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Needs Assessment and Readiness Study for Regional Transportation System Electrification within the CID Area

Electrification Needs Assessment and Readiness Memo

North Fulton Community Improvement District (CID)

January 2023

Draft Deliverable

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Contents

Chapter Page

Tables

Figures

Executive Summary

North Fulton Community Improvement District's (NFCID) needs assessment study includes analysis of existing condition, needs and gaps in the infrastructure, state of the practices, EV adoption projection and lastly the implementation strategy. Currently, NFCID houses around 60 public charging stations with around 160 charging supply ports. Among these charging stations most of them are Level 2 charger types with a handful of Direct Current Fast Charging (DCFC) charger type. Locations where both Level 2 and DCFC charger types are available, coverage is better in those areas. Existing charging coverage is moderate for today's demand, however, there are locations where the demand is higher than the coverage such as the area between Webb Bridge Rd and McGinnis Ferry Rd, north of Academy St until Union Hill Rd, and northeast area of GA 400 and GA 120.

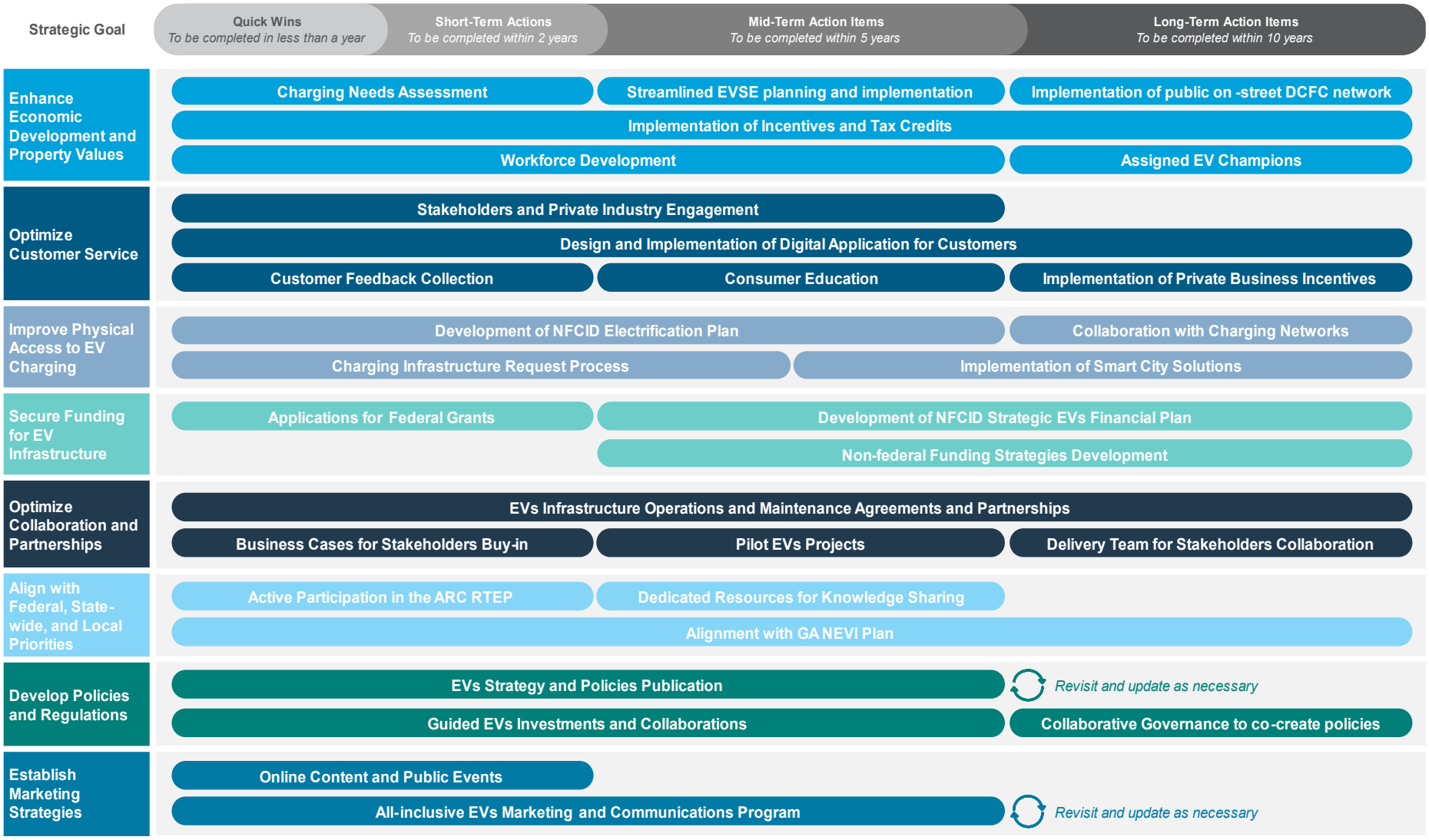
Currently the highest demand is within the range of 10-100 kilowatt-hour per square mile (kWh/ sq. mi.), and there are no areas where the demand is over 50 kWh during the peak hour. With the increased EVs in future, however, the demand will be over 100 kWh in many parts of the study area during the peak hour. Without any improvement, existing charging infrastructure will not be enough to serve the future demand, and future coverage will be very low with coverage less than 25% in most areas.

NFCID's land use is mostly commercial with some residential uses, and plenty of new developments are underway along GA 400 in the study area. Therefore, public charging stations will be required to tackle the future demand. In order to successfully build the charging stations for future demand, existing barriers and challenges also need to be overcome. Currently, tax and registration fees in Georgia for EVs are higher than other light-duty vehicles which discourages consumers from buying and EV. Lack of battery production and experienced professionals on EVs are also holding behind the EV sales market.

As part of the state of practice examination, an extensive body of literature has been reviewed to obtain an understanding of the key global trends in EVs technology and electrification worldwide and develop the NFCID implementation roadmap. The literature review included the following:

- A detailed review of **Technology and Systems** including EVs technology, EVs Communication systems, and Electric Road Systems.
- An identification of best practices for EVs **Infrastructure** planning and implementation and operations and maintenance.
- An overview of EVs **Regulatory Environment** in terms of actions from policymakers at different levels of government – local, regional, or federal – that accelerate the EVs deployment through declared EVs policies, targets, strategies, and fiscal incentives.
- A Summary of **Business Processes** and key business models to deploy EVSE projects. EVs national programs and strategies to secure federal and non-federal funding were also explored under this dimension.
- A review of **People & Consumers** market trends including but not limited to car sales and infrastructure deployments, and key stakeholders for partnership and collaboration opportunities
- A general overview of EV impacts on **Sustainability** and environmental emissions.

Findings from the existing conditions analysis and state of practice review provided a baseline to identify key priority areas and gaps for NFCID, and accordingly develop the Electrification Implementation Roadmap below.


Strategic Goal
Quick Wins
To be completed in less than a year
Short-Term Actions
To be completed within 2 years
Mid-Term Action Items
To be completed within 5 years
Long-Term Action Items
To be completed within 10 years
Enhance Economic Development and Property Values
Charging Needs Assessment
Streamlined EVSE planning and implementation
Implementation of public on -street DCFC network
Implementation of Incentives and Tax Credits
Workforce Development
Assigned EV Champions
Optimize Customer Service
Stakeholders and Private Industry Engagement
Design and Implementation of Digital Application for Customers
Customer Feedback Collection
Consumer Education
Implementation of Private Business Incentives
Improve Physical Access to EV Charging
Development of NFCID Electrification Plan
Collaboration with Charging Networks
Charging Infrastructure Request Process
Implementation of Smart City Solutions
Secure Funding for EV Infrastructure
Applications for Federal Grants
Development of NFCID Strategic EVs Financial Plan
Non-federal Funding Strategies Development
Optimize Collaboration and Partnerships
EVs Infrastructure Operations and Maintenance Agreements and Partnerships
Business Cases for Stakeholders Buy-in
Pilot EVs Projects
Delivery Team for Stakeholders Collaboration
Align with Federal, State-wide, and Local Priorities
Active Participation in the ARC RTEP
Dedicated Resources for Knowledge Sharing
Alignment with GA NEVI Plan
Develop Policies and Regulations
EVs Strategy and Policies Publication
Revisit and update as necessary
Guided EVs Investments and Collaborations
Collaborative Governance to co-create policies
Establish Marketing Strategies
Online Content and Public Events
All-inclusive EVs Marketing and Communications Program
Revisit and update as necessary

1. Introduction

The purpose of this study is to conduct initial needs assessment and identify North Fulton Community Improvement District's (NFCID) readiness to support the development of a national and regional Electric Vehicle Charging Infrastructure (EVCI) network. This study inventories current charger coverage, summarizes national and international best practices, and identifies current and future needs for regional transportation system electrification. The analysis covers light-duty vehicle demand and infrastructure. The following sections describe project background, basics of EV and charging infrastructure technology, and study approach and objectives.

1.1. Project Background

Our transportation industry is undergoing major transitions in the way motor vehicles are powered and will continue to evolve and emerge as technology advances. Globally, government agencies are seeking to simultaneously reduce their dependency on fossil fuels, improve the air quality, reduce their carbon and transportation emissions, and minimize the impacts of the climate change. One of the many strategies that can help address these priorities is deployment of Ultra Low Emission Vehicles (ULEVs), including Electric Vehicles (EV), promoting smart and sustainable mobility.

Until recently, several challenges such as the poor range and performance of EVs, high purchase costs, and the lack of charging infrastructure have caused barriers to EV deployment, adoption, and commercial mainstreaming. However, with manufacturers now investing heavily in automotive research, development, and bringing commercial applications to market, together with government agencies' support at various levels and public's awareness of the growing environmental issues, the EV market is substantially advancing. Therefore, government agencies are seeking to provide the required infrastructure for EV deployment and operation in order to meet the growing demand.

Recognizing this, NFCID took this initiative to ensure infrastructure availability to not only meet current and future demands, but also align with national trends and targets. To identify and address the associated priorities, NFCID is undertaking a range of activities, including but not limited to assess and benchmark existing conditions, review national and global state of the practice and lessons learned, and develop a thoughtful, flexible, and actionable implementation roadmap to assist the agency and partners in EV infrastructure deployment and adoption in the near future. **Figure 1** shows the study area considered for this project including the NFCID and adjacent areas.

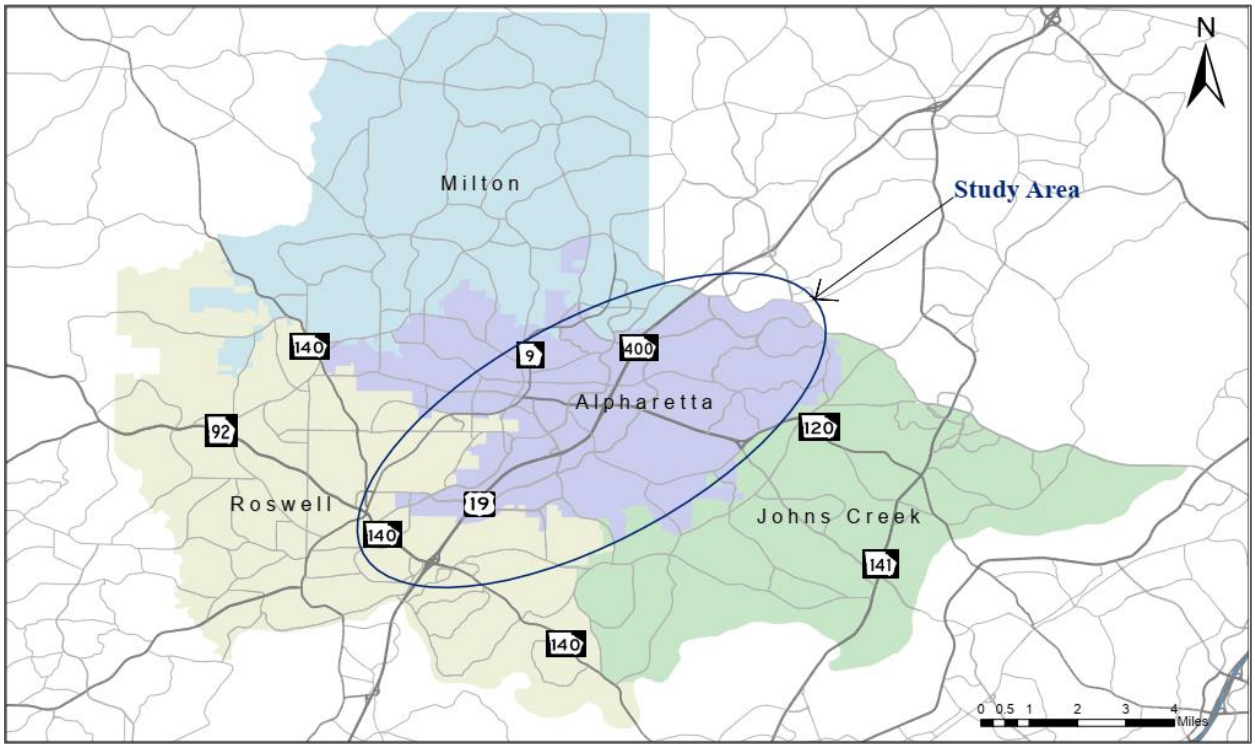


Figure 1: North Fulton CID study area

1.2. Basics of EV Technology

There is currently a range of EV types developed and deployed around the world, namely Plug-In EVs, Hydrogen Fuel Cell EVs (FCEVs), and Hybrid EVs (HEVs).

The battery system is at the heart of Plug-In EV types, with major advances in performance, longevity, and cost already made. There is a significant variation in battery range across the various drivetrain technologies. Plug-In EVs include:

1. **Battery EVs (BEVs)**, such as the Nissan Leaf or all Tesla models;
2. **Plug-In Hybrid EVs (PHEV)**, such as the Toyota Prius; and
3. **Extended-Range EVs (E-REV)**, such as the Chevrolet Volt.

Hydrogen Fuel Cell EVs (FCEVs) which whilst still being powered by electricity, use a fuel cell powered by hydrogen. Hybrid electric vehicles (HEVs) are powered by a combination of an internal combustion engine (ICE) with electric motors running off a battery pack for greater efficiency. The batteries of an HEV cannot be recharged from an external source.

Almost all EVs currently on the market are Plug-In Vehicles, requiring charging from mains electricity. However, FCEVs and advances in vehicles and fueling infrastructure are expected in the coming years. The following provides and overview of the technology used in each EV.

Battery EVs (BEV): A BEV is devoid of a petrol or diesel engine and relies solely upon the electric machine for mechanical power. The traction battery is typically the largest of all three drivetrain variants discussed.

In 2012 there were at least 13 different BEVs available in major EV markets. Typical examples are the Nissan Leaf and Renault Zoe. Pure BEVs vary in battery size from around 16 kWh (Smart Fortwo ED) to 85 kWh (Tesla S) depending on price and market segment.

Range and Charge Time: Most BEVs have a range of 85-100 miles on a single charge. The Lightning EV, Tesla Roadster, Tesla Model S and the Mercedes SLS EV are all exceptions with ranges of approximately 150, 200, 245, 265 miles, respectively. These premium vehicles possess larger traction batteries up to 85 kWh.

The typical real-world range of a Nissan Leaf, the most common BEV in the market, is 85-90 miles. The battery is charged in about six hours at 16 Amps (or four hours at 32 Amps). DC charging at 125 Amps (50 kW) from a dedicated “rapid charger” takes approximately 30 minutes from 0-80% State of Charge (SOC); with the remaining 20% topped up in a further 20-30 minutes if needed.

Plug-In Hybrids (PHEVs): PHEVs use a combination of a battery / electric motor and an ICE to propel the vehicle, with the ICE also recharging the battery / electric motor when the vehicle is moving. The battery can also be recharged from the grid.

Range and Charge Time: Most PHEVs have around 12-35 miles pure battery electric range on a single charge and then around 300-500 miles using the ICE.

The Toyota Prius plug-in, introduced to the UK market in 2012, is one of the most popular PHEVs on the market. The Toyota Prius plug-in utilizes a 4.4 kWh lithium-ion battery to allow a pure electric real-world range of approximately 12 miles. In hybrid mode, Toyota state that the vehicle achieves more than 700 miles range. The vehicle can be charged in 90 minutes.

Extended Range EVs (E-REV): E-REVs differ from PHEVs in that the vehicle is propelled by a battery / electric motor, while the ICE is used to drive a generator that charges the traction battery and/or provides power to the electric machine that drives the wheels. Typically, the traction battery of an E-REV is much larger than that used for a PHEV. Examples of EREVs on the market include the Chevrolet Volt and Vauxhall Ampera.

Range and Charge Time: Most E-REVs have around 35-100 miles pure battery electric range on a single charge and then around 70-300 miles using the ICE generator. More expensive vehicles possess larger batteries. The Vauxhall Ampera possesses a 16 kWh lithium ion battery (10 kWh useable) providing approximately 35 miles of pure electric real-world range. After this battery range is exhausted the car can drive approximately 300 miles on a tank of petrol. The vehicle takes approximately four hours to charge.

1.3. Charging Infrastructure Types and Requirements

There is a variety of charging infrastructure types in place for charging EVs, which enable standard/slow, fast or rapid charging. These charging types are summarized below:

Level 1 (Standard charging points) – Involves a dedicated circuit which can charge an EV via a single phase three pin household plug. This segment is quickly becoming obsolete for EV cars and vans because of the very slow charging speed (typically up to 12 hours for a 24 kWh traction battery) and safety issues (Atkins, 2011).

Level 2 (Fast charging points) – Generally capable of charging an EV from flat in between two and six hours. Fast charging equipment is usually installed at locations where there is a dwell time of two hours or more. Available power capacity is not usually a problem for most sites that wish to install a small number of single phase AC 7 kW points. However, higher power output units may require a modification to the site's power supply.

DC FC (Rapid charging points) – Charge a rapid charge-enabled EV to 80% in 30-60 minutes depending upon the power output and vehicle capability. The units typically resemble a petrol forecourt pump with tethered plugs and are usually over 1.6 m in height.

1.4. Study Objectives and Approach

The objectives of this study are as follows:

- Review current and future global trends in EV, technology development, policy, and regulation to identify how these fit within the region.
- Document, assess, and benchmark the current state of policy and implementation across the agency;
- Develop an overall strategic framework and action plan for NFCID that supports greater take-up of EVs in with a focus on infrastructure readiness and other areas of focus, supporting the actions of NFCID within the framework of the wider plans;
- Develop guidance for the planning and deployment of EV infrastructure, with a particular focus on installation on NFCID's networks;
- To ensure key recommendations integrate with, but do not duplicate, existing, planned, and future activities.

Based on the objectives of this study, the study utilized a data driven approach to evaluate existing and future conditions in EV charging infrastructure based on EV adoption timelines and future charging demand. ElectroTempo's EV Data Analytics was used to support existing and future needs assessment. At the same time, best practices and lessons learned were reviewed to identify applicable strategies to the CID, then an EV visioning workshop was conducted to gather input from the NFCID. The project team then developed the implementation strategy that would assist in expansion of existing EV infrastructure.

2. Existing Conditions and Future Trends

This section explores the existing conditions of EV infrastructure in the study area and where NFCID stands in terms of EV planning and adoption. This section also describes EV adoption timelines and estimated future charging demand in the future.

2.1. Existing Conditions

NFCID area consists of three cities including the City of Alpharetta, the City of Milton, and the City of Roswell. The study area is bounded by Mansell Road north to McGinnis Ferry Road. NFCID'S mission is to improve transportation, mobility, and quality of life in the region [1]. With an increased demand of EVs worldwide and a target of increasing green vehicles, NFCID is preparing to serve both. Currently there are a handful of charging stations with all three charger types, Level 1, Level 2, and Direct Current Fast Chargers (DCFC) in the NFCID region. The demand for EVs and charging stations is increasing on a daily basis. The following sections provide detailed analysis of existing conditions including charging station locations, coverage, demand, EVs policies and stakeholders, and key barriers.

2.1.1. EV Charging Stations

As Georgia's automotive industry is shifting towards more EVs, all private and public entities in the state are preparing to take on this emerging market. NFCID is also preparing to tackle this accelerated industry and has already observed a significant growth in the infrastructure. **Figure 2** below shows the locations of existing charging stations based on their charger types.

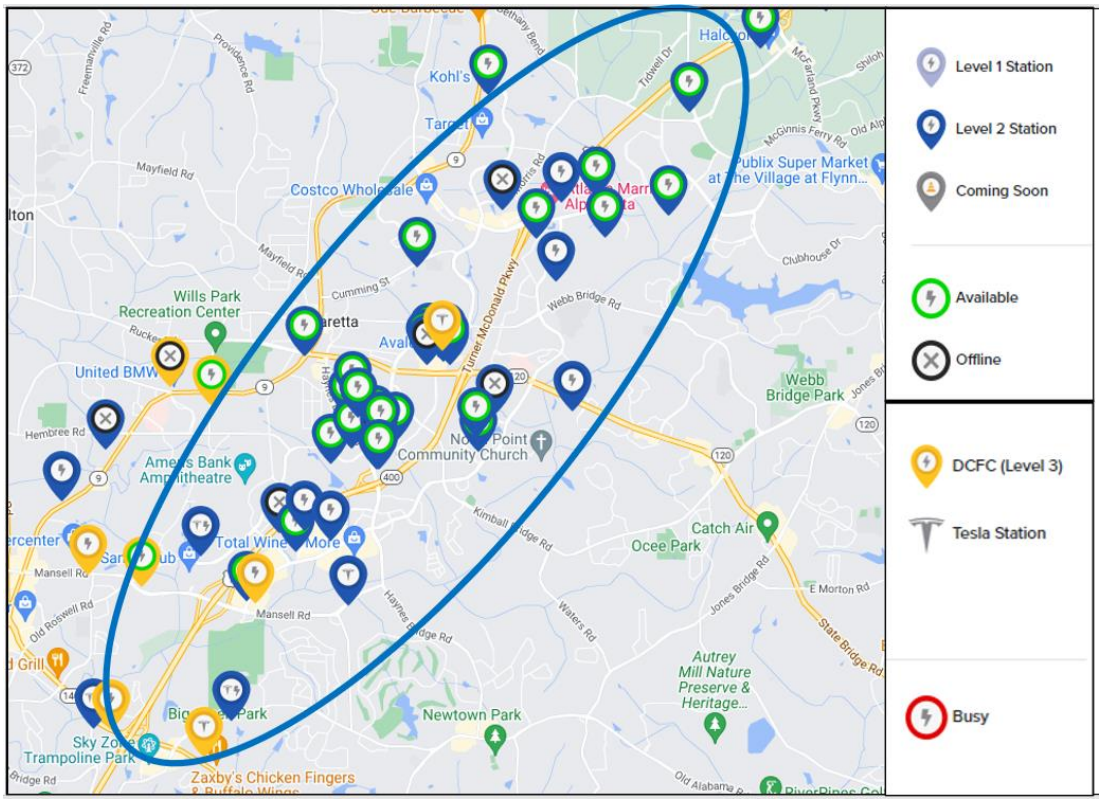


Figure 2: Existing Charging Stations by Charger Type [3]

As shown in the map, the most common charger type that currently exists is Level 2 chargers with very few DCFC ports. According to the U.S. Department of Energy, there are approximately 60 charging stations with 160 Electric Vehicle Supply Equipment (EVSE) ports all together in the NFCID region [2].

2.1.2. EV Charging Coverage

Figure 3 below shows the current EV charging coverage in the NFCID area for all available public charging stations excluding any private charging stations (assuming 10% charger utilization during the day). As mentioned above, most of the current coverage is provided by Level 1 and Level 2 charger types due to the lack of DCFCs in the NFCID region. Currently, there is a strong coverage (more than 100%) near GA 400 and SR 120/Old Milton Parkway corridor in Avalon Mall (Region A). The mall authority has built several charging stations to better serve their customers. There is also a significant number of charging stations near Westside Pkwy and Haynes Bridge Rd intersection (Region B). This area has many restaurants, shops and hotels which are served by these charging stations. Another high coverage location is the North Point Mall area where each charging station is equipped with multiple charging ports for better and faster service (Region C). Northern and southern most corridors (Regions D & E) in the study area have also relatively high coverage. On the other hand, the area between Webb Bridge Rd and McGinnis Ferry Rd (Region F) has low coverage compared to locations mentioned above. Similarly, north of Academy St until Union Hill Rd (Region G) has coverage less than 20% and northeast area of GA 400 and GA 120 has coverage less than 5% (Region H).

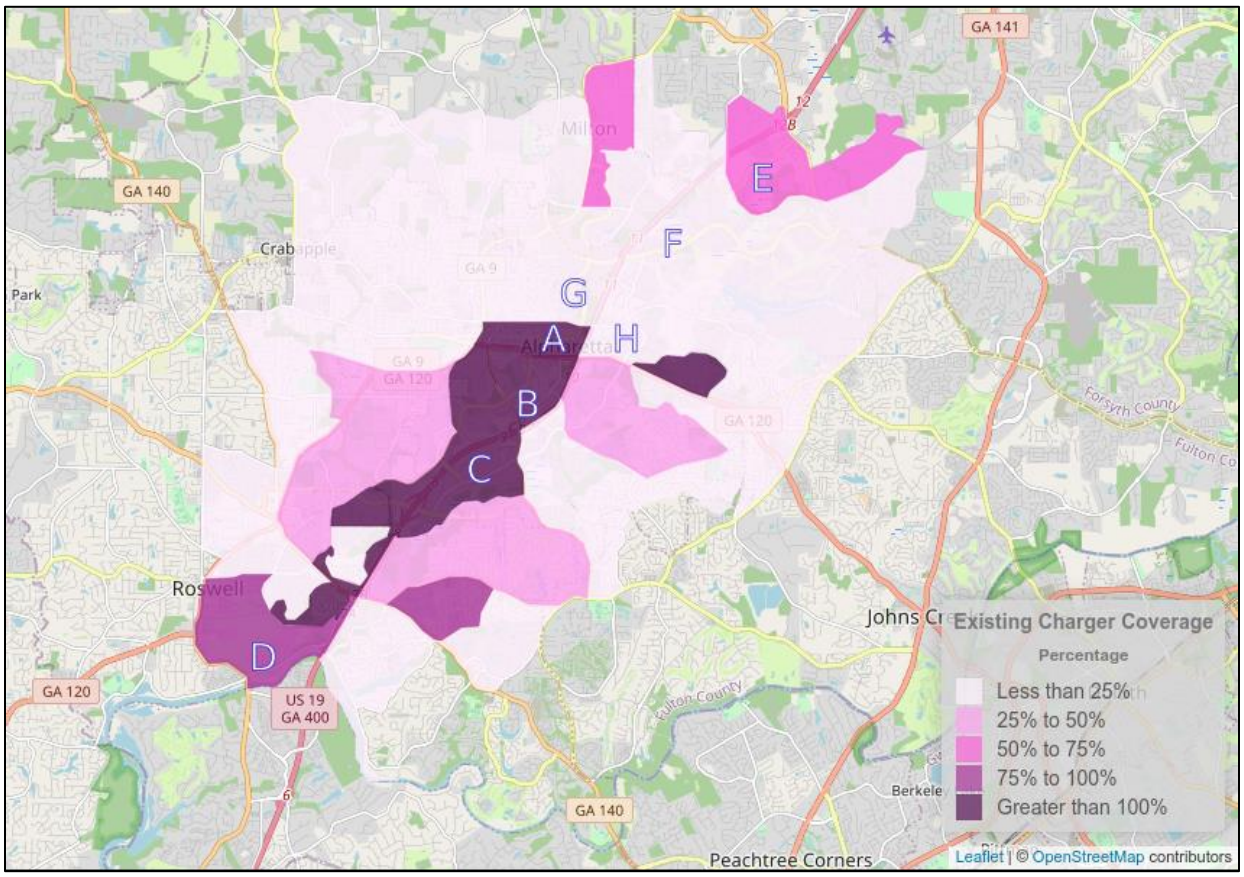


Figure 3: Existing charging coverage in NFCID [4]

2.1.3. EV Charging Demand

Total number of EVs registered in the Metro Atlanta (approx. 25,000) was used to estimate the current demand for charging of EVs in the NFCID area. **Figure 4** below reflects the current peak hour demand for workplace and public charging in the study area. Currently the highest demand is within the range of 10-100 kilowatt-hour per square mile (kWh/ sq. mi.). The demand for EV charging in the area is still growing with high charging demand at some locations. However, there are areas where there is a high demand but lack of charging stations coverage. As shown in the coverage map (**Figure 3**), the area between Region A and Region E has less coverage but higher demand. There are currently very few charging stations in that area as well. Eastern area within Region C in **Figure 3** also has higher demand but lower coverage. On the other hand, Region B and Region D in **Figure 3** has almost exactly the right amount of coverage to handle demand, which means currently the area is well-served for EV charging. However, more charging stations will be needed to accommodate the future demand.

