Study on Strategies to Promote Sustainable and Safe Mobility in APEC Economies

APEC Transportation Working Group

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Abbreviations and Acronyms

ACT	Australian Capital Territory
ADR	Australian Design Rules
AEMC	Australian Energy Market Commission
AER	Australian Energy Regulator
AFC	Alternative Fuels Corridors
AIP	Australia's Infrastructure Plan
ALA	American Lung Association
AMC	Annual Maintenance Contract
APEC	Asia-Pacific Economic Cooperation
APS	Ambitious Policies Scenario
Austroads	Australian Building Codes Board
BEB	Battery Electric Buses
BEV	Battery Electric Vehicles
BRT	Bus Rapid Transit
BYD	Build Your Dreams (Chinese Multinational Electric Vehicle Company)
CAFC	Corporate Average Fuel Consumption
CCS	Carbon Capture and Storage
CCUS	Carbon Capture, Utilization, and Storage
CERF	Climate Emergency Response Fund
CIB	Canada Infrastructure Bank
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2 equivalent	Carbon Dioxide Equivalent
CNG	Compressed Natural Gas
COPD	Chronic Obstructive Pulmonary Disease
CPI	Consumer Price Index
CTEODS	Committee on Sustainable Development Goals
CVES	Commercial Vehicle Emissions Scheme
DOT	Department of Transportation
DPF	Diesel Particulate Filters
EEAI	EV Early Adoption Incentive
ELTT	Electric Local Transport Trucks
EMCC	Energy Management Capable Consumers
EMV	Electric Mobility Vehicles (Company)
EUP	Energy Utility Provider
ERP	Emissions Reduction Plan
ERV	Emission Reduction Vehicle
Euro-NCAP	European New Car Assessment Program
ESESP	Electric Sector Energy Savings Program
ETS	Enhanced Early Turnover Scheme
EV	Electric vehicle
EVI	Electric Vehicles Initiative
FACTO	Front of Alternative Collective Transport Organizations
FBT	Fringe Benefits Tax
FEC	Federal Electricity Commission
FHWA	Federal Highway Administration
FOTEASE	Energy Transition and Sustainable Energy Use Fund
GCC	Gross cost contract
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gases
Gt	Gigaton (one billion metric tons)
Gw	Gigawatt
Gwp	Gigawatts peak
HDV	Heavy-Duty Vehicle Emissions
HLDI	Highway Loss Data Institute
ICN	Islandwide Cycling Network
ICE	Internal Combustion Engine
IEA	International Energy Agency

IIJA	Infrastructure Investment and Jobs Act
IRA	Inflation Reduction Act
IRS	Internal Revenue Services
ISP	Integrated System Plan
ITS	Integrated Transport System
iZEV	Incentives for Zero Emission Vehicles
K9G	BYD Electric Bus Model
Kto equivalent	Kilotonnes of Oil Equivalent
LCEV	Low Carbon Emission Vehicle
LDV	Light-Duty Vehicles
LEDS	Low-Emission Development Strategy
LPG	Liquefied Petroleum Gas
LTA	Land Transport Authority
LTCS	Chile's Long-Term Climate Strategy
MCMA	Mexico City Metropolitan Area
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MINEM	Ministry of Energy and Mines (Peru)
MND	Ministry of National Development
MoI	Ministry of Industry
MOHURD	Ministry of Housing and Urban-Rural Development
MTC	Ministry of Transport and Communications (Peru)
MTI	Ministry of Commerce and Industry
$MtCO_2$ equivalent	Megatons of CO_2 Equivalent (Million Tons of CO_2Equivalent)
$MtoCO_2$ equivelent	Million Tons of CO_2 Equivalent
MUTCD	Manual on Uniform Traffic Control Devices for Streets and Highways
MSE	Ministry of Sustainability and the Environment
Mwp	Megawatts peak
NAMA	Nationally Appropriate Mitigation Actions
NCC	Net Cost Contract
NCCAP	National Climate Change Action Plan
NDC	Nationally Determined Contribution
NDP	National Development Plan
NDRC	National Development and Reform Commission
NEA	National Energy Administration
NEM	National Electronic System
NEMS	National Electric Mobility Strategy
NEP	National Electromobility Program
NES	National Electricity System
NEV	New Energy Vehicle
NEVC	National Electric Vehicle Centre
NEVI	National Electric Vehicle Infrastructure
NH3	Ammonia
NHTSA	National Highway Traffic Safety Administration
NISG	National Institute of Statistics and Geography
NLPR	Non-landed private residences
NMHC	Non-Methane Hydrocarbons
NMT	Non-Motorized Transport
NOx	Nitrogen Oxides
NREL	National Renewable Energy Laboratory
NSMS	National Sustainable Mobility Strategy
NTSB	National Transportation Safety Board
NVR	National Vehicle Regulations
NZE	Net Zero Emissions Scenario
OBD	On-Board Diagnostics Systems
ODS	Sustainable Development Goals
OMV	Open Market Value
OSINERGMIN	Supervisory Agency for Investment in Energy and Mining (Peru)
O&M	Operation and Maintenance
PEMS	Portable Emissions Measurement Systems
Petrol	Petroleum

PHEV	Plug-in Hybrid Electric Vehicle
PM	Particulate Matter
PM10	Particulate Matter 10
PM2.5	Particulate Matter 2.5
PN	Particles Number
PT	Public Transport
PR	Presidential Regulation
PV	Photovoltaic
RCA	Roads Control Authority
R+P	Rail + Property
SCR	Selective Catalytic Reduction Systems
SDG	Sustainable Development Goals
SEDATU	Secretariat of Agrarian, Territorial, and Urban Development
SEMARNAT	Secretariat of Environment and Natural Resources
SLE	Super Low Energy
SPBLKU	Battery Charging Stations
SPKLU	Public Charging Stations
STEPS	Stated Policies Scenario
SUV	Sport Utility Vehicle
TCO	Total Cost of Ownership
TCRP	Transit Cooperative Research Program
TOD	Transport-Oriented Development
UNFCCC	United Nations Framework Convention on Climate Change
ULTC	Urban and Logistics Transport Company (Peru)
U.S. DOT	United States Department of Transportation
USD	United States Dollar
V2G	Vehicle-to-Grid
VGI	Vehicle-to-Grid Integration
VOC	Volatile Organic Compounds
WHO	World Health Organization
WHTC	Worldwide Harmonized Transient Cycle
WNTE	World Harmonized Not-to-Exceed
ZEB	Zero-Emission Buses
ZEV	Zero Emissions Vehicles

FINAL CONSULTANCY REPORT: WORKSHOP ON STRATEGIES TO PROMOTE SUSTAINABLE AND SAFE MOBILITY IN APEC ECONOMIES

1. Background

The transportation sector accounts for nearly 30 percent of global greenhouse gas (GHG) emissions. According to a United Nations report, combustion vehicles are the primary emitters of large amounts of CO_2, with 80 percent of vehicles in circulation powered by carbon-emitting fuels such as oil, coal, and natural gas.

The emission of pollutants is a widespread issue across both large and small economies. Economies like Canada; China; Japan; Korea; Mexico; and the United States, all part of the Asia-Pacific Economic Cooperation (APEC), rank among the highest contributors of CO_2 emissions. Consequently, the implementation of actions and methods focused on reducing emissions is a critical need across the 21 APEC economies (Australia; Brunei Darussalam; Canada; Chile; China; Hong Kong, China; Indonesia; Japan; Korea; Malaysia; Mexico; New Zealand; Papua New Guinea; Peru; the Philippines; Russia; Singapore; Chinese Taipei; Thailand; the United States and Viet Nam).

The most significant emission reduction methods include the following: i) promoting electromobility policies; ii) preparing the charging infrastructure for EVs; and iii) conducting outreach and education actions on the benefits that EV can generate.

Most APEC economies have begun transitioning towards electromobility, with different degrees of progress. The widespread use of EV is one of the alternatives to making transportation more sustainable and contributing to the reduction of GHG emissions. EV allows for safer mobility as they do not emit toxic or polluting gases, reducing exposure to air pollution and the risk of respiratory diseases. Additionally, EV are less likely to catch fire compared to internal combustion vehicles, as they do not have a combustion system and do not store flammable fuel. Furthermore, electromobility can also help to reduce the number of traffic accidents since EV have smoother acceleration and better braking capability compared to internal combustion vehicles. In this way, electromobility will enable safer mobility in APEC economies.

2. Justification

The consulting services for the project: "Workshop on strategies to promote sustainable and safe mobility in APEC economies," are aimed at providing tools to strengthen the capacities of stakeholders involved in the transport sector within APEC economies to improve policies aimed at reducing GHG emissions through the adoption of EV in urban transport.

This project will provide a study that will summarize successful examples from economies that develop public policies promoting sustainable and safe transport, specifically the reduction of transport-related GHG emissions. The study will be a valuable reference for best practices in implementing electromobility as a public transport solution, offering insights gained from the experiences of other economies.

This project will also facilitate a complementary workshop providing technical information with the presentation of strategies, actions, and public policies for the adoption of EV in urban public transport. The project will help strengthen the capacities of direct beneficiaries and the exchange of best practices with developing economies that have not yet implemented actions.

3. Objectives of the Consulting Services

The following outlines the general objective and specific objectives of the consulting services.

3.1. General Objective

Develop a study that reviews and analyzes the relevant literature on strategies to promote sustainable and safe mobility in APEC economies, with a focus on the transition to electromobility.

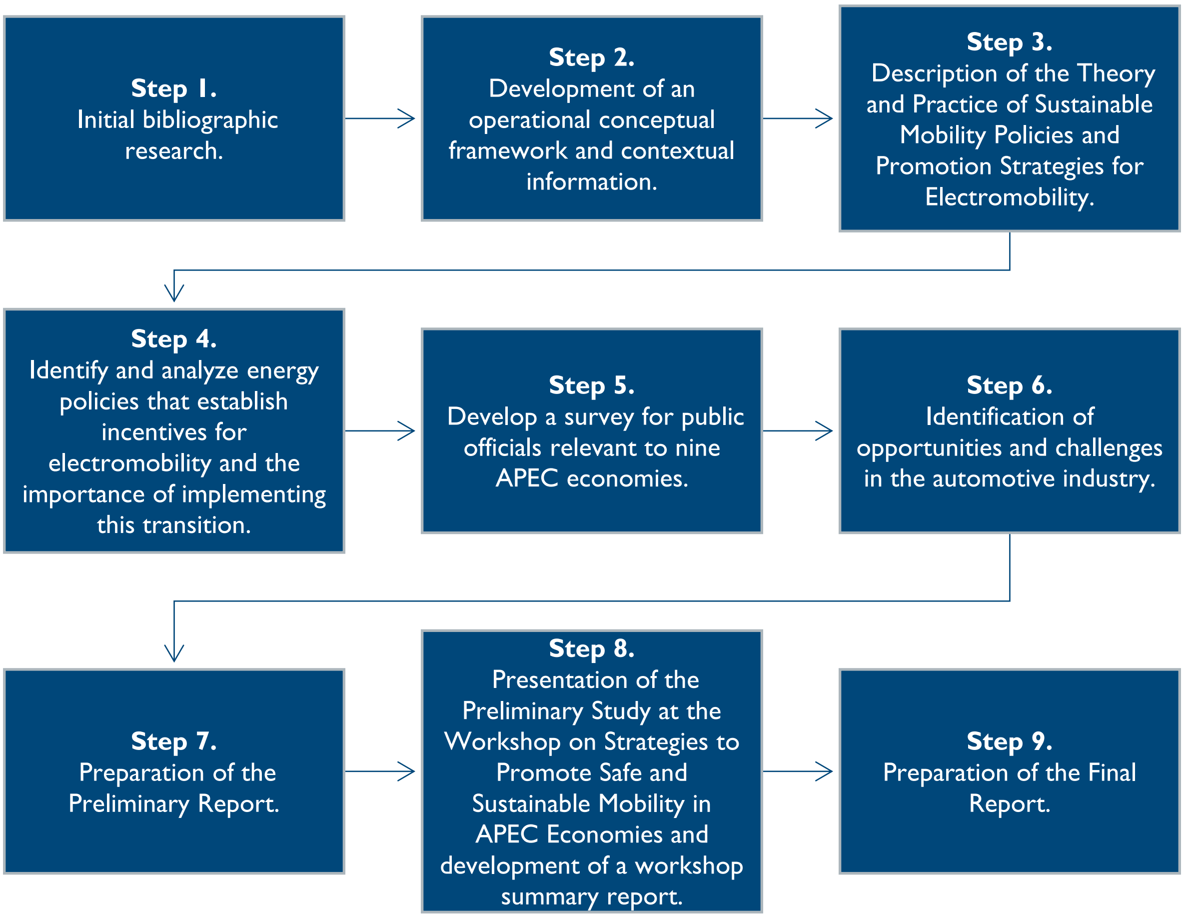
3.2. Specific Objectives

- Review the trends that define the context in which policies and strategies for the promotion of electromobility are applied.
- Propose an operational conceptual framework that will serve as the basis for research to organize the analysis of urban transport and sustainable mobility policies and strategies in APEC economies.
- Review the urban transport and sustainable mobility policies of APEC economies and the main policy instruments.
- Identify the strategies implemented in APEC economies to promote the use of EV within the framework of urban transport policies with a focus on sustainable mobility.
- Identify and analyze energy policies that establish incentives for electromobility and the importance of implementing this transition.
- Develop a survey to be conducted in eight selected APEC economies (as proposed by the consultant) to identify the policy instruments for promoting electromobility and their goals (achieved and expected outcomes).
- Identify the opportunities and challenges faced by the automotive industry in APEC economies in the context of the growing use of EV.

4. Methodology

The proposed methodology for the consulting services contains ten steps, which are presented below:

Figure 1. Methodology Steps



Step 1: Initial Bibliographic Research

The literature review provided information on the following topics: i) reference frameworks for constructing a conceptual framework to organize policies and strategies to promote electromobility; ii) context analysis of sustainable urban mobility policies and energy policies aimed at promoting electromobility; iii) identification of case studies from economies that have successfully promoted electromobility through incentives and regulations, as well as case studies of the successful application of transportation policies (including reports on the outcomes) to foster the adoption of EV; and iv) identification of the challenges and issues faced by the automotive industry in adapting to the transition towards electromobility.

Step 2: Operational Conceptual Framework and Contextual Information

The transition to electromobility in urban passenger transport involves a significant shift in the technological standard used by the automotive industry. During this consultancy, key concepts were selected and presented to help understand the future of sustainable urban mobility and how it will complement other energy, technological, or financial policies. Concepts were structured for the following topics: i) approaches for sustainable and safer urban mobility policies, specifying the role of electromobility within these policies; ii) approaches for energy efficiency policies and related incentives; iii) approaches for understanding the positive environmental impacts of electromobility; and iv) economic and financial approaches to guide subsidy policies in urban passenger transport in favor of electromobility.

This step includes an analysis of contextual information applied to 16 APEC economies: Australia; Canada; Chile; China; Indonesia; Japan; Korea; Malaysia; Mexico; New Zealand; Peru; Russia; Singapore; Chinese Taipei; Thailand; and the United States.

Step 3: Description of the Theory and Practice of Sustainable Mobility Policies and Electromobility Promotion Policies and Strategies

In this step, the public policy experiences undertaken in nine APEC economies—Australia; Canada; Chile; China; Indonesia; Mexico; Singapore; Chinese Taipei; and the United States—were systematized and analyzed. The analysis included sustainable mobility policies and the policies and strategies (regulations and incentives) to promote electromobility in each economy. Successful cases of electromobility promotion measures in these economies were also included.

Step 4: Identification and Analysis of Energy Policies that Establish Incentives for Electromobility and the Importance of Implementing this Transition

In this step, energy policies were identified and analyzed as complementary policies to sustainable urban mobility policies. The priority was to examine how energy efficiency policies could be used to promote incentives to support the transition to electromobility.

Step 5: Development of a Survey for Relevant Public Officials from Nine APEC Economies

Based on steps 3 and 4, a survey was developed to be applied to relevant public officials. The survey aimed to gather complementary information to identify the policy instruments for promoting electromobility and their objectives (both achieved and expected outcomes). The economies whose officials responded to the survey were Singapore and Chinese Taipei. The survey format and responses from these two economies can be found in Annex 10.4.

Step 6: Identification of Opportunities and Challenges in the Automotive Industry

In this step, the opportunities and challenges faced by the automotive industry in APEC economies were identified in the context of the increasing use of EVs. This information was analyzed for seven economies in the sample: Australia; Canada; China; Indonesia; Mexico; Chinese Taipei; and the United States.

Step 7: Preparation of the Preliminary Report

Based on steps 3, 4, 5, and 6, the preliminary report of the study was drafted.

Step 8: Presentation of the Preliminary Study at the Workshop on Strategies to Promote Safe and Sustainable Mobility in APEC Economies and Development of the Workshop Summary Report

Based on the progress made in step 7, the preliminary report was presented at the Workshop on Safe and Sustainable Mobility in APEC Economies.

Step 9: Preparation of the Final Report

The final report will be presented, developing the conclusions and recommendations based on the insights gained in step 8.

5. Conceptual Operational Framework

5.1. Evolution of Urban Transport and Urban Mobility Concepts

Several authors suggest that there have been four stages in the evolution of urban mobility policies[1]. Traditionally, many cities have attempted to mitigate congestion and pollution by expanding road infrastructure aimed at improving the circulation of private automobiles (first stage). However, these policies have proven to be unsustainable in the long term, as they only provide temporary relief from congestion. In response to these challenges, some cities have begun to prioritize collective transport, such as trains, subways, and buses (second stage). These modes of transport not only can move a larger number of people using less space and generating less pollution per passenger but also promote a more rational use of urban space and reduce dependence on private vehicles.

In the context of urban mobility, it is crucial to consider the needs of all users of urban space, not just those of motorists (third stage). This includes pedestrians, cyclists, and people with reduced mobility, who must be considered in urban planning to ensure they can move safely and efficiently. This approach seeks to improve the quality of urban life and promote a healthier and more equitable environment. Planning focused on proximity, cohesion, and social diversity ensures that all citizens can access resources and opportunities without relying on automobiles, thus favoring inclusive and sustainable urban development.

Finally, the concept of sustainable urban mobility represents a profound change in how transportation planning and study are approached (fourth stage). Instead of focusing solely on road capacity and traffic, there has been a shift towards concern for the movement of people in mass public transport systems and, more recently, towards the mobility of more vulnerable population groups. In recent years, experts have developed approaches that link people's movements with their environmental consequences and urban development. This evolution towards "sustainable mobility" promotes that people can access city services without traveling long distances or relying on motor vehicles.

In the document "Urban Mobility in Urban Areas"[2] the evolution of urban mobility policies is detailed through four key stages (see Table ***1***). Each of these stages is described below, highlighting the changes in approaches and strategies adopted to improve mobility in cities.

Table 1. Evolution from Circulation to Sustainable Mobility

Stage	Emphasis	Strategy	Policies
1	Traffic	Road capacity	Expansion of road infrastructure
2	Public Transport	Priority to public transport	Public transport systems to massively move passengers at high speeds
3	Mobility	Mobility for all users	Urban infrastructure (roads, bridges, etc.) and transport facilitate access for vulnerable populations
4	Sustainable Mobility	Sustainable accessibility	Urban planning (mixed land use) and transport reduce energy use and time

Source: Dextre, Juan Carlos. "Mobility in Urban Areas."

[1] This section has been prepared based on the document titled "Urban Mobility in Urban Areas," written by Juan Carlos Dextre, which analyzes the evolution of mobility policies in cities, emphasizing the need for a paradigm shift in how urban congestion and pollution are addressed.

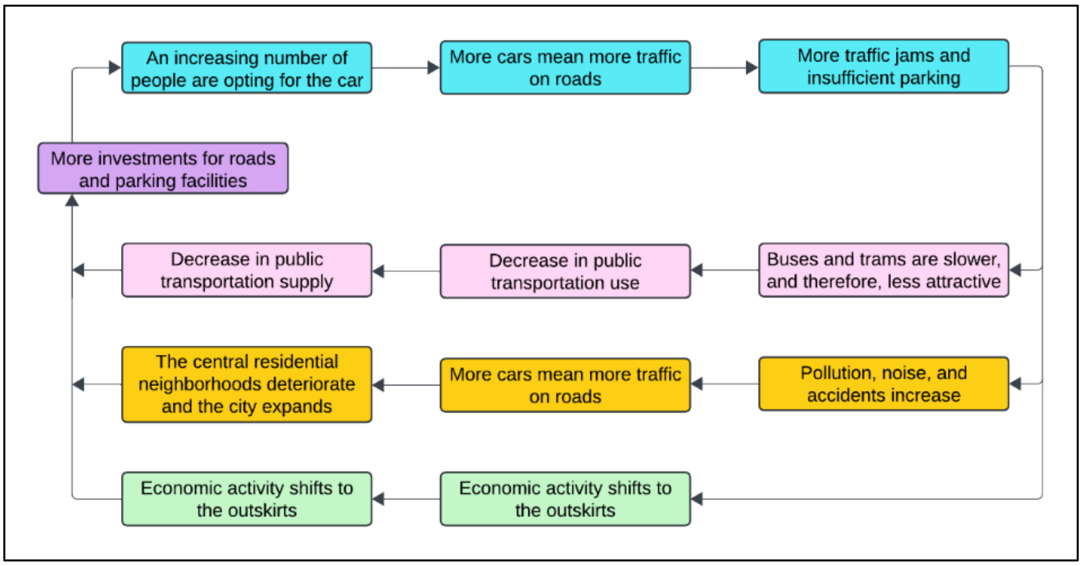
[2] Dextre, J., & Avellaneda, P. (2014). Mobility in Urban Areas. Editorial Fund of the Pontifical Catholic University of Peru. Available at: https://transitemos.org/wp-content/uploads/2023/06/Libro-MZU.pdf

Traffic or Circulation Models with an Emphasis on Road Capacity[3]

In the first stage of developing urban mobility policies, many cities have opted to expand road infrastructure as the main solution to mitigate congestion. This strategy focuses on building more lanes, overpasses, and road interchanges to increase automobile circulation capacity. However, this expansion often provides only temporary relief from congestion and can lead to a long-term increase in the use of private vehicles, intensifying the initial problem.

Figure 2 shows a negative cycle that occurs when cities expand their road infrastructure networks without proper urban planning. This expansion leads to greater urban sprawl and longer commutes, which reduce density and increase automobile dependency. As a result, energy consumption grows, and social exclusion increases. Essentially, as more roads are built and automobile use is facilitated, cities expand and fragment, exacerbating the need for more road infrastructure. This cycle highlights the need for urban planning approaches that prioritize density and accessibility to reduce dependence on private vehicles and foster greater social cohesion and environmental sustainability.

Figure 2. Territorial model that produces sprawl (unsustainable)



Source: Dextre, Juan Carlos. "Mobility in Urban Areas."

The increase in the use of private vehicles exacerbates the negative externalities of urban transport, such as congestion, pollution, and accidents. This situation deteriorates the quality of life in the city, especially in central neighborhoods, causing their decline and further extending the city. As economic activity shifts to the periphery, commutes become longer, creating new demands for investment in road infrastructure. This cycle perpetuates urban sprawl and automobile dependency, further complicating sustainable and accessible mobility in the city.

Priority Development Models of Public Transport[4]

The focus on public transport in urban design aims to maximize the efficiency of collective transport compared to the use of private automobiles. Systems such as buses,

[3] This section has been elaborated based on the following document: Dextre, J., & Avellaneda, P. (2014). Mobility in Urban Areas. Editorial Fund of the Pontifical Catholic University of Peru. Available at: https://transitemos.org/wp-content/uploads/2023/06/Libro-MZU.pdf

[4] This section has been elaborated based on the following document: Dextre, J., & Avellaneda, P. (2014). Mobility in Urban Areas. Editorial Fund of the Pontifical Catholic University of Peru. Available at: https://transitemos.org/wp-content/uploads/2023/06/Libro-MZU.pdf

trams, and subways can move more people in less space and with less environmental impact. By integrating these systems into the city's design, vehicle congestion is reduced, and urban space use is optimized, improving quality of life and promoting more sustainable and equitable mobility.

Additionally, adequate infrastructure, which includes exclusive lanes and efficient transfer systems, is crucial for the success of public transport. This design not only improves the efficiency and speed of public transport but also makes it more attractive to users. By offering a viable and convenient alternative to the automobile, the demand for road infrastructure for private vehicles is reduced, contributing to more livable and sustainable cities.

Models that Prioritize the Mobility of All Users[5]

The design approach focused on the mobility of all users aims to create an urban environment that facilitates efficient and accessible movement for all citizens. This approach advocates for integrated infrastructure that prioritizes public transport, pedestrians, and cyclists, minimizing dependence on private automobiles. The integration of different modes of transport, such as buses, trams, and bike-sharing systems, allows for smoother mobility and reduces vehicle congestion. Additionally, the importance of designing compact cities where essential services, such as schools, health centers, and commercial areas, are located near residential zones is highlighted. An inclusive and accessible design ensures that people of all ages and abilities can move easily, improving equity and social cohesion. Implementing pedestrian streets, bike lanes, and green areas contributes to creating a more pleasant and safe urban environment.

Models of Sustainable Urban Mobility[6]

Sustainable urban mobility focuses on developing cities that minimize the need for long commutes and promote more ecological and efficient modes of transport. This involves designing urban infrastructures that prioritize the use of public transport, cycling, and walking over private automobiles. An essential component is creating compact and mixed-use urban environments where services and job opportunities are near residential areas, thus reducing car dependency and fostering greater social interaction and local economic activity.

To achieve sustainable urban mobility, it is crucial to integrate land use policies with transport policies. Urban planning should consider an appropriate distribution of housing, jobs, and services, promoting balanced and accessible development. It is fundamental to implement exclusive bike lanes, safe pedestrian pathways, and efficient public transport systems to facilitate the transition to more sustainable modes of transport. Additionally, technology and innovation play a vital role in optimizing urban transport, from traffic management systems to applications that enhance the user experience in public transport.

Environmental impact is another central aspect of sustainable mobility. Reducing GHG emissions and air pollution is a priority, achieved by decreasing the number of private vehicles in circulation and increasing the use of less polluting transport options. Policies should encourage the adoption of EV and the use of renewable energy sources in public transport. Simultaneously, creating green spaces and recreational areas in cities

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[5] This section has been elaborated based on the following document: Dextre, J., & Avellaneda, P. (2014). Mobility in Urban Areas. Editorial Fund of the Pontifical Catholic University of Peru. Available at: https://transitemos.org/wp-content/uploads/2023/06/Libro-MZU.pdf

[6] This section has been elaborated based on the following document: Dextre, J., & Avellaneda, P. (2014). Mobility in Urban Areas. Editorial Fund of the Pontifical Catholic University of Peru. Available at: https://transitemos.org/wp-content/uploads/2023/06/Libro-MZU.pdf

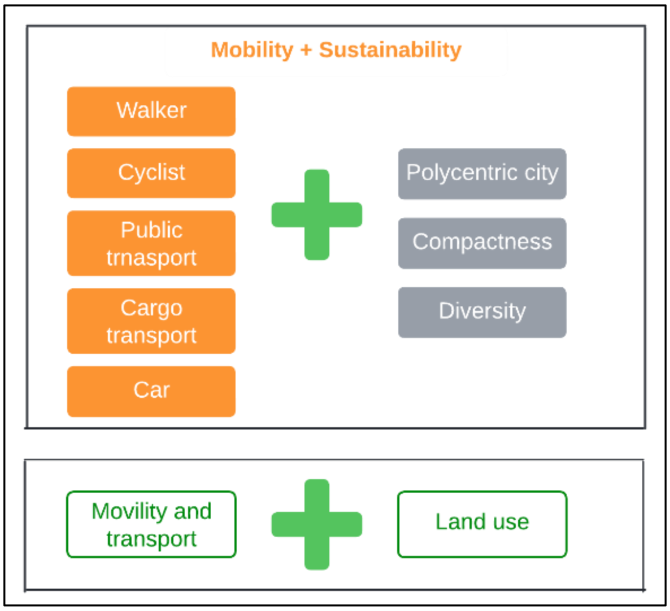
improves air quality and offers additional health and well-being benefits for residents. Sustainable mobility also addresses social inclusion, ensuring that all citizens, regardless of economic or physical condition, have access to safe and efficient transport options. This includes designing accessible infrastructures for people with reduced mobility and ensuring that public transport costs are affordable for everyone. Community participation in the planning process is crucial to identify specific needs and ensure that implemented solutions are effective and equitable. In summary, the design oriented towards sustainable mobility seeks to create more livable, equitable, and resilient cities, promoting urban development that benefits both people and the environment.

As shown in Figure 3, mobility planning must be closely integrated with urban planning, as both variables have a mutually dependent relationship that is fundamental for the sustainable development of cities. A coordinated approach to mobility and land use not only optimizes transport but also improves urban quality of life by creating more accessible, diverse, and compact environments.

According to the "Global Mobility Report 2022"[7], sustainable mobility is framed within the context of sustainable development, and transport systems are expected to serve long-term public policy objectives, including the UN Sustainable Development Goals (SDGs) and the Paris Agreement. A sustainable transport system must not only provide universal access and operate efficiently but also be safe and have minimal environmental impact, reducing GHG emissions, air pollution, and noise. Decarbonizing the transport sector is crucial to achieving the goals of the Paris Agreement, which implies radical changes in how transport systems are designed and operated.

The report also emphasizes the interconnection of sustainable mobility with other development objectives, such as poverty reduction and the promotion of inclusive economic growth. This implies the development of transport infrastructure that is reliable, sustainable, and resilient, supporting economic development and human well-being. Sustainable mobility, therefore, is not only about reducing environmental impact but also about improving equity and accessibility, ensuring that all citizens can benefit from efficient and sustainable transport systems.

Figure 3. Link Between Mobility and Land Use



Source: Dextre, Juan Carlos. "Mobility in Urban Areas."

[7] World Bank. (2022). *Global Mobility Report 2022*. Washington, DC: World Bank. Available at: https://www.sum4all.org/data/files/global_mobility_report_2022_04052023_final.pdf

Sustainable mobility translates into four main objectives, aligned with the UN SDGs: i) universal access, ii) efficiency, iii) safety, and iv) green mobility. These objectives aim to transform transport systems to be more inclusive, efficient, safe, and environmentally friendly.

Universal Access ensures that all people, including the most vulnerable communities, have access to economic and social opportunities. This implies an equitable distribution of transport services, ensuring that the travel needs of all are met. This objective includes sub-goals such as urban and rural universal access and gender equity in transport.

Efficiency focuses on optimizing the predictability, reliability, and cost-effectiveness of the transport system, avoiding time losses due to congestion or poor traffic organization. The goal is to meet transport demand at the lowest possible cost for providers and users, promoting intelligent use of available resources.

Safety aims to reduce fatalities, injuries, and traffic accidents, improving safety across all modes of transport. This not only prevents public health risks but also reduces the social and economic losses associated with unsafe mobility.

Lastly, **Green Mobility** focuses on reducing the environmental footprint of transport by decreasing GHG emissions, noise, and air pollution. It promotes the use of eco-friendly transport modes, such as public transport, cycling, and walking, and encourages the adoption of clean technologies and renewable energy in transport.

Role of Electromobility in Sustainable Urban Mobility Models

Electromobility is fundamental to achieving sustainable urban mobility by directly addressing the environmental and health challenges associated with urban transport. EV are crucial for reducing GHG emissions, one of the main sources of pollution in cities. According to the "Global Mobility Report 2022"[8], the transport sector was the fastest-growing in emissions derived from fossil fuel combustion between 2010 and 2019. To keep the global temperature increase below 1.5 degrees Celsius, it is imperative to reduce transport emissions by 74% by 2050. The adoption of EV is a key strategy in this effort, as these vehicles emit significantly less carbon per Km traveled compared to conventional vehicles.

Besides environmental benefits, electromobility improves the energy efficiency of urban transport and reduces air pollution, which has a direct impact on public health. EV, including electric buses, not only decrease dependence on fossil fuels but also reduce the emission of atmospheric pollutants that contribute to respiratory and cardiovascular diseases. Electrifying public transport is especially beneficial, as this sector is more efficient in terms of emissions per person and can improve road safety by reducing congestion and encouraging the use of more sustainable transport modes, such as walking and cycling to and from public transport stations.

For electromobility to truly transform sustainable urban mobility, it is essential to develop adequate charging infrastructure and promote policies that incentivize the use of renewable energy for EV charging. The integration of shared and electrified mobility services is also crucial to harness untapped decarbonization potential.

5.2. Integration Concepts in Transport and Urban Mobility[9]

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[8] World Bank. (2022). *Global Mobility Report 2022*. Washington, DC: World Bank. Available at: https://www.sum4all.org/data/files/global_mobility_report_2022_04052023_final.pdf

[9] This section has been elaborated based on the following document: Ministry of Transport and Communications. (2019). Theoretical Framework of Subsidy Policy. Supreme Decree No. 022-2019-MTC. Available at: https://cdn.www.gob.pe/uploads/document/file/438458/DS_N__022-2019-MTC.pdf

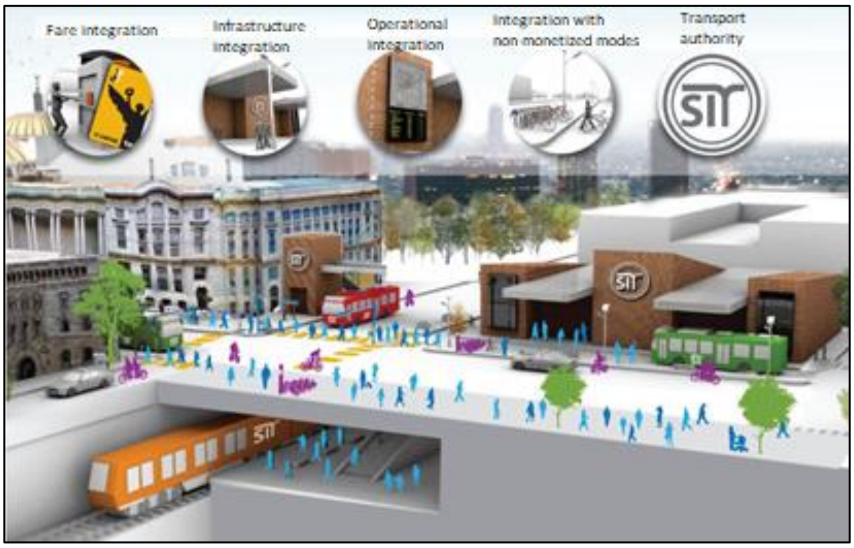
The Integrated Transport System (ITS) refers to the set of urban public transport services that operate in an integrated manner in operational, physical, and technological terms. This system employs various passenger transport means according to demand needs and is usually centrally controlled and managed, with a single or interoperable fare collection system. Bus services are organized into trunk, feeder, and complementary routes, ensuring adequate coverage and quality of service. This design not only optimizes the efficiency and safety of transport but also promotes the economic, social, and environmental sustainability of the system.

The integration of the ITS can be addressed at various levels: planning, information, physical, technological, fare, and operational integration. These levels ensure that the system functions cohesively and efficiently, adapting to the population's needs.

According to international experience, the benefits of implementing ITS include:

- Improved connectivity and urban order.
- Provision of higher quality services to users.
- Facilitated understanding and use of the system through a single source of information.
- Ability to adjust transport supply to demand, increasing road safety and modernizing the sector.
- Increased accessibility and connectivity, promoting inclusion.
- Improved business management of operators and reduced environmental pollution.
- The following illustration presents the complete integration of an ITS.

Figure 4. Integration within the Framework of an ITS



Source: CTS Embark. (2015). Concessioned Public Transport Transformation Project: Conceptual Design. Integrated Public Transportation System – SIT – of Mexico City.[10]

The main purpose of establishing integrated public transport systems in major cities around the world is to improve the current service situation. This is often marked by deficiencies such as low quality, insecurity, high pollution, oversupply, informal operation, fragmentation of operators, high operational costs, and high accident rates.

ITS Components

The following table summarizes the components of the ITS.

[10] CTS Embarq. (2015). Project for the Transformation of Concessioned Public Transport: Conceptual Design. Integrated Public Transport System – SIT – of Mexico City. Available at: https://theicct.org/sites/default/files/PresentacionSEDEMASITP_CTS%20EMBARQ.pdf

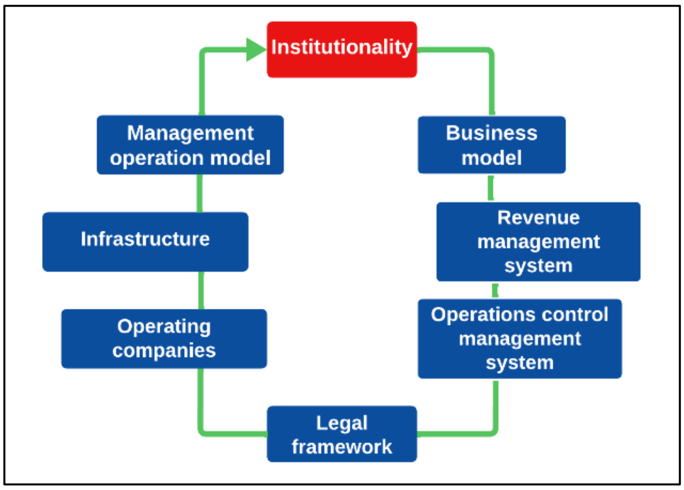
Table 2. ITS Components

ITS Component	Description
Public Transport Operators	Companies that manage business units and provide transport services according to regulations and concession contracts, offering conventional services, semi-express, express, feeder, complementary, and zonal services.
Infrastructure and Equipment	Includes segregated lanes, stations, priority traffic lights, interchanges, terminals, depots, workshops, and urban insertion elements to ensure speed, quality, and safety.
Fare Collection System	System operated by a third party, responsible for the implementation, operation, issuance, recharge, sale, and validation of payment methods. Manages the collection of fares until delivery to the fiduciary entity and distribution among operators. Comprises: i) smart cards or payment methods, ii) software and system equipment, iii) distribution and recharge points, iv) validation equipment in stations and vehicles, v) cash transfer means, vi) cash flow process and fund transfer to the fiduciary entity, and vii) security of cash and cards.
Control Center	Manages the operation of the fleet and system services, scheduling frequencies, capacity, and speed for efficient and quality operation.
Customer Service Center	Designed to interact directly with users, attending to their needs and inquiries.
Security and Surveillance System	In charge of security at stations and terminals, preventing theft and damage, and facilitating emergency response.
Communication System	Equipment necessary for communication between the control center, vehicles, and stations, including a backup system in case of emergencies.

Source: Elaborated by the author.

Due to the considerable public policy effort and the allocation of economic and financial resources, along with the commitments of both public and private actors, the configuration and implementation of an Integrated Transport System (ITS) require significant budgetary investment for its short- and medium-term operation. Until the market matures, these systems may require subsidies for both supply and demand in order for their social benefits to materialize. Figure 5 shows how the various components of an ITS are related to the necessary business and legal framework.

Figure 5. Legal and Economic-Financial Framework of ITS and its Components



Source: CTS Embarq. (2015). Project for the Transformation of Concessioned Public Transport: Conceptual Design

Integration Levels

Integration in public transport systems is defined as the manner in which different parts of the transport network are coordinated within a global mobility chain[11]. This definition underscores that the objective of integration is broader than the individual components of the public transport system; it serves as a tool to enhance overall mobility The study "Integration and Regulatory Structures in Public Transport" (IRSTP) from 2003[12] defines integration as an organizational process through which the elements of a public transport system (infrastructure networks, fares and tickets, information and marketing, etc.) interact jointly and more efficiently. This joint interaction results in an overall improvement of the system, as well as in the quality of individual services of each system component.

Integration is considered an evolutionary and dynamic process, not a fixed state. This implies that integration must continuously adapt to specific needs and contexts to achieve an optimal state at any given time. This integration process enhances the efficiency of services and reduces barriers for public transport users.

According to Carles Petit Bogué[13], "an optimal integration process is understood as that series of laws and organizational, management, cooperation, and coordination measures that produce the desired results in the most reliable and efficient manner possible". From a normative perspective, the implementation of integration requires a unique legal framework that encompasses the various areas related to mobility.

