# AMERICAN COLLEGE OF TECHNOLOGY

## DEPARTMENT OF BUSINESS STUDIES

**MASTER OF BUSINESS ADMINISTRATION PROGRAM**

# Growth and adoption of the Electric Vehicle (EV) industry: *in the Ethiopia Perspective*

**A Research Project Submitted to the Department of Business Studies of American College of Technology**

*as a Partial Fulfilment of the requirement of the Award of Master of Business Administration*

**By**

**Zewdalem Shitaye Balcha**

**Advisor**

**Tibebe Tilahun**

**December 2023**

**Addis Ababa, Ethiopia**

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## Appendix 3: Declaration

I, **ZEWDALEM SHITAYE BALCHA (OMBA-223-21A)** hereby declare that a project work entitled *"A Study on The Electric Vehicles (EV) industry growth and Impacts Globally: Specific benefits and Implementation project to Ethiopian situation."* submitted to The Department of Business studies of American College of Technology in partial fulfillment of the requirements for the award of the **Master Business Administration** is a record of original work done by me during 2023 academic year under the supervision and guidance of ______________________________ and it has not formed the basis for the award of any Degree/Diploma/Associate ship/Fellowship or other similar title of any candidate of any university.

***Place: Addis Ababa***
***Date: 25 December 2023***

## *Appendix 4 : Certificate*

This is to certify that the project work entitled *"A Study on The Electric Vehicles (EV) industry growth and Impacts Globally: Specific benefits and Implementation project to Ethiopian situation."* submitted to the Department of Business Administration, MBA Program in partial fulfillment of the requirements for the award of the **Master of Business Administration** is a record of original project work done by Zewdalem Shitaye Balcha during the period **2023** academic year under my supervision and guidance and the thesis has not formed the basis for the award of any Degree/Diploma/Associate ship/Fellowship or other similar title of any candidate of any University and it complies with the regulation and accepted standards of the College.

Name of Advisor: ________________________

Signature: ___________________

Date: __________________

## *Appendix 5: Approval Sheet*

# AMERICAN COLLEGE OF TECHNOLOGY

## DEPARTMENT OF BUSINESS STUDIES

## MASTER OF BUSINESS ADMINISTRATION PROGRAM

***"A Study on The Electric Vehicles (EV) industry growth and Impacts Globally:***
*Specific benefits and Implementation project to Ethiopian situation.***"***

**BY: Zewdalem Shitaye Balcha**

**Id Number: OMBA-223-21A**

**Approved by:**

**Advisor**

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| ***Name*** | ***Signature*** | ***Date*** |

**Internal Examiner**

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| ***Name*** | ***Signature*** | ***Date*** |

**External Examiner**

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|---|---|---|
| ***Name*** | ***Signature*** | ***Date*** |

## Appendix 6: Acknowledgment

First and foremost, I want to give my thanks to Almighty God/Allah for giving me the chance to enjoy the fruits of my Endeavour.

Second, I thank my esteemed advisor ________________________ for his /her incessant guidance, perspicacious thoughts, constructive criticism, and his /her great efforts to clarify things clearly and easily throughout my thesis writing period.

Third, my profound thanks go to the department head__________________ for his/her support and facilities extended throughout this research work.

Fourth, I thank dean of the college ___________________________for the co-operation, support, and needs rendered throughout my study period.

Fifth, I wish to express my gratitude to my friends, relatives, colleagues, and students for all the support and help that need to be extended to me for the completion of this study.

Sixth, I also extend my gratitude to the staff members and management body of ______________________for their cooperation in providing necessarily data.

Furthermore, my indebted gratitude is expressed to all of my families and friends for their encouragement in completing this research paper, especially for ___________________________

Name: **Zewdalem Shitaye Balcha**

Signature: ______________

Date: ____________

## ABSTRACT

Global warming has emerged as a critical issue over the past decade, prompting worldwide research into enhancing energy efficiency and promoting the utilization of sustainable energy sources.

Electric vehicles (EVs) have gained popularity in recent years as a means of reducing greenhouse gas emissions and dependence on fossil fuels. These vehicles are powered by electric motors, which can be either pure electric or hybrid. Hybrid electric vehicles (HEVs) combine an internal combustion engine with an electric motor and battery, allowing for improved fuel efficiency and reduced emissions.

In addition to the already popular hybrid vehicles, fully electric vehicles are being introduced to the passenger car market. Existing and proposed standards for the design of these vehicles aim to reduce the risk of hazards such as corrosive chemicals, toxic fumes, fire, and electric shock in the event of a crash, and some manufacturers are working with rescue organizations to develop appropriate procedures for dealing with these situations. EVs are a promising technology for achieving a sustainable transport sector in the future, due to their very low to zero-carbon emissions, low noise, and high efficiency. However, the large penetration of EVs is expected to affect existing power grids due to high loads.

The growth of electric vehicles has been unprecedented over the past decade, with significant adoption worldwide. This paper aims to explore the scope and opportunities of electric vehicles in Ethiopia, along with the policies and frameworks established by the Government of Ethiopia. Additionally, we examine case studies from around the world on the adoption of electric vehicles. Finally, we conclude by outlining strategies that Ethiopia could implement at the local and national levels to benefit from these developments.


**Keywords**: *E-Vehicle, Battery Technology, Electric charging station, Emission, hybrid electric vehicles*, *conventional HEVs*, *PHEVs*, *plug-in HEVs*, *energy transmission*, *battery technology*, *supercapacitor technology*, *internal EMS*, *EMS*, *energy management systems*, *review*

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# Acronyms

***AEV*** *All-electric vehicles*

***BEV*** *Battery electric vehicle*

***IEA*** *International Energy Agency*

***EIF*** *Ecosystem Integrity Fund*

***EV*** *Electric Vehicle*

***FCEV*** *Fuel cell electric vehicles*

***GERD*** *Grand Ethiopian Renascence Dam*

***HEV*** *Hybrid electric vehicle*

***kWh*** *Kilowatt-hour (unit of energy)*

***kW*** *Kilowatt (unit of power)*

***LCVs*** *Light Commercial Vehicles*

***MPVs*** *Multi-Purpose Vehicles*

***OBC*** *On-Board Charger*

***PHEV*** *Plug-in hybrid electric vehicles*

***SOC*** *State of Charge (battery charge level)*

***V2G*** *vehicle-to-grid*

# 1. Chapter I: Introduction

## 1.1. Background of the Project

The history of EV begins in the mid-19th century, closely related to the history of batteries. In 1859, the Belgian Gaston Plant´e presented the first lead-acid battery, becoming important for these vehicles and, later, for automobiles with an internal combustion engine (ICE), created by Karl Benz in 1879, allowing the commercial production of vehicles with ICE (*Høyer, 2008*) *(Hoyer K.G, 2008)*.

Electric vehicles, commonly referred to as EVs, are a category of vehicles that utilize one or multiple electric motors to propel themselves. In contrast to conventional gasoline-powered vehicles, EVs depend on rechargeable batteries to supply the necessary energy to their electric motors.

Electric vehicles (EVs) are available in various types, which include all-electric vehicles (AEVs) that solely rely on electricity and plug-in hybrid electric vehicles (PHEVs) that combine an electric motor with a gasoline engine.

Electric vehicles (EVs) offer numerous benefits when compared to traditional gasoline-powered vehicles. With zero emissions, EVs are not only environmentally friendly but also help to reduce air pollution. Coupled with lower operating costs due to the use of electricity instead of gasoline, these vehicles are sure to be a cost-effective option for many consumers. Additionally, EV drivers will enjoy a quiet ride and smooth driving experience as there is no combustion engine present.


*Figure 1: Various types of Electric Vehicles*

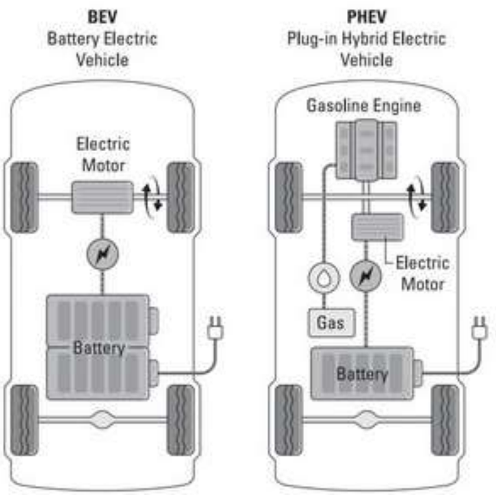


*Figure 2: Graphical Forms of the EV and PHEV*

Despite the limited driving range and longer charging times compared to refueling a gasoline vehicle, EVs are gaining in popularity. Governments and automakers are investing in the development and advancement of electric vehicles, leading to increased adoption all over the world.

The first electric cars were created in the 19th century, beginning the history of electric vehicles. However, because of their greater range and simpler recharging, gasoline-powered vehicles quickly gained in popularity.

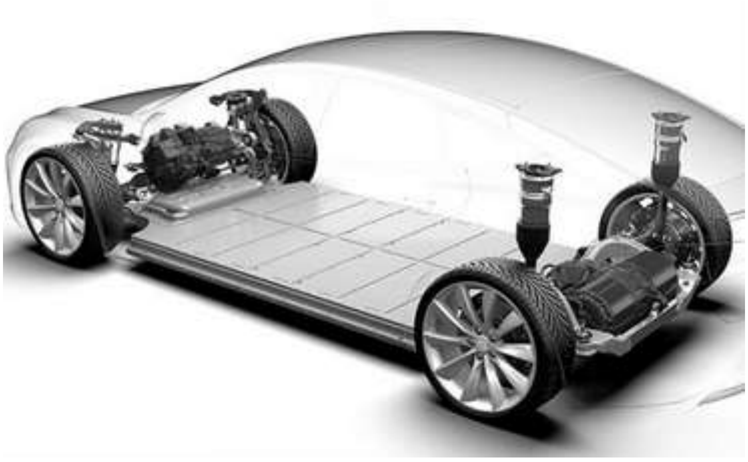

*Figure 3: EV Battery Layout*

A fresh interest in electric vehicles emerged in the 1990s as a result of worries about air pollution and global warming. Modern electric vehicles, such the General Motors EV1 and the Toyota RAV4 EV, were developed as a result.

Hybrid electric vehicles (HEVs) became more popular in the early 2000s, with the Toyota Prius emerging as the most well-liked HEV.

All-electric cars have gained a lot of popularity in recent years, and Tesla has emerged as a key player in the EV industry. Other automakers have also added electric vehicles to their line-ups, including Nissan, Chevrolet, and BMW.

The advancement of the infrastructure for charging EVs has also been crucial to their progress. The development of charging stations, funded by both public and private entities, has made it simpler for EV owners to refuel their cars while on the road.

In general, worries about air pollution and climate change, improvements in battery technology, and the development of charging infrastructure have all influenced the progress of EVs. Future trends suggest that the popularity of EVs will increase as technology advances.

According to the latest finding and the global Outlook 2023 review of *(International Energy Agency (IEA), 2023)* Electric car sales, 2016-2023 in (China, Europe, United States and Others) break new records with momentum expected to continue through 2023. Electric car markets are seeing exponential growth as sales exceeded 10 million in 2022. The share of electric cars in total sales has more than tripled in three years, from around 4% in 2020 to 14% in 2022.

EV sales are expected to continue strongly through 2023. Over 2.3 million electric cars were sold in the first quarter, about 25% more than in the same period last year. We currently expect to see 14 million in sales by the end of 2023, representing a 35% year-on-year increase with new purchases accelerating in the second half of this year. As a result, electric cars could account for 18% of total car sales across the full calendar year. National policies and incentives will help bolster sales, while a return to the exceptionally high oil prices seen last year could further motivate prospective buyers. Based on current trends, the rollout of electric vehicles is set to avoid the need for 5 million barrels of oil a day by 2030.

## 1.2. Objective of the Project

**General Objective:**

The objective of Studying EV technology and deployment in Ethiopia is to assess its potential for addressing the *environmental*, *economic*, and *social challenges* of the country's transportation system. This includes understanding the benefits, *challenges*, and *opportunities* associated with *EV adoption in Ethiopia* and *policymakers*, *researchers*, and *stakeholders* will gain a comprehensive understanding of the potential of EV technology in Ethiopia and develop effective strategies to promote its adoption and deployment.

**Specific Objectives:**

To understand the principles of electric vehicle technology, including battery technology, electric motors, power electronics, and control systems.

1. *To Analyze the existing policies and regulations related to EV adoption in Ethiopia and recommending necessary changes or additions to support the growth of the EV market.*
2. *To understand the requirements and challenges associated with building a charging infrastructure network in Ethiopia, including identifying suitable locations for charging stations and assessing grid integration capabilities.*
3. *To Assess the level of awareness and acceptance of EVs among the public and identify strategies to promote EV adoption and address any potential barriers.*
4. *To Study the potential impact of EV adoption on Ethiopia's energy sector, including electricity demand and the integration of renewable energy sources to power EVs.*
5. *To Evaluate the technological feasibility of EV deployment in Ethiopia, including the availability of EV models, battery technologies, and charging infrastructure solutions suitable for the country's unique conditions.*

## 1.3. Statement and Justification of the Problem

**Statement:** EV technology is a critical component in the transition to a more sustainable and environmentally friendly transportation system.

**Justification**: The transportation sector is a significant contributor to greenhouse gas emissions, which contribute to climate change. EV technology offers a viable alternative to traditional gasoline-powered vehicles, which produce harmful emissions. By using electricity as a fuel source, EVs produce zero emissions at the tailpipe, reducing air pollution and improving air quality. Additionally, the use of renewable energy sources, such as solar and wind power, to generate electricity can further reduce emissions and dependence on fossil fuels.

Furthermore, EV technology has the potential to reduce our dependence on oil, which is a finite resource and subject to price volatility. The use of electricity as a fuel source is *more efficient and cost-effective than gasoline*, resulting in lower operating costs for EV owners.

Finally, , EV technology offers a promising solution to *the environmental, economic*, and *social challenges of our current transportation system in Ethiopia*. It is the development of EV technology has the potential to create *new job opportunities (Charging services, diagnosis and maintenance, spare parts, manufacturing batteries, electronics, EV manufacturing, software development with Ethiopian languages, training center for EV) and stimulate economic growth*. The *production and installation of charging infrastructure,* the *development of battery technology,* and the *manufacturing of EVs themselves all require skilled workers and investment.*

Generally

## 1.4. Scope of the Project

The scope of EV technology is vast and includes various aspects such as *battery technology*, *charging infrastructure*, *electric motors*, *power electronics*, and *control systems*.

*Battery technology* is one of the most critical components of EVs. The development of high-capacity, durable, and cost-effective batteries is essential for the widespread adoption of electric vehicles. Research is going to *highlight* battery technology, including the use of new materials and designs to increase energy density and reduce costs.

*I focus on Charging infrastructure; it* is another critical aspect of EV technology. The development of fast-charging stations and the installation of charging infrastructure in public places and homes is necessary to make EVs more convenient and accessible to consumers in the Ethiopian marketplace.

**The following points requires further study in the future, which will not be covered fully in this paper (**Electric motors are the heart of EVs and vehicle-to-grid (V2G) technology)

*Electric motors are the heart of EVs*, and advancements in motor technology are continually being made to improve efficiency and reduce costs. Power electronics and control systems are also essential for the efficient operation of EVs, including the management of battery charging and discharging, motor control, and overall vehicle performance.

Other areas of EV technology that are being developed *include vehicle-to-grid (V2G) technology*, which allows EVs to store and supply electricity to the grid when needed, and autonomous driving technology, which could revolutionize the way we use and interact with vehicles.

Overall, the scope of EV technology is continually expanding, and advancements in various areas will be necessary to make electric vehicles more practical, affordable, and accessible to consumers, thus further research and study is required.

# 2. Chapter II: Project Concept

## 2.1. Opportunity study

### EV Technology Opportunities Globally:

1) Growing demand for electric vehicles due to environmental concerns and government incentives.
2) Advancements in battery technology, resulting in longer driving ranges and faster charging times.
3) The development of charging infrastructure, making it easier for EV owners to charge their vehicles on the go.
4) The potential for electric vehicles to integrate with renewable energy sources, such as solar and wind power.
5) The development of autonomous driving technology, which could revolutionize the way we use and interact with vehicles.
6) The potential for electric vehicles to reduce our dependence on oil and improve energy security.

### EV Technology Opportunities in Ethiopia:

1) Ethiopia has abundant renewable energy resources, such as hydropower, wind, and solar, which can be used to generate electricity for electric vehicles.
2) The government of Ethiopia has expressed interest in promoting the development and adoption of electric vehicles, including the installation of charging infrastructure.
3) The high cost of gasoline in Ethiopia makes electric vehicles a more cost-effective option for consumers.
4) The potential for electric vehicles to reduce air pollution in urban areas, where air quality is a significant problem.
5) The development of electric vehicles and charging infrastructure in Ethiopia has the potential to create new job opportunities in the manufacturing and installation of EV components and infrastructure.

Generally, the opportunities for electric vehicle technology in Ethiopia are significant, particularly in the areas of *renewable energy integration, air pollution reduction,* and *job creation*.

However, there are also *challenges* to the widespread adoption of electric vehicles, such as the high initial cost of EVs and the need for significant investment in *charging infrastructure*.

**Literature Review**

- *Overview of electric vehicle technology and its potential benefits*
- *Review of previous studies on electric vehicles in Ethiopia and other developing countries*

## 2.2. The project Concept and Profile

**Project concept:** The project aims to develop new technology for electric vehicles (EVs) that will allow them to charge more quickly and efficiently. The new technology is based on a solid-state battery that can store more energy than conventional lithium-ion batteries. This means that EVs equipped with the new batteries will be able to travel further on a single charge, and they will also be able to charge more quickly.

**EV technology profile:** EV technology is rapidly evolving, and there are several different types of EVs on the market today. Some of the most common types of EVs include:

- ***Battery electric vehicles (BEVs):*** BEVs are powered by a battery that is charged by plugging the vehicle into an electrical outlet. BEVs have zero emissions and are very quiet to operate.
- ***Plug-in hybrid electric vehicles (PHEVs):*** PHEVs combine a battery with a small gasoline engine. The battery can be charged by plugging the vehicle into an electrical outlet, and the gasoline engine can be used to extend the vehicle's range.
- ***Hybrid electric vehicles (HEVs):*** HEVs also combine a battery with a gasoline engine, but the battery is smaller than in a PHEV. The battery is used to power the vehicle at low speeds and during acceleration, and the gasoline engine is used to power the vehicle at higher speeds.
- ***Fuel cell electric vehicles (FCEVs):*** FCEVs use a fuel cell to convert hydrogen into electricity, which powers the vehicle's electric motor. FCEVs have zero emissions and are very efficient, but the infrastructure for hydrogen refueling is not yet widespread.