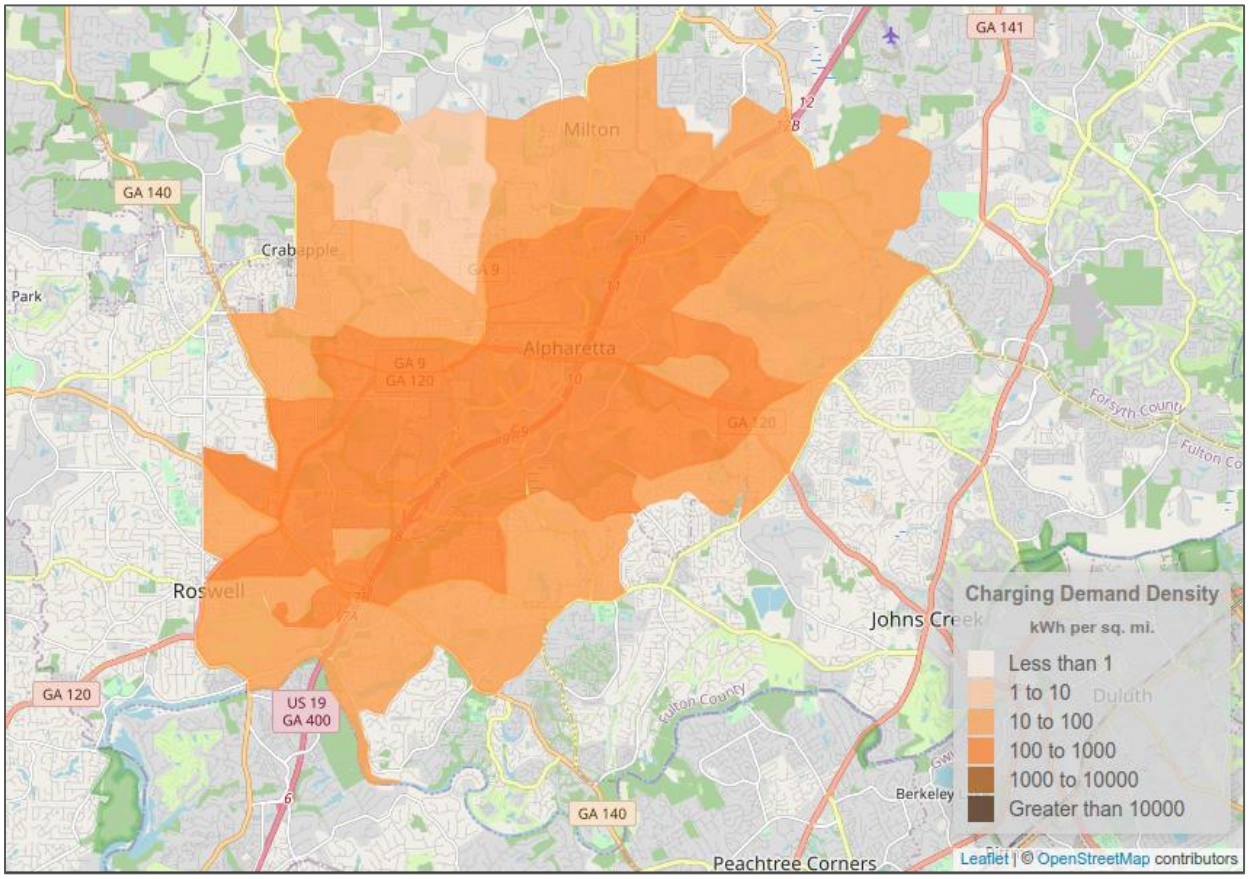


Figure 4: Current charging demand in the study area [4]

2.1.4. Needs, Challenges, and Key Barriers/Constraints

Even though EV market is taking over the auto industry worldwide, there are still constraints and challenges that decelerate its growth. According to Electro Tempo's data on EV growth in the study area, there will be around 100,000 EVs in the region by 2025. To accommodate the charging need for this

increased demand, there needs to be a systematic management of power utilisation and a plan for local deployment of charging infrastructure. Currently, the study area lacks that systematic plan to generate and supply this extra electricity. As the U.S. power supply heavily relies on fossil fuels for generating electricity, there needs to be a more renewable sources like wind and solar. Therefore, utility companies and local authorities need to have a better plan to generate this upcoming increased demand. If no action is taken, it may take a toll on consumers with heavy cost of electricity [4].

Higher registration fees and taxes on EVs are also negatively impacting the adoption of EVs. Georgia has higher registration fee on EVs than regular vehicles plus the additional fee for the Alternative Fuel Tag. Lawmakers imposed an additional $200 on alternative fuel vehicles in 2015 that is still ongoing. On top of these, consumers are also paying electricity tax. All these extra charges are discouraging consumers interested in switching to EVs and improving the air quality and public health [5] [6].

One of the key barriers in EV adoption is the shortage in manufacturing of EV batteries and its supply. Due to global political disruptions many manufacturing facilities are facing difficulties in supply and production of new batteries. Lack of availability of raw materials are also one of the main reasons for this shortage. and supply. With the increasing demand of EVs, battery materials' cost is soaring through the roof. Increased manufacturing capacity and more reliable EV battery supply chain will further expedite the adoption of EVs in the NFCID area [7].

In addition, more charging stations are needed to serve the increased demand in the upcoming years. Charging stations need to be available publicly and in the workplace for more convenient and reliable charging. Building more charging stations is not sufficient alone, charging infrastructure needs to be available when the consumers need them and where they need them. Compared to regular fuelling stations, EV charging stations need to be looked up and set aside an extra time for charging. Adoption of EVs will be faster and more reliable if its relevant infrastructure is more user friendly and fulfils their needs in the consumers' convenience.

While a significant number of EV users are already adopting the new technology, many mainstream consumers are still unaware of all the advantages of EVs. Education on the benefits of adopting EVs, information about charging infrastructure, and affordable options of EVs would be important to raise awareness about the use of EV and resulting contributions on carbon reduction and climate resiliency.

2.1.5. Existing EV-related Policies, Strategies, and Regulations

Currently there are two tax incentives for EVs from Georgia Environmental Protection Division (EPD). One of them is for building a new charging station and that is only available for businesses. The incentive provides credit of 10% or $2,500 of the charger cost, whichever is less. The charger needs to be greater than 130 volts. The second incentive is given for vehicle conversion to EV and to encourage more EV adoption. This incentive also provides credit of 10% or $2,500 of conversion cost, whichever is less. However, this tax credit is for any alternative fuel conversion and not just for EVs [8].

Previously, a tax credit of $5,000 were offered towards a new Zero Emission Vehicles (ZEV), which boosted the EV sales in Georgia. However, when this tax credit was discontinued, EV sales were observed to drastically drop [9].

An existing regulation which was passed by the Atlanta City Council requires any new residential or commercial development to install EV charging infrastructure inside the premises. Under this regulation, all new commercial parking facilities must have at least 20% of the spaces ready for EVs [9].

2.1.6. Existing Stakeholders

Some of the major stakeholders for this study includes local and state governments, utility partners, charging station vendors, and some prominent local businesses. Major stakeholders are identified and listed below by the category of the organization.

State Government:

- Georgia Department of Transportation (GDOT)

Local Government:

- Atlanta Regional Commission (ARC)
- Fulton County
- The City of Alpharetta
- The City of Milton
- The City of Roswell

Utility Partner:

- Georgia Power

EVSE Vendors:

- Charge Point
- Volta
- Electrify America
- SemaConnect

Private Businesses:

- Avalon Mall
- North Point Mall

Engagement with the stakeholders for electrification projects will depend on the role of each stakeholder.

2.1.7. Consumer Profile and Perception

Figure 5 below shows the land use map of the study area. As shown in the map, NFCID is primarily commercial land use with some residential areas. All the major activity centres like Avalon Mall, North Point Mall, and a lot of commercial and office spaces are expected to attract more public charging than private charging. Most of these activity centres are along GA 400, therefore, charging infrastructure surrounding these activity centres will also attract commuters on the highway. However, existing charging stations are very clustered in each location, which is not so convenient for users. Charging stations need to be more widespread and maintain certain distance from one another so that it is easier for users to access.

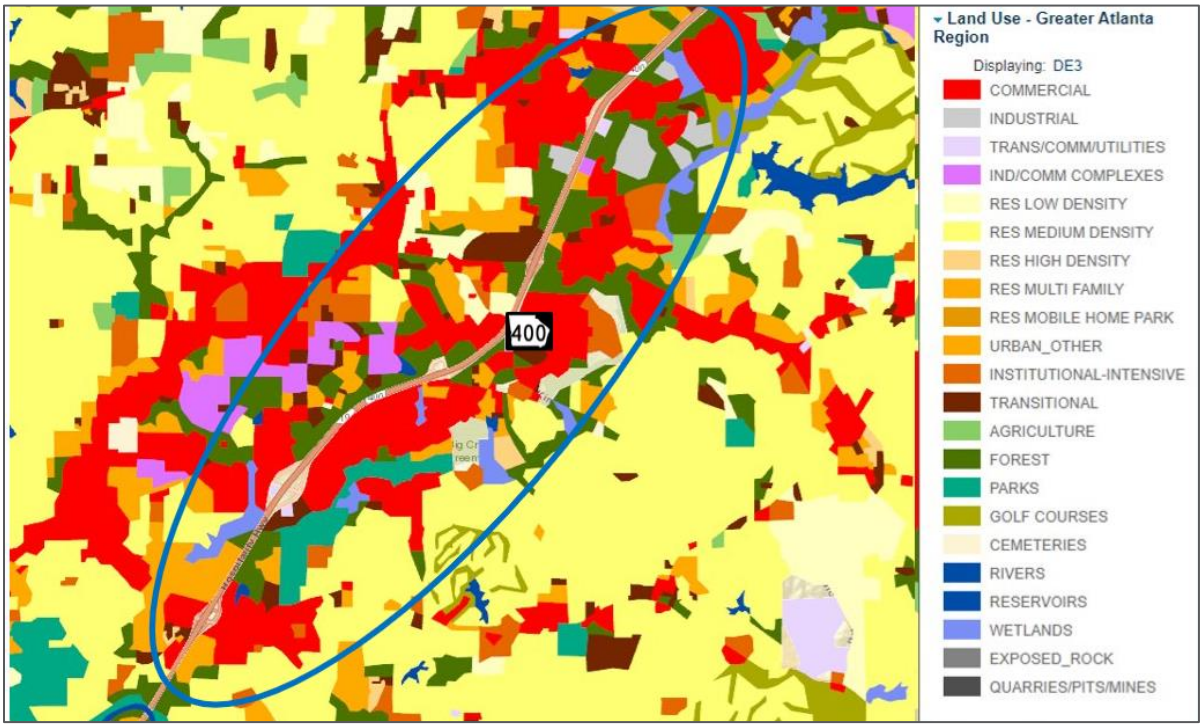


Figure 5: Land use map of NFCID [10]

2.2. EV Adoption Timelines and Future Charging Demand

This section describes assumptions and timeline for EV adoption and resulting future charging demand.

2.2.1. EV Adoption Projection

To analyze future EV adoption projections, several assumptions were made, and they are listed below [4]**.** For the target market share, Biden administration goal of 50% EV market share by 2030 was used for this study. The growth rate was also assumed as similar as the Georgia state EV adoption growth rate of 5%.

Sales Curve	
Marketshare at 2022	5.0%
Target Marketshare	50.0%
Target Year	2030
Final Marketshare	100.0%
Final Year	2060
Vehicle Population	
Initial Number of Vehicles	5,100,000
Vehicle Population Growth Rate	Normal

Vehicle Market	
Car Marketshare	38.0%
Car EV Entrance Year	2010
Car SUV Marketshare	3.0%
Car SUV EV Entrance Year	2015
Truck SUV Marketshare	28.0%
Truck SUV EV Entrance Year	2021
Van Marketshare	4.0%
Van EV Entrance Year	2024
Pickup Marketshare	27.0%
Pickup EV Entrance Year	2021

The timeline for future EV market adoption and charging demand is projected below from Electro Tempo analysis as part of this study. **Figure 6** below shows the estimate of future EV sales compared to all other light-duty vehicles. As mentioned above, with the aggressive growth rate of 5% EV sales will reach 50% by 2030 and other light duty vehicle sales will most likely shrink. **Figure 7** shows the future projection of number of EVs available.

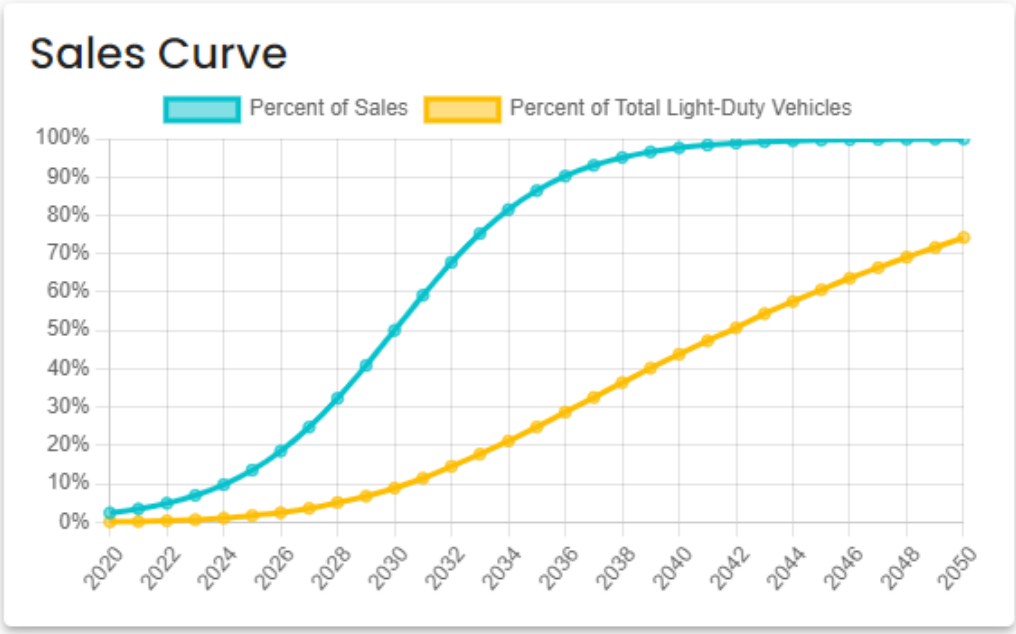


Figure 6: Future EV sales projection [4]

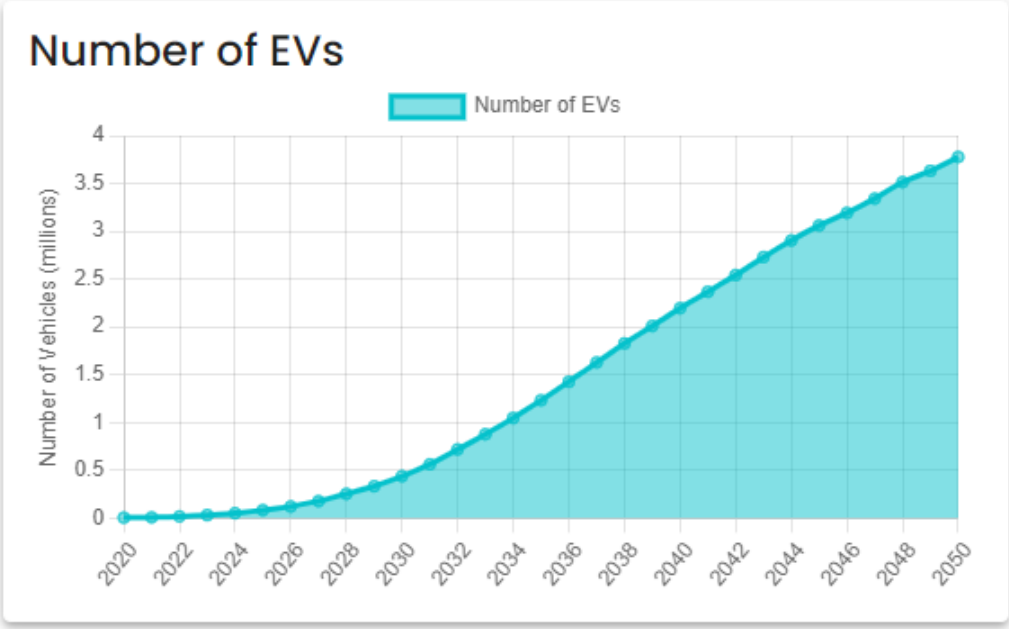


Figure 7: Projected number of EVs [4]

Based on the sales and number of EVs projection future charging demand was also estimated. **Figure 8** shows the estimated charging demand for all the increased EVs. Around 1,000 MWh for workplace and 350 MWh for public charging power is required by 2030 to accommodate charging for all the new EVs.

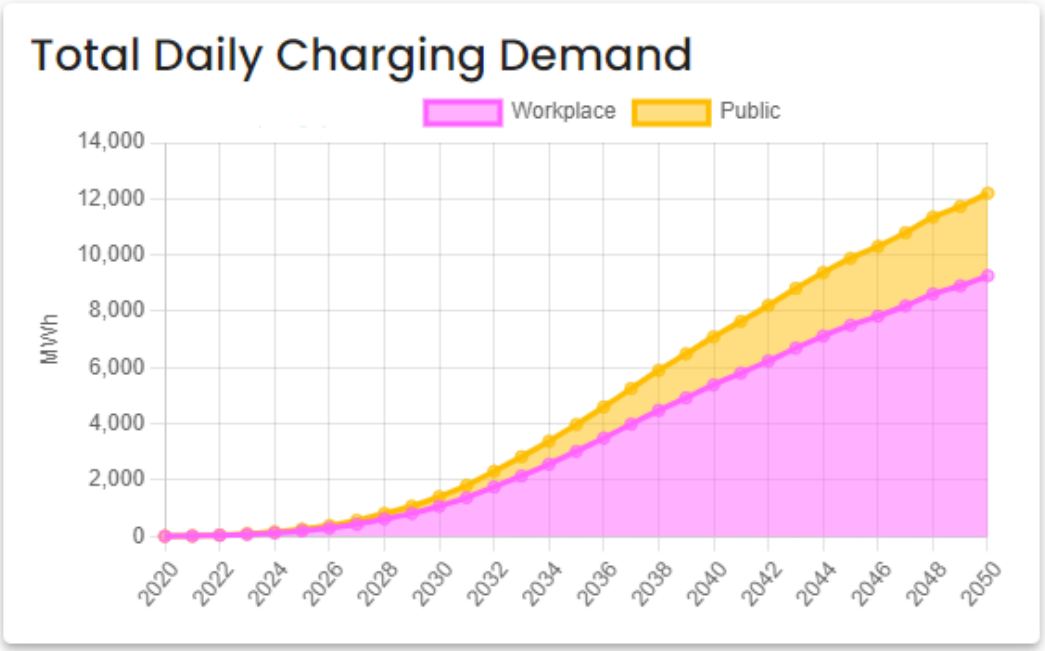


Figure 8: Estimated future charging demand [4]

An estimate for the numbers of chargers was also projected for future charging demand based on their charging types. As shown in **Figure 9** below, Level 2 chargers are the most needed charger types if 20% workplace charging demand is served by DC FC chargers. However, if more workplace demand is served by DC FC chargers, then number of Level 2 chargers decreases but still remains the most popular charger type.

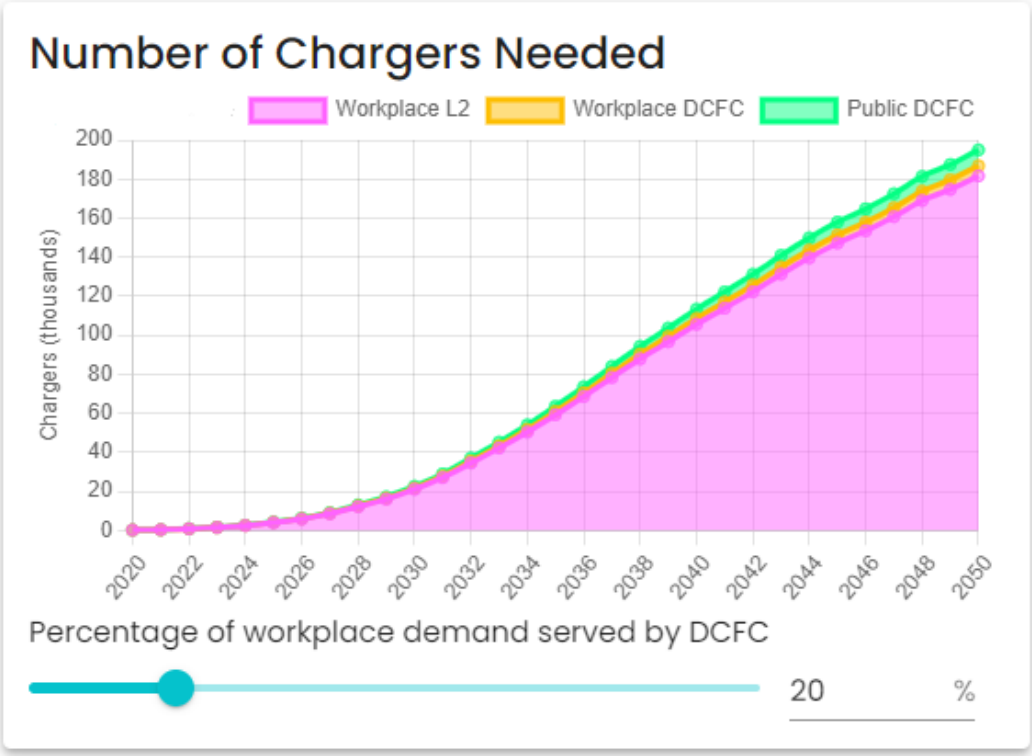


Figure 9: Future charging infrastructure required [4]

An estimate of the cost required for any new infrastructure can also be done by Electro Tempo's charger investment tool. **Figure 10** below shows an estimate of the cost for each charger type and the total cost for all the new charging stations. This tool can be used to change the price for each charger type to approximate the total cost for all chargers needed.

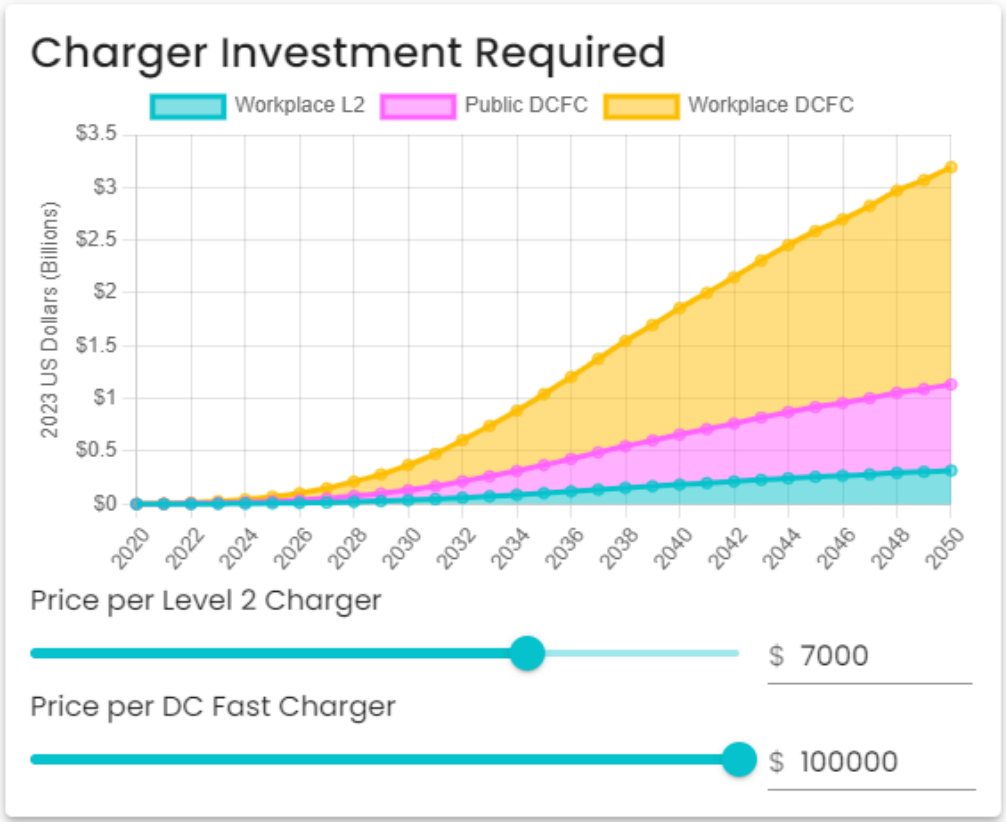


Figure 10: Future charging infrastructure required [4]

2.2.2. Future Demand

As mentioned before, the growth rate of 5% applied for future EV projection is for all Atlanta region abiding by the Biden administration goal. **Figure 11** below reflects the future charging demand projected based on that growth rate. As expected, with increased number of EVs in the future, the demand for charging will also increase. Better incentive for EV adoption and stronger battery life will also act as main reasons for higher EV adoptions in the future. Currently, there are no areas where the demand is over 50 kWh during the peak hour. However, with the increased EVs in future, the demand will be over 100 kWh in many parts of the study area during the peak hour.

Without any improvement, existing charging infrastructure will not be enough to serve the future demand. As shown in **Figure 12**, future coverage will be very low with coverage less than 25% in most areas. The priority areas for new charging infrastructure should be where there is future coverage less than 50% (**Figure 12,** Coverage 2025)

To relate some of this growth and for the purpose of this study, developments in the study area were also observed. **Figure 13** shows all the new developments that are underway along GA 400 in the study area, and these developments will create a significant new demand.

