure while managing public sector investment and risk.
6. A structured **implementation framework** is vital for the successful adoption of EVs in Tanzania. The report introduces the Siemens EV Ecosystem Readiness Index (SEERI) to benchmark Tanzania against other regions. While Tanzania shows early progress in EV policy and technology localization, significant gaps remain compared to global leaders like California and Germany. The report emphasizes the need for enhanced EV policies, sustainable regulations, and local business models to drive the country's e-mobility agenda.
7. In terms of **city-specific strategies**, the report provides targeted strategies for three of Tanzania's major cities—Dar es Salaam, Dodoma, and Mwanza—each with unique opportunities and challenges for EV adoption. Dar es Salaam, with its advanced infrastructure, is poised for

early EV adoption but faces challenges related to congestion and pollution. Dodoma's rapid growth as the political capital offers opportunities for strategic infrastructure development, while Mwanza's economic activities present different infrastructure needs.

8. All in all, enhancing policies, adopting innovative business models, strengthening sustainability regulations, and investing in technology and localization, Tanzania can pave the way for a sustainable future. Strategic collaboration between the public and private sectors, alongside international support, will be crucial in overcoming challenges and unlocking the full potential of e-mobility in the country.

2 Introduction

1. Tanzania is largely dependent on imported fossil and unrefined biomass fuels for economic and transport activities. Due to its rapid urbanization and increasing individual motorization, traffic congestion and air pollution have increased alongside GHG emissions. **Dar es Salaam is the second-fastest growing city worldwide,[1] where public transport depends on 2-wheelers, 3-wheelers and a large fleet of privately-owned minibuses.** Electric mobility (E-Mobility) has been recognized as a viable and attractive option that can create jobs, reduce energy imports, and spur green growth. In line with its National Transport Policy,[2] which envisions improving the transport sector's efficiency, cost-effectiveness, accessibility and environmental degradation, **Tanzania sought seeking technical assistance (TA) for the development of an E-Mobility program and implementation framework**. The country has implemented policies and strategies to promote renewable energy technologies in various sectors of the economy. However, there has been no specific initiative or effort directly targeting E-Mobility.

2. A key driver behind the National Electric Vehicles Policy Framework comes from the realization of the National Determined Contribution of Tanzania.[3] There, Tanzania targets to reduce 30 - 35% greenhouse gases relative to the Business-As-Usual (BAU) scenario by 2030, which leads to a reduction of 138 - 153 million tons of Carbon dioxide equivalent (MtCO2e)-gross emissions over all sectors, in which **the transport sector is declared as a priority mitigation sector**. Next to this objective, are the supporting objectives from the society, the economy, and the administration of Tanzania, wherein e-mobility typically contributes.

3. Objectives for society can mainly be categorized into health, prosperity, and equality. e-mobility can reduce emissions which directly affect health, e.g., SO_x and NO_x. A further impact on the society is affordability. **If EVs or electric transport led to a reduction of costs for mobility and transport, an increasing share of the population will be able to use mobility and improve their access on education, jobs, medical treatment, goods and authorities**, which should further result in the increase of prosperity and equality within society.

4. The **economic impact** is expressed mainly in a reduction of costs for transport and mobility. Further, it is targeted, that some parts of the e-mobility value chain can be stimulated, e.g., the mining of regional available raw materials like graphite, copper and nickel and other parts of the value chain can be localised in the future, e.g., battery manufacturing and vehicle assembly. Both expectations on the value chain would also directly contribute to objectives of the society by increasing income and prosperity. **Further economic impact could be achieved by decreasing dependencies of fuel imports by charging EVs with electricity from local renewable energies.**

5. Last, the administration aspects follow certain objectives with the implementation of e-mobility. As there are constraints in public spendings, investments and incentives for e-mobility and

[1] https://www.nationalgeographic.com/environment/article/tanzanian-city-may-soon-be-one-of-the-worlds-most-populous
[2] http://www.tzonline.org/pdf/nationaltransportpolicy2.pdf
[3] Nationally Determined Contribution

the required infrastructure must be affordable. **New regulations, which come with the implementation needs to be compatible with existing strategies and regulation**.

6.

3 Policy and Regulatory Context

9. To ensure a successful transition to an EV infrastructure, a comprehensive implementation and readiness framework must be developed. This framework serves as a foundational guide for assessing various critical aspects that impact the deployment and effectiveness of EV infrastructure. It provides a structured approach to evaluating readiness, addressing potential challenges, and aligning efforts across different stakeholders. By establishing a clear framework, organizations and policymakers can effectively plan and execute strategies that support the growth of electric mobility and meet the evolving needs of users and the broader community.

3.1 Methodology

10. Taking all these aspects into consideration, the Siemens' in-house **EV Ecosystem Readiness Index (SEERI)** calculation tool has been calibrated for this benchmarking exercise, assessing as shown in Figure 3-1 regions across four key domains of the EV Implementation Framework. Each domain is evaluated based on specific quantitative and qualitative subcategories, with scores contributing to a comprehensive gap analysis aligned with SEWA's objectives. The four key domains are:

11.

Domain Scoring (1/4): EV Policies	
EV Uptake	Measures the current penetration and growth rate of EVs.
Incentives	Evaluates financial and non-financial incentives provided to promote EV adoption and charging infrastructure development.
Customer Willingness	Assesses consumer interest and readiness to adopt EVs.
Standardization	Examines the presence and enforcement of standards for EV charging infrastructure and operations.

12.

Domain Scoring (2/4): Sustainability Regulations	
Decarbonization Targets	Reviews the establishment of goals for reducing greenhouse gas emissions.
Climate Policy	Looks at the formalization and adoption of climate-related policies and regulations.
Air Quality	Measures the impact of policies and regulations on improving air quality.

Domain Scoring (3/4): Business and Operation Models	
EV Supply Chain	Assesses the development and efficiency of the supply chain for EVs.
EV Local Business Models	Examines the presence and operation of local charge point operators and mobility service providers within the market.
Charging Station Utilization	Measures how effectively charging stations are used and managed.
Charging Station Affordability	Analyzes the cost of charging EVs per kilometer, considering various charging types, including commercial, non-commercial, Level 2 (L2), and DC fast charging.

15.

Domain Scoring (4/4): Technology and Localization	
Technical Charging Regulations	Assesses the extent and reach of regulations covering themes such as interoperability, connections, EV tariffs, incentives, and future capabilities like vehicle-to-grid technology.

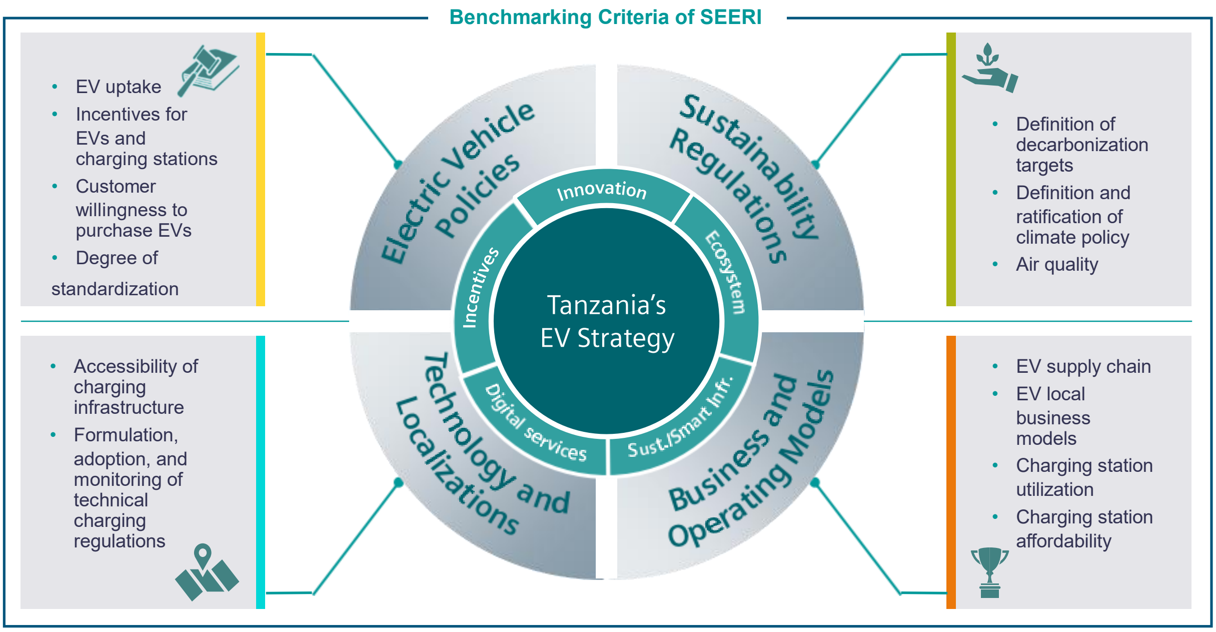


Figure 3-1: Benchmarking Criteria of SEERI[4]

[4] Siemens EV Ecosystem Readiness Index (SEERI), developed 2020

17. The selection of countries for benchmarking against Tanzania in the context of e-mobility was guided as shown in Figure 3-2 by six key comparison criteria. These criteria ensured that the selected countries offered relevant and insightful parallels or contrasts with Tanzania's current situation and potential future trajectory.

Figure 3-2: Selection Criteria

18. As illustrated in Figure 3-3, a structured approach was followed to compare benchmark countries, aiming to identify key action areas for Tanzania's e-mobility strategy. The benchmarking process involved generating raw SEERI scores, which were then visualized in a matrix to form the foundation of Tanzania's gap analysis. This analysis highlighted areas where Tanzania needs improvement, guiding the identification of key action areas. These areas were selected based on Tanzania's prioritized objectives and operational scope, ensuring that the recommendations align with the country's specific goals and context in the transition to e-mobility. The countries and regions which can be seen in the lower part were selected as benchmarks against Tanzania

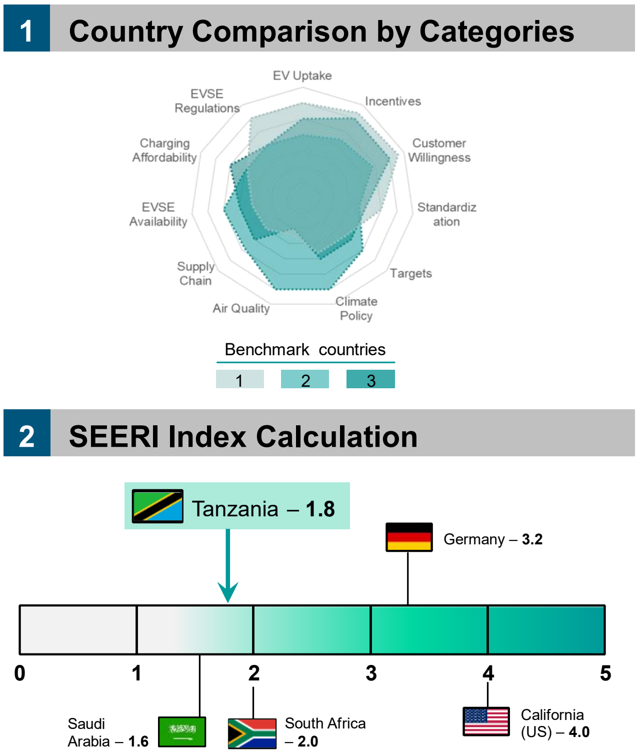


Figure 3-3: Methodology of SEERI score comparison

3.2 Benchmarking results

The following figures, Figure 3-4 , Figure 3-5, Figure 3-6, Figure 3-7, and Figure 3-8 show the results of our SEERI benchmarking with California, Germany, Saudi Arabia, South Africa and Tanzania:

3.2.1 California

Region Background

California has long been a frontrunner of climate legislation, both within the US and globally. Under current legislation, the state plans to **reduce total emissions by 40% by 2030**, and **achieve net zero by 2045**. A core component of this goal is the state's transportation decarbonization policies. Core among these are the phasing out of ICE transport for EVs, with light duty vehicles becoming fully electrified by 2035, and medium and heavy duty vehicles following suit by 2045. To facilitate its ambitious climate and transport goals, California has developed regulations and policy approaches to support the uptake of electric vehicles and implementation of charging infrastructure across state, regional and local levels. These approaches include guidelines for installation and operation, vehicle and charging subsidies and incentives, and infrastructure programs

Incentives & Regulations

- Grants and rebates for EVSE at state, regional, local and utility levels
- State and regional rebates for purchase of personal and fleet vehicles
- Time of use EV rates
- Sales and use tax exclusions for manufacturers
- EV preferential parking and priority lane

Policy & Targets

- Net Zero by 2045
- Interim 40% total emissions reduction by 2030
- 100% new light duty vehicle sales by 2035
- 100% new medium and heavy duty sales by 2045

EV Penetration

EVs	1,000,000+
Percent EVs	7.4%
Percent new EVs	12.4%
EVCP (L1)	600+
EVCP (L2)	71,000+
EVCP (fast)	7,000+

EVSE Vendors

- Variety of EVSE suppliers and charge point operators in California
- Multiple large, country-wide networks
- Utility programs have lists of approved vendors, but site hosts free to choose preference

EVSE Standards

- ☑ Connection
- ☑ Training
- ☑ Operation & Payments
- ☑ Communication Protocols

SEERI Rating: **4.0**/5.0

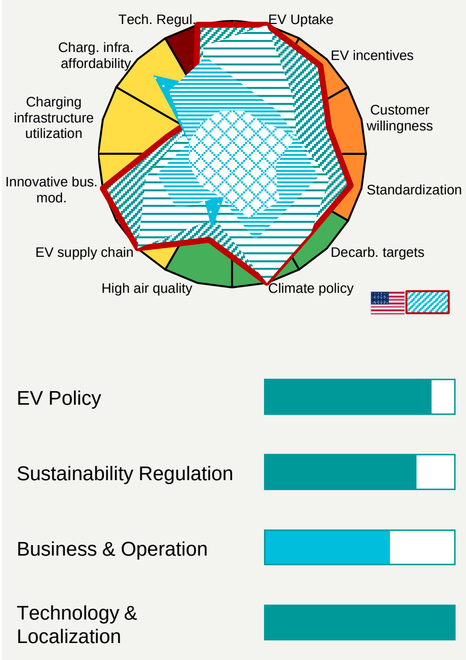


Figure 3-4: SEERI Rating California[5],[6],[7],[8]

[5] Office of Governor (2022). California ZEV Sales Near 18% of All New Car Sales in 2022

[6] UC Berkeley School of Law (2022). California Climate Policy Dashboard

[7] Based on data from Siemens market intelligence and Plugshare(2022). Plugshare

[8] US Department of Energy (2022). Electricity Laws and Incentives in California

3.2.2 Germany

Region Background

Germany is a European leader in the rollout of electric vehicles and charging stations, providing an array of incentives and regulations to enhance the development of infrastructure, and encourage the uptake in EV passenger vehicles in line with broader climate and net zero targets. Germany has achieved a strong ramp up of new EV sales, accounting for 32% of new registered vehicles in 2022. Expansive regulation across connections, interoperability and communication protocols enhances Germany's profile as a regional best practice for standardized infrastructure deployment. The initial investments in promoting EV uptake have resulted in growth which has prompted the reduction in subsidies for EVs and EVSE at the federal level.

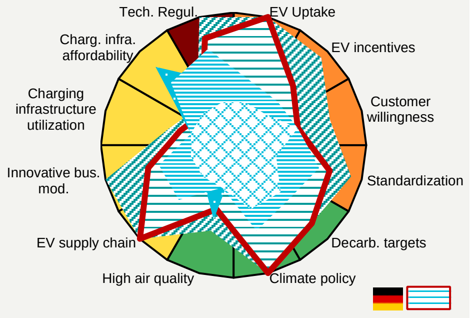
Incentives & Regulations

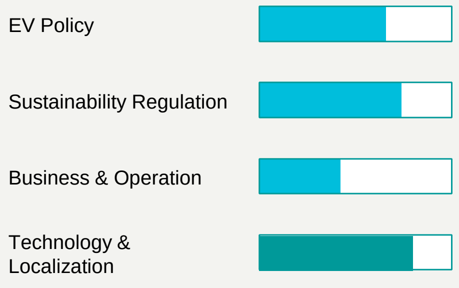
- A subsidy is offered towards EVSE through the KfW (Kreditanstalt für Wiederaufbau); additional subsidies offered by state/municipality
- State and regional rebates for purchase of personal and fleet vehicles

Policy & Targets

- Net Zero by 2045
- Interim 65% total emissions reduction by 2030
- 15 million EV (including PHEV) vehicles on the road by 2030

SEERI Rating: 3.2/5.0





EV Penetration

EVs	1,000,000+
Percent EVs	2.0%
Percent new EVs	32%
EVCP (L1)	Unknown
EVCP (L2)	37,000+
EVCP (fast)	7,000+

EVSE Vendors

- Variety of EVSE suppliers and charge point operators in Germany
- Multiple large, national and EU-wide networks and smaller municipal operators

EVSE Standards

- ☑ Connection
- ☑ Training
- ☑ Operation & Payments
- ☑ Communication Protocols

19.

Figure 3-5: SEERI Rating Germany[9],[10],[11],[12]

[9] Cleantechnica(2022). Top OEMs for Plugin Vehicle Sales in Germany (January –September 2022)

[10] APPM(2019). German Charging Infrastructure Regulations

[11] Based on data from Siemens market intelligence and Plugshare(2022). Plugshare

[12] CMS (2022). Electric vehicle regulation and law in Germany

3.2.3 Saudi Arabia

Region Background

Saudi Arabia has recently released a pledge to achieve net zero by 2060, though details on its climate action and transportation decarbonization is generally weak. While the kingdom does not have strong regulations in place to incentivize the uptake of electric vehicles, it has taken key steps to establish a charging network, and detailed connections regulations in anticipation of expected rapid future growth.

Saudi Arabia has made investments intended to bring EV manufacturing and local charging OEMs to the country.

Currently the kingdom has a 61% stake in California-based Lucid Motors through its Public Investment Fund, and plans to build networks locally, started with its Electromin-ABB charge network partnership.

Incentives & Regulations

- No subsidies or incentives for EV or EVSE

Policy & Targets

- Net Zero by 2060
- Saudi Green Initiative, includes 30% EVs in Riyadh by 2030[1)]

EV Penetration

EVs	Unconfirmed
Percent EVs	Est < 1%
Percent new EVs	Est < 1%
EVCP (L1)	Unknown
EVCP (L2)	700 +
EVCP (fast)	Unknown

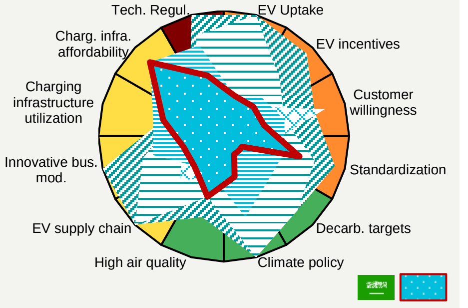
EVSE Vendors

- Electromin/ABB national charge point network, and Tesla destination charging
- Stake in USA based Lucid Motors, with plans to expand charging OEMs domestically by 2030 to capture 40% local production

EVSE Standards

- ☑ Connection
- ☒ Training
- ☑ Operation & Payments
- ☒ Communication Protocols

SEERI Rating: 1.9/5.0



- EV Policy
- Sustainability Regulation
- Business & Operation
- Technology & Localization

20.

Figure 3-6: SEERI Rating Saudi Arabia[13],[14],[15],[16]

[13] Alotaibi, S.; Omer, S.; Su, Y. Identification of Potential Barriers to Electric Vehicle Adoption in Oil-Producing Nations—The Case of Saudi Arabia. Electricity 2022, 3, 365–395. https://doi.org/10.3390/electricity3030020

[14] Based on data from Siemens market intelligence.

3.2.4 South Africa

Region Background

The EV market in South Africa is undergoing significant expansion, fueled by rising environmental awareness and government incentives. By 2024, the market is expected to generate $32.5 million in revenue, with a projected annual growth rate of 16.93% through 2028. Charging station are increasing, with 375 stations expected by the end of 2024.

Regulatory support is steady, with policies designed to encourage EV adoption and infrastructure development. Investment is pouring in, notably Ford's recent $281 million investment in local hybrid vehicle production. These factors collectively are creating a strong foundation for a thriving EV market in South Africa.

Incentives & Regulations

- To encourage local EV production, SA is introducing an investment allowance for new investments starting March 2026.

Policy & Targets

- Net Zero by 2050
- The Department of Transport published the country's Green Transport Strategy (2018 – 2050)[1)]

EV Penetration

EVs	Est 1,500
Percent EVs	Est < 1%
Percent new EVs	Est <1%
EVCP (L1)	Unknown
EVCP (L2)	350 +
EVCP (fast)	Unknown

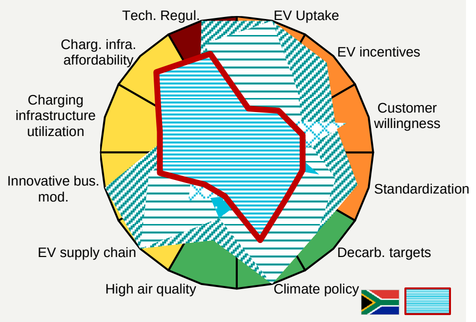
EVSE Vendors

- GridCars, is a key player in the EV infrastructure, operating in partnership with Audi.
- BMW's ChargeNow network provides charging solutions for BMW EV owners.
- Chargify, in partnership with Mercedes-Benz SA, will build 127 new EV stations.

EVSE Standards

- ☑ Connection
- ☒ Training
- ☒ Operation & Payments
- ☑ Communication Protocols

SEERI Rating: 1.9/5.0



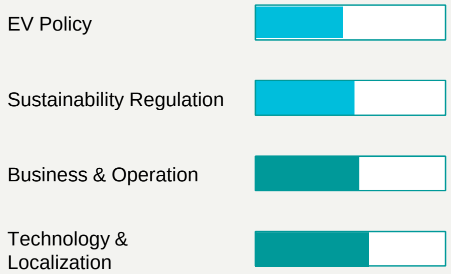


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Figure 3-7: SEERI Rating South Africa[17],[18]

[15] Based on data from Siemens market intelligence and Plugshare(2022). Plugshare

[16] Saudi Electricity Company (2022). Procedures and Guides

[17] Electric Vehicles White Paper, Department of Trade, Industry and Competition, 2023. https://www.thedtic.gov.za/wp-content/uploads/EV-White-Paper.pdf

[18] Based on data from Siemens market intelligence and Plugshare(2022). Plugshare.

3.2.5 Tanzania

Region Background

EVs are not yet popular in Tanzania for residential car owners and there are currently no set targets or policies for the transport sector concerning the deployment of EVs. Current eMobility deployment is being driven by private companies ranging from two to three wheelers to four-wheelers for tourist activities. Charging infrastructure is sparse but expanding, primarily concentrated in urban areas like Dar es Salaam.

Tanzania aims to reduce GHG emissions by 30-35% in 2030 in its updated NDC. The country plans to invest in low-emission transport system but the focus topic as reported in the NDS are mass rapid and non-motorized transport system and did not include e-mobility.

Incentives & Regulations

- No subsidies or incentives for EV or EVSE

Policy & Targets

- No explicit policies or targets relevant to EV or EVSE

EV Penetration

EVs	10,000 2W and 3W, 30 4W
Percent EVs	Est < 1%
Percent new EVs	Est < 1%
EVCP (L1)	Unknown
EVCP (L2)	Unknown
EVCP (fast)	Unknown

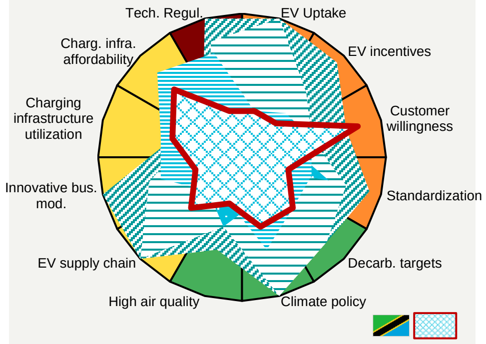
EVSE Vendors

- E-Motions offers one-phase AC chargers for retrofit 2- and 3-wheelers and wall chargers for retrofit 4-wheelers.