The role of institutions in the integration processes includes economic, environmental, and quality control; infrastructure network planning; service management and operation; system financing; revenue distribution; and operational and informational coordination, as well as service quality oversight. Literature and international experience identify several essential levels of integration for an efficient ITS:

- **Planning Integration:** Coordination of development and operational plans for different modes of transport.
- **Information Integration:** Provision of clear and accessible information to users about all transport options.
- **Physical Integration:** Ensuring physical connectivity between different modes of transport, facilitating transfers.
- **Technological Integration:** Compatibility of payment methods and interoperable fare collection systems.
- **Fare Integration:** A unified fare structure that facilitates the use of multiple transport services without significant additional costs.
- **Operational Integration:** Coordination of the daily operation of transport services to ensure continuous and high-quality service.

Below is a brief description of each type of integration[14]:

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11 This definition is used by the European Studies *Improved Structure and Organisation for Transport Operations of Passengers in Europe (ISOTOPE)* from 1997 and *Quality Approach in Tendering/Contracting Urban Public Transport Operations (QUATTRO)* from 1998. These references have been taken from the document: Petit Boqué, C. (2007). *Improving Quality in Public Transport Systems as a Pillar for More Sustainable Mobility*. Escola Tècnica Superior d'Enginyeria de Camins, Canals i Ports de Barcelona, Universitat Politècnica de Catalunya. Avialable at: https://upcommons.upc.edu/handle/2099.1/5960

12 NEA Transport Research and Training, OGM, Oxford University, Erasmus University, TIS.PT y ISIS. (2003). Integration and Regulatory Structures in Public Transport. Final Report for DG TREN, Europe Commission. Rijswijk, Netherlands.

13 Petit Boqué, C. (2007). Improving the Quality of Public Transport Systems as a Pillar for More Sustainable Mobility. School of Civil Engineering, Canals and Ports of Barcelona, Polytechnic University of Catalonia. Avialable at: https://upcommons.upc.edu/handle/2099.1/5960

14 The integration concepts are taken from the following document: Ministry of Transport and Communications. (2019). Theoretical Framework of Subsidy Policy. Supreme Decree No. 022-2019-MTC. Available at: https://cdn.www.gob.pe/uploads/document/file/438458/DS_N__022-2019-MTC.pdf

Planning Integration

Planning integration in ITS is achieved through the precise definition of objectives by constructing future scenarios. This forward-looking approach allows for mapping the optimal paths towards integration, facilitating the coordination of different modes of transport and ensuring that economic growth, social cohesion, and environmental protection are compatible. The Urban Mobility Plan and the Master Transport Plan are the main instruments defined for this task, providing a structured framework for the planning and development of integrated transport systems.

Information Integration

Information integration in an ITS is essential for the system to be perceived as a unified whole by users, reducing barriers to the use of public transport. This integration means that data on schedules, route frequencies, route alternatives, and stop locations are accessible and uniform. A well-integrated information system enhances the user experience by providing clear and consistent information across all available channels, facilitating the planning and use of public transport.

The quality and accessibility of information are crucial for attracting and retaining public transport users. Compared to private transport, where information is generally adequate and easily available, public transport systems need to offer a comparable level of information to compete effectively. This includes street signage, dynamic traffic information, and digital tools such as GPS navigators and online trip planners. Homogenizing the formats and language of the information is fundamental to ensuring that all elements of the transport system are presented in a coherent and accessible manner.

Physical Integration

Physical integration in an ITS ensures connectivity between different modes of transport, facilitating transfers and access to stations. This type of integration is achieved through the planning and construction of infrastructure that allows for a seamless connection between buses, trains, trams, and other means of transport. Physical connectivity not only improves the efficiency of the system but also provides a more comfortable and accessible travel experience for users.

To achieve effective physical integration, it is essential that stations and stops are designed to facilitate the movement of passengers between different modes of transport. This includes the creation of modal interchanges, improvements in pedestrian infrastructure, and the implementation of signage systems that guide users clearly and efficiently. The infrastructure must be accessible to all people, including those with disabilities, to ensure true inclusion and ease of use for the entire population.

Technological Integration

Technological integration in ITS focuses on achieving interoperability of payment and information systems among different operators and modes of transport. This type of integration allows users to utilize a single payment method to access all public transport services, simplifying the process and improving the efficiency of the fare collection system. Technology plays a crucial role in the management and operation of services, allowing for real-time monitoring and optimization of routes and frequencies.

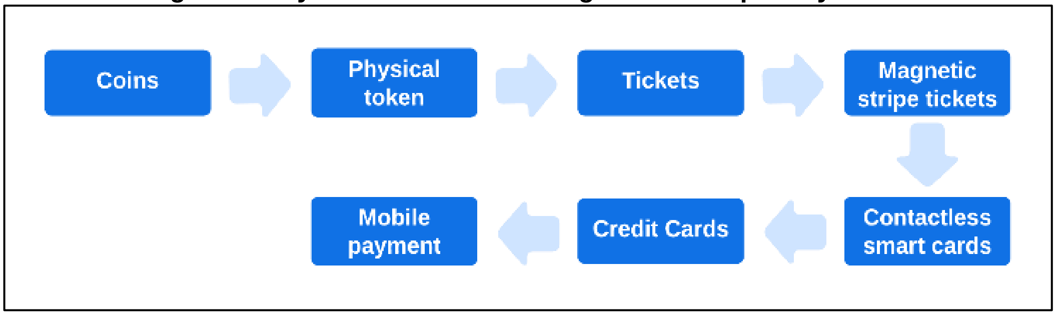
Electronic cards, both contact and contactless, are essential for driving more integrated and efficient transport systems. Their implementation has promoted compatibility across various regions and facilitated the expansion of integrated transport areas, generating economies of scale. The advantages of these electronic cards over manual payment methods are notable and are listed below:

- **Speed in Payment and Validation:** This offers greater convenience to users and reduces bus stop times.
- **Fare Integration on a Single Card:** Allows for the combination of different types of fares, such as subscriptions and temporary passes, on a single device.
- **Differentiated Fares:** Facilitates the implementation of variable fares based on schedules, distances, and zones traveled.
- **Security:** The personalization of cards provides greater security in case of loss or theft.
- **Usage Tracking:** Allows for detailed tracking of transport usage by each customer, helping to better plan the transport supply.
- **Environmental Impact:** Reduces the materials needed for the production of traditional tickets, decreasing environmental impact.
- **Personalized Offers:** Improves communication between customers and operators and facilitates advance reservation of seats.
- **Multifunctional Use:** Cards can also be used as a payment method or identification in activities not related to public transport.

At its most optimal level, technological integration also includes the creation of a Clearing House, which consolidates information on transactions made with the various payment methods of the system. This allows for the calculation of money transfers between system actors according to revenue distribution rules. Additionally, trusts are used to deposit user revenues, which are distributed among the system's actors, enhancing the bankability of transport entrepreneurs.

Private fare collection systems offer the added advantage of gathering detailed information on transport demand at different times and its geographic distribution. This data is essential for better managing and planning routes and transport supply. In some cities, these cards can be linked to users' credit cards or savings accounts, further facilitating payments. The evolution of public transport payment methods, as shown in Figure 6, highlights continuous progress toward more advanced and efficient systems, which require appropriate design to support these technological innovations, improving both the user experience and the operational and financial management of the public transport system.

Figure 6. Payment Methods in Integrated Transport Systems



Source: Rodríguez Porcel, M., & Gordillo, F. (2018). Interoperability in Fare Collection Systems for Public Transport in Latin America and the Caribbean. Inter-American Development Bank.

Fare Integration

Fare integration involves creating a unified fare structure that allows users to utilize multiple transport services without incurring significant additional costs. This approach simplifies the payment process for users and encourages the use of public transport by making journeys more affordable and accessible. Fare integration can also include discounts and reduced fares for certain population groups, promoting equity and social inclusion.

An integrated fare system requires coordination among different operators and modes of transport to establish fares that are fair and attractive to users. This may include the implementation of electronic tickets and smart payment cards that are accepted across all public transport services. The homogenization of fares and payment methods not only enhances the user experience but also facilitates the management and distribution of revenue among the various system operators.

Operational Integration

Operational integration in an ITS refers to the coordination of the daily operation of transport services to ensure continuous and high-quality service. This includes scheduling frequencies, managing capacity and service speeds, and coordinating different modes of transport to optimize efficiency and punctuality. Operational integration is crucial for providing a reliable and efficient service that meets the needs of users.
To achieve effective operational integration, it is essential for transport operators to work closely together and share real-time information. This allows for a quick response to fluctuations in demand and any service disruptions. Operational integration also includes the coordination of schedules and route planning to ensure that different modes of transport complement each other, providing a cohesive and efficient transport network.

5.3. Approaches for Energy Efficiency Policies

The concept of energy efficiency is interpreted in various ways depending on the context and objectives of each economy or institution. This section collects and synthesizes the most relevant definitions to standardize and improve the understanding of the concept, highlighting the main benefits of energy efficiency.

Definition of Energy Efficiency

The International Energy Agency (IEA defines energy efficiency as the relationship between the amount of useful work performed and the energy consumed. A device is more energy-efficient if it provides more services with the same amount of energy or the same services with less energy[15]. The energy efficiency indicator generally comprises energy consumption as the numerator and activity data as the denominator, demonstrating relative energy efficiency, whether in an aggregated manner (energy consumption per appliance) or disaggregated (average heating consumption per unit area).

Importance and Benefits

Energy efficiency garners significant global attention among policymakers for its crucial role in improving energy security, affordability, and accelerating transitions to clean energy. Known as the "first fuel" in these transitions, it is one of the fastest and most cost-effective measures to mitigate CO_2 emissions, reduce energy bills, and strengthen energy security[16]. In the context of electromobility, energy efficiency is key to improving the sustainability of the transport sector and reducing its carbon footprint.

[15] International Energy Agency. (2024). Energy efficiency. Retrieved 2 July 2024. Available at https://www.iea.org/topics/energy-efficiency
[16] International Energy Agency. (2023). Energy Efficiency 2023. Available at: https://iea.blob.core.windows.net/assets/dfd9134f-12eb-4045-9789-9d6ab8d9fbf4/EnergyEfficiency2023.pdf

Historical Analysis and Future Projections

Energy intensity is a measure of the energy used to provide a standardized product or service. It is also used to normalize and compare energy consumption across economies by expressing energy consumption per unit of gross domestic product (GDP).

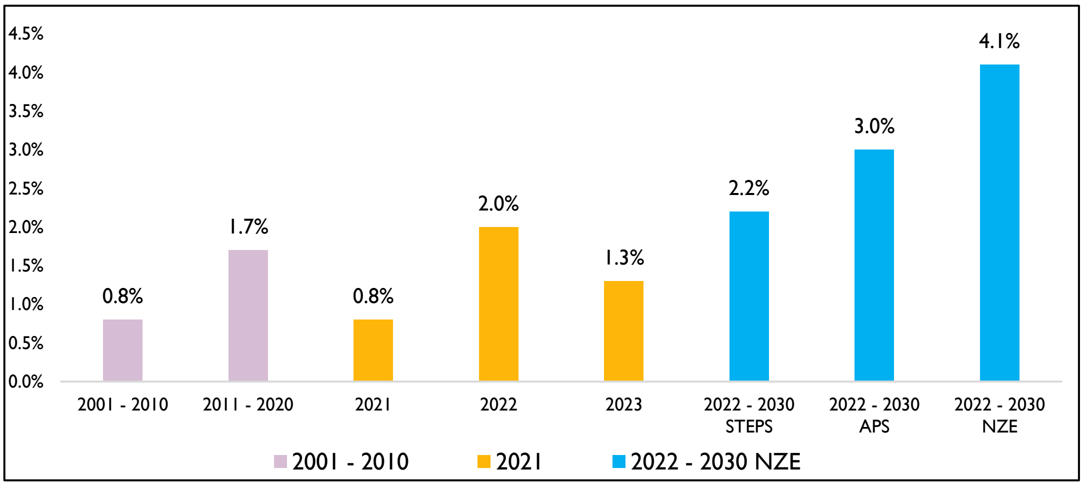
As shown inFigure 7, between 2001 and 2020, energy intensity showed continuous improvement, with a notable increase in the decade from 2011 to 2020. This progress reflects the positive impact of energy efficiency policies, technological advances, and changes in energy consumption behavior. In 2021 and 2022, the improvement in energy intensity accelerated, reaching a peak in 2022, influenced by post-pandemic economic recovery, the adoption of efficient technologies, and governmental stimulus policies.

However, in 2023, the rate of improvement in energy intensity decreased to 1.3%, compared to 2% in 2022, mainly due to an increase in energy demand of 1.7% in 2023 versus 1.3% the previous year. Factors such as economic growth and increased post-pandemic activities outpaced the gains in energy efficiency.

Future projections present several scenarios with different rates of improvement in energy intensity:

STEPS Scenario: Assumes the continuous implementation of current policies, anticipating an annual improvement of 2.2%. Although this represents progress, it is not sufficient to meet net-zero emissions targets.
APS Scenario: Considers the commitments announced by governments, projecting an annual improvement of 3.0%, reflecting greater ambition in energy policies.
NZE Scenario: The most ambitious, projects an annual improvement of 4.1%, crucial for achieving net-zero emissions by 2050 through the adoption of efficient technologies and aggressive emission reduction policies.

Figure 7. Annual Improvement in Primary Energy Intensity, 2001-2023, and by Scenario, 2022-2030



Source: International Energy Agency (IEA). (2023). Energy Efficiency 2023.

Despite the recent increase in investment in efficiency, the pace of improvement in global energy intensity has significantly slowed in the last decade and almost stalled during the first two years of the Covid-19 pandemic. Doubling the global pace of progress in energy efficiency this decade is essential to achieve the net-zero emissions scenario.

Role of Energy Efficiency in Reducing GHG Emissions

It is necessary to clarify that energy efficiency, known as the "first fuel" in transitions to clean energy, is one of the fastest and most cost-effective measures to mitigate CO_2 emissions, reduce energy bills, and strengthen energy security. In the context of electromobility, energy efficiency plays a crucial role in improving the sustainability of the transport sector and reducing its carbon footprint.

Over the past two decades, progress in energy efficiency has been remarkable, although it is necessary to double these efforts to achieve net-zero emissions targets. During this period, improvements in the energy intensity of the economy have significantly contributed to reducing CO_2 emissions that would have resulted from population growth and global income increases. However, to maximize these benefits, it is crucial to increase the pace of improvement. Compared to a scenario of higher energy demand, where an annual progress in energy intensity of 2% per year is projected during this decade, doubling this progress to 4% per year could reduce CO_2 emissions by 7 Gt, equivalent to 20% of current emissions. This would make energy efficiency and related measures account for half of all emission reductions this decade.

Energy Efficiency and Electromobility

Electromobility plays a crucial role in improving energy efficiency and reducing CO_2 emissions. EV and heat pumps are clear examples of how the transition to electricity instead of fossil fuels can optimize energy consumption. These devices not only shift energy use towards electricity, which increasingly comes from clean sources, but also require significantly less final energy to perform the same work as their traditional counterparts. For example, an EV is two to four times more efficient than a conventional vehicle, meaning it can operate with a fraction of the required energy.

The transport sector, historically dependent on oil, is undergoing a significant transformation due to the rapid adoption of EV. In 2022, electricity demand in road transport increased by 60% compared to 2019[17], reflecting the impact of electrification on energy efficiency. With greater penetration of EV, road transport is emerging as one of the most dynamic end-use sectors in the transition to clean energy. This transition not only reduces oil demand but also decreases GHG emissions associated with transport.

The electrification of transport and heating is occurring in parallel with a significant increase in electricity generation from renewable sources. This is transforming the role of energy efficiency, which is no longer limited to end-use alone but encompasses total use, demand flexibility, and optimized use of variable renewable resources. In electrical systems with high levels of renewable energy penetration, the adoption of efficient technologies can generate significant savings on energy bills, estimated at up to one-third in some cases. For example, converting conventional lighting to LED technology in the United States could save enough energy to power 3 million EV per year or heat 2.6 million homes with heat pumps[18].

The continued growth of global vehicle electrification was expected to drive investment in road transport efficiency to new highs of over USD235 million in 2023. For the first time, spending on electrification will surpass investments in efficiency in the transport sector, with nearly USD130 million allocated to this purpose[19]. This shift reflects the recognition of the superior efficiency of EV and the urgent need to reduce fossil fuel dependence. As EV adoption increases, it is crucial that policies and investments continue to support this transition to maximize its energy and environmental benefits.

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[17] International Energy Agency (IEA). (2023). Energy Efficiency 2023. Available at: https://iea.blob.core.windows.net/assets/dfd9134f-12eb-4045-9789-9d6ab8d9fbf4/EnergyEfficiency2023.pdf
[18] Ibid.
[19] Ibid.

5.4. Conceptual Approaches to the Positive Environmental Benefits of Electromobility

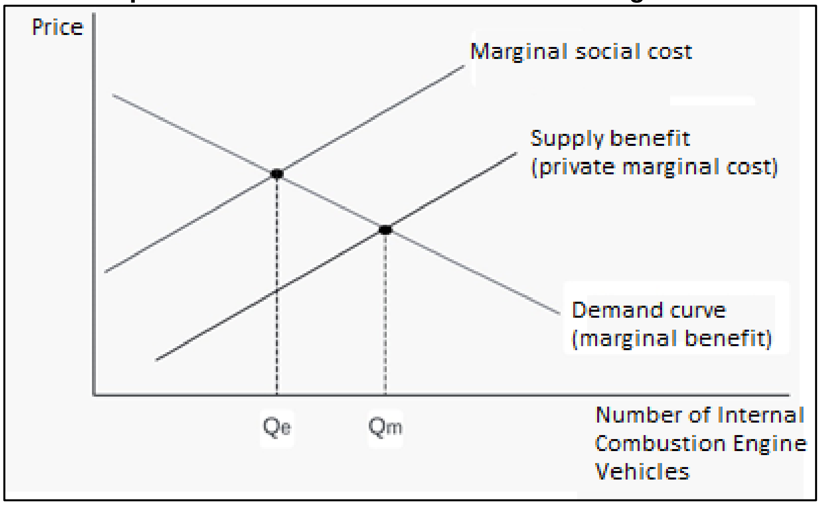
To develop this section, the concepts presented in the book "Economics of the Public Sector" by J.E. Stiglitz and J.K. Rosengard have been employed[20]. This work provides a comprehensive view of externalities and their implications for resource allocation and market efficiency. Specifically, the chapter addressing externalities and the environment will serve as the basis for understanding how the negative externalities of conventional transportation can be mitigated by the environmental benefits of electromobility.

According to the definition proposed by Stiglitz, externalities are situations where an individual or a company undertakes an action that affects another individual or company without the latter paying or receiving compensation for it. These effects, not reflected in market prices, result in inefficient resource allocation, leading to incorrect levels of production and expenditure on controlling such externalities. A clear example of a negative externality is air and water pollution. A company can reduce its pollution by investing in clean technologies; however, it lacks private incentives to do so, despite the significant social benefit. Externalities can be positive, like a well-maintained garden that beautifies a neighborhood, or negative, like factory pollution that affects public health.

Electromobility not only helps mitigate negative externalities but also generates positive externalities, as EV produce fewer pollutant emissions, thus improving air quality and reducing social costs associated with pollution. Additionally, the adoption of EV can incentivize technological innovation and the development of sustainable infrastructure, creating additional benefits for society.

Figure 8 shows how negative externalities result in the overproduction of goods, where the marginal social cost exceeds the marginal private cost, indicating that the market equilibrium produces more than the efficient level. In the case of internal combustion vehicles, their production and use generate many negative externalities, such as GHG emissions and noise pollution, which are not reflected in their market costs. This leads to an overproduction of these vehicles compared to the efficient level that would be achieved if full social costs were considered. The adoption of electromobility can not only reduce these externalities but also incentivize technological innovation and investment in sustainable infrastructures, promoting a shift towards a cleaner and more efficient transport model.

Figure 8. Overproduction of Goods and Generated Negative Externalities



Source: Stiglitz, J. E., & Rosengard, J. K. (2015). Economics of the Public Sector (4th ed.).

[20] Stiglitz, J. E., & Rosengard, J. K. (2015). Economics of the Public Sector (4th ed.). W. W. Norton & Company.

The book mentions that public sector solutions to address environmental externalities fall into two main categories: i) market-based solutions and ii) direct regulation. Market-based solutions seek to influence incentives to achieve economically efficient outcomes. An example of this is the imposition of pollution fines, which aim to reflect the true social costs and thus reduce the incentive to pollute. On the other hand, the state uses direct regulation to limit externalities, such as mandatory emission levels for vehicles.

The market-based solutions identified by Stiglitz are as follows:

Fines and Taxes: Market-based solutions include the imposition of fines and taxes proportional to the amount of pollution emitted. These fines, known as corrective or Pigovian taxes, are designed to align marginal private costs with marginal social costs, thereby reflecting the true social costs of pollution. By imposing a fixed amount equivalent to the marginal cost of pollution, companies are incentivized to reduce production to a socially efficient level.

Subsidies: Another market solution is to offer subsidies for pollution reduction. Subsidies can motivate companies to invest in cleaner technologies and sustainable practices. However, while subsidies can lead to an efficient reduction in pollution, they can also result in the overproduction of the good causing the externality, as producers receive financial incentives to produce more.

Tradable Permits: Tradable permits are another market tool used to control pollution. In this system, permits are issued that allow a specific amount of pollution and can be bought and sold in the market. This mechanism ensures that pollution remains within acceptable levels and promotes economic efficiency by allowing companies that can reduce pollution at a lower cost to sell their permits to those with higher reduction costs. However, the effectiveness of tradable permits depends on a fair initial allocation and consideration of the pollution's location, as impacts can vary by region.

Direct regulation is another traditionally used strategy to control environmental externalities. This includes imposing mandatory emission levels for vehicles, restrictions on the discharge of toxic substances, and prohibitions such as smoking on domestic flights. Direct regulation ensures that companies comply with specific pollution standards, reducing uncertainty about maximum allowable levels. However, it can be less efficient than market solutions because it does not provide additional incentives to reduce pollution below the required levels. Regulation can promote electromobility by setting stricter emission standards for internal combustion vehicles, incentivizing manufacturers and consumers to opt for EV.

Below are all the identified externalities:

Reduction of GHG Emissions (GHG)

- The massive adoption of EV could reduce global GHG emissions by up to 74% by 2050[21].
- Through the decarbonization of the energy matrix and the total electrification of the transport system by 2050, the Latin America and Caribbean region could avoid 1.1 million Mt of CO_2[22].
- Electric car sales could avoid up to 10 million barrels of oil per day by 2035, equivalent to the amount of oil used for road transport in the United States today.[23]

[21] World Bank. (2022). *Global Mobility Report 2022*. Washington, DC: World Bank. Available at: https://www.sum4all.org/data/files/global_mobility_report_2022_04052023_final.pdf
[22] Inter-American Development Bank. (2020). Electric Mobility in Latin America and the Caribbean. Available at: https://parlatino.org/wp-content/uploads/2017/09/movilidad-electrica-16-7-20.pdf
[23] International Energy Agency. (2024). Global EV Outlook 2024. Available at: https://iea.blob.core.windows.net/assets/a9e3544b-0b12-4e15-b407-65f5c8ce1b5f/GlobalEVOutlook2024.pdf

Reduction of Air Pollution

- EV produce no direct emissions during their operation, significantly reducing air pollution and improving public health. Air pollution is responsible for numerous health problems, and reducing emissions helps mitigate these negative effects.
- In Latin America and Caribbean, around 100 million people live in areas with poor air quality, with land transport being one of the main sources of pollution. Atmospheric pollution contributes to more than 300,000 annual deaths in the Americas.[24]

Reduction of Noise Pollution

- EV are notably quieter than internal combustion vehicles, improving the quality of life for urban residents by reducing noise pollution.

Promotion of Renewable Energy

- The transition to electric mobility in public transport can strengthen energy security by diversifying energy sources away from oil and promoting the use of renewable energy sources. In economies like Nepal and Laos, which generate much of their electricity from renewable sources, this transition can significantly improve the balance of payments by reducing fossil fuel imports[25].

Improvement of Urban Air Quality

- Only 10% of people worldwide live in cities that meet the World Health Organization (WHO) air quality guidelines. The adoption of EV can help improve this situation by reducing emissions of fine PM2.5, a key pollutant in urban areas[26].

Aspiration for More Sustainable Transport

- To meet the Paris Agreement target of limiting global warming to 1.5 degrees Celsius, transport emissions must be reduced to 0.2 Mt of CO_2 per capita per year by 2050, from a level of approximately 7.6 Gt of CO_2 equivalent[27].
- Various economies are formulating local electric mobility strategies, with decarbonization targets that include transitioning to 100% electric public transport in some cities by 2040. For example, Chile has set goals to electrify 100% of its public transport fleet in the capital by 2040 and nationwide by 2050[28].

5.5. Economic-Financial Approaches to Guide Subsidy Policies in Urban Passenger Transport in Favor of Electromobility[29].

The economic-financial approach identifies and analyzes subsidy policies that promote the adoption of EV in public transport through investment funds, acquisitions, financing, and business models. These measures aim to competitively level EV with internal combustion vehicles, fostering a balanced market that maximizes the benefits of electromobility, contributing to emission reductions and improving urban quality of life.

The electric public transport system is based on three main components: electric buses (e-buses), a battery-powered propulsion system, and charging infrastructure.

[24] Inter-American Development Bank. (2020). Electric Mobility in Latin America and the Caribbean. Available at: https://parlatino.org/wp-content/uploads/2017/09/movilidad-electrica-16-7-20.pdf

[25] United Nations Economic and Social Commission for Asia and the Pacific. (2023). Electric Mobility in Public Transport: A Guidebook for Asia-Pacific Countries. Available at: https://www.unescap.org/kp/2023/electric-mobility-public-transport-guidebook-asia-pacific-countries

[26] World Bank. (2022). *Global Mobility Report 2022*. Washington, DC: World Bank. Available at: https://www.sum4all.org/data/files/global_mobility_report_2022_04052023_final.pdf

[27] World Bank. (2022). *Global Mobility Report 2022*. Washington, DC: World Bank. Available at: https://www.sum4all.org/data/files/global_mobility_report_2022_04052023_final.pdf

[28] Inter-American Development Bank. (2020). Electric Mobility in Latin America and the Caribbean. Available at: https://parlatino.org/wp-content/uploads/2017/09/movilidad-electrica-16-7-20.pdf

[29] This section has been elaborated based on Section 4 "Implementing the transition" from the following document: United Nations Economic and Social Commission for Asia and the Pacific. (2023). Electric Mobility in Public Transport: A Guidebook for Asia-Pacific Countries. Available at: https://www.unescap.org/kp/2023/electric-mobility-public-transport-guidebook-asia-pacific-countries

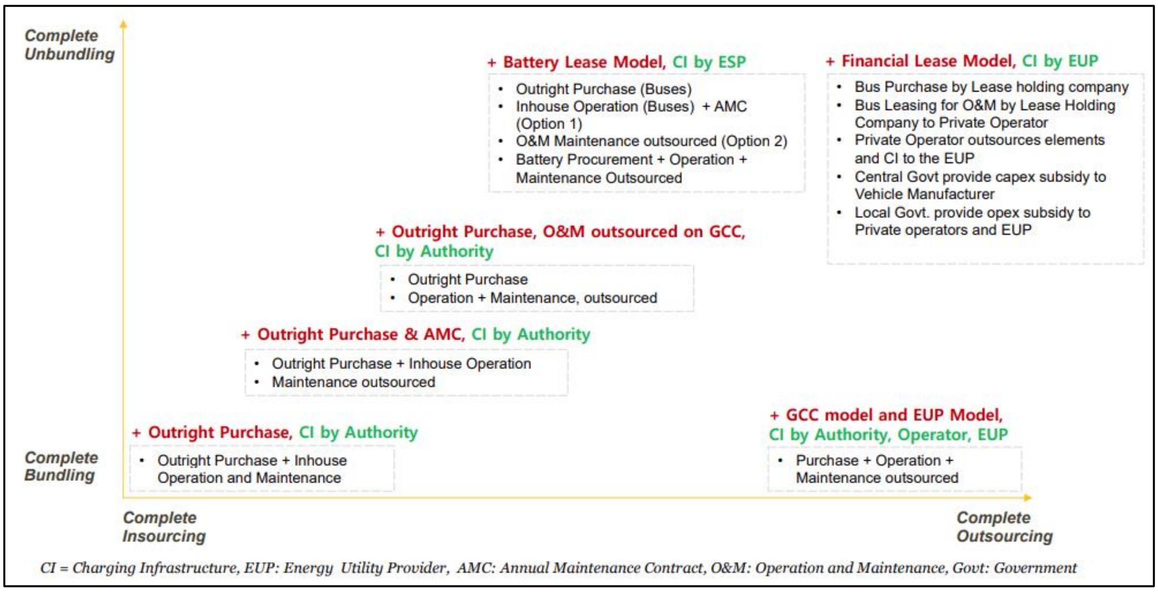
Consequently, to achieve adequate energy efficiency, it is important to implement financial interventions that efficiently dynamize and link these components.

E-buses have an inverted cost structure compared to internal combustion buses, with higher capital costs but lower operating and maintenance costs. Additionally, e-buses are less sensitive to fuel price fluctuations. However, the operation of e-buses requires higher technical maintenance capacity, additional safety measures, and more extensive training for drivers. On the other hand, the operation of this system depends on investment in charging point infrastructure, as this ensures an efficient route design. In Figure 9 , types of financing and business models based on the mentioned components and international experiences will be detailed, which could guide subsidy policies in urban passenger transport in favor of electromobility.

Firstly, the x-axis of the following illustration represents the degree of internalization and externalization of each service and activity, while the y-axis shows the degree of aggregation and disaggregation of the multiple services and activities. It is worth mentioning that the degree of externalization and integration of each business model is detailed according to the requirements of the public transport authority, based on the regulations of each economy.

The models described in Figure 9 can be explained in two sections. Firstly, there are the extreme models, which encompass all their services and activities either completely internalized and grouped or fully externalized and disaggregated. Secondly, there are models that combine and vary the previously explained models. In these new proposals, some activities are carried out internally while others are outsourced.

Figure 9. Types of Business Models for Electric Buses in Public Transport



Source: Economic and Social Commission for Asia and the Pacific (2024).

Extreme Models

- **Outright Purchase Model, CI by Authority**

The first model shown corresponds to a conventional model where buses are purchased directly and operated and maintained by a single internal technical staff of the public transport authority. This model allows public transport authorities to maintain total control over the bus fleet and its operations, ensuring that all aspects of the service comply with local standards and regulations. Additionally, direct ownership of the buses can facilitate long-term planning and the implementation of technological and operational improvements. However, this model also implies greater financial and administrative responsibility for the authority, as it must manage all aspects of maintenance and operation. Despite these challenges, the direct purchase model remains popular due to its simplicity and the ability to maintain centralized control over assets and operations.

- **Financial Lease Model, CI by EUP**

This second model is at the opposite end of the spectrum compared to the previous model (Outright Purchase Model). In this case, the bus is leased, and the battery is obtained through an energy service provider (EUP). Additionally, activities related to the operation and maintenance (O&M) of the bus, battery management, charging, and disposal are outsourced. In Asia, China's economy contributed to the development of the Financial Lease Model, which involves a complete disaggregation and outsourcing of services. This model allows public transport authorities and operators to avoid high initial capital costs, spreading costs over time through lease payments. Outsourcing battery management and charging infrastructure to specialized providers ensures greater efficiency and reliability in e-bus operations. Additionally, by separating bus and battery ownership, authorities can benefit from technological advances in batteries without needing to replace the entire vehicle. This model is particularly beneficial in emerging economies, where financial resources may be limited, and technology is rapidly evolving.

Variations of the Extreme Models

- **Outright Purchase & Annual Maintenance Contract (AMC) Model, CI by Authority**

A first variation of the previous models is found in this third modality. This model is very similar to the "Outright Purchase Model, CI by Authority", except that annual maintenance is outsourced. In this scheme, the public transport authority purchases the buses directly and handles daily operations, while long-term maintenance is managed through a contract with an external specialized provider. This approach allows the public transport authority to benefit from the technical expertise and cost efficiency of the external provider, ensuring high-quality maintenance and prolonging the buses' lifespan. Additionally, outsourcing maintenance can include additional services such as technological upgrades, spare parts management, and continuous technical support.

- **Outright Purchase Model, with O&M outsourced on GCC (gross cost contract)**

The fourth model arises as a learning experience from the Net Cost Contract (NCC) model. The NCC model establishes that the public transport operator is responsible for managing the bus and collecting fares to cover its operational costs. In this case, the operator assumes the risk of a revenue shortfall. Unlike this type of contract, the Gross Cost Contract (GCC) modality grants the operator the sole responsibility of managing the public transport route in exchange for pre-established payments per Km and/or hour. Under this modality, fares are collected and retained by the Transport Agency, thus reducing the operator's risk of covering costs.

- **Battery Lease Model, CI by ESP**

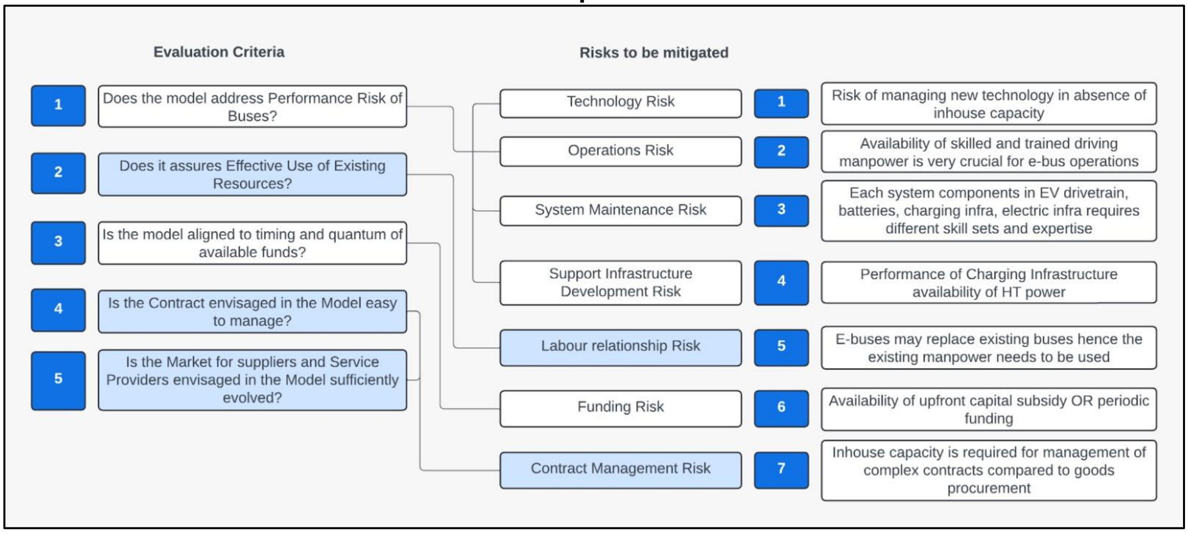
The fifth proposed model focuses on the outsourcing of battery acquisition and management. In this model, the PTA can choose to acquire the buses directly, operate them internally, and outsource annual maintenance through an AMC. Alternatively, it can fully outsource operations and maintenance (O&M). Another option is to outsource both battery acquisition and O&M, allowing an external provider to manage the entire system, including battery charging and disposal. This approach reduces initial costs, spreads costs over time, offers technological flexibility, and improves operational efficiency by leveraging the expertise of specialized providers. However, it can also create dependency on these providers, and although it reduces initial costs, it could result in higher long-term costs due to ongoing lease and service payments.

- **GCC Model and Energy Utility Provider (EUP) Model, CI by Authority, Operator and EUP**

The last model proposed in Figure 9 integrates the purchase, operation, and maintenance of electric buses through the outsourcing of these services. In this model, the PTA acquires the buses but outsources operations and maintenance to the operator and energy service provider. This approach combines the benefits of the Gross Cost Contract (GCC) and the Energy Utility Provider (EUP) Model, allowing the PTA to maintain strategic control while delegating operational and maintenance tasks to specialized entities. Outsourcing these services ensures efficient management and reduces the operational and administrative burden for the PTA, optimizing resource utilization and improving service quality.

Once the six proposed models have been identified, the PTA must determine which one to use and establish an implementation strategy according to the selected model. For this, it is necessary to evaluate the most important criteria for each economy and the associated risks. The Economic and Social Commission for Asia and the Pacific proposes some of these criteria and risks in Figure 10.

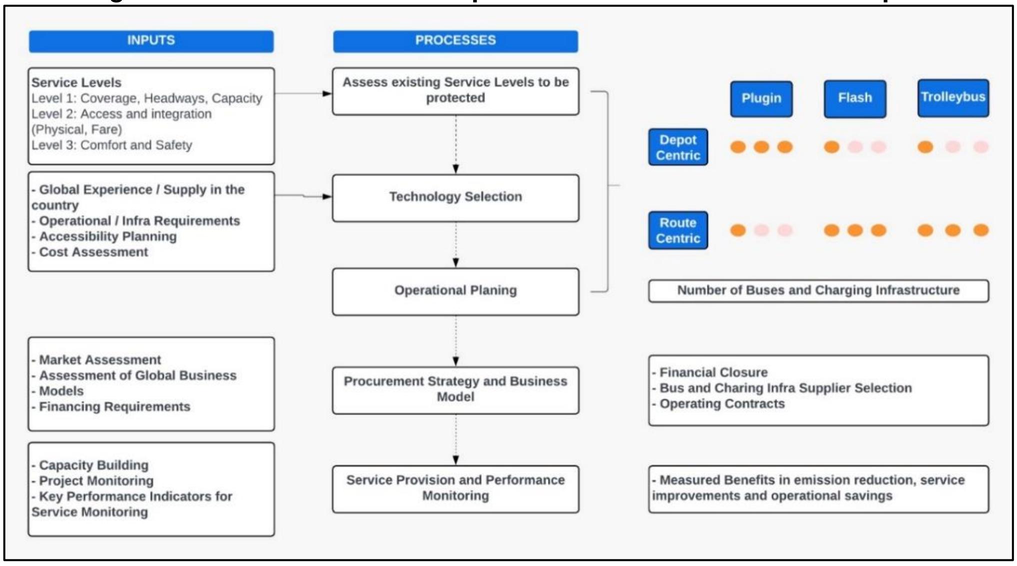
Figure 10. Criteria for Evaluating Alternative Business Models for E-Buses in Public Transport



Source: Economic and Social Commission for Asia and the Pacific (2024).

To conclude, once the business model is selected, the implementation process of e-buses into public transport is governed by three phases: i) inputs, ii) processes, and iii) outcomes.
Figure ***11*** shows this implementation scheme in detail.

Figure 11. Process for the Adoption of E-Buses in Public Transport



Source: Economic and Social Commission for Asia and the Pacific (2024).

The inputs phase establishes **service levels** and evaluates global experience, domestic supply, market assessment, and capacity development. It is important to size the level of coverage, frequencies, capacity, accessibility, integration, comfort, and safety, as well as operational, infrastructure, and financial requirements. This initial analysis allows for the identification of specific needs and conditions in the local and global context, establishing a clear framework for the next phase.

The processes phase focuses on ensuring the sustainable operability of the established service level through technology selection, operational planning, and the development of the acquisition strategy and business model. This phase is essential to ensure that the transition to electric buses is carried out efficiently and effectively, protecting current service levels while incorporating new technologies. Operational planning and the acquisition strategy are fundamental to creating a sustainable business model that can not only be implemented but also maintained in the long term.

Finally, the outcomes phase focuses on tangible implementation and the evaluation of benefits. It includes determining the number of buses and the necessary charging infrastructure, differentiating between depot- and route-based approaches. Additionally, it covers financial closure, the selection of charging infrastructure and bus suppliers, and the formalization of operational contracts. This phase ensures that the measured benefits in terms of emission reductions, service improvements, and operational savings are achieved, consolidating the project objectives and ensuring its long-term success.

6. Context Analysis: Trends in Benefits in the Processes of Migration Towards Electromobility

According to the "Global EV Outlook 2024", prepared by the IEA with support from the EVs Initiative (EVI), the transition to EV has the potential to achieve significant reductions in GHG emissions in the coming decades, crucially contributing to climate change adaptation. The following sections analyze the scenarios and main trends that determine the context for formulating transportation and energy policies related to electromobility and the factors that justify the efforts many economies are making to accelerate the global adoption of EV.