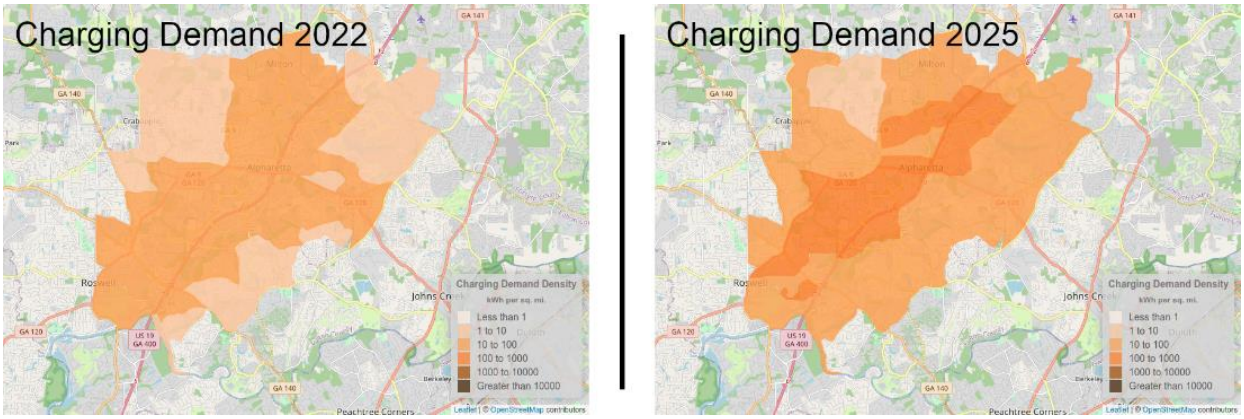


Figure 11: Existing and future charging demand [4]

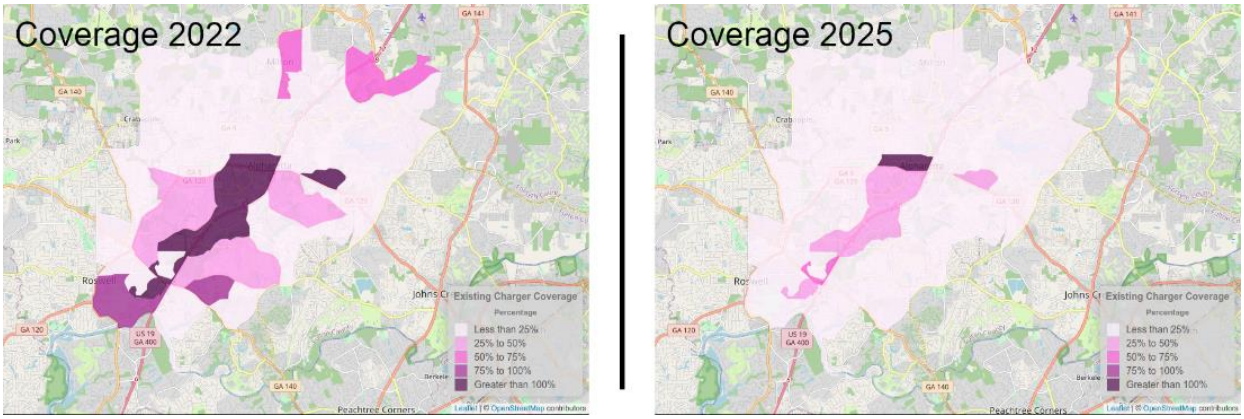


Figure 12: Existing and future charger coverage [4]

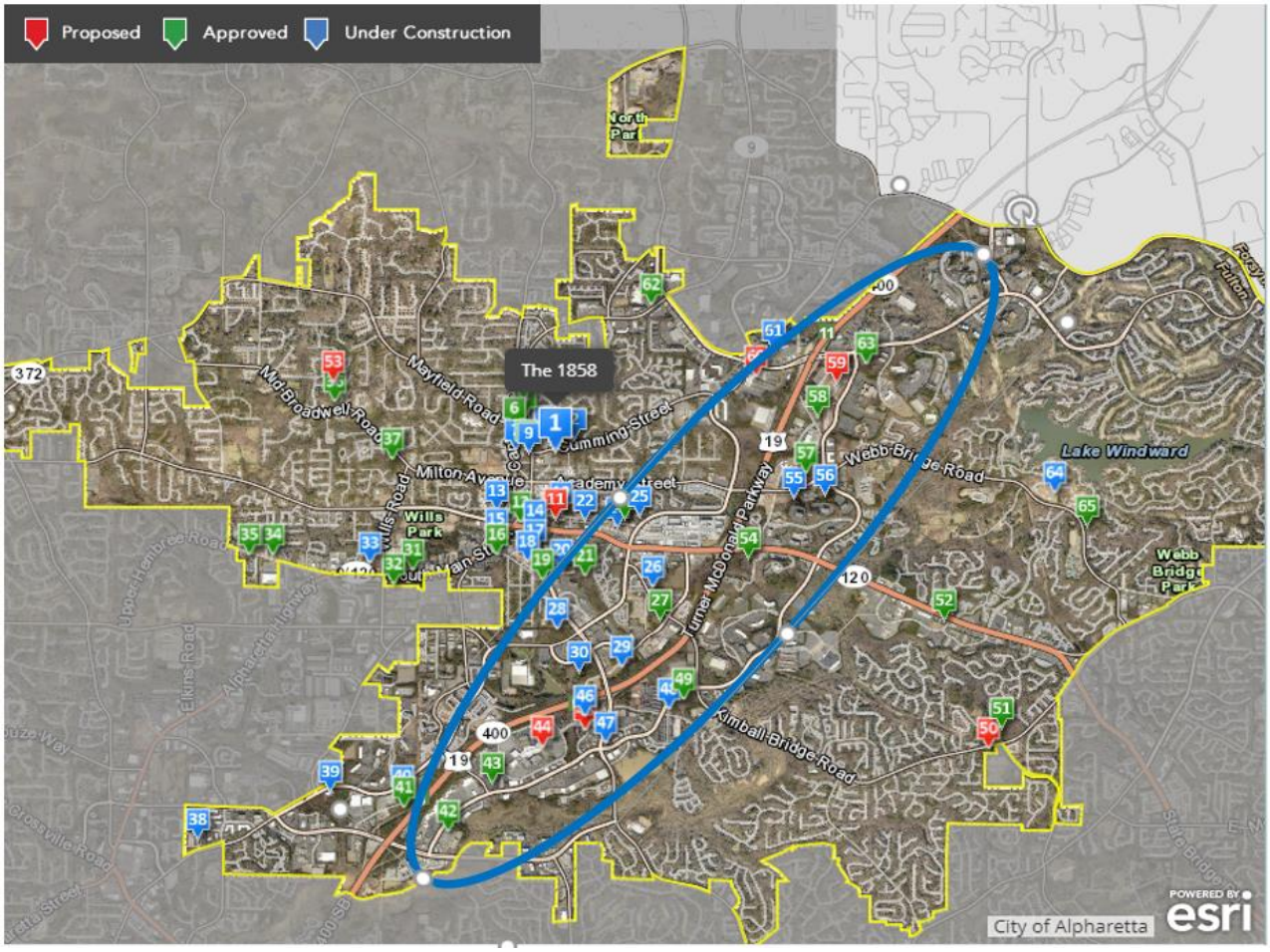


Figure 13: Ongoing and future developments in the study area [11]

3. State of the Practice/Trends

This section summarizes the state of the practice and trends in EV technologies and electrification throughout the nation and around the world.

3.1. Literature Review/Study Framework

An extensive body of literature has been reviewed as part of this study, to obtain an understanding of the status and key global trends in EV technologies and electrification worldwide. In particular, the focus of the review exercise has been to capture the state of the practice and latest thinking in terms of EVs and EVSE planning and implementation.

A framework development process was adopted during the literature review to derive the research framework and identify key elements of electrification and EV charging infrastructure deployment. The research framework shown in **Figure 14** focused on six key dimensions:

- **Technology and Systems.** This section provides a detailed review of EV technologies, EV communication systems, and an overview of Electric Road Systems technology.
- **Infrastructure.** The infrastructure dimension of this framework includes best practices and approaches for EVSE planning and implementation, as well as infrastructure operations and maintenance.
- **Regulatory Environment.** In this Study, the regulatory environment in EVs context refers to actions from policymakers at different levels of government – local, regional, or federal – that accelerate the EVs deployment through declared EV policies, targets, strategies, and fiscal incentives.
- **Business Processes.** This dimension summarizes key business models to deploy EVSE projects. This section also has example national EV programs and strategies to secure federal and non-federal funding.
- **People & Consumers:** The people and consumers dimension provides EV market trends including but not limited to car sales and infrastructure deployments, and identifies key stakeholders for partnership and collaboration opportunities.
- **Sustainability:** The last dimension presents a general overview of EV impacts on sustainability and environmental emissions.

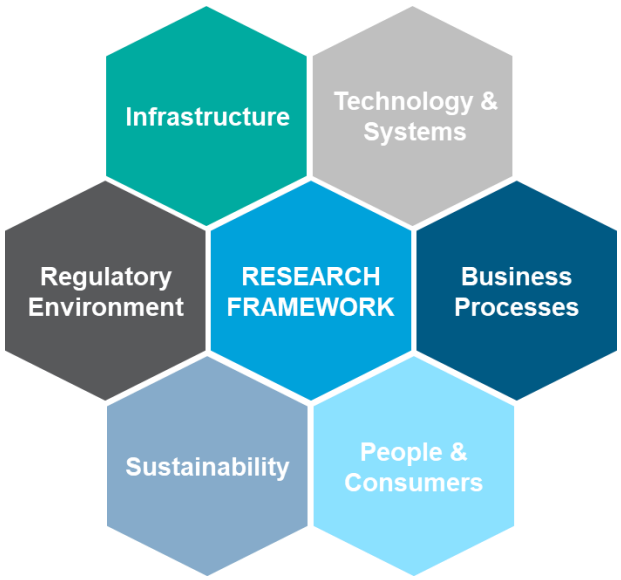


Figure 14: Literature Review/Study Framework

3.2. Technology & Systems

The automotive industry has become one of the most important world-wide industries in terms of research and development. Increasingly, there are more technological elements that are being implemented on the vehicles. EVs have been introduced as an alternative method of transportation to help mitigate environmental issues, such as carbon emissions and fuel consumption. Moreover, the implementation of effective EV charging systems and reliable communications is essential to motivate mass adoption of EVs. This section provides a detailed review of EV technologies, EV Communication systems, and Electric Road Systems technology.

3.2.1. EV Technologies

EVs are gaining momentum due to several factors. The following section reviews the advances of EVs regarding technology trends, charging methods, as well as new research challenges and open opportunities.

3.2.1.1. EV Types

Nowadays, we can encounter different types of EVs, according to their technology and vehicle autonomy. In general, they are sorted in five types [12]:

- **Battery Electric Vehicles (BEVs):** BEVs are 100% propelled by electric power and do not have an internal combustion engine. BEVs normally use large packs of batteries in order to give the vehicle an acceptable autonomy. A typical BEV will reach from 160 to 250 km, although some of them can travel as far as 500 km with just one charge. An example of this type of vehicle is the Nissan Leaf, which is 100% electric and it currently provides a 62 kWh battery that allows users to have an autonomy of 360 km.
- **Plug-In Hybrid Electric Vehicles (PHEVs)**: PHEVs are propelled by a conventional combustible engine as well as an electric engine charged by a pluggable external electric source. PHEVs can

store enough electricity from the grid to significantly reduce their fuel consumption in regular driving conditions. The Mitsubishi Outlander PHEV provides a 12-kWh battery, which allows it to drive around 50 km just with the electric engine. However, it is also noteworthy that PHEVs fuel consumption is higher than indicated by car manufacturers.

- **Hybrid Electric Vehicles (HEVs)**: Similar to PHEVs, HEVs are propelled by a combination of a conventional internal combustion engine and an electric engine. The difference is that HEVs cannot be plugged to the grid. In fact, the battery that provides energy to the electric engine is charged by the power generated by the vehicle's combustion engine. In modern models, the batteries can also be charged by the energy generated during braking, turning the kinetic energy into electric energy. The Toyota Prius, in its hybrid model (4th generation), provided a 1.3 kWh battery that theoretically allowed it an autonomy as far as 25 km in its all-electric mode.
- **Fuel Cell Electric Vehicles (FCEVs)**: FCEVs are provided with an electric engine that uses a mix of compressed hydrogen and oxygen obtained from the air, having water as the only waste resulting from this process. Although these kinds of vehicles are considered to present "zero emissions", it is worth highlighting that most of the used hydrogen in the process is extracted from natural gas. The Hyundai Nexo FCEV is an example of this type of vehicles, being able to travel 650 km without refueling.
- **Extended-range EVs (ER-EVs)**: ER-EVs to BEVs, yet the ER-EVs are also provided with a supplementary combustion engine, which charges the batteries of the vehicle if needed. This type of engine, unlike those provided by PHEVs and HEVs, is only used for charging, so that it is not connected to the wheels of the vehicle. An example of this type of vehicles is the BMW i3, which has a 42.2 kWh battery that results in a 260 km autonomy in electric mode, and users can benefit an additional 130 km from the extended-range mode.

This report uses the term "EVs" to refer to both BEVs and PHEVs since these vehicles can be recharged from external sources and are capable of operating with zero tailpipe emissions. HEVs, FCEVs, and ER-EVs are not a focus in this study unless noted otherwise.

3.2.1.2. Advantages and Challenges

The EV market is evolving rapidly, with models available in a range of vehicle types including regular sedans, SUVs, and pickup trucks. Currently EVs are gaining momentum due to the increased climate and environmental awareness. According to the International Energy Agency (IAE), the transport sector accounted for 37% of Carbon Dioxide (CO_2) emissions from end-use sectors in 2021, with the road transport accountable for over 60% of the sector emissions [13].

Therefore, most developed countries are encouraging the use of EVs to reduce the concentration of air pollutants. More specifically, they promote EVs as a sustainable and efficient mobility mode through different initiatives including tax incentives, purchase aids, or other special measures, such as free public parking or the free use of motorways. EVs offer the following advantages over traditional vehicles [12]:

- **Zero emissions**: EVs of vehicles do not emit tailpipe pollutants, CO_2, or Nitrogen Dioxide (NO_2). Also, the manufacture processes tend to be less harmful to the environment, although battery manufacturing adversely affects carbon footprint.
- **Simplicity**: The number of EV engine elements is less, which leads to lower maintenance costs. The engines are simple and compact; they do not need a cooling circuit, gearshift, clutch, or other elements that reduce the engine noise.

- **Reliability**: Having less, and simpler components makes EVs more reliable. In addition, EVs do not suffer of inherent wear and tear produced by engine explosions, vibrations, or fuel corrosion.
- **Cost**: The costs associated with EVs are lower compared to traditional vehicles. Traditional vehicles fuel and maintenance costs are higher in comparison to EVs maintenance and electricity costs. A comparison of the vehicles energy cost per km is shown in **Figure 15** below.
- **Comfort**: EVs are more comfortable, due to the absence of vibrations or engine noise.
- **Accessibility**: EVs are allowed to access urban areas that are not allowed to traditional vehicles like Zero/Low Emission Zones (ZEZ/LEZs). ZEZs/LEZs are defined areas where access by polluting vehicles is restricted to improve air quality. This favours modes such as bicycles, micro-mobility solutions, hybrid vehicles, and electric vehicles. In the United Kingdom (UK), the LEZ covers most of Greater London and is in operation 24 hours a day, every day of the year [14].

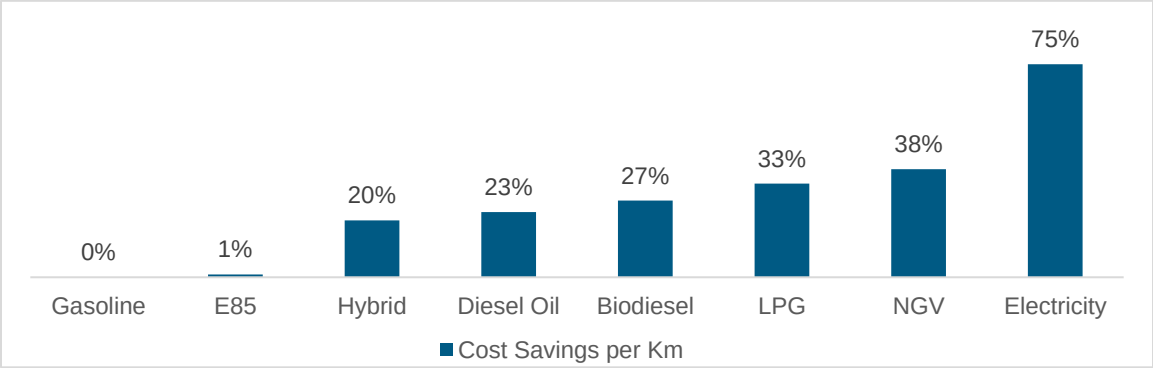


Figure 15: Comparison of savings in cost per kilometre offered by vehicles

However, large-scale adoption of EVs is still limited due to the significantly longer recharging time compared to the refuelling time of traditional vehicles, the limited driving range restricted by the EV battery capacity, and the relatively higher EV purchase prices compared to their fuel-operated counterparts. The batteries are considered the main obstacle to EV wider adoption. The development of better, cheaper, and higher capacity batteries will extend vehicles autonomy, and the users view them as a true alternative to traditional vehicles. EVs have significant battery-related challenges including [12]:

1. **Driving Range**: For the 2021 model year, the median driving range with a full charge of all EVs was 234 miles while the median range for gasoline vehicles was 403 miles [15]. Though there are ongoing efforts globally to improve that aspect. For example, the 2022 BMW iX and 2022 Tesla Model S have driving ranges of 324 and 405 miles, respectively [16].
2. **Charging Time:** When traveling with an EV a limiting factor is the time that is required for charging the batteries. Fully charging the battery pack usually takes 4 to 8 hours. To reduce the charging time, Tesla currently owns and operates the global fast charging network for EV Superchargers. Tesla Superchargers can recharge the Model S up to 50% in 20 minutes, and 80% in 30 minutes. There are currently 1,498 superchargers in the United States, with the majority (20%) in California [17].

An alternative approach to resolve the charging time issues is the creation of Battery Exchange Stations (BESs) or Battery Swap Stations (BSSs). At these stations, batteries are exchanged by similar ones already charged. Israel initially located 33 BESs, although the company that developed the battery-switching services for EVs (Better Place) filed for bankruptcy in May 2013. However, this approach was

extended to the city of Nanjing in China in 2015 for electric buses, and to Tokyo in 2010 for electric taxi vehicles in Tokyo in 2010. Lastly, Denmark currently is studying the possibility of creating a sufficient number of BESs with the purpose of providing an infrastructure with 900 charging points and charging batteries stations that have automated service operations.

- **Battery Cost**: Battery packs are the most expensive component in EVs. For instance, the batteries of the Nissan LEAF approximately account for a third of the cost of the whole vehicle. However, it is expected that this cost will gradually decrease; at the end of 2013 the battery pack cost was around $500 per kWh while currently, the price per kWh is $200 and it is expected to fall another $100 in 2025. Moreover, Tesla is building a “Gigafactory” to cut down on the production costs which will also contribute to the battery cost reduction trend. The lower battery cost is expected to have a direct impact on EV price drop, which makes them more competitive and desirable by end users.
- **Bulk and weight**: Battery packs are heavy and take up considerable vehicle space. An average EVs battery weight is 1,000lb, yet the weight can vary, depending on the battery capacity [18].

EVs play a very important role in smart cities, along with shared mobility, public transport, micro-mobility solutions, etc. Therefore, more efforts to facilitate the charging process and mitigate batter-related risks and challenges are needed. The main drawback of the EVs is their autonomy. Nevertheless, researchers are working on advanced battery technologies to increase driving range, and decrease charging time, weight, and replacement costs. These main factors will ultimately determine the future of EVs.

3.2.1.3. Charging Speeds

There are three levels for charging EVs depending on the charging speed. The slowest **Level 1** provides charging through a common residential 120V Alternative Current (AC) outlet. Alternatively, **Level 2** offers charging through 240V in residential applications, or 208V in commercial applications. Lastly, the fastest speed is the DCFC equipment, which enables rapid charging along heavy-traffic corridors at installed stations. Most PHEVs currently on the market are not compatible with fast chargers. **Table 1** below summarizes the typical power output, charging time, and locations for PHEVs and BEVs for the different charging modes [19].

Table 1: Comparison Between EVs Levels of Charging

Comparison	Level 1	Level 2	DCFC
Connector Type	J1772 Connector	J1772 Connector	CCS Connector CHAdeMO Connector Tesla Connector
Typical Power Output	1 kW	7 - 19 kW	50 - 350 k
Estimated PHEV Charge Time (8 kWh battery)	5-6 hours	1-2 hours	NA
Estimated BEV Charge Time (60 kWh Battery)	40-50 hours	4-10 hours	20 min – 1 hour
Estimated Electric Range per Hour of Charging	2-5 miles	10-20 miles	180-240 miles
Typical Locations	Home	Home, Workplace, and Public	Public

Although the development and evolution of EVs have undergone a great growth, especially in the last 20 years, there are still several interesting opportunities to explore to propose new and enhanced solutions. These include new battery technologies or manufacturing processes, optimization of the charging process, vehicle communications and Artificial Intelligence (AI) in EVs and eco charge using green energy.

3.2.2. EV Communication Systems

The implementation of effective EV charging systems is essential to motivate mass adoption of EVs. Accordingly, reliable communications between the charging systems and the EVs are vital for efficient management of the charging process.

Presently, charging EVs can be performed either using a charging cable, where the EV is plugged into a power outlet, or through wireless charging with no cables attached. Wired charging requires direct physical connectivity between the EV and the charging socket, thereby imposing an electrocution hazard to the EV user, particularly during harsh weather conditions. To overcome this hazard, effective electrical isolation is required between the EV, the EVSE, and the mains power grid, using high-frequency isolation transformers or other isolation techniques. Moreover, hardware compatibility between the EV charging connector and the charging inlet point is essential to enable wired EV charging. This impacts the convenience to EV users, as it limits the locations at which an EV can be charged to those compatible and/or interoperable with the EV connector [20]

In contrast, wireless charging is adopted as an alternative charging method, where no physical connection is required between the EV and the power source. Wireless charging is becoming more common due to its flexibility, convenience, and higher safety factor. It is commonly categorized into three modes: static charging, dynamic charging, and quasi-dynamic charging. In static charging, energy is transferred from the grid to the EV using inductive wireless power transfer while the EV is parked over a wireless charging pad. A dynamically charged vehicle, on the other hand, receives the charging energy wirelessly during its motion over a set of coils placed on the road. Quasi-dynamic charging is an integration of the two modes in which the EV is charged during transient stops at intersections and traffic signals [20].

The Norwegian capital Oslo has become the first city in the world where there are wireless charging terminals for electric taxis. The project uses electromagnetic induction charging technology with special plate integrated into the usual parking spaces of the EV taxis that transmit the energy required for battery storage through some receivers installed underneath the panels [21].

The integration of the EV charging solutions within the city infrastructure is expected to increase EV adoption by ensuring continuous charge availability and improving the convenience levels for EV owners. This contributes to the establishment of an internet of electric vehicles (IoEV) in which EVs are considered as intelligent entities with multiple sensors and actuators that can communicate and exchange information with the surrounding vehicles and infrastructure. This aims to enable driving and charging coordination, energy management, and traffic safety and optimization. A smart city infrastructure model demonstrating the integration of different EV charging infrastructures in an IoEV is shown in **Figure 16** [20].

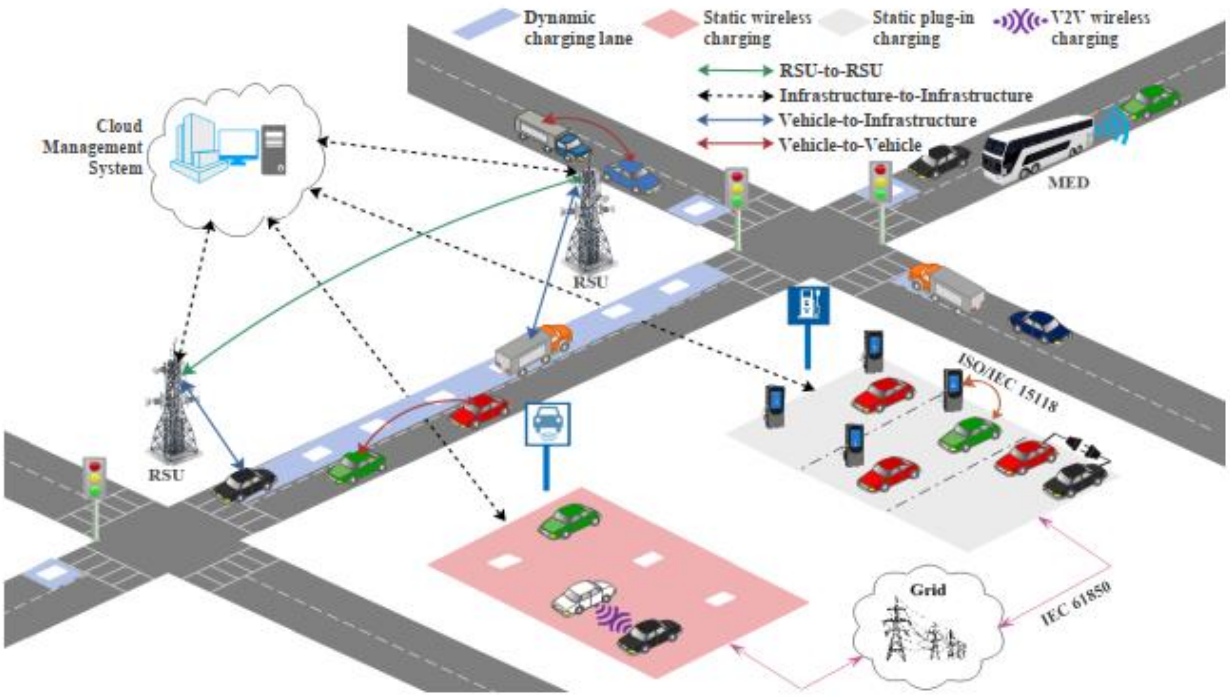


Figure 16: Smart City Infrastructure Model

To enable effective EV charging coordination and management in an IoEV, effective communication strategies need to be implemented, in which a communication link is established between the EV and its surroundings including vehicle-to-infrastructure (V2I), infrastructure-to-vehicle (I2V), and vehicle-to-vehicle (V2V) communications. Accordingly, an integrated network is required with multiple radio access networks to enable effective communication between various entities in the smart city infrastructure.

3.2.2.1. Vehicular Radio Access Technologies

There are different technologies that support the communication between EVs and different elements of the infrastructure. Direct wired communication and message exchange between the EVs and EVSEs are currently established based on the IEC 61850 and ISO/IEC 15118 standards. In addition, power line communication systems demonstrated high-speed broadband communications over low-voltage power lines, with the same charging cable being utilized to simultaneously carry communications signals along with the charging power. Wired communication systems offer security and reliability, yet they can only be utilized for plug-in and static wireless charging systems. Hence, wireless communication technologies, like cellular networks and Wi-Fi communications, are required to enable information exchange between the EVs and the charging infrastructure [20].

The choice of the most suitable communication channel and radio interface impacts the speed, security, and reliability of the coordination of the charging process. With these factors in mind, different radio access technologies (RATs) are proposed in the literature for wireless vehicular communications, including cellular networks (3G, 4G, and 5G), direct short-range communication (DSRC), and WiFi. A comparison between the specifications of these RATs is shown in **Table 2** [20].

Table 2: Comparison Between Wireless Vehicular Communication Technologies

Feature	DSRC	3G-UMTS	4G-LTE	5G Sub-6 GHz	WiFi
Coverage	1 km	10 km	30 km	1-2 km	100m
Maximum Throughput	3-27 Mbps	2 Mbps	300 Mbps	2.4Gbps	6-54 Mbps
Mobility Support	Medium	High	Very High	Ultra High	Low
Bandwidth	10 MHz	5 MHz	1.4-20 MHz	5-100 MHz	20MHz
Spectrum	Licensed	Licensed	Licensed	Licensed	Unlicensed

There is ongoing research in the literature to understand the performance of these technologies in V2V and V2I communications. Studies reviewed from the literature reveal that DSRC and cellular (3G-UMTS, 4G-LTE, 5G Sub-6GHz) have extended their capabilities to support V2V and V2I communications. Wi-Fi offers shorter coverage range and lower mobility support, which makes it difficult to be utilized for information exchange during dynamic charging of mobile EVs. Moreover, a vehicular communication network based on Wi-Fi is prone to interference, which compromises the security and privacy of the data exchange process [20].