EVSE Standards

- ☒ Connection
- ☒ Training
- ☒ Operation & Payments
- ☒ Communication Protocols

SEERI Rating: 1.9/5.0



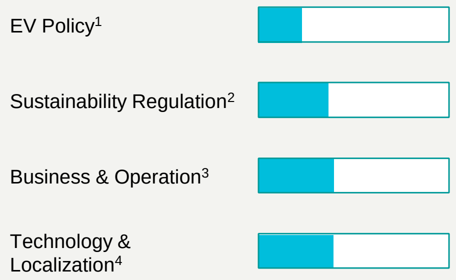


Figure 3-8: SEERI Rating Tanzania[19],[20]

[19] Barriers to E-Mobility in Tanzania, 2023. https://www.africaema.org/resources/AfEMA_country_report_2023_Tanzania.pdf

[20] Based on data from Siemens market intelligence and Plugshare(2022). Plugshare

3.3 Key take aways

22. As illustrated within Figure 3-9, the benchmarking of EV policies, sustainability regulations, business operations, and technology localization across different regions reveals significant disparities. California stands out with comprehensive EV policies and advanced technology localization, leading in sustainability regulation and business operations as well. Germany closely follows with robust EV policies and a strong focus on technology and localization, although its sustainability regulations and business operations are somewhat less developed than California's.

23. In contrast, Saudi Arabia demonstrates moderate advancements in EV policy and sustainability regulations but lags in business operations and technology localization, reflecting a more nascent stage of development. South Africa shows a balanced approach with moderate progress in sustainability regulations and technology localization, although its EV policy and business operations are still in their early stages. Finally, Tanzania has the least developed framework among the regions, with significant gaps in EV policy, sustainability regulations, and business operations, while showing some early steps toward technology localization.

24. Overall, while California and Germany lead with well-rounded and mature frameworks, other regions like Saudi Arabia, South Africa, and Tanzania are in earlier stages of development, each focusing on different aspects of the e-mobility ecosystem.

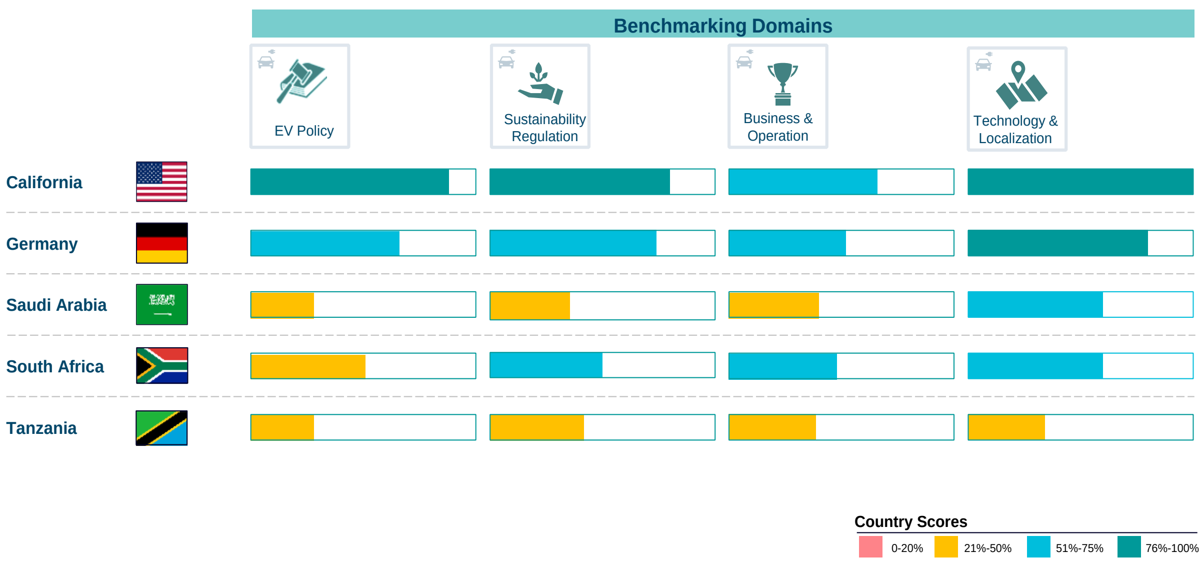


Figure 3-9: SEERI Index Regional Domain Performance (Siemens analysis)

25. Looking into Tanzania and the focus cities Dodoma, Dar es Salaam and Mwanza specifically, the following conclusions could be made:

26. **EV Policies**: Customer willingness to buy EVs in Tanzania is high, varying across cities based on median income. Despite this interest, the uptake of 4W EVs remains low, while 2W and 3W EVs

are very popular. This presents an opportunity for Tanzania to drive EV adoption through specific incentives and by defining EV and charging standards. Implementing targeted subsidies, tax breaks, and establishing clear guidelines for EV infrastructure could significantly boost the market. By focusing on these areas, Tanzania can create a more conducive environment for EV growth and meet the rising demand.

27. **Business and Operating Models**: Charging costs per kWh in Africa are relatively low compared to global EV regions, which is a significant advantage for Tanzania. However, the country currently has very little variety in charge point operators (CPOs). Investment in the sector is low, but there is potential for growth through the reduction of EV import taxes and the standardization of infrastructure. Encouraging diverse business models, such as public-private partnerships and community-based charging networks, could enhance the market. By addressing these gaps, Tanzania can attract more investment and improve the accessibility and affordability of EV charging.

28. **Sustainability Regulation**: Tanzania has established climate targets and policies like other countries in the region but falls behind global climate leaders. Besides some minor activities, the focus cities Dodoma, Dar es Salaam, or Mwanza do not have specific city-level climate policies or targets In some cases climate mitigation actions are included into city planning or urban transport planning, but an outstanding structured CO_2 mitigation strategy for example, is not available. Instead, climate action and policy initiatives are typically driven at the national level. Strengthening these regulations and ensuring their enforcement will be crucial for achieving sustainability goals. Integrating EV policies with broader climate strategies can help Tanzania align more closely with global standards and enhance its environmental impact.

29. **Technology and Localization**: Tanzania has not yet established technical regulations to ensure the safety, interoperability, and specific tariffs and metering for EV supply equipment (EVSE). Developing these regulations is essential for creating a reliable and efficient EV ecosystem. Localization efforts, such as promoting local manufacturing and assembly of EVs, can reduce costs and create jobs. Investing in research and development, skills training, and innovation will be key to advancing technology in the e-mobility sector. By focusing on these areas, Tanzania can build a robust and sustainable e-mobility market that meets both local and international standards.

30. Reflecting on the way forward, Tanzania's e-mobility market holds great potential. By enhancing policies, adopting innovative business models, strengthening sustainability regulations, and investing in technology and localization, Tanzania can pave the way for a greener and more sustainable future. Collaboration and continuous improvement will be key to overcoming challenges and unlocking the full potential of e-mobility in the country.

4 National Implementation Framework

31. The EV Ramp-up discussion is focused on reaching a consensus on GHG emissions targets and establishing an EV ramp-up curve for each vehicle group. Tanzania, having ratified the Paris Agreement in 2018, has laid out its targets and actions to contribute to this global accord through its National Climate Change Response Strategy (2021). In its Nationally Determined Contributions ratified in July 2021, Tanzania has committed to reducing greenhouse gas emissions by 30-35% relative to the Business-As-Usual scenario by 2030[21]. This ambitious target translates to a reduction of 138-153 million tons of carbon dioxide equivalent in gross emissions across all sectors, with the transport sector identified as a priority for mitigation efforts.

32. The objective of this document is to prepare Tanzania and the three key-cities to agree on GHG emissions targets for vehicles balanced with a feasible long-term investment strategy. The outcome of this process will facilitate agreement on an EV ramp-up curve tailored for the needs and capabilities of Tanzania. As shown in Figure 4-1 the EV ramp-up model considers six key dependencies, ensuring a comprehensive approach to decision-making regarding emission targets and the scaling up of EVs.

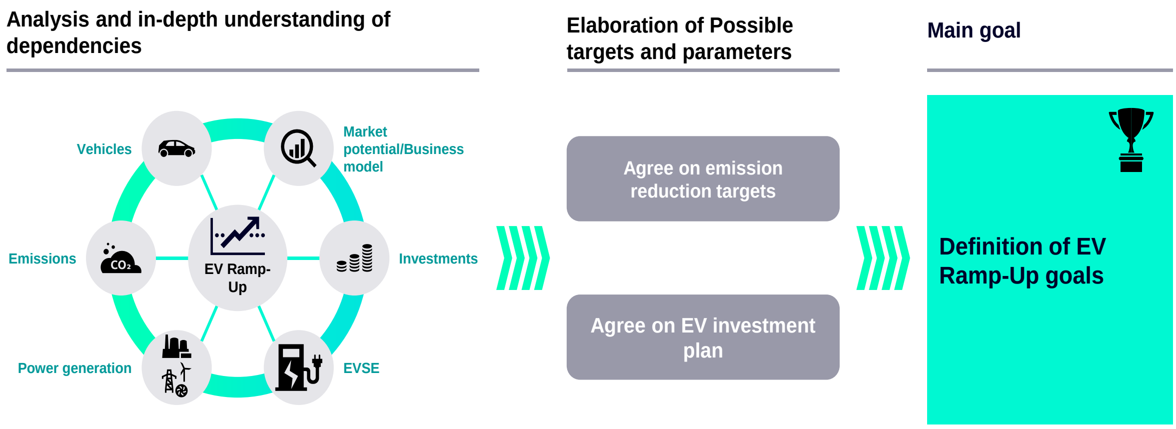


Figure 4-1: E V Ramp-up Framework

4.1 EV Ramp-Up

The perspective of vehicles is on of the decisive impact parameter on the EV ramp-up (see Figure 4-2). The focus is on the development of the vehicle market and vehicle types.

[21] Tanzania National Determined Contribution

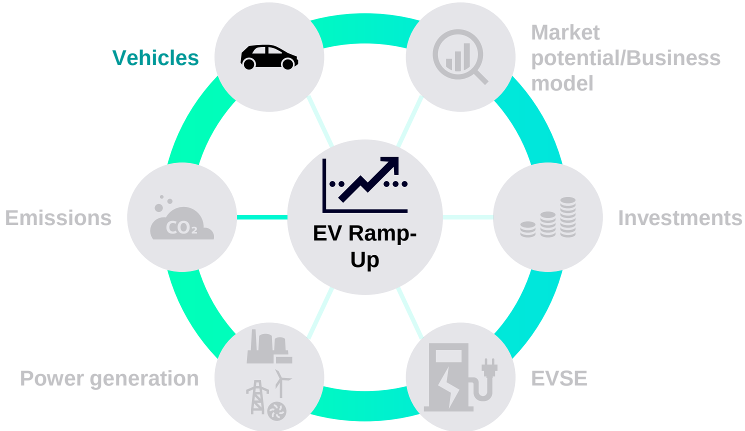


Figure 4-2: Impact of vehicle development on EV Ramp-Up

33. More than 50% of new vehicle sales will be fully or partially electric by 2050 due to a mix of strategic, technical and economic drivers which is shown in Figure 4-3. Strategically, many regions are advancing their clean air strategies to combat pollution and enhance air quality, with EVs playing a crucial role in these efforts. Additionally, sector coupling and the integration of renewable energy sources are pivotal in aligning transportation with broader sustainability goals. Technologically, the falling prices of EV batteries and the declining costs associated with acquiring and owning EVs are making them increasingly accessible. These trends are further supported by advantageous policy and regulatory environments. Economically, the continuous improvement in EV driving range, alongside the development of multi-modal transportation systems, is enhancing the practicality and appeal of EVs. Moreover, the ongoing deployment and adaptation of EV infrastructure are vital in supporting the growing number of EVs, ensuring that charging solutions keep pace with their rising adoption.

Figure 4-3: Key Drivers for EV Ramp-Up[22]

34. These drivers are crucial to be analysed and assessed properly, since the predictions regarding global passenger vehicle sales is very clear. As seen in Figure 4-4, by 2050, global new passenger vehicle sales are projected to be dominated by battery electric vehicles (BEVs), which are expected to account for 48% of the market. Internal combustion engine (ICE) vehicles will still represent a significant portion, comprising 44% of new sales. Plug-in hybrid EVs (PHEVs) are forecasted to make up 5% of the market, while fuel cell vehicles (FCVs) are anticipated to account for 3%. This distribution reflects a substantial shift towards electric mobility, highlighting the growing prominence of BEVs in the automotive sector and the gradual decline in traditional ICE vehicle sales.

[22] Wood Mackenzie 2021

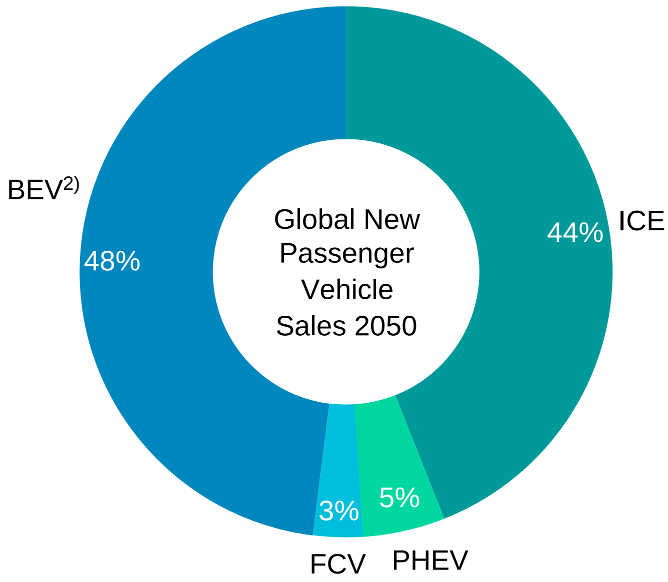


Figure 4-4: 2050 Vehicle Share

4.1.1 Methodology of EV ramp-up modelling

35. Figure 4-5 is a flow chart that illustrates the factors influencing the share of EVs in a total vehicle stock. The model relies on three key input parameters:

- The historical development of population growth and its forecast.
- The number of vehicles per 1,000 inhabitants, known as the vehicle per capita or motorization rate.
- The rate at which vehicles (ICE or EV) are decommissioned, impacting the age distribution of the vehicle stock.

36. The model uses the share of new EV sales as the primary hypothesis. The flow chart then splits into two branches, both impacting the outcome:

37. Branch 1:

- Sales of all vehicles per annum (p.a.): This reflects the total number of new vehicles sold annually.
- Sales of EVs p.a.: This reflects the number of new EVs sold annually.
- Total Number of EVs: This is the total number of EVs currently in circulation.

38. Branch 2:

- Share of EVs among new sold vehicles [%]: This represents the percentage of new vehicles sold that are EVs.

39.

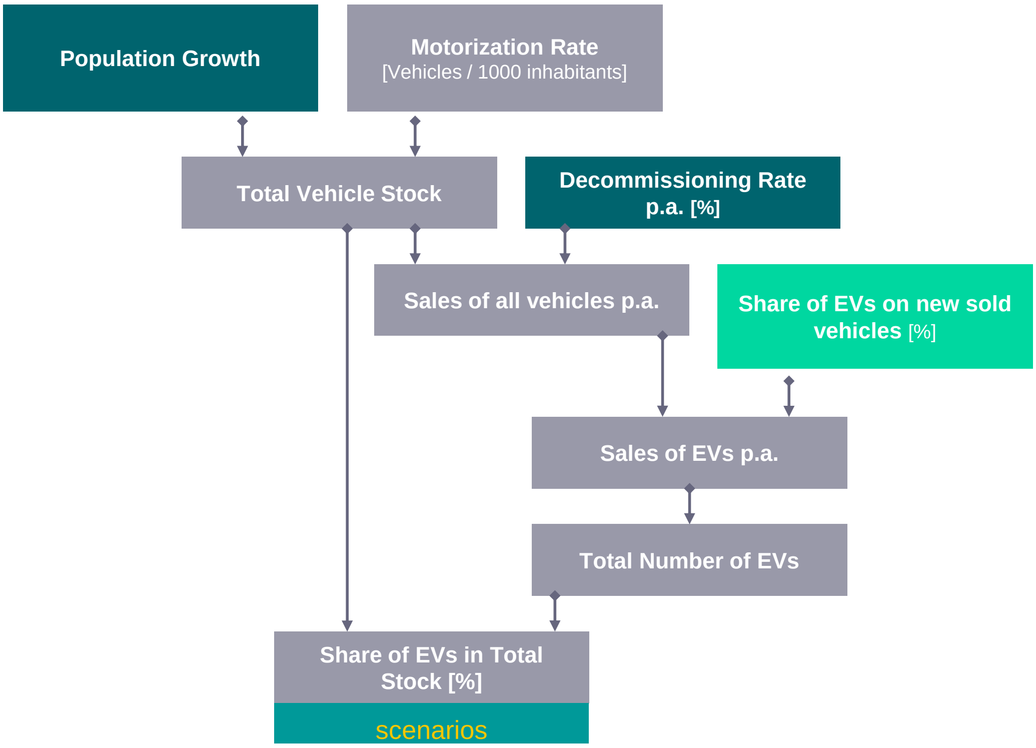


Figure 4-5: Share of EVs flow chart

40. Ultimately, both branches converge to determine the share of EVs in the total vehicle stock (%). The flow chart concludes with the term "scenarios," suggesting that by varying the input factors, different scenarios regarding the EV share in the total vehicle stock can be simulated.

By incorporating these demographic trends and the outlined parameters, our model aims to provide a comprehensive forecast of EV adoption and the necessary charging infrastructure in Tanzania over the next two decades.

4.1.2 Population growth

41. Tanzania stands as the second most populous country in East Africa, trailing only Ethiopia, with an estimated population as seen in Figure 4-6 of 61.74 million in 2021. Historical data reveals a robust population growth rate, averaging approximately 3.1% annually between 2012 and 2023. A significant majority, about 97%, of Tanzania's population resides on the mainland, while the remaining 3% live in Zanzibar.

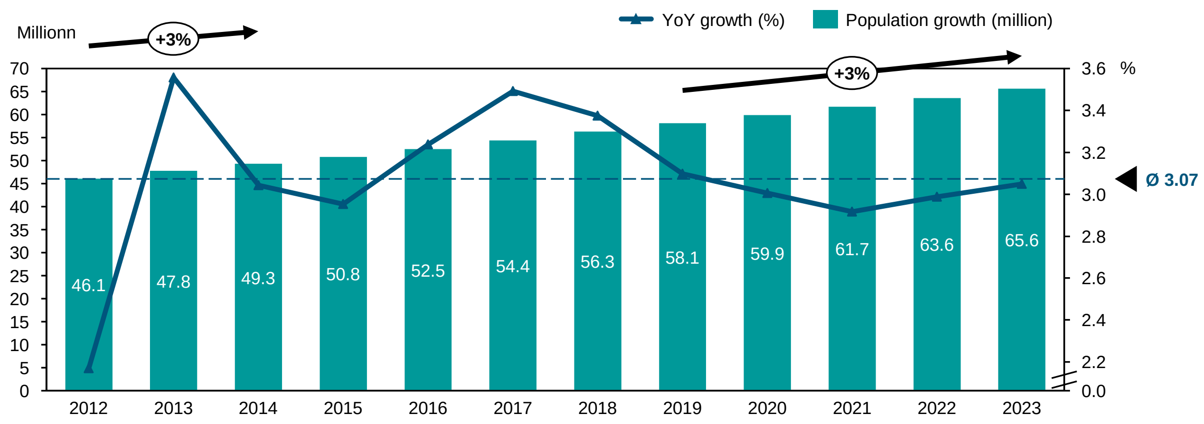


Figure 4-6: Historical Population Growth[23]

42. Projections indicate that Tanzania's population is expected to exceed as shown in Figure 4-7 100 million by 2044, growing at a compound annual growth rate (CAGR) of 2.2%.

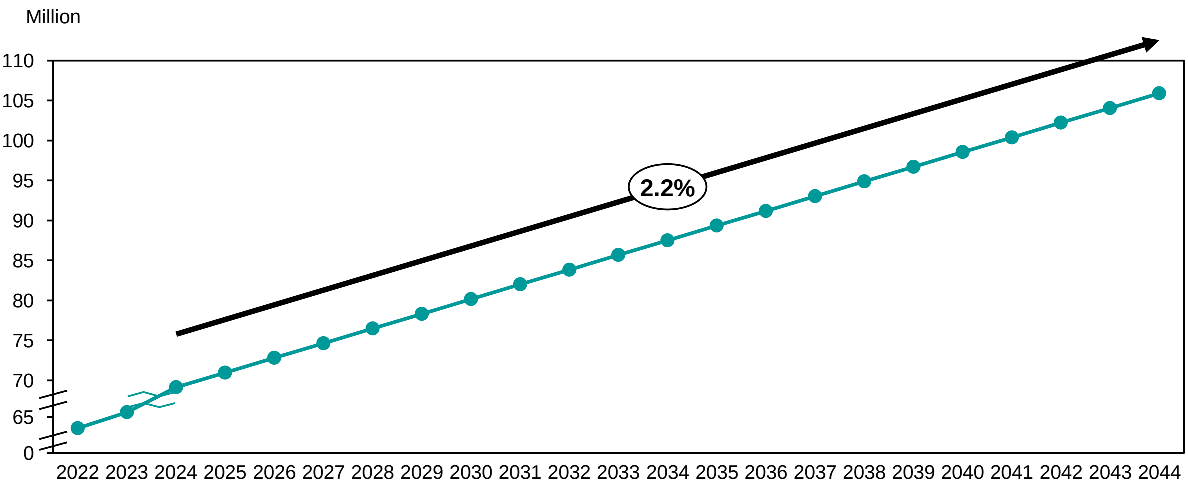


Figure 4-7: Forecasted Population Growth (Siemens analysis)

4.1.3 Motorization rate

43. The total vehicle stock in Tanzania has as seen in Figure 4-8 more than doubled over the last six years, rising from 1.9 million in 2015 to 4.3 million in 2021, with an impressive CAGR of 16%. Within this vehicle stock, motorcycles and mopeds accounted for approximately 45%, making them the most prevalent vehicle type. Private passenger vehicles or cars made up

[23] Tanzania Bureau of Statistics

27.4% of the total, while light passenger vehicles or minibuses comprised 17.25%, and 3W represented 3.15%.

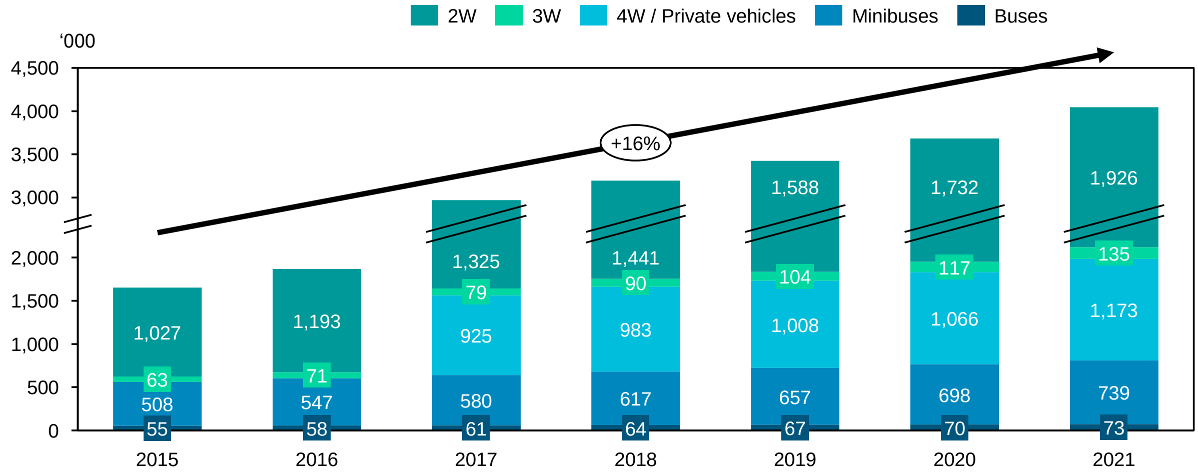


Figure 4-8: Registered vehicles in Tanzania[24]

44. The motorization rate, or vehicle per capita, which is shown in Figure 4-9 is a crucial metric that indicates the number of vehicles in use per 1,000 inhabitants across all considered categories. From 2015 to 2021, this rate witnessed a substantial CAGR of 12%, growing from 31 to 64 vehicles per 1,000 inhabitants. This increase highlights the rapid expansion of vehicle ownership in Tanzania, driven by economic growth and rising demand for personal and commercial transportation.