6.1. Benefits of GHG Emission Reductions by Scenarios

The adoption of EVs allows for a significant reduction in CO_2 and other GHG emissions. This is because EVs do not emit gases like CO_2 or others during their operation, unlike ICE vehicles, which generate CO_2 and other pollutants through their exhaust systems. The Global EV Outlook 2024 develops three scenarios from which the future benefits of implementing electromobility worldwide are estimated.

Stated Policies Scenario (STEPS)

The first of these is the STEPS, which reflects current and committed policies by economies globally. In this scenario, it is estimated that by 2035, the use of EV instead of their ICE equivalents, along with continuous improvements in ICE fuel efficiency, could avoid more than 2 Gt of CO_2 equivalent emissions. Even considering the additional emissions from electricity generation to power EV, which amount to approximately 380 MMT of CO_2 equivalent, the net emission savings are calculated to be 1.8 Gt of CO_2 equivalent for that year in the STEPS scenario[30].

Ambitious Policies Scenario (APS)

The Global EV Outlook 2024 explores two additional policy scenarios that illustrate different levels of emission reductions. The second APS, which includes more policies that are aggressive compared to STEPS. In this scenario, sustained decarbonization of energy generation sources and greater adoption of EV result in greater emission reductions. By 2035, the APS could avoid nearly 2 Gt of CO_2 equivalent in net emissions, exceeding the STEPS scenario by more than 10%.

Net Zero Emissions Scenario (NZE)

Finally, the third scenario is the NZE, which is the most aligned with global climate goals of keeping global warming below 1.5 degrees Celsius. In the 2030 projection, the NZE is expected to avoid 40% more emissions than the APS, and by 2035, this difference is reduced to less than 35%[31]. (See

Figure *12*).

Different transportation vehicles align variably with these emission reduction scenarios. Light-duty vehicles (LDV), including cars and vans, align more closely with net-zero emission goals due to strong policy support and the trend towards price parity with ICE vehicles. In the STEPS and APS scenarios, LDV avoid more than 80% of the net emissions projected to be avoided in the NZE scenario by 2035.

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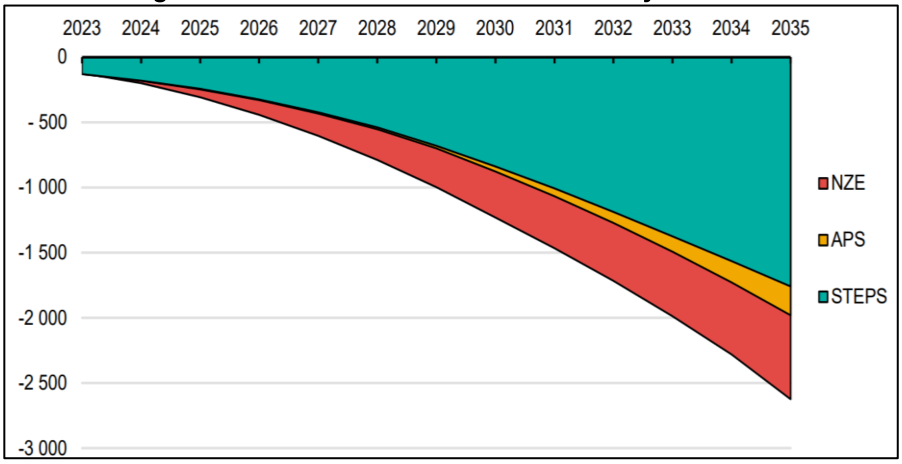
[30] International Energy Agency. (2024). Global EV Outlook 2024: Moving towards increased affordability. IEA. https://www.iea.org/reports/global-ev-outlook-2024.

[31] Ibid.

Figure 12. Net GHG emissions avoided by scenario



Source: Global EV Outlook 2024.

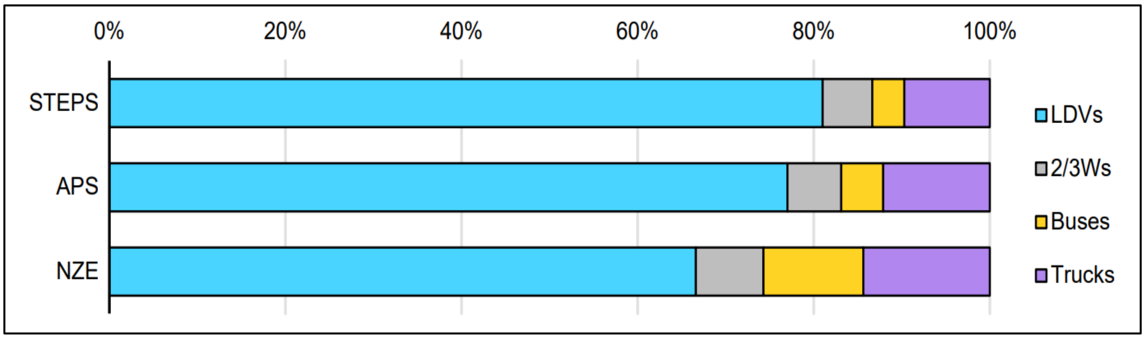
Electric trucks also show strong potential for emission reductions. In the STEPS scenario, they achieve nearly half of the net emissions avoided in the NZE scenario by 2035, and in the APS, they achieve nearly 70%, reflecting the robust policies implemented in the United States and the European Union.

Electric buses, although crucial for emission reductions in urban public transport, are less aligned with net-zero emission goals. In the STEPS scenario, they only account for 20%, and in the APS, 30% of the emission reductions in the NZE scenario by 2035. Therefore, this vehicle segment is the priority of the analysis in this report, as it is one of the vehicle types where there is room for investment and greater efforts are needed to contribute to a scenario of greater net GHG emission reductions.

On the other hand, two- and three-wheeled EV, which were adopted early in regions like Asia, accounted for just under 10% of global emissions avoided in 2023. Therefore, although their proportion decreases to 5% by 2035, they continue to provide significant cumulative emission savings.[32] (See
Figure ***13***).

Figure 13. Share of Cumulative GHG Emission Savings from 2023-2035, by Mode of Transport

[32] Ibid.

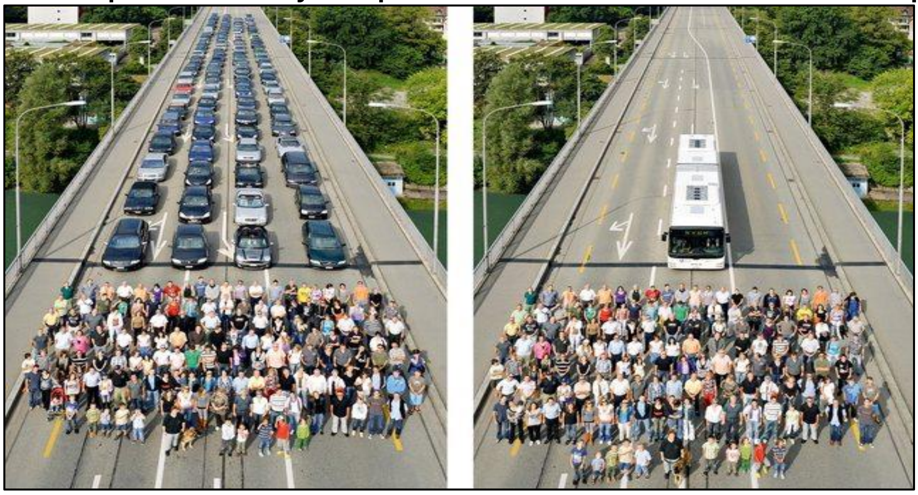


Source: Global EV Outlook 2024.

The transition to EV in the segment of sport utility vehicles (SUV) and large cars can generate significant reductions in GHG emissions in the future. The "Global EV Outlook 2024"[33] has identified that from 2010 to 2022, the preference for SUVs has limited the fuel savings that could have been achieved. Without this shift in consumer preferences, energy use per km could have decreased at an annual rate 30% higher. The potential for electrification in these vehicles offers a crucial opportunity to effectively reduce CO_2 equivalent emissions. For example, in 2023, if all sales of internal combustion or hybrid SUVs had been replaced by battery EV, around 770 MMT of CO_2 equivalent could have been avoided, an amount similar to the emissions generated by the entire road network in China that year.[34]

Specifically in Chile, according to Steinmeyer, A. (2024) in his presentation titled "Normative Aspects of the Implementation of Electromobility in Santiago de Chile" delivered during the workshop "Electromobility Towards a Sustainable and Safe Mobility" at the Lima Convention Center in Peru, the promotion of electromobility in public transport is crucial, not only because of its impact on operational efficiency compared to private transport but also due to its environmental and economic benefits. In the context of Santiago de Chile, the visual evidence of public transport efficiency is clear: while 150 people can be transported by a single bus, the same number of people would require 103 private cars to travel, underscoring the superiority of public transport in terms of space usage and energy efficiency (see Figure 14).

Figure 14. Spatial Efficiency Comparison Between Private and Public Transport

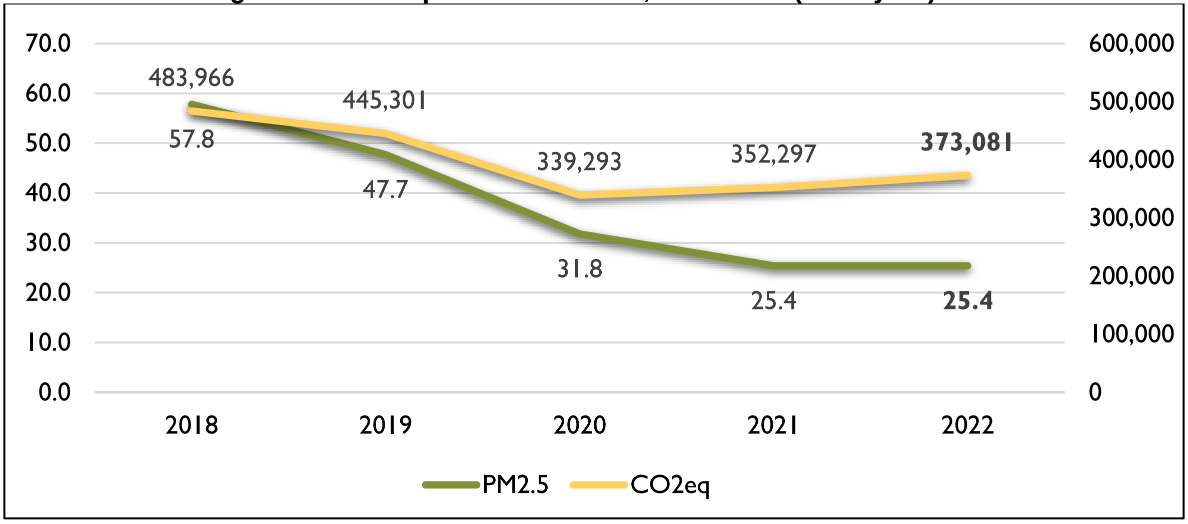


Source: Steinmeyer, A. (2024). *Normative Aspects of the Implementation of Electromobility in Santiago de Chile*. Workshop *"Electromobility Towards a Sustainable and Safe Mobility,"* Lima Convention Center, San Borja, Lima, Peru.

[33] International Energy Agency. (2024). Global EV Outlook 2024: Moving towards increased affordability. IEA. Available at: https://www.iea.org/reports/global-ev-outlook-2024.
[34] Ibid.

The push towards electromobility in Santiago de Chile's public transport system has resulted in significant reductions in pollutant emissions. Between 2018 and 2022, the city's system (RED) achieved a 46.8% reduction in particulate matter and a 16.2% reduction in carbon dioxide emissions, thanks to the gradual replacement of diesel vehicles with electric buses. Additionally, these electric buses have contributed to a 60% reduction in noise pollution compared to diesel buses, leading to a 44% decrease in noise along one of Santiago's busiest avenues.

Figure 15. Atmospheric Emissions, 2018-2022 (Tons/year)



Source: Steinmeyer, A. (2024). *Normative Aspects of the Implementation of Electromobility in Santiago de Chile*. Workshop *"Electromobility Towards a Sustainable and Safe Mobility,"* Lima Convention Center, San Borja, Lima, Peru.

6.2. Benefits from Public Health Improvements

EV do not use fuel and therefore do not emit pollutants such as CO_2, NOx, VOC, or fine PM, which can be inhaled by passengers, drivers, and pedestrians. By reducing air pollution, health care costs decrease, premature deaths are prevented, and sick days are reduced. Therefore, the transition to using EV not only provides environmental benefits but also significant economic advantages derived from improvements in public health.

According to the American Lung Association (ALA), air pollution caused by automobiles has severe health consequences, including asthma attacks, respiratory diseases, and premature deaths. In its report titled “Zeroing in on Healthy Air Report 2022,” the ALA projects that the transition to EV and non-combustion-based electricity sources, during the period from 2020 to 2050, could avoid 110,000 premature deaths, 2.7 million asthma attacks, and 13.4 million lost workdays, in addition to economic savings of approximately USD1.2 million in the United States[35].

On the other hand, according to a study on the benefits of electric cars in Shanghai [36], each EV can generate benefits exceeding USD6,000 when replacing an average ICE in China. Of these monetary benefits, approximately 40% is attributed to improvements in public health and the remaining 60% to climate benefits.

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[35] American Lung Association. (2023). Zeroing in on Healthy Air: The health and climate benefits of zero-emission transportation and electricity generation. Available at: https://www.lung.org/getmedia/13248145-06f0-4e35-b79b-6dfacfd29a71/zeroing-in-on-healthy-air-report-2022.pdf.

[36] Zhang, Y., Liu, W., Xiong, L., Liu, C., Li, H., & Wu, T. (2024). Quantifying the environmental and economic benefits of EVs: A life cycle assessment and cost-benefit analysis. Science of The Total Environment, 934, 162858. Available at: https://www.sciencedirect.com/science/article/pii/S0048969723084917

When analyzing the emissions from the energy sources that generate the electricity used for EV, it is noteworthy that these plants are significantly cleaner than conventional vehicles. For every mile traveled, EV are responsible for less than half of the equivalent GHG emissions of gasoline cars. This is because power plants operate more efficiently than gasoline engines and because a portion of the electricity comes from non-fossil fuel sources, such as hydroelectric, renewable, and nuclear energy. In fact, if EV are fully charged with renewable energy sources, such as wind or solar, the GHG emissions from EV can be reduced to zero[37].

6.3. Benefits from the Reduction in Oil Demand

The rapid adoption of EV is significantly transforming the global energy landscape, especially in terms of oil demand. According to the Global EV Outlook 2024, in the STEPS scenario projected for 2030, nearly one in three cars on the roads in China is expected to be electric. In the same period, in the United States and the European Union, nearly one in five cars in circulation will be electric.[38]. This massive shift towards electromobility includes not only passenger cars but also vans, trucks, buses, and two- or three-wheeled vehicles.

This increase in EV adoption has a direct and substantial impact on reducing oil demand. In the STEPS scenario, the transition to EV of all types will avoid the demand for 6 million barrels of oil per day by 2030. This amount increases to more than 10 million barrels of oil by 2035. This reduction in oil demand is comparable to the volume of oil currently used for road transport in the United States today.[39].

Without a doubt, this significant savings in oil consumption not only contributes to the reduction of CO_2 equivalent emissions by decreasing the combustion of fossil fuels but also generates a lower dependence on oil, which can translate into greater economic savings and more stable energy prices, in addition to reducing the vulnerability of importing economies to fluctuations in the global oil market.

6.4. Benefits from the Reduction of Investment, Operation, and Maintenance Costs of EV

The Global EV Outlook 2024 report provides data on how the ownership costs of EV are evolving compared to ICE. This analysis is fundamental to understanding the reasons behind the growing attractiveness of EV and their accelerated adoption in the global market.

The total cost of ownership (TCO) of a vehicle not only includes the initial purchase price but also the operating, maintenance, and repair costs over its lifetime. In this regard, policies and innovations applied to EV are making costs increasingly competitive compared to ICE. In 2022, the cost of owning a medium-sized EV was lower than that of an ICE in several key economies. This is primarily due to two factors: i) lower fuel costs and ii) lower maintenance costs.

Regarding fuel costs, EV are more efficient in terms of energy consumption, as the cost per Km traveled with electricity is generally lower than with gasoline or diesel. The difference is greater in regions with high fossil fuel prices and/or competitive electricity rates. The IEA reports that, on average, the operating cost per Km of an EV can be up to 50% lower than that of an ICE. Additionally, regarding maintenance costs, EV have fewer moving parts than ICE, which significantly reduces wear and tear and, consequently, maintenance costs. According to the Global EV Outlook 2024, EV owners

[37] International Energy Agency. (2024). Global EV Outlook 2024: Moving towards increased affordability. IEA. Available at: https://www.iea.org/reports/global-ev-outlook-2024.
[38] Ibid.
[39] Ibid.

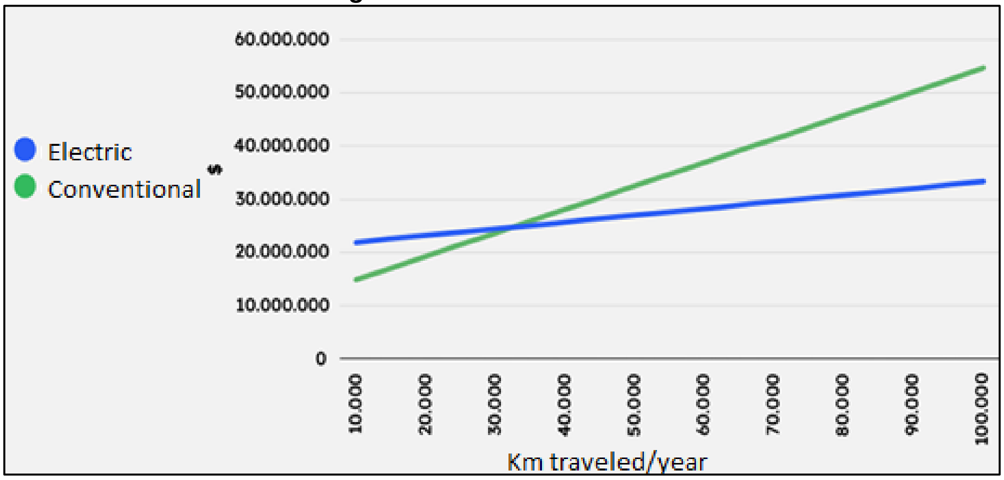
can save up to 30% in maintenance costs over the vehicle's lifetime compared to ICE. This includes lower expenses on oil changes, engine repairs, and exhaust systems[40].

Government subsidies and incentives have been crucial in making EV more accessible. In economies like Germany and France, incentives can reduce the purchase price of an EV by several thousand euros. For example, in Germany, the subsidy for purchasing an EV can reach up to EUR9,000[41] that significantly reduces the initial price difference between EV and ICE.

Despite the current challenges related to the cost difference between these two types of vehicles, the report projects that by 2030, price parity between EV and ICE will be achieved in most major markets. This means that the acquisition cost of an EV will be comparable to that of an ICE, without the need for additional subsidies. The combination of lower ownership costs, government incentives, and decreasing battery costs will make EV increasingly attractive to consumers.

The “National Electromobility Strategy” report, published by the Ministry of Energy of Chile, evaluates the economic feasibility of using EV compared to conventional vehicles. Figure 16 shows how EV can be not only competitive but also more economical in the long term compared to ICE. The analysis conducted by the Ministry of Energy of Chile represents global market information.

Figure 16. TCO Assessment



Source: National Electromobility Strategy of Chile

This analysis considers several economic factors over a six-year period, including: i) acquisition cost, ii) operating costs such as fuel and maintenance, and iii) financing rate. The blue line, representing the ownership costs of EV, shows a flatter trajectory compared to the green line, representing conventional vehicles. This is due to the lower operating costs of EV, especially in terms of fuel and maintenance costs.

In Figure 16, it can be seen that for EV, the cost of electricity per Km is significantly lower than that of gasoline or diesel, resulting in substantial savings as annual mileage increases. Additionally, EV have fewer moving components, which reduces maintenance and repair expenses. These advantages are clearly reflected in the chart, where accumulated costs for EV are consistently lower than for conventional vehicles as more Km are driven[42].

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[40] International Energy Agency. (2024). Global EV Outlook 2024: Moving towards increased affordability. IEA. Available at: https://www.iea.org/reports/global-ev-outlook-2024.
[41] Ibid.
[42] Ministry of Energy, Government of Chile. (2022). *National Electromobility Strategy*. Santiago, Chile: Ministry of Energy. Available at: https://energia.gob.cl/electromovilidad/biblioteca

The main assumptions for this analysis include: i) a base price adjusted to the consumer price index (CPI), ii) the discount rate used, iii) financing costs, and iv) fuel efficiency rates for both types of vehicles. These factors indicate that even without waiting for a reduction in acquisition costs or additional incentives, EV already represent an economically viable option for many consumers.

From an economic perspective, Steinmeyer, A. (2024), in his presentation titled "Normative Aspects of the Implementation of Electromobility in Santiago de Chile," delivered during the workshop "Electromobility Towards a Sustainable and Safe Mobility," highlighted that electric buses represent a convenient option due to their ability to cover a large number of daily kilometers (up to 250 km), which facilitates a quick return on investment.

6.5. Benefits from Safety Improvements

According to Kompass et al. (2023)[43], the adoption of EV has significantly transformed the automotive industry. Internal combustion engine (ICE) vehicles have established robust safety standards and regulations over the years, widely recognized by manufacturers, suppliers, government authorities, and consumers. In contrast, EVs are in the early stages of this process. The goal is to achieve comparable safety levels, considering the unique characteristics and risks of EV.
One of the most notable advantages of EVs, according to the authors, is the elimination of certain safety issues inherent to combustion vehicles, such as gasoline leaks or fuel tank explosions in the event of a collision. However, EV present their own safety challenges, mainly related to high-voltage systems and battery vulnerability. These vehicles require specific crash standards and tests to protect electrical components, differing from the measures needed to ensure the integrity of the fuel system in combustion engine vehicles.

Despite these challenges, EV safety is supported by data and test results. Research by the Insurance Institute for Highway Safety (IIHS) in the United States has shown that EV offer safety levels comparable to or higher than gasoline and diesel vehicles. Additionally, insurance data analysis from the Highway Loss Data Institute (HLDI) reveals that hybrid and EVs have a lower risk of injuries and accident costs, partly due to their greater weight. This study, which compared hybrid vehicles with ICE vehicles built on the same platform, found that the risk of injuries and associated accident costs are 25% lower in hybrid vehicles compared to gasoline vehicles (Kompass et al., 2023, pp. 4).

These distinctive characteristics of EVs introduce new safety challenges that need to be considered. Firstly, the rigidity and weight of the new components due to their influence on crash characteristics. Secondly, the prevention of electric shocks and short circuits in the high-voltage system. Thirdly, the risk of fire generation within the electrical energy storage systems. Lastly, the risk of gas tank explosions in hybrid vehicles.

One of the main concerns of EV users is the potential fires related to lithium-ion batteries, which are highly prevalent in these types of vehicles. However, thanks to emerging field studies and increasing educational efforts by original equipment manufacturers and research institutions, these concerns are being addressed.

Among other research, the National Transportation Safety Board (NTSB) in the United States has investigated several EV fire incidents and has reached the following conclusions regarding safety risks:

[43] Kompass, K., Königs, S., Euhus, F., Fuchs, F., Zimmermann, S., Schöneburg, R., Justen, R., & Martin, S. (2023). *Safety of Electro Mobility - White Paper of the FISITA Intelligent Safety Working Group*. FISITA. Available at: https://www.researchgate.net/publication/371991285_Safety_of_Electro_Mobility_-_White_Paper_of_the_FISITA_Intelligent_Safety_Working_Group

1. Manufacturer emergency response guides provide sufficient vehicle-specific information to disconnect the high-voltage system when the high-voltage disconnects are accessible and not damaged by crash forces.
2. Crash damage and resulting fires can prevent first responders from accessing high-voltage disconnects in EVs.
3. Instructions in most manufacturers' emergency response guides for combating high-voltage lithium-ion battery fires lack the vehicle-specific details needed to suppress the fires.
4. Thermal runaway and multiple reignitions of the battery after initial fire suppression are safety risks in high-voltage lithium-ion battery fires.
5. Remaining energy in a damaged high-voltage lithium-ion battery, known as stranded energy, poses an electric shock risk and creates the possibility of thermal runaway, which can result in battery reignition and fire.
6. Storing an EV with a damaged high-voltage lithium-ion battery within the recommended 50-foot clear area may be unfeasible in tow yards or storage facilities.
7. EV manufacturers should use the ISO 17840 standard format to present emergency response information.
8. An action by the National Highway Traffic Safety Administration (NHTSA), similar to that taken by the European New Car Assessment Program (Euro-NCAP), to incorporate scoring related to the availability of a manufacturer's emergency response guide and its adherence to ISO 17840 and SAE International's recommended practice J2990 into the U.S. New Car Assessment Program would incentivize manufacturers of vehicles sold in the United States with high-voltage lithium-ion battery systems to comply with those standards.
9. Although existing standards address damage sustained by high-voltage lithium-ion battery systems in survivable crashes as defined by federal crash standards, they do not address high-speed, high-severity crashes that result in damage to high-voltage lithium-ion batteries and the associated stranded energy (Kompass et al., 2023, pp.5).

Another point to highlight according to Kompass et al. is that EVs tend to be heavier due to their large batteries, which increases the vehicle's mass compared to ICE vehicles. This greater mass has important implications for occupant protection, as heavier vehicles tend to have an advantage in car-to-car impacts. In crashes, they provide a lower severity crash pulse to their occupants and a more severe pulse to the occupants of the lighter vehicle. Additionally, the weight distribution and structure of the EV can offer additional benefits in terms of impact absorption and occupant protection (2023, pp.13).

In conventional vehicles, the internal combustion engine, transmission, driveshaft, and other components take up a lot of space in the front compartment, which limits the impact absorption capacity in severe crashes. In contrast, EVs typically have smaller components in their front compartments. This configuration, according to Kompass, allows for the design of the vehicle structure in such a way that the acceleration pulse during frontal impacts against a flat, rigid barrier is more gradual and occupant-friendly. This can significantly improve energy absorption during the impact and reduce the severity of injuries to occupants (2022, pp.14).

The recent increase in the adoption of EV has coincided with the incorporation of numerous innovative active safety features and advanced occupant detection and restraint technologies. These innovations include automatic braking systems, lane-keeping assistance, adaptive cruise control, and advanced airbag and seatbelt systems that adjust their response according to the severity of the impact. These technologies not only reduce the likelihood of an accident occurring but also decrease the risk and severity of injuries in the event of accidents and other incidents. Although these features are not exclusive to EVs, their implementation in this type of vehicle significantly contributes to improving overall safety performance.

In conclusion, the adoption of EVs not only represents a step towards sustainability and emission reduction but also brings a series of safety benefits. Although there are still specific challenges that need to be addressed, technological advancements and emerging regulations are paving the way for EVs to offer safety levels equivalent to or superior to traditional vehicles. Over time, it is likely that these vehicles will be established as a safe and efficient option for drivers, pedestrians, and cyclists.

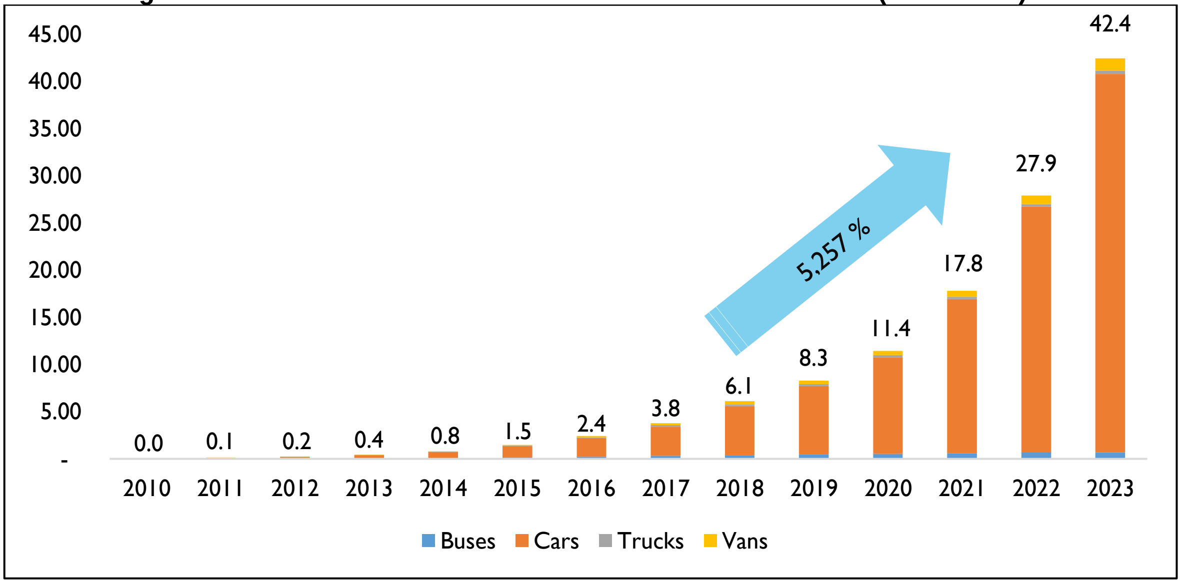
7. Trends in the Expansion of Electromobility in the International Context

The Global EV Outlook 2024 report provides a comprehensive analysis of the development and expansion of electromobility worldwide. Below are the key points of the international context in EV adoption, extracted from this report.

7.1. Global Growth in EV Adoption

In 2023, the total number of EV[44] in circulation worldwide reached 42.4 million, showing exponential growth from 2010[45] to the present. This increase has been mainly driven by electric cars or light vehicles, which lead the growth. Buses, trucks, and vans have also experienced significant growth, although on a smaller scale and proportion.

Figure 17. Global Trend of EV Stock between 2010 and 2023 (in millions)

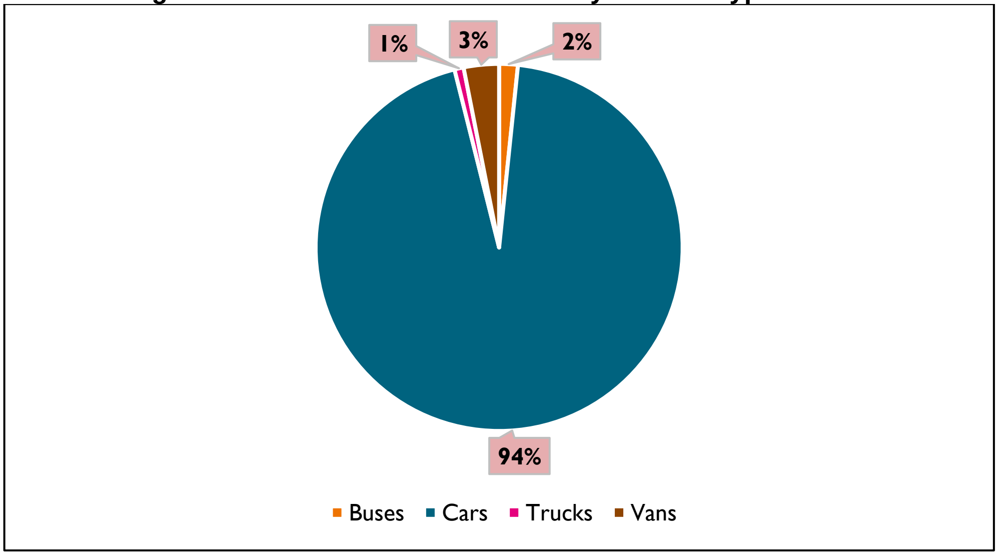


Source: Global EV Outlook 2024.

The number of electric cars in circulation worldwide reached 40 million in 2023, accounting for 94.3% of the total EV. Global sales of this type of vehicle have experienced sustained growth, with nearly 14 million units sold in 2023, representing approximately 18% of total vehicle sales. This significant increase is even more remarkable considering that in 2018, electric cars accounted for only 2% of global sales[46].

[44] EVs include cars, buses, trucks, and vans.
[45] International Energy Agency. (2024). Global EV Outlook 2024: Moving towards increased affordability. IEA. Available at: https://www.iea.org/reports/global-ev-outlook-2024.
[46] Ibid

Figure 18. Distribution of EV Stock by Vehicle Type in 2023



Fuente: International Energy Agency (2024). Global EV Outlook 2024.

Cars

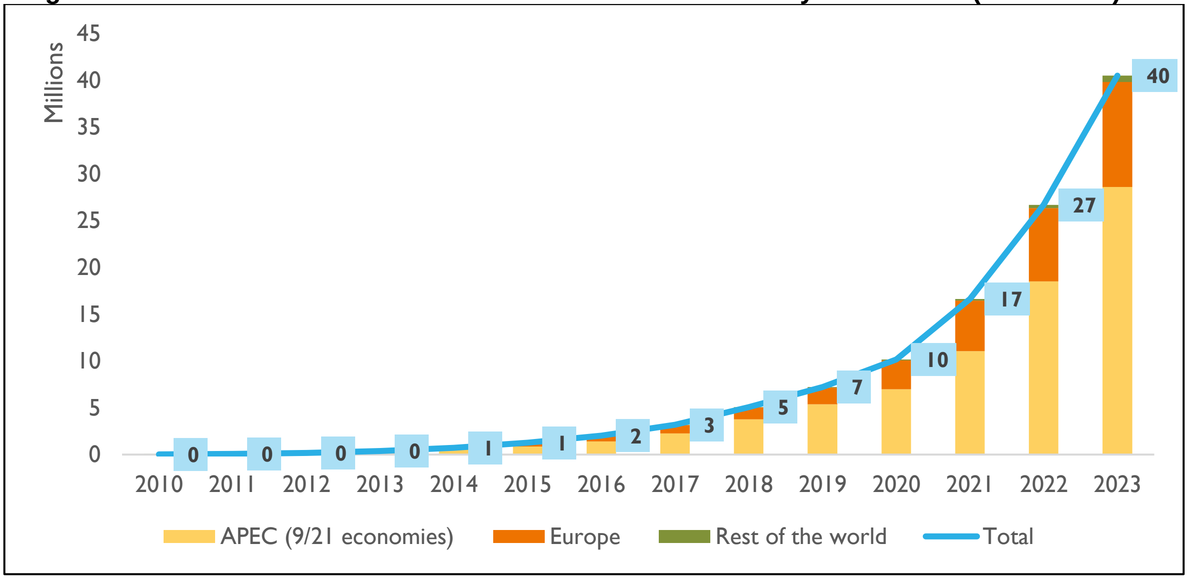
The main driver of this growth comes from three major markets: China, Europe, and the United States (See Figure 19). In China, electric cars account for more than one-third of all new registrations, reinforcing the leadership of one of the APEC economies by contributing just under 60% of global sales in 2023. Europe follows this pace with approximately one-quarter of the global market, where more than one in five new cars sold are electric. The United States, in turn, contributes about 10% of global sales, and electric cars constitute around 10% of new registrations. [47]Thus, the two main APEC economies total 70% of global sales.

However, outside these main markets, EV sales remain limited, even in economies with advanced automotive markets like Japan and India. This concentration of sales is also reflected in the distribution of the global EV fleet, which is becoming increasingly centered in these three regions[48]. Since China, Europe, and the United States account for around 92% of sales and 94.16% of the global EV stock, the transition to EV in these markets has significant global repercussions, setting trends and establishing standards that influence the evolution of the global electric mobility market.

Specifically, regarding electric cars, the growth is particularly remarkable. Between 2014 and 2023, the stock of light electric vehicles increased by 5,615%, rising from approximately 700,000 to over 40 million units (see Figure **19**). This growth has been largely driven by the economies of the APEC region, which currently account for 70.6% of the global stock of electric cars (see
Figure *20*). This widespread adoption in the Asia-Pacific region underscores the leadership of these economies in the transition toward electromobility.

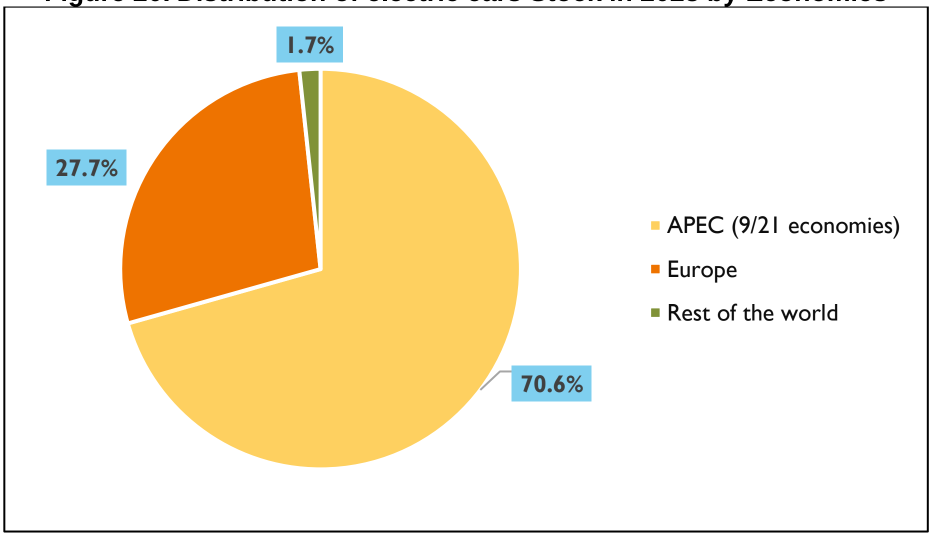
[47] International Energy Agency. (2024). Global EV Outlook 2024: Moving towards increased affordability. International Energy Agency. https://www.iea.org/reports/global-ev-outlook-2024.
[48] Ibid.

Figure 19. Global Trend of EV Stock between 2010 and 2023 by Economies (in millions)



Source: International Energy Agency (2024). Global EV Outlook 2024.

Figure 20. Distribution of electric cars Stock in 2023 by Economies



Source: International Energy Agency (2024). Global EV Outlook 2024.

Buses

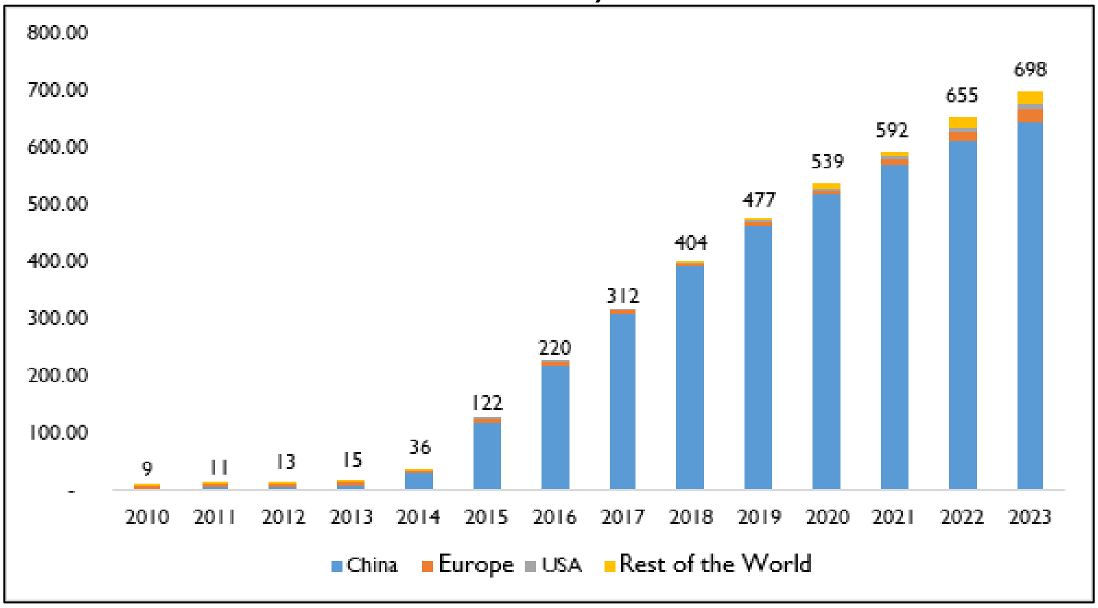
Over the past decade, the growth of electric buses has been significant, reflecting a shift in public transport strategies and policies to promote EV. The Figure 21 shows the evolution of electric bus adoption from 2010 to 2023 in several key regions such as China; Europe; the United States, and the rest of the world.