**EV technology key benefits:**

- *EVs are zero-emission vehicles*, which means they do not produce any harmful pollutants like greenhouse gasses or air pollution. This can help to improve air quality and reduce climate change.

- *EVs are very quiet to operate*, which can make them ideal for use in urban areas where noise pollution is a concern.
- *EVs are very efficient*, which means they can travel further on a single charge than conventional gasoline-powered vehicles.
- *EVs are relatively easy to maintain*, which can save you money on repairs and maintenance costs.

EV technology is a promising and rapidly evolving field with the potential to revolutionize the transportation industry. As the technology continues to improve, EVs are becoming more affordable, have longer ranges, and charge more quickly. This is making EVs more appealing to a wider range of consumers, and it is helping to accelerate the transition to a clean transportation future.

## 2.3. Preliminary study

***Background***: *Electric vehicles (EVs) are becoming an increasingly popular means to reduce greenhouse gas emissions and air pollution. However, there are still some challenges to the widespread adoption of EVs, one of which is the limited range of current EV batteries.*

*Ethiopia is a country with a rapidly growing population and economy. The country is also facing several environmental challenges, including air pollution and climate change. Electric vehicles (EVs) have the potential to help Ethiopia address these challenges by reducing greenhouse gas emissions and improving air quality.*

*The Electric power source in Ethiopia is promising for EVs like Wind, Solar and mainly hydro power energy like GERD (Grand Ethiopian Renaissance Dam) and other dams.*

*The **objective of this preliminary study** is to assess the feasibility of developing a new type of EV battery that would have a longer range and be more affordable than current EV batteries.*

*The study will consider the following factors for the introduction of EV's in Ethiopia:*

1. *The current state of EV technology*
2. *The potential demand for EVs in Ethiopia*
3. *The infrastructure needed to support EVs*
4. *The reduction of greenhouse gas, emissions, and air pollution.*
5. *The job creation and economic boosting effect of EV's in the industry.*

6. The energy security improvement by reducing Ethiopia's reliance on imported oil.

**Implementation project:**

*The Ethiopian government could implement the following EV technology project:*

1. Introduce several policies and incentives to promote the adoption of EVs. These policies could include tax incentives and subsidies for EVs, investment in the development of a nationwide network of charging stations, and education about the benefits of EVs and familiarization training for customers.
2. Partner with the private sector to import and sell EVs in Ethiopia. The government could also work with the private sector to develop local EV manufacturing capacity and provide charging services for EVs.
3. To assist private sectors in importing spare parts and to provide efficient services in the main cities of Ethiopia.

The Ethiopian government could also consider the following additional measures to promote the adoption of EVs:

- **Establish a national EV fleet.** The government could purchase a fleet of EVs for government use, which would help to demonstrate the benefits of EVs and encourage private sector adoption mainly in public transportation.
- **Prioritize EV charging infrastructure in urban areas.** Urban areas are home to most of Ethiopia's population and traffic congestion, so prioritizing EV charging infrastructure in urban areas would make EVs more accessible to potential users.
- **Provide financial assistance to low-income households.** Low-income households may not be able to afford the upfront cost of an EV, so the government could provide financial assistance to help make EVs more affordable.

The implementation of EV technology in Ethiopia is a complex undertaking, but the potential benefits are significant. By taking steps to promote the adoption of EVs, the Ethiopian government can help to improve air quality, create jobs, boost economic activity, and improve energy security.

**Additional details - In the implementation of EV technology in Ethiopia:**

- **Cost**: The cost of implementing EV technology in Ethiopia would vary depending on the specific measures adopted. However, the government could offset the cost of these *measures by reducing spending on fuel subsidies and by generating revenue from taxes on EV sales.*

- ***Timeframe**: The timeframe for implementing EV technology in Ethiopia would also vary depending on the specific measures adopted. However, the government could start by taking several short-term measures, such as providing tax incentives and subsidies for EVs, and then gradually implement more long-term measures, such as developing a nationwide network of charging stations.*
- ***Challenges**: There are several challenges that the Ethiopian government would need to address to implement EV technology. These challenges include the high cost of EVs, the lack of charging infrastructure, and the low public awareness of EVs. However, the government could overcome these challenges by working with the private sector and by providing education and awareness campaigns about the benefits of EVs.*

*The implementation of EV technology in Ethiopia is a promising initiative with the potential to improve air quality, create jobs, boost economic activity, and improve energy security. The Ethiopian government can overcome the challenges associated with implementing EV technology by working with the private sector and by providing education and awareness campaigns about the benefits of EVs.*

***Methods**: The study will involve a literature review of EV technology, as well as interviews with key stakeholders in Ethiopia. The study will also consider the findings of a recent study by the EMFED (Ethiopian Ministry of Finance and Economic Development), which found that there is a potential market for 100,000 EVs in Ethiopia by 2025.*

***Results**: The preliminary study has shown that it is feasible to develop a new type of EV battery that has a longer range and is more affordable than current EV batteries. The new battery design is based on solid-state technology, which offers several advantages over traditional lithium-ion batteries, including:*

- ***Improved energy density:** Solid-state batteries can store more energy per unit volume, which means that they can provide a longer range for EVs.*
- ***Faster charging:** Solid-state batteries can be charged more quickly than traditional lithium-ion batteries.*
- ***Increased safety:** Solid-state batteries are less likely to catch fire or explode than traditional lithium-ion batteries.*

*The preliminary study has shown that it is feasible to introduce EVs in Ethiopia. The study found that there is a potential market for EVs in Ethiopia, and that the country has the resources to develop the infrastructure needed to support EVs.*

*This study will give additional opportunities in job creation, spare parts and supplies, battery charging station, diagnosis and maintenance and production of batteries industries.*

***Conclusions:*** *The preliminary study has shown that EVs have the potential to play a significant role in Ethiopia's future. The study recommends that the Ethiopian government take steps to promote the adoption of EVs, such as providing tax incentives and subsidies, and encourage private sectors to get involved in this exercise.*

***key challenges that need to be addressed to introduce EVs in Ethiopia:***

- ***Cost****: EVs are currently more expensive than traditional gasoline-powered vehicles. This is a major challenge that needs to be addressed to make EVs more affordable for Ethiopian consumers.*
- ***Infrastructure****: Ethiopia does not have a widespread network of charging stations. This is another challenge that needs to be addressed in order to make EVs a viable option for Ethiopian consumers.*
- ***Public awareness:*** *Ethiopian consumers are not yet familiar with EVs. This is a challenge that needs to be addressed to create demand for EVs in Ethiopia and training is required for consumers especially for those who aren't computer savvy and know how to drive and use the EVs efficiently and effectively because of the high safety and tech that exist in EV technology.*

*The preliminary study of EV technology in Ethiopia has shown that EVs have the potential to play a significant role in the country's future. However, there are still some challenges that need to be addressed before EVs can be widely adopted in Ethiopia. If these challenges can be overcome, EVs could help Ethiopia to reduce greenhouse gas emissions and improve air quality.*

# 3. Chapter III: Project Methods and Procedure

The following are some project methods and procedures that can be used to study EV technology: ***Literature Review, Case Studies, Surveys and Interviews, Data Analysis, Field Visits*** - Field visits can also provide an opportunity to network with stakeholders and experts in the field has plan to visit those who have the infrastructure in place. Like (***UAE***, ***Dubai,*** and ***USA, Washington DC), Workshops and Seminars:***

## 3.1. Project Design

### 3.1.1. Data Collection

The project design will use a combination of data collection methods, including surveys, interviews, and data analysis, to assess the potential of electric vehicles in Ethiopia. The project will focus on identifying opportunities and challenges for EV adoption, as well as best practices for promoting EV adoption. The project design will provide a comprehensive understanding of EV technology and its potential to address the environmental, economic, and social challenges of our current transportation system in Ethiopia.

*Literature Review*: This section will provide a comprehensive review of the literature on electric vehicle technology, including battery technology, electric motors, charging infrastructure, and control systems. The literature review will also examine case studies of successful EV adoption in other countries and identify best practices for promoting EV adoption in Ethiopia context.

| | ***Literature*** | ***Concept Explained*** |
|---|---|---|
| *1* | *"Electric Vehicle Technology and Management "by David A. Hensley (2021)* | *Offers a practical guide to electric vehicle technology and management, covering topics such as vehicle dynamics, energy storage systems, and fleet management.* |
| *2* | *"Electric Vehicle Charging Infrastructure Planning: A Review of Models and Methods "by Xiaoping Zhang, et al. (2021)* | *Reviews the models and methods used for electric vehicle charging infrastructure planning, discussing factors such as location optimization, charging station capacity, and grid impact.* |

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| 3 | "Recent Developments in Electric Vehicle Battery Technology "by S. S. Zhang, et al. (2021): | Discusses recent developments in electric vehicle battery technology, including advancements in lithium-ion batteries, solid-state batteries, and emerging technologies |
| 4 | "Design and Optimization of Power-Split Hybrid Electric Vehicle Powertrains "by M. Li, et al. (2021) | Focuses on the design and optimization of power-split hybrid electric vehicle powertrains, considering factors such as component sizing, control strategies, and fuel efficiency. |
| 5 | "Battery Management Systems for Electric Vehicles: Challenges and Opportunities "by M. A. Hannan, et al. (2021) | Explores the challenges and opportunities in battery management systems for electric vehicles, including topics such as state-of-charge estimation, thermal management, and battery aging. |
| 6 | "Electric Vehicle Adoption in Developing Countries: The Case of Ethiopia "by M. A. Ahmed and M. A. Abdo (2021) | Focuses on the adoption of electric vehicles in developing countries, with a specific focus on the case of Ethiopia. It examines the barriers and opportunities for electric vehicle adoption, including policy support, infrastructure development, and economic considerations. |
| 7 | "Lithium-Ion Batteries: Advances and Applications "edited by Gianfranco Pistoia and Bruno Sc Rosati (2020) | Focuses on lithium-ion batteries, which are widely used in electric vehicles. It covers topics such as battery materials, cell designs, manufacturing processes, and performance optimization. |
| 8 | "The Electric Car: Is an Electric Car Right for You? "By Paul West (2020): | Offers a comprehensive guide to electric cars, including information on their benefits, drawbacks, charging infrastructure, and considerations for potential buyers. |
| 9 | "Hybrid Electric Vehicle | Focuses on the design and control aspects of hybrid |

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| | *Design and Control: Intelligent Omnidirectional Systems "by Jigging Yi, et al. (2020):* | *electric vehicles, covering topics such as powertrain architecture, energy management strategies, and intelligent control systems.* |
| *10* | *"Electric Mobility in Ethiopia: An Assessment of the Current State and Future Prospects "by D. K. Bekele and S. S. Zhang (2020)* | *Assesses the current state of electric mobility in Ethiopia, including the status of electric vehicle adoption, charging infrastructure, and policy support. It also explores the future prospects of electric mobility in the country.* |
| *11* | *"Battery Electric Vehicles: A Review of the State-of-the-Art Battery Technology "by Shiho Yu, et al. (2020)* | *provides a comprehensive review of battery technology for electric vehicles, discussing advancements in lithium-ion batteries, solid-state batteries, and other emerging technologies* |
| *12* | *"Electric Vehicle Battery Technology: Opportunities and Challenges "by S. S. Zhang, et al. (2020)* | *Discusses the opportunities and challenges associated with electric vehicle battery technology, including advancements in lithium-ion batteries, solid-state batteries, and the need for improved energy density and charging infrastructure* |
| *13* | *"Battery Electric Vehicles: A Review of the State-of-the-Art Battery Technology "by Zhihao Yu, et al. (2020):* | *Provides a comprehensive review of battery technology for electric vehicles, discussing advancements in lithium-ion batteries, solid-state batteries, and other emerging technologies.* |
| *14* | *Electric Vehicle Market Penetration: Lessons from Norway "by Benjamin Sova cool, et al. (2019)* | *The paper examines the factors that have contributed to the high electric vehicle market penetration in Norway, providing insights into policy measures, incentives, and consumer behavior.* |

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| 15 | *“Electric Vehicle Market Penetration: Lessons from Norway ”by Benjamin Sova cool, et al. (2019)* | *Examines the factors that have contributed to the high electric vehicle market penetration in Norway, providing insights into policy measures, incentives, and consumer behavior.* |
| 16 | *"Challenges and Opportunities for Electric Vehicle Adoption: A Review ”by N. S. Rao, et al. (2019)* | *Reviews the challenges and opportunities for electric vehicle adoption, including factors such as cost, range anxiety, charging infrastructure, and policy support* |
| 17 | *"Electric Vehicles in Ethiopia: Opportunities and Challenges ”by A. Hailu and T. Mulugeta (2019)* | *Discusses the opportunities and challenges of electric vehicle adoption in Ethiopia, including factors such as infrastructure requirements, policy frameworks, and economic implications.* |
| 18 | *"Recent Developments in Electric Vehicle Battery Technology ”by S. S. Zhang, et al. (2019)* | *Discusses recent developments in electric vehicle battery technology, including advancements in lithium-ion batteries, solid-state batteries, and emerging technologies* |
| 19 | *“Electric Vehicle Technologies and Opportunities: A Review ”by Y. Wang, et al. (2018)* | *Provides a comprehensive review of electric vehicle technologies and opportunities, discussing advancements in battery technology, charging infrastructure, and policy measures* |
| 20 | *"Electric Vehicle Technologies and Opportunities: A Review ”by Y. Wang, et al. (2018):* | *Provides a comprehensive review of electric vehicle technologies and opportunities, discussing advancements in battery technology, charging infrastructure, and policy measures.* |
| 21 | *"Battery Sizing and Energy Management Optimization for Plug-in Hybrid Electric Vehicles ”by J.* | *Discusses the optimization of battery sizing and energy management strategies for plug-in hybrid electric vehicles, considering factors such as cost, range, and environmental impact.* |

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|---|---|---|
| | Zhang, et al. (2018) | |
| 2 | Electric Vehicle Integration into Modern Power Networks ”by Zechun Hu, et al. (2018) | Explores the integration of electric vehicles into power networks, discussing topics such as vehicle-to-grid technology, smart charging strategies, and grid impact analysis. |
| 23 | "Battery Systems Engineering ”by Christopher D. Rehn and Chris Mi (2018): | Although not specific to electric vehicles, covers the fundamental principles of battery systems engineering, including topics such as battery modeling, control strategies, and optimization techniques. |
| 24 | "Advanced Electric Drive Vehicles ”by Ali Emadi (2018) | Explores advanced electric drive technologies and their applications in electric and hybrid vehicles, discussing topics such as motor drives, power electronics, energy management systems, and vehicle-to-grid integration. |
| 25 | "Electric Vehicles: Technology, Policy, & commercialization ”by David A. Hensley (2018) | Provides an overview of electric vehicle technology, policy frameworks, and commercialization strategies, discussing the potential benefits and challenges associated with electric vehicle adoption globally. |
| 26 | "The Electric Vehicle Revolution: A Sustainable Transportation Future ”by Mark Z. Jacobson and Antonio Bento (2018) | Discusses the potential of electric vehicles to drive a sustainable transportation future, covering topics such as environmental benefits, policy implications, and technological advancements. |
| 27 | "Electric and Hybrid Vehicles: Design Fundamentals ”by Iqbal Husain (2018) | Provides a comprehensive introduction to the design principles and engineering fundamentals of electric and hybrid vehicles, covering topics such as electric motors, power electronics, energy storage systems, and vehicle dynamics. |
| 28 | "Electric Vehicle Tech- | Provides a comprehensive introduction to electric vehi- |

| | | |
|---|---|---|
| | nology Explained "by James Larminie and John Lowry (2017) | cle technology covering topics such as electric motors, batteries, power electronics, and charging infrastructure. |
| 29 | "The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles, and Bicycles "by Mark Warner (2017) | Provides a practical guide on converting conventional vehicles into electric vehicles, covering topics such as electric motors, batteries, and the conversion process. |
| 30 | "Electric Vehicle Battery Systems "by Sandeep Dhamija (2017) | Provides a comprehensive overview of electric vehicle battery systems, covering topics such as battery chemistries, thermal management, safety considerations, and charging infrastructure. |
| 31 | "Advancements in Electric Vehicle Technologies: A Review "by Y. Wang, et al. (2017): | provides a comprehensive review of advancements in electric vehicle technologies, including battery technology, charging infrastructure, and powertrain advancements. |
| 32 | "Design Optimization of Electric and Hybrid Vehicle Powertrain Systems "by Z. Yang, et al. (2017): | Presents a design optimization framework for electric and hybrid vehicle powertrain systems, considering factors such as component sizing, energy management, and vehicle performance. |
| 33 | "Advancements in Electric Vehicle Battery Technologies: A Review "by Y. Wang, et al. (2017) | Provides a comprehensive review of advancements in electric vehicle battery technologies, including lithium-ion batteries, solid-state batteries, and emerging technologies. |
| 34 | "Electric Vehicle Adoption and its Impact on Developing Countries: A Review "by S. S. Zhang, et | Reviews the potential impact of electric vehicle adoption in developing countries, discussing factors such as infrastructure requirements, policy support, and economic implications. |

| | | |
|---|---|---|
| | *al. (2017)* | |
| *35* | *Modern electric, hybrid electric, and fuel cell vehicles: fundamentals, theory, and design/Mehrdad Ehsani ... [et al.]. p. cm.* | *Power electronics and applications series) Includes bibliographical references and index. ISBN 0-8493-3154-4 (alk. paper) 1. Hybrid electric vehicles. 2. Fuel cells. I. Ehsani, Mehrdad. II. Title. III. Series. TL221.15.G39 2004 629.22'93—dc22* |

***Table 1: - Literature Reviewed***

### 3.1.2. Data Collections

- ***The data collection methods, including surveys, interviews, and data** analysis. The data collection will focus on identifying the current state of EV adoption in Ethiopia, including EV sales, charging infrastructure, and government policies. Using survey data collection from EV owners and Sales agents is in progress*

**An Online Survey questionnaire for Electric Vehicle (EV) data collection**
**EV owners and Usages**

**Objectives:**
*The objective of Studying EV technology and deployment in Ethiopia is to assess its potential for addressing the environmental, economic, and social challenges of the country's transportation system. This includes understanding the benefits, challenges, and opportunities associated with EV adoption in Ethiopia and policymakers, researchers, and stakeholders will gain a comprehensive understanding of the potential of EV technology in Ethiopia and develop effective strategies to promote its adoption and deployment.*

**EV Ownership and Usage:**

1. Do you currently own an electric vehicle?
   - Yes
   - No
   - Planning to purchase
2. What is the make and model of your EV?
3. How often do you charge your EV?
   - Daily
   - Several times a week
   - Weekly
   - Less than once a week

**Attitudes and Perceptions:**

6. On a scale from 1 to 5, how satisfied are you with your EV's performance?
   - 1 (Not satisfied)
   - 2
   - 3
   - 4
   - 5 (Very satisfied)
7. What do you believe are the main benefits of driving an EV? (Select all that apply)
   - Environmental benefits
   - Lower operating costs
   - Tax incentives
   - Other (please specify)
8. What are the biggest challenges or concerns you have regarding EV ownership?