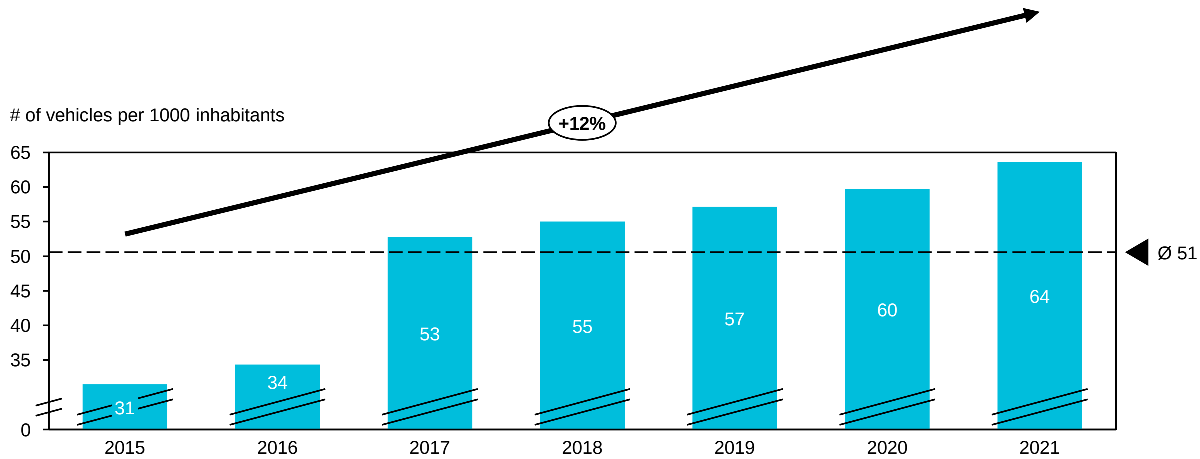


Figure 4-9: Development of MR (Siemens analysis)

[24] Ministry of Works and Transport

4.1.4 Total vehicle stock

45. The National EV Strategy focuses on 2-Wheelers, 3-Wheelers, 4-Wheelers/passenger cars, minibuses and buses. Therefore, trucks and other special purpose vehicles are excluded from the evaluation.

46. Figure 4-10 projects vehicle numbers in the future up to 2043. The CAGR of 4% annually is driven by a growing population and increasing motorization rate levels.

47.

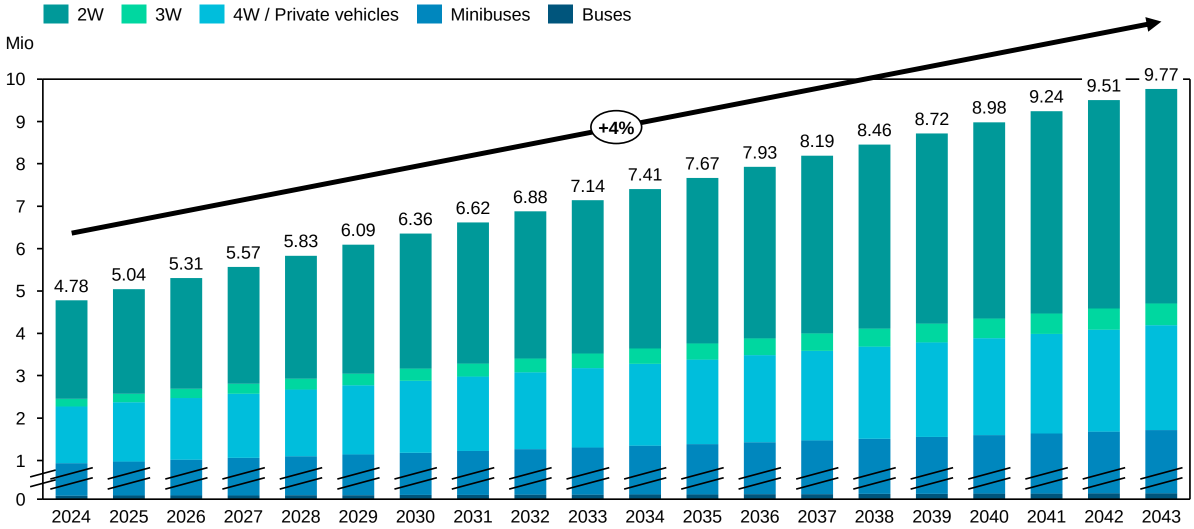


Figure 4-10: Development of Total Vehicle Stock (Siemens analysis)

48. The forecast on the population growth uses CAGR figures from the Department of Statistics of Tanzania. MR development is assumed by considering global examples and key trends in market development of Tanzania. With the anticipated population surpassing 100 million by 2044 and a rising MR, Tanzania's vehicle stock could reach 10 million by 2044. This significant growth highlights the necessity for strategic planning in transportation infrastructure and policy, emphasizing the importance of adopting sustainable solutions such as EVs. Preparing for this expansion involves not only increasing the number of vehicles but also developing adequate charging infrastructure and supportive regulations to facilitate a smooth transition to a sustainable transportation ecosystem in Tanzania.

4.1.5 Decommissioning rate p.a.

49. To estimate the decommissioning rate in Tanzania, an examination of the average lifetime of each vehicle category was conducted, considering various influential factors. Political incentives and regulations, such as bans on diesel vehicles in European cities, GDP per capita, climate conditions, and driving behaviour and culture all play a role in determining vehicle lifetime. There is an inversely proportional correlation between car age and GDP per capita, meaning higher GDP per capita generally results in a shorter vehicle lifespan due to quicker turnover of the vehicle fleet. As seen in Figure 4-11 the average vehicle lifetime for ICE vehicles in Europe is around 13 years, with variations depending on the country's development level.

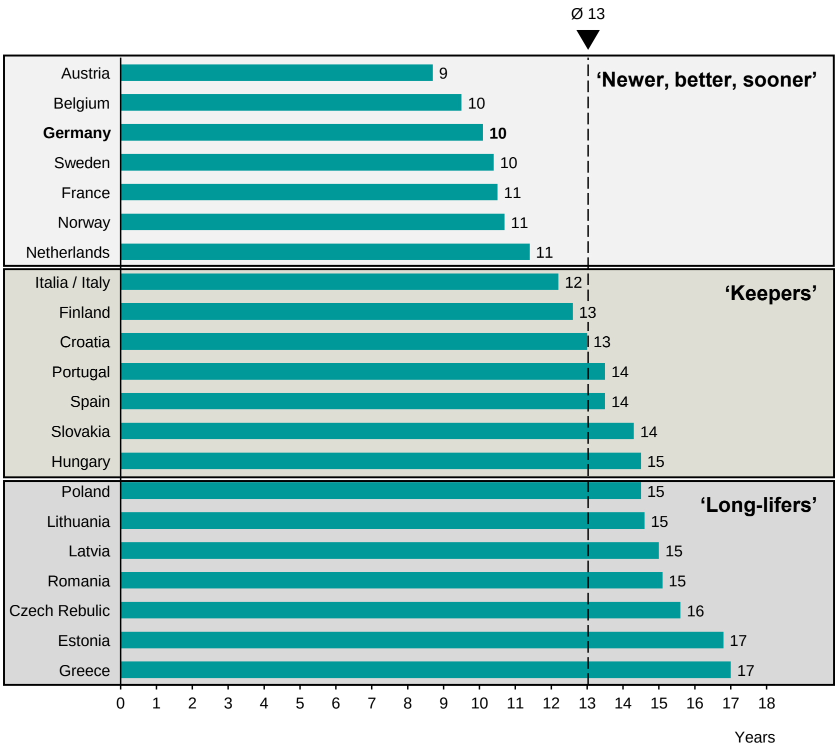


Figure 4-11: Vehicle lifetime of 4W passenger cars in Europe[25]

50. For the analysis in Tanzania, the assumed average lifetimes for vehicle decommissioning rates have been discussed by market experts of the Policy Working Group within a Policy Working Group Workshop on 3rd July 2024[26]. The decisive parameter is the lifetime of a vehicle in the Tanzanian market. The concluded lifetime parameters can be seen in Table 4-1.

Table 4-1: Assessed lifetime of vehicle types in Tanzania by PWG workshop on 3rd July 2024

EV	2W	3W	4W	Minibus	Bus
Lifetime [yrs]	5	5	15	15	20

51.

52. These assumptions provide a foundation for estimating the vehicle decommissioning rate in Tanzania, which is essential for forecasting the turnover of the vehicle fleet and planning for sustainable transportation solutions.

4.1.6 Share of new EV sales

53. A key driver for the introduction of e-mobility comes from the realization of the National Determined Contribution of Tanzania.[27] There, Tanzania targets to reduce 30 - 35% greenhouse

[25] ACEA, Vehicles in use report (own illustration)
[26] Policy Working Group Workshop 3rd July 2024 – Presentation p. 10 and Minutes of Meeting
[27] Nationally Determined Contribution

gases relative to the Business-As-Usual (BAU) scenario by 2030[28], which leads to a reduction of 138 - 153 million tons of Carbon dioxide equivalent (MtCO2e)-gross emissions over all sectors, in which **the transport sector is declared as a priority mitigation sector**.

54. For example, in 2030 an ICE 2W would emit 1,4 tons CO_2 per year in average, while an electric 2W would emit 0,32 tons of CO_2. The example is based on assumptions for yearly fuel consumption and a forecast for the power mix in Tanzania in 2030.

55. Therefore, the higher the share of electric vehicles among all vehicles in Tanzania, the lower the overall emissions of the transport sector. In consequence the share of new EV sales is a central KPI to measure the success of the introduced EV Policy Framework to mitigate CO_2 in the transport sector. Figure 4-12 shows an international benchmark on EV targets and key measures.

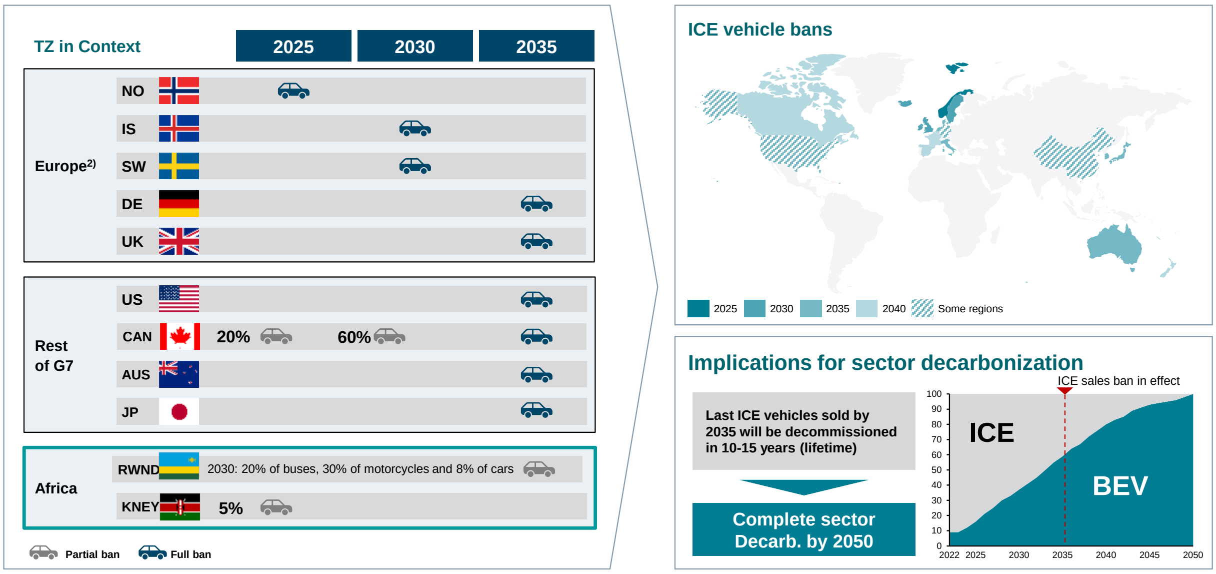


Figure 4-12: International benchmark of key actions to increase the share of EVs in the transport sector (Siemens analysis)

4.1.7 Sales of EVs p.a.

56. As shown in Figure 4-13, the annual growth of the EV share in Tanzania has been modelled across four scenarios to assess the potential impact on emission reductions. These scenarios reflect different future trajectories for the CO_2 emissions of various vehicle groups, based on the projected share of EVs within the total vehicle stock. The model considers four different CAGR for EV uptake: 0%, 2%, 4%, and 6%.

57. While there have been some EV sales in Tanzania before 2024, the volumes have been relatively small. In the moderate scenario, where the CAGR is 4%, it is projected that there will be approximately 1.5 million EVs by 2030. In comparison, the conservative scenario, with a CAGR of 2%, is expected to result in around 750,000 EVs by 2030. Conversely, the aggressive

[28] Tanzania National Determined Contribution

scenario, featuring a CAGR of 6%, could lead to approximately 2.3 million EVs by 2030. These scenarios help to visualize the impact of different growth rates on emission reductions and provide a range of potential outcomes for Tanzania's transition to electric mobility.

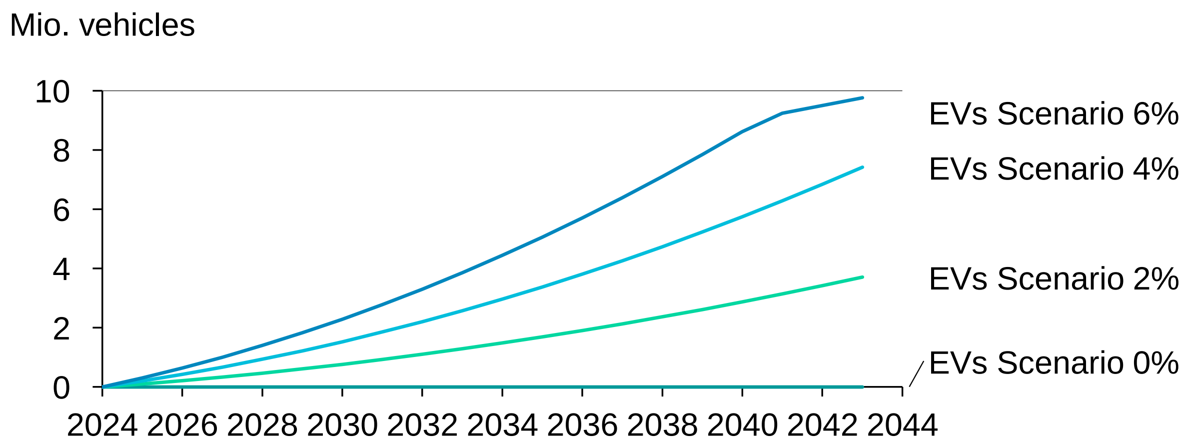


Figure 4-13: Number of EVs in four different scenarios (Siemens analysis)

4.2 Technical Feasibility

The technical evaluation of feasibility focuses on electric vehicle supply equipment (EVSE), GHG emissions and power generation (see Figure 4-14).

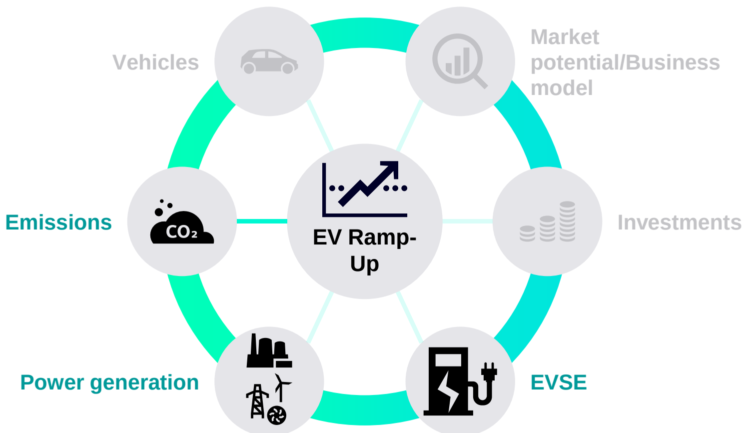


Figure 4-14: Technical impacts on EV Ramp-Up

EVSE is evaluated regarding the right type and quantity for the characteristic EV ramp-up of Tanzania. The perspective of (GHG) emissions targets the evaluation of future emissions of the entire vehicle fleet in different scenarios. The perspective of power generation compares the current strategy for the future generation with the expected demand for different EV ramp-up scenarios.

4.2.1 Electric vehicle supply equipment (EVSE)

Figure 4-15 shows expected quantities for different types of EVSE for a specific EV ramp-up scenario. The evaluation differentiates public accessible and private accessible charging infrastructure. Regarding technology the assessment differentiates casual plugs (level 1 charging), AC charge points with 11kW power (level 2 charging) and DC (high power, level 3) charge points with 50 and 100kW charging power. "Plugs" are, not any specific charging equipment, only casual plugs. The other types of chargers are specific EVSE to be installed and maintained as such.

The projection regarding quantities assumes that each vehicle type has specific preferences regarding charging technology and location. Quantities of EVSE are further impacted by numbers of electric vehicles per type and average yearly electricity consumption.

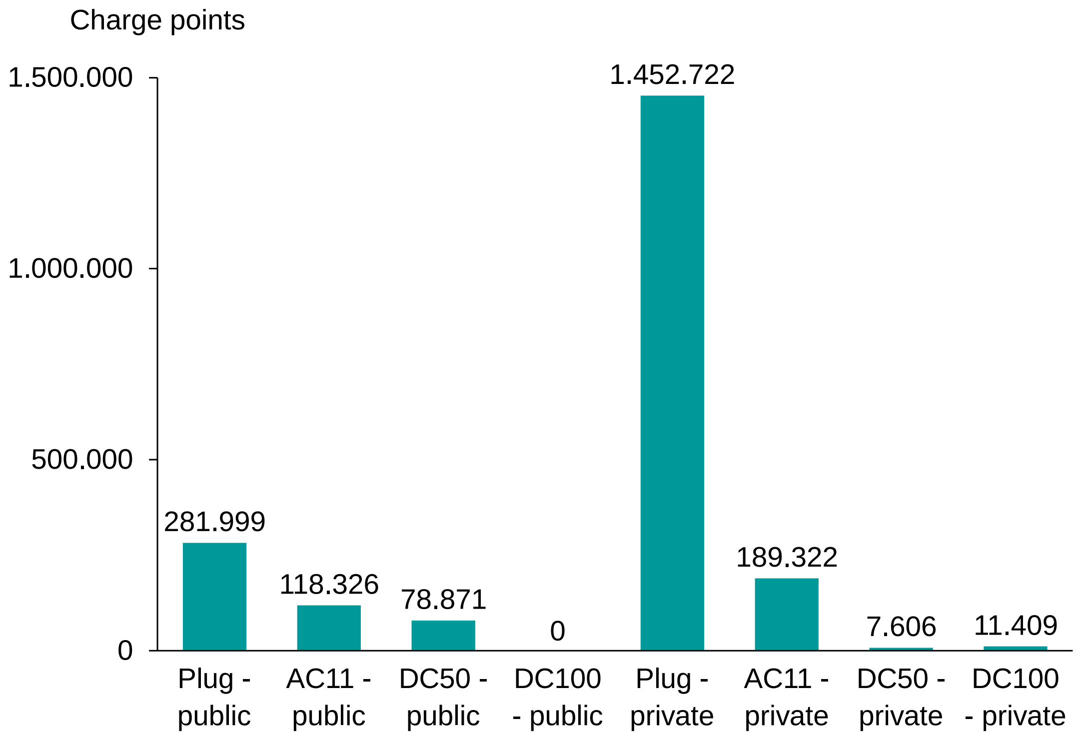


Figure 4-15: Number of charge points in 2035 per category (Siemens analysis)

Given the large number of 2W in Tanzania, it is anticipated that most charging points in 2035 will be private plugs. Group discussion within the Policy Working Group experts report that in Tanzania in 2024 many charge points are provided and installed by EV suppliers or retailers for private use. Those charge points are majorly AC wall boxes with up to 11kW charging power. Experts of PWG further reported that neighbouring Rwanda has adopted a different approach, with charge points often located at petrol stations and bus depots. This model underscores the potential for integrating charging infrastructure into existing commercial and transit hubs, offering a public-facing solution that could complement the private charging points emerging in Tanzania. Quantities for DC charging infrastructure is majorly required by buses and minibuses, but also by 4-wheel passenger cars.

58. As the EV market continues to expand, the development of both private and public charging solutions will be essential. Tanzania's focus on private plugs aligns with current practices, but exploring diverse charging infrastructure models, as seen in Rwanda, may further support the broader adoption of EVs in the region.

4.2.2 GHG Emissions

59. GHG emissions are the major driver for the implementation of electric mobility in Tanzania. To evaluate the potential impact of EVs on future vehicles emissions, this report compares four scenarios with different yearly CAGR in share of EVs (0%, 2%, 4%, 6%), shown in Figure 4-16. The projection further considers the future energy mix of Tanzania based on the outlook given in the Power System Masterplan 2020[29].

60. These scenarios illustrate how gradual adoption can influence emission reductions over time, although the significant impact on emissions savings will take several years to materialize.

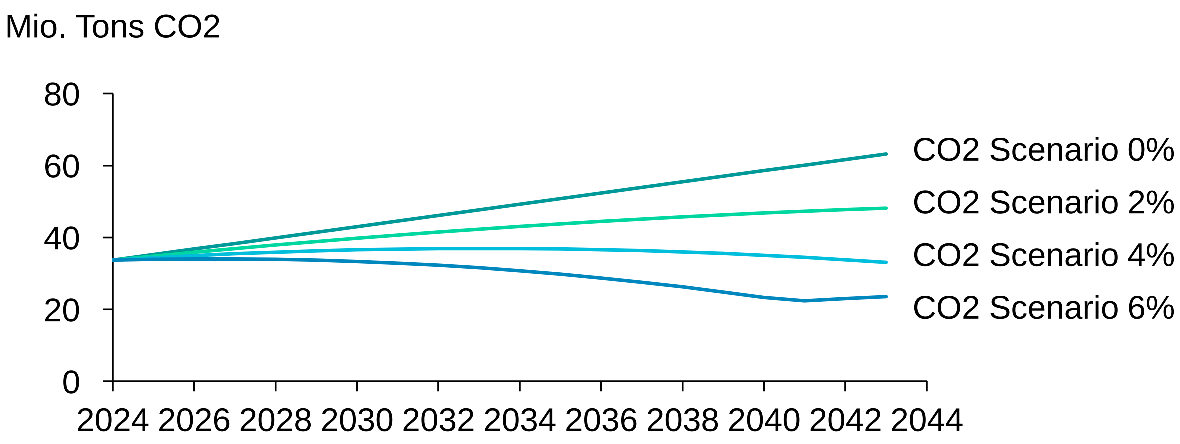


Figure 4-16: Emissions of vehicles in four different scenarios in tons CO_2 (Siemens analysis)

One such scenario as seen in Figure 4-17 referred to as the "2% scenario," represents a 2% annual increase in the share of EVs. As illustrated, minibuses and 4W ICE vehicles have the most significant impact on overall CO_2 emissions in Tanzania, primarily due to their large numbers and high specific emissions. According to Policy Working Group experts, minibuses are particularly notable for their substantial CO_2 emissions, largely because many of these vehicles are second-hand and in frequent use[30].

61.

[29] Power System Masterplan 2020
[30] Policy Working Group Workshop 3rd July 2024 Presentation and Minutes of Meeting

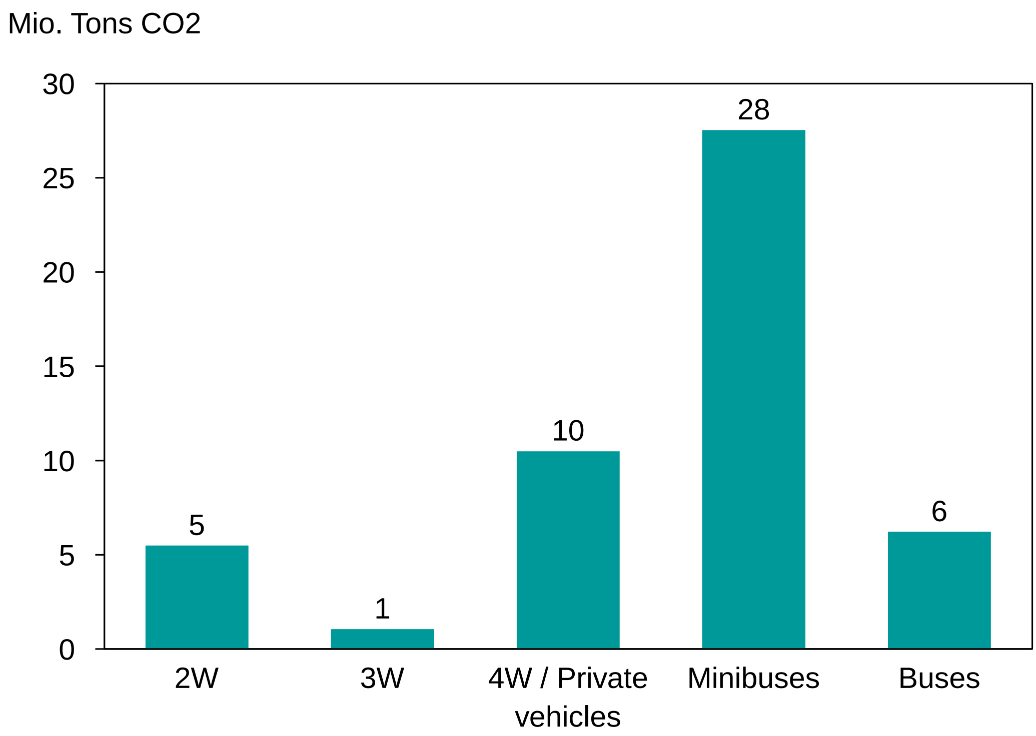


Figure 4-17: Emissions per vehicle group in Scenario 0% in 2035 in tons CO_2 (Siemens analysis)

62. In urban areas, minibuses are expected to be gradually replaced by larger buses, such as those used in Bus Rapid Transit systems. Initially, Bus Rapid Transit systems will transition to compressed natural gas and eventually move towards electric options. However, in rural and suburban areas, minibuses are likely to remain in use for a longer period.