Another comparative study between DSRC and specifically the 4G-LTE cellular technology for V2V and V2I communications was conducted at the University of Michigan Transportation Research Institute (UMTRI) to examine the feasibility of these two technologies in a large-scale, real-world environment. The reported results from the field experiments concluded that despite the broad coverage and higher data rates offered by 4G-LTE, DSRC offers significantly lower signal transmission time and is more suitable for safety-related applications. However, there are additional costs of implementation of DRSC technology due to its roadside units (RSUs), while 4G-LTE has much lower deployment costs as it utilizes the existing 4G cellular network infrastructure [22].

Accordingly, short-range wireless communication technologies, such as Wi-Fi, can be better utilized for stationary EV charging systems, as their limited throughput and questionable security significantly impacts the communication reliability and quality of service. On the other hand, the use of other wide-range RATs, such as DSRC and 4G/5G cellular networks for EV charging applications, is still premature and need to be studied and thoroughly compared to better understand their applications in uncontrolled environment to support wireless EV charging systems, particularly in dynamic charging modes [20].

3.2.2.2. Communication in EV Charging Coordination

Charging coordination is a key factor that contributes to the massive adoption of EVs as it is important to understand the communications that can facilitate the EVs energy demand/supply management and resource allocation. Charging coordination strategies can be divided into two main categories: stationary charging coordination and mobility-aware charging coordination depending on the charging mode.

Charging coordination can also be classified into centralized and decentralized coordination. In centralized scheduling for plug-in charging stations, charging decisions are made by a centralized controller that receives the information on the status of available stations and EVs in the network. In de-

centralized coordination on the other hand each vehicle individually selects the suitable charging station based on the accessible information. In both approaches, reliable and efficient information exchange between the EVs and the stations is essential for optimal decision making [20].

Different charging coordination and routing optimization techniques and strategies have been addressed in the literature. One study around the EVs route optimization and DWC, proposed the deployment of heavy vehicles as mobile charging stations, the so-called Mobile Energy Disseminators (MEDs). While a bus is moving along its normal route an EV in need of charging attaches itself to it and charges via wireless power transmission. These MEDs can also coordinate the communication and energy exchange with the charging stations [23].

Two more studies proposed a semi-distributed V2V charging scheme. In the first study basically the charging price is determined by a central device, while the charging decisions are made by vehicles. The second study proposes a charging navigation strategy in which EVs are augmented with mobile edge computing (MEC) capabilities to adaptively choose their optimal route and charging station based on different traffic models and other information received through vehicular communications [20].

The specifications of the underlying vehicular communication networks have received less attention in the research, as most of the proposed strategies in the literature assume an effective vehicular communication infrastructure for the exchange of coordination information. Hence, further studies are required to develop the end-to-end architecture of the IoEV, by defining the specifications of RATs technologies for effective EVs charging coordination.

3.2.3. Electric Road Systems

The adoption of EVs has been limited by the high costs, limited battery range, and a lack of charging convenience. Electric Road Systems (ERS) have emerged a new concept to overcome these challenges. Although there is no general consensus as to their definition, it is widely understood as a system that enables dynamic power transfer between a vehicle and the roads they are travelling along – dynamic charging. ERS is generally classified into three groups:

- Inductive (wireless)
- Conductive (catenary/overhead)
- Conductive (in-road rail)

These three ERS types use different forms of technology to provide the same principal function and service – providing on-demand power transfer for electric vehicles, automatically, while in motion at low and normal traffic speeds [24].

Different ERS technologies have been developed and tested at small scales, ranging from a few hundred meters at test sites to a few km on public roads in Sweden, Germany, and the United States (US). Agreements between Germany and Sweden have already been developed to intensify cooperation in ERS research. The Swedish Transport Administration, Trafikverket, has decided on the country's first permanent electric road, a 21km stretch of the two-lane E20 between Hallsberg and Örebro. Although it has not yet been decided which technology will be used for the electric road, they announced that it is expected to be fully operational by 2025 [25] [26].

In the US, Michigan Department of Transportation (MDOT) has awarded Electreon the ERS contract to build the United States' first, public wireless in-road charging system for the Inductive Charging Pilot Program. The project is currently slated for up to a one-mile stretch of both dynamic and stationary

wireless EV charging in Detroit. The project will be hosted by and live within Michigan Central, a mobility innovation district, and supported by partners like Ford Motor Co., DTE Energy, and the City of Detroit [27].

3.3. Infrastructure

Governments are investing in the charging infrastructure and technologies to help drive the transition to clean, zero-emission EVs. State and local leaders are advancing their communities' electrification through EVSE strategic planning to support adoption of these vehicles. The infrastructure dimension in this Study reviews best practices and approaches for EVSE planning and implementation, as well as infrastructure operations and maintenance.

3.3.1. EVSE Planning and Implementation

Most charging of EVs is currently done at home or at work in the early stages of the market. Yet the development of a robust public charging network is essential to incentivise the adoption of EVs. While in dense urban areas, drivers may lack access to private charging at home/work, rural area residents find EVs an attractive alternative to traditional vehicles. Rural residents drive more than their urban counterparts, need to spend more on vehicle fuel and maintenance, and often have fewer alternatives to driving to meet their transportation needs. Accordingly, publicly accessible charging stations play a key role in accelerating the adoption of EVs nation-wide.

As EV-related technology evolves, so does the process for EVs infrastructure planning and implementation. Furthermore, each region has its own charging site needs and constraints. The US Department of Transportation (USDOT) provided a set of guiding principles to guide the EVs planning process as follows [19] [28]:

- **There is no one-size-fits-all approach**. The needs and goals for each project and region are specific. Rural areas could vary substantially in terms of demand and infrastructure readiness.
- **Planning processes may be executed in parallel.** With EVs, there is new information that planners and stakeholders may attain at the different stages of the project. For instance, projects budgets may be revised based on the needs assessment and information acquired.
- **Early coordination with stakeholders.** As EVSE projects involve multiple key stakeholders including but not limited to local electric utility providers, EVSE manufacturers and installers, and transit agencies, coordination is important to allow for knowledge sharing and transfer of most up-to-date technical information.
- **Promoting equity in the public EV-charging system.** Stakeholders like EVSE planners, owners, and operators, do not always align with the needs of the community. Diverse populations are impacted by infrastructure projects including sizable groups of drivers who will extensively use the infrastructure either due to lack of equipment at home or long trips on the road. These community members need to be engaged with in the planning process to understand and address their needs in project siting and design.
- **Planning and Building for Flexibility.** Plan for current and future charging needs taking into considerations the type of EVSE installations and associated costs. A modular charging system can be as an example approach if there are opportunities for future expansion. In this approach customers have the flexibility to increase the power level of the charger based on demand. This approach can also help reduce site preparation costs in the future.

3.3.1.1. Global Practices of EVSE Planning and Implementation

Local governments have an important role to play in developing EVs charging infrastructure due to their authority over zoning, parking, building codes, and permitting and inspection processes. Planning, installation delays, and indirect costs are some of the challenges cities face in building charging infrastructure. Indirect costs incurred at the planning stage including the costs during site selection process, local building codes examination, stakeholders and public engagement, obtaining utility connections, and construction permits, add considerable cost to charger deployment projects.

To reduce such costs in the infrastructure planning and development process, the literature proposed three approaches adopted by European cities that are leading the transition to EVs in Europe including Amsterdam, London, Oslo, Paris, and Stockholm. The first approach is demand-driven which is done by locating new charging stations based on requests from EVs drivers or other input data retrieved from the public. The planning-oriented approach on the other hand is driven by the government authorities as they identify the charger locations for which operators can apply. Lastly, in the business-oriented approach, the deployment of charging station is done by the private sector, with the with governments' main role being to regulate and ease the process. **Table 3** provides of summary approaches deployed for publicly accessible charging infrastructure development in Amsterdam, London, Oslo, Paris, and Stockholm [29].

Table 3: Publicly Accessible Charging Infrastructure Development Approaches in Europe

City	AC Regular Charger	DCFC
Amsterdam	Demand-driven with one operator. The driver requests a charger, the application is reviewed and processed by the operator, and the city gives the formal approval	Mix of planning- and business-oriented with multiple operators. The city has installed rapid chargers for taxis which are publicly accessible. The development is otherwise left to the market.
London	Mix of demand-driven and planning-oriented with multiple operators. Local authorities primarily follow drivers' demand, while Transport for London (TfL) supplements using planning-oriented approach.	Mix of planning- and business-oriented with multiple operators. At city-owned locations, TfL conducts upstream work, and private companies operate the stations. Private businesses like parking and fuelling stations host additional chargers.
Oslo	Mix of demand-driven and planning-oriented with one operator. The chargers are owned and operated by the city.	Business-oriented. All the stations are operated by private charging station operators.
Paris	Planning-oriented with multiple operators. The city selects the charging station operator for given locations.	Mix of planning- and business-oriented with multiple operators. The city requires fuelling stations under concession contract to install a DC fast or a natural gas station at the time of contract renewal.
Stockholm	Planning-oriented with multiple operators. The charging station operator selects the location.	Planning-oriented with multiple operators. The charging station operator selects the location.

3.3.1.2. National Practices of EVSE Planning and Implementation

The USDOT has published in February 2022 a toolkit for planning and funding rural electric mobility infrastructure. In this toolkit three different levels of EVSE planning are discussed as illustrated in **Figure 17** [19]**:**

1. **Corridor-Level Planning –** infrastructure along roads and highways that facilitate interregional travel.
2. **Community-level Planning –** infrastructure needs within a particular town or region.
3. **Site-level Planning –** procurement and installation of EV chargers in a predetermined location.

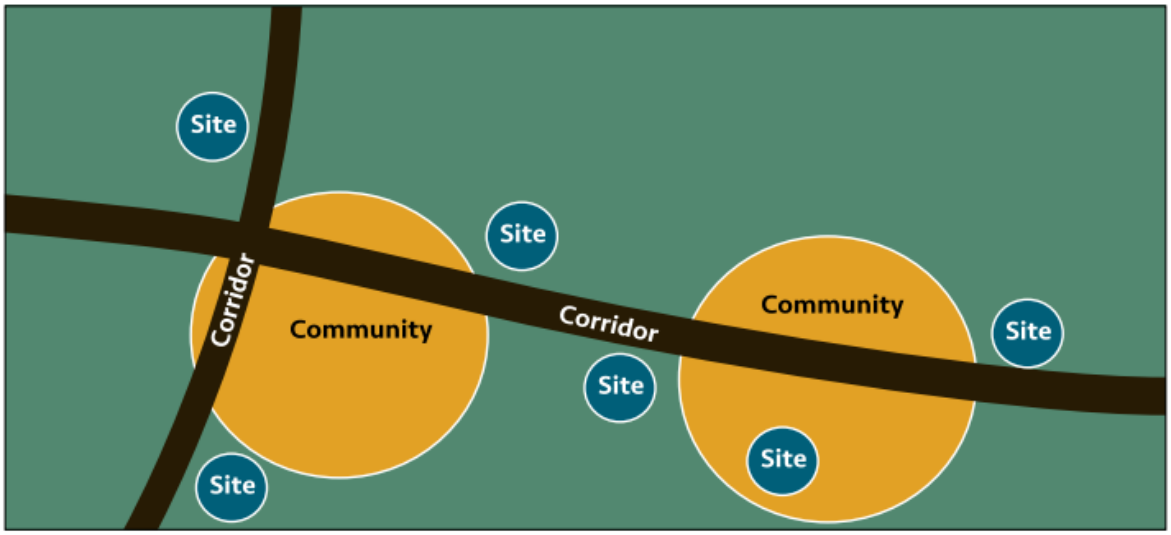


Figure 17: EVSE Levels of Planning

The relevant level of planning is dependent upon the planning lead/authority and the project stage. For instance, local and regional leaders are usually involved in community-level planning white State DOTs are more well-positioned to pursue corridor-level planning. However, as the project progresses, both entities may transition to site-level planning once chargers preferred locations are identified.

Corridor-level planning. This type of planning addresses the needs of interregional and interstate travelers and freight operators. Therefore, State DOTs, regional planning agencies, and county governments lead EVSE planning projects at this level. For rural areas, there are key considerations for corridor-level planning:

- Alternative fuel corridors are highly relevant to rural areas due to their nationwide coverage.
- Rural areas that have corridors with limited base of local EV adopters can integrate with the broader regional or national plans for electrification.
- Drivers at interstate corridors will anticipate fast chargers which are more expensive and require more electric grid infrastructure.

There are multiple regional plans and programs currently in the US at a corridor-level planning stage that also provide tools and helpful resources to aid in the planning process. Examples include:

1. **Federal Highway Administration (FHWA) Alternative Fuels Corridor (AFC) Program.** The program documentation provides resources for building out infrastructure and includes several State and regional corridor-level planning documents, including a series of Alternative Fuels Corridor Deployment Plans, and strategies for filling fast-charge infrastructure gaps along Interstate corridors.
2. **FHWA's Regional Convenings**. This resource compiles meeting materials and summary reports from a series of five regional meetings with alternative fuel corridor partners. An example meeting output and corridor-planning resource is the stakeholder responsibility matrix from the Intermountain Western Alternative Fuels Corridor Convening.
3. **The Department of Energy (DOE) Alternative Fuels Data Center's (AFDC) Corridor Measurement Tool.** This tool enables users to measure the driving distance between EV charging stations.
4. **FHWA AFC Interactive Map.** This online tool allows users to explore potential new corridors for EV charging stations.

Community-level planning. Multiple government authorities can be involved in the EVSE community-level planning like State DOTs, transportation planning agencies, transit agencies, and community organizations. At this level of planning, planners engage local stakeholders to serve a particular neighborhood, town, or region and understand their needs. Likewise, there are certain considerations for rural areas in community-level planning:

- Opportunity for rural entities to collaborate and establish partnerships with national-level organizations.
- Rural areas may face more technical constraints due to less-developed electric-grid and telecommunications infrastructure.
- Diverse stakeholders with different needs and perspectives may be conveyed at the communities, which need to be accounted for in the planning process.
- Tourism may be a factor contributing to high demand in some of the rural areas and towns.

The AFDC as part of the FHWA AFC Program has developed multiple tools to assist in the community-level planning process including:

1. **Plug-In Electric Vehicle Readiness Portal**. A primary information portal to help communities and regions assess existing conditions, identify opportunities, develop partnerships, and conduct education and outreach.
2. **A Guide to the Lessons Learned from the Clean Cities Community Electric Vehicle Readiness Projects**. A comprehensive lessons-learned summary from DOE's 16 Clean Cities EV Readiness projects with coverage of 24 States across the country.
3. **Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite**. This online tool helps communities and regions estimate the overall quantity and type of EVSE infrastructure needed

Site-level planning. At this level of planning, either regional leaders and stakeholders initiate the process as a result of corridor-level or community-level planning, or private business owners who would like to host and operate EVSE infrastructure on their premises. Below are a few considerations for rural areas:

- Similar to community-level planning, there are opportunities for partnerships and collaborations.

- Infrastructure constraints may be incurred in some areas to install fast chargers and networked charging stations.
- Lower concentration of EV owners in rural areas.

The AFDC provides general guidance of the site-level planning process, as it varies depending on the site type. The overall process though is broadly aligned as follows [30]:

1. **Identify the Need.** This step considers the community members to understand their charging needs based on travel patterns, EV ownership, charging time, and projected EVs demand. There are as well multiple resources found in the literature for charging needs estimate including:
    a. The California Energy Commission's Electric Vehicles Charger Selection Guide.
    b. The **EVI-Pro Tool Lite** for estimate of type and quantity of EVSE infrastructure.
2. **Consider Equitable Access.** Low-income and disadvantaged communities are typically exposed to a higher proportion of environmental hazards and EV charging infrastructure can make it easier to encourage EV adoption as a strategy to reduce those impacts. Charging infrastructure should consider a diverse set of community members to achieve community engagement and environmental justice goals. For example, a high-density urban area with multifamily housing might benefit from Level 2 curbside charging, while a more rural community may not have on-street parking and would benefit instead from centralized fast charging.
3. **Identify Project Partners.** Utilities play a major role in EVSE projects. Hence it is important to connect early in the process with the local and regional electric utility authorities in order to understand their EV-related policies and programs and identify any potential project constraints.
4. **Define Ownership/Business Model.** This model determines who will own, operate, and maintain the EVSE and related electrical infrastructure. In general, either the utility or the utility customer can own and operate the EVSE. The utility customer can be the site host – a property owner or tenant – or a third party, such as a charging network company. With third-party ownership and operation, the site host does not directly profit from the charging station revenue but may see an increased number of visitors.
5. **Determine the costs.** These include equipment, installation, and operations and maintenance (including electricity, demand charges, and any annual charging network fees). The Argonne National Laboratory developed the AFLEET (Alternative Fuel Life-Cycle Environmental and Economic Transportation) tool to examine the environmental and economic costs and benefits of alternative fuel and advanced vehicles (AFVs).
6. **Compliance, Permitting, and Inspection.** For EVSE charger selection, compliance with certification requirements should be ensured. Charging infrastructure should also be compliant with SAE International standards. There are optional certificates that may be of interest such as the **U.S. Environmental Protection Agency's ENERGY STAR® program**. To qualify for this certification, chargers must be rigorously tested for operational safety by a nationally recognized testing laboratory. Moreover, the electrical contractor on the job should be familiar with the relevant standards and codes and permits and inspections required from local authorities

Figure 18 below provides the AFDC checklist that can be adopted for site-level planning of EVSE infrastructure [19] [30].

Figure 18: Checklist for Key steps in Planning and Implementing EVSE Projects

3.3.2. Engagement Guide

The Alternative Fuel Toolkit is an initiative by the FHWA and Oregon DOT that offers comprehensive guidance on EVs and EVSE deployment. The toolkit provides an Engagement Guide for EV infrastructure implementation – The AFV Action Guide. As state and regional transportation agencies can engage differently in the AFV market depending on their available resources and cumulative level of experience, the AFV Action Guide helps government leaders step through the process of AFV engagement, from the early stages of learning to advanced stages of engagement, highlighting milestones along the way. A summary of the AFV Action Guide for actions of “Learners” to “Actors” can be found in **Figure 19.**

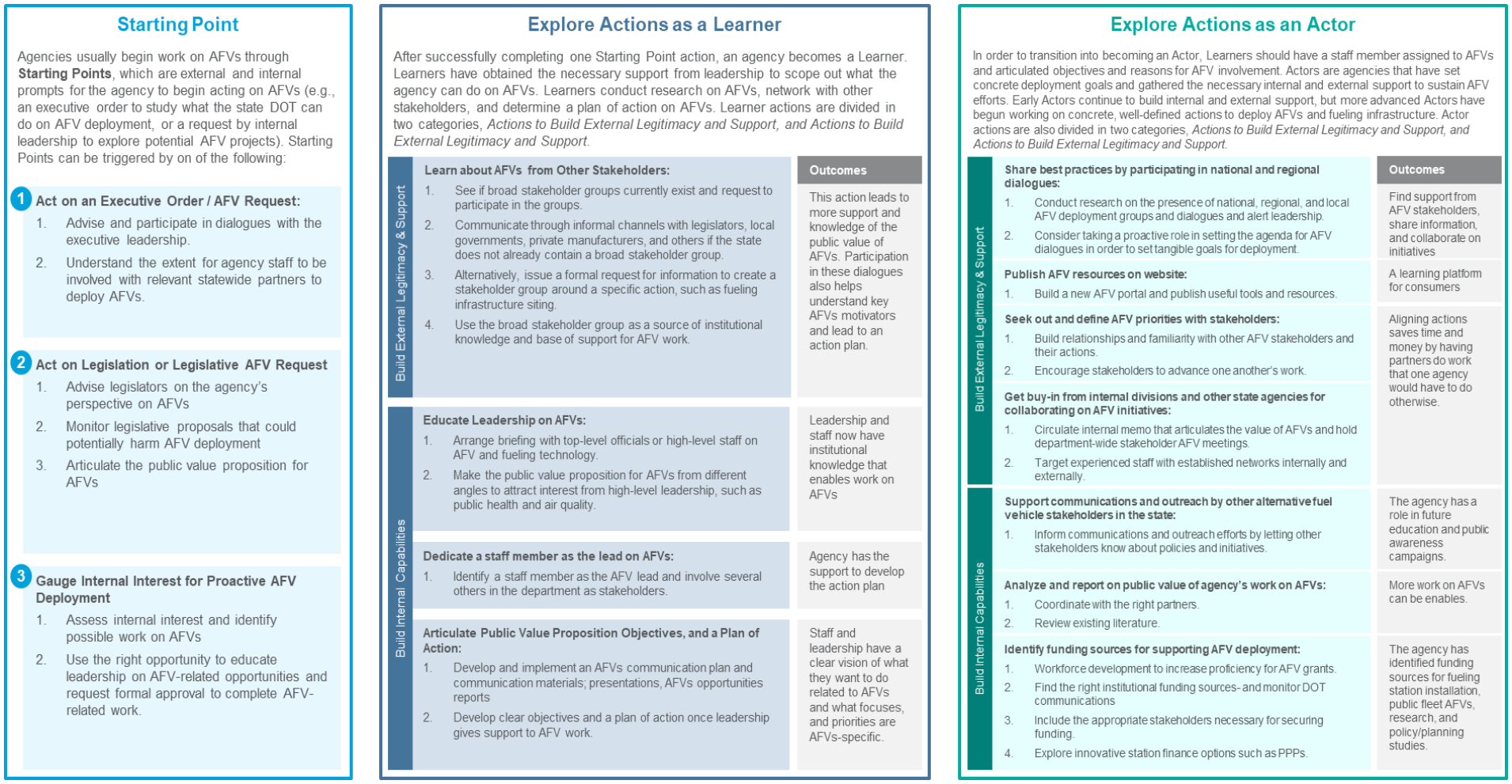


Figure 19: AFV Action Guide Summary

3.3.3. Operations and Maintenance

Once the EVSE installation is complete, there are a number of operational considerations to be aware of, including electricity and maintenance costs, fees and pricing structures, and utilization data. General maintenance activities for charging infrastructure includes storing charging cables securely, checking parts periodically, and keeping the equipment clean. Chargers may need intermittent repairs and manufacturer warranty plans vary on a case-by-case basis.

Uptime maximization - amount of time that a charging station is functioning properly and available for use - is necessary to establish a reliable EVSE network and build consumer confidence. Clearly defined operations and maintenance programs are necessary to minimize and prevent charging station downtime [31].

It is important to identify in contracts, for publicly funded EVSE, the entities responsible for station maintenance and repair, ensure adequate resources are available to conduct regular inspections, diagnose problems, and service stations in a timely manner. While establishing service contracts, agencies can explore the extent of any maintenance agreement they wish with equipment vendors, determine the duration of their agreement, and negotiate extended warranties. The Department of Energy and Environmental Protection (DEEP) in Connecticut suggests the provision of public funding for public charging equipment should be conditioned on an agreement from the recipient of the funding to ensure the operation and maintenance of the equipment is consistent with accepted operational and maintenance schedules and standards [32].

Chargers' repairs can be costly if they are no longer under warranty. Hence, repair and maintenance responsibilities should be defined and agreed upon to determine if the site host, charging network, or installer is responsible. While actual repair and replacement costs vary, the average general maintenance costs are estimated at $400 annually, per charger. Most networks also offer a maintenance plan for an additional annual fee. For example, according to the California Energy Commission's Electric Vehicle Charger Selection Guide, annual extended warranties for DC fast chargers can cost over $800 per charger per year [31].

DEEP also states that to minimize downtime, State agencies should effectively communicate with EV drivers in real time the availability of open chargers and parking spaces and scheduled maintenance plans. Suggested options include utilizing signage, mobile phone apps, and onboard technology installed in EVs [32].

Pricing Structures. Site hosts may choose to recover costs or generate revenue by charging a fee to using the charging infrastructure. Fees can be collected at the charging unit through multiple payment channels including in-person, credit cards, or mobile application. The Federal Energy Management Program (FEMP) Workplace Charging Program Guide provides examples of fees collection methods for a privately-owned workplace charging station as follows [33]:

- **Pay.gov** - Agencies can customize a payment system through the US Department of Treasury managed e-billing service that will send a monthly bill to employees, allow them to pay the bill online, and deposit the money in the Treasury. That money can be then directly applied to the facilities hosting workplace charging stations.
- **Payroll Deduction** - Agencies may alternatively withdraw the fee from employee's payroll as a post-tax deduction and then deposit the money into a Treasury account.

- **Third-Party Vendor** - A third-party vendor, such as a charging station network, parking kiosk, or a parking operator, could manually or electronically collect fees and send the agency checks, direct debit deposits, or wire transfers on a periodic basis.

Common pricing structures include by kWh, by session, by length of time, or through a subscription. Session- and time-based structures are common in states where non-utilities are prohibited from selling electricity. While charging a fee for the use of charging infrastructure is becoming more common, more than 25% of public charging (including Level 1, Level 2, and DCFC) is free to use. There are different pricing models across the charging network providers, including pricing for members versus non-members, user-specific pricing (i.e., free charging for certain vehicle owners), site host-specific pricing, and pricing based on rate of charge [31].

3.4. Regulatory Environment

Transportation electrification and the acceleration towards sustainable transportation is led by public bodies as policymakers play a pivotal role in transforming the transportation sector. As the problem with carbon emissions arise, countries across the globe have developed new robust EV strategies and policies that will serve as a strong catalyst for a global EV transition. In this Study, the regulatory environment in EVs context refers to actions from policymakers at different levels of government – local, regional, or federal – that accelerate the EVs deployment through declared EV policies, targets, strategies, and fiscal incentives. **Figure 20** shows the benchmarked countries and cities in this study.