**Future Considerations:**

9. Would you consider purchasing an EV as your next vehicle?
   - Definitely yes
   - Probably yes
   - Maybe
   - Probably not
   - Definitely not
10. What improvements would most increase your likelihood of purchasing an EV?

**An Online survey questionnaire for Electric Vehicle (EV) data collection**
**EV Sales Agents in Ethiopia**

***Objectives:***
*The objective of Studying EV technology and deployment in Ethiopia is to assess its potential for addressing the environmental, economic, and social challenges of the country's transportation system. This includes understanding the benefits, challenges, and opportunities associated with EV adoption in Ethiopia and policymakers, researchers, and stakeholders will gain a comprehensive understanding of the potential of EV technology in Ethiopia and develop effective strategies to promote its adoption and deployment.*

***Survey Questionnaire: Electric Vehicle (EV) Data Collection for Sales Agents in Ethiopia***

*Personal Information:*

1. *Full Name: ________________________*
2. *Age: _________*
3. *Gender: Male / Female / Other*
4. *Contact Information: ________________________*
5. *Dealership/Company Name: ________________________*
6. *Position/Title: ________________________*

***General Information:***

7. *How long have you been working as an EV sales agent?*
    - *Less than 1 year*
    - *1-3 years*
    - *More than 3 years*
8. *What brands of electric vehicles do you sell?*
9. *What types of electric vehicles do you sell? (e.g., cars, motorcycles, buses)*

***Market Information:***

10. *Approximately how many EVs does your dealership sell per month?*
11. *Have you noticed an increase in EV sales over the past year?*
    - *Yes*
    - *No*
    - *Not sure*
12. *What are the most popular EV models among your customers?*
13. *What are the common reasons customers cite for purchasing an EV? (Select all that apply)*
    - *Environmental concerns*
    - *Fuel savings*
    - *Lower maintenance costs*
    - *Government incentives*
    - *Other (please specify): _______________*

***Challenges and Obstacles:***

14. *What are the biggest challenges you face when selling EVs in Ethiopia?*
15. *How do you think the infrastructure for EVs in Ethiopia compares to conventional vehicles?*
16. *Are there sufficient charging stations available for EV owners in your area?*
    - *Yes*
    - *No*
    - *Not sure*
17. *What kind of support or incentives do you think would help increase EV sales in Ethiopia?*

***Customer Profile:***

18. *Can you describe the typical profile of an EV customer? (e.g., age, gender, profession)*
19. *Do customers show a preference for new or used EVs?*
20. *What are the main concerns or questions customers have about EVs before purchasing?*

***Training and Knowledge:***

21. *Have you received any specific training related to the sale of electric vehicles?*
    - *Yes*
    - *No*
22. *Do you feel you have adequate knowledge about EV technology to effectively sell EVs?*
    - *Yes*
    - *No*
    - *Somewhat*
23. *What additional training or information would help you improve your EV sales?*

***Feedback and Suggestions:***

24. *What do you think needs to be done to improve the EV market in Ethiopia?*
25. *What suggestions do you have for vehicle manufacturers to make EVs more appealing to Ethiopian customers?*

***Final Thoughts:***

26. *Is there anything else you would like to share about your experience selling EVs in Ethiopia?*

***Consent for Data Use:***

27. *Do you consent to the use of your responses for market research purposes?*
    - *Yes*
    - *No*

*Thank you for participating in this survey. Your insights are valuable to us.*

## 3.1.3. Data Analysis

- *Data Analysis*: The data analysis methods, including statistical analysis and qualitative analysis. The data analysis will focus on identifying trends, opportunities, and challenges for EV adoption in Ethiopia.

## 3.1.4. Results and Discussion:

- *Results and Discussion: This section will present the results of the data analysis and discuss the implications for promoting EV adoption in Ethiopia. The results and discus-*

*sion will also identify potential collaborations and partnerships for promoting EV adoption.*

### 3.1.5. Conclusion

- *Conclusion: This section will summarize the main findings of the project and provide recommendations for promoting EV adoption in Ethiopia.*

### 3.1.6. References

- *References: This section will provide a list of references cited in the literature review and throughout the project.*

## 3.2. Types of data

The types of data related to EV technology can be broadly classified into two categories: quantitative data and qualitative data.

1. *Quantitative Data:* This type of data is numerical in nature and can be measured and analyzed using statistical methods. Examples of quantitative data related to EV technology include:
   - *Sales data:* The number of electric vehicles sold over a given period.
   - *Charging infrastructure data:* The number of charging stations installed, their locations, and charging times.
   - *Battery data:* The capacity, lifespan, and charging times of EV batteries.
   - *Government policy data:* Incentives and regulations related to EV adoption, such as tax credits and emissions standards.
2. *Qualitative Data:* This type of data is non-numerical in nature and provides insights into people's attitudes, beliefs, and experiences related to EV technology. Examples of qualitative data related to EV technology include:
   - *Consumer surveys:* Opinions and preferences related to EVs, including factors that influence their decision to purchase an EV.
   - *Expert interviews:* Insights from experts in the field of EV technology, including manufacturers, policymakers, and academics.
   - *Case studies:* Detailed descriptions of successful EV adoption in other countries, including challenges and opportunities.
   - *Field observations:* Firsthand observations of EV manufacturing facilities, charging stations, and other relevant sites.

## 3.3. Sources of data

There are several sources of data related to EV technology. These sources can be broadly classified into primary sources and secondary sources. A *combination of quantitative and qualitative data collection methods and tools is necessary to gain a comprehensive understanding of EV technology and its potential to address the environmental, economic, and social challenges of our current transportation system.*

1) **Primary Sources:** This type of data is collected directly from original sources and can include:

- ***Surveys:*** Surveys can be conducted to collect data from consumers, *manufacturers, and other stakeholders. Surveys can be administered online, over the phone, or in person.*
- ***Interviews:*** *Interviews can be conducted with experts in the field of EV technology, including manufacturers, policymakers, and academics. Interviews can be conducted in person or over the phone.*
- ***Field observations:*** *Firsthand observations of EV manufacturing facilities, charging stations, and other relevant sites can provide valuable insights into the technology and infrastructure involved in EV adoption.*

2) **Secondary Sources:** This type of data is collected from existing sources and can include:

- ***Academic journals:*** *Academic journals can provide a wealth of information on EV technology, including research on battery technology, electric motors, and charging infrastructure.*
- ***Industry reports:*** *Industry reports can provide insights into the current state of the EV market, including sales data and trends.*
- ***Government publications:*** *Government publications can provide information on policies and regulations related to EV adoption, including tax credits and emissions standards.*
- ***News articles:*** *News articles can provide up-to-date information on developments in the EV market, including new product launches and government initiatives.*

## 3.4. Data collection methods and tools

There are several data collection methods and tools that can be used to gather data related to EV technology. These methods and tools can be broadly classified into quantitative and qualitative data collection methods.

**1) Quantitative Data Collection Methods:**

- ***Surveys***: Surveys can be used to collect quantitative data related to EV technology, including sales data, charging infrastructure data, and government policy data. Surveys can be conducted online, over the phone, or in person.
- ***Data analysis***: Data analysis can be used to analyze quantitative data related to EV technology, including EV sales data and charging infrastructure data. Statistical methods can be used to identify trends and patterns in the data.

***2) Qualitative Data Collection Methods:***

- ***Interviews***: *Interviews can be used to collect qualitative data related to EV technology, including expert insights and opinions on EV adoption and challenges. Interviews can be conducted in person or over the phone.*
- ***Case studies:*** *Case studies can be used to collect qualitative data related to successful EV adoption in other countries, including challenges and opportunities. Case studies can provide detailed descriptions of the factors that led to successful EV adoption.*
- ***Field observations***: *Field observations can be used to collect qualitative data related to EV technology, including firsthand observations of EV manufacturing facilities, charging stations, and other relevant sites.*

***3) Data Collection Tools:***

- ***Survey tools***: *Survey tools, such as SurveyMonkey and Google Forms, can be used to conduct surveys and collect quantitative data related to EV technology.*
- ***Data analysis tools:*** *Data analysis tools, such as Excel and R, can be used to analyze quantitative data related to EV technology.*
- ***Interview tools:*** *Interview tools, such as Zoom and Microsoft Teams, can be used to conduct interviews and collect qualitative data related to EV technology.*
- ***Case study tools:*** *Case study tools, such as Harvard Business Review and MIT Sloan Management Review, can be used to collect qualitative data related to successful EV adoption in other countries.*

## 3.5. Population of the study

The population of the study can be further divided into subpopulations based on their roles and responsibilities. Includes a range of individuals, organizations, and institutions involved in the development, production, distribution, and adoption of electric vehicles and related technologies such as *(Consumers. Manufacturers, Policymakers and Experts)*

1) ***Consumers****: This subpopulation of the study includes individuals who are interested in purchasing electric vehicles, as well as those who have already purchased electric vehicles I Ethiopia.*
2) ***Manufacturers****: This subpopulation includes companies involved in the development, production, and distribution of electric vehicles and related technologies.*
3) ***Policymakers****: This subpopulation includes government officials and agencies responsible for developing and implementing policies related to electric vehicles, including tax credits and emissions standards.*
4) ***Experts****: This subpopulation includes academics, researchers, and professionals with expertise in battery technology, electric motors, and charging infrastructure.*

## 3.6. Sampling design (if any)

***Mixed Sampling:*** Mixed sampling is a sampling technique that combines probability and non-probability sampling methods. This technique can be useful when the population of the study is diverse and difficult to sample using a single sampling method.

## 3.7. Sample size

*The sample size for EV technology will depend on several factors, including the research objectives, the population of the study, and the sampling technique used. There are several guidelines and formulas that can be used to determine an appropriate sample size for a given study.*

- *Rule of Thumb:* One rule of thumb is to have a minimum sample size of 30 for each subpopulation of the study. This rule of thumb assumes that the population is normally distributed and that the sample is representative of the population.
- *Power Analysis: Power analysis is a statistical method used to determine an appropriate sample size based on the expected effect size, the alpha level, and the statistical power of the study. This method can be useful when the research objectives involve detecting a specific effect size.*

## 3.8. Sampling methods

*The choice of sampling method will depend on the research objectives, the population of the study, and the data collection methods used.*

- *Simple Random Sampling:* Simple random sampling is a probability sampling method that involves selecting a sample from the population of the study using random selection methods. This method ensures that every member of the population has an equal chance of being selected for the sample.
- *Convenience Sampling:* Convenience sampling is a non-probability sampling method that involves selecting a sample based on the availability and accessibility of the participants. This method can be useful when the population of the study is difficult to access or when time and resources are limited.
- *Purposive Sampling:* Purposive sampling is a non-probability sampling method that involves selecting a sample based on specific criteria or characteristics. This method can be useful when the research objectives require a specific type of participant or when the population of the study is small.

## 3.9. Data analysis methods and tools

The choice of data analysis method and tool will depend on the research objectives, the type of data collected, and the research questions being asked.

- ***Qualitative Analysis:*** Qualitative analysis will be used to analyze data collected through interviews, case studies, and field observations. This can include content analysis, thematic analysis, and discourse analysis.
- ***Data Visualization:*** Data visualization tools can be used to visually represent the data collected. This can include scatter plots, line graphs, bar charts, and heat maps.
- ***Geographic Information Systems (GIS):*** GIS tools can be used to analyze spatial data related to EV technology, including the location of charging stations and the distribution of EV sales.

## 3.10. Schedule

The schedule for a research project related to EV technology will depend on several factors, including the research objectives, the scope of the study, and the available resources. However, a general schedule for a research project related to EV technology may include the following phases (Planning Phase, Data Collection Phase, Data Analysis Phase, Report Writing Phase, and Presentation Phase).

| | Phase | No Days | Start | End |
|---|---|---|---|---|
| 1 | Planning | 10 | 24/10/2023 | 5/10/2023 |
| 2 | Data Collection | 30 | 6/11/2023 | 5/12/2023 |
| 3 | Data Analysis | 10 | 6/12/2023 | 16/12/2023 |
| 4 | Report Writing | 30 | 17/12/2023 | 16/01/2024 |
| 5 | Presentation | 5 | 17/01/2024 | 25/01/2024 |
| | **Total No Days** | **85** | **24/72023** | **25/01/2024** |

*Table 2:- Research Project Schedule*

## 3.11. Resource Budget

The resource budget for a research project related to EV technology will depend on the research objectives, the scope of the study, Site visit in Dubai and Addis Ababa, and based on the available resources. However, a general resource budget for a research project related to EV technology include the following items: *(Personnel Costs, Equipment and Supplies, Travel and Accommodation, Data analysis and Reporting)*

**Research Project - Cost allocation Table (in Birr)**

| | Expenses | No | Unit cost | Total |
|---|---|---|---|---|
| 1 | Personal Costs | 30 | 500 | 15,000 |
| 2 | Equipment and Supplies | 2 | 2,000 | 4,000 |
| 3 | Travel and Accommodation | 5 | 10,000 | 50,000 |
| 4 | On-site Visit – Dubai and Addis | 5 | 30,000 | 15,000 |
| 5 | Data Analysis and Reporting | 10 | 600 | 6,000 |
| 6 | Miscellaneous | 1 | 20,000 | 20,000 |
| | **Total Estimate Cost** | | | **246,000** |

*Table 3:- Research Project - Cost allocation Table (in Birr)*

# 4. Chapter IV: Project Preparation

## 4.1. MARKETS AND DEMAND ANALYSIS

### 4.1.1. INITIAL INVESTMENT COST

| | ***Expenses*** | ***No*** | ***Unit cost*** | ***Total*** |
|---|---|---|---|---|
| 1 | *Personal Costs* | *30* | *500* | *15,000* |
| 2 | *Equipment and Supplies* | *2* | *2,000* | *4,000* |
| 3 | *Travel and Accommodation* | *5* | *10,000* | *50,000* |
| 4 | *On-site Visit – Dubai and Addis* | *5* | *30,000* | *15,000* |
| 5 | *Data Analysis and Reporting* | *10* | *600* | *6,000* |
| 6 | *Miscellaneous* | *1* | *20,000* | *20,000* |
| | ***Total Estimate Cost*** | | | ***246,000*** |

*Table 4:- Research Project - Cost allocation Table (in Birr)*

### 4.1.2. PRODUCTION COSTS/OPERATIONAL COSTS

*Operational costs, or operating expenses (OPEX), are the costs required to conduct our day-to-day business. These costs are not directly tied to production but are necessary for the overall functioning of the project. They include:*

*(Rent, Utilities, Salary, Insurance, Taxes, Maintenance, and repairs…)*

*EV Charging Solutions ( 7kW 11kW 22kW AC EV Charger)*

| | *Product Features* | *Detail* |
|---|---|---|
| 1 | *Rated Power* | *7kW, 11kW, 22kW* |
| 2 | *Input/ Output Current* | *16A, 32A* |
| 3 | *Communication Method* | *LAN/ Wifi / 4G (optional)* |
| 4 | *Payment method* | *NFC/ RFID/ Plug and Charge/APP (Optional)* |
| 5 | *Applicable models:* | *All brands of electric vehicles car* |

*Table 5: - EV Charging Solutions ( 7kW 11kW 22kW AC EV Charger)*

### 4.1.3. STATUS OF EV IN ETHIOPIA

*As of 2021, the status of electric vehicles (EVs) in Ethiopia is still in the early stages of development. The government has expressed interest in promoting EVs as a way to reduce air pollution and dependence on fossil fuels. However, there are currently very few EVs on the road in Ethiopia, and the infrastructure for charging stations is still limited.*

*Efforts are being made to increase the adoption of EVs, including the development of policies and incentives to encourage their use. Additionally, there are plans to establish more charging stations across the country to support the growing number of EVs.*

*Overall, while the use of EVs is still relatively low in Ethiopia, there is potential for growth in the future as the government and private sector work to promote and support the transition to electric transportation.*

***All EVs In Ethiopia Now Exempted From VAT, Surtax, & Excise Tax***

*Clearing the Air*

*The Ethiopian government has recently issued a series of circulars confirming the tax-free status of imported and locally sold electric vehicles (EVs). This development comes as a part of the government's drive to encourage investment in EVs. The announcement was made by three significant government bodies – the Ministry of Finance, Addis Ababa City Revenue Bureau, and Ministry of Revenue.*

*The aim of these circulars is to resolve any confusion among dealers regarding the tax status of EVs. In September, the government announced tax exemptions on EVs, including excise tax, VAT, surtax, and partial customs duties, as part of efforts to promote sustainable transport. However, the exemption led to uncertainty among revenue officials over whether EVs were exempt upon importation and during local sales.*

*The tax exemption is expected to accelerate the adoption and assembly of EVs in Ethiopia, helping the country tap into the rapidly growing global market for electric cars. It is believed that the clarified guidance will boost Ethiopia's emerging EV industry by enabling dealers to offer competitive prices that reflect the tax exemption. This move will also reduce the cost of EVs, making them more affordable in the local market.*

*As a result of the tax exemptions, assembled EVs will only be subject to a 15% customs duty, withholding tax, and a 3% social responsibility tax. The tax reductions apply only to the Cost, Insurance and Freight (CIF) values of the EVs and are not progressive, reducing the overall cost of these vehicles for consumers.*