The capacity of trains, both for passengers and cargo, may not be substantial enough to significantly influence overall vehicle development and emissions reductions in the short term. The PWG concluded that electrifying minibuses presents challenges in Tanzania, particularly because these vehicles are predominantly privately owned. Despite these challenges, best practices from Rwanda demonstrate that electric minibuses are technically and economically feasible, providing a model that could inform future efforts in Tanzania[31].

4.2.3 Power generation

63. In a scenario where the EV share increases by 4% annually, the overall electricity consumption from EVs is expected to gain significance year by year. As seen in Figure 4-18 additional consumption needs to be considered ahead as additional generation must be planned several years in advance.

64. The baseline electricity consumption data for Tanzania is derived from Power System Masterplan 2020 from Tanzania. This data provides a framework for understanding current and future energy needs in Tanzania[32].

[31] basigos-electric-buses-power-rwandas-green-transportation-revolution

[32] Power System Masterplan 2020

65. While the incremental increase in electricity demand due to EVs might be small in the short term, it remains crucial for accurate demand forecasting. As the number of EVs grows, even a modest increase in electricity consumption could impact the overall energy demand and infrastructure planning. Therefore, incorporating this factor into the demand forecast ensures that Tanzania's energy supply can be adequately prepared to accommodate future needs as the EV market expands.

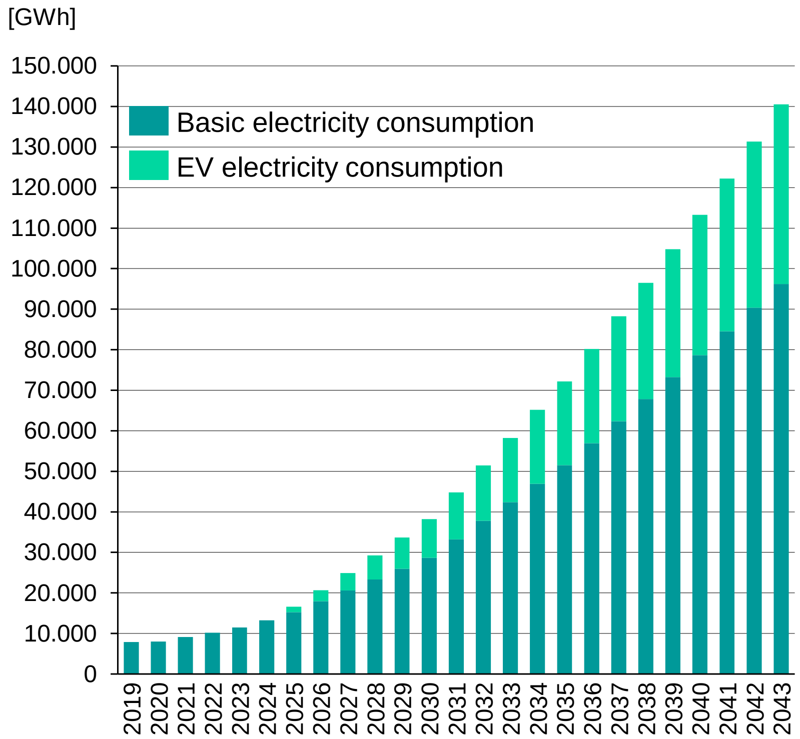


Figure 4-18: Basic and EV electricity consumption in Tanzania (Siemens analysis)

66. Based on estimates, the peak load demand for electricity in Tanzania may exceed as seen in Figure 4-19 power generation capacity starting from 2033, largely due to the additional load from electric mobility. This forecast is derived from assumptions outlined by the Ministry of Energy and the Power System Masterplan for Tanzania.

67. In a scenario where the EV share increases by 4% annually from 2024 onwards, peak load demand could potentially surpass generation capacity as early as 2026. This anticipated peak in e-mobility demand is expected to occur between 7 and 8 p.m., which aligns with typical charging times for EVs[33]. Additionally, there may be challenges related to transmission and distribution systems, which could become bottlenecks as demand increases.

[33] Policy Working Group Workshop 3rd July 2024 - Presentation and Minutes of Meeting

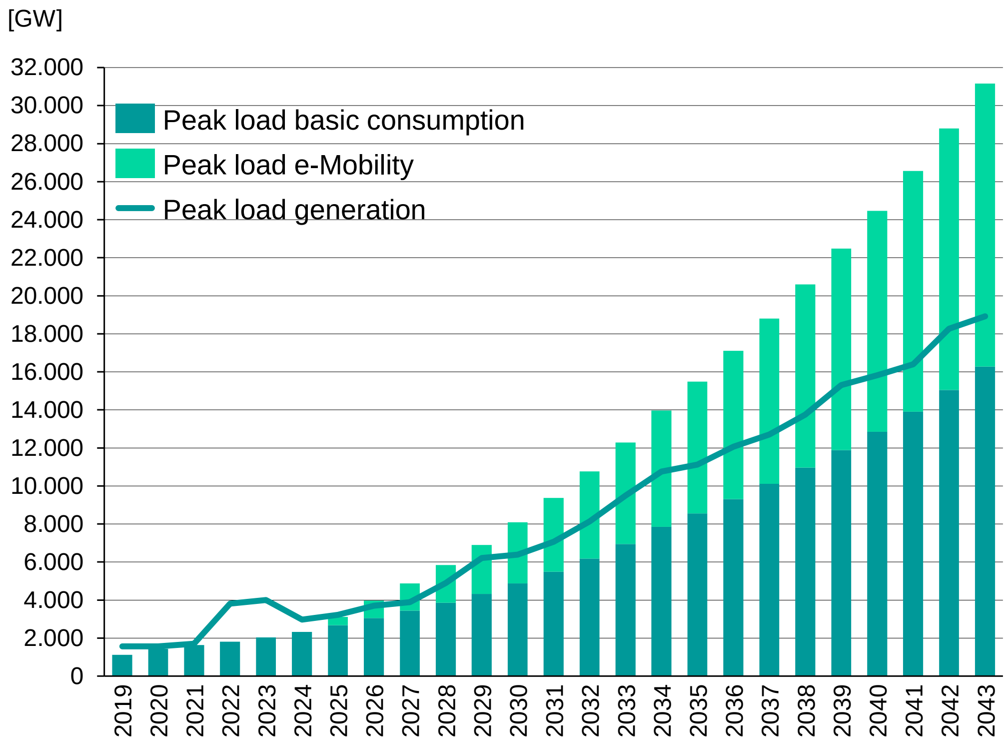
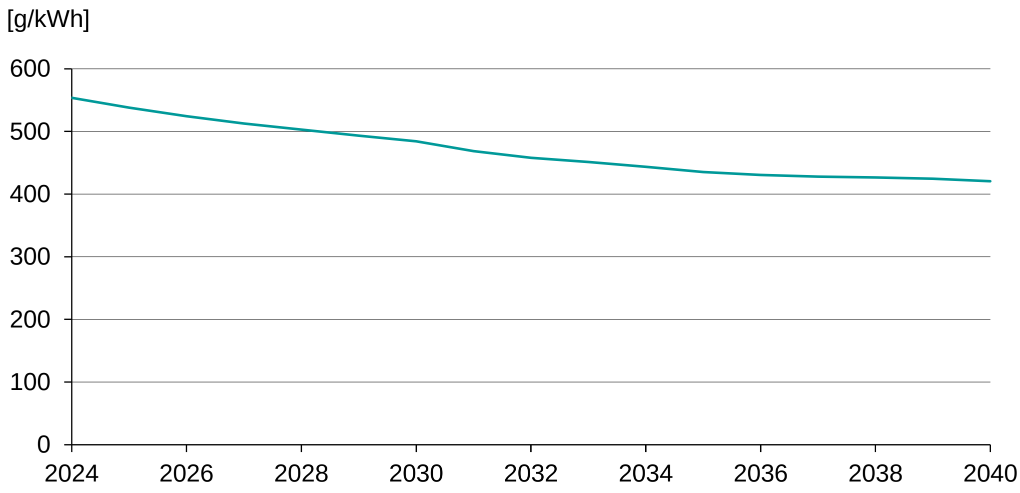


Figure 4-19: Peak load for basic consumption, e-mobility and generation in Tanzania (Siemens analysis)

68. The Policy Working Group notes that peak power issues are not an immediate concern due to the slow growth in EV numbers, particularly for 4W vehicles and buses, which are expected to adopt at a slower rate.

69. To manage load peaks effectively, best practices such as those implemented in Kenya could be considered. Kenya utilizes a time-of-use tariff system, offering special rates for EV charging during off-peak hours. In Tanzania, the current prepaid billing system and the ongoing rollout of smart meters by TANESCO are positive steps towards implementing similar time-of-use tariffs. Smart meters are particularly well-suited for this purpose as they enable more precise tracking of electricity usage and support the application of differential pricing based on time of use. This approach could help mitigate peak load challenges and support the sustainable integration of EVs into Tanzania's energy infrastructure.

70. In addition to generation capacity and power it is important to consider the electricity emission factor of Tanzania to effectively reduce future GHG emissions. The specific emissions of Tanzania’s electricity mix are visualized in Figure 4-20. Due to a stable outlook on gas-fired electricity generation, the emission factor only declines slightly, though significant renewable energy sources like Julius Nyerere Hydropower Station.



71.

Figure 4-20: Projection of the emission factor of Tanzania's electricity mix based on Power System Masterplan 2020 (Siemens Analysis)

72.

73. In parallel to generation capacity, there might be a need for expansion of transmission and distribution systems. Such bottlenecks are usually identified during expansion of load or generation assets and usually occur punctually or regionally. Identification and evaluation are done in specific power system studies.

4.3 Economic Feasibility

The economic feasibility study analyses investment requirements for different EV ramp-up scenarios. The focus is on expenditures in electric vehicles, electric vehicle supply equipment (EVSE), installation of EVSE and maintenance of EVSE. Based on that projection the government of Tanzania is enabled to consider investment capabilities in their selection of their EV ramp-up scenario by balancing investment requirements and emission reduction targets (see Figure 4-21).

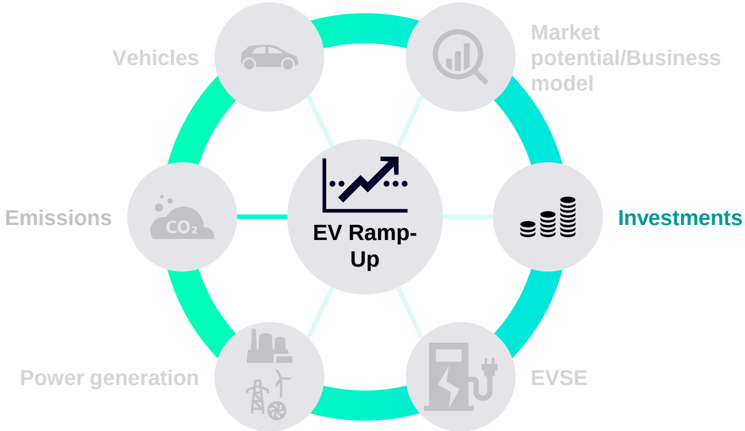


Figure 4-21: Investment requirements impacting economic feasibility of EV Ramp-Up

4.3.1 EV investment

74. In Tanzania, the market volume for EVs is as seen in Figure 4-22 expected to be predominantly driven by 4W passenger cars and minibuses due to their higher numbers and greater prices compared to 2W and 3W. In a scenario where the EV share increases by 4% annually across all vehicle categories, 4W passenger cars and minibuses are projected to dominate the market due to their significant numbers and higher cost.

75. For the purpose of this analysis, EV prices in Tanzania are modelled without accounting for inflation to maintain consistency and comparability across different periods. According to the Policy Working Group's assumptions, the prices of EVs are set as follows: 2W at $750, 3W at $1,500, 4W at $13,000, minibuses at $20,000, and buses at $50,000. These price points reflect the expected cost structure and affordability of EVs in Tanzania, influencing the market dynamics and adoption rates within different vehicle categories.

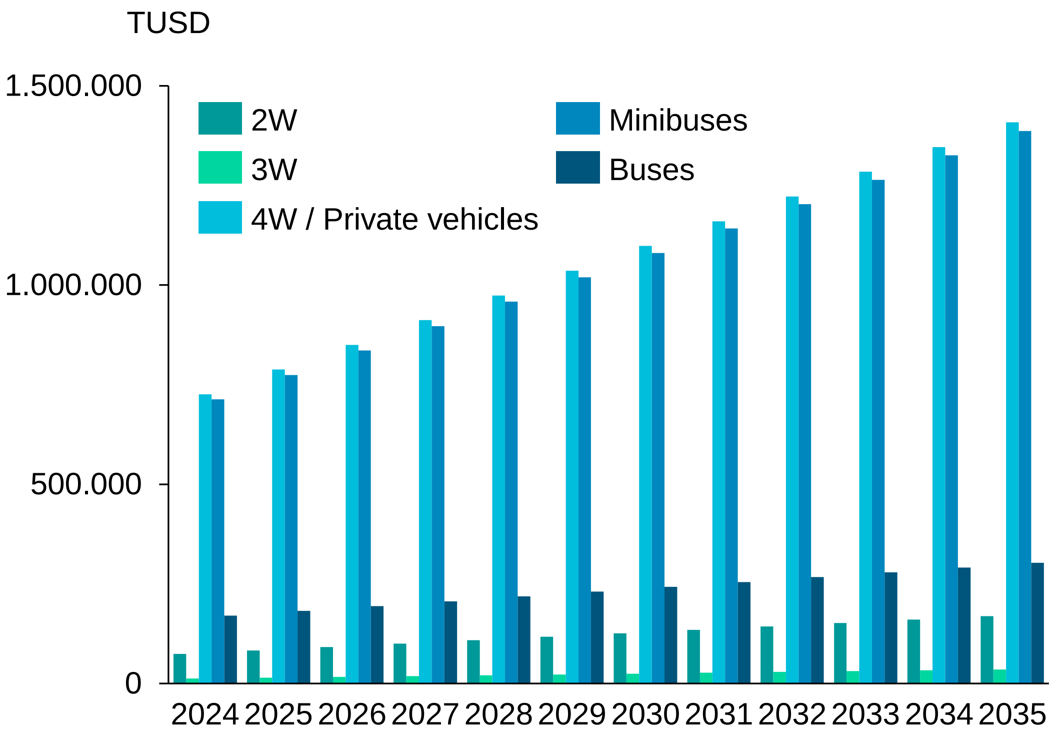


Figure 4-22: Potential EV market Volume for all vehicle groups in Scenario 4% in TUSD (Siemens analysis)

76. Given the lower purchasing power of households in Tanzania and the current availability of 4W and minibuses, it can be anticipated that the growth rate for these categories may be slower compared to 2W. However, international experience indicates that wealthier individuals are more likely to adopt EVs, which could drive higher demand among this segment despite the overall slower increase.

4.3.2 EVSE investment

77. The investment in EVSE is expected to be as illustrated in Figure 4-23 predominantly driven by public direct current (DC) charging points. The market volume for EVSE is determined by the number of installed chargers each year, as projected by the EV ramp-up model, and the associated costs.

78. For this analysis, EVSE prices are modelled without inflation to ensure comparability across different periods. The assumed prices are as follows: AC11 chargers at $2,000, DC50 chargers at $24,000, and DC100 chargers at $30,000. These price points reflect the expected investment requirements for installing various types of chargers and highlight the financial considerations involved in scaling up EV charging infrastructure.

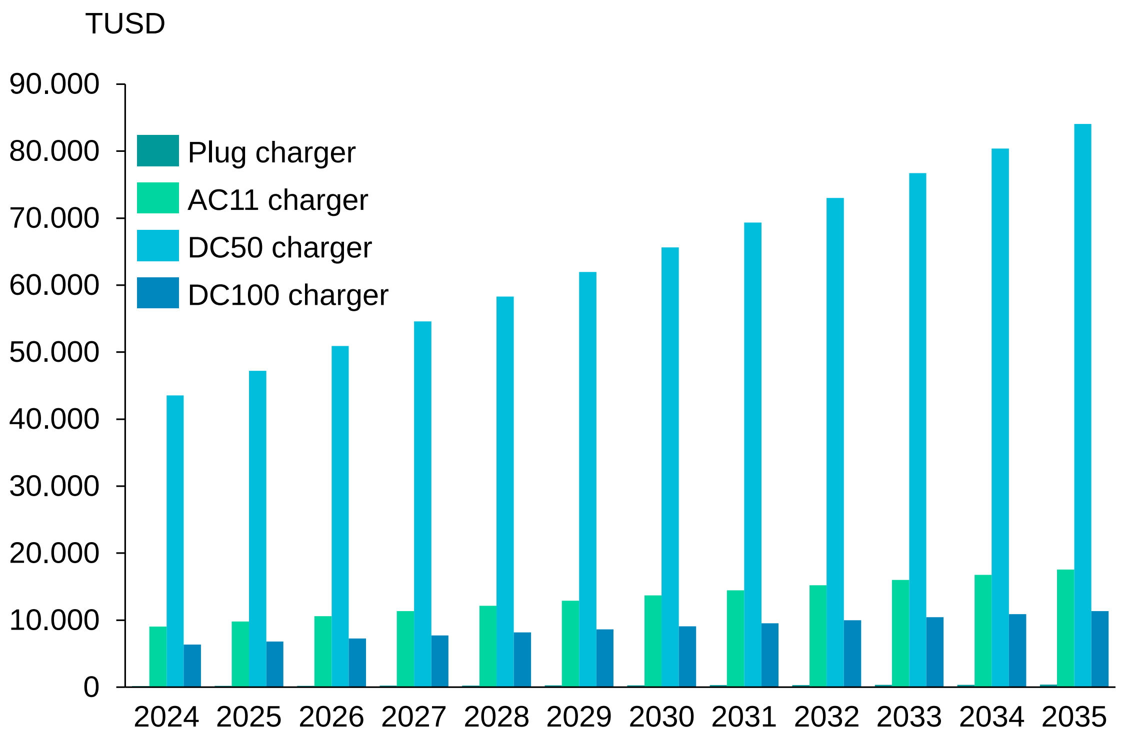


Figure 4-23: Potential EVSE market Volume for all vehicle groups in Scenario 4% in TUSD (Siemens analysis)

79. DC chargers are forecasted to dominate the market due to their higher prices compared to alternating current (AC) chargers or basic plugs. This higher cost reflects their advanced capabilities and faster charging times, which are crucial for certain use cases in public charging infrastructure.

80. The growth of the EVSE market will be influenced by potential incentives and policy innovations. For instance, provisions within the Electricity Act 2017 on financing electricity systems could play a significant role. Additionally, policy measures such as net metering could attract private sector investments, scaling up the deployment of charging infrastructure.

4.3.3 EVSE installation investment

81. The market volume for EV supply equipment installation is anticipated to grow in tandem with the increasing deployment of EVs. This market volume is based on several factors, including the installation effort, hourly labour rates, and the number of newly installed charging stations.

82. For installation work, the hourly rate is assumed to be $4 for wiring and commissioning of AC chargers, while the rate for DC chargers is higher at $5 per hour due to the more specialized skills required. These prices are modelled without accounting for inflation to ensure consistency and comparability across different periods.

83. As shown in Figure 4-24 in a scenario where the EV share increases by 6% annually, it is projected that EVs will make up 100% of the vehicle market by 2041. After this point, the installation of new charging points is expected to plateau, as the need for new chargers will shift from substituting petrol vehicles to accommodating the growth in population and motorization. Consequently, the market volume for EVSE installations will no longer be driven by the

transition from ICE vehicles but by the increasing demand from new EV users and expanding infrastructure needs.

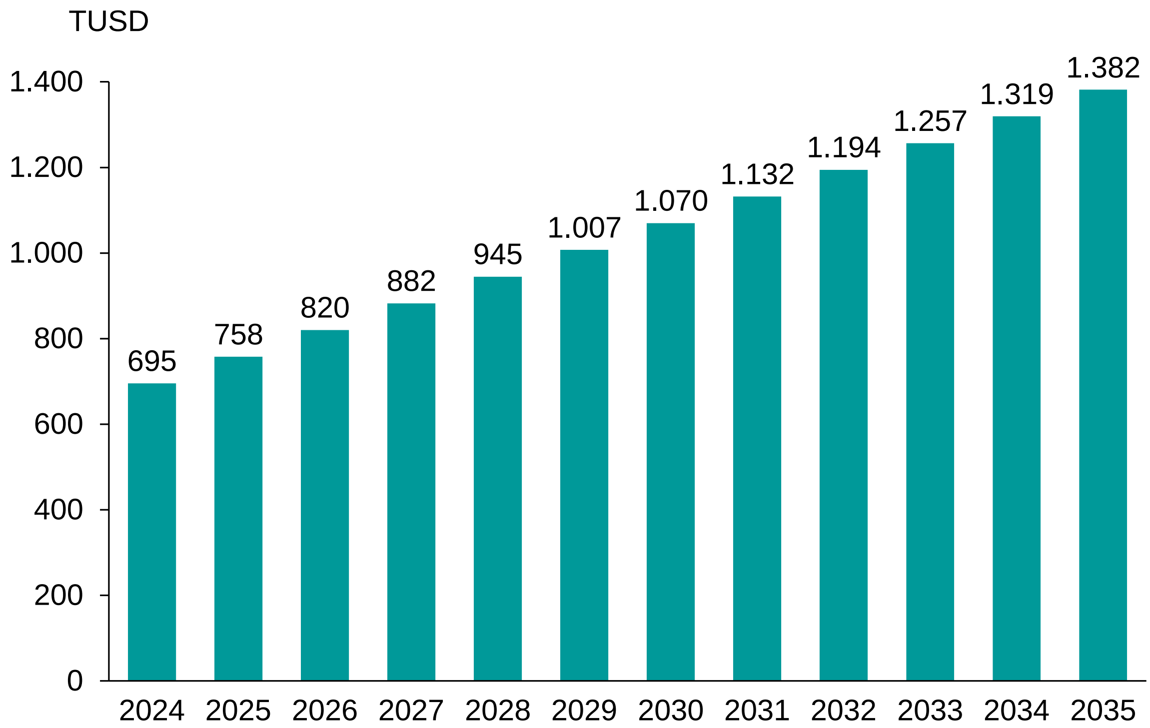


Figure 4-24: Potential EVSE Installation Market Volume in for all vehicle groups in Scenario 4% in TUSD (Siemens analysis)

4.3.4 EVSE maintenance expenditures

84. The market for EVSE maintenance, while in the beginning smaller in scale compared to the installation market, represents a stable, long-term recurring business. From 2028 on maintenance might overcompensate installation, because of the number of installed charging stations. The maintenance market is influenced by factors like those affecting installation, including the number of installed charging stations, installation effort, and hourly labor rates.

85. For maintenance, the hourly rate is set at $4 for AC chargers and $5 for DC chargers, reflecting the more specialized skills required for DC charger upkeep. These rates are designed to cover the ongoing costs associated with maintaining EVSE infrastructure.

86. As seen in Figure 4-25 in a scenario where the EV share increases by 6% annually, the market will see its peak when EVs reach 100% of the vehicle share by 2041. Beyond this point, the demand for new charging points will primarily be driven by increases in population and motorization, rather than by the replacement of petrol vehicles. Consequently, while the initial market growth for EVSE maintenance will align with the expansion of charging infrastructure, long-term demand will remain steady due to the ongoing need for maintenance services as the installed base of chargers continues to operate.