China stands out as the leading economy in implementing this technology, with a massive increase in electric buses in circulation, rising from fewer than 2,000 units in 2010 to over 643,000 in 2023. This leadership is largely due to supportive government policies and infrastructure improvements that the economy has developed.

Europe has also seen sustained growth, increasing its numbers from just over 6,000 buses in 2010 to nearly 24,000 buses in 2023. In Europe, the growth in the number of buses has been driven by the need to comply with strict environmental regulations and the European Union's commitment to reducing carbon emissions.

In the United States, although growth has been more moderate, the number of electric buses has increased significantly, reaching 7,700 units in 2023. It is foreseeable that the global trend towards the electrification of public transport could lead to a profound change in the reduction of equivalent GHG emissions and the improvement of air quality in urban areas.

Figure 21. Global Trend of Electric Bus Stock between 2010 and 2023 by Economies (in millions)



Source: Global EV Outlook 2024

7.2. APEC Growth in EV Adoption in APEC Economies

In the last decade, economies in the APEC region have experienced a notable increase in EV adoption. This growth has been driven by a combination of factors, including favorable government policies, growing concern about air quality and climate change, and technological advances in the automotive industry.

Leading economies like China and the United States have made significant progress, while others, such as Mexico and Thailand, are beginning to solidify their strategies for integrating electric vehicles into their transportation systems. This section explores the situation of sixteen APEC economies (Australia; Canada; Chile; China; Indonesia; Japan; Korea; Malaysia; Mexico; New Zealand; Peru; Russia; Singapore; Chinese Taipei; Thailand; and the United States) that are adopting and promoting the use of electric vehicles, highlighting both the challenges and achievements in this transformative process toward sustainable mobility.

7.2.1. Selection Criteria for the Fifteen APEC Economies

The selection of these sixteen economies is based on two main criteria. First, it was considered that these economies represent a significant proportion of the world's EV stock (71.6%) in 2023. This criterion is essential as it reflects the leadership and commitment of these economies to the adoption of sustainable mobility technologies, evidenced by their ability to influence global EV market trends. Second, priority was given to access to detailed and reliable information on their policies and progress in electromobility. This aspect is crucial for conducting a rigorous and well-documented analysis, allowing an understanding not only of adoption figures but also of the strategies and policies that have facilitated these achievements.

7.2.2. Australia

In May 2024, the Australian Government passed the New Vehicle Efficiency Standard 2024 (NVES Act) which sets out a vehicle efficiency (CO_2) standard for Australia's light vehicle sector[49]. Prior to this law, Australia was one of the few advanced economies without a vehicle efficiency standard. Standards have been adopted by the European Union; United Kingdom; United States; Canada; Mexico; China; Japan; India; Korea; Saudi Arabia; and New Zealand[50]. A lack of energy regulation in Australia previously resulted in significantly higher per capita fuel consumption compared to other developed economies. New cars in Australia use, on average, 40% more fuel than in the European Union, 20% more than in the United States, and 15% more than in New Zealand[51]. This not only negatively affects the environment but also increases costs for consumers. Australia's New Vehicle Efficiency Standard will reduce emissions from new passenger vehicles by around 60% by 2030, and roughly halve the emissions of new light commercial vehicles over the same period. By 2050, the Standard will deliver around: 321 million tonnes of carbon abatement, AUD95 billion in fuel saving for Australians, AUD5 billion in health savings and improved fuel security for Australia[52].

The transportation sector is one of the main sources of GHG emissions in Australia, accounting for approximately 19% of total emissions, according to the "National EV Strategy Annual Update 2023-24". Passenger vehicles and light commercial vehicles alone contribute 60% of transport emissions and more than 10% of Australia's total emissions. Projections indicate that by 2030, transportation will become the largest source of emissions in Australia. The electrification of transport, powered by the abundant renewable energy resources of this economy, is essential to achieve the economic-wide emissions reduction target of 43% below 2005 levels by 2030 and to achieve net-zero emissions by 2050[53].

To meet domestic emission reduction commitments, it is essential for Australia to reduce road transport emissions by replacing ICE vehicles, which run on gasoline and diesel, with EV, which emit fewer pollutants. These EV must become the primary form of light transport. This transition is crucial for not only improving air quality and reducing GHG emissions but also for offering significant economic opportunities. Australia has abundant mineral resources, capital, and skills necessary to support this transformation. By leveraging these assets, this economy can play a fundamental role in the global EV revolution, which could translate into greater economic prosperity and job creation.

Global demand for essential minerals for EV and battery storage, such as lithium, copper, nickel, and magnesium, is expected to grow at least 30 times by 2040, according to the IEA. Australia, with its significant deposits of vanadium, cobalt, and lithium, is well-positioned to meet this demand. Currently, half of all raw materials used in battery production are extracted in Australia, and this economy is the world's largest producer of lithium, contributing more than half of global mining production in 2021. The value of Australian lithium exports is projected to increase from AUD1.1 million in 2020-21 to nearly AUD14 million in 2022-23. Additionally, the development of a battery industry could contribute AUD7.4 million annually to the economy and create 34,700 jobs by

[49] Australian Government. (2024). New Vehicle Efficiency Standard Act 2024. Available at https://www.legislation.gov.au/C2024A00034/latest/text.

[50] Department of the Prime Minister and Cabinet. (2024). Cleaner, Cheaper to Run Cars: The Australian New Vehicle Efficiency Standard. Commonwealth of Australia. Available at: https://oia.pmc.gov.au/published-impact-analyses-and-reports/cleaner-cheaper-run-cars-australian-new-vehicle-efficiency

[51] Department of Climate Change, Energy, the Environment and Water (DCCEEW). (2023). National EV Strategy. Commonwealth of Australia. Available at https://www.dcceew.gov.au/sites/default/files/documents/national-electric-vehicle-strategy.pdf

[52] Department of the Prime Minister and Cabinet. (2024). Cleaner, Cheaper to Run Cars: The Australian New Vehicle Efficiency Standard. Commonwealth of Australia. Available at: https://oia.pmc.gov.au/published-impact-analyses-and-reports/cleaner-cheaper-run-cars-australian-new-vehicle-efficiency

[53] Department of Climate Change, Energy, the Environment and Water (DCCEEW). (2024). National EV Strategy Annual Update 2023-24. Commonwealth of Australia. Available at: https://www.dcceew.gov.au/sites/default/files/documents/national-electric-vehicle-strategy-annual-update-2023-24.pdf

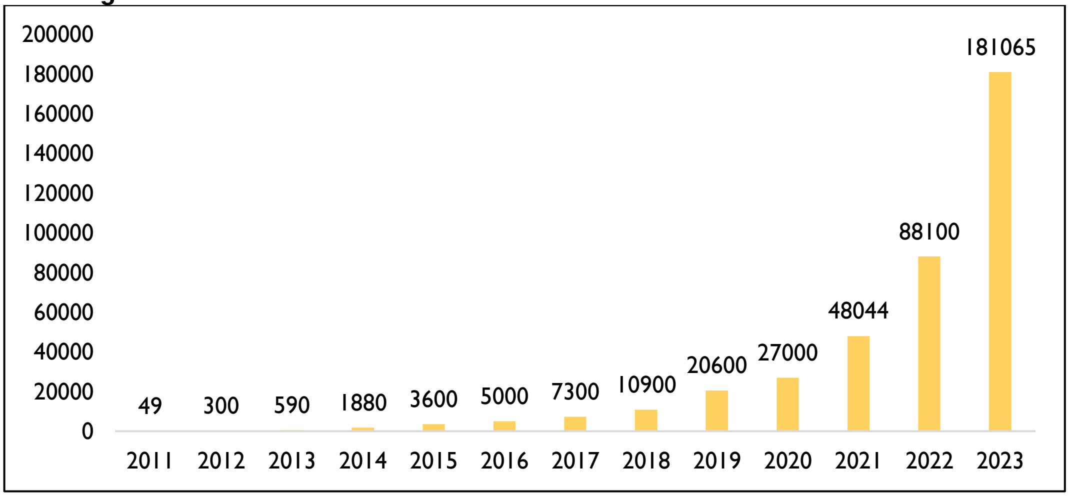
2030.[54], consolidating Australia's position as a leader in the global supply chain for energy storage technologies.

Australia is experiencing rapid growth in the use of EV, although it still faces significant challenges. Since the implementation of the "National EV Strategy" in April 2023, the EV market in Australia has seen remarkable growth. EV sales accounted for 9.4% of all light vehicle sales as of April 2024, marking a significant increase compared to 8.4% in 2023 and 3.8% in 2022.[55]

The document highlights how the availability and choice of EV models have increased considerably. In 2023, there were 148 EV variants available for sale in Australia, representing a 56% increase compared to the previous year. This increase in supply has allowed more Australian consumers to access EV, thus driving overall adoption. Accordingly, by the end of 2023, Australia already had around 181,000 EV, of which 150,000 (83%) were battery EV. **Error! Not a valid bookmark self-reference.** shows the evolution of the EV stock from 2011 to 2023.

Additionally, the "National EV Strategy Annual Update 2023-24" highlights the development of public charging infrastructure for EV in Australia, which has experienced significant and accelerated growth. By the end of March 2024, approximately 900 fast and ultra-fast charging stations had been installed across the economy. These stations, equipped with around 2,000 fast and ultra-fast charging plugs, facilitate access to efficient and rapid charging.[56] This increase in charging infrastructure represents more than a 90% rise in the number of available locations compared to December 2022, providing robust capacity to meet the growing demand from EV users.

Figure 22. Evolution of the EV Stock between 2010 and 2023 in Australia



Source: Global EV Outlook 2024.

The Australian Government is taking a collaborative approach with state and territory governments to drive the electrification of public and private transport, with a particular emphasis on electric buses.

Several initiatives are underway to expand the electric bus network across the economy. The Australian Government, in collaboration with the Government of Western Australia, is allocating AUD125 million to electric bus charging infrastructure in Perth, complemented by the local production of 130 new electric buses.

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[54] Department of Climate Change, Energy, the Environment and Water (DCCEEW). (2023). National EV Strategy. Commonwealth of Australia. Available at:
[55] Ibid.
[56] Department of Climate Change, Energy, the Environment and Water (DCCEEW). (2024). National EV Strategy Annual Update 2023-24. Commonwealth of Australia. Available at: https://www.dcceew.gov.au/sites/default/files/documents/national-electric-vehicle-strategy-annual-update-2023-24.pdf

In Australia, significant investments are being made to adopt electric buses in various regions. In New South Wales, the government has allocated AUD3 million for the manufacturing of 1,200 zero-emission buses (ZEB) and the construction of the necessary charging infrastructure in Sydney and its surroundings. This effort also includes an additional AUD25 million for regional trials of electric and hydrogen fuel cell buses, thus supporting the transition to cleaner and more sustainable public transport. Additionally, the Government of Tasmania is promoting the transition to ZEB by funding trials of electric and hydrogen buses in the north and south of the state. The Government of Tasmania has set an ambitious goal to fully electrify its government fleet by 2030, which will contribute to an increase in the availability of EV in the second-hand market, benefiting local consumers'.[57]

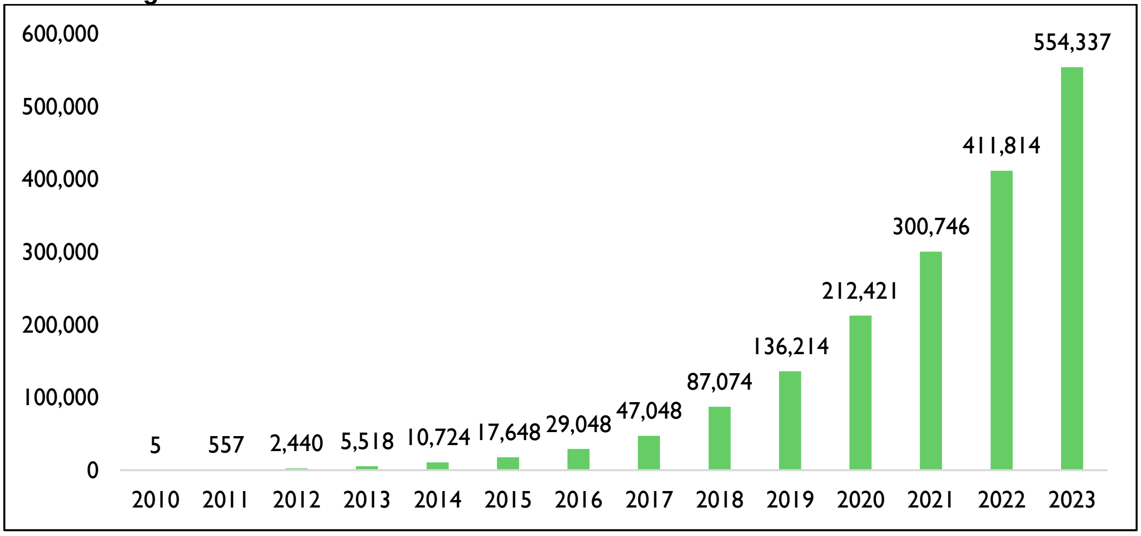
7.2.3. Canada

According to the "National Emissions Inventory of Canada", in 2019, total GHG emissions reached 730 MMT of CO_2 equivalent. Of this total, the transportation sector stood out as the second largest source of emissions, contributing 25% of the total. Although in 2019 Canada's total emissions were approximately 9 MMT of CO_2 equivalent lower than those recorded in 2005 were, emissions from the transportation sector have increased by 16% since that year[58].

According to the Global EV Outlook 2024, the EV fleet in Canada reached 554,337 units in 2023. The vast majority of these vehicles are cars, constituting 99.28% of the total. In contrast, trucks total 550,320 units, representing 0.43%. In third place are buses, with 1,600 units and a proportion of 0.06%. Finally, vans, with only nine units, represent a negligible 0.002% of the EV fleet. The following presents the evolution of the total EV stock in Canada from 2010 to 2023, highlighting the remarkable growth and diversification during this period.

Specifically, regarding the evolution of electric buses in Canada, there has been a notable increase in the number of units between 2018 and 2023. This increase, representing a variation of 83.21%, reflects the commitment and decisive actions towards the electrification of public transport in the economy (see Figure 24).

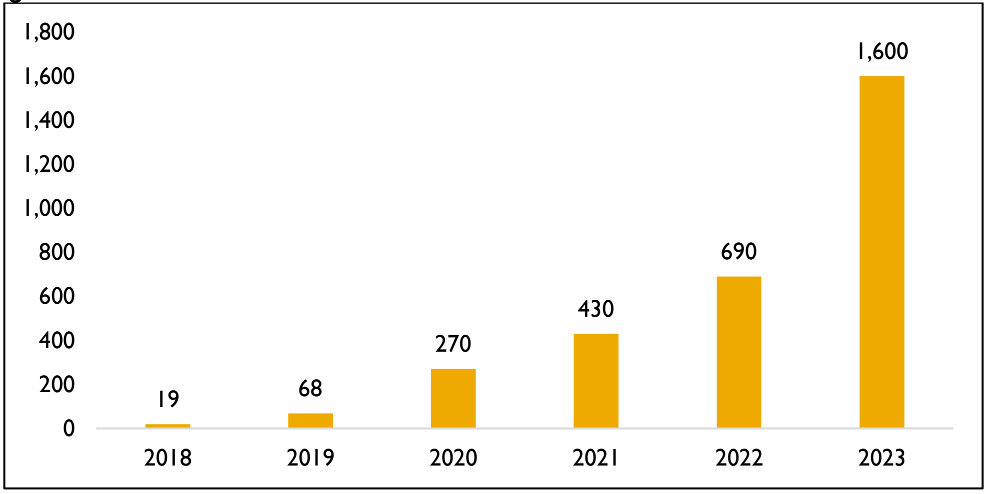
Figure 23. Evolution of the EV Stock between 2010 and 2023 in Canada



Source: Global EV Outlook 2024.

[57] Department of Climate Change, Energy, the Environment and Water (DCCEEW). (2023). National EV Strategy. Commonwealth of Australia. Available at https://www.dcceew.gov.au/sites/default/files/documents/national-electric-vehicle-strategy.pdf
[58] Government of Canada. (2022). 2030 Emissions Reduction Plan: Canada's Next Steps for Clean Air and a Strong Economy. Available at: https://publications.gc.ca/site/eng/9.909338/publication.html

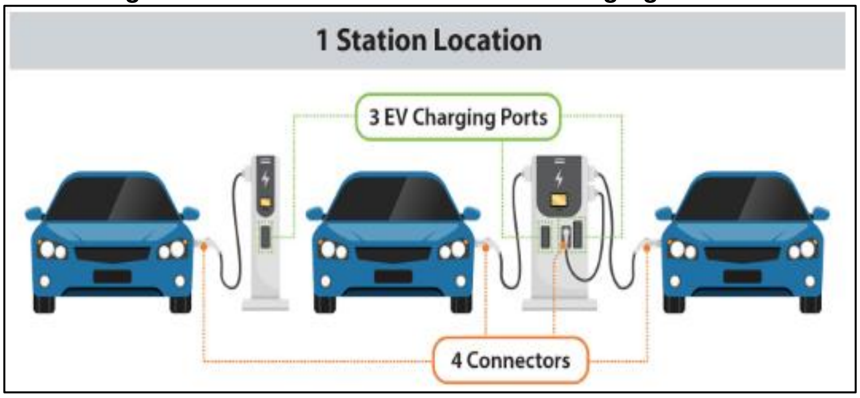
Figure 24. Evolution of the Electric Bus Stock between 2018 and 2023 in Canada



Source: Global EV Outlook 2024.

On the other hand, regarding the charging and refueling infrastructure in the Canadian economy, it is essential to understand its structure to properly assess its operational capacity. The technology employed and the number of charging points or ports are important factors in determining the performance of both public and private infrastructures. According to the operation of EV, the Canadian government presents in Figure 25 the components that make up the operational capacity and their interrelationship.

Figure 25. Structure of an Electric Charging Station



Source: Government of Canada (2024)

In 2024, the Government of Canada reported 12,674 charging stations available for various types of fuels, including natural gas, biodiesel, hydrogen, propane, electric power, among others. Specifically, electric charging infrastructure represents 94.51% of the total, with 11,978 stations and 30,352 charging ports. Of these, 1,934 stations and 5,297 charging ports are fast charging[59].

For its part, the types of connectors in the EV industry are of crucial importance. The availability and compatibility of connectors at charging stations determine better coverage in multifamily residential buildings, workplaces, public spaces, streets, and commercial fleets. Good diversified coverage is achieved by offering various types of connectors at the same station or by standardizing to a single type of connector. The current situation of connector distribution in the Canadian economy is shown in Figure ***26***.

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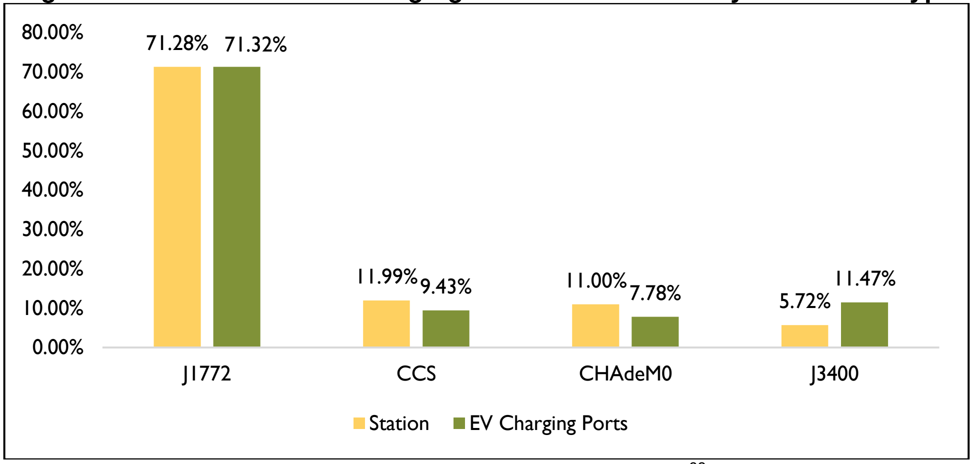
[59] Goverment of Canada. (2024). Zero-emission vehicle charging stations. Available at https://tc.canada.ca/en/road-transportation/innovative-technologies/zero-emission-vehicles/zero-emission-vehicle-charging-stations#/analyze?country=CA&ev_levels=all&fuel=ELEC&status=P&access=public&access=private

Figure 26. Distribution of Charging Stations and Ports by Connector Type



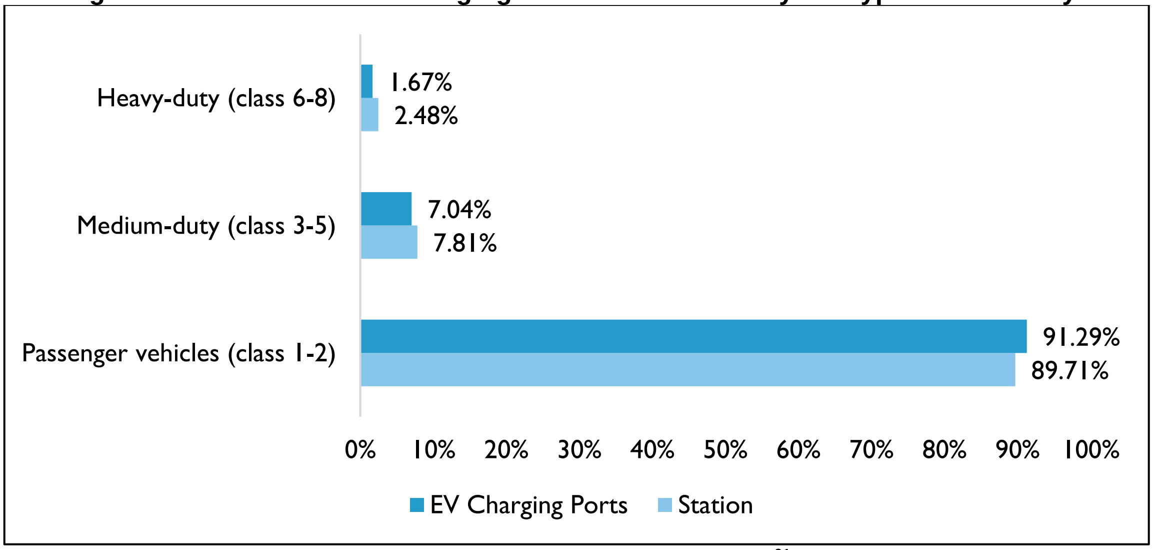
Source: Government of Canada (2024)[60]

Another way to measure the accessibility of charging and refueling stations is by evaluating their capacity to accommodate larger vehicles. Some stations have access limitations due to factors such as a low canopy, insufficient parking space adjacent to the pump, limited maneuvering space, or connector type as mentioned earlier. Accessibility options include the following:

- Accommodates passenger vehicles (Class 1-2).
- Accommodates medium-duty vehicles (Class 3-5).
- Accommodates heavy-duty vehicles (Class 6-8).

The distribution by type of accessibility is show below.

Figure 27. Distribution of Charging Stations and Ports by EV Type Accessibility



Source: Government of Canada (2024)[61]

7.2.4. Chile

The government of Chile considers the transition to electromobility in the economy an imperative necessity to address the environmental, economic, and social challenges this economy currently faces. The document titled "National Electromobility Strategy," developed by the Ministry of Energy of Chile, provides a solid foundation for the large-

[60] Ibid.
[61] Ibid.

scale adoption of EV. The fundamental benefits supporting this transition are outlined below.

One of the main motivations for adopting electromobility in the economy is the significant reduction of GHG emissions. In line with international commitments, Chile aims to reach its peak annual emissions by 2025 and reduce its total emissions to less than 1100 MMT of CO_2 equivalent between 2020 and 2030. Currently, the transportation sector is responsible for 25.5% of the economy's total GHG emissions, mainly due to the use of fossil fuels. Therefore, it is essential for this sector to actively contribute to this goal.[62] The adoption of EV is seen as a crucial strategy in the sector to meet environmental objectives. It is expected that the electrification of transport will contribute to a 20% reduction in the energy sector emissions by 2050[63].

In Chile, the operating and maintenance costs of EV are considerably lower compared to ICE vehicles. The document highlights that EV have lower maintenance costs, which can be reduced by up to 75% due to the fewer moving parts and the simplicity of their systems[64]. Additionally, the cost of electricity is significantly lower than that of fossil fuels, being approximately eight times lower per Km traveled. These operational savings are especially beneficial for high-mileage fleets, such as taxis and public transport, where EV can become the most cost-effective option even before reaching price parity with ICE.

Another crucial aspect of the transition to electromobility is the improvement in energy independence and security. Currently, Chile relies heavily on the importation of fossil fuels for the transportation sector. The electrification of transportation can reduce this dependence by harnessing the abundant renewable energy potential of this economy. Chile has a renewable energy potential of 2,375 GW, which is 70 times the current total installed capacity of the electric system[65]. This renewable resource can be used to power EV, reducing the need to import fossil fuels and strengthening energy security.

The “National Sustainable Mobility Strategy” envisions that by 2050, Chile will have transportation systems and urban development that together will enable equitable and sustainable mobility in cities. This progress will have minimal impact on negative externalities, especially in reducing GHG emissions. The use of more efficient and less polluting vehicles will be prioritized, contributing to a high quality of life, fostering sustainable economic development, and ensuring adequate levels of accessibility and safety for all citizens, regardless of their income level, age, gender or condition.

Particularly, the document “National Electromobility Strategy” estimates that the “My Electric Taxi " program will generate a 74% energy savings for taxis, by reducing nearly 4,000 liters of gasoline per vehicle per year[66]. Additionally, the document estimates that the incorporation of each electric bus in public transport will reduce CO_2 equivalent emissions by 60 Mt.

Regarding infrastructure, the availability of public chargers has seen significant evolution between 2011 and 2023 (See Figure 28). While in 2011, there was only one fast public charger and one slow charger, by 2023, these numbers reached a total of 330 and 740, respectively.

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[62] Ministry of Transport and Telecommunications of Chile. (2023). National Strategy for Sustainable Mobility (ENMS). Urban Road and Transport Program, with the support of the EUROCLIMA+ Project. Available at:: https://www.subtrans.gob.cl/wp-content/uploads/2022/11/Documento-oficial-ENMS-2023-SECTRA.pdf

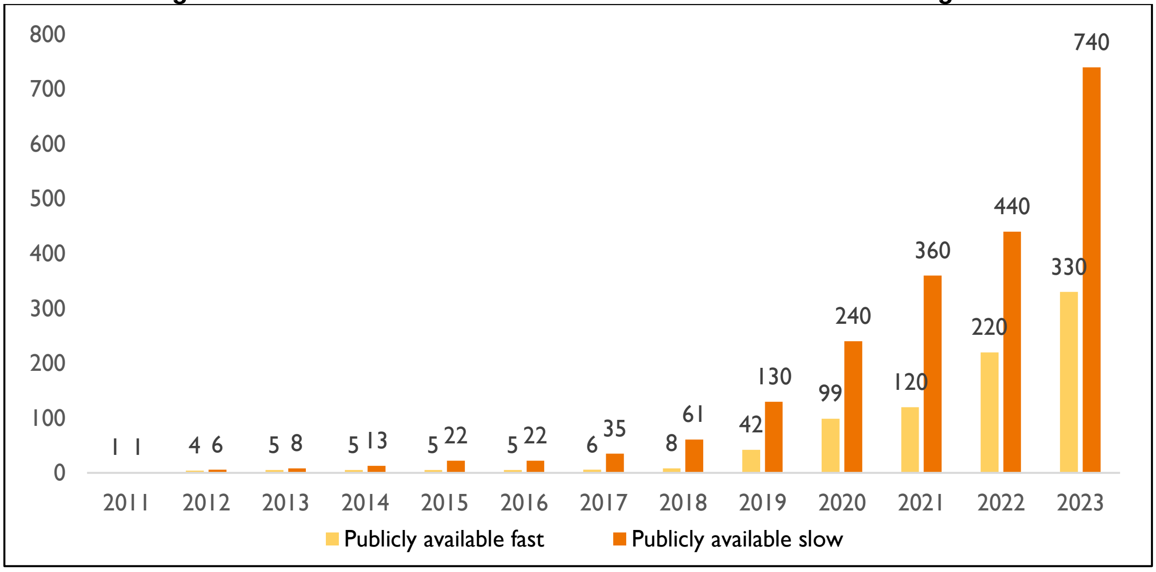
[63] Ministry of Energy, Government of Chile. (2022). National Electromobility Strategy. Santiago, Chile. Available at: https://energia.gob.cl/sites/default/files/documentos/estrategia_nacional_de_electromovilidad_2021_0.pdf. (p.14, 24)

[64] Ibid.

[65] Ibid.

[66] Considering that a taxi travels 70,000 Km per year.

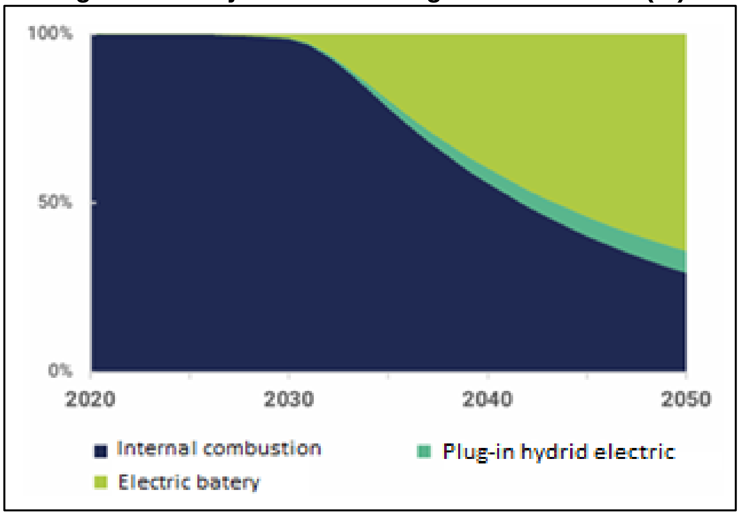
Figure 28. Evolution of the Stock of Fast and Slow Public Chargers



Source: Global EV Outlook 2024.

In the same way, according to the Electromobility platform of Chile[67], in April 2023, the EV fleet grew significantly, reaching 6,498 units in circulation. This includes 4,245 light and medium vehicles, 1,954 urban electric buses, 199 intercity buses, and 100 electric trucks in operation. By June 2024, the total number of electric buses had risen to 2,310 units, of which 2,267 units are located in the capital, Santiago; 30 units in Valparaíso; 10 units in Las Condes; and the remaining 3 units in La Reina[68].

Figure 29. Projection of the Light Vehicle Fleet (%)



Source: Ministry of Energy of Chile. (2022). National Energy Policy: 2022 Update.

Finally, Figure 29 shows the projection of the stock of EV and PHEV in the economy for the year 2050. This growing trend reflects the economy's commitment to reducing emissions and improving air quality in cities.

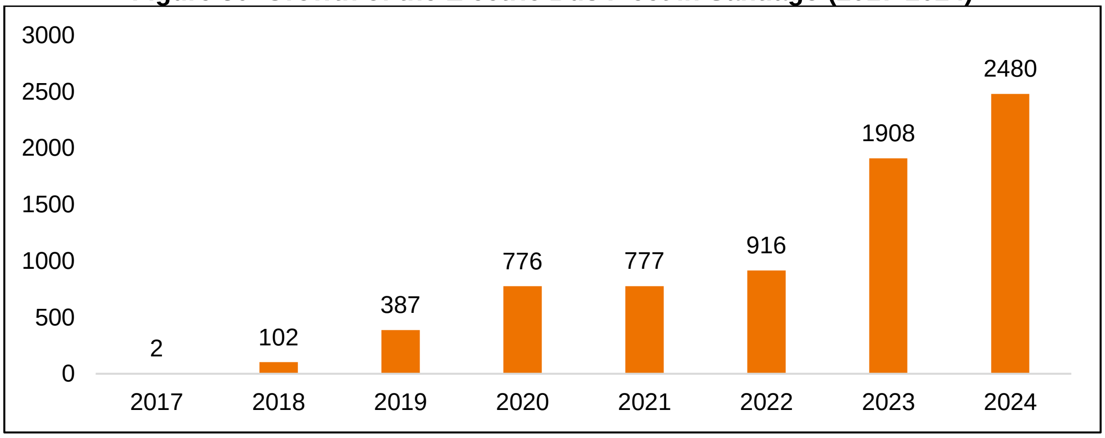
According to Steinmeyer, A. (2024) in his presentation titled "Normative Aspects of the Implementation of Electromobility in Santiago de Chile" delivered during the workshop "Electromobility Towards a Sustainable and Safe Mobility" in the first half of 2024, there has been a remarkable increase in the adoption of private vehicles powered by zero- and low-emission technologies, with a 106.4% rise in registrations, reaching a total of 7,268 units sold. This growth intensified even further in June, when 1,933 of these

[67] https://energia.gob.cl/electromovilidad/orientaciones-de-politicas-publicas
[68] E-Bus Radar. Electric Buses in Latin America. https://www.ebusradar.org/es/

vehicles were sold, representing a 125.8% increase compared to previous periods. These figures reflect a significant shift in consumer preferences toward more sustainable and less polluting transportation options, in line with global trends of emission reduction and environmental protection.

Regarding the adoption of electric buses, Steinmeyer, A. (2024) notes that Santiago de Chile has shown sustained growth in incorporating this type of bus into its public transport fleet. Currently, one-third of the buses in operation are electric. Since the introduction of the first two electric buses in 2017, the number of these vehicles has grown exponentially, reaching a total of 2,480 units in 2024 (See Figure 30). Projections indicate that by 2025, more than half of the city's bus fleet will consist of electric vehicles (over 3,500 buses), solidifying Santiago as a pioneering city in the implementation of low-emission technologies in the public transportation sector.

Figure 30. Growth of the Electric Bus Fleet in Santiago (2017-2024)

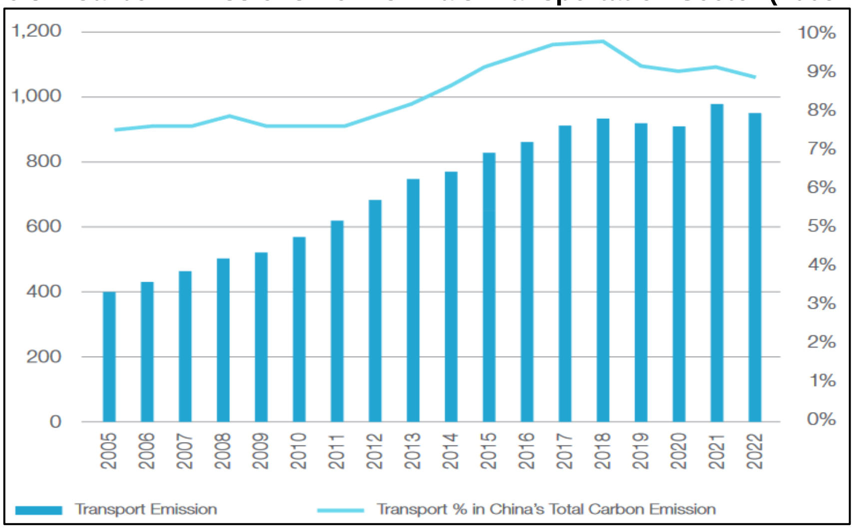


Source: Steinmeyer, A. (2024). Normative aspects of the implementation of electromobility in Santiago de Chile. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Lima Convention Center, San Borja, Lima, Peru.

7.2.5. China

The Figure 31 shows the carbon emissions from China's transportation sector from 2005 to 2022. In 2022, carbon emissions from China's transportation sector reached 946 MMT, representing approximately 9% of the total, of which about 3% came from passenger transport. This reflects the significant environmental impact of transportation and underscores the need for decarbonization initiatives in this sector.

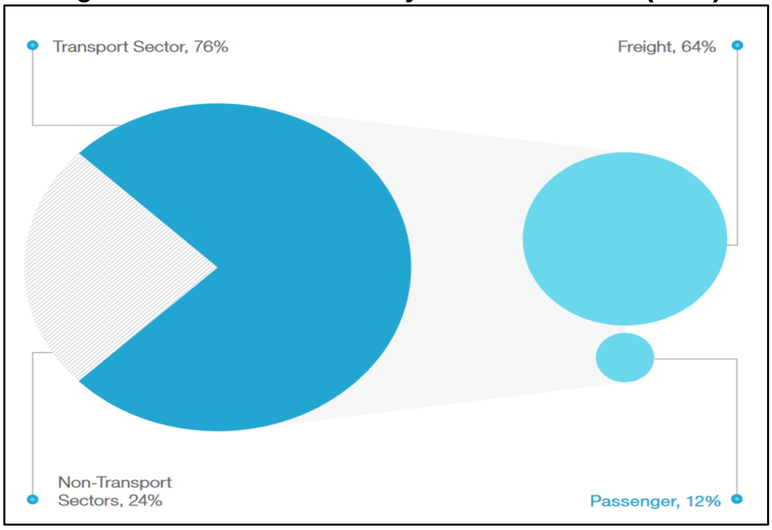
Figure 31. Carbon Emissions from China's Transportation Sector (2005-2022)



Source: Yin, L., Zheng, B., Wang, M., Gong, H., & Sun, X. (2023). China is racing towards zero emission transport: urban mobility beyond cars.

76% of the local NOx emissions come from the transportation sector, with freight transport contributing 64% and passenger transport 12%. Although passenger transport is not the main contributor to PM2.5 emissions at the local level, it does contribute 12% of NOx emissions, concentrated in cities with a combined population of 910 million inhabitants (See Figure 32). This highlights the importance of addressing NOx emissions in transportation to improve air quality and public health. Therefore, the transition to zero-emission urban mobility is crucial for China to achieve its pollutant emission reduction goals.

Figure 32. NOx Emissions by Sectors in China (2021)



Source: Yin, L., Zheng, B., Wang, M., Gong, H., & Sun, X. (2023). China is racing towards zero emission transport: urban mobility beyond cars.

Vehicle electrification in China is producing significant local benefits in terms of emission reductions and air quality improvement. According to the study "Synergy and co-benefits of reducing CO_2 and air pollutant emissions by promoting EVs—A case of Shanghai," [69] the adoption of EV has led to a considerable decrease in emissions of CO_2, CO, NOx, NMHC, and PM10. For example, in 2016, electric buses in Shanghai managed to reduce CO_2 emissions by nearly 48,851 Mt, accounting for 47.39% of the total CO_2 reduction from all types of EV in the city.

Moreover, the long-term operating costs of EV are significantly lower compared to internal combustion vehicles, with the total lifetime costs of a private electric car in Shanghai being only 10.53 yuan per 100 Km, compared to 47 yuan for a fuel vehicle. These findings demonstrate that the transition to EV is not only environmentally beneficial but also economically viable.

In a more specific context, the document "Health benefits of vehicle electrification through air pollution in Shanghai, China" (Zhang et al., 2024)[70] details how the adoption of EV in Shanghai has improved public health by reducing exposure to air pollutants. The study found that replacing an average ICE vehicle with an EV in Shanghai can offer an average economic benefit of USD6,400, mainly derived from the reduction in mortality associated with PM2.5. EV have approximately 20 times lower health impacts than ICE per 1,000 Km driven, resulting in significant public health benefits. Additionally, although electricity generation for these vehicles remains a challenge due to reliance on fossil fuel sources, EV still emit fewer GHG over their entire lifecycle compared to ICE.

[69] Alimujiang, A., & Jiang, P. (2020). Synergy and co-benefits of reducing CO_2 and air pollutant emissions by promoting EVs—A case of Shanghai. Energy for Sustainable Development, 55, 181-189. Available at: https://doi.org/10.1016/j.esd.2020.02.005.