## Implications for Ethiopia's EV Industry and Economy

*The impact of these tax exemptions on Ethiopia's EV industry and economy could be substantial. Ethiopia, like many African countries, relies heavily on fossil fuel imports to meet their energy requirements in the transport sector. These imports constitute a significant portion of the total import bill, draining the countries of the much needed and scarce for-*

*eign currency. By accelerating the adoption of electric vehicles, Ethiopia hopes to substitute these costly fossil fuel imports with locally produced clean electricity.*

*Furthermore, Ethiopia's grid is powered 100% by renewable energy, primarily hydro, and some wind. According to IRENA, of the 15,075 GWh generated in 2020, 14,404 GWh were from hydro and marine, and wind contributed 609 GWh. Therefore, the adoption of EVs fits perfectly into the country's energy mix and supports its commitment to sustainability.*

## Attracting Investment in the EV Sector

*The tax exemptions and the government's clear commitment to sustainable transport have already started attracting investment into the electric vehicle sector. Marathon Motor Engineering, a joint venture between Hyundai Motor Company and Olympic Champion Haile Gebrselassie, started assembling the all-electric Hyundai Ioniq in Ethiopia in 2020. Another firm, Greentech Africa, has been selling electric vehicles, energy storage, and water purifiers in Ethiopia.*

## Looking Ahead: Ethiopia's EV Future

*With the exemption of VAT, Surtax, and Excise Tax, the price of fully built imported EVs will decrease immediately while local assembly firms scale up. Ethiopia's Minister of Transport and Logistics has a 10-year plan and intends to support the import of at least 4,800 electric buses and 148,000 electric automobiles as part of that plan to catalyze the adoption of electric vehicles in the country.*

*While the East African EV landscape is shaping up nicely, it is hoped that other countries in East Africa and around the rest of the continent will follow suit. The Ethiopian government's recent move to exempt EVs from various taxes is a clear indicator of the country's commitment to sustainable transport and a greener future.*

### 4.1.4. CASE STUDY - Rwanda Has Awesome New Incentives for EVs

*Rwanda is introducing a new set of incentives to catalyses the adoption of electric vehicles. Rwanda's updated Nationally Determined Contribution (NDC), outlines the importance of electric vehicles and the enforcement of vehicle emission standards as key mitigation measures on the path to reduce greenhouse gases. Earlier this month, Rwanda's government approved a new set of incentives that will help meet these goals.*

*Speaking at the E-Mobility Technology Showcase in Kigali, Janvier Twagirimana, Transport External link & Donor Coordinator in the Ministry of Infrastructure (MININ-*

*FRA), gave a summary of these incentives in his presentation "Status of E- Mobility in Rwanda."*

***Fiscal Incentives:***

- *Electricity tariffs for charging stations to be capped at the industrial tariff. This means that charge point operators will be billed at close to USD 10 cents/kWh instead of close to 20 cents/kWh*
- *Electric vehicles will also benefit from reduced tariffs during off peak periods*
- *Electric vehicles, spare parts, batteries, and charging station equipment will all be exempted from import and excise duties. All of these would also be treated as zero rated VAT products and will also be exempt from withholding tax.*

***Non-Fiscal Incentives:***

- *Rent free land for charging stations on land owned by the government*
- *Provisions for EV charging stations in the building code and city planning rules*
- *Green license plate to allow preferential parking for EVs and free entry into any future congestion zones*
- *Access to dedicated bus lanes*
- *Provide preference to electric vehicle for government hired vehicles*
- *Regulate the importation of used vehicles by imposing an age limit*
- *Establish restricted zones where only green vehicles can have access*
- *Enforcement of existing emission standards to discourage the purchase of polluting vehicles.*
    - *Rent free land for charging stations on land owned by the government*
    - *Provisions for EV charging stations in the building code and city planning rules*
    - *Green license plate to allow preferential parking for EVs and free entry into any future congestion zones*
    - *Access to dedicated bus lanes*
    - *Provide preference to electric vehicle for government hired vehicles*
    - *Regulate the importation of used vehicles by imposing an age limit*
    - *Establish restricted zones where only green vehicles can have access*
    - *Enforcement of existing emission standards to discourage the purchase of polluting vehicles.*

- *Rwanda is actively encouraging investment in the e-mobility sector, and the Rwanda Development Board (RDB) also gave a presentation outlining some of the initiatives to encourage investment. Some of these incentives include a preferential corporate income tax rate of 15% for investors operating in e-mobility. Firms operating in the energy, ITC, and mass transport industries also qualify.*
- *There are already several firms in the EV space in Rwanda and the new incentives should give them a major boost. Some of the firms that were exhibiting at the E-Mobility Technology Showcase in Kigali include Guraride, Volkswagen, Victoria Motors, Rwanda Electric Motorcycles, and Ampersand. Ampersand has just secured a $3.5 million investment from the Ecosystem Integrity Fund (EIF). The deal is the largest ever e-mobility investment by a venture capital fund in Sub-Saharan Africa and marks a turning point in global electric transport.*
- *Rwanda's new incentives are quite comprehensive and will certainly help catalyze the transition to electromobility. Let's hope more countries in the region also follow soon with similar incentives.*
- *Images courtesy of Guraride and Ampersand*

### 4.1.5. EV SALES WORLDWIDE AND IN ETHIOPIA

*detailed overview of the major types of vehicles available globally and imported into Ethiopia:*

*Vehicles available worldwide come in various types and categories, and Ethiopia, like many countries, imports a diverse range of vehicles for different purposes. Here is a general list of vehicle types available globally that might be imported into Ethiopia:*

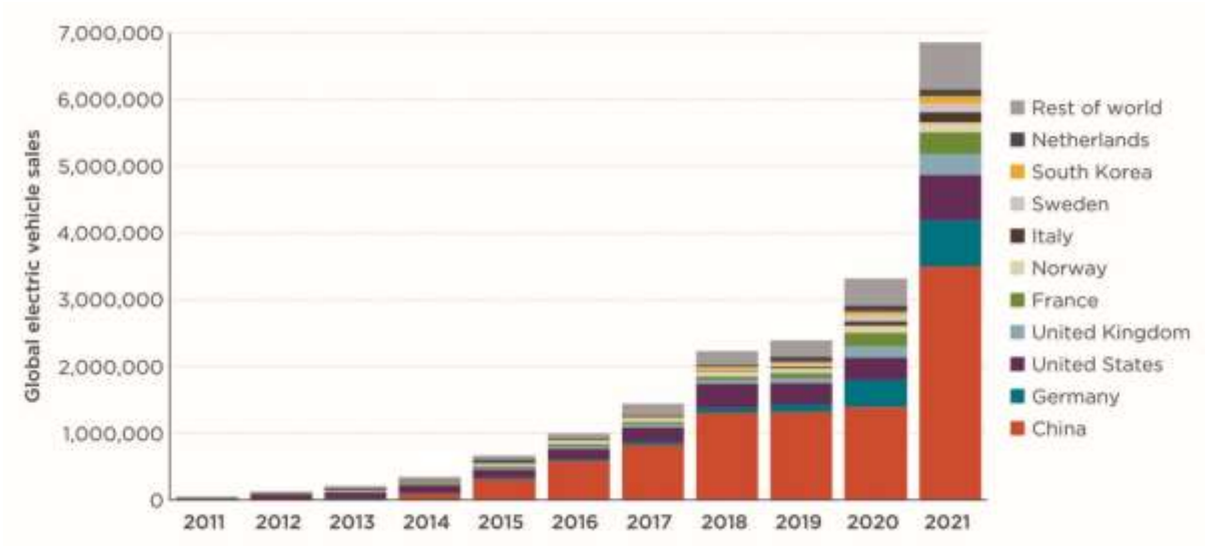


*Figure 4: Global EV sales 2011 – 2021*

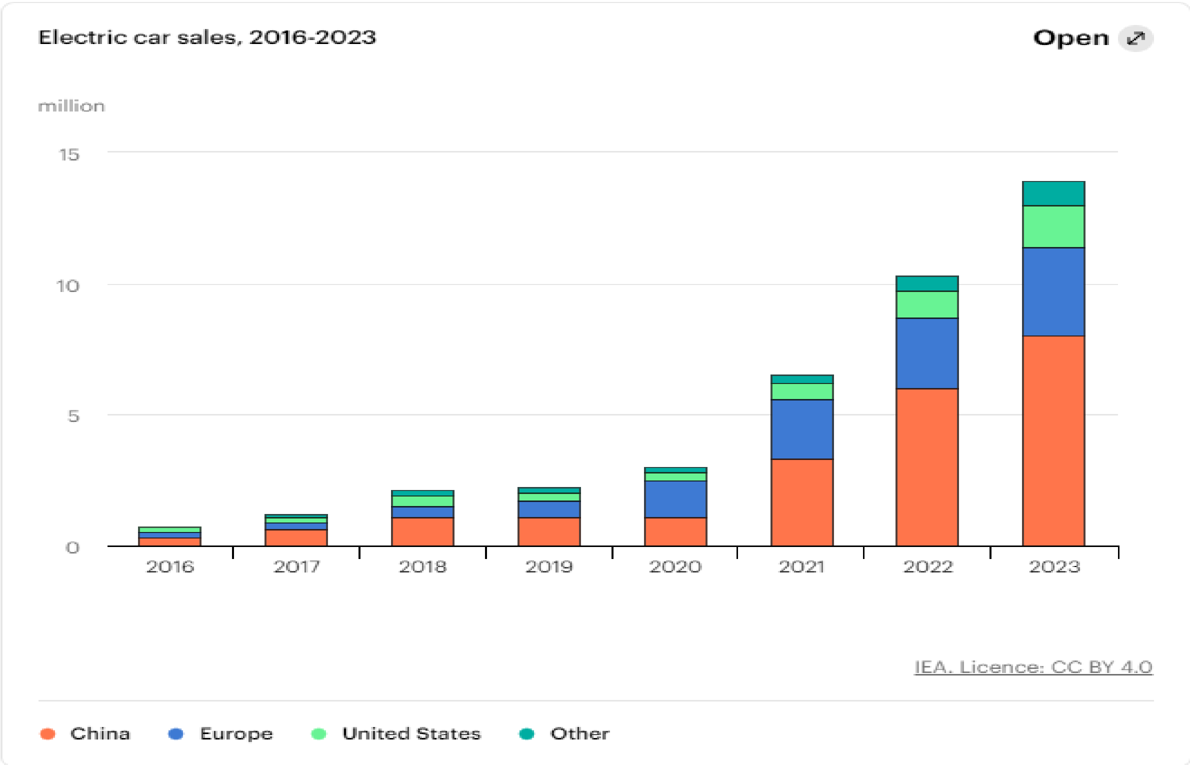


*Figure 5EV Sales 2016-2023*

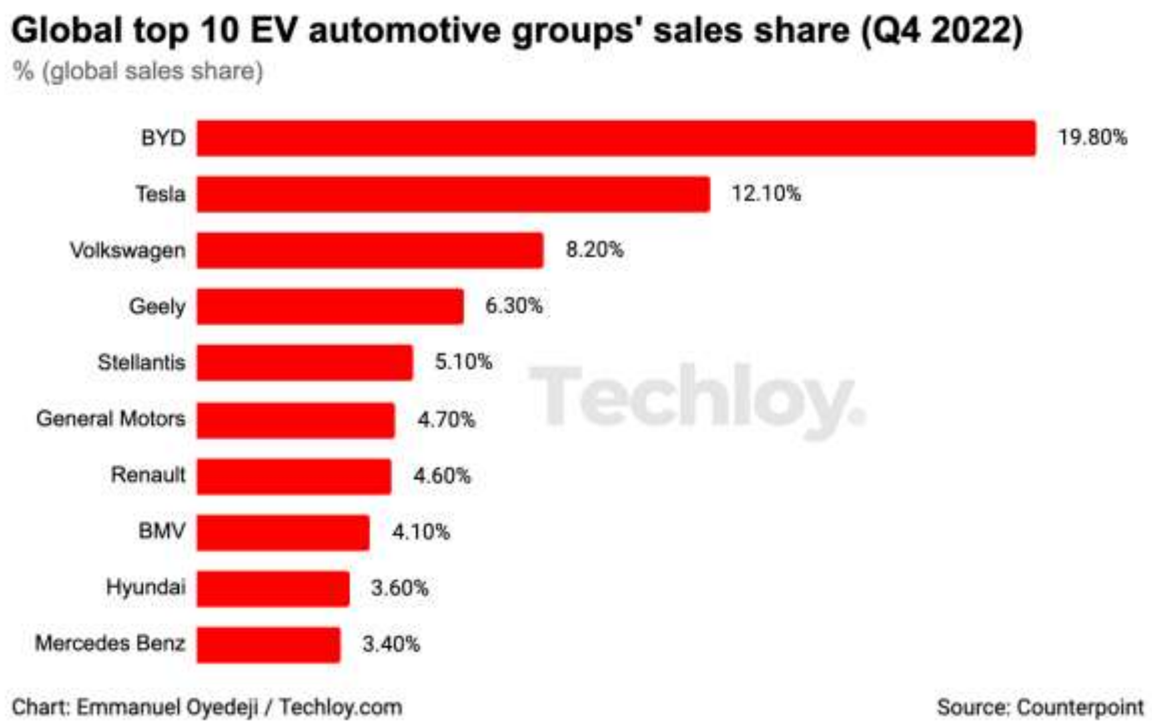


*Figure 6: - Global Top 10 EV Automotive Groups Sales Share*

1. ***Passenger Vehicles:*** *Passenger Vehicles: These include sedans, hatchbacks, coupes, convertibles, and SUVs. They are primarily used for personal transportation.*

   - *Sedans: These are cars with a separate trunk and typically have four doors. Popular models imported include Toyota Corolla, Volkswagen Jetta, Hyundai Elantra, etc.*
   - *Hatchbacks: Compact cars with a rear door that swings upward to provide access to a cargo area. e.g. Toyota Yaris, Volkswagen Polo, Renault Clio*
   - *SUVs (Sport Utility Vehicles): These vehicles combine elements of road-going passenger cars with features from off-road vehicle. e.g. Toyota RAV4, Honda CR-V, Hyundai Tucson, etc.*
   - *Coupes: Cars with two doors and a fixed roof.*
   - *Convertibles: Cars with a retractable roof.*
   - *Station Wagons: Cars with an extended rear cargo area.*
   - *Minivans: Designed to transport passengers in a three-row seating configuration with larger cargo space. e.g. Toyota Hiace, Nissan Urvan, etc.*

- *Multi-Purpose Vehicles (MPVs): Also known as minivans, these vehicles are designed for passenger transport and offer more space and flexibility than standard sedans.*
- *Plug-in Hybrid Electric Vehicles (PHEVs): Similar to HEVs but with larger batteries that can be recharged by plugging into an external power source.*

2. ***Commercial Trucks**: These are used for both personal and commercial purposes, featuring a cargo bed at the back for transporting goods. Ranging from light commercial vehicles (LCVs) to heavy-duty trucks, these are used for transporting goods and materials.*
   - *Pickup Trucks - Toyota Hilux, Isuzu D-Max, Mitsubishi L200*
   - *Light Commercial Vehicles - Small trucks and vans like Toyota Dyna, Isuzu NPR, Tata Ace*
   - *Heavy Trucks - Mercedes-Benz, MAN, Scania, Volvo, etc.*
3. ***Buses**: Used for public transportation, private charter, and tourism, buses come in various sizes, from minibuses to full-sized coaches. E..g. Mercedes-Benz, Higer, Yutong, Ankai, etc.*
4. ***Motorcycles**: Including scooters, bikes, and motorbikes, these two-wheeled vehicles are used for both personal transportation and commercial activities, such as delivery services.*
   - *Electric Vehicles (EVs): With the global shift towards sustainable energy, electric cars, buses, and motorcycles are increasingly being adopted and could be imported into Ethiopia.*
   - *Battery Electric Vehicles (BEVs): These are fully electric vehicles powered by rechargeable battery packs.*
   - *Hybrid Electric Vehicles (HEVs): Combine an internal combustion engine with an electric propulsion system.*
5. ***Construction and Agricultural Vehicles:** These include tractors, excavators, bulldozers, and backhoe loaders, which are essential for construction projects and agricultural work.*
   - *Construction equipment - JCB, Caterpillar, Hyundai, etc.*

- *Electric cars - Slowly growing in popularity, e.g., BYD, Tesla*

6. ***Motorcycles, Two-Wheelers, and Scooters:***
   - *Motorcycles: Two-wheeled vehicles varying from small commuter bikes to large touring motorcycles. e.g., Hero, Bajaj, TVS, Lifan, etc.*
   - *Scooters: Typically have a step-through frame and an automatic transmission, making them easy to ride. e.g., Vespa, Piaggio, TVS, etc.*
   - *Three-wheelers Tuk tuks (auto rickshaws) - Bajaj RE, Piaggio Ape*

7. ***Special Purpose Vehicles** - Specialized Vehicles: Such as ambulances, fire trucks, garbage trucks, and armoured vehicles, which are designed for specific functions.*
   - *Emergency Vehicles: Ambulances, fire trucks, police cars.*
   - *Military Vehicles: Armoured cars, troop carriers, and other specialized military transport.*
   - *Construction Vehicles: Bulldozers, excavators, cranes, and other heavy machinery used in construction.*

8. ***Agricultural Vehicles:** Agricultural Vehicles: Tractors, combine harvesters, and other farming equipment*
   - *Tractors - Massey Ferguson, Mahindra, John Deere, Foton, etc.*
   - *Combine Harvesters - Claas, John Deere, CASE IH*

9. ***Recreational Vehicles:***
   - *Campervans: Equipped with living accommodations for travellers or campers.*
   - *ATVs (All-Terrain Vehicles): Designed for off-road use, including dirt bikes and quad bikes.*

*Ethiopia has historically had high import duties on vehicles, which can limit the range of vehicles imported. Moreover, there are restrictions on the age of vehicles that can be imported, typically allowing only cars that are relatively new. This is part of an effort to modernize the vehicle fleet and reduce environmental impact. As the country develops, there is also a growing interest in electric and hybrid vehicles, although the market for these is still in its infancy*

*In Ethiopia, the types of vehicles imported are influenced by several factors, including the country's import regulations, road infrastructure, fuel prices, and the economic climate. Passenger vehicles like sedans, SUVs, and hatchbacks are commonly imported, with brands like Toyota, Hyundai, and Suzuki being popular. Commercial vehicles, including light and heavy trucks and buses, are also imported to support various industries and public transportation needs. There is also a market for two-wheelers, agricultural, and construction vehicles*