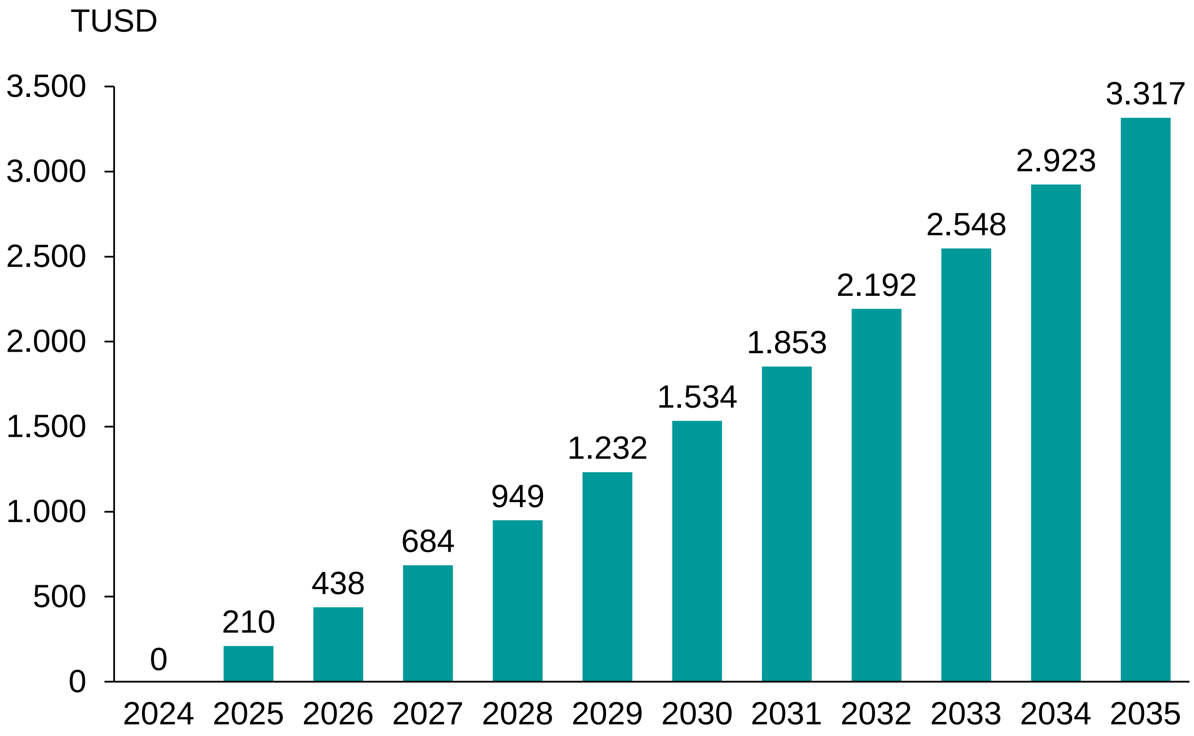


Figure 4-25: Potential EVSE Maintenance Market Volume in for all vehicle groups in Scenario 4% in TUSD (Siemens analysis)

5 Local Implementation Framework

87. Considering Dar es Salaam, Dodoma, and Mwanza, each city presents unique opportunities and challenges for the adoption of EVs. While these cities share some similarities, their distinct social, economic, and technical characteristics directly influence their respective paths toward EV integration.

88. Addressing the specific needs and leveraging the unique characteristics of each city will be crucial for the successful ramp-up of EVs across Tanzania. Tailoring strategies to the individual contexts of Dar es Salaam, Mwanza, and Dodoma will ensure a more effective and inclusive transition to electric mobility.

89. In this section, the objective is to understand the factors influencing EV ramp-up for each city by examining as seen in Figure 5-1 the current population growth, motorization rate and emissions of each city as we have previously established that these factors are indicative of EV ramp-up. Additionally, driving factors as well as potential challenges will also be considered. Finally, business models and reflections for each city's modes of transport will be covered.

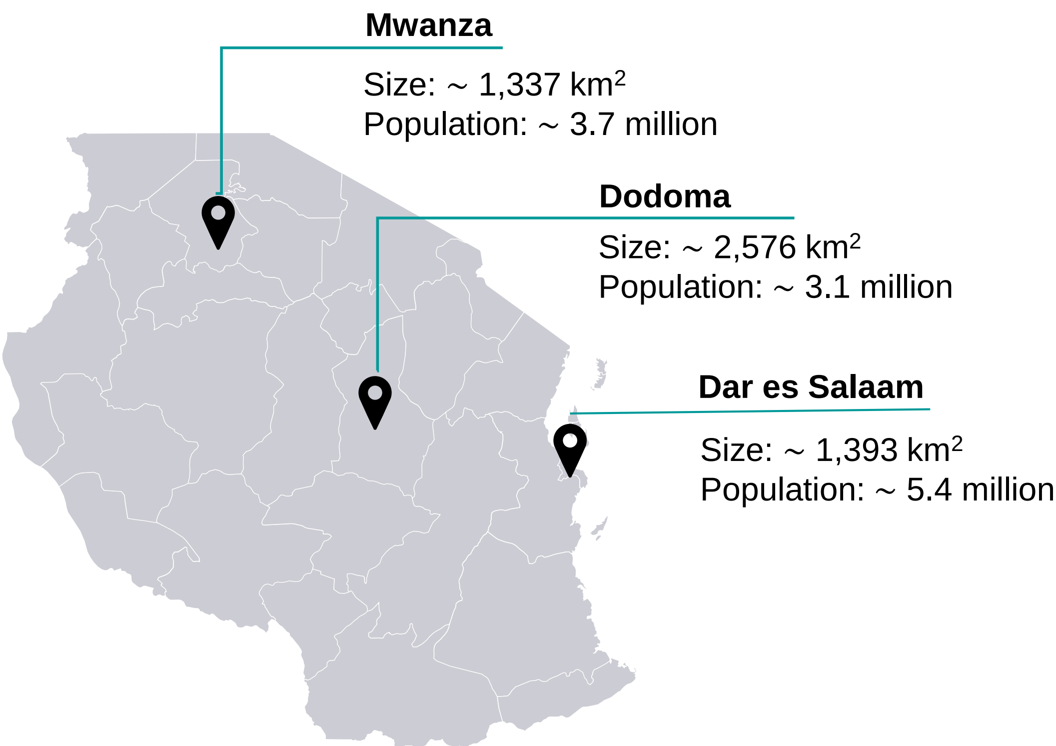


Figure 5-1: Tanzania Country Map, Three Cities Overview[34]

[34] National Bureau of Statistics report, 2022 (own illustration)

5.1 Local business models

90. Active and accessible markets are crucial to ensure that low-cost technologies and services with competitive features are available in Tanzania and its three focus cities Dodoma, Dar es Salaam. This category analyzes the different stakeholders that are involved in the installation, operationalization of EV charging infrastructure both for private and public users to break it down to local level and adapt it to local requirements. They cover the electrical grid and asset operators, Electrical Vehicle Supply Equipment (EVSE), Installers of charging infrastructure components, owners of different sites where EV charging infrastructure can be installed, Charge Point Operators (CPOs) and Mobility Service Providers (MSPs). This scheme can be applied for all three target cities Dodoma, Dar es Salaam and Mwanza in varying role models and constellations.

91. Figure 5-2 shows the EV value chain in its current state. The diagram outlines that required roles in e-mobility are not yet occupied.

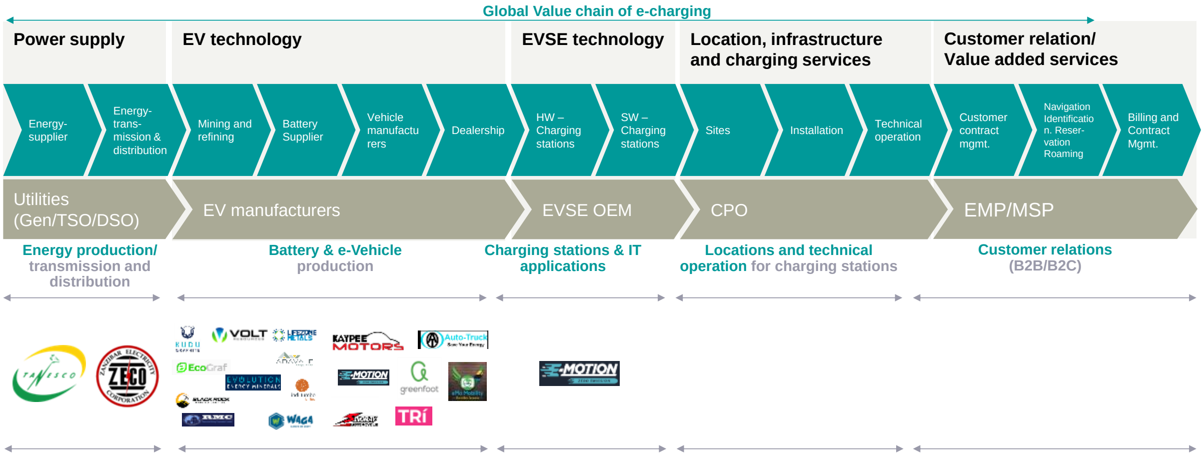


Figure 5-2: Five e-charging infrastructure business models (Siemens analysis)

5.1.1 Business models overview

92. The introduction of e-mobility in Tanzania will lead as illustrated in Figure 5-3 to the emergence of various business models, depending on the country's EV strategy and the organization of roles within the sector. Two key roles exist within this ecosystem, each with distinct responsibilities and contributions to the EV market:

93. **Charge Point Operator (CPO)**:

94. **Hardware Procurement and Installation**: The CPO is responsible for sourcing and installing charging station hardware from various vendors. This role involves selecting suitable technology and managing the physical setup of charging infrastructure.

95. **Operational Management**: The CPO oversees the daily operations of charging stations, including access management, payment processing, and customer support. This ensures that users have convenient and reliable access to EV charging services.

96. **Maintenance Coordination**: To ensure that charging stations remain operational and effective, the CPO coordinates maintenance activities. This includes routine checks and repairs to provide consistent access to charging facilities.

97. **Mobility Service Provider (MSP)**:

98. **Customer Offerings and Add-ons**: The MSP enhances the EV ownership experience by offering a range of services and add-ons, such as vehicle sharing options. These services are designed to add value and convenience for EV users.

99. **Seamless Charging Access**: MSPs facilitate seamless access to charging stations across different vendors. They integrate various charging networks into their service offerings, often through mobile applications, to provide a unified experience for users.

100. **Service Agreements and Applications**: Services are typically delivered through mobile apps, which allow users to easily locate and access charging points. MSPs also establish service agreements with multiple service providers to ensure comprehensive coverage and integration.

101. The choice between different business models and the organization of these roles will significantly influence the development of Tanzania's e-mobility sector. By understanding and implementing these roles effectively, Tanzania can create a robust infrastructure that supports the growth of electric transportation and meets the needs of its users.

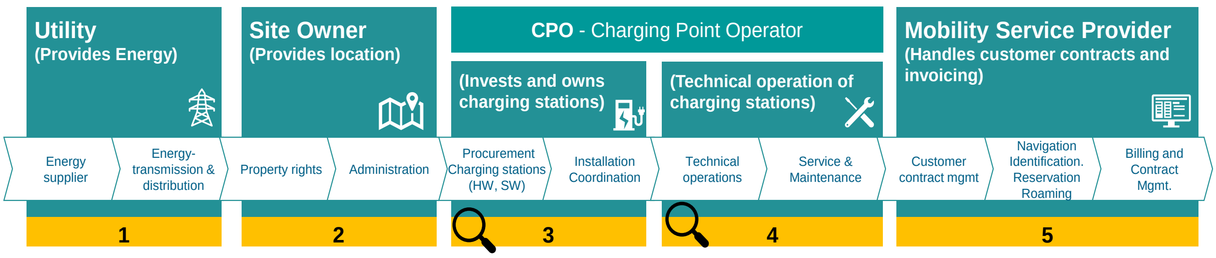


Figure 5-3: EV Charging Value Chain (Siemens analysis)

5.1.2 CPO business model in Tanzania

102. The role of a CPO is critical in the technical implementation and operation of these charging stations. While CPOs are responsible for setting up and maintaining the charging infrastructure, they do not directly provide electricity to EV users; this function is managed by MSPs.

103. The financial dynamics of the CPO market are influenced by the costs associated with charging stations, installation, and maintenance. DC chargers, given their more advanced and complex technology, typically generate higher operational margins compared to AC chargers. This is due to the higher costs and value associated with the rapid charging capabilities of DC technology. Public charging infrastructure with DC charging stations offers as shown in Figure 5-4 the highest returns for CPOs.

104. Revenue for CPOs is primarily derived from service fees charged per kilowatt-hour or per charging session. These fees are paid by MSPs, who, in turn, factor these costs into their pricing

models for end customers and EV drivers. As a result, the cost structure for the CPO is integrated into the broader pricing strategy of the MSP.

105. The average yearly revenue for charge point operation of an AC 11kW charge point is assumed with $140, whereas a DC50 charge point with $1,500 per year. This significant difference underscores the higher returns associated with DC charging infrastructure. The higher returns compensate the higher level of investment for EVSE and in some cases for additional investment in grid connection. This makes it a lucrative area for CPOs within the evolving e-mobility sector.

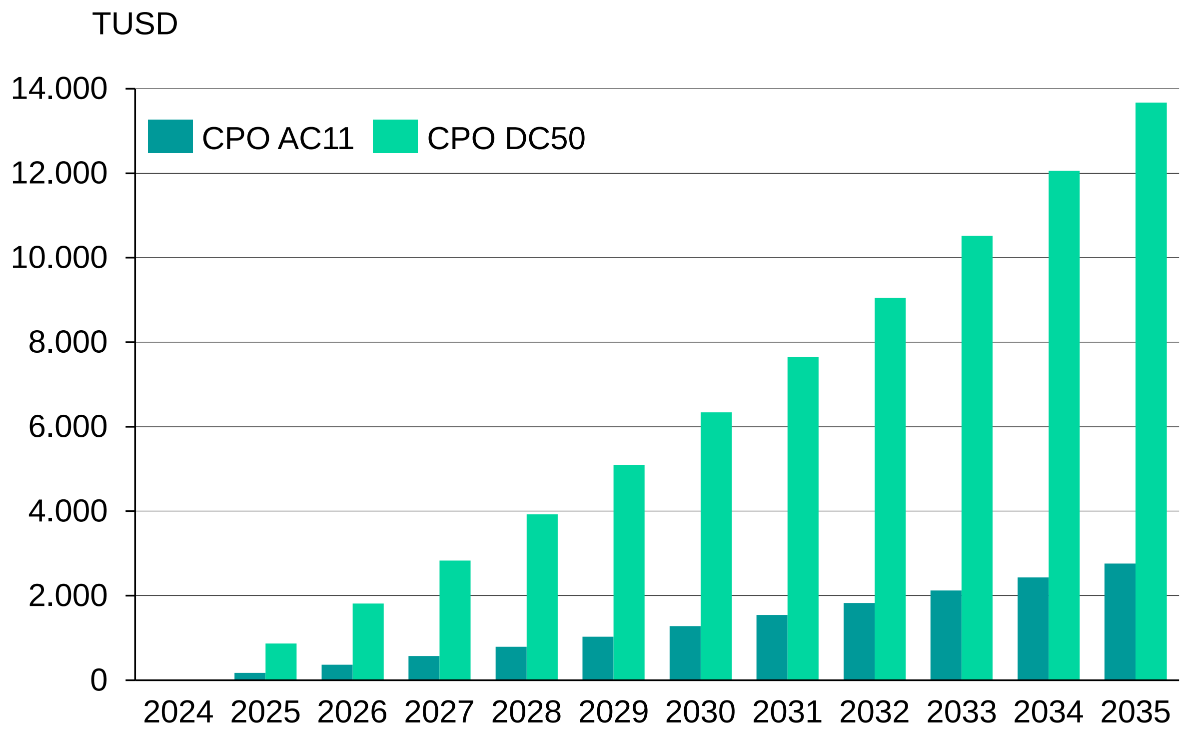


Figure 5-4: Potential Return (EBIT) of the CPO Business Models for AC 11kW and DC 50kW charging stations in Scenario 4% in TUSD (Siemens analysis)

106. The business model for a CPO is as illustrated in Figure 5-5 characterized by high capital expenditure (CAPEX) and relatively low operational expenditure (OPEX). This model is primarily driven by the substantial initial investment required for hardware procurement and installation. The CAPEX includes the costs of purchasing and implementing charging infrastructure, such as DC chargers, which are more expensive due to their advanced technology.

107. OPEX for a CPO, on the other hand, are lower and typically encompass ongoing maintenance and repair of the charging stations. The revenue for a CPO is generated through service fees charged per kilowatt-hour or per charging session. These fees are paid by MSPs, who incorporate these costs into their pricing for end users.

108. The financial streams for the CPO market in Tanzania, particularly for AC charging, are influenced by scenarios such as a 4% annual increase in the share of EVs, which could be considered an ambitious growth rate. The market design for CPOs could vary, ranging from a monopoly model with a single public or private player to a competitive market structure. For instance, Rwanda has opted for a competitive market approach for CPOs, which may serve as a model for Tanzania's market development.

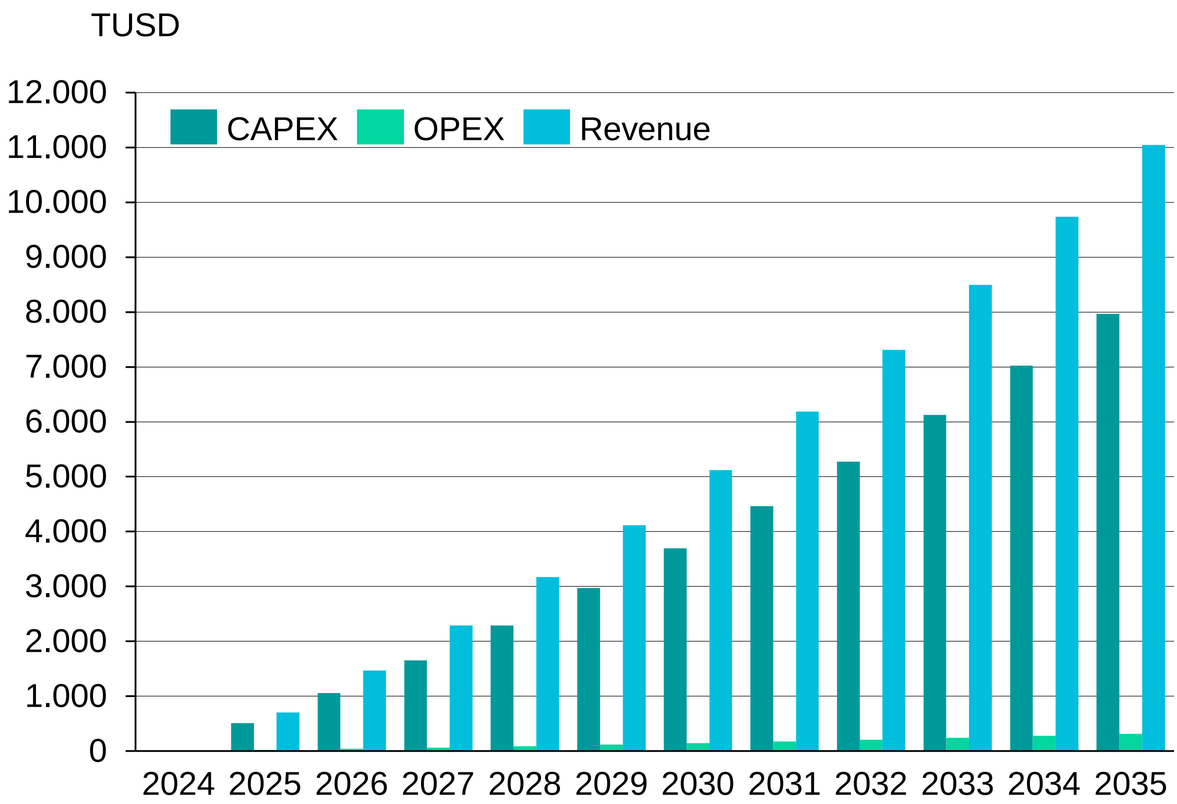


Figure 5-5: CAPEX, OPEX and Revenue of the CPO Business Model for AC 11kW chargers in Scenario 4% in TUSD (Siemens analysis)

5.1.3 MSP business model in Tanzania

109. The business model of a MSP is characterized by high OPEX, primarily due to the costs associated with electricity procurement. The MSP plays a crucial role in setting and managing EV charging tariffs at public charging points.

110. Key components of the MSP business model include the costs of charge point usage, electricity procurement, billing processes, and marketing efforts directed at end customers. The financial returns for an MSP are as shown in Figure 5-6 driven by the profit margins between the cost of electricity procurement and the retail price charged to EV users.

111. Estimates suggest that the cost of electricity procurement is around $0.08 per kilowatt-hour. In comparison, the retail prices for charging vary: $0.13 per kWh for general plug-in chargers, $0.17 per kWh for AC11 charging stations, and $0.32 per kWh for DC50 chargers. Given these

prices, the highest returns are anticipated from public DC chargers, due to their ability to handle larger volumes of electricity, which enhances profitability through higher margins per unit of electricity sold.

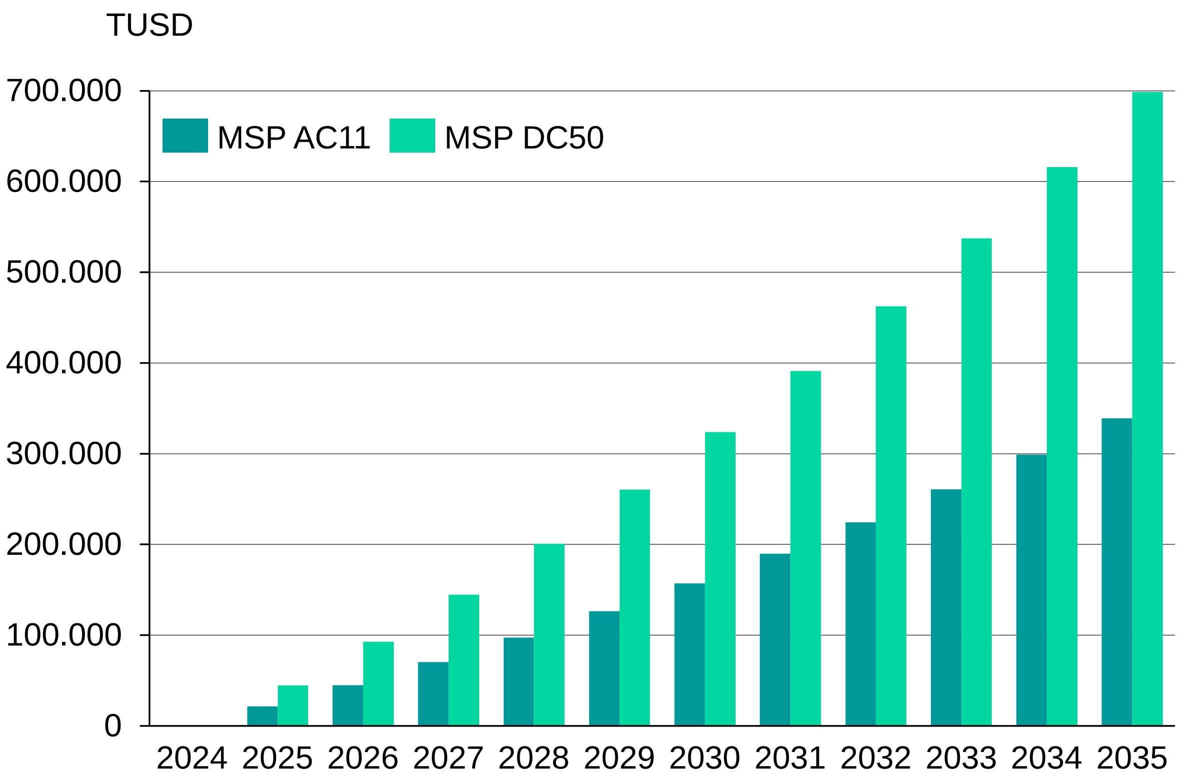


Figure 5-6: Potential Return (EBIT) of the MSP Business Models for AC 11kW and DC 50kW charging stations in Scenario 4% in TUSD (Siemens analysis)

112. The financial model for MSPs reveals as seen in Figure 5-7 a trend of exponentially increasing revenues, tempered by significantly high and rising OPEX. This trend is illustrated in the estimated financial streams for the MSP market in Tanzania, particularly for AC charging, under a scenario with a 4% annual increase in the share of EVs, which is considered a progressive growth rate.