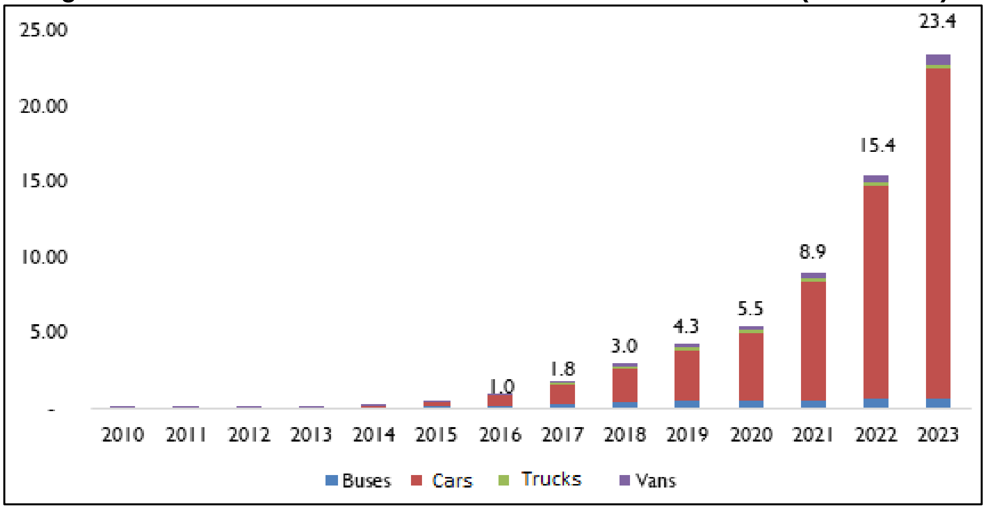
[70] Zhang, S., Jiang, Y., Zhang, S., & Choma, E. F. (2024). Health benefits of vehicle electrification through air pollution in Shanghai, China. Science of The Total Environment, 914, 169859. Available at: https://doi.org/10.1016/j.scitotenv.2023.169859. (p. 1)

These specific studies of Shanghai illustrate how the adoption of EV can have positive effects both locally and at a larger scale. While Shanghai sees direct benefits in reducing air pollutants and improving public health, more broadly, the adoption of EV significantly contributes to reducing fossil fuel dependency and mitigating climate change. This underscores the importance of continuing to support the transition to EV in China by promoting and implementing policies that incentivize their adoption and improving vehicle charging infrastructure to maximize these benefits.

China has consistently maintained a dominant position in the global EV market. In 2023, this economy accounted for approximately 60% of global EV sales, with a total of 8.1 million new registrations of electric cars. This represents a 35% increase compared to the previous year, highlighting the rapid growth and maturity of the Chinese EV market. Despite the overall Chinese automotive market experiencing an 8% contraction in conventional car sales, the EV sector grew by 5%, driving the overall growth of the automotive market in China[71].

In addition to annual sales, the accumulated stock of EV in China has reached very significant levels. By 2023, China had a total of 23.4 million EV in circulation, distributed among cars, buses, trucks, and vans. This stock includes 21.8 million electric cars, 643,600 electric buses, 311,200 electric trucks, and 684,400 electric vans. These numbers not only demonstrate the massive scale of EV adoption in China but also its leadership in the adoption of various types of EV (See Figure 33).

Figure 33. Global Trend of EV Stock between 2010 and 2023 (in millions)



Source: Global EV Outlook 2024.

The adoption of EV in China is not only limited to the domestic market; it has also strengthened its position as the world's largest EV exporter, with more than 1.2 million EVs exported in 2023, an 80% increase compared to the previous year. The main export destinations include Europe and various Asia-Pacific economies, such as Australia and Thailand.[72]

China has developed the largest electric vehicle charging infrastructure in the world, which has been a crucial factor in supporting the growth of the EV market. By the end of 2023, China had more than 3.2 million public and private charging points, with a significant focus on the installation of fast chargers.

[71] International Energy Agency. (2024). Global EV Outlook 2024: Moving towards increased affordability. IEA. Available at: https://www.iea.org/reports/global-ev-outlook-2024.
[72] International Energy Agency. (2024). Global EV Outlook 2024: Moving towards increased affordability. IEA. Available at: https://www.iea.org/reports/global-ev-outlook-2024

This massive expansion of charging infrastructure has facilitated the widespread use of EVs, eliminating one of the main barriers to their adoption. The ratio of public electric charging points per vehicle in China is one of the most favorable globally, with approximately one public charger for every 10 EVs. This contrasts with the global average and highlights China's commitment to providing convenient and extensive access to vehicle charging infrastructure[73].

China has also made significant advances in adopting EVs in public transportation and heavy-duty vehicles. In 2023, electric buses accounted for approximately 3% of total bus sales in China. Additionally, electric truck sales increased by 35% compared to 2022, representing about 3% of total truck sales.[74] These figures underscore China's efforts to promote EV adoption across not only private transportation but also the public transport and freight segments.

Despite these achievements, the path toward the mass adoption of EVs in China is not without challenges. Market consolidation and price competition are marking a new phase in China's EV industry, which could impact manufacturers and cost structures as the market matures.

7.2.6. Indonesia

Indonesia contributes approximately 3.5% of global GHG emissions. Between 2018 and 2020, the economy's emissions averaged 1,495 MMT of CO_2 equivalent annually, a high figure in absolute terms compared to similar economies[75].

In 2020, the use of liquid fuels for transportation in Indonesia generated 135,217 Gg of CO_2 equivalent, representing 23% of the total emissions from the energy sector.[76] It is estimated that the transportation sector contributes 21% of the GHG from fuel combustion in the economy, totaling 532 MMT that year. Additionally, 96% of the transportation sector's GHG emissions come from the road sector[77].

According to the document titled “Global EV Outlook 2024” [78] the EV fleet in Indonesia, in 2019, was less than 100 units. However, between 2020 and 2021, this figure increased to approximately 1,000 units. Subsequently, in 2022, annual sales skyrocketed to over 10,000 units, while. in 2023. they reached 17,000 units due to government purchase incentives.

To promote domestic manufacturing, the Indonesian government limited purchase incentives in 2023 to models with 40% local content. However, only two models (the Hyundai Loniq and the Wuling Air) met this criterion. This factor, along with rising interest rates, may have slowed the growth of the EV market[79].

Regarding electric buses and two and three wheeled vehicles, significant results have yet to be achieved. In 2023, there were only 100 electric buses in Indonesia, which had been imported from China and were operating in the city of Jakarta. However, the provincial government currently plans to add another 200 buses in 2024. Consequently, Indonesia seeks to increase domestic production of electric motorcycles, allocating

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[73] Ibid.
[74] Ibid.
[75] World Bank. (2023). Indonesia Country Climate and Development Report. Available at: https://www.worldbank.org/en/country/indonesia/publication/indonesia-country-climate-and-development-report
[76] ESTADOS UNIDOS Department of Agriculture, Foreign Agricultural Service. (2023). Indonesia Climate Change Report. https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Indonesia%20Climate%20Change%20Report_Jakarta_Indonesia_ID2023-0014.pdf
[77] Asian Transport Outlook. (2023). Indonesia E-mobility Country Profile. Available at: https://asiantransportoutlook.com/documents/67/Indonesia_20231002b.pdf
[78] International Energy Agency. (2024). Global EV Outlook 2024 [PDF]. Available at: https://iea.blob.core.windows.net/assets/a9e3544b-0b12-4e15-b407-65f5c8ce1b5f/GlobalEVOutlook2024.pdf
[79] Ibid.

USD455 million in subsidies to reach 800,000 new electric motorcycle sales and convert 200,000 conventional motorcycles. The Jakarta city government, in particular, aims to electrify its fleet of 10,000 buses by 2030, setting an ambitious goal towards more sustainable transportation.

Regarding electric transportation infrastructure, it is estimated that there are currently around 840 public charging stations in operation in Indonesia. In 2022, the installation of SPKLU experienced rapid progress, growing by more than 200% compared to the previous year. However, this development is not evenly distributed, with 88% of the total SPKLU concentrated in Jakarta and Bali. Nevertheless, by June 2023, it was announced that 616 EV charging stations and 1,401 SPBLKU had already been installed[80].

The transition to electromobility in Indonesia has been bolstered by its position as one of the world's leading nickel producers. According to the United States Geological Survey report[81], there has been a significant increase in demand for nickel sulfate due to the global ternary precursors of lithium-ion batteries (also known as Nickel-Manganese-Cobalt). In this context, Indonesia plays a crucial role in the global nickel market. In 2023, Indonesia's nickel production was estimated to reach 1.8 MMT, representing 50% of the world's total production. Additionally, the report mentions that Indonesia holds 55% of the world's nickel reserves, underscoring its strategic importance in supplying this vital mineral in the context of EV production[82].

Finally, it is important to highlight that the World Bank's modeling for Indonesia indicates that a vehicle fleet electrification strategy alone could show limited results in terms of emission reductions, due to the high proportion of coal in Indonesia's energy mix. This isolated approach achieves only a 2% reduction in GHG emissions by 2030 and 19% by 2040, as the power grid begins to decarbonize. However, when an electric mobility strategy is combined with urban mobility improvements, such as increasing the public transport share to 25% and implementing mass rapid transit systems, the emission reductions are much more significant, reaching 31% by 2030 and 38% by 2040[83]. This underscores the importance of developing a comprehensive sustainable mobility plan to achieve the economy's emission reduction goals.

7.2.7. Japan

Japan is the fifth-largest producer of CO_2 equivalent emissions in the world, playing a significant role in the fight against global warming. Additionally, this economy ranks eighth in per capita emissions worldwide. In 2020, this economy emitted approximately 1,044 MMT of CO_2 equivalent, representing a 20.8% decrease compared to 2013. The transportation sector contributed 17.7% of these emissions, equivalent to 185 MMT. Within this sector, passenger vehicles accounted for 48.4% of emissions (8.6% of the total), while trucks contributed 39.2% (6.9% of the total) of the economy's emissions[84]. In 2021, Japan's energy sector generated 988 MMT of CO_2 equivalent, representing 84.5% of the economy's total emissions, of which 18.7% came from the transportation sector[85]. Subsequently, in 2022, CO_2 equivalent emissions rose to 185,040 Kt of CO_2,

[80] Asian Transport Outlook. (2023). Indonesia E-mobility Country Profile. Available at: https://asiantransportoutlook.com/documents/67/Indonesia_20231002b.pdf

[81] U.S. Department of the Interior & U.S. Geological Survey. (2024). Mineral Commodity Summaries 2024. Available at: https://pubs.usgs.gov/periodicals/mcs2024/mcs2024.pdf

[82] U.S. Department of the Interior & U.S. Geological Survey. (2024). Mineral Commodity Summaries 2024. Available at: https://pubs.usgs.gov/periodicals/mcs2024/mcs2024.pdf

[83] World Bank. (2023). Indonesia Country Climate and Development Report. Available at:https://www.worldbank.org/en/country/indonesia/publication/indonesia-country-climate-and-development-report

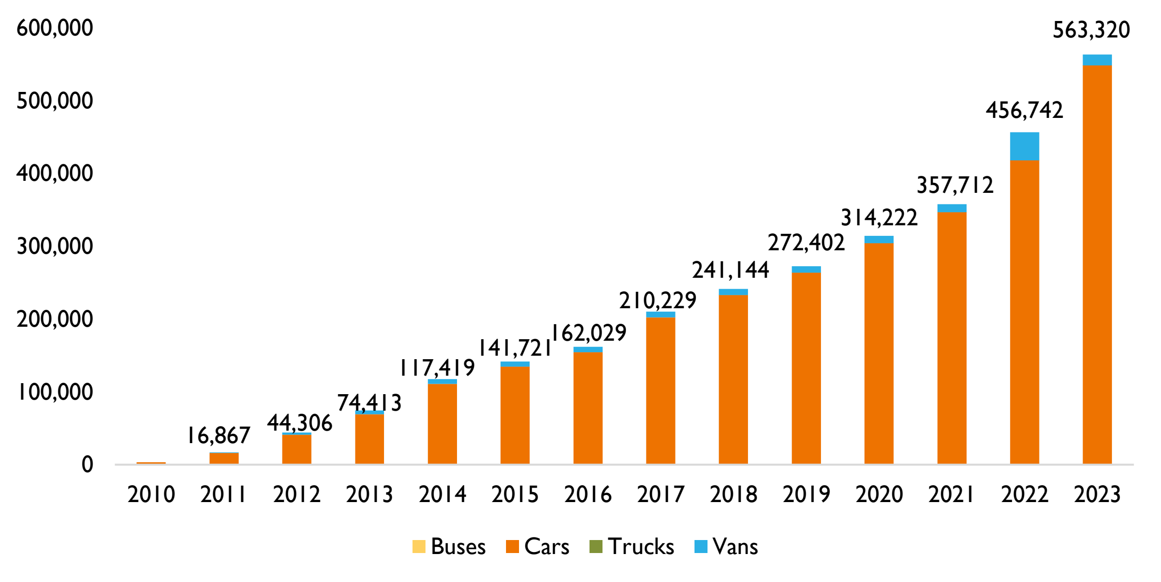
[84] Ecomo. (2023). 2024 - Transport and Environment [PDF]. Available at: https://www.ecomo.or.jp/english/pdf/tej2023.pdf

[85] Ministry of the Environment, Government of Japan. (n.d.). Japan's GHG Emissions and Absorptions in Fiscal Year 2021 (Final Figures). Available at: https://www.env.go.jp/en/press/press_01366.html

representing 16.3% of Japan's total GHG emissions (excluding LULUCF), with road transport accounting for 88.9% of emissions within the transportation category[86].

According to the Global EV Outlook (2024), Japan's EV fleet in 2024 reached a total of 563,320 units. Of this total, the vast majority are cars, representing 97.26%. Vans are in second place with 15,000 units, accounting for a significantly smaller proportion at 2.66% of the total. Buses are in third place with 270 units, making up 0.05%. Finally, trucks represent 0.03% of the total EV fleet with 150 units. Below is the evolution of the total stock from 2010 to 2023.

Figure 34. Evolution of the EV Stock between 2010 and 2023 in Japan



Source: Global EV Outlook 2024.

The evolution of the EV fleet in Japan is promoted by the "Green Growth Strategy through Achieving Carbon Neutrality by 2050". This comprehensive plan addresses both the electrification of transportation and the decarbonization of energy, due to the rapid change in the global automotive market. Since electrified vehicles require large amounts of electricity for charging and battery production, it is essential to have decarbonized and low-cost electricity. The strategy projects that renewable energy will remain the main source of electricity, while additional options such as nuclear energy, hydrogen, and carbon recycling are explored[87].

Japan's Green Growth Strategy aims to deploy 150,000 charging points by 2030, including 30,000 fast chargers, to achieve a level of convenience comparable to refueling conventional vehicles. In the APS, the number of charging points for LDV reaches 160,000 by 2030, of which approximately 55,000 are fast chargers. By 2035, the number of public charging points reaches 190,000 in the APS. The number of light EV per public charging point increases from around 18 in 2023 to more than 80 in 2035 in the APS[88]. Similarly, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) has implemented the Green Slow Mobility initiative, aimed at solving various transportation problems in local areas. This initiative seeks to ensure transportation services in regions with an aging population and to develop new forms of sustainable tourist mobility. Green Slow Mobility uses EV that can travel at speeds below 20 Km per hour on public roads, using energy generated from sustainable sources such as solar or wind, to achieve truly decarbonized transportation[89].

[86] Ministry of the Environment, Japan. (2024). National Greenhouse Gas Inventory Document of JAPAN. Available at: https://www.nies.go.jp/gio/en/archive/nir/pi5dm3000010ii0r-att/NID-JPN-2024-v3.0_gioweb.pdf
[87] Ecomo. (2023). 2024 - Transport and Environment. Available at: https://www.ecomo.or.jp/english/pdf/tej2023.pdf
[88] Global EV Outlook (2024)
[89] Ecomo. (2023). 2024 - Transport and Environment. Available at: https://www.ecomo.or.jp/english/pdf/tej2023.pdf

On the other hand, the Action Plan for the Implementation of a Low-Carbon Society in the Bus Sector aims to reduce CO_2 equivalent emission intensity by 6% by 2030 compared to 2015, promoting greater use of public transport buses. To achieve this, eco-driving is encouraged and these measures are intensified during the eco-driving promotion month. Additionally, the introduction of buses equipped with stop systems and digital recorders is promoted. The adoption of EV and high fuel efficiency vehicles is also promoted through government subsidy programs and the Nihon Bus Association[90].

Finally, the Japanese economy offers significant tax incentives to promote the adoption of eco-friendly vehicles, including a reduction or exemption from three vehicle taxes: the motor vehicle tonnage tax, the automobile acquisition tax, and the motor vehicle tax (ownership).

The vehicles eligible for these tax benefits include both high fuel efficiency internal combustion engines and EV, fuel cell vehicles, PHEV, natural gas vehicles, and clean diesel passenger vehicles. Additionally, different levels of subsidies are provided, with up to JPY400,000 for EV and fuel cell vehicles, up to JPY200,000 for PHEV, up to JPY150,000 for clean diesel vehicles, and up to JPY2.3 million for fuel cell vehicles. This plan also supports the deployment of charging infrastructure, thereby facilitating a broader transition to sustainable mobility[91].

7.2.8. Korea

Since 1990, emissions generated by road vehicles, including passenger cars, trucks, and buses, have been responsible for more than 87% of the total GHG emissions generated by the transportation sector in Korea. This figure increased to nearly 96% in 2017[92]. However, since 2018, the growth of emissions in the sector has experienced a significant slowdown. In 2021, these emissions represented only 18.5% of the 558.62 MMT of CO_2 equivalent derived from fuel combustion in the economy's energy sector. Korea is currently the eighth-largest CO_2 equivalent emitter in the energy sector worldwide.

According to the "Global EV Outlook 2024" report, Korea is the leading economy in terms of FCEV stock, representing about 40% of all FCEV, primarily due to its large passenger car fleet, which exceeded 33,000 units in 2023. This can be explained by the fact that Korea accounts for about 9% of the global capacity for manufacturing cathode active material and 20% of the installed capacity for lithium oxide[93].

On the other hand, in 2023, 543,900 EV were registered, representing a 39.51% increase compared to the number registered in 2022. This growth was complemented by an increase in the number of publicly accessible EV chargers. In 2022, the total number of chargers reached 194,081 units, of which 89.36% were slow chargers and the remaining 10.64% were fast chargers[94].

The Korean government, following the ratification of the Paris Agreement in 2016, has made the reduction of its GHG emission levels one of its main objectives. In this regard, in 2021, it enacted the Framework Act on Carbon Neutrality, which sets a minimum emission reduction target of 35% compared to the level recorded in 2018[95].

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[90] Ibid

[91] International Energy Agency. (n.d.). Tax Relief and Subsidies for Eco-Friendly Vehicles. IEA. Available at: https://www.iea.org/policies/13826-eco-car-tax-break-and-subsidies-for-vehicles

[92] The Government of the Republic of Korea (2020). 2050 Carbon Neutral Strategy. Available at: https://unfccc.int/sites/default/files/resource/LTS1_RKorea.pdf

[93] Global EV Outlook 2024

[94] Statista. EVs in the Republic of Korea. Available at: https://www-statista-com.up.idm.oclc.org/study/71107/electric-vehicles-in-south-korea/

[95] The Government of the Republic of Korea. Fourth Biennial Update Report

To achieve this goal, the government updated the emission reduction guidelines and targets by sector specified in the "NDC 2030" plan, which was first published in 2018. One of the key strategies for reducing emissions in the transportation sector consisted of increasing the number of eco-friendly vehicles. Therefore, the acquisition of at least 500,000 units of eco-friendly vehicles for commercial projects was planned, as well as the expansion of the EV and hydrogen stock to at least 4.5 million units by 2030[96].

Additionally, in 2021, the creation of the "2050 Carbon Neutrality" plan was also promoted, with the goal of achieving zero emissions in the transportation sector by 2050. One of the main mechanisms is to increase the fleet of clean vehicles, which will reach a total of 24.3 million vehicles, of which 18.8 million will be EV. Additionally, alongside this increase, the plan includes banning the emission of new combustion engine vehicles starting in 2040.

As a result of the gradual electrification of the fleet and the efficiency gains associated with it, by 2050, fossil fuel consumption in road transport will be reduced by approximately 407 terawatt-hours compared to levels recorded in 2020[97].

Finally, according to the study “Decarbonizing Road Transport in Korea: Role of EV Transition Policies,” by Yong-Gun Kim, Hyungwoo Lim, and Jeongeun Lee[98], it is expected that the transport sector, especially road transport which is currently responsible for sector pollution, will reduce at least 92% of GHG emissions by 2050. In this regard, the rapid adoption of clean vehicles will bring significant benefits to society by directly reducing GHG emissions in the transport sector. Additionally, it will promote the evolution of the industry due to the decreased demand for conventional fuels that will take place.

7.2.9. Malaysia

The transition to electromobility in Malaysia is essential to meet international commitments and address environmental and energy challenges. Malaysia is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC), having ratified the Kyoto Protocol in 2002 and the Paris Agreement in 2016. Under the Paris Agreement, Malaysia committed to reducing GHG emissions intensity by 45% of GDP by 2030, compared to 2005 levels. This includes an unconditional reduction of 35% and an additional 10% conditional on receiving climate finance, technology transfer, and capacity building from developed economies[99].

In 2017, Malaysia's final energy consumption reached 62,848 Kt of oil equivalent, an increase of 9.8% compared to the previous year. The transport sector was the second fastest-growing sector in terms of energy consumption, with a total consumption of 23,522 ktoe, representing 37% of the total consumption. This sector was also the second largest GHG emitter, contributing 20% of Malaysia's total GHG emissions in 2014. Of the total emissions, 18% corresponded to road transport[100]. The study "Low Carbon Mobility

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of the Republic of Korea. Available at: https://unfccc.int/sites/default/files/resource/1092386_Republic%20of%20Korea-BUR4-3-Fourth%20Biennial%20Update%20Report%20of%20the%20Republic%20of%20Korea_rev.pdf

[96] Proposal to Increase the National GHG Reduction Target for 2030 (NDC). Available at: https://climate-laws.org/documents/2030-national-greenhouse-gas-reduction-target-ndc-upgrade-plan_16ba?id=2030-national-greenhouse-gas-reduction-target-ndc-upgrade-plan_7c03

[97] Green Energy Strategy Institute. 2050 Climate Neutrality Roadmap for Korea K-Map Scenario. Available at: https://static.agora-energiewende.de/fileadmin/Projekte/2021/2021_04_INT_Korea_Map/K-Map_EN_final.pdf

[98] Kim, Y., Lim, H. & Lee, J. (2024). Decarbonizing road transport in Korea: Role of EV transition policies. Transportation Research Part D: Transport and Environment. 128. Available at: https://www.sciencedirect.com/science/article/pii/S136192092400041 5?ref=pdf_download&fr=RR-2&rr=89c454c688e8c2ba

[99] Malaysia Green Technology and Climate Change Centre (MGTC). (2021). Low Carbon Mobility Blueprint 2021-2030. Available at: https://www.mgtc.gov.my/wp-content/uploads/2021/11/Low-Carbon-Mobility-Blueprint-2021-2030.pdf

[100] Malaysia Green Technology and Climate Change Centre (MGTC). (2021). *Low Carbon Mobility Blueprint 2021-2030*. Available at: https://www.mgtc.gov.my/wp-content/uploads/2021/11/Low-Carbon-Mobility-Blueprint-2021-2030.pdf

Blueprint 2021-2030" estimated that electric buses can reduce GHG emissions by 48%[101] compared to diesel buses, providing a promising alternative for achieving substantial reductions in carbon emissions. The electrification of vehicles, including private cars and public buses, is crucial to mitigate these emissions. In this context, the plan projects the incorporation of 2,000 electric buses by 2030, which will significantly contribute to reducing the carbon footprint of the transport sector.

The government, in collaboration with the Ministry of Finance and existing dealers, is exploring methods to promote the acquisition of EV through subsidies and other incentives. The Canadian government is considering providing subsidies for the purchase of electric buses, similar to what other economies such as China (USD81,600 per bus), India (USD6,000 per bus), and Japan (USD19,000 per bus) are doing[102].

The lack of an adequate network of charging stations for EV constitutes one of the biggest challenges for users. In Malaysia, as in most economies, charging points are limited to specific locations. According to the Malaysian Automotive Association[103] (MAA), There are currently 611 public charging stations operating in major urban centers: Kuala Lumpur, Selangor, Penang, and Johor.

Regarding the types of charging stations, Malaysia has approximately 600 alternating current (AC) charging stations and only about twenty direct current (DC) stations. DC chargers are essential for mitigating range anxiety of EV, as they allow a full battery charge in less than an hour. On the other hand, AC chargers, which take between 3 and 8 hours, are more suitable for overnight charging. In Malaysia, AC chargers have a power output ranging from 3.7 to 22 kW and generally use a type 2 charger that complies with the international standards of the International Electrotechnical Commission (IEC)[104].

3.2.1. Mexico

Mexico faces significant challenges regarding mobility and transportation, similar to those faced by many other APEC economies globally. The continuous growth of urban areas and the increasing population have considerably increased the demand for efficient and sustainable transportation systems. The transition to electromobility in Mexico is driven by multiple reasons, including energy efficiency, the reduction of pollutant emissions, and economic and social benefits.

One of the main drivers of electromobility is the urgent need to reduce GHG and other pollutant emissions. Mexico, as a signatory of several international climate change agreements, is committed to reducing its emissions to mitigate global warming.

In 2021, Mexico's gross GHG emissions reached 714 MMT of CO_2 equivalent, representing 1.4% of the global total and positioning Mexico as the second-largest emitter in Latin America, surpassed only by Brazil[105]. According to the report "Emissions and Sources of GHG in Mexico 2024," prepared by Lara Ramírez and others, the transportation sector contributes significantly, being responsible for approximately 32% of total GHG emissions[106]. These emissions mainly stem from the combustion of fossil fuels, which not only exacerbate climate change but also deteriorate air quality in urban areas.

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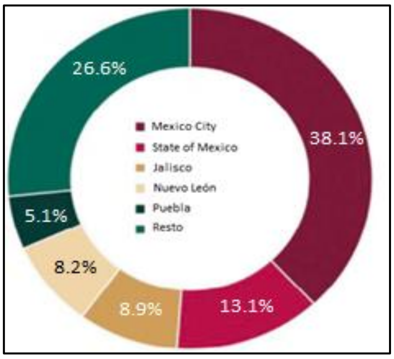
101 Ibid.
102 Ibid.
103 ICEX Spain Export and Investment. (2022). The EV Market in Malaysia 2022. Available at https://www.icex.es/content/dam/es/icex/oficinas/058/documentos/2022/12/estudios-de-mercado/EM_El%20mercado%20del%20vehiculo%20electrico%20en%20Malasia%202022.pdf
104 Ibid.
105 Lara Ramírez, M. A., & Li Ng, J. J. (2024). Mexico | Emissions and Sources of GHGs. BBVA Research. Available at: https://www.bbvaresearch.com/wp-content/uploads/2024/01/2024-Emisiones-y-Sources-GEI-Mexico.pdf (p.1).
106 Lara Ramírez, M. A., & Li Ng, J. J. (2024). Mexico | Emissions and Sources of GHGs. BBVA Research. Available at: https://www.bbvaresearch.com/wp-content/uploads/2024/01/2024-Emisiones-y-Sources-GEI-Mexico.pdf (p.5).

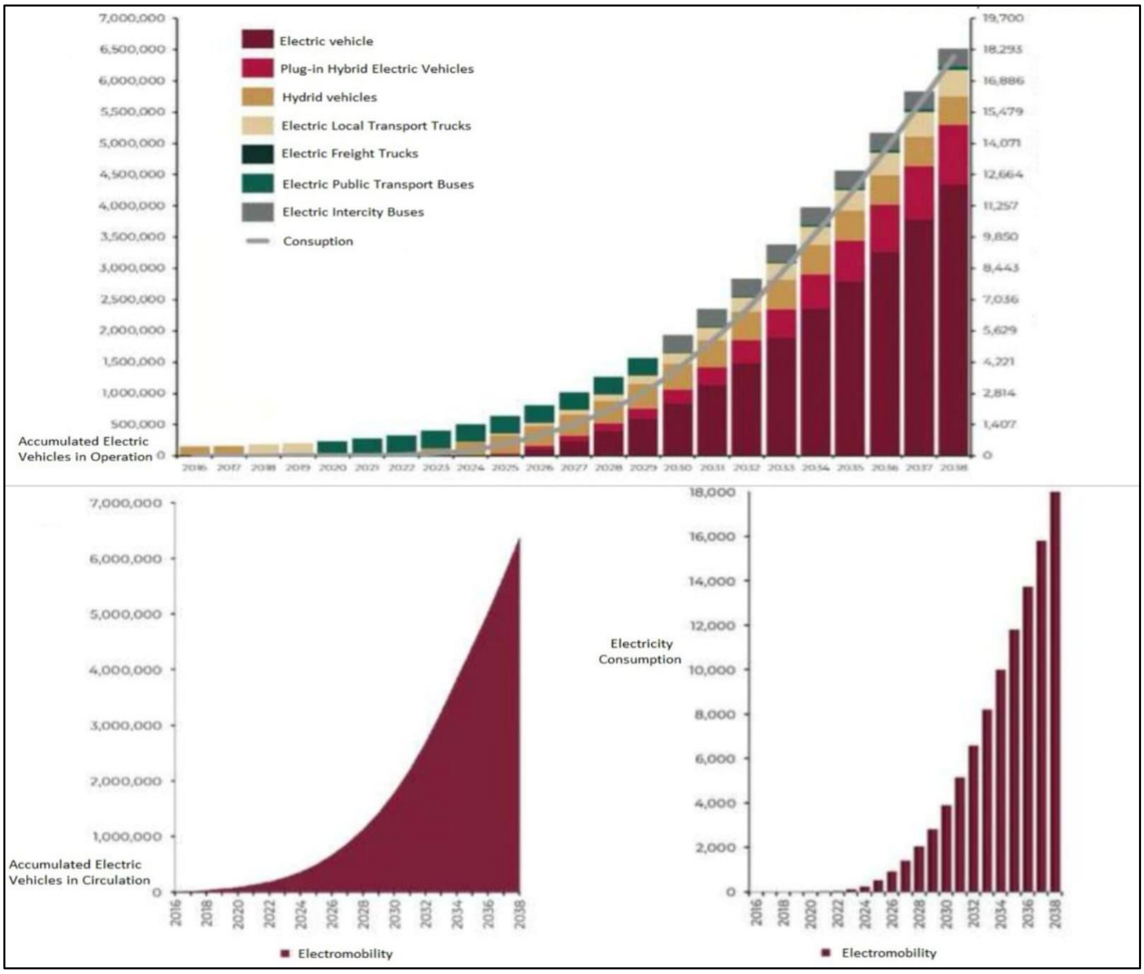
Another benefit of the transition to electromobility is the energy efficiency of EVs compared to ICE vehicles. According to the report titled "Electromobility Notebook in Mexico," EV can convert up to 85% of the energy stored in their batteries into movement, while internal combustion vehicles achieve an efficiency close to 30%[107]. This higher efficiency translates into lower absolute energy consumption and a significant reduction in vehicle operating costs.

Figure 35. Concentration of EVs in Federal Entities in 2023



Source: Ministry of Energy. (2024). National Electric System Development Program 2024-2038.

Figure 36. Evolution of EVs 2016-2038



Source: Ministry of Energy. (2024). National Electric System Development Program 2024-2038.

[107] Flores Hernández, A. S., & Tovar Paulino, I. (2023). Notebook on Electromobility in Mexico. National Commission for the Efficient Use of Energy (CONUEE). Available at: https://www.gob.mx/cms/uploads/attachment/file/857010/cuaderno_ELECTROMOVLIDAD_EN_M_XICO.pdf (p.3).

In 2023, 72,524 electric and hybrid vehicles were sold in Mexico, representing 5.3% of the total motor vehicles sold in the economy. This figure represents a significant increase of 42% compared to 2022, equivalent to an increase of 21,459 units[108]. The federal entities with the highest concentration of these vehicles were Mexico City, with 15,084 units; the State of Mexico, with 5,168 units; followed by Jalisco, Nuevo León, and Puebla, with 3,543, 3,256, and 2,005 units, respectively. These five entities concentrate 73.4% of EVs in the economy (see Figure **35**).

The following illustration presents the evolution of EV in Mexico from 2016 to 2038, projecting sustained growth in the adoption of these vehicles. **Error! Reference source not found.** highlights that by 2038, light, cargo, and bus EV are expected to reach a total of approximately 6.4 million units, representing 35.1% of motor vehicles marketed that year. The projected distribution for 2038 suggests that 70.3% will be EVs, 15.1% plug-in hybrid electric vehicles (PHEV), 7% hybrids, 6.7% light electric cargo vehicles, 0.8% electric buses, 0.01% heavy cargo trucks, and 0.04% long-distance electric buses (see **Error! Reference source not found.**).

Mexico has made significant strides in the implementation of electromobility, especially in the public transportation sector. Mexico City has been a prominent example in this effort. From the early electric streetcars to the modern trolleybus system, the electrification of public transport has been a key element. Recently, the city has renewed its bus rapid transit fleets, with Line 3 of the Metrobus achieving a significant reduction in pollutant emissions, ranging between 80% and 84%[109], thanks to the full adoption of EV.

Additionally, Mexico has developed a robust mass transportation infrastructure, which includes nine types of mass electric transport systems across its territory, as follows: i) Metrorrey Collective Transport System, ii) Urban Electric Train System, iii) My Electric Transport System, iv) Metro Collective Transport System, v) Light Rail Line, vi) Trolleybus Network, vii) Cable Car Network, viii) Suburban Train, and ix) Electric Metrobus Buses. Other major cities in Mexico have also implemented EVs in public transportation. For example, Guadalajara implemented the C98 route of "My Electric Transport" in 2021, the first fully electric bus route in this economy. Monterrey operates the Metrorrey Collective Transport System, which integrates electric solutions into its daily operations, and recently, in February 2023, inaugurated a fleet of 60 electric Metrobuses on Line 3 in Mexico City[110]. This diversified electric transportation network not only aims to reduce pollutant emissions but also seeks to improve energy efficiency in public transportation, in alignment with local goals to increase the proportion of clean energy in the energy matrix.

The impact of electromobility has also extended to taxi services and other forms of transportation in Mexico City. Initiatives such as the electric cycle taxis of Front of Alternative Collective Transport Organizations (FOTCA) and the 200 EVs of the company VEMO are transforming urban mobility, offering sustainable and efficient alternatives.

Regarding Mexico's charging infrastructure, shows a notable increase in the public availability of fast and slow chargers between 2015 and 2023. In 2015, there were only 83 slow chargers publicly available and 6 fast chargers. Over time, sustained growth is observed, reaching a total of 2,000 slow chargers and 76 fast chargers in 2023. The

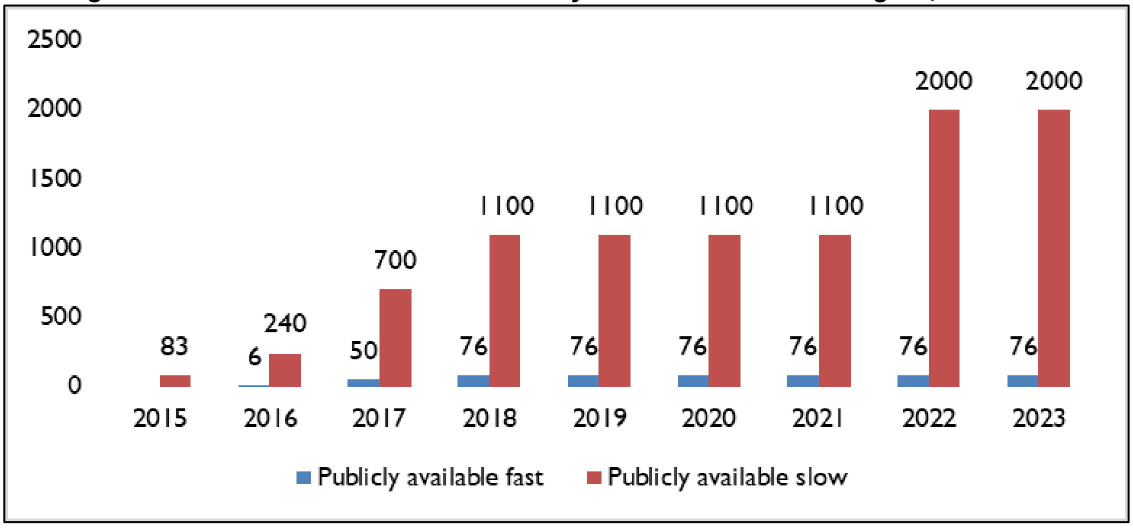
[108] Secretary of Energy. (2024). National Electrical System Development Program 2024-2038. Mexico: Official Gazette of the Federation. Available at: https://www.cenace.gob.mx/Docs/16_MARCOREGULATORIO/Prodecen//20%202024-2038%20Cap%C3%ADtulos%201%20al%206.pdf (p.43).

[109] Pineda, L., Jiménez, C., & Delgado, O. (2022). Strategy for the Deployment of Electric Fleet in Mexico City's Passenger Public Transport Corridor System 'Metrobús': Lines 3 and 4. International Council on Clean Transportation (ICCT). Avialable at: https://theicct.org/wp-content/uploads/2022/03/MexCity-ZEBRA-A4-v4-may22.pdf (p.32)

[110] National Commission for the Efficient Use of Energy (CONUEE). (2023). Infographic on Mass Electric Transport in Mexico. Available at: https://www.gob.mx/cms/uploads/attachment/file/812358/Infograf_a_Transportes_El_ctricos_Masivos_en_M_xico.pdf

Special Climate Change Program (PECC) 2021-2024 projects the installation of approximately 21,799 charging stations by 2038[111], underscoring the economy's commitment to the transition towards more sustainable mobility.

Figure 37. Evolution of Public Availability of Fast and Slow Chargers, 2015-2023



Source: Global EV Outlook 2024.

According to Hernandez-Nochebuena, M. A. (2024) in his presentation titled "Incentives for Electromobility" delivered during the workshop "Electromobility Towards a Sustainable and Safe Mobility," charging infrastructure is a fundamental pillar for the development of electromobility in Mexico. The economy has made significant progress in this area, with approximately 2,089 charging stations installed by 2023, and an expected increase of 50% to 70% by 2024, reaching between 3,000 and 3,500 stations.

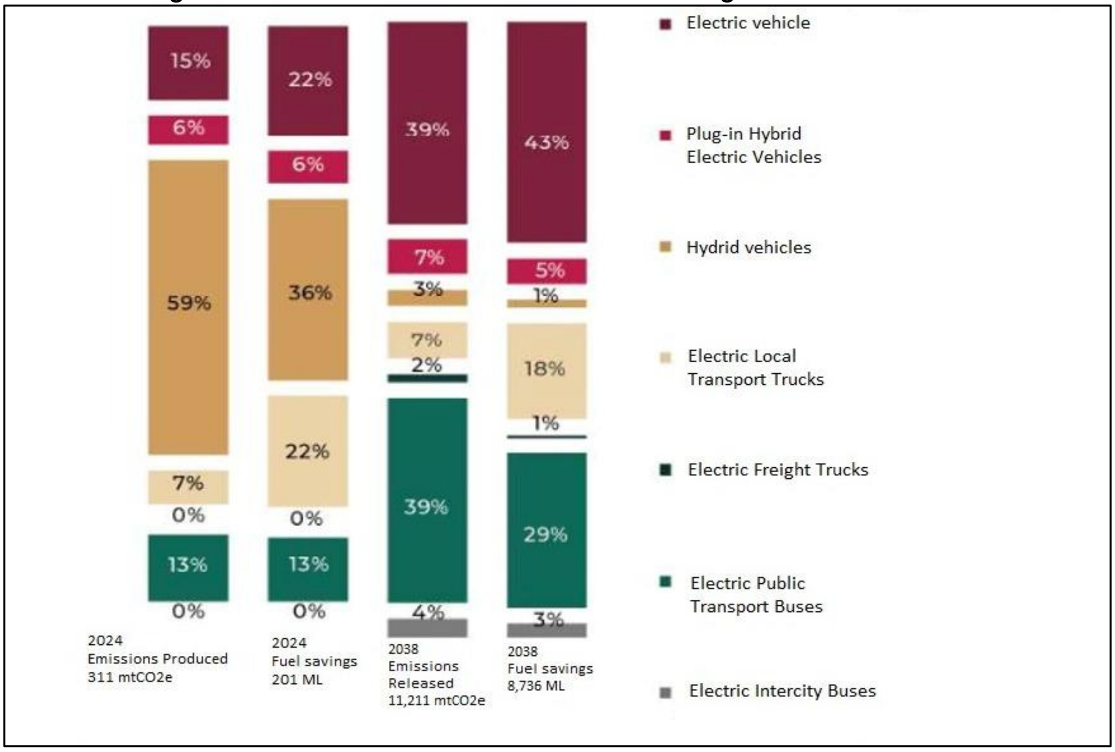
According to PRODESEN, the impact of electric mobility between 2024 and 2038 is reflected in the total emissions avoided, which will increase from 311 thousand Mt of CO_2 equivalent to 11,211 $MtCO_2e$. In terms of fuel savings, an increase from 201 million liters in 2024 to 8,736 million liters in 2038 is projected. The following figure shows these projections, highlighting the contribution of different types of electric and hybrid vehicles.