*It is important to note that Ethiopia's vehicle import regulations may affect the types and models of vehicles that can be brought into the country. High import taxes and restrictions on the age of imported vehicles are some of the measures that can influence the market.*

*Additionally, Ethiopia has been investing in local assembly and manufacturing plants in partnership with international car manufacturers to reduce the need for imports and foster the local automotive industry.*

### 4.1.6. THE CHARGING INFRASTRUCTURE

*The Electric Vehicle (EV) charging infrastructure is an essential component in the widespread adoption of electric vehicles. It consists of the network of charging stations, equipment, and services that allow EV owners to recharge their vehicles' batteries. Here's an overview of the key aspects of the EV charging infrastructure:*

*Charging Stations: These provide the physical locations where EVs can charge. They are found in various public, commercial, and residential locations. Major charging networks include ChargePoint, Blink, EVgo, Electrify America, Tesla Superchargers, etc. These providers often offer membership or pay-as-you-go options for EV drivers.*

- *Charging Levels - There are different levels of EV charging which deliver electricity at different speeds. Level 1 is slow charging through a regular wall outlet. Level 2 is faster charging through a 240V outlet. Level 3/DC fast charging rapidly charges an EV battery in under an hour.*
  - *Level 1 Charging: Uses a standard 120V AC outlet and is the slowest method, typically adding about 2 to 5 miles of range per hour of charging. It's often used for overnight charging at home.*

- *Level 2 Charging: Requires a 240V AC outlet and can charge an EV much faster, typically delivering about 12 to 80 miles of range per hour of charging. These are common in both residential and commercial settings.*
- *DC Fast Charging (DCFC) or Level 3 Charging: Uses direct current (DC) to charge an EV rapidly, often providing 60 to 100 miles of range in just 20 minutes of charging. These are typically found along highways and in public charging stations for quick top-ups.*

2. *Connectors and Standards: Different EVs use different types of charging connectors. The most common standards include the J1772 connector for Level 1 and Level 2 charging, which is used by most non-Tesla EVs in North America, the Combined Charging System (CCS) for DC fast charging, CHAdeMO primarily used by Japanese manufacturers, and Tesla's proprietary connector.*

   *Generally, Different charging connectors and ports are used to charge EVs. The most common are J1772, CCS, CHAdeMO and Tesla's proprietary connector.*

3. *Apps and Software - Apps help drivers locate stations, initiate charging, make payments and more. Smart charging software optimizes charging with grid demand.*
   - *Power Levels - Most public Level 2 stations provide power up to 19.2kW while DC fast chargers go over 50kW. Higher power means faster charging.*

2. *Location of Charging Stations: Charging stations can be found in various locations, including public parking areas, shopping centres, workplaces, hotels, and residential complexes. Highway rest stops are increasingly being equipped with fast chargers to facilitate long-distance travel.*
3. *Payment and Access: Many charging stations require users to have an account with the network provider, while others offer contactless payment options. Access can be granted through a mobile app, RFID card, or by using a credit card at the station.*
4. *Smart Charging: Many modern charging stations are equipped with smart technology that allows for features such as scheduling charging times, tracking energy usage, and integrating with renewable energy sources.*
5. *Challenges and Future Developments: The EV charging infrastructure still faces challenges such as the need for more widespread and evenly distributed charging stations, faster charging technologies, and the integration of the charging network with the elec-*

*trical grid. Innovations such as battery swapping, wireless charging, and vehicle-to-grid (V2G) technology are being explored to address these challenges.*

*As the number of EVs on the road continues to grow, the development of a robust and user-friendly charging infrastructure is crucial to support this transition and alleviate "range anxiety" among potential EV adopters.*


*Figure 7: - EV Sales Market Share top 10 countries in Ethiopia*

### 4.1.7. Maintenance and diagnosis

*Electric vehicles (EVs) require different maintenance and diagnostic procedures compared to internal combustion engine (ICE) vehicles due to their unique components and systems. Here is an overview of maintenance and diagnostic considerations for EVs:*

*Electric vehicles (EVs) have maintenance and diagnostic needs that differ from traditional internal combustion engine vehicles. Here's a more detailed look at what's involved:*

#### 4.1.7.1. EV Maintenance:

1. *Battery Maintenance:*

*The most significant component in an EV is the battery pack. It's essential to maintain the battery's health by keeping it within recommended charge levels (typically between 20% and 80%) and avoiding exposure to extreme temperatures for extended periods.*

- *The battery pack is the heart of an EV. It's important to maintain it properly by following the manufacturer's guidelines for charging (avoiding both complete depletion and constant high-level charging).*
- *Battery thermal management systems should be checked and maintained to ensure proper cooling or heating, as extreme temperatures can degrade battery performance and lifespan.*

2. *Brake System: EVs use regenerative braking to capture energy and recharge the battery, which can lead to less wear on the brake pads and discs. However, they still need regular checks to ensure they are functioning correctly.*
   - *While regenerative braking reduces wear on brake pads and rotors, they still require periodic inspection and maintenance.*
   - *Brake fluid should be replaced at intervals recommended by the manufacturer.*
3. *Cooling System: EV batteries and power electronics generate heat and often have a dedicated cooling system that needs to be maintained, including coolant fluid replacement at manufacturer-recommended intervals.*
   - *The cooling system for the battery pack and power electronics needs periodic checks and maintenance, including coolant level and quality checks.*
4. *Tire Maintenance: Proper tire inflation and regular rotation are essential for EVs, especially since they are often heavier than ICE vehicles, which can lead to faster tire wear.*
   - *Tires should be regularly inspected for wear and proper inflation due to the additional weight of EVs and the instant torque that can lead to quicker wear.*
5. *Suspension and Alignment: Regular checks and maintenance of the suspension and wheel alignment can help prevent uneven tire wear and ensure the vehicle handles correctly.*
   - *Due to the increased weight from the battery pack, suspension components may wear out more quickly and should be inspected regularly.*
6. *Software Updates: EVs often receive software updates that can improve vehicle performance, range, and functionality. These updates can sometimes be done remotely or may require a visit to a service center.*

   - *Software updates can often improve vehicle performance, range, and battery management. These can sometimes be done over-the-air or may require a visit to a dealership.*

7. *High-Voltage Electrical System: The high-voltage cables and components should be inspected for any signs of wear or damage, as they are critical to the vehicle's safety and operation.*
   - *High-voltage cables and connectors should be inspected for signs of damage or corrosion.*

#### 4.1.7.2. EV Diagnosis:

1. *Diagnostic Equipment: Diagnostic Tools: Specialized diagnostic tools and software are required to read the EV's fault codes and monitor the health of the battery and electric drive system. These tools are often proprietary to each manufacturer.*
   - *Specialized EV diagnostic tools are required to interface with the vehicle's computer systems to read trouble codes and monitor the health of the battery and electric drive system.*
2. *Battery Diagnostics: Battery capacity and health can be assessed using diagnostic equipment to measure state of charge (SoC), state of health (SoH), and to detect any imbalances between cells.*
   - *Diagnostics can determine the state of charge (SoC), state of health (SoH), and overall battery performance. Imbalances between cells can also be detected.*
3. *Motor and Inverter Diagnostics:* *The electric motor(s) and inverter(s) need to be checked for proper operation, including looking for any abnormal sounds or behaviors.*
4. *Thermal Management Diagnostics: Diagnostics may include checking the operation of the cooling system, including pumps, fans, and coolant condition. Checking the operation of the cooling system is important to ensure that the battery and power electronics are kept within optimal temperature ranges.*
5. *Electrical Inspections: High-voltage cables and connections must be inspected for integrity and proper insulation to prevent electrical hazards.*

6. *Motor and Inverter Inspection: Electric motors and inverters can be diagnosed for efficiency and any potential faults. This may include checking for unusual noises, vibrations, or heat generation.*
7. *On-Board Diagnostics (OBD): Many EVs have an OBD-II port, allowing for the connection of a scan tool to read diagnostic trouble codes (DTCs) and to monitor real-time data.*
8. *High-Voltage Safety: Safety is paramount when working on the high-voltage components of an EV. Only qualified technicians with specialized training should perform these tasks.*
   - *Safety is paramount when working on the high-voltage components of an EV. Only qualified technicians with specialized training should perform these tasks.*
9. *Recalls and Technical Service Bulletins (TSBs): Staying informed about any manufacturer recalls or TSBs can help diagnose and resolve known issues with specific EV models.*
   - *Keeping up with any recalls or TSBs can help address known issues with specific EV models.*

*Regular maintenance and prompt attention to any diagnostic alerts can help ensure the longevity and reliability of an EV. As EV technology continues to evolve, maintenance and diagnostic procedures will also adapt, potentially becoming more streamlined and user-friendly.*

*It's important to note that working on an EV's high-voltage system requires specialized training and equipment due to the risk of electric shock. Therefore, it's recommended that only qualified technicians perform diagnostics and repairs on these systems. Regular maintenance according to the manufacturer's schedule can help prevent many issues and extend the life of the vehicle.*

### 4.1.8. GOVERNMENT POLICIES

*Government Involvement: Governments around the world are investing in the expansion of the EV charging infrastructure to encourage the transition to electric vehicles. This includes funding for public charging stations, incentives for private installations, and regulations to ensure new buildings are EV-ready.*

### 4.1.9. CHARGING STATION

***List of charging stations for electric vehicles in Ethiopia.***

***Find the nearest EV charger for your electric car in Ethiopia***


Figure 8: - Find the nearest EV charger for your electric car in Ethiopia

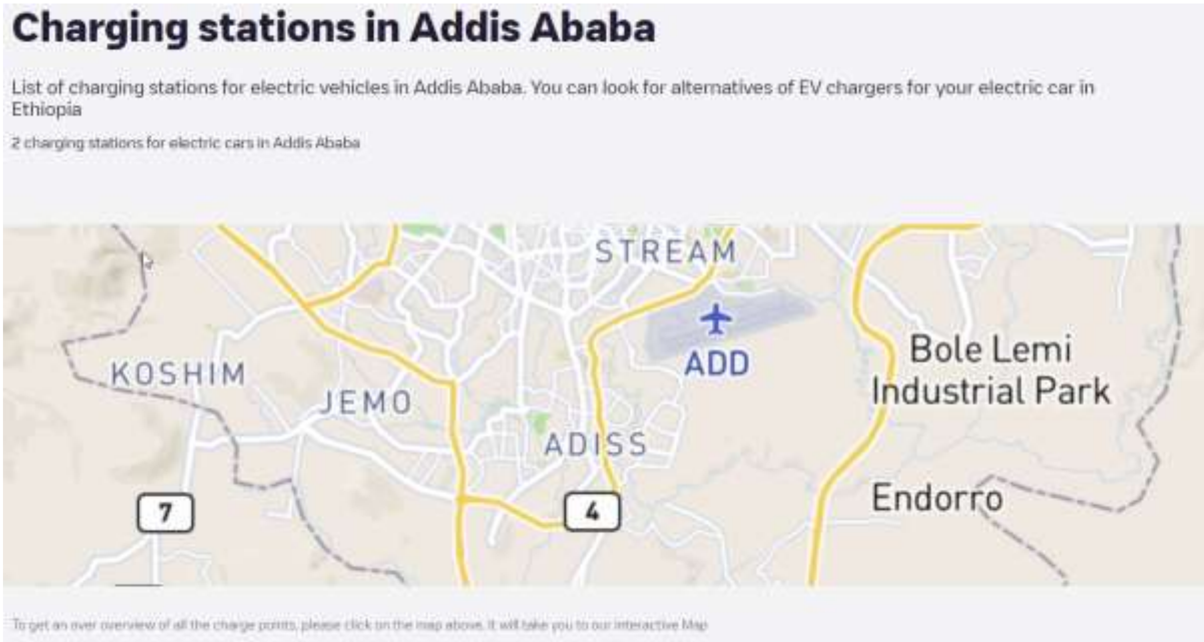


Figure 9: - New Charging Station in Addis Ababa

NEWEST CHARGEPOINTS

Shopping Centre

Gotera Condo - 11232 Gotera condo

#### 4.1.9.1. EV charging station installation cost

*The cost of installing an electric vehicle (EV) charging station can vary widely depending on several factors, such as the type of charger, the location, the need for electrical upgrades, and labor costs. Here's a general breakdown of the costs associated with installing an EV charging station:*

*1. "Charger Type": The cost of the charger itself can range from a few hundred dollars for a basic Level 1 charger to several thousand dollars for a Level 2 charger. Commercial Level 3 DC fast chargers can cost tens of thousands of dollars.*

*2. "Electrical Upgrades": If your existing electrical system needs upgrades to support the charger, this can add to the cost. For example, you might need a new circuit breaker, additional wiring, or even a new panel.*

*3. "Installation Labor": Hiring a professional electrician to install the charger is recommended. Labor costs can vary depending on the complexity of the installation and local rates.*

*4. "Permitting and Inspection": You may need to obtain a permit from your local government, which could include an inspection fee. The cost for permits and inspections can vary by location.*

*5. "Additional Equipment": Sometimes additional equipment such as conduit, a pedestal for mounting, or protection devices like a Ground Fault Circuit Interrupter (GFCI) may be needed.*

*6. "Networking and Software": For commercial installations or advanced home chargers, networking capabilities and software for managing the charger may add additional costs.*

*Here's a rough estimate of the costs:*

- ✓ *"Level 1 Charger": Often included with the vehicle, but if you need to purchase one, it's typically around $300-$600. Installation might not be needed if you have an existing outlet that meets the requirements.*
- ✓ *"Level 2 Charger": The units can cost between $500-$2,000, with installation costs potentially adding $500-$2,000 more, depending on the complexity of the job and local labor rates.*

- ✓ *"Level 3 Charger": These chargers are usually for commercial use and can cost from $20,000 to over $100,000, with installation costs varying widely based on the project's scale and infrastructure needs.*

*Please note these are rough estimates and prices can change over time. Additionally, some governments offer incentives, rebates, or tax credits that can offset the installation costs. It's always best to get multiple quotes from professional installers and check for any available incentives in your area.*

#### 4.1.9.2. EV Diagnosis and Maintenance

*Electric vehicles (EVs) are becoming increasingly popular due to their environmental benefits, lower running costs, and advancements in technology. EV diagnosis and maintenance differ from traditional internal combustion engine vehicles in several ways. Here's a general overview of what is involved in diagnosing and maintaining an electric vehicle:*

#### 4.1.9.3. EV Diagnosis

*1. "Diagnostic Tools": Many of the diagnostic tools for EVs are similar to those used for conventional vehicles, such as OBD-II scanners. However, these tools must be compatible with the specific electric vehicle's systems.*

*2. "Battery Health": One of the key areas for diagnosis in an EV is the battery pack. Technicians check the state of charge (SOC), state of health (SOH), and overall battery performance.*

*3. "Thermal Management System": EVs have complex thermal management systems to keep the battery at optimal temperatures. Diagnosing issues with this system is crucial as it can affect battery life and performance.*

*4. "Electric Motor(s)": The electric motor(s) must be checked for proper operation, including power delivery and any abnormal noises or vibrations.*

*5. "Power Electronics": The inverter, converters, and onboard charger are critical components that control the flow of electricity. Diagnosing these components requires specialized knowledge and equipment.*

*6. "Software Updates": EVs often require software updates to improve performance and fix bugs. Diagnosis might include checking for the latest firmware versions and updating as necessary.*

*7. "Regenerative Braking System": This system can have issues that need to be diagnosed, such as reduced efficiency or operational problems.*

#### 4.1.9.4. EV Maintenance

*1. "Battery Maintenance": While EV batteries generally require less maintenance than gasoline engines, it is important to monitor their health and maintain proper charging practices to maximize their lifespan.*

*2. "Cooling System": The cooling system for the battery and other electronic components needs to be checked and maintained regularly to ensure it is functioning correctly.*

*3. "Brake System": Although regenerative braking reduces wear on the brakes, the brake system still needs regular maintenance, including pad replacement and fluid checks.*

*4. "Tire Maintenance": EVs can be heavier than their gasoline counterparts due to the weight of the battery, which can lead to faster tire wear. Regular tire checks and rotations are important.*

*5. "Suspension Components": The added weight of an EV can also affect suspension components, necessitating regular inspections and potential replacements more frequently than in ICE vehicles.*

*6. "Software and Firmware": Regular updates to the vehicle's software and firmware are needed to ensure optimal performance and to introduce new features or fixes.*

*7. "High-Voltage Components": Safety checks on high-voltage cables and components are crucial due to the risks associated with high-voltage electricity.*

*8. "Cabin Air Filter": The cabin air filter should be replaced regularly to ensure good air quality inside the vehicle.*

*It's important to note that specific maintenance and diagnostic procedures can vary significantly between different EV models and manufacturers. Always refer to the vehicle's owner's manual for model-specific information and follow the recommended maintenance schedule provided by the manufacturer. For actual diagnostic and maintenance work, it is best to have a qualified EV technician perform the tasks, as they require specialized knowledge and safety precautions.*

#### 4.1.9.5. EV Marketing costs

*Marketing costs for an EV charging station can vary widely depending on the scale of the operation, the target market, and the chosen marketing strategies. Here are some factors that can influence the marketing costs:*

1. ***Brand Development**: This includes the costs of creating a brand identity, which encompasses logo design, brand messaging, and overall visual identity. This is crucial for making the charging station recognizable and trusted by potential users.*
2. ***Digital Marketing**: Online advertising through platforms like Google Ads, social media ads (Facebook, Instagram, Twitter, LinkedIn), and search engine optimization (SEO) to increase visibility.*
3. ***Content Production**: Creation of marketing materials such as brochures, flyers, blog posts, videos, and other content that can help educate potential customers about the benefits of using your charging stations.*
4. ***Public Relations**: Costs associated with hiring a PR firm or in-house efforts to generate media coverage and public awareness.*
5. ***Partnerships**: Forming partnerships with EV manufacturers, dealerships, or local businesses can be a cost-effective marketing strategy, but may involve co-marketing expenses.*
6. ***Events and Sponsorships**: Hosting or sponsoring events can raise awareness and encourage community engagement, but these activities can be expensive.*
7. ***Sales Promotions**: Discounts, free charging periods, or other promotional offers can attract users but may reduce initial revenue.*
8. ***Market Research**: Understanding the market through surveys, focus groups, and*

*Marketing costs for electric vehicles (EVs) can encompass a variety of strategies and channels, much like those for EV charging stations, but with a focus on the vehicles themselves. Here are several components of EV marketing costs:*