113. For MSPs, CAPEX is minimal and generally pertains to IT infrastructure and software required for managing billing and customer interactions. However, the majority of costs are attributed to OPEX, which includes substantial expenditures on electricity procurement, fees paid to CPOs, and labor costs for servicing and maintaining operations. These ongoing operational costs can significantly impact profitability, despite the increasing revenues generated from electricity retail at charging stations.

114. The market structure for MSPs could vary between a monopoly, with a single public or private entity managing all aspects, or a competitive market with multiple players. In many leading e-mobility markets, a competitive model has been adopted, drawing from practices in household

electricity retail. This approach may offer insights and best practices for Tanzania as it navigates the development of its e-mobility sector.

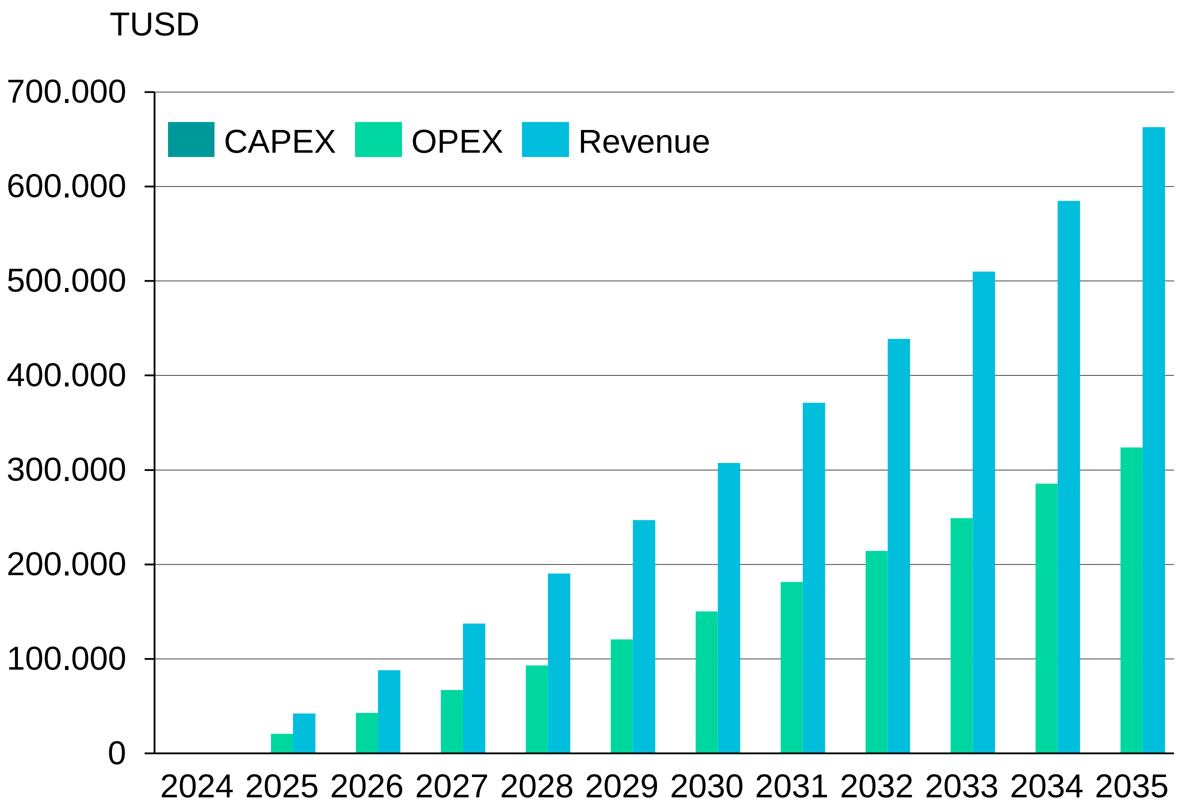


Figure 5-7: CAPEX, OPEX and Revenue of the MSP Business Model for AC 11kW chargers in Scenario 4% in TUSD (Siemens analysis)

5.2 Dodoma

115. Dodoma, as the capital city, benefits from ongoing development and supportive government initiatives aimed at fostering sustainable practices. This positioning offers a favourable environment for future EV integration, particularly as infrastructure improvements and policy frameworks evolve to support greener transportation solutions.

5.2.1 Overview

116. The city is experiencing rapid population growth, with an annual increase of about 3.9%[35]. This growth, coupled with the city's status as the political and administrative capital of Tanzania, is driving significant changes in motorization rates. Although the motorization rate in Dodoma is currently lower than in Dar es Salaam, it is on the rise due to the government's relocation to

[35] Tanzania National Bureau of Statistics, 2022

the city. This relocation is not only boosting the population but also increasing the number of vehicles on the roads.

117. Despite having lower GHG emissions compared to Dar es Salaam, Dodoma is witnessing a rise in GHG emissions due to the growing population and vehicle numbers. The average income in Dodoma is less than that in Dar es Salaam, but it is gradually increasing. The city's ongoing infrastructure projects are essential to support this growth, although Dodoma faces challenges such as developing infrastructure and having less commercial activity compared to Dar es Salaam.

118. Traffic congestion is a significant issue, with roads and public spaces being heavily occupied by motorized traffic, accounting for up to 94% of the space, despite representing only 30% of travelers using private vehicles. During peak hours, travel speeds slow down considerably, and this problem is expected to worsen as the number of cars on the road increases more rapidly than road capacity. Private minibuses, which are widely used, contribute the most to CO_2 emissions among motorized vehicles due to their large numbers and high specific fuel consumption. The quality of service provided by daladalas could be better, particularly in terms of convenience and schedule reliability, leading to a shift towards private vehicles as people's incomes increase and they seek better quality transportation. However, the privately owned minibuses, often operated by small businesses, are difficult to replace. These operators face challenges such as low-profit margins, limited access to bank financing, and the need for new expertise and access to charging infrastructure. Critical locations like central daladala terminals are often overloaded, exacerbating congestion issues. Road safety is also a significant concern, with a high rate of fatalities, particularly among vulnerable populations. Furthermore, there is a considerable gender gap in access to mobility, adding to the complexity of the challenges faced in this sector.

119. The need for strategic measures to address the challenges in transport and mobility must be emphasized. Firstly, there is a pressing need to slow down the increase in private vehicle ownership to mitigate congestion and its associated issues. This can be achieved by redistributing road spaces to accommodate a larger group of travellers, encouraging the use of alternative modes of transportation. Making public transport affordable and attractive to different social classes is crucial to reducing the reliance on private vehicles. A significant shift from independently operated daladalas to a more organized and publicly managed transport system is also required. Additionally, developing expertise in planning electrified bus routes is essential to ensure a smooth transition to more sustainable transportation options. This includes the need to build expertise in the planning and implementing charging infrastructure to support the growing demand for electric vehicles and buses.

120. The need for strategic measures to address the challenges in transport and mobility must be emphasized. Firstly, there is a pressing need to slow down the increase in private vehicle ownership to mitigate congestion and its associated issues. This can be achieved by redistributing road spaces to accommodate a larger group of travellers, encouraging the use of alternative modes of transportation. Making public transport affordable and attractive to different social classes is crucial to reducing the reliance on private vehicles. A significant shift from independently operated daladalas to a more organized and publicly managed transport system is

also required. Additionally, developing expertise in planning electrified bus routes is essential to ensure a smooth transition to more sustainable transportation options. This includes the need to build expertise in the planning and implementing charging infrastructure to support the growing demand for electric vehicles and buses.

5.2.2 EV Ramp-Up

Based on development of its population the vehicle development in Dodoma is projected as in Figure 5-8.

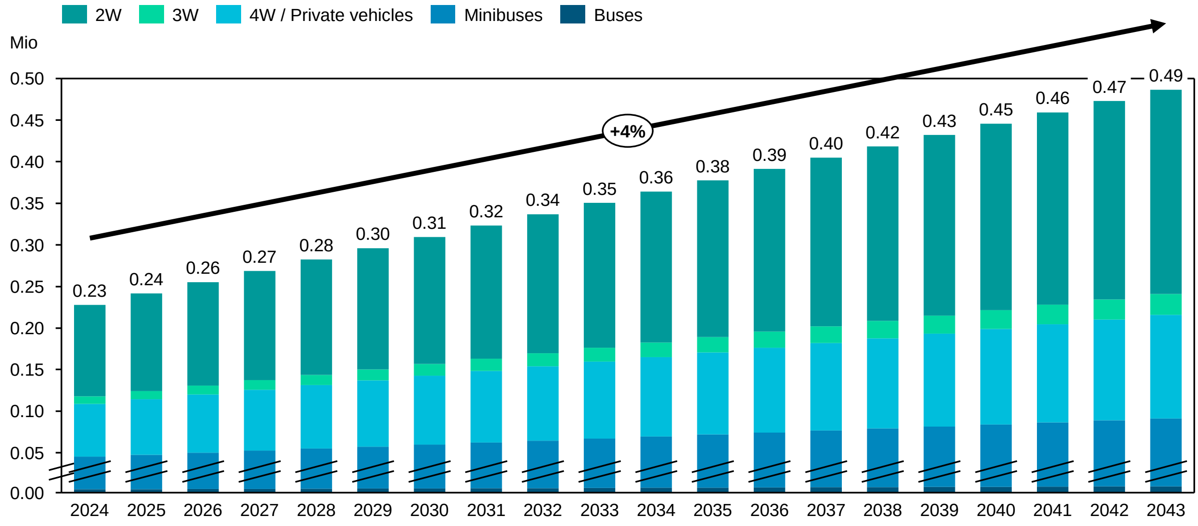


Figure 5-8: Development of Vehicle Stock in Dodoma (Siemens analysis)

Based on the expected development of vehicles, the EV ramp-up can be projected according to Figure 5-9. The scenarios 0%, 2%, 4% and 6% describe a yearly increase of EV share among total vehicle stock.

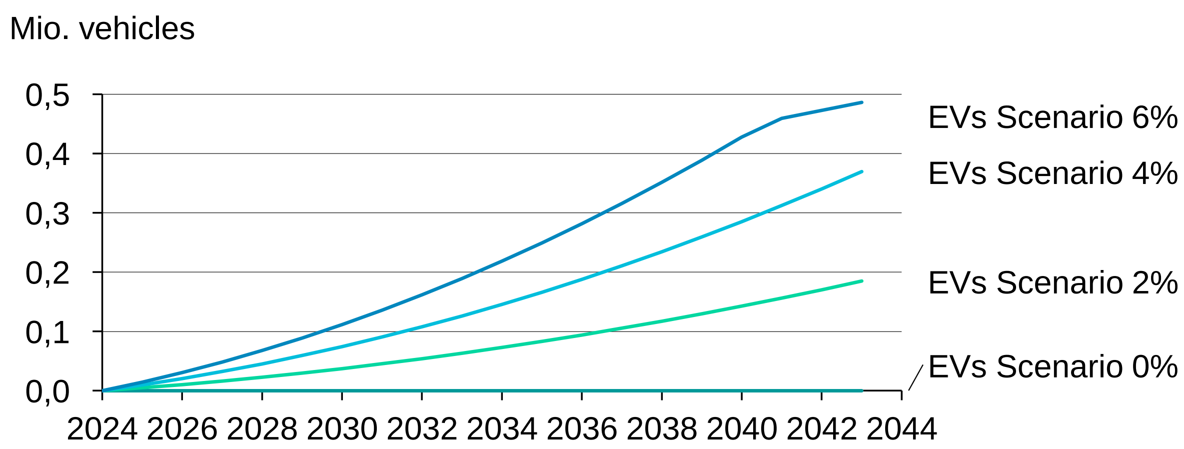


Figure 5-9: Number of EVs in Dodoma in four different assumed scenarios (Siemens analysis)

5.2.3 Implementation of National EV Framework

121. Table 5-1 gives an overview of recommended actions for local EV implementation in Dodoma.

Table 5-1: EV implementation actions for Dodoma

Action	Within years	Type of action	Lead
Integrate e-mobility into city and urban transport plans	2,5	Regulation	City Council
Build capacity on electrification of bus routes on all academic levels	2,5	Capacity building	City Council
Pilot project on bus depot of electric buses	2,5	Capacity building	City Council
Incentivize 2W against 4W/passenger cars	2,5	Incentive	City Council
Integrate EV charging stations in the DSO grid code	2,5	Regulation	EWURA
Establish TANESCO as an end-to-end (E2E) integrator responsible for sourcing, installing, and operating charging stations of all power levels.	5	Regulation	EWURA
Establish TANESCO as a mobility service provider offering electricity at public charging stations in charging tariffs to ev drivers	5	Regulation	EWURA
Build capacity in the DSO planning entity on determining available hosting capacity for EV chargers	5	Capacity building	EWURA
Increase number of depots and routes for electric buses	5	Infrastructure	City Council
Update grid and substations around bus depots	5	Infrastructure	City Council
Install rooftop PV on large rooftops around bus depots and evaluate BESS	5	Infrastructure	City Council
Introduce offerings for public buses with different quality and price; but with general	5	Infrastructure	City Council

competitive prices to push daladalas out the market; product differentiation for example in space, seats, security, speed, frequency			
Ban daladalas stepwise from routes of electric buses	10	Regulation	City Council
Establish competitive markets for charge point operators and mobility service providers	10	Regulation	City Council/ EWURA

There should be a focus on building capacity in critical areas of the electrification of public transport. First, it is essential to develop expertise in planning bus routes tailored explicitly for electric buses, as these vehicles have different operational requirements than traditional diesel buses. The differences include shorter travel distances per charge, longer charging times, and a higher sensitivity of energy consumption to warm climates. Additionally, in regions with limited electricity grid supply, load management activities may be necessary to ensure service reliability. A practical step towards this goal would be the implementation of a pilot site that features bus routes for electric buses, with a dedicated depot linked to university and vocational training facilities. This pilot site would serve as a training ground for staff to gain hands-on experience planning and operating electric bus routes. It is crucial to ensure that gender equality is considered in the educational and training offerings, providing equal opportunities for all individuals to participate and contribute to developing sustainable transportation systems.

122. Specific actions to scale the adoption of electric buses should include a thorough evaluation and prioritization of all key bus routes based on their suitability for electric buses and the associated transition costs. This assessment will help identify which routes are most feasible for electrification in terms of operational efficiency and financial viability. Following this evaluation, a detailed transition roadmap outlining the steps necessary to electrify bus routes and depots should be developed. This roadmap should also include plans for upgrading the energy infrastructure to support the increased demand for electricity. An investment plan must be created alongside this roadmap to secure the necessary funding and ensure the smooth implementation of the electrification process.

123. Furthermore, it is crucial to incorporate updates on bus routes into broader city planning and energy system planning strategies. This ensures that transportation developments are aligned with urban growth and energy availability. Additionally, options should be created for independent daladala operators to transition into working within the public transport system or to organize themselves into more extensive networks. These networks offer significant benefits, such as access to financing for electric buses, shared charging infrastructure, and centralized planning and scheduling of bus routes. To make public transport appealing to a broader demographic, it is essential to differentiate offerings by quality and price. This approach would cater to individuals with varying income levels, including those with lower, middle, and higher incomes. Finally, the introduction of no-emission zones in areas with highly congested traffic should be initiated. These zones would help reduce pollution in the most crowded spots, promoting cleaner air and a healthier urban environment.

124. The realization of charge point operation and electricity retail on charge points should develop in three steps. Short-term, establish TANESCO as an end-to-end (E2E) integrator responsible for sourcing, installing, and operating charging stations of all power levels. TANESCO would also provide electricity directly to end customers, ensuring a streamlined and efficient service from the initial setup to the ongoing operation of the charging infrastructure. Mid-term, develop and implement regulations governing the market for commercial charge point operators. These regulations should focus on establishing technical standards and ensuring IT interoperability, which is crucial for smoothly integrating various charging systems and services across the market. Long-term, align the market structure for the supply of charging electricity, particularly by mobility service providers, with the existing market structure for electricity retail in non-transport applications. This alignment will create a cohesive and well-regulated framework, ensuring consistency and reliability across all sectors of electricity usage.

5.2.4 Investment and financing

Especially larger vehicles like 4W (passenger cars), minibuses and buses need charging stations with higher rated power output, typically between 11kW and 100kW. The ramp-up of EVs will significantly increase capital demand for installing and operating charging stations (see Figure 5-10 and Figure 5-11).

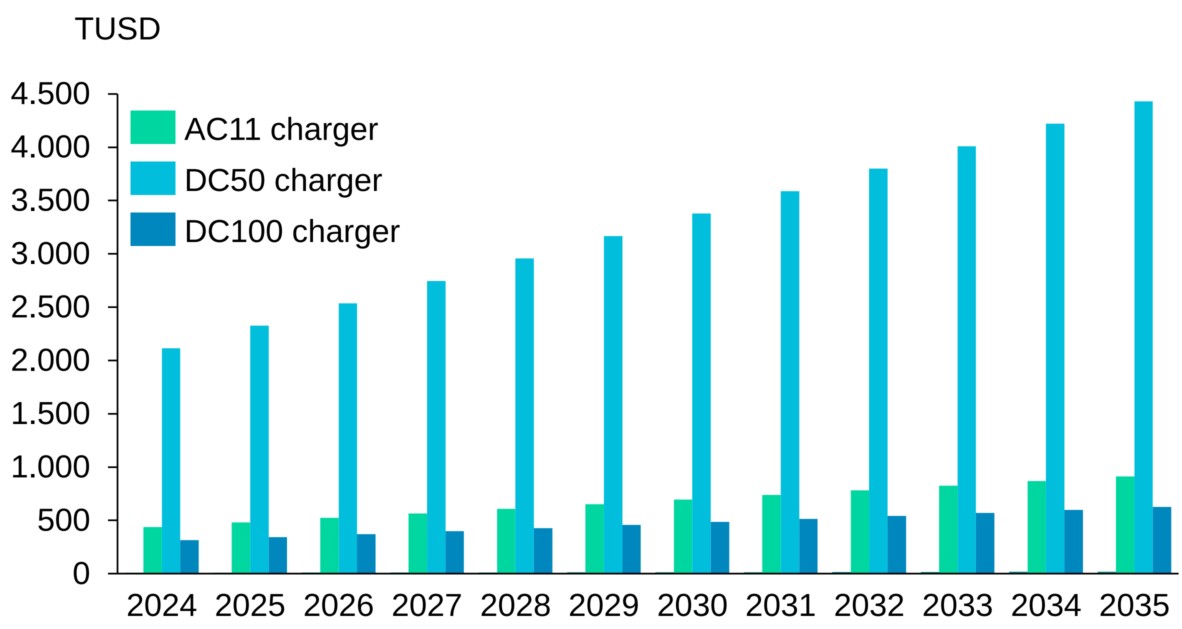


Figure 5-10: Potential investment in charging stations in Dodoma from 2024-2035 in a scenario with assumed 4% increased yearly EV share (Siemens analysis)

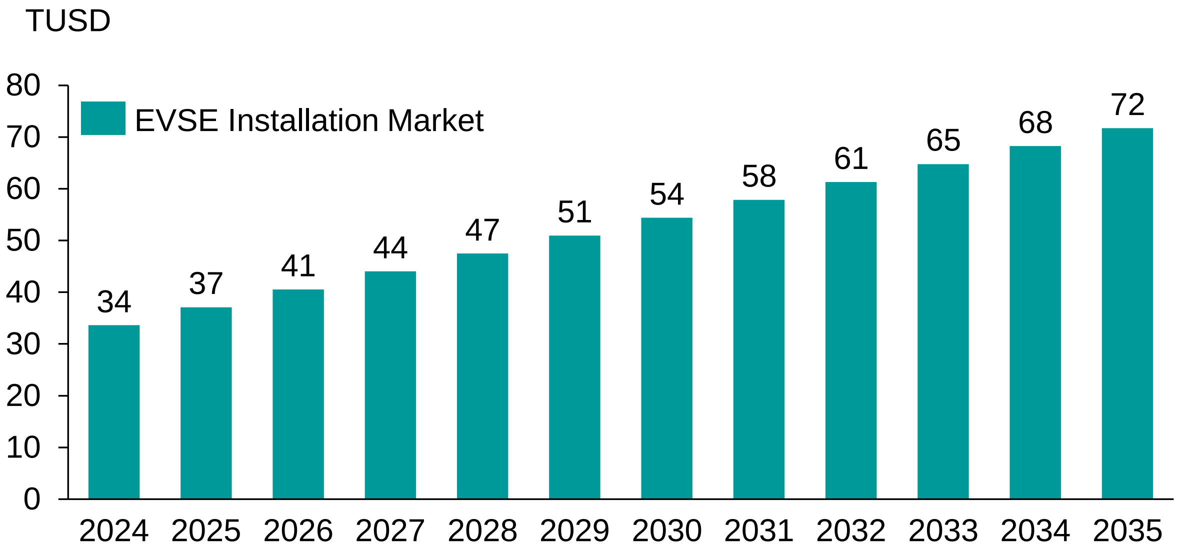
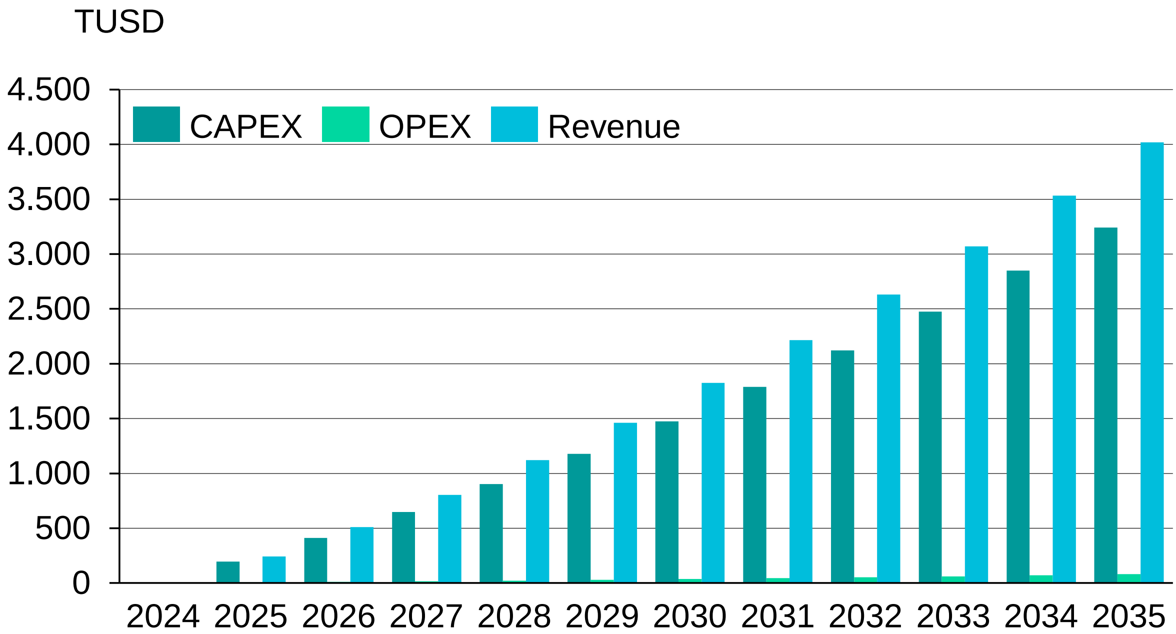


Figure 5-11: Potential investment for installation of charging stations in Dodoma from 2024-2035 in a scenario with assumed 4% increased yearly EV share (Siemens analysis)

125. While this investment is substantial, it is expected to be covered by future revenues and to offer reasonable returns on investment, making it attractive for private sector participation. The financial model for a CPO business on DC charging stations with 50kW power output is shown in Figure 5-12.