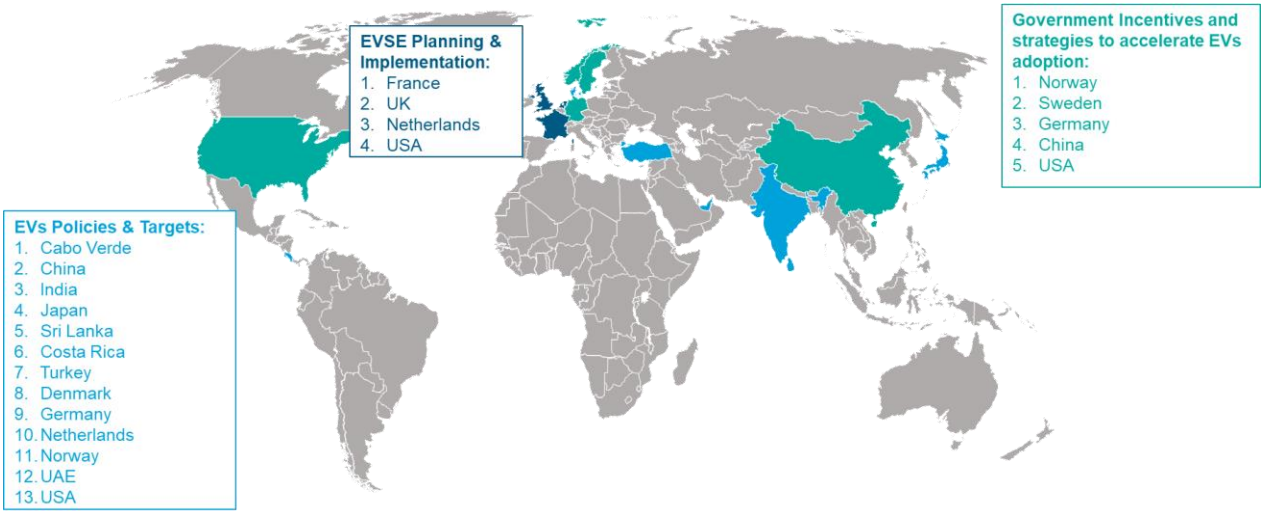


Figure 20: Benchmarked Countries and Cities

3.4.1. EV Policies and Targets

EV policies are regulated by the government to achieve their electrification and carbon emissions reduction objectives. Over the last decade a variety of support policies for EVs were instituted in key markets which helped stimulate a major expansion of electric car models and adoption of EVs. Governments have also provided support for EV charging infrastructure through measures such as direct investment to install publicly accessible chargers or incentives for EV owners to install charging points at home. In some places building codes may require new construction or substantial remodels to include charging points, like in apartment blocks or retail establishments. Efforts by cities has encouraged EVs sales even outside of urban areas. Such measures include strategic deployment of charging

infrastructure and putting in place preferential/prohibited circulation or access schemes such LEZs and ZEZs or differentiated circulation fees. As seen in **Figure 21** more than 20 countries have announced the full phase-out of internal combustion engine (ICE) car sales over the next 10-30 years switching to ZEV and sales, including emerging economies such as Cabo Verde, Costa Rica and Sri Lanka. Moreover, more than 120 countries have announced economy-wide net-zero emissions pledges that aim to reach net zero in the coming few decades [34].

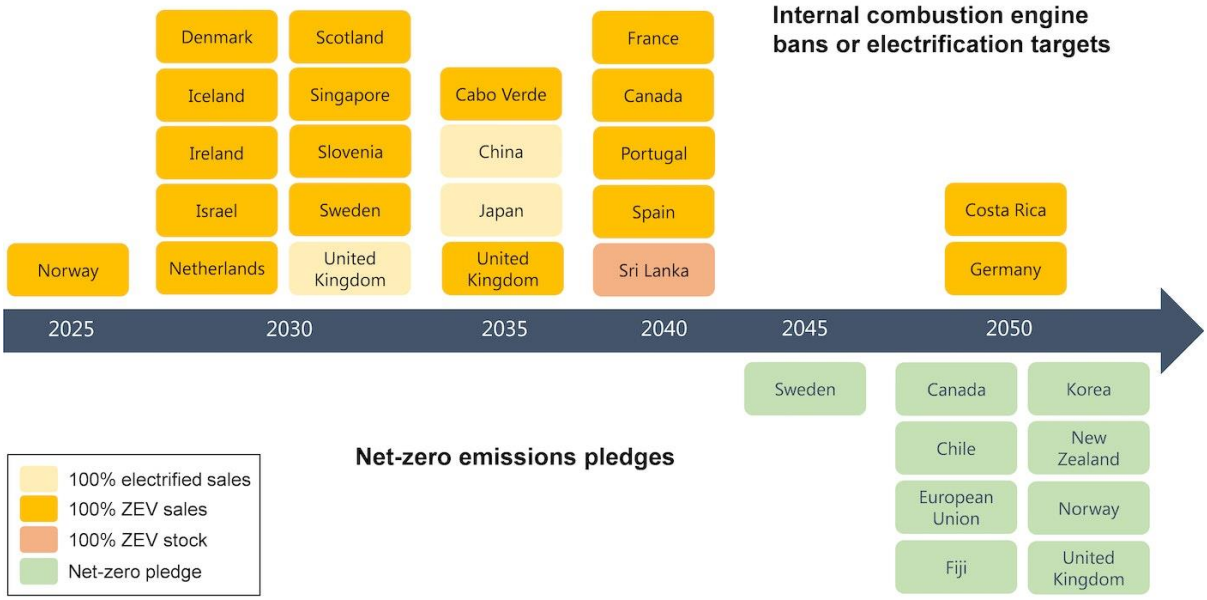


Figure 21: ICE bans and Electrification Targets

Although most targets have been set for light-duty vehicles (LDV), the electrification of medium- and heavy-duty vehicles (HDV) is increasingly recognized to reduce both local pollutant and CO_2 emissions. Electrification of HDVs requires policy support and commercial deployment similar to that passenger cars. In 2020, California proposed a ZEV sales requirement for heavy-duty trucks. The **Advanced Clean Truck Regulation** is due to take effect from 2024. Netherlands as well are implementing zero-emission commercial vehicle zones. Electric buses are already under operations in key cities around the world, supported by national and local policies that target air pollution. Policy instruments to promote electric buses are diverse; competitive tenders, green public procurement programs, purchase subsidies and direct support to charging infrastructure deployment, as well as effective pollutant emissions standards [35].

Table 4 highlights some key global and national policies and measures that support the deployment of EVs and ZEVs. The policies are structured in three categories [35]:

1. **Legislation** - Legally binding commitments such as regulations and standards.
2. **Targets** - Announced government targets incorporated in legislation, budgetary commitments, or national climate plans.
3. **Ambitions** - Government goals or objectives as set out in a policy document.

Table 4: Summary of Key Global and National EV Policies and Targets

Region / country	Key Policy Measures and Targets	Year announced	Category
Africa			
Cabo Verde	**Target:** 100% EVs in government LDV stock by 2030. **Target:** 35% share of EVs in passenger LDV sales by 2025, 70% by 2030 and 100% by 2035. **Target:** 15% share of EVs in medium truck sales by 2025, 35% by 2030 and 100% by 2035. 25% share of EVs in heavy truck sales by 2030 and 100% in 2035. **Target:** 100% EV stock by 2050. **Target:** 50% share of EVs in urban bus sales by 2025, 75% in 2030 and 100% by 2040.	2019	Multiple vehicle categories
Asia			
China (EVI member)	**National level**		
	Legislation: Fuel economy standard tightened: 4.6 L/100 km (WLTP) or 4.0 L/100km (NEDC) by 2025 for passenger LDVs.	2017	LDV
	Legislation: New Energy Vehicle (NEV) mandate sets annual ZEV credit targets for OEMs to reach as a percentage of annual vehicle sales: 12% NEV credit for passenger LDV sales by 2020 (with each EV sold eligible to earn multiple credits depending on the all-electric range, battery density and vehicle efficiency). Targets are 14% in 2021, 16% in 2022 and 18% in 2023 (with gradual tightening of credits to 2023).	2020	LDV
	Target: 20% share of NEVs in LDV and HDV sales by 2025.	2020	Multiple vehicle categories
	Ambition: 72% share of NEVs in national urban public transport and 20% in logistics distribution by 2025.	2021	Multiple Vehicle Categories
	Ambition: 100% share of EVs in passenger LDV sales by 2035 (of which 50% are NEVs and 95% of those are BEVs).	2020	LDV
	Legislation: Fuel economy standard (legislation): Stage III National Standard of 10.6 – 41.5 L/100 km for new type approvals (July 2019) and all sales and registrations (July 2021) for heavy commercial vehicles (depending on vehicle class and weight). **Target:** reduce fuel consumption by 14 - 16% compared to Stage II.	2018	HDV
	Ambition: Charging infrastructure sufficient to meet the needs of more than 20 million NEVs by 2025.	2022	Charging Infrastructure
	Ambition: 60% of expressway service areas to have rapid charging by 2025.	2022	Charging Infrastructure
	Ambition: >80% NEVs in new (or replaced) public fleets (e.g. buses, taxis, delivery vehicles) in pilot zones and key air pollution regions by 2025.	2020	All
	Ambition: 13 million slow charging stations and 0.8 million fast charging stations by 2025. 15 million (cumulative) slow charging stations and 1.46 million (cumulative) fast charging stations by 2035.	2020	Charging Infrastructure

Region / country	Key Policy Measures and Targets	Year announced	Category
	Ambition: 1,000 battery swap stations and production of more than 100,000 vehicles capable of battery swapping.	2021	Charging Infrastructure
	Subnational level		
	Shanghai Ambition: 1.2 million NEV annual production capacity by 2025.	2021	LDV
	Shanghai Target: 96% of all buses and all new coaches to be new energy or clean energy vehicles by 2025.	2022	HDV
India (EVI member)	**National level**		
	Legislation: Corporate average fuel economy standard: 4.77 L/100 km (NEDC) in 2022 for passenger LDVs.	2015	LDV
	Ambition: 30% share of EVs in passenger LDV sales by 2030.	2017	LDV
	Ambition: 2, 877 charging stations in 25 states and 1,576 charging stations across 9 expressways and 16 highways.	2021	Charging Infrastructure
	Ambition: Charging stations every 40 - 60 km on national highways or 700 charging stations by 2023 covering 35,000 – 40,000 km of national highways.	2021	Charging Infrastructure
	Subnational level		
	Delhi Target: 25% share of BEVs in new vehicle sales by 2024.	2020	Multiple vehicle categories
	State of Goa Target: 30% share of BEVs in all vehicle registrations (two/three wheelers and LDVs) by 2030.	2021	Multiple vehicle categories
Japan (EVI member)	**Legislation:** Fuel economy standard: 25.4 km/L for passenger LDVs by 2030, equivalent to a 32.4% improvement relative to 2016 and includes EVs.	2019	LDV
	Ambition: carbon-neutral manufacturing including production, use and disposal of cars by 2050.	2020	LDV
	Ambition: 100% electrified vehicles in passenger LDV sales by 2035.	2020	LDV
	Target: 1,200 fuel cell urban bus stock by 2030.	2019	HDV
	Legislation: Fuel economy standard: 6.52 - 7.63 km/L (JC08) by 2025 (depending on vehicle class and weight) for heavy commercial vehicles. Target to reduce fuel consumption by 13.4 - 14.3% relative to 2015 standard.	2019	HDV

Region / country	Key Policy Measures and Targets	Year announced	Category
	Target: 150, 000 EV charging points (including 30,000 fast chargers) and1,000 hydrogen refuelling stations by 2030.	2021	Charging Infrastructure
Sri Lanka	**Target:** All state-owned vehicles to be electric by 2025 (across all modes).	2017	Multiple vehicle categories
	Target: all passenger LDVs to be electrified by 2040.	2017	LDV
Central and South America			
Costa Rica	**Target:** 70% share of ZEVs in bus and taxi sales by 2035, and 100% by 2050.	2018	Multiple vehicle categories
	Ambition: 60% share of ZEVs in the LDV (private and institutional) fleet by 2050. **Ambition:** 100% share of ZEVs in new LDV sales by 2050.	2018	LDV
Eurasia			
Turkey	**Ambition:** 30% of ZEVs in new truck and bus sales by 2030, 100% by 2040.	2021	M/HDV
Europe			
Denmark (EVI member)	**Ambition:** 1 million passenger ZEVs in LDV stock by 2030.	2020	LDV
	Ambition: End the sale of new petrol and diesel cars from 2030. PHEVs will no longer be sold from 2035. **Ambition**: 100% share of ZEVs in urban bus procurements by 2025 and 100% ZEV urban bus fleet by 2030.	2018	LDV
	Ambition: 30% of ZEVs in new truck and bus sales by 2030, 100% by 2040.	2021	M/HDV
Germany (EVI member)	**Ambition**: 50,000 EV charging stations (20 000 of which are fast chargers) by 2025.	2021	Charging Infrastructure
	Ambition: 50% share of electric urban buses by 2030.	2020	HDV
	Ambition: 15 million EVs on the road by 2030.	2021	LDV
	Ambition: 1 million EV charging stations by 2030.	2019	Charging Infrastructure
Netherlands (EVI member)	**Target:** 15,000 stock of passenger FCEVs by 2025 and 300,000 by 2030. **Target**: 3 000 heavy-duty FCEVs by 2025. Target: 50% share of ZEVs in taxi stock by 2025. **Target**: all vehicles on the road should be ZEVs by 2050.	2019	Multiple vehicle categories

Region / country	Key Policy Measures and Targets	Year announced	Category
	Ambition: 100% share of ZEVs in passenger LDV sales by 2030.	2017	LDV
	Legislation: Zero emission transport zones to be introduced in 26 cities by 2025.	2021	Multiple vehicle categories
	Ambition: charging infrastructure to meet the needs of 1.9 million BEVs on the road by 2030.	2019	Charging Infrastructure
	Ambition: 30% of ZEVs in new truck and bus sales by 2030, 100% by 2040.	2021	HDV
	Ambition: 100% share of ZEVs in sales of vehicles in the cleaning industry (i.e., garbage trucks, sweepers)] by 2030.	2020	Multiple vehicle categories
Norway (EVI member)	**Target:** 100% share of ZEVs in passenger LDV sales by 2025.	2016	LDV
	Target: 100% share of ZEVs (or biogas) in urban bus sales by 2025. **Target:** 75% share of ZEVs in long-distance bus sales, 50% ZEVs in truck sales and 100% share of ZEVs in heavy van sales by 2030.	2016	HDV
	Ambition: 30% of ZEVs in new truck and bus sales by 2030, 100% by 2040.	2021	M/HDV
United Kingdom (EVI member)	**Ambition:** Phase out petrol and diesel passenger LDV sales by 2030. All sales of passenger LDVs to be BEVs or FCEVs by 2035.	2020	LDV
	Ambition: Government car and van fleet to be 100% ZEV by 2027. **Legislation:** Introduce a new road vehicle CO_2 emissions regulatory regime in 2024.	2021	LDV
	Ambition: 300,000 public charging stations by 2030.	2022	Charging Infrastructure
	Legislation: Introduce a ZEV mandate to set targets for a percentage of manufacturers' new car and van sales to be ZEVs each year from 2024.	2021	LDV
	Ambition: 30% of ZEVs in new truck and bus sales by 2030, 100% by 2040.	2021	M/HDV
Middle East			
United Arab Emirates	**Legislation**: 20% of government vehicles procured are electrified in 2025 and 30% in 2030.	2020	Multiple vehicle categories
North America			
United States	**National level**		

Region / country	Key Policy Measures and Targets	Year announced	Category
(EVI member)	**Legislation**: Standards to reduce GHG emissions from LDVs by 1.5% per year from MY 2021/2022, 10% by MY 2022/2023, 5% by MY 2023/2024 and 6.6% by MY 2025/2026.	2021	LDV
	Legislation: Corporate Average Fuel Economy (CAFE) standard: improve the fleet average fuel economy of LDVs by 1.5% for MY 2022/2023, 8% for MY 2024/2025 and by 10% for MY 2026.	2021	LDV
	Ambition: 100% share of ZEVs in federal government vehicle procurement by 2035, including 100% share of ZEVs in light-duty vehicle acquisitions by 2027.	2021	Multiple vehicle categories
	Ambition: 50% share of ZEVs in passenger LDV sales by 2030.	2021	LDV
	Subnational level		
	Legislation: ZEV mandate: 22% ZEV credit sales in passenger LDVs by 2025 in ten states. (California, Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Rhode Island and Vermont.)	2016	LDV
	Ambition: 30% share of ZEV in all new medium- and heavy-duty commercial vehicle sales by 2030 and 100% by 2050 in 15 states and the District of Columbia. (California, Colorado, Connecticut, Hawaii, Maine, Maryland, Massachusetts, New Jersey, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, Vermont and Washington.)	2020	HDV
	Target: 3.3 million ZEVs in LDV stock (combined) in eight US states by 2025 (California, Connecticut, Maryland, Massachusetts, New York, Oregon, Rhode Island and Vermont).	2014	LDV
	State of California Target: 1.5 million ZEV stock (LDV, MDV, HDV) by 2025 and 5 million by 2030.	2012	Multiple vehicle categories
	State of California Legislation: Advanced Clean Trucks Rules requires 40 - 75% of sales by manufacturers (varied by vehicle class and weight) to be ZEV by 2035 (increasing targets from 2024).	2020	HDV
	State of Oregon Legislation: Clean Truck Rules requires 40-75% of sales by manufacturers (varied by vehicle class and weight) to be ZEV by 2035 (increasing targets from implementation beginning in MY 2025).	2021	HDV
	State of California Legislation: Low Carbon Fuel Standard sets annual carbon intensity targets. Transport fuel suppliers generate credits for fuels below the CI target (including electricity and hydrogen). The aim is to reduce the CI of the transportation fuel pool at least 20% by 2030 relative to 2010.	2009	Multiple vehicle categories
	State of California Target: 100% ZEV transit bus acquisitions by 2029, with a goal of full transition by 2040.	2019	HDV
	State of California Legislation: 100% share of ZEVs in passenger vehicles sales by 2035. 100% share of ZEVs in medium- and heavy-duty vehicle sales by 2045, for all operations where feasible and by 2035 for drayage trucks (i.e., operating in ports).	2020	Multiple vehicle categories
	State of California Target: 250,000 charging stations by 2025.	2018	Charging Infrastructure
	State of Massachusetts Ambition: 100% share of ZEVs in passenger LDV sales by 2035.	2020	LDV

3.4.2. Strategies and Government Incentives

EV strategies focus on key actions and policy instruments to support the transition from traditional ICE vehicles to EVs. For example, Electric car sales broke all records in 2020 as they were up over 40% from 2019. This is notable as sales of all types of cars was less by 16% in 2020 reflecting pandemic-related conditions. Prior to the pandemic, many countries were already developing and strengthening e-mobility strategies with fiscal incentives and more rigorous vehicle CO_2 emission standards. Purchase incentives increased in early 2020, notably in Germany, France, and Italy. As a result, electric car sales in Europe were 55% higher during the first-half of 2020 relative to the same period in 2019.

To accelerate the adoption of EVs, actions from both market leaders and followers are needed. A primary direction is to continue to implement and broaden EV strategies and government incentives. A summary of some key EV strategies globally identified in the literature review is provided in **Table 5** [34] [36] [37] [38] [39]**.**

Table 5: Examples of Key Global EV Strategies and Incentives

Region / country	EVs Strategies and Incentives	Year announced	Category
China	**New Energy Vehicle (NEV) National Program Strategy:** ○ 5% new passenger car sales by 2012 ○ $1.5bn for grants and discounted loans for large-scale pilot programs of electric buses, sanitation trucks, and taxis.	2009	Multiple vehicle categories
	Ten Cities, Thousand Vehicles - Large subsidies were provided by the central government for 10 cities to run pilot programs aiming to add 1,000 NEVs annually over 3 years.	2009	Multiple vehicle categories
	Increased budgets primarily to fund battery technology for BEVs, PHEV and FCEVs. The annual production and sales targets were set at 500,000 plug-in electric vehicles by 2015 and would rise to 2 million by 2020 to result in a cumulative 5 million NEVs by the end of 2020.	2012	Multiple vehicle categories
	Traffic Control Policies in Beijing to limit the number of annual vehicle registrations in 2015.	2015	LDV
	Exemption of EVs from traffic and vehicle ownership control in several large cities such as Beijing, Guangzhou, Shanghai, and Tianjin. For example, in 2015, the municipal government of Beijing announced that EVs will not be subject to the city's traffic control during peak hours.	2015	Multiple vehicle categories
	Fiscal subsidies for EV procurement including, purchasing tax exemptions, vehicle registration tax exemptions, and import duty reduction for EV-related parts and equipment	2014	LDV
	Government support for car sharing schemes electrification in Shanghai. The EVCard program one of the first car share schemes in China, where Shanghai city government offer financial support to private operators for all aspects of car share scheme electrification including platform development, charging infrastructure deployment, and operating costs.	2014	All
	NEV Credit Mandate sets annual ZEV credit targets for manufacturers as a percentage of their annual vehicle sales. In 2020, the targets were extended to 2023, by which the target will be 18% (16% in 2022, 14% in 2021). Each EV can receive between 1 and 3.4 credits depending on its characteristics. Each manufacturer can achieve the target in several ways, mainly by selling BEVs, PHEVs and FCEVs in various proportions, and by trading credits with other manufacturers.	2017	Multiple vehicle categories
	Fiscal Incentives to electrify bus fleets in Shenzhen. The Three major bus operators in the city were incentivized to electrify their fleet with an annual subsidy of USD 75,500 for each vehicle, 80% funded by the Shenzhen city authorities and 20% from central government.	2017	HDV
	Industry Partnership with the bus manufacturer BYD in Shenzhen. To speed up the development of new vehicles, the city adopted a partnership model, where it helped BYD refine its technology by giving detailed technical feedback on early versions of its electric buses.	2017	HDV
	Vehicle price cap at 300,000 yuan, to encourage the development of a new business model for battery swapping as battery swap mode vehicles are not subject to this regulation.	2020	LDV
	Financial assistance for construction and operation of charging facilities, and regulatory provisions for streamlining charging infrastructure planning processes.	-	Charging Infrastructure
Norway	**Carbon Reduction Strategy (Climate Policy)** through a green transport system.	1990	Multiple vehicle categories

Region / country	EVs Strategies and Incentives	Year announced	Category
	No purchase/import tax on EVs	1990	Multiple vehicle categories
	Decreased annual registration on EVs.	2000	Multiple vehicle categories
	Exemption from Tolls and Parking fees for EVs drivers	2000-2017	Multiple vehicle categories
	0% VAT on EV purchases	2001	Multiple vehicle categories
	Nationwide Access to Bus Lanes for EVs.	2005	LDV
	Financial support for deployment of charging stations	2009	Charging Infrastructure
	Charging Right Strategy for people living in apartment buildings **–** an expanded charging network with fast charging stations on all main roads in Norway.	2017	Charging Infrastructure
	Low Emission Zone in Oslo in the form of three toll rings around the city, where the toll rates are dependent on type of fuel. Zero-emission trucks (weight above 3.5 ton) are exempt from paying the toll.	2017	Multiple vehicle categories
	50% Rule – 50% discount on parking and toll fees for EVs.	2017	Multiple vehicle categories
Sweden	**Super Green Car Rebate** where buyers receive a €4,200 for new cars that emit no more than 50 grams of CO_2/km.	2012-2017	LDV
	EVs-first procurement strategy in Stockholm for EV adoption in its municipal fleet. When a new municipal vehicle is considered for purchase, the fleet manager assesses the needs of the department to see if choosing an EV is possible, or if e-bikes or cargo bikes might be suitable. To help staff consider this switch, a suitable EV is available to test drive for a couple of weeks to reduce any concerns.	2016	Multiple vehicle categories
	Electrification Strategy was launched to contribute to a fast, smart and economically efficient electrification and comprises all user sectors, not just transport.	2020	Multiple vehicle categories
	Government's Electrification Commission to accelerate the electrification of the transport sector with a counseling body to ensure knowledge exchange between the government and industry, research and society.	2020	Multiple vehicle categories
	Grants for EV buses of 20% of the EV bus purchase price for public transport authorities, municipalities, or limited companies. For private transport companies, the grant is 40% of the difference between the EV bus purchase price and a comparable diesel bus.	-	HDV
	Free Access to HOV (high occupancy vehicle) and bus lanes in some areas.	-	LDV
	Charge the Car Grant covers 50% of the cost of EVSE materials, up to a maximum cost per charge point of €1,000 for individuals and €1,500 for companies, municipalities, councils, and foundations.	-	Charging Infrastructure
	Pilot Project for Easier Electric Charging in Gothenburg from 1st April, drivers can use city car parks to charge residential EVs, whether parking or not. The pilot project lasts one year and is a collaboration between the traffic office, Gothenburg Energy, and Gothenburg Parking.	2022	LDV
	Expansion of the EV public charging network in Gothenburg with 500 new charging stations available in public parking areas around the city.	2020	Charging Infrastructure
Germany	**2030 Climate Action Program -** €2.5 billion to be spent on battery cell production and the expansion of the charging infrastructure, with Germany aiming to have 1 million charging stations by 2030	2020	Charging Infrastructure
	All gas stations to offer **EV charging** in the future	2020	Charging Infrastructure
	2020 Economic Stimulus Package: ○ Bonuses for manufacturers investment in new technologies, processes, and plants ○ €200 million in 2020 and 2021 for small and medium-sized enterprises (SMEs) to exchange their fleet to electric mobility.	2020	Multiple vehicle categories

Although motivations among state policymakers vary, many states are working to diversify the transportation sector fuel mix and drive down emissions by encouraging the use of alternative fuels, including electricity, natural gas, hydrogen, and biofuels. To accomplish this, many states have implemented strategies and incentives to promote the adoption of EVs. **Table 6** provides a summary of some key strategies and incentives to encourage mass adoptions of EVs in the states [34] [40] [41] [42] [43] [44] [45] [46] [47].