1. ***Brand Positioning and Messaging**: Developing a strong brand image and message that resonates with the values and interests of potential EV buyers, such as sustainability, innovation, and performance.*

2. ***Advertising**: Costs associated with traditional advertising (TV, radio, print) and digital advertising (online ads, social media campaigns, pay-per-click). Digital advertising can be particularly effective given the tech-savvy nature of many EV buyers.*
3. ***Website and Online Presence**: Designing and maintaining an engaging website that provides detailed information about the EV models, their features, and benefits. This also includes search engine optimization (SEO) to ensure high visibility in search results.*
4. ***Social Media Marketing**: Engaging with potential customers through platforms like Facebook, Twitter, Instagram, and YouTube. This may involve creating organic content or paid promotions to increase reach.*
5. ***Influencer Partnerships**: Collaborating with influencers who can reach potential EV buyers and sway their opinions can be a significant part of the marketing budget.*
6. ***Dealership Training and Materials**: Training dealership staff to effectively sell EVs and providing them with marketing materials can help ensure that the sales process aligns with the brand's marketing efforts.*
7. ***Customer Experience and Test Drives**: Offering test drives and immersive experiences can help convince potential buyers but may involve logistical costs.*
8. ***Events and Auto Shows**: Participating in auto shows, industry conferences, and hosting launch events for new models can be a substantial marketing expense.*
9. ***Educational Campaigns**: Since EVs are still a relatively new technology for many consumers, educational campaigns that explain the benefits and address common concerns about EV ownership can be critical.*
10. ***Loyalty and Referral Programs**: Implementing programs to reward current EV owners for referrals can help generate word-of-mouth marketing but requires some investment to manage and fulfil rewards.*
11. ***Public Relations**: Managing media relations and getting coverage in news outlets, magazines, and online publications can enhance brand credibility and reach.*
12. ***Market Research**: Conducting research to understand consumer behavior, preferences, and trends in the EV market to tailor marketing strategies effectively.*
13. ***Regulatory Compliance**: Ensuring all marketing materials and claims comply with local and international regulations, which may require legal consultation.*

*The actual marketing budget for EVs will depend on the size of the company, the scope of the marketing campaign, the target market, and the competitive landscape. It's also worth noting that as the EV market matures, marketing strategies may shift to focus more on differentiating specific models and features rather than promoting the concept of electric mobility itself.*

#### 4.1.10. PROJECTION OF CASH FLOW (INITIAL CASH FLOW, NET CASH FLOW, AND TERMINAL CASH FLOW)

*Creating a projection of cash flow for an EV charging station involves estimating all the expected cash inflows and outflows over a certain period. This projection allows you to assess the financial viability and plan. Here's a simplified approach to projecting cash flow for an EV charging station:*

1. ***Initial Capital Expenditure (CapEx)*:**
   - ***Purchase of charging equipment**: The cost of the charging stations themselves.*
   - ***Installation costs**: Including electrical work, construction, permits, and inspections.*
   - ***Site preparation**: Costs for preparing the location, which might include paving, lighting, and signage.*
   - ***Network and software setup**: Costs for software to manage the charging stations, process payments, and provide customer support.*
2. ***Operating Expenses (OpEx)*:**
   - ***Electricity costs**: The cost of the electricity supplied to EVs.*
   - ***Maintenance and repairs**: Regular servicing and any unexpected repairs.*
   - ***Network service fees**: Ongoing fees paid to charging network providers for use of their software and services.*
   - ***Insurance**: Liability and property insurance for the charging station.*
   - ***Property rent or mortgage**: If applicable, the cost of renting or buying the land or space where the charging station is located.*
   - ***Marketing and advertising**: Costs to promote the charging station.*
   - ***Labor**: Salaries or wages for employees managing the station.*

- ***Administrative costs**: Including office supplies, utilities, and other miscellaneous expenses.*
- ***Taxes and regulatory fees**: Any applicable local, state, or federal taxes or fees.*

3. ***Revenue Streams**:*
   - ***Charging fees**: Income from customers using the charging service, which could be per kWh, per hour, or a flat fee.*
   - ***Membership or subscription fees**: If a subscription model is used.*
   - ***Advertising**: Income from selling advertising space at the charging station or within the network app.*
   - ***Grants and incentives**: Any government or utility grants, tax credits, or rebates received for operating an EV charging station.*
4. ***Cash Flow Projection**:*
   - ***Monthly Cash Inflow**: Sum of all revenue streams per month.*
   - ***Monthly Cash Outflow**: Sum of all operating expenses per month.*
   - ***Net Monthly Cash Flow**: Monthly inflow minus monthly outflow.*
   - ***Cumulative Cash Flow**: Running total of net monthly cash flow, adding each month's net cash flow to the previous total.*
5. ***Break-even Analysis**:*
   - *Determine the point at which cumulative cash flow becomes positive after recovering from initial CapEx.*
6. ***Sensitivity Analysis**:*
   - *Assess how changes in key assumptions (e.g., utilization rate, electricity cost, charging fees) affect cash flow.*
7. ***Return on Investment (ROI)**:*
   - *Calculate the ROI by comparing the net cash flows to the initial investment to determine the profitability over time.*

*When creating a cash flow projection, it is important to be as accurate as possible with the estimates and to consider the best, base, and worst-case scenarios. Regularly updating the projec-*

*tion with actual figures once the charging station is operational will also provide a more accurate financial picture and allow for adjustments in strategy or operations.*

### 4.1.11. EV CHARGING SOLUTIONS

#### AC CHARGER

| | | |
|---|---|---|
| ***1*** |  | *7kW Home Charger*<br><br>*Simple, smart, and powerful, our 7kW home charger is built to make charging at home as easy as possible. Charging schedules, load balancing, and energy sources from solar & battery can all be managed with your phone.*<br><br>*✓Smart charging and load balancing*<br><br>*✓Charging power 7kW or 11kW optional* |
| ***2*** |  | *EV Wall Charger*<br><br>*Grasen EV Wall Charger 7kW and 22kW versions are designed for residential applications. It's easy to install, and supports plug and charge.*<br><br>*Plug and Charge*<br><br>*Charging power 7kW or 22kW optional* |
| ***3*** |  | *Home EV Charger*<br><br>*Grasen Level 2 EV charger is CE-approved and OCPP compatible, it supports dynamic load balance and has a high safety level.*<br><br>*✓Smart charging and load balancing*<br><br>*✓Charging power 7kW or 22kW optional* |
| ***4*** |  | *Level 2 EV Charger*<br><br>*Grasen Level 2 EV charger is CE-approved and OCPP compatible, it supports dynamic load balance and has a high safety level.*<br><br>*✓ Smart charging and load balancing* |

| | | |
|---|---|---|
| | | ✓ *Charging power 7kW or 22kW optional* |
| **5** |  | *Dual EV Charger*<br><br>*Charging power 2x7kW(single phase) or 2x22kW(three phase) optional, 2xMID Meter inside compatible with the calibration law.*<br><br>✓ *Smart charging and load balancing*<br><br>✓ *2 x 7kW/11kW output power optional* |

*Table 6:- AC Charging Solutions*

## DC Charger

| | | |
|---|---|---|
| **1** |  | *Wallbox DC Fast Charger*<br><br>*The second-generation 30kW or 60kW DC wallbox charger is designed for easy installation and low maintenance. The compact size and lightweight make it perfect for fast charging at the commercial parking lot, residential, EV dealerships, and fleet operators.*<br><br>✓ *Smart charging and load balancing*<br><br>✓ *Multi-standard CCS CHAdeMO GB/T* |
| **2** |  | *CCS EV Charger*<br><br>*Grasen Newly Released CCS EV charger – R series DC EV charging station is a product that combines performance and cost-effectiveness.*<br><br>✓ *Smart charging and load balancing*<br><br>✓ *Multi-standard CCS CHAdeMO GB/T* |
| **3** |  | *DC EV Charging Station*<br><br>*Grasen DC EV charging station is CE-approved and features a wide output voltage range of 150V~1000V, supporting multi-standard charging.*<br><br>✓ *Smart charging and load balancing* |

| | | |
|---|---|---|
| | | ✓ Multi-0standard CCS CHAdeMO GB/T |
| **4** |  | DC Fast Charging Stations<br>Grasen DC Fast Charging Stations are CE-approved and feature a wide output voltage range of 150V~1000V, supporting multi-standard charging.<br>✓ Smart charging and load balancing<br>✓ Multi-standard CCS CHAdeMO GB/T |
| **5** |  | Multi-standard DC Charging Station<br>Grasen CE-approved Multi-standard DC Charging Station has 2 DC outlet ports and 1 AC outlet port, which can charge 3 vehicles simultaneously.<br>✓ Smart charging and load balancing<br>✓ Multi-standard CCS CHAdeMO GB/T |

*Table 7: - DC Charging Solutions*

## 4.1.12. FINANCIAL EVALUATION

### 4.1.12.1. Payback period (PBP)

*To calculate the payback period for the installation of a charging station, we would need to consider several factors beyond the product features. Here's a general approach to calculating the payback period:*

1. ***Initial Investment**: This includes the cost of the charging station itself, installation costs, any necessary electrical upgrades, and other associated costs.*
2. ***Operating Costs**: This includes the cost of electricity, maintenance, network fees (if applicable), and any other ongoing expenses.*
3. ***Revenue Streams**: If we are charging users to use the station, we will need to estimate the revenue. This could come from pay-per-use fees, subscription models, or other payment methods mentioned (NFC/RFID, Plug and Charge, APP).*

4. ***Utilization Rates***: *Estimate how often the charging station will be used. This will depend on the location, the number of electric vehicles in the area, and other factors.*

5. ***Electricity Rates***: *The cost of electricity to charge the vehicles will affect both operating costs and pricing for customers.*

6. ***Incentives***: *Include any government or utility incentives, tax breaks, or rebates that may apply to the installation of EV charging stations.*

*Given these factors, the payback period formula is:*

***[ \text{Payback Period} = \frac{\text{Initial Investment}}{\text{Annual Savings or Earnings}} ]***

*Where:*

- ***Initial Investment*** *is the total upfront cost.*
- ***Annual Savings or Earnings*** *is the net profit per year after subtracting operating costs from revenue.*

*Here's a simplified example:*

- *Initial Investment: $10,000 (for the purchase and installation of the charging station)*
- *Annual Operating Costs: $500 (electricity, maintenance, etc.)*
- *Annual Revenue: $3,000 (from customers using the service)*

*[ \text{Annual Net Earnings} = \text{Annual Revenue} - \text{Annual Operating Costs} ]*
*[ \text{Annual Net Earnings} = $3,000 - $500 = $2,500 ]*

*[ \text{Payback Period} = \frac{$10,000}{$2,500} = 4 \text{ years} ]*

*In this simplified example, the payback period would be 4 years. However, it's important to note that the actual calculation can be more complex and should include a detailed financial analysis considering all potential variables specific to the location and usage of the charging station.*

### 4.1.13. ACCOUNTING RATE OF RETURN (ARR)

*The Accounting Rate of Return (ARR), or Simple Rate of Return, is a financial metric used to measure the profitability of an investment. It is calculated by dividing the average annual profit (or accounting income) by the initial investment or the average in-*

*vestment over the life of the project. Here's how to calculate the ARR for an EV charging station installation:*

1. ***Determine the Initial Investment**: This includes the cost of the charging station, installation costs, electrical upgrades, and any other capital expenditures.*
2. ***Estimate the Annual Operating Income**: This is the revenue generated from the charging station minus the annual operating expenses (such as electricity, maintenance, and network fees).*
3. ***Calculate Depreciation**: If you are including depreciation as an expense, you will need to determine the annual depreciation of the charging station. This is typically done by dividing the initial investment by the useful life of the asset.*
4. ***Calculate the Average Annual Profit**: Subtract the depreciation (if included) from the annual operating income.*
5. ***Calculate the Average Investment**: This can be done by taking the sum of the beginning and ending book value of the investment (initial cost minus accumulated depreciation over time) and dividing it by 2. Alternatively, you can use just the initial investment if you prefer a simpler approach.*
6. ***Calculate ARR**: Divide the average annual profit by the average investment.*

*Here's the formula for ARR:*

***[ \text{ARR} = \left( \frac{\text{Average Annual Profit}}{\text{Average Investment}} \right) \times 100% ]***

*An example calculation:*

| | Description | Amount |
|---|---|---|
| 1 | Initial Investment: | $10,000 |
| 2 | Useful Life of the Asset: | 10 years |
| 3 | Annual Operating Income: | $3,000 |
| 4 | Annual Operating Expenses: | $500 |

| | | |
|---|---|---|
| 5 | Annual Depreciation: | 10,000/10 years=10,000/10years=1,000 |

Table 8: - ACCOUNTING RATE OF RETURN (ARR)

***[ \text{Average Annual Profit} = \text{Annual Operating Income} - \text{Annual Operating Expenses} - \text{Annual Depreciation} ] [ \text{Average Annual Profit} = $3,000 - $500 - $1,000 = $1,500 ]***

***[ \text{Average Investment} = \frac{\text{Initial Investment} + (\text{Initial Investment} - \text{Total Depreciation})}{2} ] [ \text{Average Investment} = \frac{$10,000 + ($10,000 - $10,000)}{2} = \frac{$10,000}{2} = $5,000 ]***

***[ \text{ARR} = \left( \frac{$1,500}{$5,000} \right) \times 100% = 30% ]***

*In this example, the ARR for the EV charging station installation would be 30%. This means that the project is expected to generate an average return of 30% of the average investment per year over its useful life. Keep in mind that this is a simplified example, and actual ARR calculations should include a more detailed financial analysis with all relevant factors considered.*

#### 4.1.13.1. NET PRESENT VALUE (NPV)

*The Net Present Value (NPV) is a financial metric used to evaluate the profitability of an investment by calculating the present value of expected cash flows over the life of the investment, discounted at a specific rate, usually the cost of capital or discount rate. NPV considers the time value of money, recognizing that a dollar today is worth more than a dollar in the future.*

*To calculate the NPV for an EV charging station installation, follow these steps:*

1. ***Estimate the Cash Flows**: Determine the expected annual cash inflows (revenue from customers) and outflows (operating expenses, maintenance, electricity costs, etc.) for each year of the project's life.*
2. ***Determine the Discount Rate**: This could be the weighted average cost of capital (WACC), required rate of return, or another appropriate discount rate reflecting the risk of the investment.*

3. ***Calculate the Present Value of Each Cash Flow**: Discount each cash flow back to its present value using the formula:*

$$PV = \frac{CF}{(1 + r)^n}$$

*Where:*

- *( $PV$ ) = Present Value*
- *( $CF$ ) = Cash Flow for a given year*
- *( $r$ ) = Discount rate*
- *( $n$ ) = Year number*

4. ***Calculate the Net Present Value**: Sum the present values of all future cash flows and subtract the initial investment.*

*The NPV formula is:*

$$NPV = \sum_{n=1}^{N} \frac{CF_n}{(1 + r)^n} - I$$

*Where:*

- *( $CF_n$ ) = Cash flow in year ( $n$ )*
- *( $r$ ) = Discount rate*
- *( $N$ ) = Total number of periods*
- *( $I$ ) = Initial investment*

*If the NPV is positive, it indicates that the expected earnings (discounted back to present dollars) exceed the initial investment; the project is likely to be profitable. If the NPV is negative, the project is expected to lose money.*

*Let's go through a simplified example:*

| | Description | Amount |
|---|---|---|
| 1 | Initial Investment: | $50,000 |
| 2 | Project Lifetime: | 10 years |
| 3 | Annual Revenue: | $10,000 |
| 4 | Annual Operating Expenses: | $2,000 |
| 5 | Annual Depreciation: | 10,000-2,000=8,000 |
| 6 | Discount Rate: | 8% |

*Table 9:- NET PRESENT VALUE (NPV)*

$$NPV = -\$50,000 + \sum_{n=1}^{10} \frac{\$8,000}{(1 + 0.08)^n}$$

*You would then calculate the present value for each year's cash flow and sum them up:*

$$NPV = -\$50,000 + \frac{\$8,000}{1.08} + \frac{\$8,000}{(1.08)^2} + \dots + \frac{\$8,000}{(1.08)^{10}}$$

*Using a financial calculator or spreadsheet software, we would find the sum of the present values of the cash flows and then subtract the initial investment to find the NPV.*

### 4.1.13.2. INTERNAL RATE OF RETURN (IRR)

*The Internal Rate of Return (IRR) is a financial metric used to estimate the profitability of potential investments. It is the discount rate that makes the net present value (NPV) of all cash flows from a particular project equal to zero. In other words, the IRR is the annualized effective compounded return rate that can be earned on the invested capital, i.e., the yield on the investment.*

*To calculate the IRR for an EV charging station installation, we would typically follow these steps:*

1. ***Estimate the Cash Flows**: Determine the expected annual net cash flows (revenues minus expenses) for each year of the project's life, including the initial investment as a negative cash flow at the start.*
2. ***Set NPV to Zero**: Use the NPV formula and set it equal to zero, solving for the discount rate (which is the IRR in this case).*

*The formula for NPV is:*

$$NPV = \sum_{t=0}^{N} \frac{CF_t}{(1 + IRR)^t}$$

*Where:*

- *$CF_t$ = Net cash flow at time $t$*
- *$IRR$ = Internal rate of return*
- *$t$ = Time period (year)*
- *$N$ = Total number of periods (life of the project)*

*The initial investment is typically represented as $CF_0$ and is a negative number because it's an outflow.*

3. ***Solve for IRR**: The equation is generally solved using numerical methods or financial calculators/software, as there is no algebraic solution for IRR in most cases.*

*Let's go through a simplified example:*

| | Description | Amount |
|---|---|---|
| 1 | Initial Investment: | 50,000 (Year 0: \( CF_0 = -\50,000 )) |
| 2 | Project Lifetime: | 5 years - 15,000 for each of the next 5 years (Years 1 to 5: \( CF_t = \15,000 )) |

Table 10:- Table 4.1.13.2. INTERNAL RATE OF RETURN (IRR)

*The NPV equation with unknown IRR is:*

$$0 = -\$50,000 + \frac{\$15,000}{(1 + IRR)} + \frac{\$15,000}{(1 + IRR)^2} + \frac{\$15,000}{(1 + IRR)^3} + \frac{\$15,000}{(1 + IRR)^4} + \frac{\$15,000}{(1 + IRR)^5}$$