Figure 38 presents the emissions avoided and fuel savings for the period 2024-2038. In 2024, it is estimated that EV will avoid 15% of emissions, PHEV 6%, and hybrid vehicles 7%. The largest percentage of emissions avoided will come from electric local transport trucks (CTLE) at 59%. By 2038, EV are expected to avoid 43% of emissions, PHEV 5%, and HVs 18%. Additionally, electric local transport trucks will continue to be a significant source of emission reductions at 29%.

In terms of fuel savings, in 2024 it is projected that EVs will contribute 6%, PHEV 6%, and HVs 13%, with a total of 201 million liters saved. By 2038, EVs are expected to save 3%, PHEV 1%, and HVs 4%, reaching a total of 8,736 million liters saved.

[111] Ministry of Energy. (2024). National Electric System Development Program 2024-2038. Mexico: Official Gazette of the Federation. Available at: https://www.cenace.gob.mx/Docs/16_MARCOREGULATORIO/Prodecen//20%202024-2038%20Cap%C3%ADtulos%201%20al%206.pdf (p.72).

Figure 38. Emissions Avoided and Fuel Savings in 2024 and 2038



Source: Secretariat of Energy. (2024). National Electric System Development Program 2024-2038.

7.2.10. New Zealand

According to the Ministry for the Environment of New Zealand, in 2022, the transport sector accounted for 49.90% of total emissions from fuel combustion. Additionally, of the total road transport emissions, 47.54% corresponded to the use of cars, 30.63% to heavy trucks and buses, 21.49 % to light trucks, and 0.33% to motorcycles[112].

As a result, the New Zealand Ministry of Transport reports that annually harmful emissions result in the premature death of more than 2,200 New Zealand adults, over 9,200 hospital admissions for respiratory and cardiac diseases, more than 13,200 cases of childhood asthma, and social costs of USD10.5 million. Although diesel vehicles constitute only 23% of the vehicle fleet, they are responsible for 82% of the damage due to their high levels of nitrogen oxide and particulate emissions. These pollutants cause respiratory and cardiovascular damage, contribute to smog, and can cause lung cancer and asthma[113].

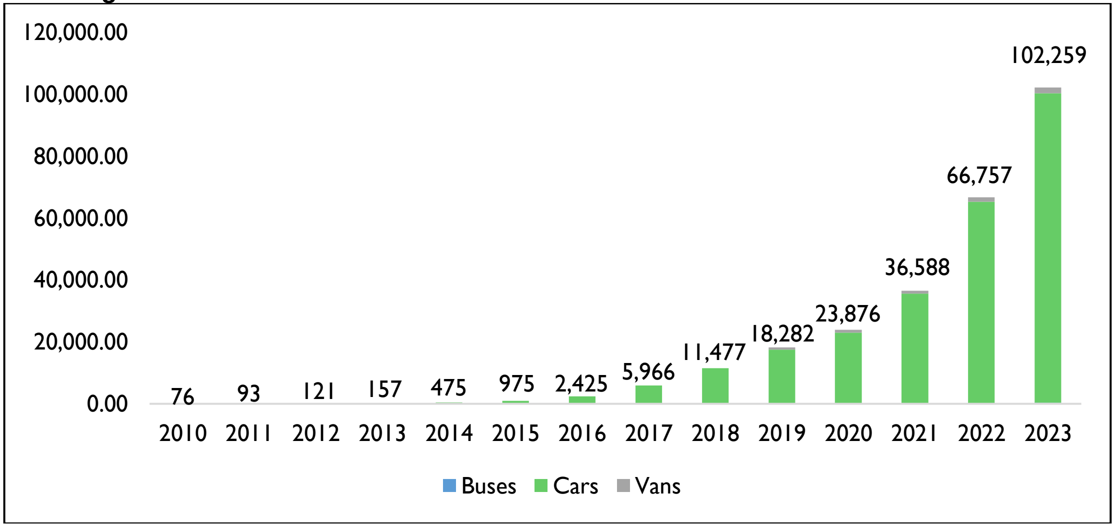
According to the Global EV Outlook (2024)[114], the EV fleet in New Zealand reached a total of 120,259 units in 2023. Of this total, the overwhelming majority are cars, representing 97.81%. Second are trucks with 550,320 units, although with a significantly lower proportion of 0.43%. Third are vans (1,888 units) with a proportion of 1.85%. Finally, buses (351 units) represent 0.34% of the total EV fleet. The following figure shows the evolution of the total stock from 2010 to 2023.

[112] New Zealand Ministry for the Environment. (n.d.). New Zealand's Greenhouse Gas Emissions Tracker. Environment.govt.nz. Available at: https://emissionstracker.environment.govt.nz/#NrAMBoCZQXXYCM4BEA5ApgF2XYkqiSS4CcKOMQA

[113] New Zealand Ministry of Transport. (n.d.). Reducing noxious vehicle emissions from road transport. Transport.govt.nz. Available at: https://www.transport.govt.nz/area-of-interest/environment-and-climate-change/reducing-noxious-vehicle-emissions-from-road-transport

[114] International Energy Agency. (2024). Global EV Outlook 2024. Available at: https://iea.blob.core.windows.net/assets/a9e3544b-0b12-4e15-b407-65f5c8ce1b5f/GlobalEVOutlook2024.pdf

Figure 39. Evolution of the EV Stock between 2010 and 2023 in New Zealand



Source: Global EV Outlook 2024.

The evolution of the EV fleet in New Zealand towards electromobility is driven by the Transport Decarbonization Action Plan 2022-25, which aims to reduce GHG emissions from the transport sector by 41% by 2035. The plan, supported by USD1.1 million from the Climate Emergency Response Fund (CERF), includes three key actions: i) Car-free mobility, which focuses on improving public transport, increasing safe routes for pedestrians and cyclists, and reducing the need for travel, with the goal of reducing light vehicle Km traveled by 20% by 2035, ii) Transition to ZEV, which promotes the adoption of low-emission vehicles, improves charging infrastructure, and removes polluting vehicles, with the goal of achieving 30% zero-emission vehicles in the light vehicle fleet by 2035 and iii) Low-emission freight and heavy transport, which develops an efficiency and emission reduction strategy, supports rail and maritime transport, and adopts low-emission trucks and buses, with the goal of reducing freight transport emissions by 35% by 2035. The ERP outlines 77 actions to achieve these objectives and reduce transport emissions by 41% by 2035[115].

Currently, New Zealand's economy has several favorable conditions to benefit from EV due to the following factors. Firstly, more than 80% of its electricity comes from renewable sources, ensuring a sufficient supply for widespread EV adoption. Secondly, over 85% of households have off-street parking, facilitating home charging. With a low average trip, urban drivers travel only 22 Km per day, a distance easily covered by current EV batteries[116].

Finally, there are regulatory foundations that can be used as incentives for replacing ICE vehicles with EV. The 2017 Energy Innovation Amendment Act amended the 1998 Land Transport Act to empower RCA to draft bylaws identifying EV as a vehicle class that can access special vehicle lanes. These changes also required modifications to regulations related to road users and traffic control devices. The RCA, in consultation with communities, has the final decision on the opening of special lanes for EV[117].

The regulatory amendments have included the addition of a definition of EV as "a motor vehicle whose motive power is derived wholly or partly from an external source of electricity." The definition of special vehicle lanes, such as bus and transit lanes, was

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[115] New Zealand Ministry of Transport. (n.d.). Public transport decarbonization. Transport.govt.nz. Available at: https://www.transport.govt.nz/area-of-interest/public-transport/public-transport-decarbonisation

[116] NZ transport Agency. New Zealand Transport Agency. (n.d.). EVs. NZTA.govt.nz. Available at: https://www.nzta.govt.nz/vehicles/vehicle-types/electric-vehicles/

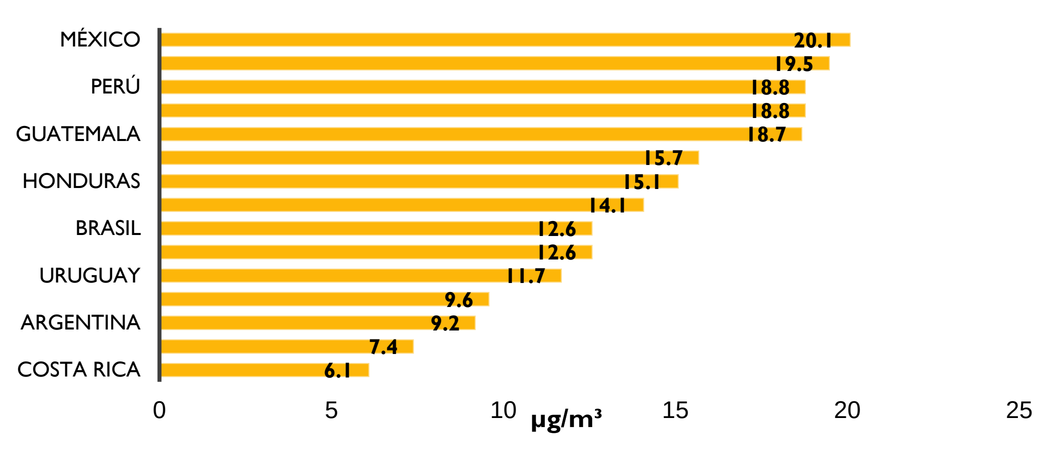
[117] New Zealand Government. (2017). Energy Innovation (EVs and Other Matters) Amendment Act 2017. Legislation.govt.nz. Available at: https://www.legislation.govt.nz/act/public/2017/0027/latest/DLM7005010.html

also amended to include EV, and the application of bus traffic signals was extended to EV. Additionally, the necessary markings and signs were created to notify road users if an EV can use special vehicle lanes[118].

7.2.11. Peru[119]

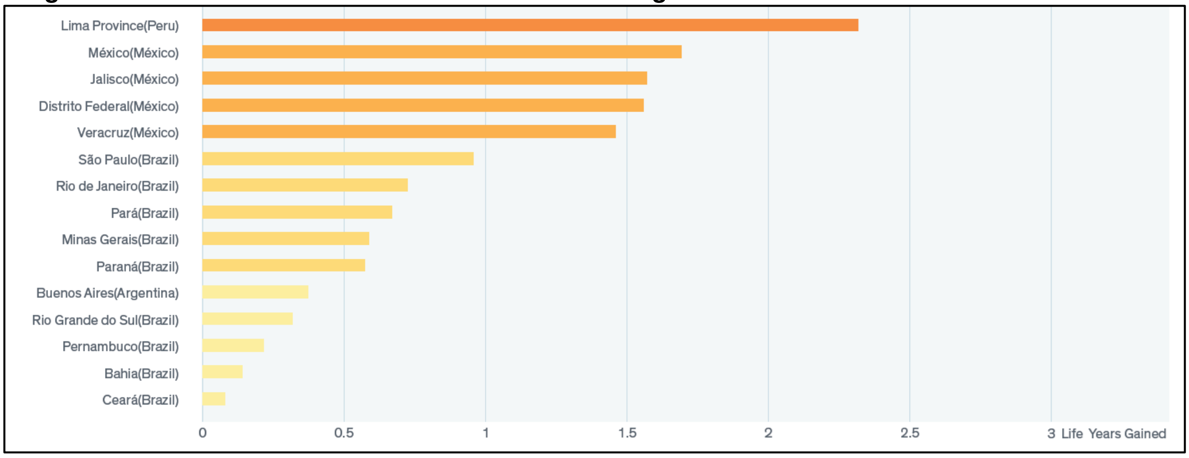
According to Guerrero, N. (2024) in his presentation titled "Electric Mobility in Peru: Challenges and Opportunities Towards a Sustainable Future," delivered during the workshop "Electromobility Towards a Sustainable and Safe Mobility," the 2023 air quality report highlights the alarming situation in several key APEC economies regarding the average concentration of PM2.5, a dangerous pollutant to health. Mexico leads the ranking in Latin America with an average concentration of 20.1 µg/m³, closely followed by Peru and Chile with 19.5 and 18.8 µg/m³, respectively, underscoring the severity of the problem in these economies. These elevated pollution levels have a direct impact on the health of urban populations, particularly in densely populated cities where exposure to PM2.5 is persistent.

Figure 40. World Air Quality Report: Latin America (Average PM2.5 Concentration)



Source: Guerrero, N. (2024). *Electric Mobility in Peru: Challenges and Opportunities Towards a Sustainable Future*. Workshop *"Electromobility Towards a Sustainable and Safe Mobility,"* Lima Convention Center, San Borja, Lima, Peru.

Figure 41. Gain in Life Years in Latin American Regions Due to Air Pollutant Reduction



Source: Guerrero, N. (2024). *Electric Mobility in Peru: Challenges and Opportunities Towards a Sustainable Future*. Workshop *"Electromobility Towards a Sustainable and Safe Mobility,"* Lima Convention Center, San Borja, Lima, Peru.

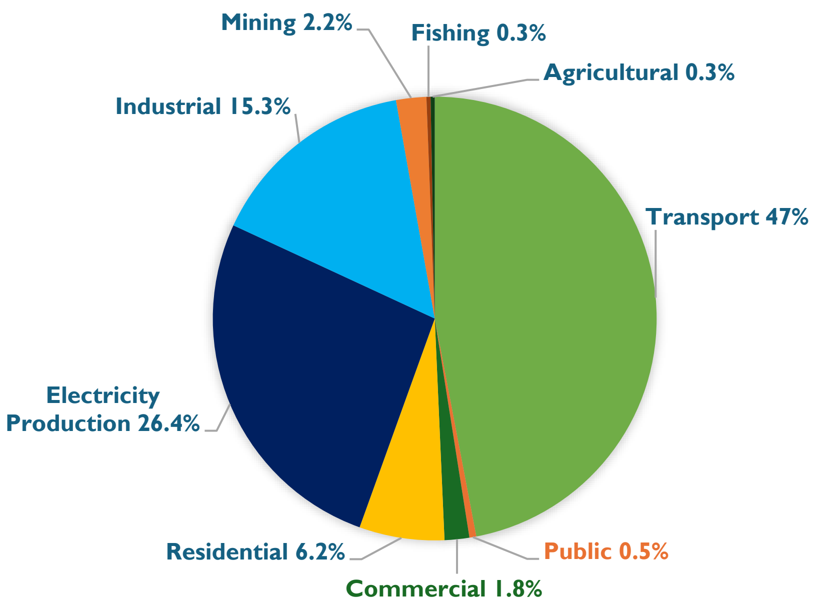
[118] Ibid.
[119] The data shown for this economy have been extracted from the following document: Supervisory Agency for Investment in Energy and Mining (Osinergmin). (2019). Electromobility: Concepts, Policies, and Lessons Learned for Peru. Lima: Osinergmin. Available at: https://cdn.www.gob.pe/uploads/document/file/1306300/Electromovilidad.%20Conceptos%2C%20pol%C3%ADticas%20y%20lecciones%20aprendidas%20para%20el%20Per%C3%BA..pdf?v=1600463826

On the other hand, the air quality-related life expectancy index shows that reducing PM2.5 levels to the standards recommended by the WHO could result in a significant increase in life expectancy in regions like Lima and Mexico City. In Lima, for instance, it is estimated that residents could gain up to 2.5 additional years of life, while in several regions of Mexico, the gain would also be considerable (approximately 1.5 years).

This situation reflects an urgent need to adopt measures to improve air quality in these economies, focusing on emission reduction policies and transitioning to cleaner technologies in transportation and other key sectors. The electrification of transportation and the implementation of sustainable solutions are fundamental strategies for mitigating these environmental risks and improving public health in the region.

The transportation sector represents the greatest challenge in terms of CO2 emissions in Peru, accounting for 47% of CO2 equivalent emissions, according to the "2022 National Energy Balance" from the Ministry of Energy and Mines (MINEM)[120]. This situation highlights the urgency of focusing efforts on mitigating emissions from transportation, one of the main sources of pollution in the economy. Compared to other sectors such as electricity production (26.4%) and industry (15.3%), transportation ranks as the largest source of emissions, emphasizing the need to implement electrification strategies and transition towards cleaner technologies in this sector.

Figure 42. Participation of sectors in CO2 equivalent emissions



Source: Guerrero, N. (2024). *Electric Mobility in Peru: Challenges and Opportunities Towards a Sustainable Future*. Workshop *"Electromobility Towards a Sustainable and Safe Mobility,"* Lima Convention Center, San Borja, Lima, Peru.

According to the 2019 report by the Supervisory Agency for Investment in Energy and Mining (OSINERGMIN), in Lima and Callao, 81% of daily trips are made using public transport. However, only a small fraction of these trips use more integrated mass transit systems, such as Metro Line 1, the Metropolitano, and road corridors, which account for 2.31%, 4.50%, and 3.20% of total trips, respectively. Although they represent a small proportion of the total, these systems have shown greater potential to integrate sustainable electric transportation solutions.

[120] Guerrero, N. (2024). *Electric Mobility in Peru: Challenges and Opportunities Towards a Sustainable Future*. Workshop "*Electromobility Towards a Sustainable and Safe Mobility,*" Lima Convention Center, San Borja, Lima, Peru.

The general situation of transport companies in the city of Lima contributes to PM2.5 levels that are three times higher than the standards recommended by the WHO. The transportation sector is one of the largest contributors to air pollution in Peru, directly responsible for 19% of GHG emissions.

Measures taken since 2018 have been fundamental in the adoption of more sustainable transport technologies. On 8 June 2018, the Ministry of Energy and Mines (MINEM) announced the creation of a regulatory framework to promote the adoption of EVs and hybrids. This effort, led by the Directorate of Energy Efficiency of MINEM and the Nationally Appropriate Mitigation Actions (ANAM) Project, with funding from the Global Environment Facility (GEF), established the necessary legal framework to facilitate the entry of these technologies into the Peruvian market. The main objectives include the promotion of infrastructure for the widespread use of electric transport and the implementation of pilot programs with electric buses and light vehicles.

To support this growth, MINEM organized the I Congress of Electromobility in Lima on 6 September 2018, formalized by Ministerial Resolution No. 297-2018-MEM/DM. This event brought together public and private institutions, as well as international experts, to foster information exchange and promote the EV industry in Peru.

Recognizing the need to update regulations to support the integration of new technologies, on 13 September 2018, the MTC began developing a regulatory framework to facilitate the inclusion of EV in public transportation. The next day, the Ministry of Production announced plans to introduce electric mototaxis in cities like Lima, Moyobamba, Pucallpa, and Iquitos. These vehicles, by converting traditional engines to electric, promise to significantly reduce operating costs. For example, in Pucallpa, the company Ecoenergy SAC has demonstrated that the recharging cost of an electric mototaxi ranges between PEN3.00 and PEN4.50, compared to PEN20 or PEN32 for traditional fuel refueling. Additionally, an electric mototaxi from Ecoenergy SAC can travel over 130 km on a single charge and reach speeds of up to 60 km/h.

On 23 September 2018, a milestone was reached with the launch of the first fully electric public transport bus in San Isidro, Lima. This bus is part of the Pilot Plan of the MiBus Project, a collaboration between the Municipality of San Isidro and Engie Peru. Powered by 30kW photovoltaic solar panels, the bus avoided more than ten Mt of CO_2 equivalent emissions in its first month of operation.

On 14 December 2018, the Peruvian government advanced in modernizing the vehicle fleet by amending the National Vehicle Regulations (NVR) to include electric cars and pedal-assist bicycles. This measure promotes the adoption of vehicles with innovative and energy-efficient technologies and establishes the implementation of a National Vehicle Homologation System to ensure that models meet environmental and energy efficiency standards.

In 2019, the expansion of electromobility continued with the presentation of the first fully electric bus for the mining industry by Engie Peru on 26 April. This bus, designed to operate in diverse and harsh conditions, traveled the route between Lima and Cajamarca, passing through Chimbote and Trujillo, demonstrating that electric transport is viable in both urban and rural areas. With a range of 280 km per charge and operating costs 87% lower than conventional buses, this vehicle underscores the efficiency and versatility of electric technology.

On 29 April 2019, BYD and ETUL launched the first electric bus on a commercial route in Lima, covering the route from San Juan de Lurigancho to Chorrillos. This bus, the BYD K9G electric bus model, with a capacity for 80 passengers, travels 240 km daily and transports more than 21,600 passengers monthly.

Finally, on 31 May 2019, the company Taxi Directo began operating the first electric taxis in Lima. These vehicles offer significant advantages in terms of reduced maintenance and operating costs. For example, the monthly maintenance cost of an electric taxi is approximately PEN50, much lower than the PEN250 to PEN500 spent on conventional cars. Additionally, for a 200 km trip, an electric taxi consumes only PEN5 in electricity, compared to PEN50 in gasoline, PEN25 in LPG, or PEN20 in CNG.

According to Guerrero, N. (2024), in his presentation titled "Electric Mobility in Peru: Challenges and Opportunities Towards a Sustainable Future," delivered during the workshop "Electromobility Towards a Sustainable and Safe Mobility," he stated that the development of electric charging infrastructure regulations has begun. The first step was Supreme Decree No. 022-2020-EM, which approved provisions on charging infrastructure and the supply of electricity for electric mobility, establishing an initial regulatory framework. Additionally, Supreme Decree No. 036-2023-EM introduces a regulatory framework for the installation, adaptation, and operation of charging infrastructure, emphasizing the need to continue developing new regulations that facilitate the entry and expansion of electric mobility in the economy. These measures are crucial to ensuring that charging infrastructure is aligned with technological advances and market needs, thus driving the transition towards more sustainable transportation in Peru.

Furthermore, various Peruvian Technical Standards (NTP) have been implemented based on international standards, such as NTP-IEC 61851-1:2020, which regulates the conductive charging system for EV. Other standards, such as NTP-IEC 62196-1:2020 and NTP-IEC 62196-2:2020, focus on vehicle connectors, sockets, and power inlets, all of which are essential components for the safe and efficient charging of EV.

7.2.12. Russia

In 2021, Russia; the United States; Brazil; China; India; Indonesia; and the European Union were the largest global GHG emitters. Together, including international transport emissions, these emitters generated a total of 33 Gt CO_2 equivalent, representing 65% of global emissions. Specifically, Russia contributed 5% of the global emissions in the same year[121].

In 2022, Russia's energy sector annual CO_2 emissions amounted to 1613.3 MMT, representing a reduction of 46.7 MMT compared to 2021. This resulted in a decrease in the proportion of global emissions represented by Russia, which fell to 4.45%[122]. In 2021, GHG emissions from transport accounted for 10.6% of those generated by the energy sector in the Russian economy.

Additionally, according to the Ministry of Internal Affairs of the Russian Federation, between 2018 and 2023, there was a notable increase in the number of EV in Russia, but the growth dynamics were very uneven. In 2018, there were 20 484 electric cars in Russia, a number that increased to 26,665 in 2019, more 1,3 times. However, the real surge occurred in 2021, with the EV fleet growing more than 3,78 times compared to 2019, reaching 100,929 EV. In 2022, the EV fleet in Russia reached 157,812 EV.

In accordance with the Federal Law on "Strategic Planning in the Russian Federation"[123]the Government of the Russian Federation developed and approved a "Concept" for the development of the production and use of vehicles in the Russian

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[121] United Nations Environment Program (2023). Emissions Gap Report. Available at: https://wedocs.unep.org/handle/20.500.11822/43922;jsessionid=A135C5CACB8C14CD222F73BCF66762F4

[122] Ritchie, H. & Roser, M. (2020). Russia: CO_2 country profile. Our World in Data. Available at: https://ourworldindata.org/co2/country/russia

[123] Government of the Russian Federation (2021). Available at: http://static.government.ru/media/files/bW9wGZ2rDs3BkeZHf7ZsaxnlbJzQbJJt.pdf

Federation until 2030. The concept is a sectoral planning framework aimed at establishing regulatory, investment, infrastructural, and technological conditions to ensure the competitiveness of EV transport and its components produced in Russia. Through these conditions, the government aims to advance on several fronts to achieve its goal regarding the development of EV production and use in the economy[124].

The tasks proposed in the "Concept" document include the development of a production base in Russia for manufacturing EV, strengthening the technological competencies of local automotive equipment and component manufacturers through greater localization of production, introducing innovative electric mobility products to the market to stimulate demand and establish after-sales services, and creating the necessary engineering and transportation infrastructure in the economy. Additionally, the aim is to eliminate existing regulatory barriers that limit the use of EV[125].

In this regard, the implementation of the mentioned tasks is divided into two strategic stages. The first stage (2021-2024) focuses on the production of at least 25,000 EV and the installation of 9,400 charging stations, including at least 2,900 fast charging stations. The second stage (2025-2030) has even more ambitious goals, aiming for EV to represent at least 10% of the total volume of vehicles produced. Additionally, the proposal includes the start of production of traction battery cells, cathode and anode materials, the installation of 72,000 charging stations (including 28,000 fast charging), the establishment of 1,000 hydrogen refueling stations, and the creation of 39,000 specialized jobs throughout the entire technological production chain of EV within the economy[126].

7.2.13. Singapore

The transition to electromobility in Singapore is a strategic measure with multiple environmental, economic, and social benefits. One of the most significant benefits is the reduction of CO_2 equivalent emissions. According to the Land Transport Authority of Singapore (LTA), if all light vehicles in Singapore were electric, between 1.5 and 2 MMT of carbon emissions would be reduced, representing approximately 4% of the total emissions[127].

Additionally, the Ministry of Transport of Singapore[128] mentions that driving an electric car more than halves the carbon footprint compared to driving a similar ICE car. Moreover, EVs are less polluting and quieter, contributing to a more pleasant living environment. This is because EVs do not emit exhaust gases and operate with efficient electric motors, significantly reducing air pollution and noise in urban areas. This change not only helps combat climate change but also improves quality of life by reducing exposure to harmful pollutants and decreasing environmental noise.

The report "E - MOBILITY - Technology Roadmap" highlights that the electrification of vehicles in Singapore, including private cars, taxis, and public buses, can drastically reduce CO_2 equivalent emissions. For instance, replacing conventional buses with electric buses can decrease emissions by up to 56% per vehicle. Furthermore, in the proposed high-electrification scenario, EVs are projected to reduce emissions by 30% by 2050 compared to the business-as-usual scenario[129]. These reductions are crucial for

[124] Ibid.
[125] Ibid
[126] Ibid
[127] Land Transport Authority (n.d.). Our EV vision. Land Transport Authority. Available at: https://www.lta.gov.sg/content/ltagov/en/industry_innovations/technologies/electric_vehicles/our_ev_vision.html
[128] Singapore Ministry of Transport. (n.d.). EVs. In Ministry of Transport. Available at: https://www.mot.gov.sg/what-we-do/green-transport/electric-vehicles
[129] National Climate Change Secretariat (NCCS). (2020). E-MOBILITY Technology Roadmap. Available at: https://www.nccs.gov.sg/files/docs/default-source/default-document-library/e-mobility-technology-roadmap.pdf (p.2).

meeting Singapore's sustainability goals and improving air quality in the urban environment.

The shift to electromobility is also justified by the ability to integrate renewable energy sources, such as solar power, to fuel the EV fleet. The document "E – MOBILITY - Technology Roadmap" prepared by the Land Transport Authority indicates that with the integration of photovoltaic (PV) energy, emissions from the EV fleet can be further reduced by up to 64% compared to the business-as-usual scenario[130]. This integration not only supports Singapore's clean energy goals but also leverages opportunities for new energy storage and management technologies, such as using vehicle batteries to store surplus energy and thereafter feed energy back into the grid, known as vehicle-to-grid (V2G).

Regarding the electrification of public transport, the LTA is firmly committed to transitioning to a greener bus fleet. The LTA aims to electrify half of the bus fleet by 2030 and achieve a 100% clean energy bus fleet by 2040. This ambitious plan has begun with the deployment of 60 electric buses[131] and the replacement of 400 diesel buses with electric ones by 2025. With the incorporation of these 60 electric buses, an annual reduction of approximately 7,840 Mt of CO_2 emissions is expected, equivalent to the annual emissions of 1,700 passenger cars. Additionally, taxi fleet operators have also committed to electrifying their fleets, aiming for at least half of the total taxi fleet to be electric by 2030[132].

As shown in Table 3, which displays the distribution of vehicles by fuel type, there is a growing trend in the total number of greener vehicles, such as hybrids and EVs, in the segments of cars, taxis, and freight vehicles.

Among the main data highlighted in the table for the year 2023 are the following:

- The stock of electric cars[133] in Singapore was 92,575, representing 14.21% of the total number of cars in the economy.
- The stock of electric taxis [134] in Singapore was 10,755, representing 78.96% of the total number of taxis in the economy.
- The stock of electric buses [135] in Singapore was 292, representing 1.64% of the total number of buses in the economy.
- The stock of electric freight vehicles[136] in Singapore was 3,370, representing 2.34% of the total number of freight vehicles in the economy.

The analysis of vehicle distribution by fuel type between 2018 and 2023 shows a notable increase in the adoption of EVs, including hybrids and PHEV. In 2018, there were 28,140 electric cars (summing pure electrics and various forms of hybrids), a figure that increased to 92,575 in 2023. Electric buses, for their part, increased from 27 units in 2018 to 292 in 2023. This significant growth indicates a transition towards more sustainable transport options.

Table 3. Motor Vehicle Population by Type of Fuel Used

End of Period (Year)		2018	2019	2020	2021	2022	2023
Cars	Petrol	569,673	574,967	568,376	568,376	558,729	540,605
	Diesel	17,253	18,049	18,076	18,136	18,261	18,037

130 Idem.
131 40 of these electric buses use plug-in charging, while 20 use pantograph chargers. Available at: https://evreporter.com/wp-content/uploads/2022/10/Singapore-EV-Landscape_2022_EVreporter.pdf
132 Land Transport Authority (n.d.). Our EV vision. Land Transport Authority. Available at: https://www.lta.gov.sg/content/ltagov/en/industry_innovations/technologies/electric_vehicles/our_ev_vision.html
133 The definition of an electric car also includes hybrid vehicles (petrol-electric and diesel-electric).
134 The definition of an electric taxi also includes hybrid vehicles (petrol-electric and diesel-electric).
135 The definition of an electric bus also includes hybrid vehicles (petrol-electric and diesel-electric).
136 The definition of an electric cargo vehicle also includes hybrid vehicles (petrol-electric and diesel-electric).

End of Period (Year)		2018	2019	2020	2021	2022	2023
	Petrol-Electric	27,179	35,718	41,845	54,820	65,882	79,256
	Petrol-Electric (PHEV)	380	473	552	692	1,101	1,359
	Petrol-CNG	386	250	202	164	143	85
	CNG	-	-	-	-	-	-
	Electric	560	1,120	1,217	2,942	6,531	11,941
	Diesel-Electric	21	19	18	20	19	18
	Diesel-Electric (PHEV)	-	-	-	-	1	1
	Total	615,452	630,596	634,042	645,150	650,667	651,302
Taxis	Petrol	53	24	21	15	9	5
	Diesel	15,089	9,759	6,508	4,951	4,012	2,860
	Petrol-Electric	5,337	8,626	9,117	9,617	9,661	10,284
	Petrol-CNG	-	-	-	-	-	-
	CNG	-	-	-	-	-	-
	Electric	102	133	32	304	402	471
	Total	20,581	18,542	15,678	14,887	14,084	13,620
Motorcycles	Petrol	136,840	140,396	140,781	141,589	142,433	143,218
	Electric	2	2	1	5	115	270
	Total	136,842	140,398	140,782	141,594	142,453	143,488
Goods & Other Vehicles	Petrol	4,879	5,109	5,816	9,096	11,447	12,213
	Diesel	136,478	135,773	134,860	134,527	131,623	128,381
	Petro-Electric	1	1	1	2	2	4
	Petrol-CNG	2	1	-	-	-	-
	CNG	2	2	2	1	1	-
	Electric	39	71	97	387	1,894	3,338
	Diesel-Electric	7	7	7	11	17	24
	Total	141,408	140,964	140,783	144,024	144,984	143,960
Buses	Petrol	33	18	14	42	97	135
	Diesel	18,875	19,248	18,798	18,353	17,538	17,406
	Petrol-CNG	-	-	-	-	-	-
	CNG	12	-	-	-	-	-
	Electric	4	10	50	75	151	242
	Diesel-Electric	23	50	50	50	50	50
	Total	18,947	19,326	18,912	18,520	17,836	17,833

Source: Annual Vehicle Statistics 2023[137]

In comparison, gasoline and diesel vehicles have experienced a slight decline, suggesting a shift in consumer preference towards greener vehicles.

In its commitment to sustainability, Singapore has set ambitious targets for the adoption of "Cleaner Energy Vehicles." The primary goal is that by 2040, 100% of vehicles in the economy will operate on cleaner energy technologies, including EVs, hybrids, hydrogen fuel cell vehicles, among others. EV in particular produce less than half the emissions of

[137] Land Transport Authority. (2024). Annual Vehicle Statistics 2023. Motor vehicle population by fuel type used. https://www.lta.gov.sg/content/dam/ltagov/who_we_are/statistics_and_publications/statistics/pdf/MVP01-4_MVP_by_fuel.pdf

a vehicle with an internal combustion engine, highlighting their importance in the economy's decarbonization strategy. To achieve this goal, Singapore has implemented regulatory measures such as the ban on registering new internal combustion engine cars and taxis from 2030 and diesel cars and taxis from 2025, as well as the installation of 60,000 charging points across the island by 2030, in tandem with EV adoption[138].

In its effort to have 100% of vehicles powered by cleaner energy by 2040, Singapore is promoting the adoption of EVs across all land transportation segments, although progress has been uneven across different modes of land transport.
In the taxi sector, major operators have committed to electrifying their fleets, supported by the expansion of fast chargers in public residential hubs to facilitate electrification. In the case of motorcycles, Singapore is taking a more conservative approach due to safety concerns, particularly regarding fires during charging in high-rise residences. As a result, safer operations such as battery swapping in controlled sandboxes are being developed to balance safety and accessibility. For buses, Singapore has committed to electrifying half of its public transport fleet by 2030, by progressively replacing diesel buses reaching the end of their life cycles. For heavy freight vehicles, this sector presents significant decarbonization challenges, but Singapore is exploring a variety of technologies, including hydrogen fuel cells and electrification, with the aim of identifying viable solutions suited to the industry's needs[139].

Additionally, the Singaporean government has led efforts to upgrade electrical infrastructure and deploy charging points in public residential facilities. Currently, half of the carparks in these areas are already equipped with chargers, and the goal is for all public residential towns to have EV charging points by the end of 2025. This effort ensures that residents of public housing have access to a robust and reliable charging infrastructure, which is crucial for the widespread adoption of EV in Singapore[140].

7.2.14. Chinese Taipei

The government of Chinese Taipei has demonstrated a significant commitment to reducing GHG emissions. As a result, its public policies have managed to decouple economic growth from GHG emissions since 2005 (see Figure 43). While GDP has increased by 64%, net GHG emissions have decreased, and the GHG emission intensity (CO_2 equivalent/GDP) has been reduced by 34%. This progress suggests a transition towards a more sustainable economic model, where growth does not result in a proportional increase in pollutant emissions[141].

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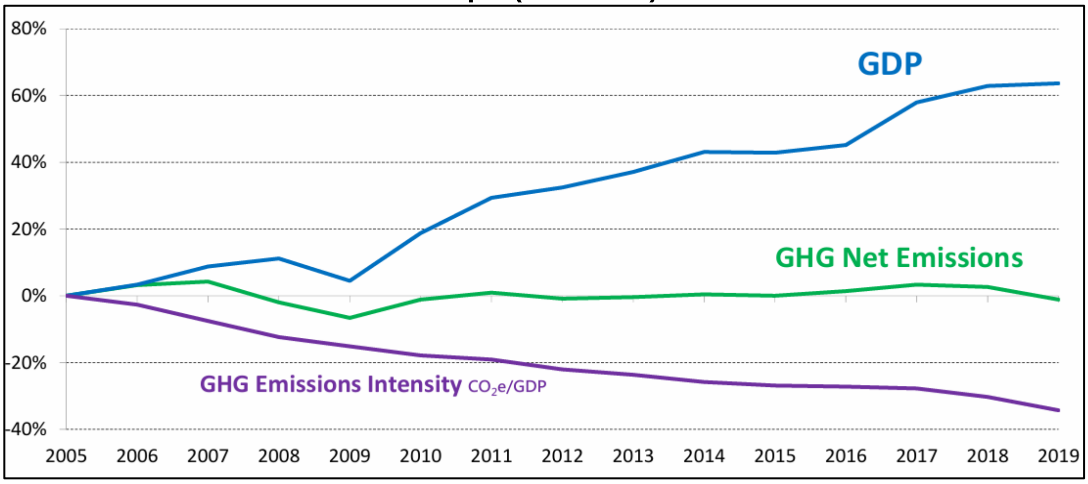
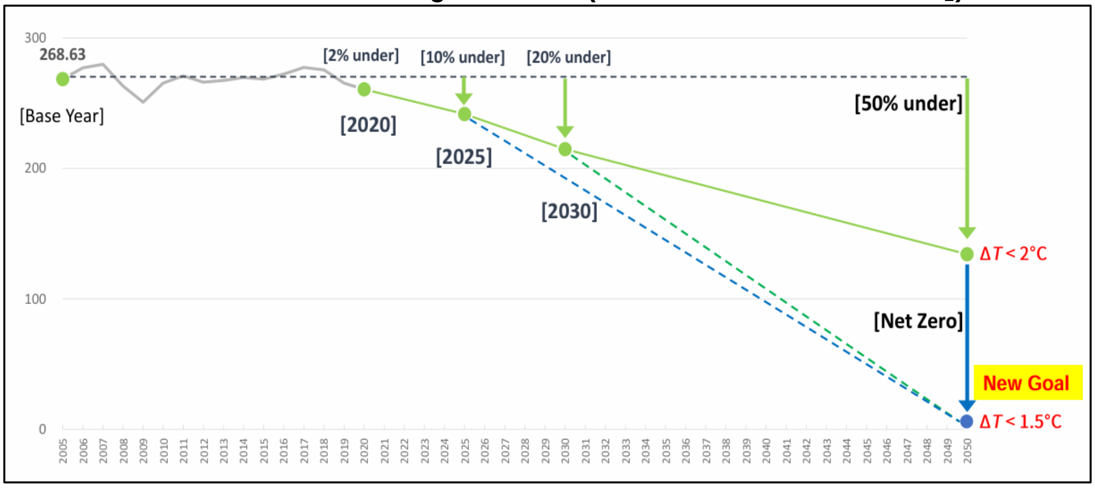
[138] The information was extracted from the following presentation: Ng, E. (2024). *Singapore's Vehicular Electrification Journey*. Workshop "*Electromobility Towards a Sustainable and Safe Mobility,*" Lima Convention Center, San Borja, Lima, Peru. Ministry of Transport Singapore.
[139] Ibid.
[140] Ibid.
[141] Chinese Taipei's Ministry of Economic Affairs. (2022). *Chinese Taipei's pathway to net-zero emissions in 2050*. Available at: https://ws.ndc.gov.tw/Download.ashx?u=LzAwMS9hZG1pbmlzdHJhdG9yLzExL3JlbGZpbGUvMC8xNTA0NS8xMzdmMjYyMS01NmQ4LTQ0MjctODkxZS05MDQ1MjdjZmMzMzYucGRm&n=VGFpd2Fu4oCZcyBQYXRod2F5IHRvIE5ldC1aZXJvIEVtaXNzaW9ucyBpbiAyMDUwLnBkZg%3d%3d&icon=.pdf

Figure 43. Progress in Decoupling Economic Growth and GHG Emissions in Chinese Taipei (2005-2019)



Source: Chinese Taipei's Ministry of Economic Affairs. (2022). *Chinese Taipei's Pathway to Net-Zero Emissions in 2050.*

Figure 44. Long-Term Roadmap for Local GHG Emission Reduction in Chinese Taipei: Net-Zero Emissions Target for 2050 (in million metric tons of CO_2)



Source: Chinese Taipei's Ministry of Economic Affairs. (2022). *Chinese Taipei's Pathway to Net-Zero Emissions in 2050.*

In this same line of thinking, recent amendments to Chinese Taipei's GHG Act set ambitious emission reduction targets that go beyond public transport policies. Among them is the goal of achieving net-zero emissions by 2050 (see Figure *44*). From a baseline of 268.63 million metric tons of CO_2 equivalent annually in 2005, a progressive reduction is projected, starting with a 2% decrease in 2020, followed by 10% by 2025, and 20% by 2030. After 2030, the reduction intensifies significantly, with a target to cut emissions by 50%. The aim is to meet the goal of keeping the global temperature rise below 2°C. Additionally, a more ambitious target is set to limit warming to 1.5°C, which requires continuous efforts toward net-zero emissions by 2050. This trajectory underscores Chinese Taipei's government's commitment to climate change mitigation and the implementation of effective public policies to reduce its carbon footprint.