Table 6: Examples of Key National EV Strategies and Incentives

State	EV Strategies and Incentives	Year announced	Category
Federal	**National Electric Vehicle Infrastructure Formula Program (NEVI) to** provide funding to States to strategically deploy EV charging infrastructure and to establish an interconnected network to facilitate data collection, access, and reliability.	2022	Charging Infrastructure
	Advanced Technology Vehicle (ATV) and Alternative Fuel Infrastructure Manufacturing Incentives. The DOE offers direct loans to eligible manufacturers for up to 30% of the cost of re-equipping, expanding, or establishing manufacturing facilities used to produce qualified ATVs, ATV components, or alternative fuel infrastructure, including associated hardware and software.	2008	Multiple vehicle categories
	The Advanced Research Projects Agency - Energy (ARPA-E) was established within the U.S. Department of Energy (DOE) with the mission to fund projects that will develop transformational technologies that reduce the nation's dependence on foreign energy imports and reduce energy related emissions. The ARPA-E focuses on various concepts in multiple program areas including, but not limited to, vehicle technologies, biomass energy, and energy storage.	2009	Multiple vehicle categories
	Airport ZEV and Infrastructure Incentives for up to 50% of the cost to acquire ZEVs and install or modify supporting infrastructure for airport-owned or on-road vehicles used exclusively for airport purposes.	2012	All
	Clean Vehicle Credit for buyers of new all-electric cars and hybrid plug-in vehicles. Taxpayers receive certain financial incentives based on income for meeting certain requirements.	2018	LDV
	Electrification of Federal Government Fleet with the goal to acquire 100% ZEVs by 2035	2021	LDV
	Charging Infrastructure Funding. Government financial support included $5 billion to build out a network of EV charging along highways (AFCs) and provided another $2.5 billion in competitive grant funding to further build out charging infrastructure (though this includes all alternative fueled charging technologies).	2021	Charging Infrastructure
	Clean Bus Incentives. The Environmental Protection Agency's (EPA) Clean School Bus program provides funding to eligible applicants for the replacement of existing school buses with clean, alternative fuel school buses or zero-emission school buses.	2022	HDV
	Commercial EVs and FCEVs Tax Credit. Beginning January 1, 2023, a tax credit will be available to businesses for the purchase of new EVs and FCEVs up to 15% of the vehicle purchase price for plug-in hybrid electric vehicles, and 30% of the vehicle purchase price for EVs and FCEVs.	2023	Multiple vehicle categories
	Alternative Fuel Infrastructure Tax Credit. Fueling equipment for natural gas, propane, hydrogen, electricity, E85, or diesel fuel blends containing a minimum of 20% biodiesel, is eligible for a tax credit of 30% of the cost or 6% in the case of property subject to depreciation, not to exceed $100,000.	2023	Charging Infrastructure
Washington, DC	**Investing in a Charge Point in Central Station Dedicated for the Taxi Industry.** A public-private partnership (PPP) between the District of Columbia Department of For-Hire Vehicles (DFHV), ChargePoint, Transco, and Union Station has resulted in the installation of two fast charging stations in the Union Station Parking Garage for the exclusive use of the EV taxicabs.	2018	LDV
	Additional state financial support for EV adoption by reducing the cost barrier for disadvantaged communities. These include $25 million in funding to support EV adoption among low-income household, state sales tax exemptions on new and used EV purchases, and $2.2 million in grant funding for zero-emissions carshare pilot programs.	2021	All
	Washington State Plan for Electric Vehicle Infrastructure Deployment web page. The plan web page is maintained by WSDOT to keep stakeholders involved in the planning process and to share opportunities to provide input. The fact sheet, interactive map, and survey are linked on the webpage.	2021	Charging Infrastructure
	Virtual public listening sessions hosted on GoTo Webinar. WSDOT shared information about the NEVI program, state plans, and opportunities to provide input, and administered a series of polls. During these sessions, targeted questions about the benefits and disadvantages of the deployment of charging infrastructure were asked to attendees' communities.	2021	Charging Infrastructure
	EVs charging infrastructure installations first for all interstates. The priority deployments will include completing the state's north/south and east/west interstates.	2021	Charging Infrastructure
	Clean Carbon Fuel Standard. The Washington Department of Ecology will develop rules to establish a Clean Fuels Program that reduces the overall	2023	Multiple vehicle categories

State	EV Strategies and Incentives	Year announced	Category
	carbon intensity of transportation fuels by 4.3 million metric tons a year by 2038.		
	Public-Private Partnership Contracting Strategy to ensure the long-term sustainability of the stations. WSDOT set EV stations operations and maintenance requirements to include, at a minimum: ADA compliance, MUTCD compatible signage, workforce training requirements, interoperability requirements, minimum reliability standards, and minimum time-of-day accessibility requirements. WSDOT will maintain a database to ensure an up-to-date list of all station owners and service providers.	2023	Charging Infrastructure
California	**EVs Working Group in San Francisco (EVWG).** The EVWG aims to identify actions and policies to continue EV growth in the City. It is led by the Office of the City Administrator and the San Francisco Department of the Environment, and includes representatives from City departments, regional and state agencies, non-government organizations, and industry partners.	2015	LDV
	Disadvantaged Communities Advisory Group (DACAG) to ensure that disadvantaged communities benefit from proposed clean energy and pollution reduction programs. The group meets throughout the year to review the California Public Utilities Commission (CPUC) and the California Energy Commission (CEC) clean energy programs and policies to ensure that disadvantaged communities, including tribal and rural communities, benefit from proposed clean energy and pollution reduction programs. Group members are either from or represent disadvantaged communities.	2015	All
	Micro-mobility (Dockless e-scooters) in Santa Monica. Santa Monica was the first city to see hundreds of e-scooters deployed across the city with no municipal regulation, permits, or requirements. In September 2018, these e-scooters became regulated with permits from the city yet with no requirement for suppliers to provide docks.	2017	LDV
	Los Angelo's Climate Mayors' Purchasing Collaborative online platform and resource portal that guides and encourages city leaders and public bodies across the USA to buy EVs for municipal fleets collectively, reducing costs and sharing best practice on implementation.	2018	Multiple vehicle categories
	Government financial support and assistance for the Frito-Lay Zero and Near-Zero Emission Project to replace its existing diesel-powered freight equipment with zero-emission (ZE) and near-zero emission (NZE) technologies.	2019-2022	HDV
	Streamlining charging infrastructure processes in San Francisco. The city began working with the global organization of city leaders, C40, to define the potential for on-street fast charging and establish guidelines and criteria to help develop a viable pilot program to expand on-street fast charging	2020	Charging Infrastructure
	ZEV Market Development Strategy. The Governor's Office of Business and Economic Development (GO-Biz) collaborated with other agencies and partners to direct the development of the ZEV Market Development Strategy. The ZEV Strategy outlines the roles of state agencies in building and incentivizing the ZEV market and presents each agency's objectives. Each year, each agency submits an action plan to GO-Biz which describes the agency's actions, priorities, and equity strategies to support the ZEV Strategy.	2021	All
	The SB 671 Committee Monthly Meetups. Caltrans is coordinating with the California Transportation Commission (CTC) and a variety of freight industry stakeholders on the CTC's Clean Freight Corridor Efficiency Assessment under Senate Bill (SB) 671. The assessment seeks to identify freight corridors and infrastructure needed to support the deployment of zero-emission medium- and heavy-duty vehicles.	2022	HDV Charging Infrastructure
	EV charging infrastructure installations through competitive grant-funding opportunity (GFO). The CEC and Caltrans will jointly develop a competitive GFO to seek applicants to propose projects to acquire, install, own, operate, and maintain EV chargers at stations that meet the NEVI Program requirements.	2021	Charging Infrastructure
	Alternative Fuel Infrastructure Grant – Santa Barbara County. The Santa Barbara County Air Pollution Control District (SBCAPCD) provides grants for the installation of alternative fuel infrastructure located in Santa Barbara County. Grants may cover 80% of project cost, up to $250,000.	2022	Charging Infrastructure
	Alternative Fuel and Vehicle Incentives. The CEC administers the Clean Transportation Program to provide financial incentives for businesses, vehicle and technology manufacturers, workforce training partners, fleet owners, consumers, and academic institutions with the goal of developing	2022	Multiple vehicle categories

State	EV Strategies and Incentives	Year announced	Category
	and deploying alternative and renewable fuels and advanced transportation technologies.		
Georgia	**High Occupancy Vehicle (HOV) and High Occupancy Toll (HOT) Lane Exemption.** Alternative fuel vehicles (AFVs) displaying the proper alternative fuel license plate may use HOV and HOT lanes, regardless of the number of passengers. Qualified AFVs may also use the HOT lanes toll-free. AFVs include electric vehicles and bi-fuel or dual-fuel vehicles that operate on natural gas or propane.	2018	Multiple vehicle categories
	Alternative Fuel and Advanced Vehicle Job Creation Tax Credit. A business that manufactures alternative energy products for use in battery, biofuel, and electric vehicle enterprises may claim an annual tax credit for five years. The amount of the tax credit is based on the number of eligible new full-time employee jobs.	2020	Multiple vehicle categories
	EV Charging Station Rebate – Georgia Power. Georgia Power offers residential customers a $250 rebate for Level 2 EV chargers installed between January 1, 2020, and December 31, 2022.	2020	LDV
	Georgia EV Infrastructure Deployment Plan Public Outreach Strategies. GDOT will provide public presentations and supporting information virtually regularly on the NEVI program webpage. Special attention will be paid for disadvantaged communities to participate and provide feedback in the form of surveys, opinion forms, and email.	2021	Charging Infrastructure
	EV charging infrastructure installations through competitivities solicitations. GDOT is likely to conduct multiple competitive solicitations and award funding to project partners to develop sites, and install, operate, and maintain, EV charging infrastructure.	2021	Charging Infrastructure
	Outreach to Disadvantaged Communities. GDOT will engage the equity community in three main areas: local governments, technical workforce training, and interviews with equity community organizations.	2021	Charging Infrastructure

3.5. Business Processes

The Business Processes dimension provides an overview of the approaches to business planning and budgeting for EVSE projects. In this section, key business models to deploy EVSE projects are summarized, in addition to example EV national programs, Federal funding sources, and Non-Federal funding strategies.

3.5.1. Business Models

EVSE business models define how EVSE services are deployed and offered to customers. Site-level planners need to determine who will own, operate, and maintain the EVSE and related electrical infrastructure. In general, either the government, utility companies, or the utility customer can own and operate the EVSE. The utility customer can be the site host—a property owner or tenant—or a third party, such as a charging network company. With third-party ownership and operation, the site host does not directly profit from the charging station revenue but may see an increased number of visitors. For example, visiting EV drivers may purchase items from a retailer's business while charging their vehicles. Ownership and management of EVSE can be also done through a partnership agreement between public and private entities. **Table 7** below provides a summary of potential business models for EVSE installation and management [19] [48].

Table 7: Business and Ownership Models for EVSE Installation and Management

Model	Description
Electric Utility Owner-Operator	The electric utility installs, owns, and manages all components of the utility system and EVSE. In this model, the utility would charge and collect EVSE user fees. For large investments like DC FC installations, this may be the preferred approach, as it will help ensure long-term operability and public access.
Electric Utility with Private Concessionaire	The electric utility installs and owns all components of utility system and EVSE. A private business manages the EVSE through a contract with the electric utility. A primary advantage for private businesses is control over pricing and, more broadly, consistency and optimization of customer experience. This control comes at a price, however, as operators are responsible for station maintenance and operational, coordination with utilities as well as having detailed knowledge of electricity rate structures.

Model	Description
Electric Utility Make-Ready	Private sector installs, owns, and manages the EVSE. All infrastructure up to electrical panel is installed by the electric utility. Electrical panel owned and operated by the private sector. This is usually a good option for sites that do not want to (or are unable to) invest in premises wiring upgrades, as it allows the utility to absorb and recover those costs
Electric Utility with Government Incentive	The private sector installs, owns, and manages the electrical panel and EVSE unit. Government provides an incentive to the private sector to help install the EVSE.
EDL to Meter	The private sector installs, owns, and manages the electrical panel and EVSE unit.

3.5.2. Programs and Funding

Since EV charging infrastructure can require significant capital investment, grants and loans may be necessary to make EV infrastructure projects feasible for many entities. A variety of Federal, State, and local funding and financing options are explored under the following section.

3.5.2.1. Federal Funding Sources

Federal funding for electric vehicle infrastructure can be drawn from several sources, including discretionary and formula grant programs, loan financing programs, and tax incentives. The below table provides an overview of these funding types [49].

Table 8: Federal Funding Sources

Program Type	Description
Discretionary Grant Funding Programs	For discretionary grant programs, an agency solicits applications and competitively selects projects based on eligibility, evaluation criteria, and departmental or program priorities.
Formula Grant Funding Programs	Formula grant programs apportion funding based on formulas in statute. The recipients of these funds can be States, federally recognized Tribal recipients, cities and counties, or transit agencies. Recipients are responsible for determining how the funds are used according to program guidelines. The NEVI is one example of these programs.
Loan Financing Programs	Credit assistance programs leverage Federal funds to accelerate project delivery when direct funding programs are not readily available or applicable. Public credit assistance programs may also attract private and other non-Federal co-investment for projects. This can take the form of secured (direct) loans, loan guarantees, and lines of credit.
Tax Incentives (e.g., credits, exemptions, deductions)	The U.S. tax code contains potential funding sources for individuals, non-governmental organizations, and private organizations in the form of tax incentives. Specifically, exemptions, exclusions, and deductions all reduce an entity's taxable income, while credits, preferential tax rates, and deferrals decrease tax liability or even generate cash payments from the government to the taxpayer. The Internal Revenue Service (IRS) is responsible for administering these policies.

The USDOT provides a funding matrix shown in Appendix **A**, that has a comprehensive list of all available federal programs for EVs, a couple of which are highlighted in the following section. The matrix also notes the type of EV activities that are eligible for funding under different programs, as well as the eligible entities [50] . Applicable programs for the NFCID are highlighted in **Table 9**.

Table 9: Applicable Federal Funding Programs for EVs

Agency/Office	Program Name	Program Type	Program Description	Eligible Parties	LDV Charging	Transit Charging	Commercial Charging	Infrastructure Planning	Workforce Development	Vehicle Acquisition
DOT FHWA	Charging & Fueling Infrastructure Grants (Corridor Charging)	Grant	Deploy EV charging and hydrogen/propane/natural gas fueling infrastructure along designated alternative fuel corridors and in communities.	States/Territories, MPOs, Counties, Cities, Tribes, Transit Agencies	X	X	X	X		
DOT FHWA	Charging and Fueling Infrastructure Grants (Community Charging)	Grant	Program funds will be made available each fiscal year for Community Grants, to install EV charging and alternative fuel in locations on public roads, schools, parks, and in publicly accessible parking facilities. These grants will be prioritized for rural areas, low-and moderate-income neighborhoods, and communities with low ratios of private parking, or high ratios of multiunit dwellings.	States/Territories, MPOs, Counties, Cities, Tribes, Transit Agencies	X	X	X	X		
DOC EDA	FY2020 EDA Public Works and Economic Adjustment Assistance Program	Grant (Discretionary)	Provides investments that support construction, non-construction, technical assistance, and revolving loan fund projects designed to leverage existing regional assets and support the implementation of economic development strategies that advance new ideas and creative approaches to advance economic prosperity in distressed communities.	States, Tribes, localities, nonprofits	X		X	X	X	
DOC EDA	Build to Scale Program	Grant (Discretionary)	Provides funds for organizations to aid companies in developing the next generation of tech-based economic development initiatives, including commercial EV technology implementation.	States, Tribes, localities, nonprofits			X		X	
DOC EDA	Planning and Localities Technical Assistance Program	Grant (Discretionary)	Awards funding to eligible recipients (within Economic Development Districts) to create and implement regional economic development plans designed to build capacity and guide the economic prosperity and resiliency of an area or region.	States, Tribes, localities, nonprofits				X	X	
DOC EDA	Research and National Technical Assistance	Grant (Discretionary)	Supports research and technical assistance projects designed to leverage existing regional assets and support the implementation of economic development strategies that advance new ideas and creative approaches to advance economic prosperity in distressed communities.	States, Tribes, localities, nonprofits				X		

Agency/Office	Program Name	Program Type	Program Description	Eligible Parties	LDV Charging	Transit Charging	Commercial Charging	Infrastructure Planning	Workforce Development	Vehicle Acquisition
DOL	Workforce Opportunity for Rural Communities	Grant (Discretionary)	Funds projects that demonstrate alignment of regionally driven, comprehensive approaches to addressing economic distress and the necessary workforce development activities to ensure dislocated and other workers in the regions are capable of succeeding in current and future job opportunities.	States, Tribes, localities, nonprofits, individuals					X	
DOT FHWA	Advanced Transportation and Congestion Management Technologies Deployment	Grant (Discretionary)	Makes competitive grants for the development of model deployment sites for large scale installation and operation of advanced transportation technologies.	States, localities, transportation providers	X	X				
DOT FTA	Accelerating Innovative Mobility	Grant (Discretionary)	Promotes forward-thinking approaches to improve transit financing, planning, system design, and service. Program also supports innovative approaches to advance strategies that promote accessibility, including equitable and equivalent accessibility for all travelers.	States, Tribes, localities, transportation providers, nonprofits, private sector	X	X		X		
DOT FTA	Urbanized Area Formula Funding	Grant (Formula)	Provides capital, planning, and operating assistance to urbanized areas and to governors for transit capital and operating assistance in urbanized areas and for transportation-related planning. An urbanized area is an incorporated area with a population of 50,000 or more that is designated as such by the U.S. Department of Commerce, Bureau of the Census. Funding can support rural areas if the service provided also impacts a rural area.	States, Tribes, localities, transit providers		X		X	X	X
DOT OST	Rebuilding American Infrastructure with Sustainability and Equity	Grant (Discretionary)	Provides a unique opportunity for the USDOT to invest in road, rail, transit, and port projects that achieve national objectives. Starting in FY21, RAISE has substantially increased program focus on ZEV infrastructure, including EV charging.	States, Tribes, localities, transportation providers	X	X	X	X		
DOT OST	Infrastructure for Rebuilding America	Grant (Discretionary)	Advances the Administration's priorities of rebuilding America's infrastructure and creating jobs by funding highway and rail projects of regional and national economic significance that position America to win the 21st century.	States, Tribes, localities, transportation providers	X		X	X		

Agency/Office	Program Name	Program Type	Program Description	Eligible Parties	LDV Charging	Transit Charging	Commercial Charging	Infrastructure Planning	Workforce Development	Vehicle Acquisition
USDA NRCS	Urban Agriculture and Innovative Production	Grant (Discretionary)	Assists eligible entities with projects that support the development of urban agriculture and innovative production.	Tribes, localities, nonprofits	X		X	X		

3.5.2.2. National Electric Vehicle Infrastructure (NEVI) Formula Program

Under the Bipartisan Infrastructure Law, the NEVI Formula Program was established to provide funding to States to strategically EV charging infrastructure and to establish an interconnected network to facilitate data collection, access, and reliability.

Each State was required to develop and submit an EV Infrastructure Deployment Plan describing how the State intends to use its apportioned NEVI Formula Program funds in accordance with program guidance to develop the EV charging infrastructure. The program funding is offered for up to 80% of eligible project costs. The States accordingly proposed in their plan funding strategies to recover the 20% non-federal share of the project costs. **Table 10** provides funding strategies from State Deployment Plans to deliver the EV charging network [45] [46] [51] [52].

Table 10: Example State Funding Sources for Non-Federal Share of Network Costs

State	Funding Sources and Strategies
Washington	The source of match to the NEVI federal funding is toll credits. Washington earns toll credits when capital investments are made in federally approved tolled facilities including toll roads and bridges. These credits can then be used as a 'soft match', meaning do not provide additional money for the project but reduces or eliminates the amount of funding the state contributes. This allows the state's EV infrastructure program to be funded with 100% federal funds as opposed to the traditional 80/20 percent split between federal and state/local funding sources.
California	As part of the EVs deployment strategy through GFOs, grant recipients will own and receive revenue from the chargers. Grant recipients will provide a cost share that will cover at least the non-federal share of 20% of project costs. An evaluation criterion of minimizing public funding will incentivize applicants to provide higher cost shares, as well as to lower overall costs.
Pennsylvania	PennDOT will develop a funding program where third parties, such as site hosts and/or EV network companies, fund the non-federal cost-share and collect revenue generated from EV drivers using the charging stations.
Nevada	The existing investment in EV charging through NV Energy is a program investing approximately $100 million in Nevada, and NDOT intends to leverage this program funding as a private match for the new proposed federal NEVI stations within the NV Energy territory.

3.5.2.3. Alternative Fuel Corridor (AFC) Designations

At the national level, since 2016, the FHWA AFC Designations have catalyzed the expansion of a national corridor network of EV charging stations along 58,980 miles of the National Highway System (NHS), including portions of 106 Interstates and 104 U.S. highways and State roads. FHWA works with other Federal, State, and local officials and with private industry to facilitate an Interstate and major road network of alternative clean fuel stations (EV charging, hydrogen, natural gas, and propane) so commercial and passenger vehicles can reliably travel between cities and regions and across the Nation.

The AFC program engages State and local officials, including State DOTs and transportation planning agencies, and frequently collaborates with local Clean Cities coalitions to identify candidate highway segments for this national network. The program also encourages multistate and regional cooperation and collaboration on planning and developing alternative fueling and charging locations along corridors and provides guidance to States on implementing EV charging and other alternative fueling highway signage [53].

3.6. People and Consumers

The people and consumers dimension is defined as part this Study to understand the consumer behavioural trends in the adoption of EVs. EVs market trends explored under this section include car sales and registrations, consumers and governments spendings, charging infrastructure availability, private sector plans, and the State of Georgia EVs market review. Moreover, key stakeholders and players in the EVs industry are listed to identify partnership and collaboration opportunities.

3.6.1. Market Trends

This section provides an overview of the market trends in electric mobility with historical data on EV registrations and sales, and availability of charging infrastructure. It explores the main factors driving electrification of road transport, including roll-out plans from the private sector and other developments.

3.6.1.1. EV Sales and Registrations

After a decade of rapid growth, in 2020 the global electric car stock hit the 10 million mark; a 43% increase over 2019. China, with 4.5 million electric cars, has the largest fleet, though in 2020 Europe had the largest annual increase to reach 3.2 million. As previously mentioned, electric cars are gradually becoming more competitive due to governments fiscal incentives that buffered electric car purchases from the downturn in car markets. About 3 million new electric cars were registered in 2020. For the first time, Europe led with 1.4 million new registrations. China followed with 1.2 million registrations and the US registered 295,000 new electric cars. **Figure 22** provides a summary of electric car registrations in major markets in 2020 despite the Covid-19 pandemic [54].

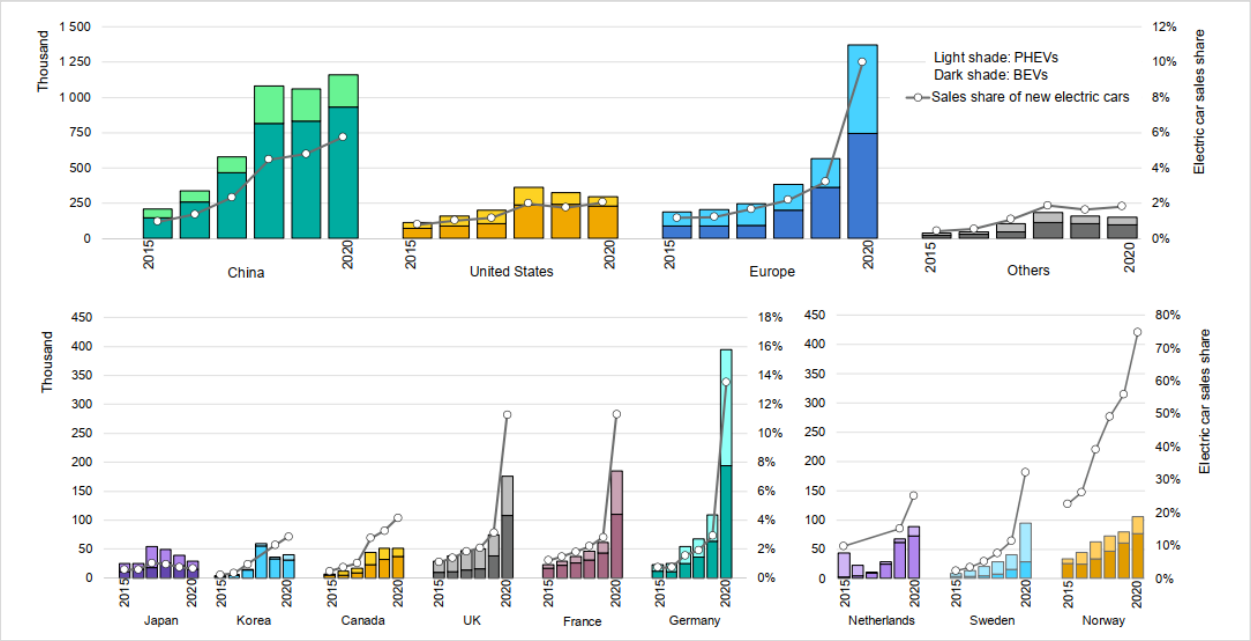


Figure 22: Electric Car Registrations and Sales Share Selected Countries and Regions

Starting with Europe, overall car market contracted 22% in 2020. Yet, new electric car registrations more than doubled to 1.4 million representing a sales share of 10%. In the large markets, Germany registered 395,000 new electric cars, France registered 185,000, and United Kingdom registered 176,000. This surge in electric car registrations in Europe reflect two policy measures. First, 2020 was the target year for the European Union's CO_2 emissions standards. Second, many European governments increased subsidy schemes for EVs as part of stimulus packages to counter the effects of the pandemic [54].

The overall car market in China was impacted by the pandemic less than other regions. Registration of new electric cars was lower than the overall car market in the first half of 2020. This trend reversed in the second-half as China constrained the pandemic. The result was a sales share of 5.7%, up from 4.8% in 2019. BEVs were about 80% of new electric cars registered. Key policy actions muted the incentives for the electric car market in China. Purchase subsidies were initially due to expire at the end of 2020, but by April 2020 and during the pandemic, they were instead cut by 10% and extended through 2022 [54].

Lastly, the US car market declined 23% in 2020, though electric car registrations fell less than the overall market. In 2020, 295,000 new electric cars were registered, of which about 78% were BEVs, down from 327,000 in 2019. Their sales share nudged up to 2%. Federal incentives decreased in 2020 due to the federal

tax credits for Tesla and General Motors, which account for the majority of electric car registrations, reaching their limit [54].

3.6.1.2. Consumer and Government Spendings

Consumers spent USD 120 billion on electric car purchases in 2020, a 50% increase from 2019, which breaks down to a 41% increase in sales and a 6% rise in average prices. The rise in average prices reflects that Europe, where prices are higher on average than in Asia, accounted for a bigger proportion of new electric car registrations. In 2020, the global average BEV price was around USD 40,000 and around USD 50,000 for a PHEV.

Governments across the world spent USD 14 billion on direct purchase incentives and tax deductions for electric cars in 2020, a 25% rise year-on-year. Despite this, the share of government incentives in total spending on EVs has been on a downward slide from roughly 20% in 2015 to 10% in 2020 [54].