*To find the IRR, you would use a financial calculator, spreadsheet software like Microsoft Excel, or a programming language with financial functions. In Excel, for example, you can use the IRR function and provide the range of cash flows, including the initial investment.*

*The IRR is the rate you would enter the formula to make the sum of the present values of all cash flows (both inflows and outflows) equal to zero. It represents the break-even rate of return for the project; if the actual return is higher than the IRR, the project is considered profitable.*

*Please note that this is a simplified example, and real-world calculations would need to consider factors such as varying cash flows, taxes, maintenance costs, and any salvage value at the end of the project's life. Additionally, the IRR should be compared against the required rate of return or the company's cost of capital to determine if the project is a good investment.*

#### 4.1.13.3. BREAK-EVEN ANALYSIS (BEA)

*A break-even analysis for an EV charging station installation determines the point at which the total revenues equal the total costs, meaning the project starts to generate profit. To perform a break-even analysis, you will need to consider both fixed costs and variable costs associated with the operation of the charging station, as well as the price at which you will be selling the charging service.*

*Here's a step-by-step approach to conducting a break-even analysis:*

1. ***Identify Fixed Costs**: Fixed costs are expenses that do not change with the volume of sales or services provided. For an EV charging station, fixed costs might include the initial installation cost, land lease or purchase cost, insurance, property taxes, and any regular maintenance contracts.*
2. ***Identify Variable Costs**: Variable costs fluctuate with the level of output or service provided. For an EV charging station, variable costs might include electricity costs, transaction fees, and additional maintenance or repair costs that depend on usage.*
3. ***Determine the Charging Price**: This is the price you will charge customers for using the EV charging station, typically on a per kWh basis.*
4. ***Calculate the Contribution Margin**: The contribution margin is the selling price per unit minus the variable costs per unit. This margin contributes to covering the fixed costs.*
5. ***Compute the Break-Even Point**: The break-even point (BEP) in units can be calculated using the formula:*

**[ BEP_{units} = \frac{Total Fixed Costs}{Contribution Margin Per Unit} ]**

6. ***Calculate the Break-Even Revenue**: To find the break-even revenue, multiply the BEP in units by the price per unit.*

**[ BEP_{revenue} = BEP_{units} \times Price Per Unit ]**

*Let's go through a simplified example:*

| | Description | Amount |
|---|---|---|
| 1 | Initial Investment (Fixed Cost): | $50,000 |
| 2 | Annual Fixed Costs (maintenance, insurance, etc.): | 5,000 |
| 3 | Variable Cost per kWh (electricity, transaction fees): | $0.10 |
| 4 | Selling Price per kWh: | $0.30 |

*Table 11:- Table - 4.1.13.3. BREAK-EVEN ANALYSIS (BEA)*

*First, calculate the contribution margin per kWh:*

**[ Contribution Margin Per kWh = Selling Price Per kWh - Variable Cost Per kWh ]**

**[ Contribution Margin Per kWh = 0.30−0.30−0.10 = $0.20 ]**

*Now, calculate the break-even point in kWh:*

**[ BEP_{kWh} = \frac{Total Fixed Costs}{Contribution Margin Per kWh} ] [ BEP_{kWh} = \frac{50,000+50,000+5,000}{$0.20} = 275,000 \text{ kWh} ]**

*This means that the EV charging station needs to sell 275,000 kWh of electricity to break even.*

*To find the break-even revenue:*

**[ BEP_{revenue} = BEP_{kWh} \times Selling Price Per kWh ] [ BEP_{revenue} = 275,000 \times $0.30 = $82,500 ]**

*So, the station needs to generate $82,500 in revenue to break even.*

*Keep in mind that this is a simplified example for illustrative purposes. In reality, the analysis would need to account for factors such as the mix of fixed and variable costs, potential changes in electricity rates, and the demand for charging services, which can vary based on location, time of day, and the number of electric vehicles in the area.*

## 4.2. RAW MATERIALS AND SUPPLIES STUDY

*Currently I am working on BYD company in Hong Kong China*

*The installation of electric vehicle (EV) charging stations involves several raw materials and supplies. Below is a non-exhaustive list of components and materials typically required for the setup of EV charging infrastructure:*

### 4.2.1. CORE COMPONENTS

1. ***Charging Station Unit****: The primary equipment that includes the EVSE (Electric Vehicle Supply Equipment) hardware.*
2. ***Cable and Connector****: The cord that connects the charging station to the electric vehicle, typically with a standardized connector such as J1772, CCS, CHAdeMO, or Tesla proprietary connectors.*
3. ***Circuit Breakers****: To protect the electrical circuit from damage caused by overcurrent.*
4. ***Conduit****: Protective casing for electrical wiring.*
5. ***Wiring****: Electrical cables for power and communication lines.*
6. ***Mounting Equipment****: Stands, brackets, or pedestals to secure the charging station.*

### 4.2.2. ANCILLARY MATERIALS

1. ***Concrete****: For creating a base pad for the charging station if it's not wall mounted.*
2. ***Metal Framing****: For supporting equipment and possibly for cable runs.*
3. ***Signage****: To indicate parking spots reserved for EV charging and instructions for use.*
4. ***Paint****: For marking parking spaces and possibly for protective coatings on metal works.*

### 4.2.3. ELECTRICAL INFRASTRUCTURE

1. ***Transformers****: For stepping down or stepping up the voltage to meet the requirements of the charging station.*
2. ***Switchgears****: For controlling, protecting, and isolating electrical equipment.*

3. ***Disconnect Switches**: For safety purposes, allowing the charging station to be disconnected from the power source.*
4. ***Metering Equipment**: To measure the amount of electricity used for billing purposes.*
5. ***Grounding Equipment**: For safety, to prevent electric shock by providing a path for fault current to the ground.*
6. ***Surge Protection Devices**: To protect the charging station from voltage spikes.*

### 4.2.4. INSTALLATION TOOLS AND EQUIPMENT

1. ***Drilling Machines**: For making holes in walls or concrete pads.*
2. ***Screwdrivers, Wrenches, Pliers**: For assembling and securing components.*
3. ***Wire Strippers and Crimpers**: For preparing and connecting wires.*
4. ***Multi meter and Clamp Meter**: For electrical testing and troubleshooting.*
5. ***Personal Protective Equipment (PPE)**: Gloves, safety glasses, hard hats, etc., for installer safety.*
6. ***Level and Measuring Tape**: For precise installation.*

### 4.2.5. NETWORKING AND COMMUNICATION SUPPLIES

1. ***Ethernet Cables**: For wired network connections.*
2. ***Wi-Fi Routers or Cellular Gateways**: For wireless communication.*
3. ***RFID Readers**: For user authentication in some charging stations.*

### 4.2.6. SOFTWARE AND MANAGEMENT SYSTEMS

1. ***Charging Station Management Software**: For operation, monitoring, and maintenance of charging stations.*
2. ***Payment Processing Systems**: For handling transactions if the charging service is not free.*

### 4.2.7. COMPLIANCE AND SAFETY MATERIALS

1. ***UL Listed Components**: To meet safety standards.*

2. ***NEC Code Compliant Materials**: To abide by the National Electrical Code requirements.*

*This list is just a starting point, and the specific requirements can vary greatly depending on the type of charging station (Level 1, Level 2, or DC Fast Charging), the location (residential, commercial, or public), and local regulations and standards. It's also important to consider the environmental conditions where the charging station will be installed, as this can affect the choice of materials (e.g., corrosion resistance for coastal areas).*

*For a detailed study, Currently I am working* ***with BYD EV car manufacturing company in Hong Kong China****. it would be beneficial to consult with manufacturers, suppliers, and installation professionals, as well as to review industry standards and guidelines from organizations such as SAE International, the International Electrotechnical Commission (IEC), and local governing bodies.*

## 4.3. LOCATION AND SITE ASSESSMENT

*EV Charging Station Location and Site Assessment in Addis Ababa*

*When assessing a location for an EV charging station in Addis Ababa or any other city, several factors must be taken into consideration to ensure the site is viable, accessible, and convenient for users. Here is a list of considerations for a location and site assessment:*

### 4.3.1. DEMAND ANALYSIS

1. ***Proximity to High Traffic Areas****: Locations near main roads, highways, commercial centres, or areas with high EV usage are preferable.*
2. ***EV Ownership and Adoption Rates****: Understanding the local market for electric vehicles is crucial to predict the demand for charging stations.*

### 4.3.2. ACCESSIBILITY

1. ***Ease of Access****: The site should be easily accessible from main roads without complex manoeuvres.*
2. ***Visibility****: The charging station should be visible to EV drivers, possibly with clear signage.*
3. ***Parking Space****: There should be adequate space for EVs to park and charge, without obstructing other vehicles or pedestrians.*

### 4.3.3. INFRASTRUCTURE

1. ***Electrical Grid Capacity****: The local grid must be able to support the additional load from the charging station.*
2. ***Connectivity****: Availability of network connectivity for smart charging stations that require internet access for monitoring and payments.*
3. ***Safety and Security****: The site should be safe for users at all times and secure from* **vandalism or theft.**

### 4.3.4. REGULATORY COMPLIANCE

1. ***Zoning Laws****: Ensure the location complies with local zoning regulations for the installation of charging infrastructure.*

2. ***Building Permits****: Necessary permits must be obtainable for the construction and operation of the charging station.*

3. ***Environmental Regulations****: Compliance with environmental regulations, especially if construction is required.*

#### 4.3.5. COST FACTORS

1. ***Land Acquisition or Rental Costs****: Costs associated with acquiring or renting the land for the charging station.*

2. ***Installation Costs****: Costs of materials, labor, and any civil works required for installation.*

3. ***Utility Costs****: Costs for electricity and grid connection, including demand charges and any potential need for grid upgrades.*

#### 4.3.6. FUTURE EXPANSION

1. ***Scalability****: The site should allow for additional charging points to be added in the future as demand grows.*

2. ***Technological Upgrades****: Consideration for future technological advancements in charging equipment and compatibility.*

#### 4.3.7. USER AMENITIES

1. ***Waiting Area****: Space for drivers to rest or work while their vehicle is charging.*

2. ***Retail and Services****: Proximity to shops, restaurants, or other services can be a value-added feature for a charging station location.*

#### 4.3.8. PARTNERSHIPS

1. ***Local Businesses****: Partnerships with local businesses can provide mutual benefits, such as increased foot traffic for the businesses and amenities for EV users.*

2. ***Government Incentives****: Exploration of any government incentives or support for sustainable transportation infrastructure.*

#### 4.3.9. ENVIRONMENTAL IMPACT

1. ***Sustainability****: Consideration for the use of renewable energy sources to power the charging stations.*

2. ***Impact Assessment**: An analysis of the potential environmental impact of the charging station, including noise and light pollution.*

*To assess the suitability of a location in Addis Ababa, local data and insights are essential. This may involve conducting surveys, analyzing traffic patterns, consulting with local EV owners, and collaborating with city planners and utility providers. Additionally, understanding the specific needs and behaviors of EV users in Addis Ababa will help tailor the charging station to local preferences and requirements.*

*For a comprehensive assessment, it may be helpful to engage with experts in urban planning, electrical engineering, and sustainable transportation, as well as to review case studies or guidelines from cities with established EV charging infrastructure.*

## 4.4. PRODUCTION PROGRAM AND PLANT CAPACITY (IF ANY)

*The availability of publicly accessible fast chargers is expanding, which is crucial for supporting longer trips by electric vehicles (EVs). This growth in infrastructure is expected to encourage EV purchases among those without private charging options and alleviate concerns over driving range, thus promoting the adoption of EVs.*

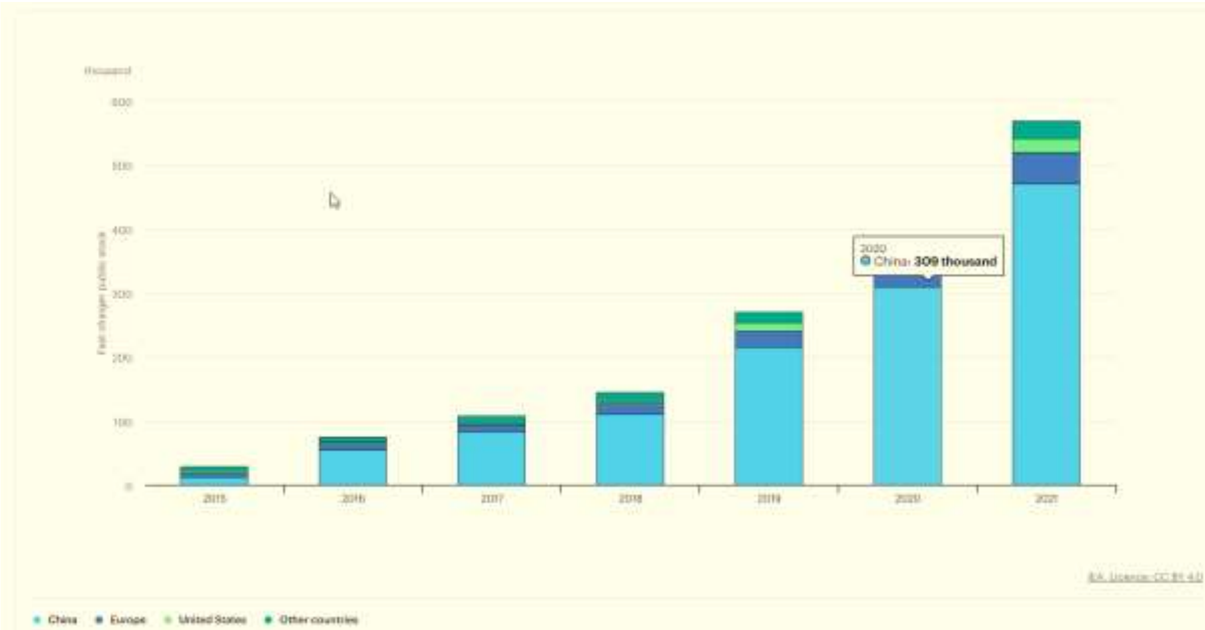


*Figure 10: Fast publicly available chargers, 2015-2021 - Source: Global EV outlook 2022 – IEA.org*

## 4.5. TECHNOLOGY SELECTION (IF ANY)

*The development of electric vehicle (EV) charging infrastructure in Ethiopia is a key component in the transition towards an electrified transportation future. Although specific details about the current number of charging stations and their distribution are not readily available in the search results, the establishment of a robust charging network is a priority for the country.*

*According to a LinkedIn article titled "Accelerating Progress: Revolutionizing Ethiopia's Electric Vehicle Market," the country is actively working on setting up the necessary infrastructure to support electric vehicles* ***(writer, Nov 1, 2023).*** *This suggests that efforts are being made to overcome the challenges of transitioning to electric mobility, which includes the expansion of charging networks.*

*Furthermore, a study published by Hindawi, titled "Evaluation of Electric Vehicle-Dependent Strategy in Addis Ababa, Ethiopia Transport System," assesses the transport system of Addis Ababa, considering various factors such as the number of vehicles and roadway width* **(Eticha, 2023)**. *While this paper does not provide specific details about the charging infrastructure, it indicates a broader interest in understanding and improving the city's readiness for electric vehicles.*

*The Electro maps database lists charging stations for electric vehicles, and while it mentions that there are charging stations available throughout Ethiopia, it does not provide a specific number or locations for these stations. This lack of detailed information suggests that the EV charging infrastructure in Ethiopia may still be in its nascent stages, with ongoing developments expected as the country moves towards electrification of its transport sector.*

*In summary, while exact data on the number and distribution of EV charging stations in Ethiopia is not provided, there is evidence of a concerted effort to build and expand the necessary infrastructure to support a growing fleet of electric vehicles in the country.*

*There are money companies who produce charging stations among them the CHINESE market is a little cheaper.*

*Biggest EV Charging Station Manufacturers in the World*

- *Tesla. Tesla has approximately 3.400 Supercharger stations and more than 31.000 EV charging sockets and that makes Tesla one of the companies that have the largest fast-charging stations network. ...*
- *ABB.*
- *Siemens*
- *Tritium*
- *Star Charge*
- *Wallbox*
- *Eaton*
- *Schneider Electric.*

## 4.6. ORGANIZATIONAL AND HUMAN RESOURCE

*To effectively address the organizational and human resource considerations for EV charging station installation, it is important to focus on several key factors:*

1. ***Designation of Responsibilities****: The first step is to designate a responsible individual or group to oversee the ongoing operation and maintenance of the EV charging stations. This ensures that there is clear accountability and a point of contact for any issues that may arise*[1].
2. ***Charging Strategy****: When installing commercial EV charging stations, it is crucial to develop a comprehensive charging strategy. This includes understanding the needs of the users, the types of vehicles that will be charged, and the expected frequency of use. A well-thought-out strategy will help in making informed decisions about the type and number of charging stations to install*[2].
3. ***Network Provider Considerations****: Choosing a network provider for the charging stations involves several considerations such as the quality of equipment, access control, operating costs, maintenance, and warranties. Selecting a reliable network provider can help ensure that the charging stations are well-maintained and operate efficiently*[3].