To achieve an effective transition to sustainable transport, electrification efforts in Chinese Taipei must be complemented by an integrated approach, as seen in the case of New Taipei. In 2019, the transportation sector in Chinese Taipei generated 35 million metric tons of CO_2 equivalent, accounting for 23.6% of non-electricity-related emissions[142].

Similarly, the government of the most populous city (New Taipei) has faced similar challenges, with the transportation sector emitting 4.87 million metric tons of CO_2 equivalent in 2020, 94% of which comes from land transport. This high proportion of emissions is directly related to the large number of vehicles registered in the city, totaling 3,242,379 vehicles, equivalent to 804 vehicles per 1,000 inhabitants[143]. These data reveal the importance of addressing not only the electrification of the vehicle fleet but also implementing policies that discourage excessive use of private vehicles, such as the creation of green corridors and the expansion of public transport networks.

Moreover, the experience of New Taipei's government highlights that mitigation actions must be broad and multisectoral to achieve the net-zero emissions goal by 2050. The city government's plan includes the full electrification of buses by 2030 and the electrification of public sector vehicles by 2035. These efforts must be complemented by the development of renewable energy infrastructure and technological modernization. Additionally, the city faces further challenges related to climate change, such as rising temperatures and more intense extreme weather events, which increase the demand for cooling energy. This reinforces the need to integrate clean energy solutions across all sectors, ensuring that the transition to more sustainable transportation not only reduces CO_2 equivalent emissions but also mitigates environmental impacts and enhances urban resilience to the effects of climate change[144].

There are several benefits of the widespread adoption of electromobility and other sustainable initiatives implemented in New Taipei, which have significantly contributed to the reduction of GHG emissions and improved air quality. The actions taken to develop a sustainable urban transport system have resulted in an estimated annual reduction of 141,648 metric tons of CO_2 equivalent. Of this total, the majority, 134,900 metric tons of CO_2 equivalent, is attributed to the introduction or expansion of the public transport system and fare discounts, demonstrating that affordable and improved access to public transport can be a powerful driver of carbon emission reductions[145].

Additionally, the promotion of vehicle electrification and public bicycle rentals contributed to an annual reduction of 6,598 metric tons of CO_2 equivalent, highlighting the direct benefits of electromobility in reducing emissions. Moreover, air quality monitoring shows a significant decrease in PM2.5 levels, from 22.7 $\mu g/m^3$ in 2014 to 14.2 $\mu g/m^3$ in 2021, further demonstrating the additional benefits of electromobility, not only in terms of carbon emission reduction but also in improving public health by reducing air pollutants[146].

In 2022, EV constituted only 0.5% of the total fleet in Chinese Taipei, with 34,160 registered units, while their share in the new vehicle sales market reached 11.9%. However, the plan for transitioning to electric mobility anticipates a considerable increase in these percentages. By 2025, EVs are expected to account for 1.4% of the total fleet and 20% of new sales. This growth trend is projected to continue through 2040, when EVs will represent 43.2% of the total fleet, with 100% of new sales being electric vehicles.

[142] Chinese Taipei's Ministry of Economic Affairs. (2022). *Chinese Taipei's pathway to net-zero emissions in 2050*. Available at: https://ws.ndc.gov.tw/Download.ashx?u=LzAwMS9hZG1pbmlzdHJhdG9yLzExL3JlbGZpbGUvMC8xNTA0NS8xMzdmMjYyMS01NmQ4LTQ0MjctODkxZS05MDQ1MjdjZmMzMzYucGRm&n=VGFpd2Fu4oCZcyBQYXRod2F5IHRvIE5ldC1aZXJvIEVtaXNzaW9ucyBpbiAyMDUwLnBkZg%3d%3d&icon=.pdf

[143] Climate Health Evidence. (n.d.). Developing sustainable urban transport in New Taipei. Available at: https://climatehealthevidence.org/case-studies/developing-sustainable-urban-transport-new-taipei

[144] Climate Health Evidence. (n.d.). Developing sustainable urban transport in New Taipei. Available at: https://climatehealthevidence.org/case-studies/developing-sustainable-urban-transport-new-taipei

[145] Íbid.

[146] Ibid.

This widespread adoption of EVs is crucial for aligning the transportation sector with long-term sustainability and emission reduction goals.

On the other hand, in 2022, electric buses in Chinese Taipei represented 10% of the total fleet, with 1,170 registered units, and achieved a 4.4% market share in new bus sales. The strategic plan for transport electrification aims to significantly increase these numbers, with a target of 35% of the bus fleet being electric by 2025, which would translate into 4,600 electric buses in operation. By 2030, the goal is for 100% of the bus fleet to be electric. This approach reflects a strong commitment to decarbonizing public transport, using electrification as a means to reduce sector emissions[147]. For a detailed analysis of the five-year targets, refer to
Table ***4***.

Table 4. Current Situation and Projection of EV

Tipo de Vehículo	Indicador	Línea de Base	Proyecciones			
		2022	2025	2030	2035	2040
E-bus	% del total de la flota	10%	35%	100%		
	N° de matriculas	1,170	4,600	11,700		
VE	% del mercado	4.4%	10%	30%	60%	100%
	% de la flota	0.5%	1.4%	7.3%	20.3%	43.2%
	Ventas anuales	16,106	38,000	114,000	228,000	380,000
	N° de Matriculas	34,160	101,365	519,365	1,431,365	3,027,365

Source: Chinese Taipei's Ministry of Transportation and Communications. (2022). *2050 Net-zero Transition: Electric & Carbon-Free Vehicles. Chinese Taipei's 2050 Net Zero Carbon Emission Path and Strategic Planning.*

According to Chen, J. (2024) in his presentation titled "Chinese Taipei's Innovative E-Bus Solution: Facilitating Smart Transformation in Route Tendering," delivered during the workshop "Electromobility Towards a Sustainable and Safe Mobility" at the Lima Convention Center in Peru, Chinese Taipei's plan to electrify its entire urban bus fleet by 2030 is structured into three main phases: Introduction (2020-2022), Promotion (2023-2026), and Popularization (2027-2030).

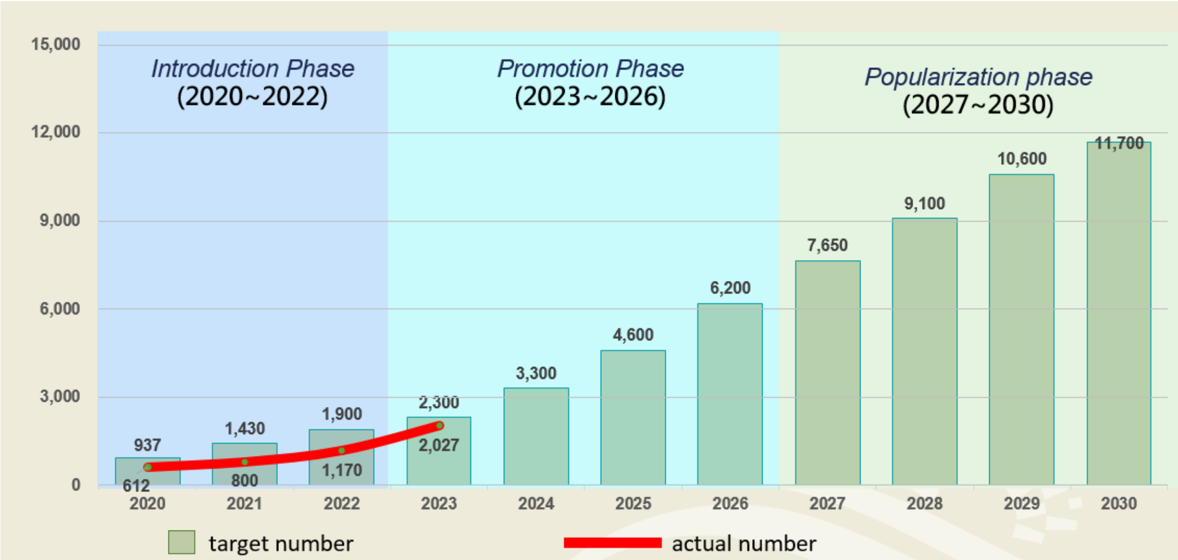
During the first phase, the priority was to establish the basic infrastructure needed and begin the gradual implementation of electric buses, with a target of 1,900 units by 2022. This initial phase also included providing higher subsidies to encourage companies to replace their diesel buses with electric ones, recognizing the initial challenges and costs associated with this transition. Additionally, efforts were made to create adequate charging infrastructure and coordinate with utility companies to address challenges related to power supply and space management for charging infrastructure.

The Promotion phase aims to accelerate adoption by significantly increasing the number of electric buses in operation. During this period, battery costs are expected to decrease, and energy density is expected to improve, reducing the need for subsidies to incentivize the transition. Furthermore, the integration of smart charging technologies, such as those used to optimize energy demand and generate additional revenue, is expected to play a key role in expanding the electric fleet. Finally, in the Popularization phase, the goal is to fully consolidate fleet electrification, reaching a total of 11,700 electric buses by the end of the period. During this phase, battery technology is expected to have advanced

[147] Chinese Taipei's Ministry of Transportation and Communications. (2022). *2050 Net-zero transition: Electric & carbon-free vehicles.* Chinese Taipei's 2050 Net Zero Carbon Emission Path and Strategic Planning. Available at: https://ws.ndc.gov.tw/Download.ashx?u=LzAwMS9hZG1pbmlzdHJhdG9yLzExL3JlbGZpbGUvMC8xNTA0Ni9kZjI0N2VlYS1iYjFjLTRjMmEtOGIxNS1mZTVlODEzNjA0YjAucGRm&n=MDdfQ2FyYm9uIEZyZWUgRWxlY3RyaWMgVmVoaWNsZXMgKGRyYWZ0KS5wZGY%3D&icon=.pdf

sufficiently to enable full electrification, even on more challenging routes, and the charging network should be sufficiently expanded and optimized to support the full demand of the electric fleet (see Figure 45).

Figure 45. Progress Towards Full Electrification of Urban Buses in Chinese Taipei by 2030



Source: Chen, J. (2024). *Chinese Taipei's Innovative E-Bus Solution: Facilitating Smart Transformation in Route Tendering.* Workshop *"Electromobility Towards a Sustainable and Safe Mobility,"* Lima Convention Center, San Borja, Lima, Peru.

The transition to an electric bus fleet in Chinese Taipei presents multiple benefits that extend to various key areas, including the environment, the economy, and social development.

From an environmental perspective, bus electrification contributes significantly to reducing pollutant emissions, minimizing the negative impact on air quality, and consequently improving citizens' quality of life. Economically, the electrification and application of technologies in urban transport not only accelerate the development of this sector but also generate substantial economic benefits. These include a 50% reduction in energy consumption, a 20% extension in battery life, and a 25% increase in charger utilization. Furthermore, these advances not only improve livability in the Asia-Pacific region but also attract both domestic and foreign investments, boost industrial development, and promote economic growth.

Socially, bus electrification has a significant positive impact, helping to reduce labor intensity, promote gender equality, and stimulate the development of EVs. These initiatives not only improve working conditions but also ensure that technological and economic progress is inclusive, benefiting all sectors of society. The emphasis on social justice ensures that the benefits of this transformation are shared equitably, creating a fairer and more sustainable environment.

In terms of environmental benefits, the transition to electric buses results in an annual reduction of 548,000 tons of CO_2, generating estimated benefits of NTD2 billion. Additionally, an annual reduction of 78 tons of PM2.5 is expected, with a positive economic impact of approximately NTD5 billion. Fuel cost savings reach NTD4 billion, contributing to total savings of between NTD10 and 11 billion across the entire electric bus fleet in Chinese Taipei. These outcomes highlight the positive economic and environmental impact of public transport electrification.

Regarding operational and labor cost savings, contracted capacity is reduced by 50%. Additionally, the service life of vehicle batteries is extended by approximately 20%.

These benefits, along with a 5% reduction in daily manual operations and savings in human resources, contribute to total estimated savings of between NTD3 and 5 billion.

Finally, the current state of charging infrastructure for EVs in Chinese Taipei is in a phase of rapid expansion, driven by government initiatives to achieve a zero-emission market for passenger vehicles and motorcycles by 2040. On 13 June 2023, the Ministry of Transportation and Communications (MOTC) of Chinese Taipei announced an ambitious plan to accelerate the installation of public charging stations, backed by a special budget of NTD32 million through the Future-Oriented Infrastructure Development Program. Between 2023 and 2024, the government aims to install 4,000 slow charging stations and 400 fast charging stations across the island. To support this development, significant subsidies have been established for local governments and MOTC agencies, offering up to NTD26,666 per slow charger and up to NTD66,666 per fast charger. Additionally, the new policy requires that at least 2% of spaces in public parking lots and 1% in private parking lots be reserved for EV charging.

7.2.15. Thailand[148]

According to the report "Thailand E-mobility Country Profile," the transport sector in Thailand is a major contributor to air pollution and GHG emissions. In 2020, the transport sector generated 29% of the economy's total GHG emissions, equivalent to 243 MMT. Road transport is the biggest culprit, accounting for 96% of these emissions. This pollution has serious public health implications in Thailand. It is estimated that road transport is responsible for 8.3% of illnesses related to PM2.5 exposures. In 2019, PM2.5 exposure caused more than 29,500 premature deaths in the economy. Among the most significant diseases associated with this type of pollution are ischemic heart disease, which accounts for 25% of the total, and chronic obstructive pulmonary disease (COPD), which constitutes 10% of the total.

Due to the high contribution of the automotive sector to Thailand's GDP (approximately 10%), the economy is moving towards the electrification of its vehicle fleet. Thailand aims to become an EV production hub in Southeast Asia. To support this transition, the development of charging infrastructure is crucial. According to the report, Thailand has a total of 4,628 charging stations, of which 1,482 are public and managed by 12 local developers.

The EV fleet in Thailand has seen significant growth in recent years. As of June 2023, the number of EV registrations reached 430,000, representing a 29% increase compared to the end of 2022. This growth is even more notable considering that in 2020 there were only 192,000 EVs registered, which means the number has nearly doubled in just three years. By the end of 2023, 38 battery EV models offered by 21 different companies were projected to be available. This diversification and increase in EV offerings reinforce Thailand's commitment to transport electrification and support the continued growth of the EV market in the economy.

Furthermore, in 2022, the cumulative registration of urban transport buses saw a notable increase, reaching a total of 15,473 units. This fleet was composed of 7,408 diesel buses, 5,621 compressed natural gas (CNG) buses, and 953 battery electric buses (BEB). In Bangkok specifically, a total of 9,053 fixed-route buses were registered during the same period. This figure included 2,794 diesel buses, 5,308 CNG buses, and 950 BEB. The statistics show significantly different year-on-year variations among the categories, with a 4.7% annual decrease in diesel buses, a 15.4% drop in CNG buses, and an impressive

[148] The data shown for this economy have been extracted from the following document: Thailand: International Council on Clean Transportation (ICCT). (2023). Thailand E-mobility Country Profile. Available at: https://asiantransportoutlook.com/documents/65/Thailand_20231002.pdf

726.1% increase in BEB, highlighting the growing trend towards the adoption of clean technologies in urban public transport[149].

The evolution of electromobility in Thailand has been strongly driven by a series of key government policies. In 2017, the government initiated the promotion of EV production in the economy, and in 2020, the National EV Policy Committee was established to coordinate the development of the EV industry. In that same year, the Thailand Board of Investment approved a significant package of incentives for the production of various types of EV, including tax exemptions that can last up to 8 years for electric bus projects, provided manufacturers meet specific criteria, such as the production of additional critical components.

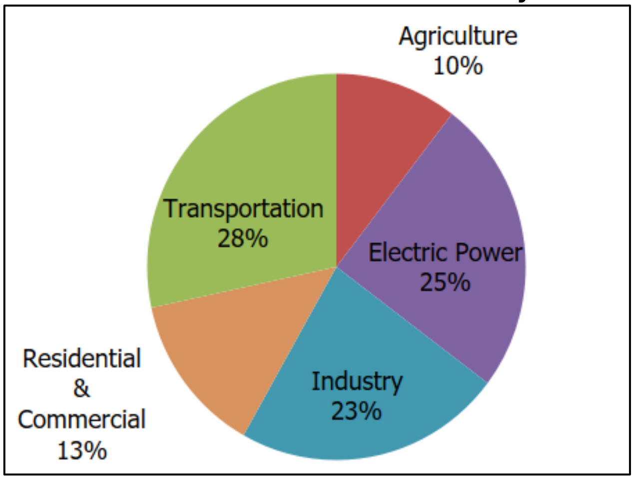
In 2021, Thailand launched the "30@30" policy, which stipulates that 30% of automotive production must be Zero Emissions Vehicle (ZEV) by 2030. This policy includes an ambitious plan for the production of 18,000 electric buses and trucks by 2025. In 2022, significant fiscal incentives were implemented, such as reducing import tariffs from 80% to 40% EV and lowering the excise tax for imported EV from 8% to 2%. These incentives are designed to reduce costs and encourage the adoption of EV, including electric buses.

To support the electrification of public transport, the government also offers import tariff exemptions and excise tax deductions for machinery and components intended for the production of electric buses. These measures aim to strengthen local production capacity and facilitate the import of essential parts that are not available in the domestic market.

7.2.16. The United States

In 2022, total CO_2 equivalent emissions in the United States reached 6,343.2 MMT[150]. The following figure presents a breakdown of total greenhouse gas emissions by economic sector in the economy. In Figure 46, it can be seen that the transportation sector is the largest emitter of GHG, contributing 28% of total emissions. This is followed by the electric power generation sector at 25%, industry at 23%, the residential and commercial sector at 13%, and agriculture at 10%.

Figure 46. Total U.S. Greenhouse Gas Emissions by Economic Sector



Source: Environmental Protection Agency. (n.d.). Sources of greenhouse gas emissions.

The transportation sector is the primary direct contributor to GHG emissions in the United States, primarily due to the combustion of fossil fuels such as gasoline and diesel in

[149] Economic and Social Commission for Asia and the Pacific (2023). Study report on transitioning to electric public buses in Thailand. Available at: https://www.unescap.org/sites/default/d8files/event-documents/ESCAP-2022-RP-Transitioning-to-Electric-Public-Buses-Thailand%20%281%29.pdf

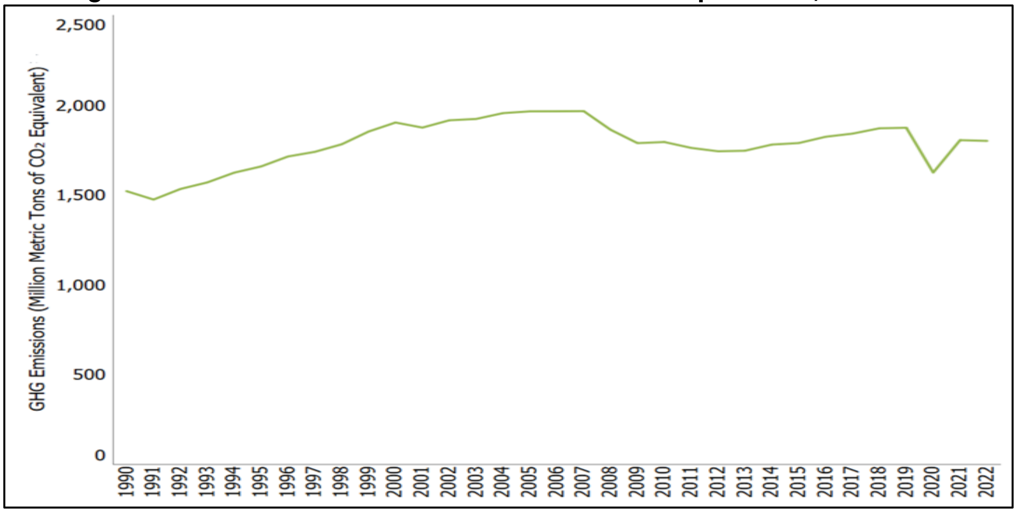
[150] U.S. Environmental Protection Agency. (n.d.). *Fast facts on transportation greenhouse gas emissions*. Available at https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions

internal combustion engines. According to the United States Environmental Protection Agency, most of these emissions come from passenger cars, medium- and heavy-duty trucks, and light trucks, including SUV, pickup trucks, and minivans, which account for more than half of the sector's emissions. Other modes of transportation, such as commercial aircraft, ships, trains, and pipelines, also contribute to emissions, although to a lesser extent.[151].

Regarding emission trends, the transportation sector has experienced a 19% increase in total fossil fuel emissions from 1990 to 2022. In 2022, the sector's direct and indirect emissions accounted for 29% of total GHG emissions in the United States[152]. Although transportation emissions decreased slightly (less than 1%) from 2021 to 2022, they have increased significantly over time due to the rising demand for travel. Factors such as population growth, economic development, urban expansion, and periods of low fuel prices have contributed to this increase.

Figure 47 presents the trend of GHG emissions from the transportation sector in the United States from 1990 to 2022. In 2022, total emissions amounted to 6,343.2 MMT of CO_2 equivalent. The trend shows a steady increase in emissions until the early 2000s, followed by stabilization and slight decreases in recent years. This reflects efforts to improve fuel efficiency in new vehicles and the transition to more energy-efficient vehicles.

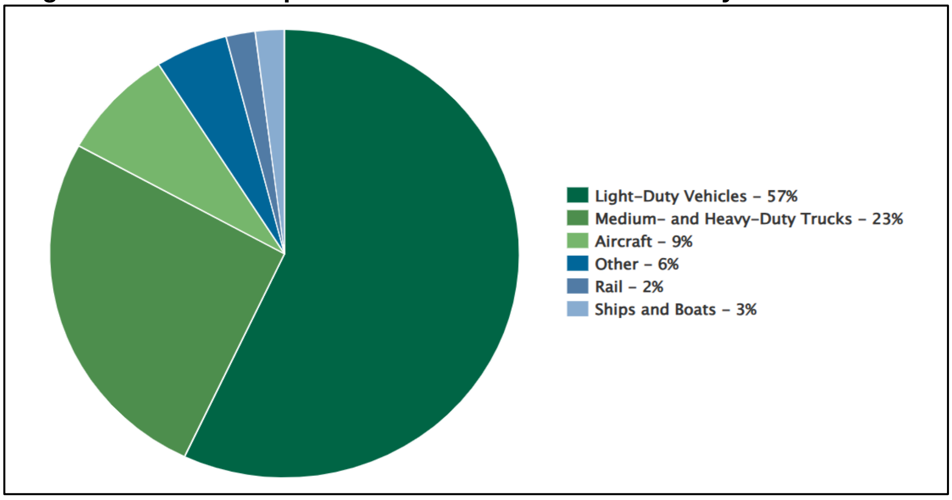
Figure 47. Greenhouse Gas Emissions from Transportation, 1990-2022



Source: Environmental Protection Agency. (n.d.). Sources of greenhouse gas emissions.

[151] Ibid.
[152] Ibid.

Figure 48. U.S. Transportation Sector GHG Emissions by Source in 2022



Source: U.S. Environmental Protection Agency. (n.d.). *Fast facts on transportation greenhouse gas emissions*.[153]

Figure 48 shows the distribution of GHG emissions by different modes of transportation in the United States for the year 2022. Light vehicles are the primary contributors, accounting for 57% of the sector's emissions. They are followed by medium- and heavy-duty trucks at 23%, while airplanes contribute 9%. Other modes of transportation, including trains and ships, represent smaller proportions: 6% for other means, 2% for railways, and 3% for ships. This chart highlights the need to focus on reducing emissions from both light and heavy vehicles to mitigate the environmental impact of transportation.

The adoption of EV in the United States is proving to be a significant strategy for improving air quality and reducing GHG emissions nationwide. According to the report "The Road to Clean Air" by the ALA, if all vehicles on the road in the United States were electric, up to 6,300 premature deaths could be avoided each year. Additionally, this transition would generate USD72 billion annually in public health benefits due to improved air quality. These benefits include the reduction of 93,000 asthma attacks and 416,000 lost workdays annually[154]. With the reduction of up to 1.5 MMT of CO_2-equivalent per year by 2050, the electrification of transportation not only improves air quality but also plays a crucial role in mitigating climate change nationwide[155].

Electrification also offers significant public health and economic benefits. According to the report titled "Driving to Clean Air" (ALA, 2022), by 2050, the adoption of EVs could generate up to USD978 billion in cumulative public health benefits. This transition could prevent 89,300 premature deaths, reduce 2.2 million asthma attacks, and prevent 10.7 million lost workdays annually due to air quality-related illnesses[156].

Finally, the report "Zeroing in on Healthy Air" by the ALA in 2022 estimates that, by 2050, a complete transition to zero-emission passenger vehicles by 2035 and zero-emission medium- and heavy-duty trucks by 2040, accompanied by renewable, non-combustion electricity generation, could generate over USD1.2 trillion in cumulative public health benefits. These benefits include preventing up to 110,000 premature deaths, reducing

[153] U.S. Environmental Protection Agency. (n.d.). *Fast facts on transportation greenhouse gas emissions*. Available at https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions
[154] American Lung Association. (2020). The road to clean air: Benefits of a nationwide transition to EVs. Available at https://www.lung.org/getmedia/99cc945c-47f2-4ba9-ba59-14c311ca332a/electric-vehicle-report.pdf (p.7).
[155] American Lung Association. (2020). The road to clean air: Benefits of a nationwide transition to EVs. Available at: https://www.lung.org/getmedia/99cc945c-47f2-4ba9-ba59-14c311ca332a/electric-vehicle-report.pdf (p.8).
[156] American Lung Association. (2022). *Driving to clean air: The health and climate benefits of zero-emission cars and electricity*. https://www.lung.org/getmedia/9e9947ea-d4a6-476c-9c78-cccf7d49ffe2/ala-driving-to-clean-air-report.pdf (p.2).

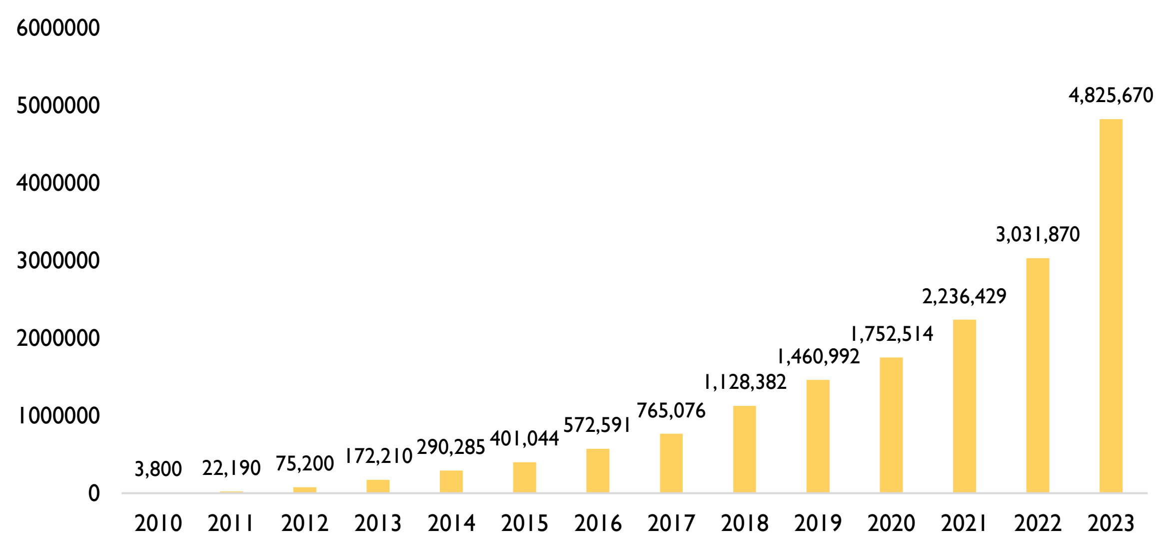
nearly 3 million asthma attacks, and decreasing over 13 million lost workdays due to air pollution.[157].

The United States is emerging as a key market in the global transition to EVs. Despite being surpassed in sales volume by China and Europe, the U.S. market is showing robust growth and increasing adoption of electromobility technologies. According to the Global EV Outlook 2024, the year 2023 was significant for EVs in the U.S., both in terms of sales and charging infrastructure.

In 2023, the United States registered a total of 1.4 million new EVs, representing an increase of more than 40% compared to 2022. This growth is notable, especially in a context of slowing sales growth in previous years. Currently, EVs represent approximately 10% of the new car market in the U.S., with strong demand driven by popular models such as the Tesla Model Y. This model saw a 50% increase in sales after becoming eligible for the full USD7,500 tax credit. In addition to annual sales, the cumulative stock of EVs in the United States has also shown substantial growth. By 2023, the total EV stock in the U.S. reached approximately 4.8 million units[158] (see Figure 49).

The electric bus sector in the United States (see Figure 50) is also making progress, albeit at a more moderate pace compared to other types of EVs. In 2023, electric buses accounted for 3% of total bus sales. This growth indicates a shift towards more sustainable public transportation solutions, although it still represents a small fraction of the total bus market. Electric trucks are also increasing in the United States. Sales of electric trucks grew by 35% compared to 2022, representing approximately 1.5% of truck sales. This growth is supported by stricter emission standards and policies that support the electrification of heavy vehicles.

Figure 49. Global Trend of EV Stock between 2010 and 2023

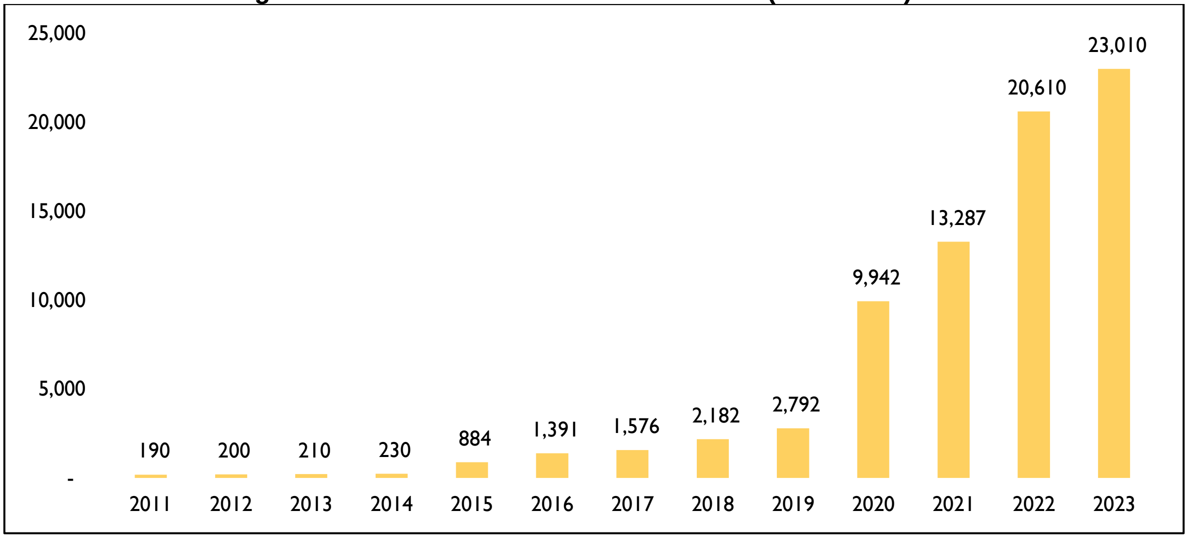


Source: Global EV Outlook 2024.

[157] American Lung Association. (2023). Zeroing in on Healthy Air: The health and climate benefits of zero-emission transportation and electricity generation. Available at https://www.lung.org/getmedia/13248145-06f0-4e35-b79b-6dfacfd29a71/zeroing-in-on-healthy-air-report-2022.pdf (p.3).

[158] International Energy Agency. (2024). Global EV Outlook 2024: Moving towards increased affordability. IEA. https://www.iea.org/reports/global-ev-outlook-2024 (p.18).

Figure 50. Evolution of Electric Bus Stock (2011-2023)



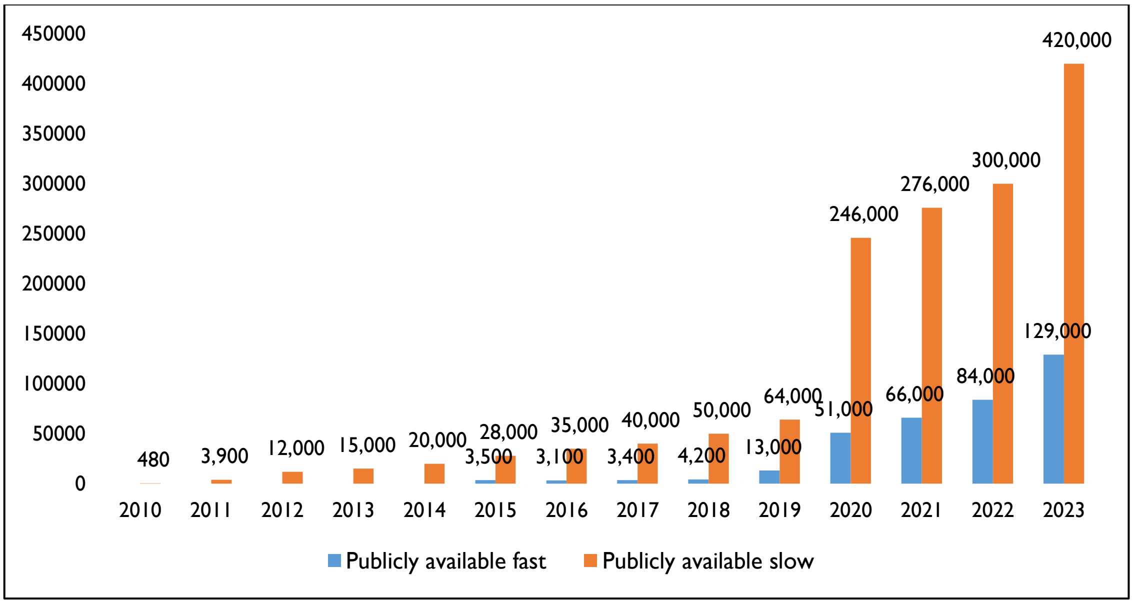
Source: Global EV Outlook 2024.

Although the EV market in the United States is expanding, it faces several challenges. The need to improve the affordability of EVs remains a key issue. Despite decreasing battery prices and growing competition, EVs are still more expensive than ICE vehicles. Additionally, charging infrastructure must continue to develop to keep pace with EV adoption, especially in rural and relatively underdeveloped areas.

On the other hand, EV charging infrastructure in the United States has experienced significant growth and is a factor that promotes EV adoption. In 2023, the number of public charging points installed increased by 40% compared to 2022. This growth has been particularly notable in the deployment of fast chargers, which are essential for the viability of EVs on long-distance trips and commercial use. Broad and affordable access to public EV charging infrastructure is crucial for the mass transition to electric transport. Although most EV charging still occurs in private settings, such as homes and workplaces, growth in public infrastructure is vital for the expansion of the EV market. To meet the projected EV deployment levels in announced policy scenarios, a sixfold increase in public charging capacity is needed by 2035. The Biden-Harris Administration has set a goal of building an accessible and equitable network of 500,000 charging stations by 2030, facilitating the use of EVs for both local and long-distance travel for all Americans[159].

Figure 51. Evolution of Public Availability of Fast and Slow Chargers in the United States (2010-2023)

[159] U.S. Department of Transportation. (n.d.). Community benefits of urban mobility electrification. Available at https://www.transportation.gov/urban-e-mobility-toolkit/e-mobility-benefits-and-challenges/community-benefits



Source: Global EV Outlook 2024.

According to Hill, Jason. (2024), in his presentation titled "Incentives for Electromobility: The U.S. Approach," delivered during the workshop "Electromobility Towards a Sustainable and Safe Mobility," minimum standards for charging infrastructure, based on U.S. experience, encompass essential aspects to ensure the system's accessibility and efficiency. These include the installation, operation, and maintenance of EV charging infrastructure, ensuring its reliability and availability for users. Interoperability of the stations is equally crucial, allowing different types of EVs to use the facilities seamlessly.

Additionally, proper signage and traffic control devices must be clearly established to safely guide drivers to charging stations. Network connectivity and data presentation are also fundamental, facilitating effective monitoring and management of the system. Finally, it is essential that information on the location, pricing, real-time availability, and accessibility of charging stations is readily available through mapping applications, allowing users to plan their routes more efficiently and enhancing their overall experience.

8. Analysis of General and Specific Policies for Promoting Electromobility and Success Stories in Eight APEC Economies

This section reviews the general policies on sustainable urban mobility for nine economies and identifies the role of electromobility promotion within urban transportation policies. Additionally, it reviews general energy policies and the instruments for promoting energy efficiency in the transition toward the adoption of EV. The subsections conclude with specific electromobility policies and reviews of success stories.

8.1. Australia

8.1.1. Urban Mobility Policies Related to the Transition to Electromobility[160]

According to Australia's 2021 Infrastructure Plan (PIA) titled “Reforms to Meet Australia's Future Infrastructure Needs”[161], the vision for 2036 is to ensure that transport services efficiently connect people and goods across Australia's vast territory, offering high-quality

[160] This section has been prepared based on the document: Infrastructure Australia. (2021). 2021 Australian Infrastructure Plan. Infrastructure Australia. ISBN: 978-1-925352-59-7 (print), 978-1-925352-60-3 (online). Available at: https://www.infrastructureaustralia.gov.au.

[161] Infrastructure Australia. (2021). *2021 Australian Infrastructure Plan*. Infrastructure Australia. ISBN: 978-1-925352-59-7 (print), 978-1-925352-60-3 (online). Available at https://www.infrastructureaustralia.gov.au.

urban travel and effective supply chains. This vision encompasses both metropolitan and rural areas, guaranteeing that all Australians have access to efficient and reliable transportation.

The PIA's diagnosis indicates that Australia is at a crucial stage in terms of urban mobility, facing significant challenges due to rapid technological advancements, changing public expectations, and the impact of the COVID-19 pandemic. The document notes that the economy's transport infrastructure is undergoing significant transformation, driven by new technologies and evolving user needs. For example, Western Australia is implementing significant changes in urban mobility, moving towards providing public transport services with constant frequencies and no fixed schedules. Additionally, regarding electromobility, states such as the Australian Capital Territory (ACT), New South Wales, Queensland, and Victoria are leading processes to promote both electric and autonomous vehicles.

Concerning urban mobility plans, the PIA highlights that to be effective, these plans must be managed with a long-term vision and that transport investments must be consistent with a comprehensive vision of settlement and activity, based on population projections and growth scenarios. Plans should be framed within a consistent framework of movement and location, addressing how links in a multimodal network can deliver specific mobility and access outcomes. Moreover, it is crucial that these plans are explicitly linked to budgets that integrate both capital and operating costs with revenue forecasts, thereby ensuring the financing of desired outcomes for users.

The PIA[162], also underscores the importance of leveraging technological innovations to provide efficient and safe urban mobility in all urban environments, enabling users to opt for more sustainable modes of transport and rely less on cars. Among the highlighted priorities are the completion of local active and public transport networks around new urban centers and the promotion of more sustainable transport patterns.

It is worth noting that the frequent use of bus services to connect different urban centers through future railway corridors will strengthen the long-term role of mass transit. Additionally, the entire public transport network and first and last mile services must be inclusive and accessible to diverse user groups, especially people with disabilities and an aging population, through the implementation of consistent reporting and updated accessibility standards. Furthermore, as vehicle connectivity and autonomy increase, it will be crucial to integrate and apply digital technology in both traffic management systems and the design of new roads. Finally, to promote the widespread use of EV, the report highlights the need to renew Australia's vehicle fleet, along with the installation of EV charging stations, including those with bidirectional capacity in residential areas and public zones.