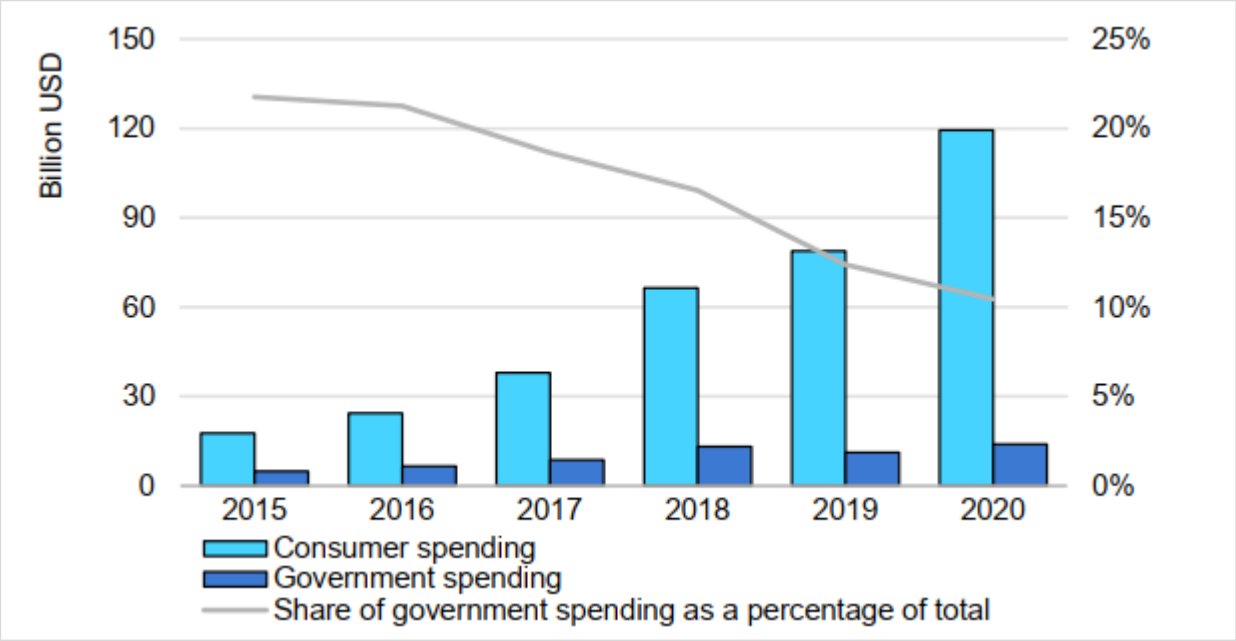


Figure 23: Consumer and Government Spending on Electric Cars

3.6.1.3. Trends in Charging Infrastructure Deployment

Publicly accessible chargers reached 1.3 million units in 2020, of which 30% are fast chargers. Installation of publicly accessible chargers was up by 45%, a slower pace compared to 85% in 2019, which most likely attributed to work interruption in key markets due to the pandemic. China leads the world in availability of publicly accessible chargers. Stock of fast and slow (L1 and L2) publicly accessible chargers for electric light-duty vehicles between 2015 and 2020 is illustrated in **Figure 24.**

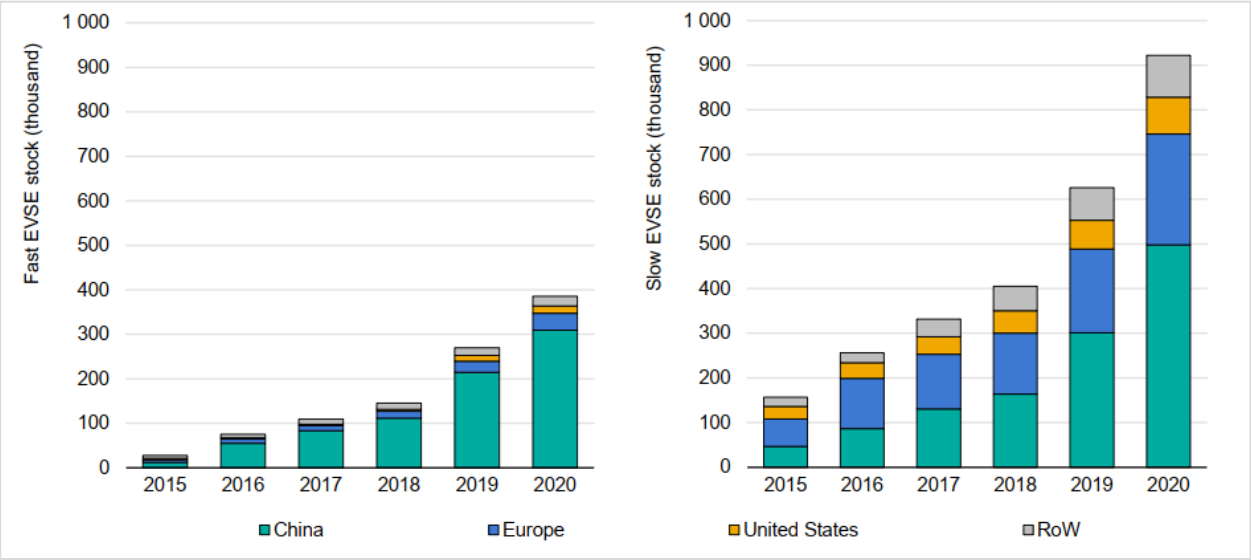


Figure 24: Stock of Publicly Accessible Chargers for Electric Light-duty Vehicles

Most European countries to meet the recommended EVSE targets for publicly accessible chargers set by the Alternative Fuel Infrastructure Directive (AFID). AFID, the key policy regulating the deployment of public electric EVSE in the European Union, recommended that member states aim for 1 public charger per 10 EVs, a ratio of 0.1 in 2020. In the European Union, the average public EVSE per EV ratio was 0.09 at the end of 2020. Nonetheless, some countries exceeded the target set by the AFID in 2020. Netherlands and Italy are at 0.22 and 0.13 respectively, with almost all being slow chargers, though fast chargers are 3% of the installations in the Netherlands and 9% in Italy. Countries with the highest EV penetration tend to have the lowest EVSE per EV ratios, such as Norway (0.03), Iceland (0.03) and Denmark (0.05). This is most likely because in these sparsely populated countries, there are many detached houses and private parking spaces. Hence, most EV owners can largely use private home charging. The ratio for public chargers per EV stock by country for the year of 2020 is shown in **Figure 25.**

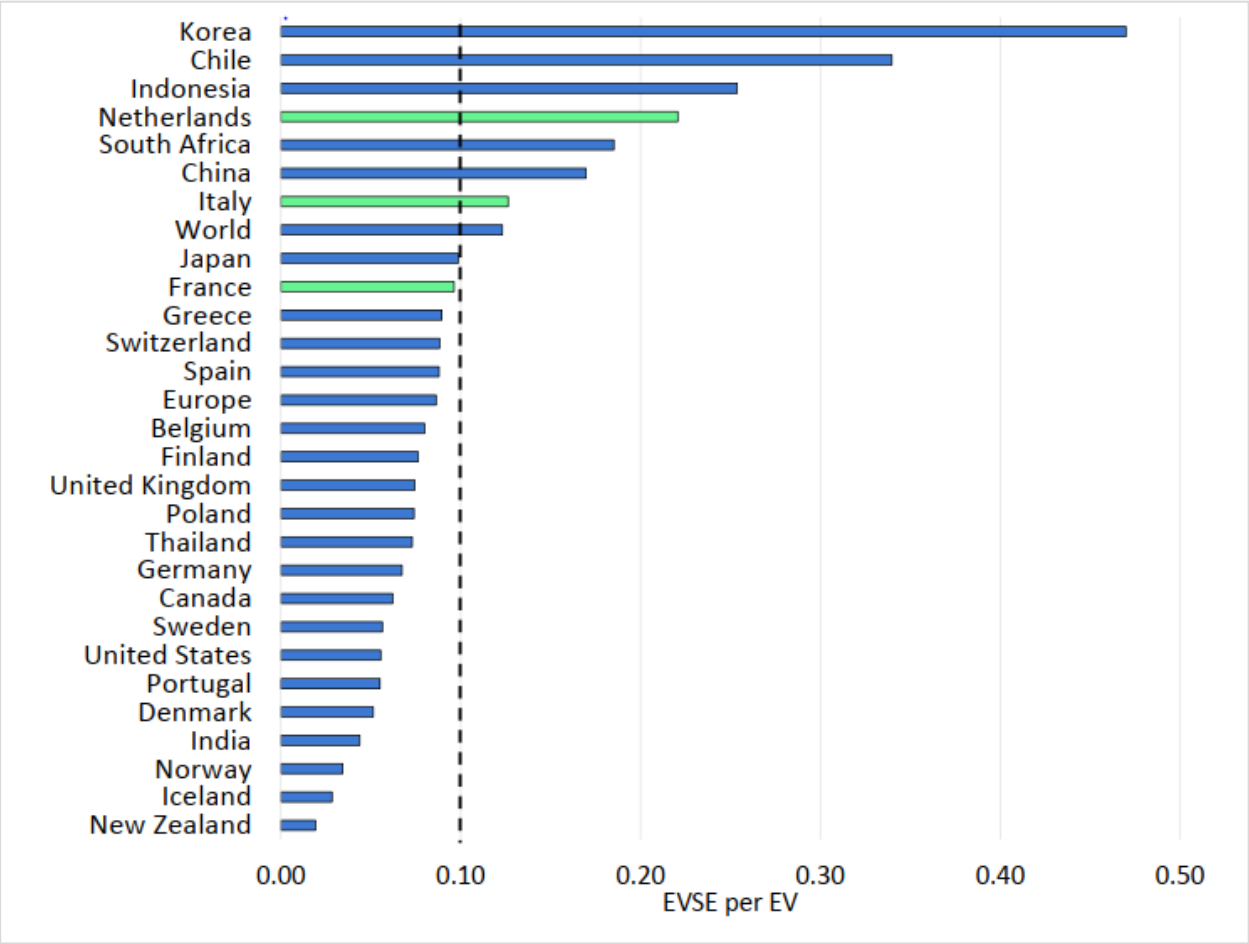


Figure 25: Ratio of Public Chargers per EV Stock by Country, 2020

The roll-out of public charging infrastructure has so far mostly focused on serving electric light-duty vehicles. The electrification of heavy freight trucks (HFTs) is a longer-term endeavor, with less than 40 electric HFTs on the road in 2020 [54].

3.6.1.4. Private Sector Electrification Trends

Despite a turbulent year, major companies around the world are accelerating the transition to electric mobility by shifting fleets to electric vehicles and installing charging stations. Examples of targets and commitments to electrification from the private sector are shown **Table 11** [54]**.**

Table 11: Private Sector Declarations Related to Electric Commercial Vehicles

Company	Operating Area	Year Announced	Target / Actions
Amazon	Global	2020	Orders 100,000 BEV light-commercial vehicles from start-up company Rivian. Amazon aims to be net-zero emissions by 2040.
Anheuser-Busch	United States	2019	Orders up to 800 hydrogen fuel cell Nikola heavy-duty trucks.
DHL Group	Global	2019	Delivery of mail and parcels by EVs in the medium term and net-zero emissions logistics by 2050.
FedEx	Global	2018	Transition to an all zero-emission vehicle fleet and carbon neutral operations by 2040.
H_2 Mobility Association	Switzerland	2019	19 of Switzerland's largest retailers invest in Hyundai hydrogen trucking services that will deploy up to 1,600 heavy-duty zero-emission trucks.

Company	Operating Area	Year Announced	Target / Actions
Ingka Group (IKEA)	Global	2018	Zero-emission deliveries in leading cities by 2020 and in all cities by 2025.
Japan Post	Japan	2019	Electrify 1,200 mail and parcel delivery vans by 2021 and net-zero emissions logistics by 2050.
JD	China	2017	Replace entire vehicle fleet (> 10,000) with New Energy Vehicles by 2022.
SF Express	China	2018	Launch nearly 10,000 BEV logistics vehicles.
Suning	China	2018	Independent retailer's Qingcheng Plan will deploy 5 000 new energy logistics vehicles.
UPS	North America	2019	Order 10,000 BEV light-commercial vehicles with potential for a second order.
Various companies	Multinational	2018	Walmart, Pepsi, Anheuser pre-order 2,000 Tesla Semi models within -Busch, FedEx, Sysco and other large multinational corporations six months of truck's debut.
Walmart	United States	2020	Electrify the whole vehicle fleet by 2040.

Moreover, the Climate Group's EV100 Initiative brings together over 100 private companies in 80 markets committed to making electric transport the new normal by 2030. This equates to 4.8 million vehicles switched to EVs and chargers installed in 6,500 locations by 2030. Collectively, by 2020 EV100 members had already deployed 169,000 zero-emission vehicles, double the previous year. Even though companies identify commercial vans and heavy-duty vehicles as the most difficult EVs to find, the number of commercial electric vehicles rose 23% in 2020. EV100 members are also expanding the availability of charging infrastructure for staff and customers, with 16,900 charging points installed at 2,100 locations worldwide [54].

3.6.1.5. State of Georgia Market Trends

Electric vehicle ownership in Georgia keeps growing, as consumers' tastes change, and a wave of new models hit the market. In 2021, more than 4,000 EVs were sold in Georgia, representing a total annual growth of 29% in sales. Car registrations increased by approximately 40% between 2021 and 2022, with more than 42,500 EVs currently registered in Georgia [55].

To support EV drivers, and encourage increased adoption, public and private entities are offering incentives and suggesting policies to support continued growth of the electric mobility sector. Existing incentives for personal consumers and businesses to convert to electric include the EVSE Tax Credit and Georgia Power Rebate [55].

Moreover, since 2020, more than 30 EV-related projects have contributed over $13.3 billion in investments in Georgia. In May 2022, Hyundai Motor Group (HMG) announced plans to open its first fully dedicated EV and battery manufacturing facility in Georgia. HMG expects to begin construction on the new facility in January 2023, with full production expected in the first half of 2025, with annual capacity of 300,000 units. In December 2021, Rivian located their largest manufacturing facility in Georgia, slated to start production in 2024 with annual capacity of 400,000 vehicles [55].

Georgia is also 6th in the nation for public EV charging stations, offering more than 1,500 individual outlets, equating to more outlets per capita than anywhere in the Southeast. Georgia has more than 1,200 miles of federally designated EV-ready AFCs along its interstates and highways including I-16, I-20, I-75, I-85, I-95, I-185, I-575, and I-985. Georgia is due to receive $135 million in federal funds from the infrastructure spending bill Congress passed to build EV charging stations. The state continues to foster public-private partnerships and other business models to continue the state-wide expansion of charging infrastructure [55] [56].

3.6.2. Partnerships and Collaborations

Partnerships and collaborations play an important role in most EV charging projects. There are key partners and stakeholders that can assist in planning, funding, and implementing EVSE infrastructure. Engaging with stakeholders during the different levels of the EVSE planning process can facilitate the EVSE implementation and minimize unanticipated risks. **Table 12** provides a summary of key stakeholders and partners to engage with in addition to their roles and influences on EVSE projects [19].

Table 12: Key Partners and Stakeholders in EVSE Projects

Stakeholder	Examples	Roles and Influences
State-wide and Multistate Partners	Organizations planning for EV corridors State Environmental, Energy, and Transportation Agencies Multistate Initiatives Working on Climate Change and Electric Vehicles	State-wide and multistate agencies and groups can play a key role in connecting stakeholders, identifying available funding opportunities, and providing technical expertise. Some of these partners are specific to a particular State or region of the country, while others are national initiatives with affiliated local, State, or regional stakeholder groups.
Local and Regional Planning Partners	Clean Cities Coalitions Planning Agencies and Metropolitan Planning Organizations	Local and regional planning organizations also play a key role in connecting stakeholders, identifying available funding, and providing technical assistance at all project stage. Planning agencies accept input from stakeholders to develop transportation plans for the coming years, providing opportunities to partner on coordination of EVSE projects throughout a region or State and for programming funding that flows through these planning agencies to such projects.
Electric Utilities	Local Utility Company	Electric utilities are responsible for the delivery of and play an essential part in the rollout of EV charging infrastructure, as they are among the first partners that should be considered for EVSE installations. Coordination with the local utility is even more demanding in rural areas, where the infrastructure may be less robust and high-capacity EVSE installations are more likely to require upgrades to electrical service.
EV Charging Networks	Private Charging Network Companies	Many public charging stations are owned or operated by private charging network companies that require a membership to recharge an EV at their stations. A charging network can be a logical partner to engage early in the site-level planning process. As partners, charging networks can bring technical expertise and facilitate connections to other important project stakeholders, such as architects, engineers, and contractors. They also develop training resources, such as specifications and installation guides, for EV installers.
Site Host (Owners or Occupants of the Land)	Tourist destinations and public lands Businesses and Institutions, such as hotels, shops, universities, and restaurants Transportation Facilities, such as airports and fleet depots Community Sites, such as a public library or town hall	While site hosts can initiate EVSE planning and installation, they can also be key partners for other entities looking to install and operate EV charging stations. Public-private partnerships (P3s) involve partnerships between public agencies (such as local governments and transportation authorities) and private companies to produce publicly accessible infrastructure. Benefits of using a P3 project delivery method can include leveraging private funding or financing for a project, accelerating project delivery, and minimizing risk for a public agency.

3.7. Sustainability

Electric cars are better for the environment, they emit fewer greenhouse gases and air pollutants than petrol or diesel cars, this takes into account their production and electricity generation to keep them running. As a cleaner alternative, electric vehicles are an important step in sustainable transportation. Notable for their fuel efficiency, EVs can be a cost-effective way to reduce operating expenses. The price of electricity in the United States averages 10 cents per kilowatt-hour (kWh). Typically, an electric car costs approximately 3 cents per mile—much lower than a gasoline car at 10 cents per mile. EVs do not have parts such as fuel lines, fuel tanks, and tailpipes which means that they do not emit CO_2, which helps reduce air pollution. The pollution caused by conventional vehicles is not limited to the exhaust coming from their tailpipes. The process of extracting oil, refining it into fuel, and transporting it to gas stations also generates a large amount of air pollution. These emissions are called upstream emissions. Even though modern vehicle manufacturers have lowered their CO_2 emissions, the manufacturing process continues to have a negative impact on the environment.

The production of EV batteries also creates upstream emissions. In fact, the production process for EVs can be more taxing on the environment than that of conventional vehicles. EVs remain the cleanest option for transportation as their entire life cycle is much more sustainable in the long run. As EVs use electricity as fuel, driving makes up for their higher manufacturing emissions. On average, an EV produces half the emissions of a conventional car over its lifetime, completely outperforming from a sustainability standpoint. Just one electric car on the roads can save an average 1.5 million grams of CO_2. That's the equivalent of four return flights from London to Barcelona. The national average is 4,815 pounds of CO_2-equivalent emissions for a typical EV per year as compared to the average gasoline-powered car which produces 11,435 pounds of CO_2-equivalent emissions annually." EVs will continue to grow and develop further making them more efficient and sustainable [57] [58] [59].

4. Implementation Strategy

In addition to the existing conditions analysis and state of practice and trends review, a visioning workshop was conducted on December 5th, 2022, to comprehensively understand the current position of NFCID in terms of EVs readiness and their EVs aspiration and vision. The questionnaire provided in Appendix **B** was utilized to facilitate and guide the discussion and co-develop the NFCID strategic objectives and goals of electrification. Findings and notes from the workshop were taken into account to compliment the previous analysis and develop the implementation strategy action items and roadmap.

4.1. Implementation Strategy Framework

This section sets out a strategic framework and action plan to support further adoption and expansion of EV infrastructure and deployment in CID area. It includes a vision, strategic goals, key action items, and suggested timelines. **Figure 26** demonstrates the implementation strategy framework.

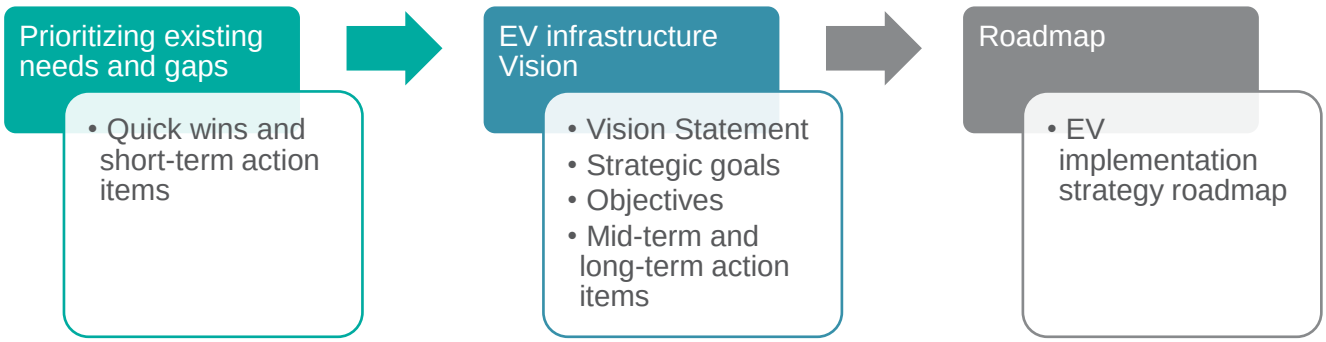


Figure 26: Implementation Strategy Framework.

4.2. Prioritizing Existing Needs and Gaps

A key objective of this study was to determine quick wins and short-term actions that could help NFCID with readiness and expansion of EV infrastructure with immediate results. Based on the findings in Section 2, the following action items are to be completed in less than two years to also lay the appropriate foundation for future actions.

4.2.1. Quick Wins and Short-Term Action Items

Table 13: Immediate and Short-Term Action Items

Priority Area	Quick Wins *To be completed in less than a year*	Short Term Action Items *To be completed within two years*
Shortage of DCFC Chargers	• Conduct detailed assessment and site audits of EVSE infrastructure to verify charging needs	
Lack of EV Incentives	• Develop processes and procedures for incentives and annual tax credits	
Limited EV Expertise	• Conduct a detailed workforce skills assessment	• Develop a training plan and deliver training
Tactical inter-agency coordination for EVSE	• Plan for charging stations along Georgia 400 corridor	
Charging Stations are clustered in the same location	• Identify charging ‘blackspots’ in public, workplace, and residential settings	

Priority Area	Quick Wins *To be completed in less than a year*	Short Term Action Items *To be completed within two years*
Limited EV Expertise	• Engage with private industry and stay informed on future technologies and products	
Inadequate Customer Service	• Develop strategies for EV traveller information	
Public Awareness and Stakeholders Education	• Develop and publish an online public feedback survey	
Tactical Inter-agency Coordination for EVSE	• Actively engage with businesses to understand future needs for workplace charging	
Lack of Strategic EVSE Planning Approach	• Develop a process for charging infrastructure requests at residential multi-unit dwellings	
Limited Strategic Financial Planning for EVSE	• Secure EVs grant team	
Limited Strategic Financial Planning for EVSE	• Apply for federal grants for EVs infrastructure deployment	
Tactical inter-agency coordination for EVSE	• Integrate EV discussion items in stakeholder meetings, briefings, etc.	
Public Awareness and Stakeholders Education	• Identify and develop targeted business cases for stakeholders and decision makers buy-in	
Tactical Inter-agency Coordination for EVSE	• Initiate processes and procedures to develop public and private agreements	
Tactical Inter-agency Coordination for EVSE	• Identify opportunities to align with GA NEVI plan	
Tactical Inter-agency Coordination for EVSE	• Actively participate in the development of the ARC RTEP	
Tactical Inter-agency Coordination for EVSE	• Identify opportunities to align with the CID Blueprint III	
Lack of Strategic EVSE Planning Approach	• Formally publish and adopt the EV Infrastructure Implementation Strategy	
Limited Strategic Financial Planning for EVSE	• Develop monitoring and evaluation processes to measure the impact of investments and policies	
Public Awareness and Stakeholders Education	• Implement communications activities such as online content and public events	
Public Awareness and Stakeholders Education	• Develop a sustained marketing and communications program for EVs promotion	
Higher EV Registration Fees	• Initiate discussions with local and state governments to lower/eliminate the Georgia EVs registration fee	
Shortage of Electricity Supply	• Encourage utility companies to develop strategic utility supply plan to include more renewable options	• Support utility companies to adopt the strategic utility supply plan

Priority Area	Quick Wins *To be completed in less than a year*	Short Term Action Items *To be completed within two years*
Shortage of EVs Battery Supply	• Encourage and support EV battery manufacturers to improve their supply chain	

4.3. Visioning

One of the gaps identified from the existing conditions reviews was the absence of a holistic and strategic direction for EV infrastructure development and expansion. Therefore, the following components have been developed to assist NFCID with formal adoption of a strategic direction for planning and implementation of necessary projects and activities.

- **Establish Vision Statement:** describing NFCID's long term goals and desire
- **Identify Strategic Goals:** identifying of '*what*' specific goals to achieve
- **Define Objectives:** defining '*how*' to fulfil the strategic goals
- **Establish Action Items and Implementation Time Frames:** step-by-step action to achieve the objectives

4.3.1. Vision Statement

The following Vision Statement has been developed based on the discussions of future goals:

'Provide safe and reliable Electric Vehicle Charging Infrastructure to address the growing demand and trends'

4.3.2. Strategic Goals and Objectives

The following strategic goals have been identified in conjunction with the Vision. It is important to understand the rationale behind the identified strategic goals and their contribution in improving the overall Quality of Life (QoL) for NFCID residents and visitors.

- **Enhance Economic Development –** EVs are becoming essential to NFCID's ability to attract and support commerce. A supportive and innovative EV infrastructure increases the contribution of the EV industry to NFCID' economic competitiveness.
- **Optimize Customer Service –** whether for to residents, visitors, or businesses, customer service is a key element of success and good customer service will improve customer satisfaction level.
- **Improve Physical Access to EV Charging –** as a result of the growing demand for EV, it is important to ensure availability and ease of access to sufficient EV charging throughout the NFCID area.
- **Secure Funding –** to ensure sufficient resources for deployment and expansion of EV infrastructure, this goal will provide the necessary means and considerations to secure funding sources and levels.
- **Optimize Collaboration and Partnerships –** Collaboration among internal and external stakeholders and partners is crucial to safe, seamless, and reliable EV charging infrastructure and deployment.
- **Align with Federal, Statewide, and Local Priorities –** to ensure an integrated approach to planning and decision-making in providing EV infrastructure that aligns with federal, statewide, and local goals and priorities.
- **Develop Policies and Regulations –** ensure inclusion of specific activities required and related to business processes and procedures in delivering safe and reliable EV infrastructure.
- **Establish Marketing Strategies –** undertake marketing and awareness activities to make a strong business case for EV infrastructure expansion and secure buy-in from the decision makers.

Table 14 provides the strategic objectives under each goal.

Table 14: Strategic Goals and Objectives

Strategic Goals	Strategic Objectives
Enhance Economic Development and Property Values	• Develop skilled workforce • Align with Georgia 400 transit development • Develop tax incentives and annual tax credit for businesses
Optimize Customer Service	• Improve charging reliability and duration • Manage demand and promote charging infrastructure availability • Enhance ease of use through improving charging fees collection and payment experience • Obtain feedback through public meetings or customer surveys • Provide EV traveller information
Improve Physical Access to EV Charging	• Manage/reduce drive time to charging stations • Application of Smart City solutions • Improve workplace charger availability
Secure Funding for EV Infrastructure	• Become a part of AFC corridor re-designation • Actively pursue Federal funding for community charging and corridor charging
Optimize Collaboration and Partnerships	• Collaborate across divisions and districts • Develop targeted business cases for buy-in • Identify partnership opportunities to pursue Federal Grants • Identify opportunities to pursue partnerships with private vendors (technology, manufacturing, grid companies, etc.) • Establish vendor partnership agreements to preserve, operate, and maintain the EV infrastructure
Align with Federal, Statewide, and Local Priorities	• Align with ARC RTEP • Integrate actions with CID Blueprint III • Align with NEVI deployment Plan
Develop Policies and Regulations	• Develop land use policies and regulations for EV infrastructure • Enhance connectivity and access to EV charging points through transportation planning • Develop roadway utilization policies for EVs
Establish Marketing Strategies	• Develop strategies for public outreach engagement • Actively engage the public and decision makers for EV adoption acceleration

4.3.3. Mid-Term and Long-Term Action Items

In alignment with the immediate and short-term actions items and the strategic goals and objectives presented in the previous sub sections, **Table 15** includes a list of mid-term and long-term action to be undertaken.

Table 15: Mid-Term and Long-Term Action Items

Strategic Objectives	Mid-Term Action Items *To be completed within 5 years*	Long-Term Action Items *To be completed within 10 years*
Enhance Economic Development and Property Values	• Streamline processes for charging infrastructure planning and implementation • Adopt user/business incentives and annual tax credits • Recruit and retain knowledge, skills, and abilities (KSA) and assign internal EV champions • Provide EV charging stations around Georgia 400 transit stops	• Establish a network of on-street public fast charging stations • Assign EV champions with defined roles and responsibilities for cross-jurisdictional and cross-agency planning.
Optimize Customer Service	• Encourage local manufacturers to apply for federal grants for battery technology advancement and research • Develop a digital application to locate, reserve, pay and provide real-time traveller information for charging at any location • Develop and publish a consumer education plan • Implement strategies for EV traveller information and integrate with the digital application	• Adopt the digital application for charging at any location • Develop and adopt private business incentives for employees and customers
Improve Physical Access to EV Charging	• Develop detailed NFCID Electrification Plan • Define and adopt clear principles for space and use of micro mobility schemes (e-scooters, e-bikes) • Adopt the charging request process and roll-out the procedure to the public	• Collaborate with private charging providers to compliment the charging network • Encourage the electrification of car sharing schemes • Adopt requirements and regulations for charging infrastructure in all new developments
Secure Funding for EV Infrastructure	• Adopt strategies for non-federal funding through solicitations, PPP investments, etc. • Develop a strategic financial plan and budget linked to the NFCID Electrification Plan	• Develop strategies to drive the commercial EV market involvement and limit the need for public funding • Develop a strategic financial plan for phasing out of fossil fuelled vehicles with a sustainable renewal strategy
Optimize Collaboration and Partnerships	• Develop and adopt agreements to preserve, operate, and maintain EV charging and infrastructure • Develop and adopt agreements for pilot projects and EV testing	• Collaborate with suppliers and end users to track and manage against service level agreements and availability expectations • Establish a delivery team that collaborates with internal and external stakeholders on EV projects
Align with Federal, Statewide, and Local Priorities	• Dedicate resources to promote knowledge sharing between internal and external partners	-
	• Actively participate and engage in the GA NEVI plan	

Strategic Objectives	Mid-Term Action Items *To be completed within 5 years*	Long-Term Action Items *To be completed within 10 years*
Develop Policies and Regulations	• Develop requirements and regulations for charging infrastructure in all new developments • Embed EV commitments and priorities to all relevant local strategies and policies • Establish a dedicated steering group to guide investments and collaborates with private sector partners	• Re-visit EV policies and regulations and update as necessary • Establish collaborative governance that includes key public and private sector partners and participates in co-creation of policies
Establish Marketing Strategies	• Adopt the marketing and communications program for EVs promotion • Implement a dedicated program of commercial and technical support to encourage organizations to invest in EVs	• Re-visit EV marketing strategies and update as necessary

4.4. Roadmap

The roadmap encompasses all the action items (immediate, short-term, mid-term, and long-term) outlined in the previous sub-sections. These action items have practical value and represent specific activities that must be undertaken to move the EV infrastructure forward.