*By addressing these organizational and human resource considerations, businesses and institutions can create a sustainable and user-friendly EV charging infrastructure.*

## 4.7. SOCIAL ANALYSIS

*To conduct a thorough social analysis of EV charging station installation, one would need to gather data from various sources, including public opinion surveys, market research, policy documents, and case studies of existing EV infrastructure projects. Additionally, it would be beneficial to engage with stakeholders such as EV users, community groups, industry experts, and policymakers to gain a comprehensive understanding of the social dynamics at play.*

*The social analysis of EV charging station installation involves examining the various social factors, impacts, and trends related to the deployment of electric vehicle (EV) charging infrastructure. Here are some key aspects to consider:*

- *Public Awareness and Perception*
- *Consumer Behavior and Adoption Rates*
- *Equity and Accessibility*
- *Government Policies and Incentives:*
- *Community Impact and Engagement*
- *Job Creation and Economic Impact*
- *Urban Planning and Real Estate*
- *Sustainability and Environmental Concerns*
- *Partnerships and Stakeholder Involvement*
- *Technological Literacy and Education*
- *Cultural Shifts*
- *Impact on Traditional Automotive and Fuel Industries*

## 4.8. ECONOMIC ANALYSIS

*An economic analysis for EV charging station installation requires a detailed assessment of the financial implications, including a thorough understanding of the costs and potential revenue streams. It's also important to consider the broader impact on the environment, local economy, and the evolving landscape of transportation. Decision-makers should use a combination of financial metrics and strategic considerations to ensure a sound investment that aligns with long-term sustainability goals and market trends.*

*An economic analysis of electric vehicle (EV) charging station installation involves assessing both the costs and benefits associated with the project. This analysis is crucial for businesses, governments, and individuals considering the investment. Below are the key components of an economic analysis for EV charging station installation:*

### 4.8.1. COSTS

1. ***Capital Expenditure (CapEx):***
    - *Purchase of charging stations (Level 1, Level 2, DC Fast Chargers)*
    - *Infrastructure modifications (electrical upgrades, construction work)*
    - *Permits and licensing fees*
2. ***Operational Expenditure (OpEx):***
    - *Electricity costs for charging*
    - *Maintenance and repair of charging stations*
    - *Software subscriptions for station management*
    - *Insurance and liability coverage*
3. ***Installation Costs:***
    - *Labor costs for installation*
    - *Project management and engineering services*
    - *Inspection and commissioning costs*
4. ***Financing Costs:***
    - *Interest on loans*
    - *Opportunity cost of capital*

### 4.8.2. BENEFITS

1. ***Revenue Streams:***
    - *Charging fees from EV drivers*
    - *Subscription or membership fees*
    - *Advertising revenue (if applicable)*
2. ***Incentives and Grants:***
    - *Federal, state, or local government incentives*
    - *Utility company rebates or incentives*
    - *Tax credits or deductions*
3. ***Indirect Benefits:***
    - *Increased property value or appeal*
    - *Attraction of customers to a business*
    - *Employee benefits for workplace charging*
    - *Environmental benefits and potential carbon credits*
4. ***Cost Savings:***
    - *Reduced fuel costs for fleet operators*
    - *Lower maintenance costs compared to ICE vehicle refuelling infrastructure*

### 4.8.3. ANALYSIS TECHNIQUES

1. ***Net Present Value (NPV):***
    - *Calculation of the present value of net cash flows (benefits minus costs) over the lifespan of the charging stations.*
2. ***Internal Rate of Return (IRR):***
    - *The discount rate at which the NPV equals zero, representing the project's profitability.*
3. ***Payback Period:***
    - *The time it takes for the initial investment to be recouped through net cash flows.*

4. ***Cost-Benefit Analysis (CBA):***
    - *A comparison of the total expected costs vs. the total expected benefits to determine the project's feasibility.*
5. ***Sensitivity Analysis:***
    - *Assessing how sensitive the project's success is to changes in key assumptions (e.g., electricity prices, utilization rates).*
6. ***Break-even Analysis:***
    - *Determining the point at which revenue from the charging stations covers all associated costs.*

### 4.8.4. CONSIDERATIONS

- ***Market Analysis:*** *Understanding the demand for EV charging in the area, including the number of EVs and projected growth.*
- ***Location:*** *Choosing strategic locations that maximize utilization and revenue.*
- ***Pricing Strategy:*** *Setting competitive pricing to attract users while ensuring profitability.*
- ***Technology:*** *Investing in future-proof technology that can adapt to advancements in EVs and charging standards.*
- ***Partnerships:*** *Collaborating with other businesses or governments to share costs and benefits.*

## 4.9. FINANCIAL ANALYSIS

*To perform this analysis, you'll need to gather data on costs, potential revenue, and market trends. You may also need to use financial modelling software or spreadsheets to project cash flows and perform calculations like NPV and IRR. It's important to consider the specific circumstances of your project, as costs and revenues can vary greatly depending on location, type of installation, and other factors.*

*Creating a financial analysis for the installation of EV (Electric Vehicle) charging stations involves several steps and considerations. Below is a general outline of how to approach this analysis:*

1. ***Initial Costs:***
    - ***Purchase of Charging Stations:*** *The cost of the charging stations themselves will vary depending on the type of chargers (Level 1, Level 2, or DC Fast Charging) and the number of chargers you plan to install.*
    - ***Installation Costs:*** *These costs include labor, electrical upgrades, permitting, and any construction needed to accommodate the chargers.*
    - ***Site Preparation:*** *Costs for preparing the site, such as paving, painting, signage, and lighting.*
2. ***Operating Costs:***
    - ***Electricity Costs:*** *The cost of the electricity needed to power the charging stations.*
    - ***Maintenance and Repairs:*** *Regular maintenance, software updates, and occasional repairs.*
    - ***Network Fees:*** *If the charging stations are part of a network, there may be associated fees.*
    - ***Insurance:*** *Additional insurance costs to cover the charging stations.*
3. ***Revenue Streams:***
    - ***Charging Fees:*** *Revenue generated from users paying to charge their vehicles.*
    - ***Subscription Services:*** *If you offer a subscription model for frequent users.*
    - ***Advertising:*** *Income from advertising on the charging station or related apps.*

- ***Grants and Incentives:*** *Any available government grants, tax credits, or utility incentives that can offset costs.*

4. ***Financial Projections:***
   - ***Break-even Analysis:*** *Calculate how long it will take for the revenue to cover the initial and operating costs.*
   - ***Cash Flow Analysis:*** *Project the cash flow from the charging stations over time.*
   - ***Net Present Value (NPV):*** *Determine the present value of future cash flows to assess profitability.*
   - ***Internal Rate of Return (IRR):*** *Calculate the rate of growth a project is expected to generate.*
5. ***Sensitivity Analysis:***
   - ***Utilization Rates:*** *Estimate how often the charging stations will be used and how that impacts revenue.*
   - ***Electricity Price Fluctuations:*** *Consider how changes in electricity prices will affect operating costs.*
   - ***Changes in Demand:*** *Account for potential increases or decreases in EV usage over time.*
6. ***Risk Assessment:***
   - ***Technology Risk:*** *The risk that the charging technology becomes obsolete.*
   - ***Regulatory Risk:*** *Potential changes in regulations that may impact operations.*
   - ***Market Risk:*** *Changes in the competitive landscape or EV market penetration.*
7. ***Funding Sources:***
   - ***Equity Financing:*** *Money raised from investors in exchange for ownership stakes.*
   - ***Debt Financing:*** *Loans or bonds that will need to be repaid with interest.*
   - ***Public Funding:*** *Potential government or utility grants or loans.*
8. ***Conclusion and Recommendations:***
   - *Summarize the findings of the financial analysis.*

- *Provide recommendations on whether to proceed with the installation based on financial viability.*

# 5. Chapter V - Conclusion and Recommendations

## 5.1. SUMMARY

### RESULTS AND FINDINGS

- Description of the data collected and analyzed.
- Analysis of the opportunities and challenges of electric vehicle adoption in Ethiopia
- Discussion of the potential impact of electric vehicles on the Ethiopian economy, environment, and society

## 5.2. CONCLUSIONS

### CONCLUSION AND RECOMMENDATIONS

SUMMARY OF THE MAIN FINDINGS AND CONCLUSIONS

*Ethiopia's grid is powered 100% by renewable energy, primarily hydro, and some wind. According to IRENA, of the 15,075 GWh generated in 2020, 14,404 GWh were from hydro and marine, and wind contributed 609 GWh. Therefore, the adoption of EVs fits perfectly into the country's energy mix and supports its commitment to sustainability.*

*With the exemption of VAT, Surtax, and Excise Tax, the price of fully built imported EVs will decrease immediately while local assembly firms scale up. Ethiopia's Minister of Transport and Logistics has a 10-year plan and intends to support the import of at least 4,800 electric buses and 148,000 electric automobiles as part of that plan to catalyze the adoption of electric vehicles in the country.*
*While the East African EV landscape is shaping up nicely, it is hoped that other countries in East Africa and around the rest of the continent will follow suit. The Ethiopian government's recent move to exempt EVs from various taxes is a clear indicator of the country's commitment to sustainable transport and a greener future.*

- Recommendations for policymakers, industry stakeholders, and researchers
- Limitations of the study and directions for future research

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# 7. Appendices

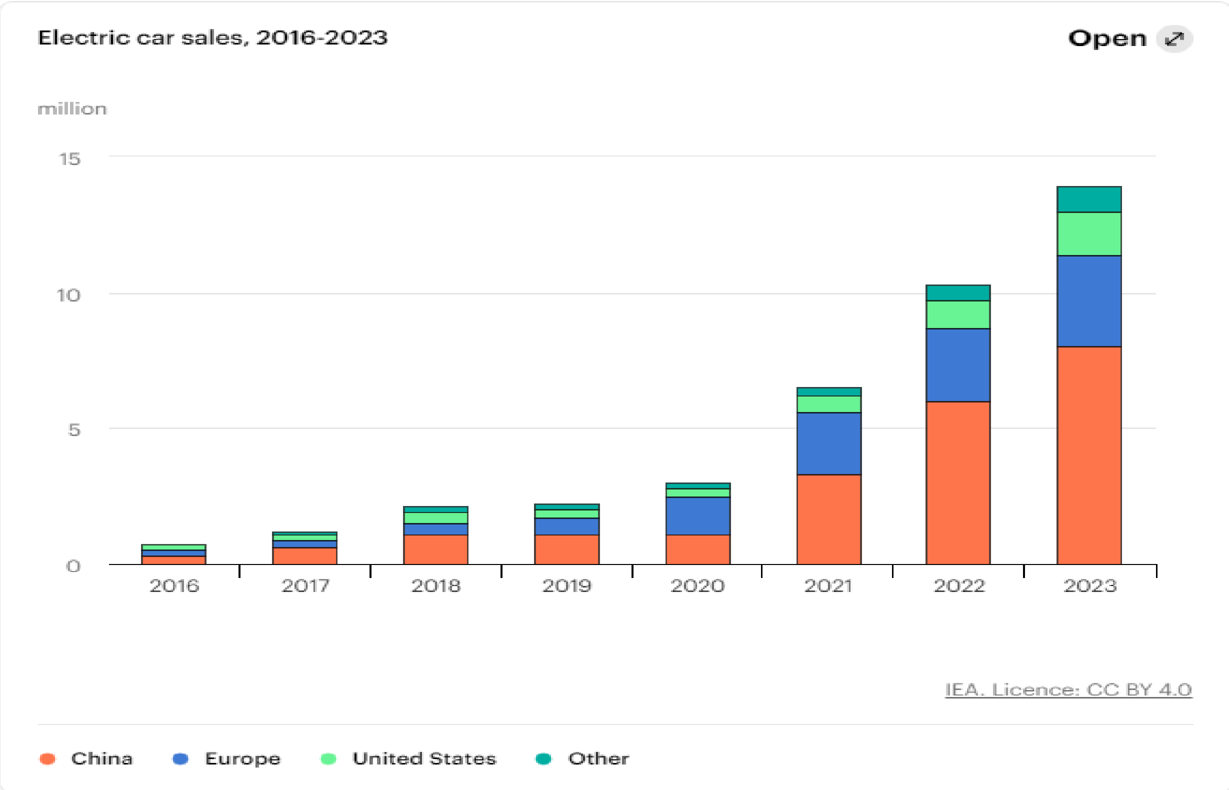


***Figure 1:*** *Electric car Sales 2016-2023*

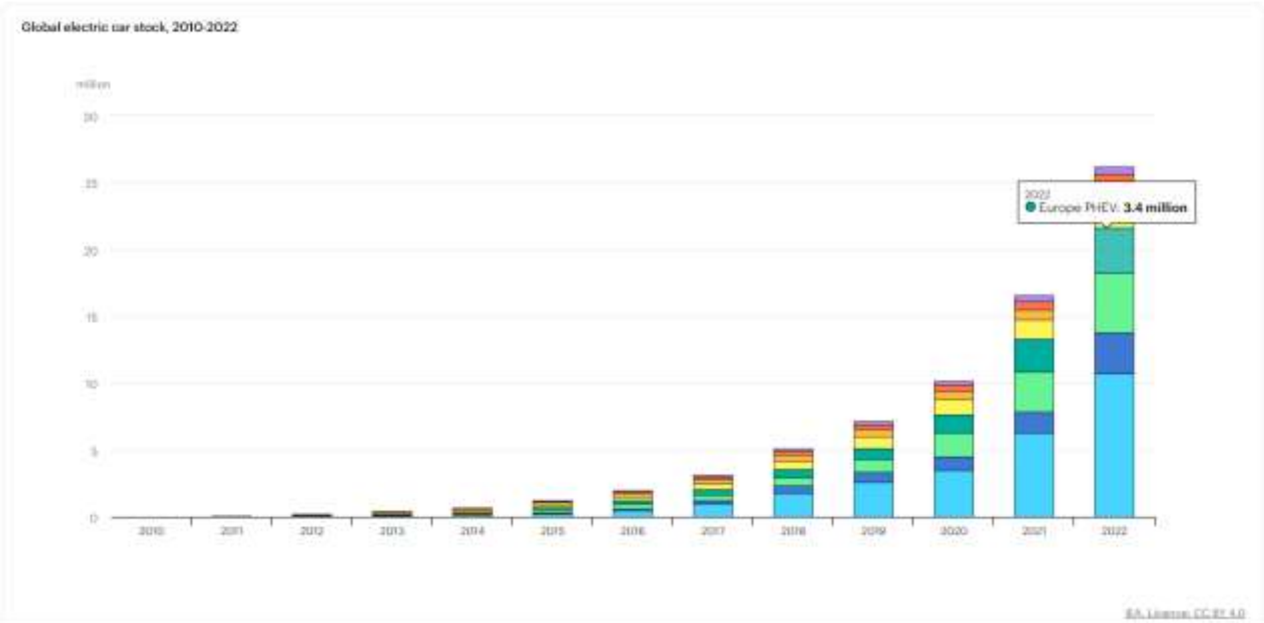


***Figure 2:*** *General EV stock 210-2020*

# Annex I

## *Survey Questionnaire*

**An Online survey Questionnaire for Electric Vehicle (EV) data collection**
**EV owners and Usages**

**Objectives:**

*The objective of Studying EV technology and deployment in Ethiopia is to assess its potential for addressing the environmental, economic, and social challenges of the country's transportation system. This includes understanding the benefits, challenges, and opportunities associated with EV adoption in Ethiopia and policymakers, researchers, and stakeholders will gain a comprehensive understanding of the potential of EV technology in Ethiopia and develop effective strategies to promote its adoption and deployment.*

**EV Ownership and Usage:**

4. Do you currently own an electric vehicle?
   - o Yes
   - o No
   - o Planning to purchase
5. What is the make and model of your EV?
6. How often do you charge your EV?
   - o Daily
   - o Several times a week
   - o Weekly
   - o Less than once a week

**Attitudes and Perceptions:**

9. On a scale from 1 to 5, how satisfied are you with your EV's performance?
   - o 1 (Not satisfied)
   - o 2
   - o 3
   - o 4
   - o 5 (Very satisfied)
10. What do you believe are the main benefits of driving an EV? (Select all that apply)
    - o Environmental benefits
    - o Lower operating costs
    - o Tax incentives
    - o Other (please specify)
11. What are the biggest challenges or concerns you have regarding EV ownership?

**Future Considerations:**

11. Would you consider purchasing an EV as your next vehicle?

    - Definitely yes
    - Probably yes
    - Maybe
    - Probably not
    - Definitely not

12. What improvements would most increase your likelihood of purchasing an EV?

*Thank you for participating in this survey. Your insights are valuable to us.*

## An Online survey questionnaire for Electric Vehicle (EV) data collection EV Sales Agents in Ethiopia

***Objectives:***

*The objective of Studying EV technology and deployment in Ethiopia is to assess its potential for addressing the environmental, economic, and social challenges of the country's transportation system. This includes understanding the benefits, challenges, and opportunities associated with EV adoption in Ethiopia and policymakers, researchers, and stakeholders will gain a comprehensive understanding of the potential of EV technology in Ethiopia and develop effective strategies to promote its adoption and deployment.*

***Survey Questionnaire: Electric Vehicle (EV) Data Collection for Sales Agents in Ethiopia***

*Personal Information:*

7. *Full Name: ___________________________*
8. *Age: __________*
9. *Gender: Male / Female / Other*
10. *Contact Information: ___________________________*
11. *Dealership/Company Name: ___________________________*
12. *Position/Title: ___________________________*

***General Information:***

10. *How long have you been working as an EV sales agent?*
    - *Less than 1 year*
    - *1-3 years*
    - *More than 3 years*
11. *What brands of electric vehicles do you sell?*
12. *What types of electric vehicles do you sell? (e.g., cars, motorcycles, buses)*

***Market Information:***

14. *Approximately how many EVs does your dealership sell per month?*
15. *Have you noticed an increase in EV sales over the past year?*
    - *Yes*
    - *No*
    - *Not sure*
16. *What are the most popular EV models among your customers?*
17. *What are the common reasons customers cite for purchasing an EV? (Select all that apply)*
    - *Environmental concerns*

- *Fuel savings*
- *Lower maintenance costs*
- *Government incentives*
- *Other (please specify): ________________*

***Challenges and Obstacles:***

18. *What are the biggest challenges you face when selling EVs in Ethiopia?*

19. *How do you think the infrastructure for EVs in Ethiopia compares to conventional vehicles?*

20. *Are there sufficient charging stations available for EV owners in your area?*

    - *Yes*
    - *No*
    - *Not sure*

21. *What kind of support or incentives do you think would help increase EV sales in Ethiopia?*

***Customer Profile:***

21. *Can you describe the typical profile of an EV customer? (e.g., age, gender, profession)*

22. *Do customers show a preference for new or used EVs?*

23. *What are the main concerns or questions customers have about EVs before purchasing?*

***Training and Knowledge:***

24. *Have you received any specific training related to the sale of electric vehicles?*

    - *Yes*
    - *No*

25. *Do you feel you have adequate knowledge about EV technology to effectively sell EVs?*

    - *Yes*
    - *No*
    - *Somewhat*

26. *What additional training or information would help you improve your EV sales?*

***Feedback and Suggestions:***

26. *What do you think needs to be done to improve the EV market in Ethiopia?*

27. *What suggestions do you have for vehicle manufacturers to make EVs more appealing to Ethiopian customers?*

***Final Thoughts:***

27. *Is there anything else you would like to share about your experience selling EVs in*

*Ethiopia?*

***Consent for Data Use:***

28. *Do you consent to the use of your responses for market research purposes?*
    - *Yes*
    - *No*

*Thank you for participating in this survey. Your insights are valuable to us.*

# Annex II
# Data Analysis and Results of Survey Questionnaire