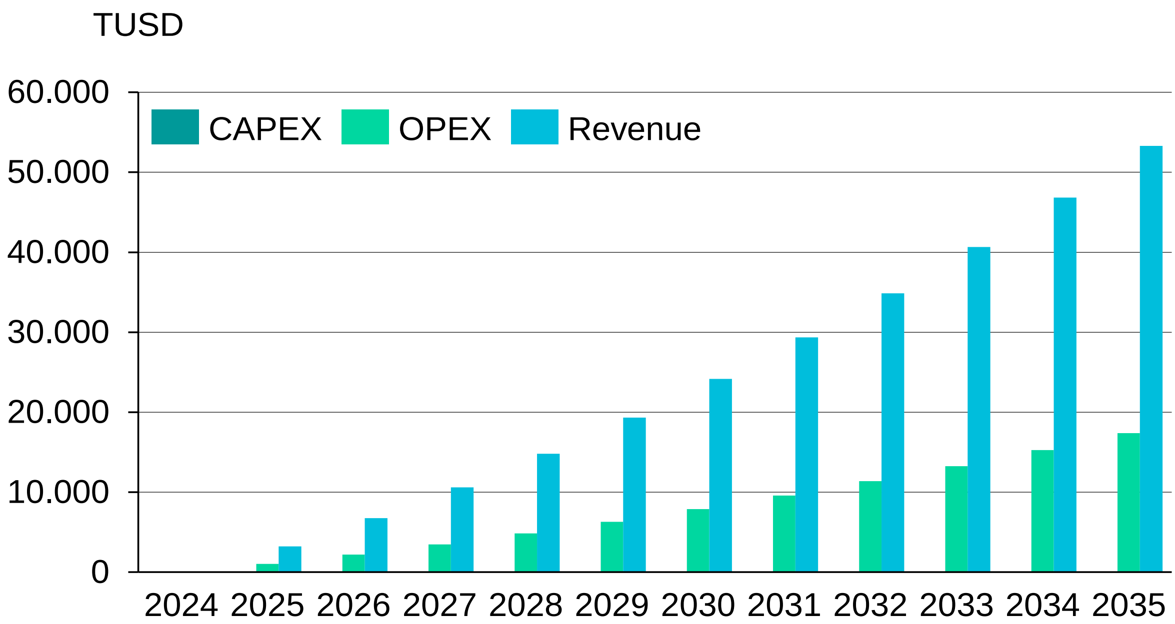


126.

Figure 5-12: Financial model of the CPO Business Models for DC 50kW charging stations in Dodoma in Scenario 4% in TUSD[36] (Siemens analysis)

[36] assumptions: DC50 charge point: 12TUSD, installation: 20hrs, yearly maintenance 5hrs, compensation: 5USD/hr, yearly revenue per charging station: 1,5TUSD

127. The respective financial model for MSP business is shown in Figure 5-13.



128.

Figure 5-13: Financial model of the MSP Business Models for DC 50kW charging stations in Dodoma in Scenario 4% in TUSD[37] (Siemens analysis)

129. However, capacity building is an essential component that does not generate direct revenues and will need to be financed by the public sector. The public sector could seek additional funding from non-governmental organizations and international financial institutions to support this effort. The charging infrastructure and electricity supply should be primarily provided by TANESCO, with initial financing potentially sourced from development banks. To sustain and expand this infrastructure, further investment could be facilitated by establishing a joint venture or, in the mid-term, by opening the market through a concessionaire model. This approach would allow for increased private sector involvement while maintaining oversight and strategic direction by the public sector.

5.3 Dar es Salaam

130. Dar es Salaam, with its existing infrastructure and robust economic status, stands out as a prime candidate for early EV adoption. However, the city faces challenges related to congestion and pollution that must be addressed to facilitate a smooth transition to electric mobility. Enhancing public transportation and developing EV-friendly infrastructure could play key roles in mitigating these issues.

131. Dar es Salaam is witnessing a swift population increase, with an annual growth rate of approximately 2.1%[38]. As the primary commercial and industrial hub, the city attracts a significant influx of people, which contributes to its high motorization rate. The prevalence of private

[37] assumptions: electricity buy: 0,08 USD/kWh, electricity sell: 0,32USD/kWh, yearly CPO fee per charge point: 1500USD, yearly process cost per charge point: 12USD
[38] Tanzania National Bureau of Statistics, 2022

vehicles, coupled with traffic congestion and industrial activities, leads to the highest emission levels among the three cities.

132. The average income in Dar es Salaam is relatively higher, reflecting its economic prominence. The city benefits from well-developed road networks and public transportation systems, although these are often strained. Key challenges include managing traffic congestion, pollution, and the limited space available for expansion. These factors are critical when considering the integration of EVs into Dar es Salaam's transportation framework

5.3.1 Overview

133. Traffic volumes have surged along major routes such as Bagamoyo Road and Nyerere Road. Travel speeds during peak hours are significantly reduced, and this issue is expected to worsen as the number of vehicles continues to outpace road capacity. The situation is further exacerbated by ongoing construction projects like the Tazara fly-over, which are contributing to additional delays. Private minibuses are a significant source of CO^2 emissions among motorized vehicles, mainly due to their sheer numbers and high specific fuel consumption. The quality of service that daladalas provide could be better, particularly in terms of convenience and schedule reliability. As incomes rise, more people are shifting to private vehicles in search of better-quality transportation, which further strains the road network. Replacing privately owned minibuses is challenging, as small businesses typically operate these vehicles with low-profit margins. These operators need help accessing bank financing and require new expertise, particularly for transitioning to electric cars and establishing charging infrastructure. Critical locations like the central daladala terminal are frequently overloaded, compounding congestion issues. Road safety is another vital concern, with a high rate of fatalities, especially among vulnerable populations. Additionally, there is a significant gender gap in access to mobility, highlighting the need for more inclusive transportation solutions.

134. There is a need for targeted strategies to address the growing challenges in transport and mobility. First, it is essential to slow the increase in private vehicle ownership to reduce congestion and its negative impacts on the city's infrastructure. Road spaces should be redistributed to benefit a larger group of travelers, prioritizing public and shared transportation options over private cars to achieve this. Making public transport affordable and attractive to people from different social classes is crucial for encouraging widespread use. A vital component of this strategy is driving a shift from independently operated daladalas to a more organized and integrated public transport system, which would offer greater efficiency and reliability. Additionally, there is a pressing need to build expertise in planning electrified bus routes, ensuring that the transition to electric buses is well-managed and sustainable. This includes developing the necessary skills and knowledge for planning and implementing charging infrastructure, which will be essential to support the widespread adoption of electric vehicles and buses.

5.3.2 EV Ramp-Up

Based on development of its population the vehicle development in Dar es Salaam is projected as in Figure 5-14.

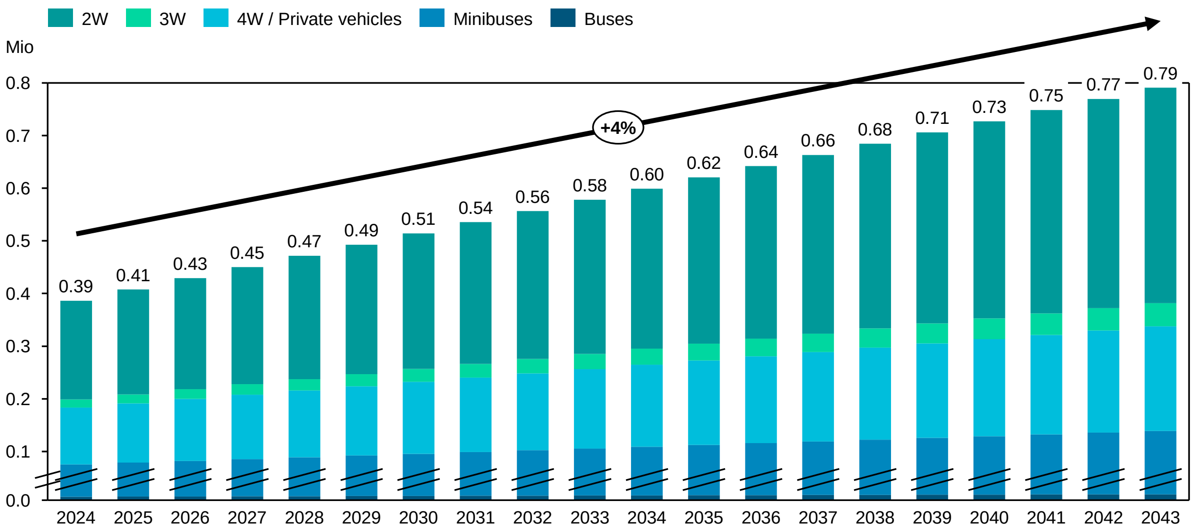


Figure 5-14: Development of Vehicle Stock in Dar es Salaam (Siemens analysis)

Based on the expected development of vehicles, the EV ramp-up can be projected according to Figure 5-15. The scenarios 0%, 2%, 4% and 6% describe a yearly increase of EV share among total vehicle stock.

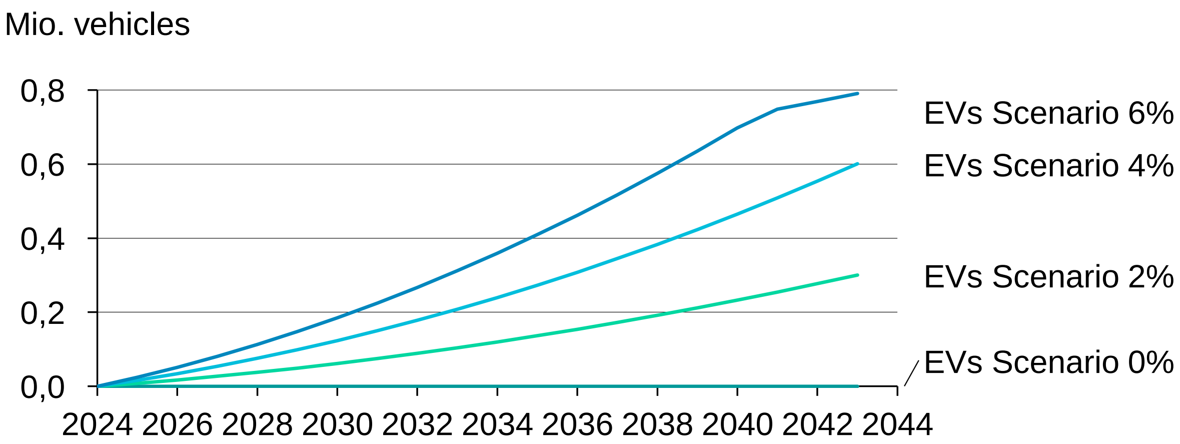


Figure 5-15: Number of EVs in Dar es Salaam in four different assumed scenarios (Siemens analysis)

5.3.3 Implementation of National EV Framework

135. Table 5-2 gives an overview of recommended actions for local EV implementation in Dar es Salaam.

Table 5-2: EV implementation actions for Dar es Salaam

Action	Within years	Type of action	Lead

Integrate e-mobility into city and urban transport plans	2,5	Regulation	City Council
Build capacity on electrification of bus routes on all academic levels	2,5	Capacity building	City Council
Pilot project on bus depot of electric buses	2,5	Capacity building	City Council
Incentivize 2W against 4W/passenger cars	2,5	Incentive	City Council
Integrate EV charging stations in the DSO grid code	2,5	Regulation	EWURA
Establish competitive markets for charge point operators and mobility service provid-ers	2,5	Regulation	City Council/ EWURA
Build capacity in the DSO planning entity on determining available hosting capacity for EV chargers	5	Capacity building	EWURA
Increase number of depots and routes for electric buses	5	Infrastructure	City Council
Update grid and substations around bus de-pots	5	Infrastructure	City Council
Install rooftop PV on large rooftops around bus depots and evaluate BESS	5	Infrastructure	City Council
Introduce offerings for public buses with dif-ferent quality and price; but with general competitive prices to push daladalas out the market; product differentiation for example in space, seats, security, speed, frequency	5	Infrastructure	City Council
Ban daladalas stepwise from routes of elec-tric buses	10	Regulation	City Council

136. Bus routes should be tailored to the unique requirements of electric buses, which differ significantly from those of traditional diesel buses. Key differences include a shorter travel range per charged battery than a diesel tank, longer charging times versus refueling, and a higher sensitivity of energy consumption per kilometer to warmer climates. In scenarios where electricity grid supply is constrained, it may be necessary to implement load management strategies. In addition, a pilot site featuring electric bus routes with a depot connected to a university and vocational training facilities should be established. This site will be a practical training ground for staff planning and operating electric bus routes. It is essential to ensure that gender equality is a critical consideration in developing and providing educational and training opportunities.

137. To scale electric buses effectively, it is crucial to evaluate and prioritize key bus routes based on their suitability for electric buses and the associated transition costs. The development of a detailed roadmap for electrifying bus routes and depots, including necessary energy

infrastructure upgrades and a clear investment plan, should follow this. Updates to bus routes must be integrated into broader city planning and energy system strategies. Additionally, independent daladala operators should be provided with options to work within the public transport framework or organize into more extensive networks, facilitating access to financing for electric buses, shared charging infrastructure, and centralized route planning. Public transport services should be diversified by offering varying quality and pricing levels to appeal to a wide range of income groups. Finally, introducing no-emission zones in high-traffic areas will help reduce pollution and encourage the adoption of electric buses.

138. The realization of charge point operation and electricity retail on charge points should develop in three steps. In the short term, it is essential to establish regulations governing the market for commercial charge point operators, focusing on operation fees, technical standards, and IT interoperability. Additionally, TANESCO must be enabled to upgrade its energy infrastructure to accommodate the growing demand for e-mobility. This includes developing planning, installation, and operation capabilities and preparing to handle a significant volume of inquiries from competitive charge point operators and fleet depots seeking low- and medium-voltage grid connections.

139. In the mid-term, a review of electricity peak demand should be conducted, considering the incorporation of load management functionalities and time-of-use pricing for charging electricity. These load management strategies should be aligned with the rollout of smart meters.

140. In the long term, the market structure for supplying charging electricity through mobility service providers should be aligned with the market structure for electricity retail in non-transport applications. This may involve the implementation of a regional or national roaming platform that allows users to charge at various locations regardless of their electricity provider.

5.3.4 Investment and financing

Especially larger vehicles like 4W (passenger cars), minibuses and buses need charging stations with higher rated power output, typically between 11kW and 100kW. The ramp-up of EVs will significantly increase capital demand for installing and operating charging stations (see Figure 5-16 and Figure 5-17).

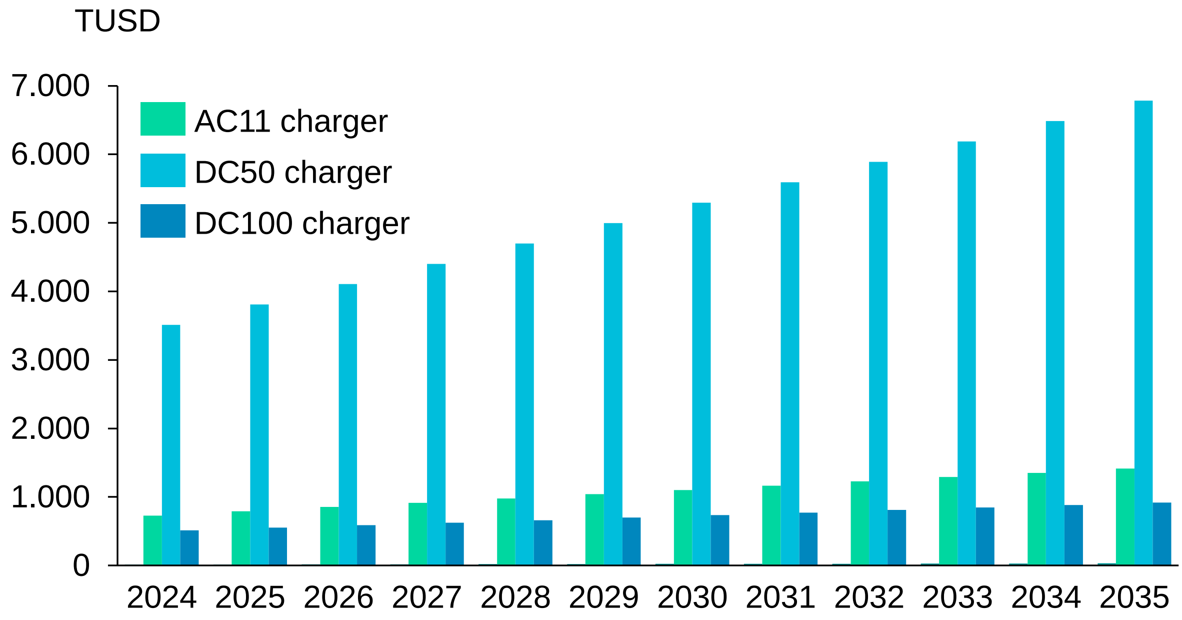


Figure 5-16: Potential investment in charging stations in Dar es Salaam from 2024-2035 in a scenario with assumed 4% increased yearly EV share (Siemens analysis)

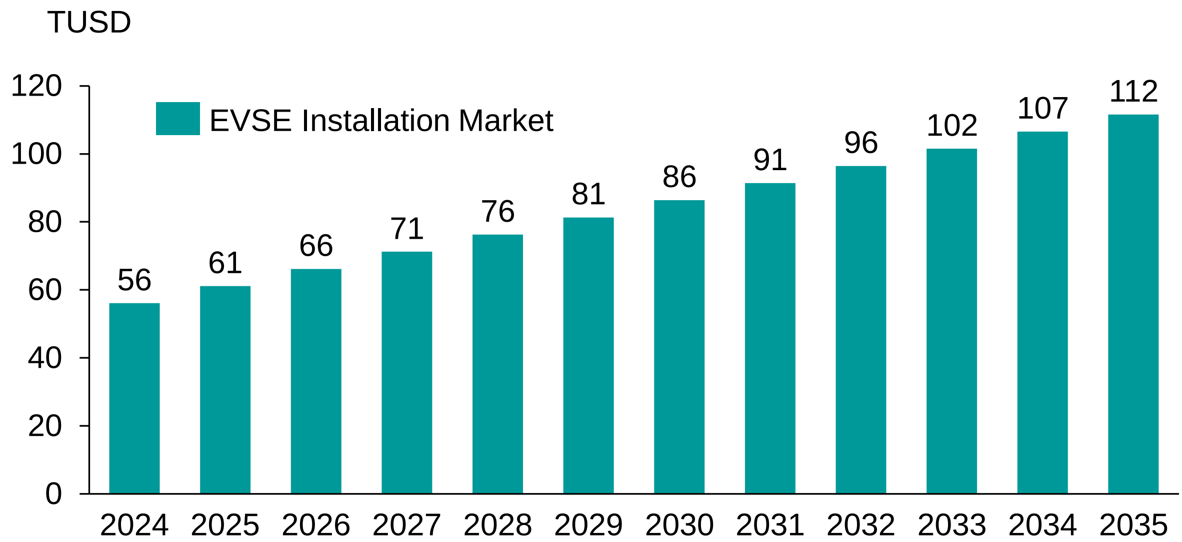
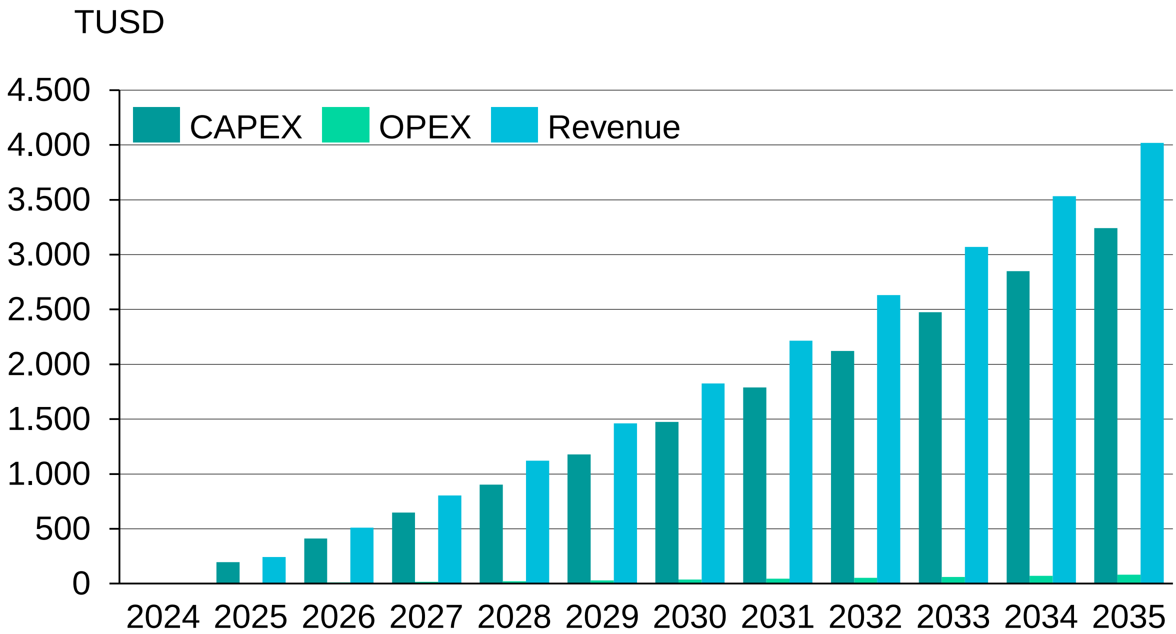


Figure 5-17: Potential investment for installation of charging stations in Dar es Salaam from 2024-2035 in a scenario with assumed 4% increased yearly EV share (Siemens analysis)

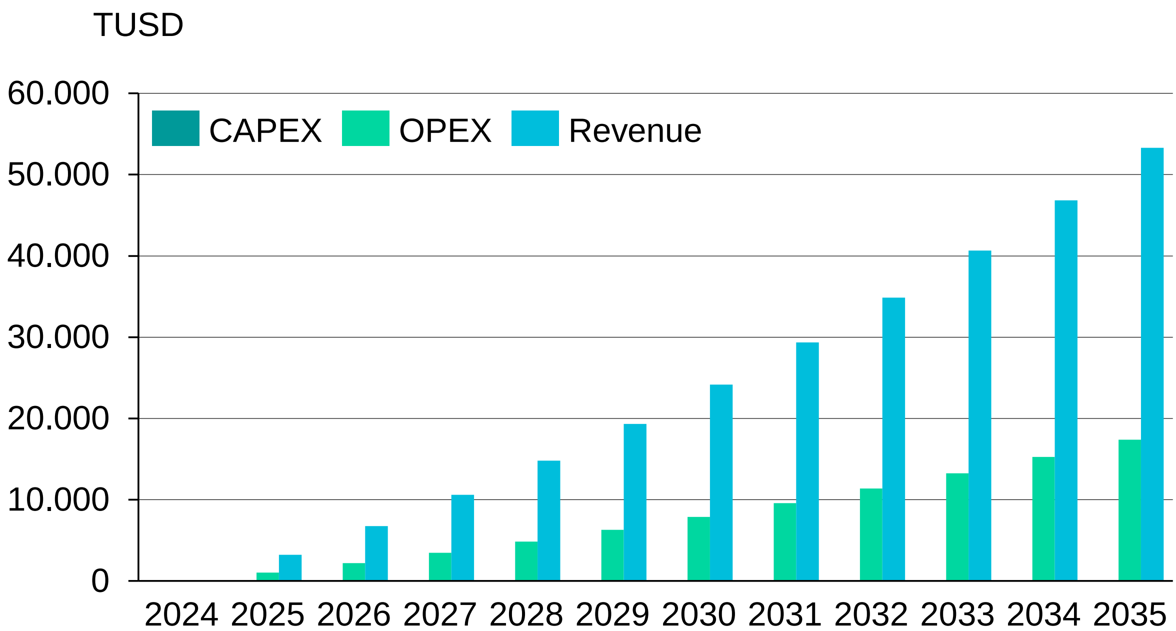
141. While this investment is substantial, it is expected to be covered by future revenues and to offer reasonable returns on investment, making it attractive for private sector participation. The financial model for a CPO business on DC charging stations with 50kW power output is shown in Figure 5-18.



142.

Figure 5-18: Financial model of the CPO Business Models for DC 50kW charging stations in Dar es Salaam in Scenario 4% in TUSD[39] (Siemens analysis)

143. The respective financial model for MSP business is shown in Figure 5-19.



144.

Figure 5-19: Financial model of the MSP Business Models for DC 50kW charging stations in Dar es Salaam in Scenario 4% in TUSD[40] (Siemens analysis)

[39] assumptions: DC50 charge point: 12TUSD, installation: 20hrs, yearly maintenance 5hrs, compensation: 5USD/hr, yearly revenue per charging station: 1,5TUSD

[40] assumptions: electricity buy: 0,08 USD/kWh, electricity sell: 0,32USD/kWh, yearly CPO fee per charge point: 1500USD, yearly process cost per charge point: 12USD

145. However, capacity building, which does not generate direct revenue, will need to be financed by the public sector, with potential support from non-governmental organizations and international financial institutions. The private sector should provide charging infrastructure from the outset, in combination with a concessionaire model for public locations, given the large size of Dar es Salaam. To encourage the initial implementation of charging stations, incentives could be introduced, with further support possibly provided by international financing institutions.