Strategic Goal	Quick Wins *To be completed in less than a year*	Short-Term Actions *To be completed within 2 years*	Mid-Term Action Items *To be completed within 5 years*	Long-Term Action Items *To be completed within 10 years*
Enhance Economic Development and Property Values	Conduct detailed assessment and site audits of EVSE infrastructure to verify charging needs Develop processes and procedures for incentives and annual tax credits Conduct a detailed workforce skills assessment Develop a training plan and deliver training Plan for charging stations around Georgia 400 corridor		Streamline processes for charging infrastructure planning and implementation Adopt user/business incentives and annual tax credits Recruit and retain knowledge, skills, and abilities (KSA) and assign internal EV champions Provide EVs charging stations around Georgia 400 transit stops	Establish a network of on-street public fast charging stations Assign EV champions with defined roles and responsibilities for cross-jurisdictional and cross-agency planning.
Optimize Customer Service	Identify charging 'blackspots' in public, workplace, and residential settings Engage with private industry and stay informed on future technologies and products, and supply chain improvements Develop strategies for EV traveller information Develop and publish an online public feedback survey Initiate discussions with local and state governments to lower/eliminate the Georgia EVs registration		Encourage local manufacturers to apply for federal grants for battery technology advancement and research Develop a digital application to locate, reserve, pay and provide real-time traveller information for charging at any location Develop and publish a consumer education plan Implement strategies for EV traveller information and integrate with the digital application	Adopt the digital application for charging at any location Develop and adopt private business incentives for employees and customers
Improve Physical Access to EV Charging	Actively engage with businesses to understand future needs for workplace charging Develop a process for charging infrastructure requests at residential multi-unit dwellings Encourage utility companies to develop strategic utility supply plan Support utility companies to adopt the plan		Develop detailed NFCID Electrification Plan Define and adopt clear principles for space and use of micro mobility schemes (e-scooters, e-bikes) Adopt the charging request process and roll-out the procedure to the public	Collaborate with private charging providers to compliment the charging network Encourage the electrification of car sharing schemes Adopt requirements and regulations for charging infrastructure in all new developments
Secure Funding for EV Infrastructure	Secure EVs grant team Apply for federal grants for EVs infrastructure deployment		Adopt strategies for non-federal funding through solicitations, PPP investments, etc. Develop a strategic financial plan and budget linked to the NFCID Electrification Plan	Develop strategies to drive the commercial EV market involvement and limit the need for public funding Develop a strategic financial plan for phasing out of fossil fuelled vehicles with a sustainable renewal strategy
Optimize Collaboration and Partnerships	Integrate EV discussion items in stakeholder meetings, briefings, etc. Identify and develop targeted business cases for stakeholders and decision makers buy-in Initiate processes and procedures to develop public and private agreements		Develop and adopt agreements to preserve, operate, and maintain EV charging and infrastructure Develop and adopt agreements for pilot projects and EV testing	Collaborate with suppliers and end users to track and manage against service level agreements and availability expectations Establish a delivery team that collaborates with internal and external stakeholders on EV projects
Align with Federal, State-wide, and Local Priorities	Identify opportunities to align with GA NEVI plan Actively participate in the development of the ARC RTEP Identify opportunities to align with the CID Blueprint III		Dedicate resources to promote knowledge sharing between internal and external partners Actively participate and engage in the GA NEVI plan	
Develop Policies and Regulations	Formally publish and adopt the EV Infrastructure Implementation Strategy Develop monitoring and evaluation processes to measure the impact of investments and policies		Develop requirements and regulations for charging infrastructure in all new developments Embed EV commitments and priorities to all relevant local strategies and policies Establish a dedicated steering group to guide investments and collaborates with private sector partners	Re-visit EV policies and regulations and update as necessary Establish collaborative governance that includes key public and private sector partners and participates in co-creation of policies
Establish Marketing Strategies	Implement communications activities such as online content and public events Develop a sustained marketing and communications program for EVs promotion		Adopt the marketing and communications program for EVs promotion Implement a dedicated program of commercial and technical support to encourage organizations to invest in EVs	Re-visit EV marketing strategies and update as necessary

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Appendices

Appendix A. Federal Funding Sources

Agency/Office	Program Name	Program Type	Program Description	Eligible Parties	LDV Charging	Transit Charging	Commercial Charging	Infrastructure Planning	Workforce Development	Vehicle Acquisition
DOC EDA	FY2020 EDA Public Works and Economic Adjustment Assistance Program	Grant (Discretionary)	Provides investments that support construction, non-construction, technical assistance, and revolving loan fund projects designed to leverage existing regional assets and support the implementation of economic development strategies that advance new ideas and creative approaches to advance economic prosperity in distressed communities.	States, Tribes, localities, nonprofits	X		X	X	X	
	Build to Scale Program	Grant (Discretionary)	Provides funds for organizations to aid companies in developing the next generation of tech-based economic development initiatives, including commercial EV technology implementation.	States, Tribes, localities, nonprofits			X		X	
	Planning and Localities Technical Assistance Program	Grant (Discretionary)	Awards funding to eligible recipients (within Economic Development Districts) to create and implement regional economic development plans designed to build capacity and guide the economic prosperity and resiliency of an area or region.	States, Tribes, localities, nonprofits				X	X	
	Research and National Technical Assistance	Grant (Discretionary)	Supports research and technical assistance projects designed to leverage existing regional assets and support the implementation of economic development strategies that advance new ideas and creative approaches to advance economic prosperity in distressed communities.	States, Tribes, localities, nonprofits				X		
DOE Loan Programs Office	Advanced Technology Vehicles Manufacturing (ATVM) Loan Program	Loan (Innovative Finance)	Supports the manufacture of eligible light-duty vehicles and qualifying components under the ATVM Loan Program.	States, localities, private sector	X					X
	Title XVII Renewable Energy and Efficient Energy Projects	Loan Guarantee (Innovative Finance)	Provides loan guarantees to projects that support innovative, renewable energy and energy efficiency projects in the United States.	States, Tribes, localities, transportation providers, nonprofits, private sector	X			X		
DOE VTO	Vehicle Technologies Office Funding Opportunities	Various	Supports high-impact projects that can significantly advance its mission to reduce petroleum reliance by developing and deploying more energy efficient and sustainable transportation technologies. VTO regularly updates its FOAs with information on available VTO grant opportunities.	States, Tribes, localities, transportation providers, nonprofits, private sector, individuals	X	X	X	X	X	X

Agency/Office	Program Name	Program Type	Program Description	Eligible Parties	LDV Charging	Transit Charging	Commercial Charging	Infrastructure Planning	Workforce Development	Vehicle Acquisition
DOE Weatherization and Intergovernmental Programs Office	State Energy Program	Grant (Formula)	Provides funding and technical assistance to States, territories, and the District of Columbia to enhance energy security, advance State-led energy initiatives, and increase energy affordability. Some States allocate funds to projects that promote the buildout of EV infrastructure in rural areas. Contact the State energy office for more information about program guidance and eligibility for a particular State.	States	X	X	X	X		
DOE	Property Assessed Clean Energy Programs	Loan (Innovative Finance)	Allows a commercial or residential property owner to finance the up-front cost of energy or other eligible improvements on a property and then pay the costs back over time through a voluntary assessment; the assessment is attached to the property instead of the individual.	Nonprofits, private sector, individuals	X					
DOL	Workforce Opportunity for Rural Communities	Grant (Discretionary)	Funds projects that demonstrate alignment of regionally driven, comprehensive approaches to addressing economic distress and the necessary workforce development activities to ensure dislocated and other workers in the regions are capable of succeeding in current and future job opportunities.	States, Tribes, localities, nonprofits, individuals					X	
DOT FAA	Airport Zero Emission Vehicle	Grant (Discretionary)	Improves airport air quality and facilitates use of zero emissions technologies at airports by funding the purchase of ZEV and to construct or modify infrastructure needed to use ZEVs. Eligible parties must be airport sponsors that are in the National Plan of Integrated Airport Systems (NPIAS).	States, Tribes, localities, transportation providers	X	X		X		X
	Voluntary Airport Low Emissions Program	Grant (Discretionary)	Improves airport air quality and provides air quality credits for future airport development; airport sponsors can use funds to finance low emission vehicles, refueling and recharging stations, gate electrification, and other airport air quality improvements. Eligible parties must be Commercial airport sponsors that are in the NPIAS and located in areas that do not meet National Ambient Air Quality Standards.	States, Tribes, localities, transportation providers	X	X		X		X
DOT FHWA	Charging & Fueling Infrastructure Grants (Corridor Charging)	Grant	Deploy electric vehicle (EV) charging and hydrogen/propane/natural gas fueling infrastructure along designated alternative fuel corridors and in communities.	States/Territories, MPOs, Counties, Cities, Tribes, Transit Agencies	X	X	X	X		

Agency/Office	Program Name	Program Type	Program Description	Eligible Parties	LDV Charging	Transit Charging	Commercial Charging	Infrastructure Planning	Workforce Development	Vehicle Acquisition
	Charging and Fueling Infrastructure Grants (Community Charging)	Grant	Program funds will be made available each fiscal year for Community Grants, to install EV charging and alternative fuel in locations on public roads, schools, parks, and in publicly accessible parking facilities. These grants will be prioritized for rural areas, low-and moderate-income neighborhoods, and communities with low ratios of private parking, or high ratios of multiunit dwellings.	States/Territories, MPOs, Counties, Cities, Tribes, Transit Agencies	X	X	X	X		
	Advanced Transportation and Congestion Management Technologies Deployment	Grant (Discretionary)	Makes competitive grants for the development of model deployment sites for large scale installation and operation of advanced transportation technologies.	States, localities, transportation providers	X	X				
	National Highway Performance Program	Grant (Formula)	Provides support for the condition and performance of the national highway system (NHS), for the construction of new facilities on the NHS, and to ensure that Federal funds are directed to support progress toward the achievement of performance targets established in a State's asset management plan for the NHS.	States	X	X			X	
	Surface Transportation Block Grant Program	Grant (Formula)	Provides flexible funding that may be used by States and localities for projects to preserve and improve the conditions and performance on any Federal-aid highway, bridge and tunnel projects on any public road, pedestrian and bicycle infrastructure, and transit capital projects, including intercity bus terminals.	States	X	X	X	X	X	
	Congestion Mitigation & Air Quality Improvement	Grant (Formula)	Provides a flexible funding source to State and local governments for transportation projects and programs to help meet the requirements of the Clean Air Act. Funding is available to reduce congestion and improve air quality for areas that do not meet the National Ambient Air Quality Standards.	States	X	X	X		X	X
	National Highway Freight Program	Grant (Formula)	Funds projects that improve the efficient movement of freight on the National Highway Freight Network.	States			X	X		X
	State Planning and Research	Grant (Formula)	Provides funding for making transportation investment decisions throughout the State. The goals of the funding are to develop cooperative planning efforts	States				X		

Agency/Office	Program Name	Program Type	Program Description	Eligible Parties	LDV Charging	Transit Charging	Commercial Charging	Infrastructure Planning	Workforce Development	Vehicle Acquisition
			that support transportation investment decisions statewide.							
	Highway Infrastructure Program	Grant (Allocated)	Funds projects for Surface Transportation Block Grant purposes and to provide necessary charging infrastructure along corridor-ready or corridor-pending alternative fuel corridors designated by FHWA.	States	X	X	X	X	X	
	Puerto Rico Highway Program	Grant (Allocated)	Carries out priorities of the highway program in the Commonwealth of Puerto Rico.	Puerto Rico	X	X	X	X	X	X
	Territorial Highway Program	Grant (Allocated)	Assists each U.S. territory in the construction and improvement of a system of arterial and collector highways and necessary inter-island connectors.	U.S. territories (other than Puerto Rico)	X	X	X	X	X	
	Federal Lands Transportation Program	Grant (Allocated)	The program focuses on improving Federal lands transportation facilities that are located on, adjacent to, or provide access to Federal lands and which are owned and maintained by Federal land management agencies. Funds are distributed to Federal land management agencies.	Federal land management agencies	X	X	X	X	X	X
	Federal Land Access Program	Grant (Allocated)	Aims to improve transportation to and within Federal lands by improving transportation facilities that provide access to, are adjacent to, or are located within Federal lands.	States, Tribes, localities	X	X	X	X	X	X
DOT FTA	Public Transportation on Indian Reservations Program; Tribal Transit Program	Grant (Discretionary)	Aims to improve transportation to and within Tribal lands by funding capital, operating, planning, and administrative expenses for public transit projects that meet the growing needs of rural Tribal communities.	Tribes		X		X		X
	Accelerating Innovative Mobility	Grant (Discretionary)	Promotes forward-thinking approaches to improve transit financing, planning, system design, and service. Program also supports innovative approaches to advance strategies that promote accessibility, including equitable and equivalent accessibility for all travelers.	States, Tribes, localities, transportation providers, nonprofits, private sector	X	X		X		
	Integrated Mobility Innovation	Grant (Discretionary)	Supports the transit industry's ability to leverage and integrate mobility innovations with existing services, while examining the impact of innovations on agency operations and the traveler experience.	States, localities, Tribes, transportation providers		X				
	Area of Persistent Poverty Program	Grant (Discretionary)	Supports planning, engineering and technical studies, or financial planning to improve transit services in areas experiencing long-term economic distress.	States, localities, transportation				X		

Agency/Office	Program Name	Program Type	Program Description	Eligible Parties	LDV Charging	Transit Charging	Commercial Charging	Infrastructure Planning	Workforce Development	Vehicle Acquisition
				providers, nonprofits						
	Public Transportation Innovation	Grant (Discretionary)	Provides funding to develop innovative products and services assisting transit agencies in better meeting the needs of their customers.	States, localities, transportation providers, nonprofits, private sector				X		
	Grants for Buses and Bus Facilities Discretionary Program	Grant (Discretionary)	Makes Federal resources available to States and direct recipients to replace, rehabilitate, and purchase buses and related equipment and to construct bus-related facilities, including technological changes or innovations to modify low- or no-emission vehicles or facilities.	States, Tribes, localities, transportation providers		X			X	X
	Low or No Emission Vehicle Program	Grant (Discretionary)	Provides funding to State and local governmental authorities for the purchase or lease of zero-emission and low-emission transit buses, as well as acquisition, construction, and leasing of required supporting facilities.	States, Tribes, localities, transportation providers		X			X	X
	Grants for Buses and Bus Facilities Formula Program	Grant (Formula)	Provides funding to States and transit agencies through a statutory formula to replace, rehabilitate, and purchase buses and related equipment and to construct bus-related facilities. Subrecipients: public agencies or private nonprofit organizations engaged in public transportation.	States, Tribes, localities, transportation providers		X			X	X
	Metropolitan Planning	Grant (Formula)	Provides funding and procedural requirements to State DOTs for multimodal transportation planning in metropolitan areas and States.	States, transportation providers				X		
	Tribal Transit Formula Grants	Grant (Formula)	Aims to improve transportation to and within Tribal lands by funding capital, operating, planning, and administrative expenses for public transit projects that meet the growing needs of rural Tribal communities.	Tribes		X		X		X
	Formula Grants for Rural Areas	Grant (Formula)	Provides capital, planning, and operating assistance to States to support public transportation in rural areas with populations of less than 50,000, where many residents often rely on public transit to reach their destinations. State and Tribes receive formula funding, then redistribute funds to projects in rural areas.	States, Tribes		X		X	X	X

Agency/Office	Program Name	Program Type	Program Description	Eligible Parties	LDV Charging	Transit Charging	Commercial Charging	Infrastructure Planning	Workforce Development	Vehicle Acquisition
	Enhanced Mobility of Seniors & Individuals with Disabilities	Grant (Formula)	Provides formula funding to States for the purpose of assisting private nonprofit groups in meeting the transportation needs of older adults and people with disabilities when the transportation service provided is unavailable, insufficient, or inappropriate to meeting these needs. Subrecipients: private nonprofit groups providing transportation to these groups.	States		X		X		X
	Rural Transportation Assistance Program	Grant (Formula)	Provides a source of funding to assist in the design and implementation of training and technical assistance projects and other support services tailored to meet the needs of transit operators in nonurbanized areas.	States, localities, transportation providers				X	X	
	Urbanized Area Formula Funding	Grant (Formula)	Provides capital, planning, and operating assistance to urbanized areas and to governors for transit capital and operating assistance in urbanized areas and for transportation-related planning. An urbanized area is an incorporated area with a population of 50,000 or more that is designated as such by the U.S. Department of Commerce, Bureau of the Census. Funding can support rural areas if the service provided also impacts a rural area.	States, Tribes, localities, transit providers		X		X	X	X
DOT MARAD	America's Marine Highway Program	Grant (Discretionary)	Funds previously designated Marine Highway Projects that support the development and expansion of documented vessels or port and landside infrastructure.	States, Tribes, localities, transportation providers, private sector	X		X	X		X
	Port Infrastructure Development Program	Grant (Discretionary)	Makes grants to improve facilities related to coastal seaports or Great Lakes ports. Funds are to be awarded as discretionary grants on a competitive basis for projects that will improve the safety, efficiency, or reliability of the movement of goods into, out of, around, or within a port.	States, Tribes, localities, transportation providers	X			X		X
DOT OST	Rebuilding American Infrastructure with Sustainability and Equity	Grant (Discretionary)	Provides a unique opportunity for the USDOT to invest in road, rail, transit, and port projects that achieve national objectives. Starting in FY21, RAISE has substantially increased program focus on ZEV infrastructure, including EV charging.	States, Tribes, localities, transportation providers	X	X	X	X		
DOT OST					X		X	X		

Agency/Office	Program Name	Program Type	Program Description	Eligible Parties	LDV Charging	Transit Charging	Commercial Charging	Infrastructure Planning	Workforce Development	Vehicle Acquisition
Build America Bureau	Infrastructure for Rebuilding America	Grant (Discretionary)	Advances the Administration's priorities of rebuilding America's infrastructure and creating jobs by funding highway and rail projects of regional and national economic significance that position America to win the 21st century.	States, Tribes, localities, transportation providers						
EPA	National Grants: Diesel Emissions Reduction Act	Grant (Discretionary)	Awards funding to eligible government agencies and nonprofits for eligible diesel emissions reduction solutions, including the replacement of heavy-duty diesel vehicles with EVs.	States, Tribes, localities, transportation providers, nonprofits		X	X			X
	Tribal and Insular Area Grants: Diesel Emissions Reduction Act	Grant (Discretionary)	Awards funding to eligible Tribes and Insular Areas for eligible diesel emissions reduction solutions, including the replacement of heavy-duty diesel vehicles with EVs.	States, Tribes		X	X			X
	School Bus Rebates: Diesel Emissions Reduction Act	Grant (Discretionary)	Awards funding to public and private fleet owners for the replacement of old diesel school buses with cleaner buses, including EVs. Anticipated: rebates for electric school bus replacements in underserved communities.	States, Tribes, localities, private sector		X				X
	State Grants: Diesel Emissions Reduction Act	Grant (Formula)	Allocates DERA funds to eligible U.S. States and territories for the establishment of diesel emissions reduction programs. States can prioritize specific eligible diesel emissions reduction solutions under DERA, including the replacement of heavy-duty diesel vehicles with EVs.	States		X	X			X
IRS	Alternative Fuel Vehicle Refueling Property Credit	Tax Credit	EV charging infrastructure installed through December 31, 2021, is eligible for a tax credit of 30 percent of the cost, not to exceed $30,000. Charging station owners who install qualified equipment at multiple sites are allowed to use the credit toward each location. Consumers who purchase qualified residential charging equipment prior to December 31, 2021, may receive a tax credit of up to $1,000.	Nonprofits, private sector, individuals	X					
SBA	Small Business Innovation Research	Grant (Discretionary)	Enables small businesses to explore their technological potential and provides the incentive to profit from its commercialization.	Private sector, individuals				X		

Agency/Office	Program Name	Program Type	Program Description	Eligible Parties	LDV Charging	Transit Charging	Commercial Charging	Infrastructure Planning	Workforce Development	Vehicle Acquisition
	Small Business Technology Transfer	Grant (Discretionary)	Enables small businesses to explore their technological potential and provides the incentive to profit from its commercialization.	Private sector, individuals				X		
USDA NRCS	Urban Agriculture and Innovative Production	Grant (Discretionary)	Assists eligible entities with projects that support the development of urban agriculture and innovative production.	Tribes, localities, nonprofits	X		X	X		
	Environmental Quality Incentives Program	Grant (Discretionary)	Provides agricultural producers and non-industrial forest managers with financial resources and one-on-one help to plan and implement improvements or conservation practices.	Tribes, private sector, individuals	X		X		X	
	Conservation Innovation Grants	Grant (Discretionary)	Supports the development of new tools, approaches, practices, and technologies to further natural resource conservation on private lands.	States, Tribes, localities, nonprofits, private sector, individuals	X		X			
USDA RD	Rural Placemaking Innovation Challenge	Cooperative Agreement	Helps rural communities create plans to enhance capacity for broadband access; preserve cultural and historic structures; and support the development of transportation, housing, and recreational spaces.	Tribes, localities, transportation providers, nonprofits, private sector	X	X		X	X	
	Rural Economic Development Grant Program	Grant (Discretionary)	Provides zero-interest loans to localities' utilities, which they use to establish a revolving loan fund to pass funding through to local businesses (i.e., the ultimate recipients) for projects that create and retain employment in rural areas.	Localities, nonprofits	X		X	X	X	
	Renewable Energy Development Assistance	Grant (Discretionary)	Assists rural small businesses and agricultural producers by conducting and promoting energy audits and providing Renewable Energy Development Assistance.	States, Tribes, localities, nonprofits, private sector, individuals				X		
	Community Facilities Grant Program	Grant (Discretionary)	Provides affordable funding to develop essential community facilities in rural areas. Essential community facility: a facility that provides an essential service to the locality's community for the orderly development of the community in a primarily rural area.	Tribes, localities, nonprofits	X			X		X
	Rural Business Development Grants	Grant (Discretionary)	Provides technical assistance and training for small rural businesses for activities related to rural	States, Tribes, localities,	X		X	X	X	

Agency/Office	Program Name	Program Type	Program Description	Eligible Parties	LDV Charging	Transit Charging	Commercial Charging	Infrastructure Planning	Workforce Development	Vehicle Acquisition
			transportation improvement, technology-based economic development, and more.	transportation providers, nonprofits						
	Rural Energy for America Program – Guaranteed Loans	Loan	Provides guaranteed loan financing to agricultural producers and rural small businesses for renewable energy systems or to make energy efficiency improvements; switching from diesel to electric irrigation motors qualifies.	Private sector, individuals			X			X
	Community Facilities Direct Loan Program	Loan	Provides affordable funding to develop essential community facilities in rural areas. An essential community facility is defined as a facility that provides an essential service to the locality's community for the orderly development of the community in a primarily rural area.	States, Tribes, localities, transportation providers, nonprofits	X	X		X	X	
	Rural Economic Development Loan Program	Loan	Provides zero interest loans to local utilities, which they, in turn, pass through to local businesses (ultimate recipients), for projects that will create and retain employment in rural areas. The ultimate recipients repay the lending utility directly. The utility is responsible for repayment to the USDA.	Localities, nonprofits	X		X	X	X	
	Intermediary Relending Program	Loan (Revolving Fund)	Provides 1 percent low-interest loans to localities lenders or "intermediaries" that re-lend to businesses to improve economic conditions and create jobs in rural communities. Intermediaries relending the capital to other parties with a maximum loan of $250k or 75 percent of total project.	States, Tribes, localities, nonprofits	X		X	X	X	
	Business & Industry Loan Guarantees	Loan Guarantee	Offers loan guarantees to lenders for their loans to rural businesses.	Tribes, localities, transportation providers, nonprofits, private sector, individuals	X			X	X	
USDA RD RUS	Denali Commission High Energy Cost Grants	Grant (Discretionary)	Assists the Denali Commission in lowering the cost of energy for families and individuals in areas with extremely high per-household energy costs. Eligible projects improve energy facilities serving communities with extremely high energy costs, partly by	States, Tribes, localities, nonprofits, private sector, individuals	X			X		

Agency/Office	Program Name	Program Type	Program Description	Eligible Parties	LDV Charging	Transit Charging	Commercial Charging	Infrastructure Planning	Workforce Development	Vehicle Acquisition
			implementing energy efficient technology and practices.							
	High Energy Cost Grants	Grant (Discretionary)	Assists energy providers and other eligible entities in lowering energy costs for families and individuals in areas with extremely high per-household energy costs.	States, Tribes, localities, nonprofits, private sector, individuals	X			X		
	Energy Efficiency and Conservation Loan Program	Loan	Provides loans to finance energy efficiency and conservation projects for commercial, industrial, and residential consumers. Applicants must be utilities and/or energy distributors.	Localities, Tribes, private sector	X			X		
	Rural Energy Savings Program	Loan	Provides loans to rural utilities and other companies who provide energy efficiency loans to qualified consumers to implement durable cost-effective energy efficiency measures. Applicants must be utilities and/or energy distributors.	Localities, Tribes, private sector	X			X		
	Distributed Generation Energy Project Financing	Loan/Loan Guarantee	Provides loans and loan guarantees to energy project developers for distributed energy projects including renewables that provide wholesale or retail electricity to existing Electric Program borrowers or to rural communities served by other utilities. Applicants must be utilities and/or energy distributors.	States, Tribes, localities, nonprofits, private sector	X			X		
	Electric Infrastructure Loan & Loan Guarantee Program	Loan/Loan Guarantee	Makes insured loans and loan guarantees to finance the construction of electric distribution, transmission, and generation facilities, including system improvements and replacements required to furnish and improve electric service in rural areas, as well as demand side management, energy conservation programs, and on-grid and off-grid renewable energy systems. Applicants must be retail or power supply providers.	States, Tribes, localities, nonprofits, private sector	X			X		

Appendix B. Visioning Workshop Questionnaire

Visioning Workshop Questionnaire:

1.	What are the top five (or more) local key drivers for EV in your region?
2.	What are the top five (or more) intended outcomes of the key drivers?
3.	What are some of the existing plans and/or programs that include EV components? a. Policies b. Strategies c. Regulations d. Others
4.	What is NFCID's vision for EV infrastructure and deployment?
5.	Are there existing funding mechanisms for EV infrastructure and deployment?
6.	What are the key barriers to EV infrastructure and deployment in the region?
7.	Are there existing partnerships (public or private) established for EV infrastructure and deployment?
8.	Are there existing incentives (financial or non-financial) for EV deployment? If yes, what are the incentives?
9.	Are there existing targets for EV infrastructure and deployment? a. Local/Regional b. Statewide c. Federal
10.	What is the target year for installation of EV infrastructure?
11.	Who are the key stakeholders?
12.	Are there existing operations and maintenance processes for EV infrastructure and deployment?
13.	How does this study fit into the CID Blueprint III?

Atkins
1600 RiverEdge Parkway, NW
Suite 700
Atlanta, GA 30328-4612

Tel: +1 770 933 0280/+1 800 826 4284
Fax: +1 770 933 0691