5.4 Mwanza

146. Mwanza, known for its growing trade activities and moderate motorization rates, presents a different set of opportunities. The city's economic growth could drive demand for EVs, but the moderate motorization rates suggest a need for targeted initiatives to boost EV adoption. Investments in charging infrastructure and incentives for early adopters could accelerate the transition.

147. Mwanza, located on the shores of Lake Victoria, exhibits moderate population growth with an annual increase of around 2.9%[41]. The city's motorization rate is similarly moderate, characterized by a growing number of motorcycles and small cars. Emissions in Mwanza are influenced by both industrial activities and the expanding vehicle fleet, though they remain at a moderate level. The average income in the city is relatively moderate, reflecting its economic activities which include fishing, trade, and small-scale industries.

148. The city's growth and motorization are supported by its strategic geographical location, which enhances trade and mobility due to its proximity to Lake Victoria. However, Mwanza faces challenges such as a lag in infrastructure development and limited urban planning, which hinders the rapid adaptation to increased vehicle use and population growth.

5.4.1 Overview

149. The city faces significant challenges in transport and mobility, with a substantial increase in traffic across various areas leading to severe congestion due to inadequate traffic-carrying capacity and unorganized traffic flow. Despite 91% of road space in the city centre being allocated to motor vehicles, only 36% of people use them. There are proposals to expand the capacity of key roads, such as Nyerere, Pamba, and Kenyatta, by converting them into one-way thoroughfares with dedicated one-way BRT lanes, and a new road is proposed to connect Kamanga Ferry from Makongoro Road to improve accessibility to unused land along the lakefront. Travel speeds are significantly reduced during peak times, a situation expected to worsen as vehicles grow faster than road capacity, exacerbated by ongoing construction projects like the Tazara fly-over. Public transport satisfaction is notably low, with overall satisfaction and safety ratings averaging 2.5 out of 5, and no significant differences observed between genders. Private minibuses, which are prevalent, contribute the highest absolute CO^2 emissions among motorized vehicles due to their sheer numbers and high fuel consumption. Daladalas, while affordable, offer poor quality in terms of convenience and scheduling, prompting those with rising incomes to shift to private vehicles for better quality. Small businesses' private ownership of

[41] Tanzania National Bureau of Statistics, 2022

minibuses makes their replacement challenging, as operators need higher profit margins, limited access to bank financing, and new requirements for expertise and charging infrastructure. Key locations, such as the central daladala terminal, are severely overloaded, and road safety remains poor, with a high rate of fatalities, particularly among vulnerable groups. Additionally, there is a significant gender gap in access to mobility, further complicating the city's transport landscape.

150. To address the city's transport challenges, it is crucial to slow the increase in private vehicles and redistribute road spaces to accommodate more travellers. Public transport must be affordable and attractive to various social classes, fostering a shift from independently operated daladalas to a more integrated public transport system. Building expertise in planning electrified bus routes and implementing charging infrastructure is essential for supporting this transition and ensuring the city's mobility system is sustainable and efficient.

5.4.2 EV Ramp-Up

Based on development of its population the vehicle development in Mwanza is projected as in Figure 5-20.

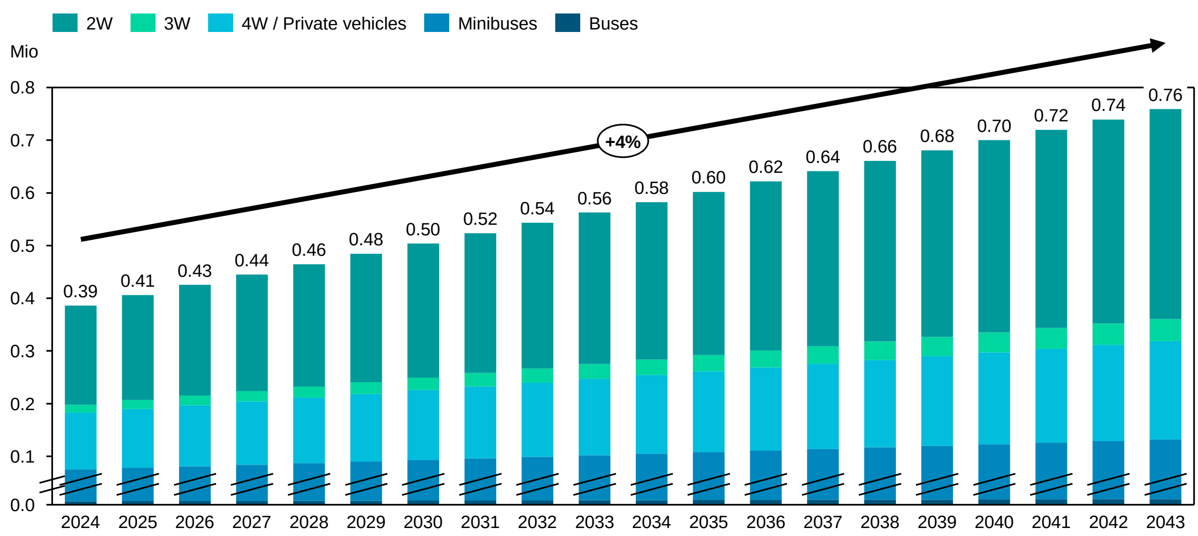


Figure 5-20: Development of Vehicle Stock in Mwanza (Siemens analysis)

Based on the expected development of vehicles, the EV ramp-up can be projected according to Figure 5-21. The scenarios 0%, 2%, 4% and 6% describe a yearly increase of EV share among total vehicle stock.

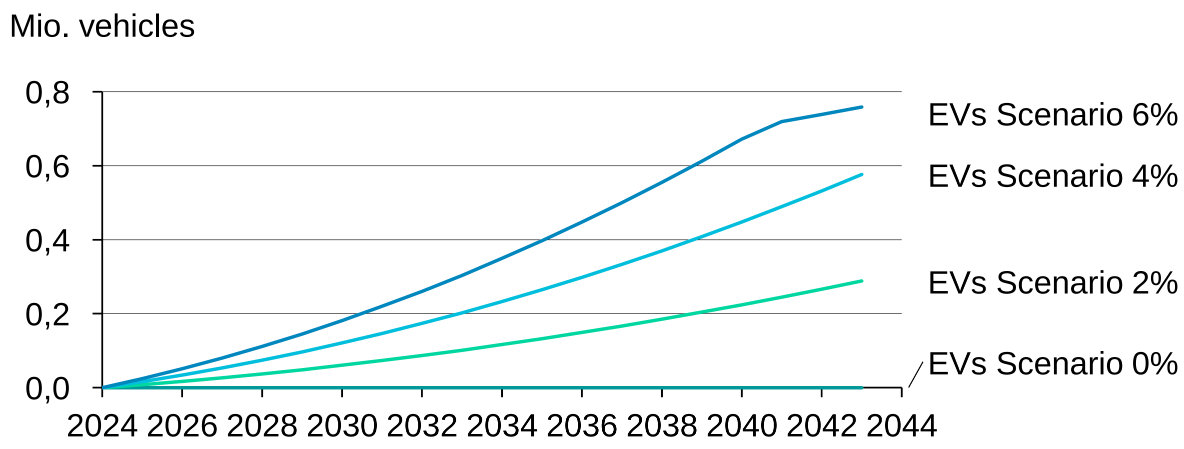


Figure 5-21: Number of EVs in Mwanza in four different assumed scenarios (Siemens analysis)

5.4.3 Implementation of National EV Framework

151. Table 5-3 gives an overview of recommended actions for local EV implementation in Mwanza.

Table 5-3: EV implementation actions for Mwanza

Action	Within years	Type of action	Lead
Integrate e-mobility into city and urban transport plans	2,5	Regulation	City Council
Build capacity on electrification of bus routes on all academic levels	2,5	Capacity building	City Council
Pilot project on bus depot of electric buses	2,5	Capacity building	City Council
Incentivize 2W against 4W/passenger cars	2,5	Incentive	City Council
Integrate EV charging stations in the DSO grid code	2,5	Regulation	EWURA
Establish TANESCO as an end-to-end (E2E) integrator responsible for sourcing, installing, and operating charging stations of all power levels.	5	Regulation	EWURA
Establish TANESCO as a mobility service provider offering electricity at public charging stations in charging tariffs to EV drivers	5	Regulation	EWURA

Build capacity in the DSO planning entity on determining available hosting capacity for EV chargers	5	Capacity building	EWURA
Increase number of depots and routes for electric buses	5	Infrastructure	City Council
Update grid and substations around bus depots	5	Infrastructure	City Council
Install rooftop PV on large rooftops around bus depots and evaluate BESS	5	Infrastructure	City Council
Introduce offerings for public buses with different quality and price; but with general competitive prices to push daladalas out the market; product differentiation for example in space, seats, security, speed, frequency	5	Infrastructure	City Council
Ban daladalas stepwise from routes of electric buses	10	Regulation	City Council
Establish competitive markets for charge point operators and mobility service providers	10	Regulation	City Council/ EWURA

152. The necessary skills and expertise for planning bus routes that accommodate the unique needs of electric buses, which differ significantly from those of diesel buses, should be developed. Key differences include a shorter travel range per charged battery than a diesel tank, longer charging times versus fueling, and more significant variability in energy consumption per kilometer due to warmer climates. In cases where the electricity grid supply is limited, it may be necessary to implement load management strategies. A pilot site featuring electric bus routes with a depot connected to a university and vocational training facilities should also be established. This site will serve as a hands-on training center for staff in the planning and operating of electric bus routes, with a strong emphasis on ensuring gender equality in the educational and training opportunities provided.

153. Scaling electric buses involves evaluating and prioritizing key bus routes based on their suitability for electric buses and the associated transition costs while developing a comprehensive roadmap for electrifying bus routes and depots, including necessary upgrades to energy infrastructure and a supporting investment plan. Updates to bus routes should be integrated into broader city planning and energy system strategies to align with overall urban development. Supporting independent daladala operators by offering pathways to join public transport or organize into more extensive networks could provide opportunities for financing electric buses, sharing charging infrastructure, and centralizing route planning and scheduling.

Differentiating public transport offerings by quality and price is essential to attract passengers across various income levels. Also, establishing no-emission zones in congested areas could reduce pollution and promote using electric buses and other eco-friendly transport options.

154. The realization of charge point operation and electricity retail on charge points should develop in three steps. In the short term, establishing regulations for the commercial charge point operator market is essential, focusing on operation fees, technical standards, and IT interoperability. TANESCO should be able to upgrade its energy infrastructure to support e-mobility by developing planning, installation, and operational capabilities and preparing for a high volume of inquiries from charge point operators and fleet depots seeking low and medium-voltage grid connections. In the mid-term, reviewing electricity peak demand and considering load management functionalities, including time-of-use pricing for charging electricity, will be necessary, with load management actions aligned with the rollout of smart meters. In the long term, it will be necessary to align the market structure for charging electricity supplied by mobility service providers with the market structure for electricity retail in non-transport applications, potentially implementing a regional or national roaming platform to enable users to charge at various locations operated by different electricity providers.

5.4.4 Investment and financing

Especially larger vehicles like 4W (passenger cars), minibuses and buses need charging stations with higher rated power output, typically between 11kW and 100kW. The ramp-up of EVs will significantly increase capital demand for installing and operating charging stations (see Figure 5-22 and Figure 5-23).

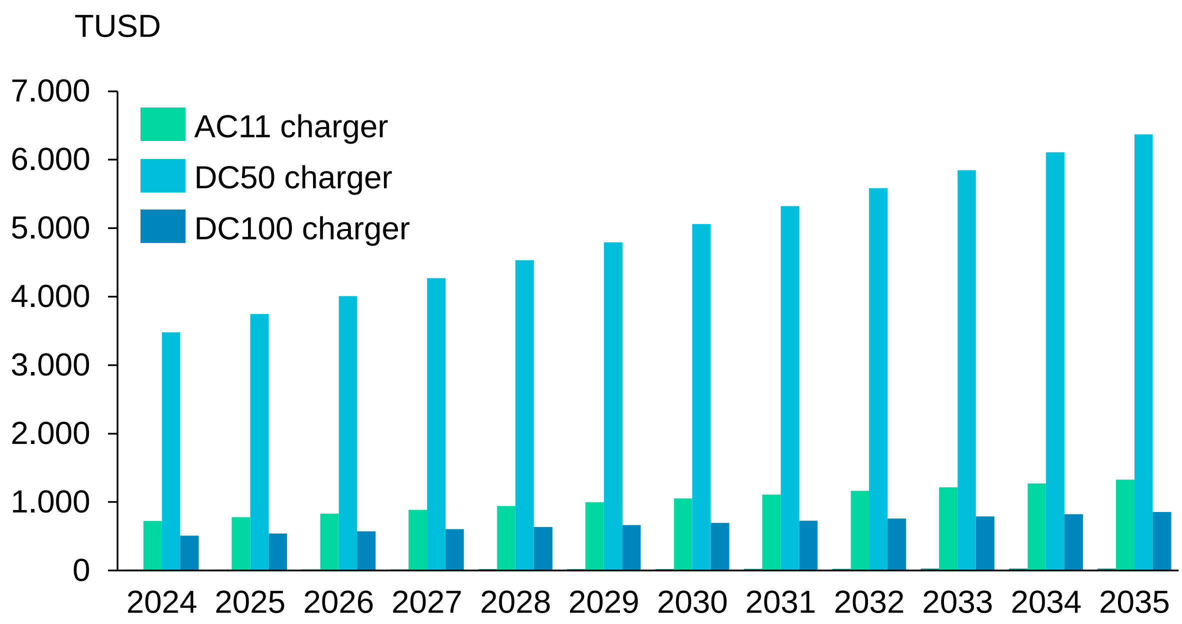


Figure 5-22: Potential investment in charging stations in Mwanza from 2024-2035 in a scenario with assumed 4% increased yearly EV share (Siemens analysis)

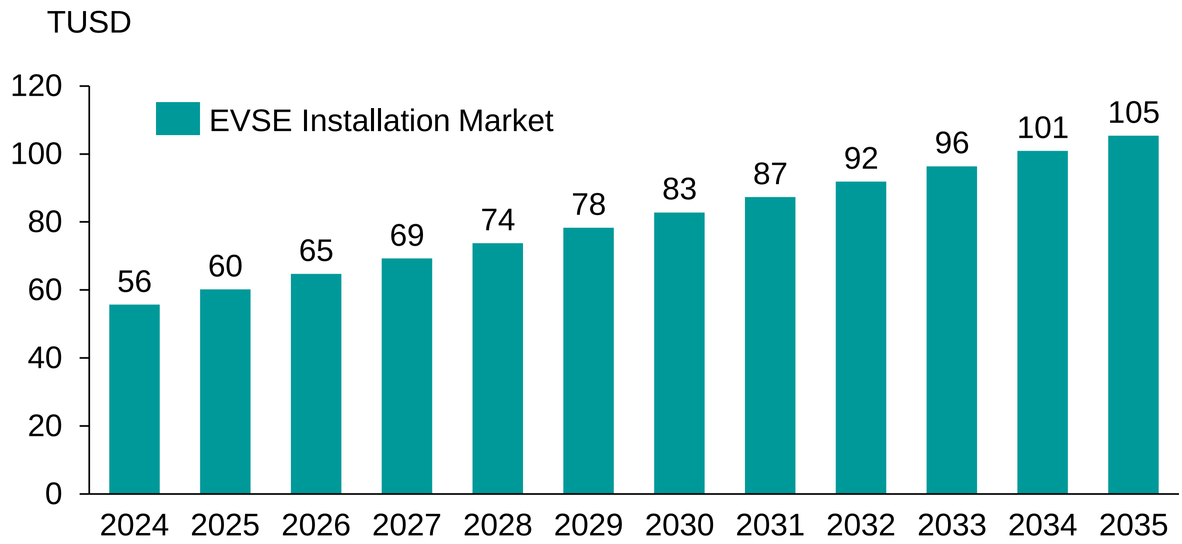
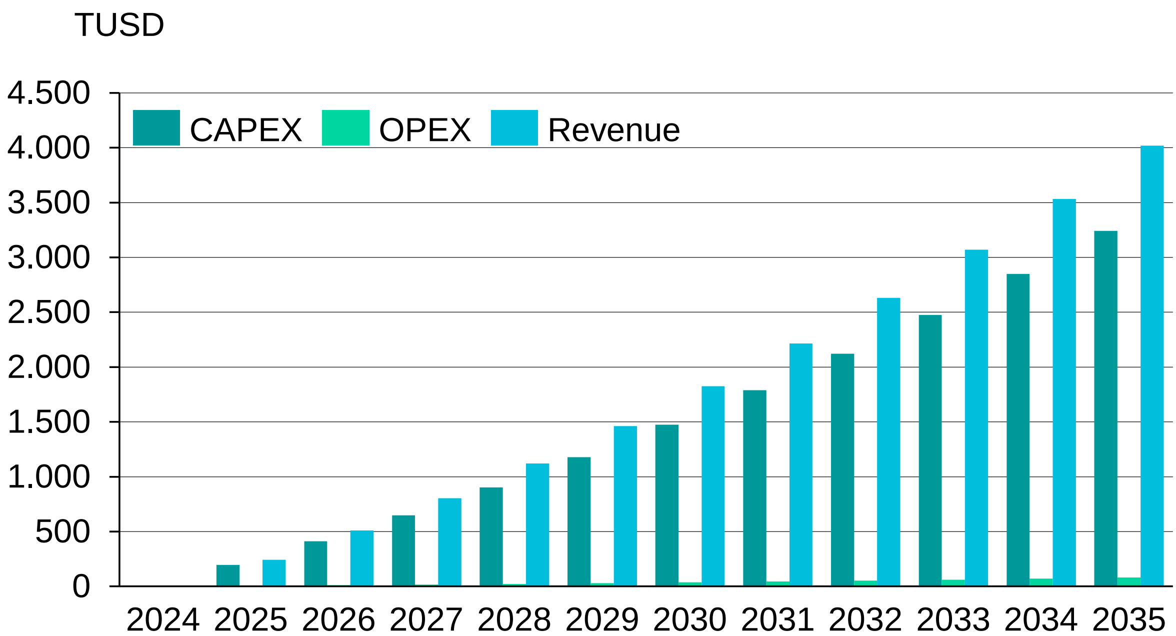


Figure 5-23: Potential investment for installation of charging stations in Mwanza from 2024-2035 in a scenario with assumed 4% increased yearly EV share (Siemens analysis)

155. As the demand for capital increases during the ramp-up of electric vehicles, investment in charging stations, installation, and operation will be covered by revenues, which are expected to offer reasonable returns. The financial model for a CPO business on DC charging stations with 50kW power output is shown in Figure 5-24.



156.

Figure 5-24: Financial model of the CPO Business Models for DC 50kW charging stations in Mwanza in Scenario 4% in TUSD[42] (Siemens analysis)

[42] assumptions: DC50 charge point: 12TUSD, installation: 20hrs, yearly maintenance 5hrs, compensation: 5USD/hr, yearly revenue per charging station: 1,5TUSD

157. The respective financial model for MSP business is shown in Figure 5-25.

158.

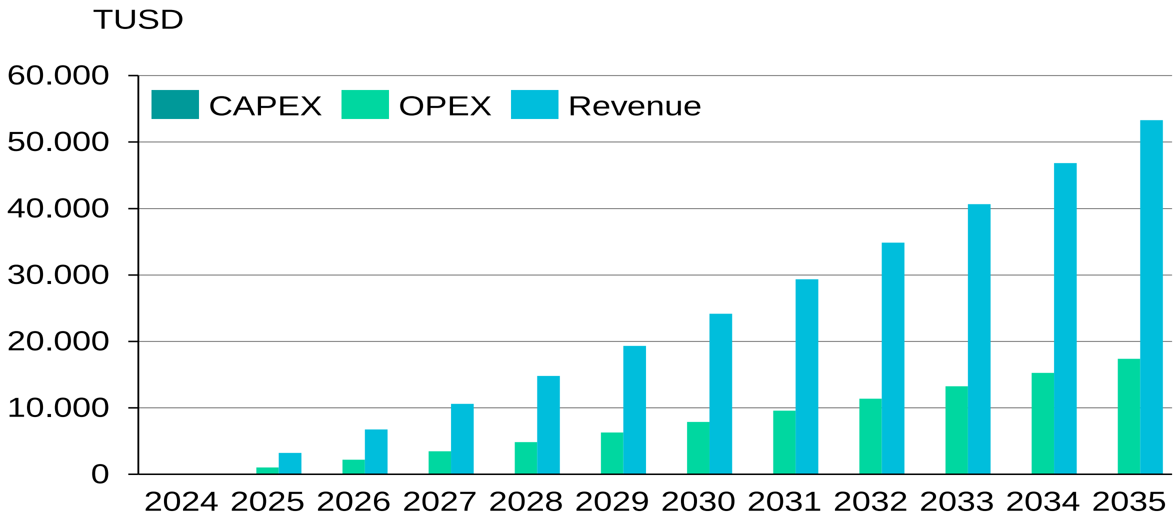


Figure 5-25: Financial model of the MSP Business Models for DC 50kW charging stations in Mwanza in Scenario 4% in TUSD[43] (Siemens analysis)

159. However, capacity building, which does not generate direct revenue, will need to be financed by the public sector, with potential support from non-governmental organizations and international financial institutions. Initial charging infrastructure could be provided by TANESCO, with the possibility of selling TANESCO assets to the private sector once the market for charge point operators reaches a reasonable size. Engaging the private sector early in the operation of charging infrastructure through a concessionaire model for public locations due to Mwanza's size is beneficial. Incentives might be introduced to facilitate the implementation of initial charging stations, with further support from international financing institutions.

5.5 Key differences

160. Dar es Salaam, the largest city in Tanzania in terms of population, is experiencing rapid growth and remains the city with the highest motorization rate. This urban center is the country's economic powerhouse, driving significant economic activities, including commerce and industry. Despite its advanced infrastructure and economic status, Dar es Salaam faces high emissions levels but also boasts the most ambitious targets for emission reductions.

161. Dodoma, while currently trailing Dar es Salaam in terms of population size and motorization rate, is catching up due to the government's strategic relocation of administrative functions to the city. This shift is positioning Dodoma as an emerging political and administrative hub, which could influence its future economic and motorization dynamics.

162. Mwanza, notable for its significance in trade and fishing, has a moderate motorization rate compared to Dar es Salaam and Dodoma. Its growing economic activities and role as a trade

[43] assumptions: electricity buy: 0,08 USD/kWh, electricity sell: 0,32USD/kWh, yearly CPO fee per charge point: 1500USD, yearly process cost per charge point: 12USD

center offer unique opportunities for EV adoption, though it will need to address the specific infrastructure and market needs of its sector.

163. In summary, while Dar es Salaam leads in both population and motorization, it faces high emissions and ambitious reduction targets. Dodoma is rapidly developing into a key political center, and Mwanza's trade significance provides a different context for EV integration. Tailoring strategies to these unique urban characteristics will be crucial for effectively advancing EV adoption and addressing emission challenges across Tanzania's major cities.

6 Conclusion and Outlook

On national level the government of Tanzania needs to prepare for any transformation to e-mobility. The private sector is already active with e-mobility. Now it is on the government to build the regulatory framework and assure a smooth transition. This is crucial to avoid technical and economic inefficiency and foster competitiveness of the companies against players from other countries.

Due to availability and affordability, it is expected that e-mobility will enter the market first with 2W and 3W. Those vehicles have significant shorter lifetimes than other vehicles and are replaced in shorter cycles. Further, 2W and 3W do not rely on advanced charging infrastructure. That means, this vehicle class does not rely on large infrastructure investment, does not contribute significantly to reduction of CO_2 emissions, but contributes to gender and youth equality, making individual transport available and reliable. Further, for those vehicle classes exists a realistic chance to localize value creation. The challenge for the government is to provide safety and recycling standards, as well as opportunities for capacity building.

Minibuses and 4W (passenger cars) can contribute in a higher extent to reduction of CO_2 emissions. The transformation of those vehicle classes requires a more costly infrastructure, and the transformation takes longer due to longer vehicle lifetimes in the market. For this vehicle class it's important to design markets for charge point operation and electricity retail at charge points.

On local level, the transformation to e-mobility can be understood as opportunity to transform personal transport from individual transport towards public mass transport. This transformation offers the opportunity to introduce transport products in higher quality to affordable prices, reduce traffic jams and travel times and reduce CO_2 emissions. This step would contribute significantly to equality for gender and youth.