To drive the adoption of EV in Australia, it is crucial to implement strategies that address both financial incentives and the necessary infrastructure. These measures will not only facilitate the transition to cleaner transport technologies but also significantly contribute to emission reductions and the improvement of air quality in the economy. Below are some of the key recommendations for specifically promoting the use of EV according to the report "Reforms to Meet Australia's Future Infrastructure Needs"[163]:

- **Policy to Promote the Use of EV**

To drive the adoption of EV, it is crucial to implement policies that facilitate and promote their use nationwide. In some economies, EV purchases are subsidized by the

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[162] Ibid.

[163] Infrastructure Australia. (2021). *2021 Australian Infrastructure Plan*. Infrastructure Australia. ISBN: 978-1-925352-59-7 (print), 978-1-925352-60-3 (online). Available at https://www.infrastructureaustralia.gov.au.

government with significant financial incentives, such as AUD2,500 in Canada and up to AUD14,000 in Germany. Although Australia has not yet implemented specific local subsidies for EV purchases, there is still a significant willingness to adopt clean and green transport technologies even without these incentives.

- **Provide Adequate Infrastructure**

Creating adequate infrastructure is fundamental to capitalizing on this interest and facilitating the mass adoption of EV. Accessible charging facilities are essential for shared EV and micromobility devices. These facilities should be widely available and as visible as possible, strategically located in areas such as city streets, shopping centers, and other key transit points. This accessibility will help overcome one of the main barriers to EV adoption: concerns about the availability of charging points.

- **Bidirectional Charging Facilities**

Bidirectional charging installations represent the next generation of charging infrastructure, allowing EV to function as "batteries on wheels." These vehicles can draw and return energy to the grid as needed, optimizing the use of energy resources and contributing to grid stability. Implementing these technologies will require updated construction standards that include uniform technical specifications in the economy.

- **Consistent Technical Standards**

To accelerate the adoption of EV, it is crucial to adopt consistent technical standards nationwide. These standards should facilitate the import and use of a wide range of zero-emission passenger and freight vehicles, ensuring that Australia is prepared for the transformative impacts of electric, connected, and autonomous vehicles. Harmonizing these standards will also contribute to the effectiveness and efficiency of public transport services and related infrastructure.

- **Facilities for Zero-Emission Buses**

Additionally, specific facilities must be established to accommodate these eco-friendly vehicles. Bus depots should be constructed in dense urban areas rather than distant industrial zones, improving the efficiency and effectiveness of bus services and the availability of energy supplies. This approach not only optimizes operational logistics but also enhances public access to clean and efficient transport services.

Standards Promoting or Accelerating the Transition to Electromobility

- **National Transport Commission Act 2003**

The National Transport Commission Act 2003 (Cth) is a law that addresses safety, productivity, and environmental objectives agreed upon by all jurisdictions. The responsibilities of the Australian government under this law include: i) Establishment of the Fuel Excise Levy[164], ii) Control of vehicle importation and iii) Accessibility standards for disabled persons. The regulation provides a regulatory and financial framework that can be used to develop policies and standards to promote the adoption of EV in Australia.

- **Australian Transport Assessment and Planning (ATAP) Guidelines**

These guidelines are a set of directives developed to provide a standardized and coherent framework for transport assessment and planning in Australia. They assist

[164] The Fuel Excise Levy is a tax applied to the sale of fossil fuels. This tax is used to generate revenue for the maintenance and development of road infrastructure.

planners and decision-makers in comprehensively evaluating transport projects, considering economic, social, and environmental benefits. The ATAP Guidelines include methodologies for economic assessment, cost-benefit analysis, environmental and social impact assessment, and strategic planning. They also promote community engagement and transparency in the decision-making process, ensuring that decisions reflect local needs and priorities.

The ATAP Guidelines play a crucial role in the transition to electromobility in Australia by providing a coherent framework for evaluating and planning EV-related projects. These guidelines allow for an accurate assessment of the economic and environmental benefits of EV adoption, helping to identify the most effective investments in charging infrastructure and support technologies. By integrating sustainability and emission reduction considerations into transport planning, the ATAP Guidelines ensure that electromobility projects align with the sustainability of the economy and energy efficiency goals. Additionally, they encourage community participation and transparency, which can increase public support and acceptance of electromobility initiatives.

- **Guide to Traffic Management**

The Guide to Traffic Management compiles a series of directives developed to provide a standardized and coherent framework for traffic management in Australia. These guidelines address all aspects of traffic management, including the planning, design, operation, and maintenance of road networks. The primary goal is to improve road safety, traffic efficiency, and accessibility. The guide offers recommendations on signage, traffic demand management, intersection and road design, and the integration of advanced traffic management technologies. It also includes methods for evaluating the performance and effectiveness of traffic management measures.

The Guide to Traffic Management significantly supports the transition to electromobility in Australia by providing clear guidelines for integrating EV into existing traffic networks. These directives can help plan and design charging infrastructure for EV in strategic locations, improving accessibility and convenience for EV users. Additionally, they may include recommendations for traffic management that prioritize EV and promote more efficient use of road networks, reducing congestion and emissions. By standardizing traffic management practices, the Guide to Traffic Management ensures that electromobility initiatives are implemented consistently and effectively across the economy, contributing to a more sustainable and efficient transport system.

- **Safety and Emission Standards in Australia**

Australia has a series of safety and emission standards that regulate the importation and use of vehicles in the economy. These standards are designed to ensure that vehicles meet environmental and safety requirements before being allowed on Australian roads. The main standards and their functions are as follows:

- **ADR**

In the document "ADR"[165], the safety and emission standards for vehicles in Australia are established. These standards are mandatory regulations that all new vehicles must comply with before being used on Australian roads. The ADR covers various aspects of vehicle safety, including vehicle structure, braking systems, lighting, and emission control. Additionally, the document sets procedures for the inspection and testing of vehicles and vehicle components to ensure their compliance with established standards.

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[165] Australian Government. (2021). *Australian Design Rules (ADR)*. Available at https://www.legislation.gov.au/C2018A00163/latest/text.

These standards aim to ensure public safety and environmental protection by reducing harmful gas emissions and improving vehicle energy efficiency.

- **New Vehicle Efficiency Standard Act 2024**

The New Vehicle Efficiency Standard Act 2024[166] (the Standard) is Australia's first fuel efficiency standard, which aims to reduce CO_2 emissions from the transport sector by incentivizing the supply of more fuel-efficient and zero or low emission vehicles into the Australian market. The Standard commences on 1 January 1 2025 and applies to new passenger and light commercial vehicles. From 1 July 2025, vehicle suppliers will be required to meet or beat set CO_2 emission targets. Suppliers who have met the target for a year will accrue tradeable units. Suppliers who have not met the target for a year will have 2 years to cover the shortfall by either supplying more fuel-efficient vehicles to beat its target or by purchasing or trading units, before a financial penalty becomes payable. Over time, the CO_2 emission targets are lowered to increase the supply of more fuel-efficient, low or zero emissions vehicles into the Australian market. The NVES Regulator is responsible for administering the legislation, and is responsible for maintenance of the unit registry, monitoring and reporting, and compliance related activities, including issuing of infringement notices.

At the regional level, two key strategies or action plans for the transition to EV have been identified:

✓ **ACT Zero Emissions Vehicles Strategy 2022 – 2030**

The "ACT Zero Emissions Vehicles Strategy 2022-30"[167] presents a comprehensive and ambitious approach to transforming the transport sector in the ACT towards a zero-emissions future. This strategy is designed around six priority actions: i) Establishing a unified local market for electric, connected, and autonomous vehicles; ii) Developing EV fleets capable of interacting with the power grid, including bidirectional charging installations; iii) Ensuring fast-charging facilities for buses and other EV; iv) Providing bidirectional charging facilities at key locations; v) Expanding the EV charging network with at least 180 public stations by 2025; and vi) Implementing community education programs and fleet advisory services, increasing user awareness and comfort with EV. These measures will facilitate the transition to cleaner transport technologies, reduce emissions, and improve air quality.

The document sets forth the vision for the year 2030, projecting that Australia will be a leading economy in the adoption of EV technologies with the goal of achieving net-zero GHG emissions by 2045. Currently, transportation is the largest contributor to GHG emissions, accounting for more than 60% of the total, with passenger vehicles being the primary source of these emissions. The strategy emphasizes the urgency of reducing transport emissions to meet climate targets.

The strategy defines clear objectives for reducing transport emissions and promoting the adoption of EV. These include setting ambitious sales targets for EV, aiming for 80-90% of new vehicle sales by 2030, and the gradual phase-out of ICE vehicles starting in 2035.

[166] Australian Government. (2024). New Vehicle Efficiency Standard Act 2024. Available at https://www.legislation.gov.au/C2024A00034/latest/text.

[167] Government of the Australian Capital Territory. (2022). *ACT Zero Emissions Vehicles Strategy 2022-30*. Canberra: Government of the Australian Capital Territory. Available at https://www.climatechoices.act.gov.au/__data/assets/pdf_file/0006/2038497/2022_ZEV_Strategy.pdf

The strategy also includes significant financial incentives, such as tax exemptions[168] and interest-free loans[169] to make EV more affordable and accessible to citizens.

One of the main components of the strategy is the expansion of the EV charging network. By 2025, it proposes having at least 180 public charging stations available and implementing incentives for installing charging infrastructure in multi-unit buildings. This expansion is crucial to addressing "range anxiety" and facilitating the transition to EV for residents who do not have access to private charging points.

The strategy includes community education programs and fleet advisory services aimed at increasing user awareness and comfort with EV. Detailed information will be provided about EV technology, environmental and economic benefits, and available charging infrastructure details.

Through their strategic document, ACT leaders commit to leading by example, ensuring that 100% of their newly leased passenger vehicles are zero-emissions vehicles. Additionally, a strategic plan will be developed for the long-term charging needs of the government fleet, and opportunities will be explored to replace government commercial and heavy vehicles with EV as technologies become available.

Finally, the strategy underscores the importance of updating policies and regulations to support the transition to EV. This includes reforms in parking regulations and the inclusion of EV in government driving tests, among other initiatives.

- ✓ **Victoria's ZEV Roadmap**

The "ZEV Roadmap" of the State of Victoria is a document published by the state government [170], that proposes a strategy for transitioning to ZEV with the goal of achieving net-zero GHG emissions in the road transport sector by 2050. The roadmap focuses on both short-term and long-term actions, including the creation of infrastructure, subsidy policies, and educational programs to promote the adoption of ZEV among the population and industries.

The document emphasizes the urgency of combating climate change and reducing GHG emissions. The State of Victoria, under the Climate Change Act 2017, is legally committed to achieving net-zero emissions by 2050. Transport is responsible for approximately 25% of the emissions in the State of Victoria, highlighting the importance of decarbonizing this sector.

The government of Victoria has allocated AUD100 million to support the transition to ZEV. This includes a public subsidy program of AUD46 million for the purchase of more than 20,000 ZEVs and AUD19 million to accelerate the deployment of EV charging infrastructure. Additionally, AUD20 million is allocated for trials of zero-emission public transport buses and AUD10 million to replace 400 vehicles in the government fleet with ZEV by 2023.

The plan sets ambitious targets, such as achieving 50% of light vehicle sales as ZEVs by 2030 and ensuring that all public transport bus purchases are ZEV starting from 2025. A network of EV charging stations is being developed across the region. Additionally, a

[168] The document provides a full exemption from the registration tax for new zero-emission vehicles, meaning no registration tax is paid for the purchase of these vehicles. This exemption also applies to used EVs and hydrogen vehicles purchased from 1 August 2022, thus reducing the initial acquisition cost.
[169] Through the "Sustainable Household Scheme," interest-free loans of up to USD15,000 are offered for the purchase of new or used ZEV, as well as for charging infrastructure and its installation. Buyers have up to ten years to repay these loans without initial costs or additional fees.
[170] Government of Victoria. (2021). *Victoria's Zero Emissions Vehicle Roadmap*. Melbourne: Government of Victoria. Available at https://www.energy.vic.gov.au/__data/assets/pdf_file/0036/575676/Zero-Emission-Vehicle-ZEV-Roadmap.pdf.

public educational campaign will be implemented to increase awareness and adoption of ZEV, which will include online tools, demonstration events, and capacity building.

ZEV not only help reduce carbon emissions but also improve urban air quality and reduce noise pollution. This can have a significant impact on public health, decreasing the incidence of respiratory and cardiovascular diseases. Moreover, the adoption of ZEV is seen as an opportunity for economic growth and job creation in sectors related to the manufacturing, maintenance, and recycling of these vehicles.

The document also addresses the challenges and opportunities that the State of Victoria faces in its transition to ZEV. These challenges include the need to overcome barriers such as the high initial costs of EV, the lack of available models in the Australian market, and insufficient charging infrastructure. However, opportunities are also highlighted, such as the potential to position Victoria as a leader in the innovation and development of ZEV technologies.

In conclusion, the "Zero Emissions Vehicle Roadmap" of the State of Victoria is a comprehensive plan that seeks to transform the transport sector in the region, aligning local policies with global emission reduction goals and promoting a cleaner and more sustainable future. Through strategic investments, the establishment of clear targets, and a strong educational campaign, the leaders of the State of Victoria are taking public policy measures to lead the transition towards zero-emission transport. The strategy is ambitious and aims to transform the transport sector towards a zero-emissions future. This roadmap focuses on actions to be undertaken over the next decade to eliminate barriers to the adoption of ZEV technologies and to seize the opportunities associated with this technological transition.

8.1.2. Energy Policy Related to the Transition to Electromobility[171]

Australia is uniquely positioned to lead the global energy transformation. The energy sector is undergoing fundamental changes in how, where, and when energy is generated, transported, and stored, who participates in the market, and how users pay for it. This energy transformation is crucial for Australia's future, as energy, particularly electricity, is essential for the Australian lifestyle and is a pillar of the economy. The energy sector occupies a central place in discussions and work programs at all levels of government, energy market organizations, energy regulators, and major industrial corporations.

Australia, with its abundant natural resources, is well positioned to capitalize on the benefits of low-cost, low-emission energy sources. Strong leadership is necessary to ensure that Australia continues to be a preferred provider of energy products while shifting away from dependence on fossil fuel exports towards a broader range of energy sources, especially those that generate low emissions, such as green hydrogen.

The Australian energy market is governed by laws and regulations that apply across various regions of the economy[172]. These include the Electricity Law, the Gas Law, and the Energy Retail Law. It is important to mention that a Renewable Energy Target (RET) scheme was established under the Renewable Energy (Electricity) Act 2000 (Cth). This scheme comprises the Large-scale Renewable Energy Target (LRET) and the Small-scale Renewable Energy Scheme (SRES). Renewable energy leverages Australia's potential to generate electricity from wind and solar power.

[171] This section has been prepared based on the document: Infrastructure Australia. (2021). 2021 Australian Infrastructure Plan. Infrastructure Australia. ISBN: 978-1-925352-59-7 (print), 978-1-925352-60-3 (online). Available at: https://www.infrastructureaustralia.gov.au.

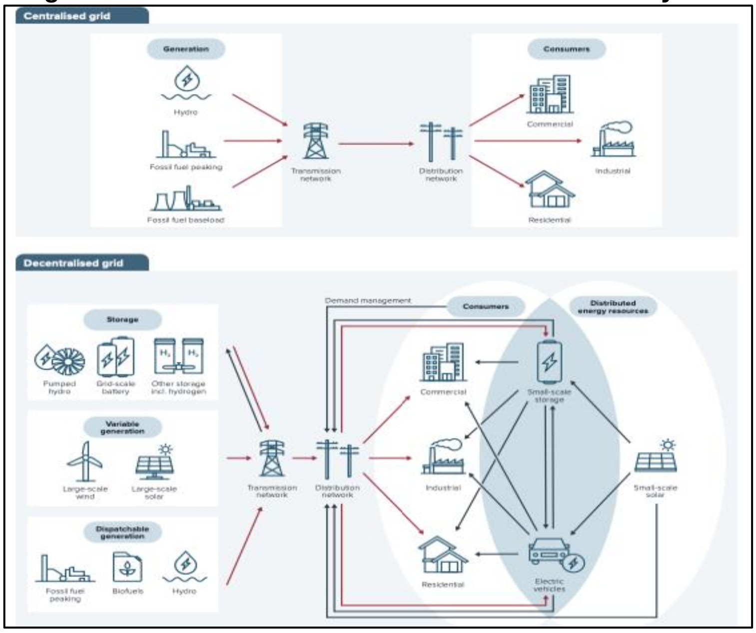
[172] These laws apply in New South Wales, Queensland, Victoria, South Australia, Tasmania, and the Australian Capital Territory, and to a lesser extent in the Northern Territory and Western Australia

The AEMC[173], The Australian Energy Regulator (AER)[174] and the Australian Energy Market Operator (AEMO)[175] are the main entities that manage and regulate the Australian energy market.

Figure 52 shows how the electrical system is changing in this economy, transitioning from a centralized network to a decentralized network. This change is driven by the adoption of advanced technologies and the need for greater efficiency and sustainability. Electromobility is fundamental in this process, not only by reducing emissions in the transport sector but also by integrating into the electrical grid as a distributed energy resource. EV, for example, can act as energy storage units, helping to balance supply and demand on the grid and promoting greater adoption of renewable energy sources.

This transformation towards a decentralized grid is essential to ensure a more resilient and adaptable energy supply. By allowing more participants (including consumers) to generate and store energy, greater flexibility and responsiveness in the energy system are encouraged.

Figure 52. Centralized and Decentralized Electric System



Source: Infrastructure Australia. (2021). *Australian Infrastructure Plan*.

Energy Sector Governance: Energy Market Bodies

The AEMC is responsible for developing the rules for the electricity and gas markets. The entity drafts and amends the Electricity Rules, Gas Rules, and Energy Retail Rules, which are the regulatory instruments governing the local energy markets. While the AEMC cannot propose rule changes, it manages the rule change process and makes decisions on rule change requests submitted by others.

The AER enforces the rules established by the AEMC. The AER monitors, investigates, and ensures compliance with energy legislation and rules in Australia's energy markets. The AER regulates electricity networks and gas pipelines by setting the maximum revenue they can earn.

AEMO operates the electricity and gas markets. AEMO oversees system performance, forecasts demand and supply, and coordinates emergency arrangements. Additionally,

173 AEMC develops rules for electricity and gas markets.
174 AER regulates the electricity and gas markets, except in Western Australia, which has the Economic Regulation Authority.
175 AEMO operates the electricity and gas systems at the national level, excet in the Northern Territoty.

AEMO leads the design of Australia's future energy system through the Integrated System Plan (ISP), which provides an integrated roadmap for the efficient development of the electricity market.

The ESB provides comprehensive system oversight for energy security and reliability. The ESB leads the post-2025 market design process and was established in 2017 by the COAG Energy Council to ensure that the local electricity market is fit for purpose. Finally, the COAG, now known as the Cabinet Energy Reform Committee, provides oversight and coordination of energy policy, as energy policy is the responsibility of the states and territories.

ISP 2024

The ISP 2024 is a comprehensive roadmap to guide Australia's energy transition, developed by AEMO[176]. This plan identifies the essential investments in energy generation, storage, and transmission to ensure that the NEM can meet net-zero emissions targets by 2050. The ISP is published every two years and is based on extensive consultation with over 2,100 stakeholders. These include representatives from the government, industry, consumers, and the community.

The ISP 2024 addresses the phased retirement of coal-fired power plants, with nearly all expected to be retired by 2040. In their place, a significant expansion of renewable energy generation, supported by storage and gas generation, is planned as the most cost-effective way to provide reliable and affordable electricity. The plan also details the need to nearly triple the NEM's generation capacity by 2050 to meet the growing demand for electricity as other sectors become electrified.

The ISP 2024 highlights that EV can play a crucial role in the stability and flexibility of the electrical system. EV have the capability to act as mobile batteries, allowing them to store energy during periods of low demand and return it to the grid when demand is high. This process, known as V2G, can help balance the supply and demand of electricity, reducing the need for large-scale storage infrastructure investments.

Additionally, the integration of EV into the electrical grid can help manage the variability of renewable energy sources, such as solar and wind. Since these sources are intermittent and depend on variable weather conditions, EV can provide a source of flexibility that helps smooth out fluctuations in renewable energy generation. For example, on sunny or windy days, EV can charge their batteries, and during times of lower renewable production, they can discharge energy back to the grid.

The ISP also mentions that consumers who own EV can participate in demand response programs, where owners are incentivized to charge or discharge their vehicles at specific times to help balance the grid. This type of coordination can result in significant savings for both consumers and the electrical system as a whole, by reducing the need to generate additional energy during peak demand times.

8.1.3. Specific Electromobility Policies and Their Effectiveness in Different Contexts

The PIA[177] prioritizes the electrification of transportation as a fundamental pillar for the economy's energy transition. The document details several essential aspects to facilitate the adoption of EV and proposes strategies to address the challenges that arise with this transition.

[176] AEMO. (2024). 2024 Integrated System Plan (ISP). Available at https://aemo.com.au/-/media/files/major-publications/isp/2024/2024-integrated-system-plan-isp.pdf?la=en.
[177] Infrastructure Australia. (2021). *2021 Australian Infrastructure Plan*. Infrastructure Australia. ISBN: 978-1-925352-59-7 (print), 978-1-925352-60-3 (online). Available at https://www.infrastructureaustralia.gov.au.

According to the Office of Infrastructure, Transport, and Regional Economics of the Australian Government, a rapid increase in EV adoption is expected in Australia. It is projected that more than 50% of new car sales in the economy will be electric by 2036. This growth has been evident since 2018 and 2019 when EV sales increased by 200%. This trend is expected to continue, with 56% of consumers considering purchasing an EV as their next car. Furthermore, vehicle fleets are moving towards electrification. Several state transport authorities are planning the transition to electric buses.

The mass adoption of EV poses significant challenges for the electrical grid, especially if many vehicles are charged simultaneously in the same location. This type of network congestion can increase maintenance and operation costs. Additionally, the unpredictable behavior of EV charging, due to their inherent mobility, complicates demand planning on the grid. To overcome these challenges, joint coordination and planning between the energy and transport sectors are crucial.

The Australian government, through the Department of Climate Change, Energy, the Environment and Water, must lead intersectoral coordination to maximize the benefits of new technologies and facilitate effective collaboration. This coordination is essential to develop strategies that optimize charging infrastructure and ensure the efficient and sustainable integration of EV into the local power grid. The Australian government envisions the implementation of strategies to address several crucial issues, including those mentioned below.

Smart Electric Rates to Support EV

The strategies considered include the implementation of smart electricity tariffs to support EVs, ensuring appropriate cost allocation for the necessary grid upgrades, and developing unified approaches for modeling EV demand by transport agencies and infrastructure companies. Additionally, it is essential to capture and share data to improve system planning and modeling, increase visibility into EV charging behavior to optimize grid operation, and establish agreements on charging infrastructure standards with state and territory departments, as well as the Australian Building Codes Board. Technical specifications for zero-emission heavy vehicles must also be defined across jurisdictions.

Investments in Electrification

The planning and response of the energy sector to the adoption of EV are crucial to reduce distribution network costs for both users and taxpayers. New distribution infrastructure will be necessary to support the transition to EV, and timely investment will be essential to balance EV adoption and ensure convenient charging, thereby avoiding unnecessary costs for customers. The AEMC should consider regulatory changes that allow network operators greater flexibility in investments that facilitate electrification. Additionally, the Distributed Energy Resources Register, which currently provides coverage for stationary energy resources, should be expanded to include EV charging, facilitating efficient and targeted investment in the distribution network.

Australia's National EV Strategy

The "National EV Strategy" was developed by the Department of Climate Change, Energy, the Environment, and Water in 2023. This strategy is a significant milestone in the economy's transition to a decarbonized transportation system, marking a coordinated effort to increase EV adoption. The strategy is part of the government's "Powering Australia" plan, which aims to improve affordability, generate jobs, and reduce emissions.

The document emphasizes the urgency of acting to reduce transport emissions, which are projected to be Australia's largest GHG emitter by 2030. The strategy prioritizes light passenger and commercial vehicles due to their significant contribution to transport GHG emissions.

During consultations for the strategy's formulation, stakeholders highlighted the need for leadership to facilitate the transition to EV. The importance of a fuel efficiency standard was emphasized as crucial for reducing GHG emissions from light vehicles and ensuring an adequate supply of fuel-efficient vehicles.

The strategy also includes measures to support the integration of EV in homes and workplaces, such as battery recycling initiatives, infrastructure planning, and emergency services training. It also underscores the importance of continuous collaboration with states and territories to ensure a consistent local approach to issues like charging infrastructure standardization and EV accessibility.

The document argues that mass EV adoption will not only help reduce GHG emissions but also bring significant economic benefits. Battery production and recycling, as well as the development of charging infrastructure, will create new jobs and foster technological innovation. Additionally, EV are expected to offer lower operating costs for consumers, with significant savings on fuel and maintenance. The strategy also addresses public health benefits from reduced air pollution, which is linked to various respiratory and cardiovascular diseases. EV adoption will improve air quality and reduce public health costs.

The "National EV Strategy" sets an action framework through 2030 and beyond, with annual reviews and a comprehensive review in 2026 to ensure the initiatives are adequate and responsive to community needs. Highlighted actions include implementing a fuel efficiency standard for light vehicles, supporting charging infrastructure, and promoting the manufacture and recycling of EV in Australia.

Ultra-Fast EV Charging Infrastructure Network[178]

The Ultra-Fast EV Charging Infrastructure Network project in Australia is an initiative aimed at enhancing the economy's readiness for EV adoption by mitigating drivers' range anxiety. This project is led by Evie Networks and partially funded by the ARENA, with a AUD15 million fund under the Advancing Renewables Program and a total project cost of AUD50.2 million.

The primary objective of this project is to develop and construct at least 42 ultra-fast charging sites strategically located along major highways on the east coast of Australia, including Adelaide, Perth, and Tasmania. These charging stations will be spaced approximately every 150 km, allowing EV drivers to travel between Australia's major cities with the assurance of convenient and secure charging locations. The technical features of these charging stations include the following.

- Each site will be equipped with at least two ultra-fast direct current (DC) chargers.
- Each charger provides up to 350 kW of power, allowing the addition of between 200 to 400 Km of range in approximately 15 minutes, which is 15 times faster than commercially available home charging points.
- Powered by renewable energy, aligning with the economy's sustainability goals.

Finally, the ultra-fast charging technology employed in this project represents a significant innovation in the electric mobility sector. Enabling fast and efficient charging

[178] Australian Renewable Energy Agency. (n.d.). National Ultrafast EV Charging Infrastructure Network. Available at: https://arena.gov.au/projects/national-ultrafast-ev-charging-infrastructure-network/

on high-traffic routes will facilitate a quicker transition to mass EV adoption. Additionally, the project will benefit from the site selection reports and guides developed by Evie Networks, ensuring an efficient and cost-effective deployment process.

“Driving the Nation Fund”[179]

The “Driving the Nation Fund” is an Australian government initiative that facilitates the economy's transition to the use of EVs and hydrogen technologies in transportation. Additionally, this fund aims not only to expand the charging infrastructure for EVs but also to support the decarbonization of heavy transport through the development of hydrogen refueling infrastructure.

Initially funded with AUD250 million, the fund was expanded in 2022 with an additional investment of AUD250 million, reaching a total of AUD500 million. This investment is distributed across four key components:

- **EV Charging Network**: With an allocation of AUD39.3 million, this component focuses on the installation of 117 EV chargers on key routes of Australia's highways, facilitating a continuous and reliable charging network.

- **Hydrogen Highways**: This component includes up to AUD80 million in co-investments with state and territory governments to establish a hydrogen refueling network on heavy transport routes, promoting the decarbonization of freight transport.

- **Recharging Automotive Program**: With a budget of AUD60 million, this program supports the installation of EV charging infrastructure in car dealerships and mechanical workshops across the economy, improving access and convenience for end users.

- **“Driving the Nation Program”**: With AUD70.7 million, this program co-finances initiatives aimed at reducing road transport emissions in Australia, promoting greater adoption of clean technologies.

8.1.4. Success Cases[180]

- A notable success story in the implementation of electromobility in Australia is the adoption and expansion of EV charging infrastructure. This progress is reflected in the increase of fast and ultra-fast charging points across the economy. By the end of 2023, Australia had 812 public fast and ultra-fast charging sites, a significant increase from the 464 sites available at the end of 2022. This growth represents a 75% increase in fast charging infrastructure in just one year, and by the first quarter of 2024, this figure is expected to have reached approximately 900 sites.

- The "Electric Car Discount" is an initiative by the Australian government implemented in 2022 to encourage the adoption of EV by making them more affordable for consumers and businesses. This program includes several key measures:

  ✓ Exemption from Fringe Benefits Tax (FBT): This exemption applies to eligible EV provided by employers to their employees. It includes battery electric cars, hydrogen fuel cell electric cars, and plug-in hybrid cars. To be eligible, the

[179] Department of Climate Change, Energy, Environment and Water. (n.d.). “Driving the Nation Fund”. Available at: https://www.dcceew.gov.au/energy/transport/driving-the-nation-fund

[180] The success stories presented in this section have been built based on the information provided by the National EV Strategy Annual Update 2023-24 document from the Australian Department of Climate Change, Energy, Environment and Water.

vehicles must have an initial sale price below the luxury car tax threshold for fuel-efficient cars (approximately AUD84,916 for the 2022-23 fiscal year). This exemption significantly reduces costs for employers and employees using salary sacrifice arrangements, providing savings of up to AUD9,000 annually for employers and AUD4,700 annually for employees[181] (see Table 5).

- ✓ Removal of the 5% import tariff: In addition to the FBT exemption, the 5% import tariff for eligible EV has been removed, making these vehicles more accessible for Australian families[182].
- ✓ Periodic review: The measure will be reviewed after three years to ensure it continues to be effective in promoting the adoption of EV[183].

Table 5. Savings for the employer due to the non-application of FBT to the provision of electric cars

Subject	**Amount / Details**
FBT Valuation Method	Statutory Formula Method
Cost of Electric Car	AUD48,000
Taxable Value without Exemption	AUD9,600 (calculated as AUD48,000 x 20% statutory fraction)
FBT Liability	AUD9,385.86 (calculated as AUD9,600 x 2.0802 x 47%)
FBT where Exemption for Electric Cars Applies	AUDNil
Annual FBT Savings for the Employer	AUD9,385.86

Source: BDO Australia (2022)[184]

- Another key aspect of success has been the collaboration between the government and the private sector. The ARENA has funded several innovative projects to improve charging infrastructure and promote the adoption of EV. For example, ARENA announced an investment of AUD4.76 million to help Europcar install 256 chargers at least 41 sites around Australia, supporting the integration of approximately 3100 new EV into their passenger rental fleet over the next three years .
- Additionally, state-level programs have been implemented to support charging infrastructure and the adoption of EV. In New South Wales, for example, grants were launched for the installation of chargers at tourist destinations and programs to support charging infrastructure in multi-unit residential buildings.
- These combined efforts have resulted in a significant increase in EV adoption in Australia, with EV representing 9.4% of all new light vehicle sales by the end of April 2024, compared to 8.4% in 2023 and 3.8% in 2022.

Finally, Table 6 presents successful cases in the implementation of charging infrastructure and the transition to electric buses.

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181 https://ministers.treasury.gov.au/ministers/jim-chalmers-2022/media-releases/electric-car-discount-bill-introduced-parliament
https://ministers.treasury.gov.au/ministers/jim-chalmers-2022/media-releases/tax-cut-electric-vehicles-passes-parliament

182 https://ministers.treasury.gov.au/ministers/jim-chalmers-2022/media-releases/tax-cut-electric-vehicles-passes-parliament

183 https://ministers.treasury.gov.au/ministers/jim-chalmers-2022/speeches/second-reading-speech-treasury-laws-amendment-electric-car

184 BDO Australia. (2022). Electric cars now exempt from FBT - what this means for you. Available at: https://www.bdo.com.au/en-au/insights/tax/articles/electric-cars-now-exempt-from-fbt-what-this-means-for-you

Table 6. Successful Cases in the Implementation of Charging Infrastructure and the Transition to Electric Buses by Geographic Areas

Geographic Area	Success Case	Description
ACT	Expansion of Public Charging	The ACT continues to expand its public charging infrastructure, with grant funding recipients announced in August 2022. The network is expected to expand to 100 public chargers in 2023.
	Zero-Emissions Bus Transition	The first buses under the ACT Zero-Emissions Bus Transition Plan were delivered at the end of 2022, as part of the territory's plan to achieve a zero emission public transport system by 2040.
New South Wales	Destination Charging	NSW is providing AUD20 million to co-fund the purchase and installation of EV chargers at eligible regional destinations, which seeks to reduce range anxiety and encourage EV uptake across the state. In June 2022, NSW committed a further AUD10 million to invested in kerbside EV charging to support owners with limited off-street parking.
	Expansion of Public Charging	The NSW Government conducted two rounds of the AUD149 million public EV Fast Charging Grants scheme to co-fund infrastructure across the state. 86 ultra-fast charging stations are already underway as part of round one, with round two in progress.
	Launch of Apartment Charging Guide	The Government also released a step-by-step guide to making residential and commercial buildings EV ready, providing a practical resource for property owners and tenants about how to approach EV integration. Additionally, AUD10 million has been committed to support over 125 strata buildings to retrofit the electrical infrastructure required to install EV chargers.
	Zero Emission Buses Funding	NSW announced AUD3 billion in funding under its Zero Emission Buses program, which provides for more than 1,200 new buses to be manufactured to replace the entire NSW bus fleet with EVs, the construction of a new bus depot at Macquarie Park and conversion of 11 existing bus depots for electric charging.
Northern Territory	EV Charger Grants Scheme	The NT Government has committed AUD300,000 to the provision of residential and business grants for co-funding EV charger purchases and installation.
Queensland	Expansion of Queensland Electric Super Highway and Public Charging	The QLD Government is allocating AUD10 million to co-fund the installation of public fast charging infrastructure across the state. This initiative builds on the Queensland Electric Super Highway, including the Phase 3 expansion which adds 24 sites in regional Queensland. At completion of this next phase, QESH will be a comprehensive fast charging network connecting EV drivers across the state.
	Electric Bus Program	QLD opened Australia's first all-electric bus depot in April 2022, in addition to numerous electric buses entering the QLD transit system, progressing towards a government commitment for all new buses in South East Queensland to be zero emissions vehicles from 2025.
South Australia	Expansion of Public Charging Infrastructure	The SA Government has awarded a AUD12.4 million grant to the RAA for the construction of a state-wide EV charging network. The network comprises over 530 regular, fast and ultra-fast chargers across 140 sites, with more than 75% of sites in rural areas. Construction commenced in December 2022 and is due for completion in 2024.
Victoria	Electric Bus Program Expansion	Under its commitment to expand use of electric heavy vehicles and incentivise local industry, the VIC Government has commenced a threeyear Zero Emissions Bus Trial, with 52 electric buses to be trialled on select bus routes in Melbourne, Seymour and Traralgon. The Ivanhoe bus depot will be converted into a fully zero-emissions depot by 2024. A further 36 electric buses are being incorporated into the network through conventional contract arrangements. Victoria will only purchase zero emission buses from 2025
	EV Charger Regulation Clarity	The Victorian Government made a sensible clarification of the electricity retailer regulatory framework for charge point operators (CPOs). A General Exemption Order was published in September 2022 clarifying regulations by specifically excluding CPOs from requiring a retail electricity licence to sell electricity through an EV charger in Victoria.

Geographic Area	Success Case	Description
Tasmania	Supporting EV Transition	Following the introduction of stamp duty and registration fee exemptions in 2021, the TAS Government continues to support EV uptake, and is working towards its goal for an all-electric government fleet by 2030. The Government continues to support installation of charging infrastructure across the state under its ChargeSmart Fast Charging Program.
	Zero Emission Bus Trials	In mid-2022, TAS announced plans to conduct zero emission bus trials in Launceston and Hobart to inform the state's public transport transition. Following the public tender process, the successful electric bus suppliers will be announced in early 2023.
Western Australia	Charging Infrastructure	The WA Government is investing more than AUD22 million in the WA EV Charging Network. Construction of infrastructure commenced in November 2022. AUD15 million has also been committed to support Not-for-Profits, SMEs, and local governments to install charging infrastructure, and AUD4 million has been allocated to install charging infrastructure at train stations.
	Electric Bus Transition	Following the Federal Government's provision of AUD125 million funding for electric bus charging infrastructure in the 2022-23 Federal Budget, WA will be investing in the local manufacture of 130 buses to transition the Perth bus network and deliver infrastructure upgrades. This builds on the existing electric bus trial that commenced in Perth in February 2022.
Collective Efforts at a Broader Scale	EV Ready Developments	Building ministers have agreed on reforms to improve the energy efficiency, accessibility, and liveability of new homes in Australia. Changes include updates to the National Construction Code (NCC) to make it easier for people living in apartments to switch to EVs by providing base infrastructure for future EV charging. The new provisions will become mandatory on 1 October 2023.

Source: EV Council. (2022)[185]

8.1.5. Limitations, Opportunities, and Challenges for the Automotive Industry in the Transition to Electromobility[186]

In 2022, Australia experienced a dynamic period for the EV market. Federal, state, and territorial governments actively supported EV adoption, recognizing its importance not only for achieving Australia's climate goals but also for reducing the economy's reliance on uncertain and costly global fuel supplies.

Firstly, in the context of opportunities for the Australian economy, the following stand out:

- **Critical Minerals and Battery Production:** The demand for minerals necessary for EV and battery storage could grow at least 30 times by 2040, according to the IEA. Australia, with its abundant reserves of lithium, copper, nickel, and magnesium, is in a privileged position. This economy already extracts half of all materials used in battery production. With significant deposits of vanadium, cobalt, lithium, and other essential materials, Australia has the opportunity not only to manufacture batteries for domestic use but also to create jobs by exporting them globally.

- **Lithium Exports:** Australia is the world's largest producer of lithium, contributing more than half of global production in 2021. The value of lithium exports is expected to increase more than tenfold in two years, from AUD1.1 billion in the 2020-21 period to nearly AUD14 billion in 2022-23, with continued growth in the coming years. The development of a battery industry could contribute AUD7.4 billion annually to the economy and support 34,700 jobs by 2030.

[185] EV Council. (2022). Australian EV industry recap 2022. Available at https://electricvehiclecouncil.com.au/wp-content/uploads/2023/02/AUSTRALIAN-ELECTRIC-VEHICLE-INDUSTRY-RECAP-2022.pdf

[186] Department of Climate Change, Energy, the Environment and Water (DCCEEW). (2023). The National EV Strategy. Canberra: Commonwealth of Australia. Available at: https://www.dcceew.gov.au/sites/default/files/documents/national-electric-vehicle-strategy.pdf págs. 11-12 y 24-25

- **Manufacturing and Supply Chain:** Disruptions in the international supply chain are putting pressure on EV manufacturers, limiting their production and distribution capabilities. However, Australia has the capacity to develop manufacturing opportunities that support the supply of EV, including components and batteries. The government has committed AUD15 billion to establish the National Reconstruction Fund (NRF), which will finance projects in priority areas to diversify and transform the Australian industry and economy, with transport and low-emission technologies as highlighted investment areas.

- **International Clean Energy Partnerships:** Australia has established a series of bilateral clean energy partnerships with Korea, Japan, and the United States, aimed at strengthening cooperation in clean energy technologies, supply chains, and trade. For example, the Low and Zero Emissions Technology Partnership between Australia and the Republic of Korea provides a mechanism to implement practical joint initiatives with Korea in hydrogen fuel cell EV.

On the other hand, the challenges and limitations facing the Australian economy include:

- **Supply Chain Disruptions:** Global supply chain disruptions pose a significant challenge for EV manufacturers, affecting their ability to produce and distribute vehicles. This underscores the need for Australia to develop its own manufacturing and component capabilities to reduce dependence on international supply chains.

- **Local Manufacturing Capacity:** Although Australia possesses the necessary mineral resources for battery production, developing a robust local manufacturing capacity that can compete globally requires significant investment and overcoming technological and logistical barriers.

- **Charging Infrastructure:** Developing adequate charging infrastructure is crucial to support the mass adoption of EV. Without an accessible and efficient network of charging stations, consumer confidence in EV could be compromised.

- **Initial Transition Costs:** The transition to electromobility involves considerable initial costs for both consumers and manufacturers. Investments in research and development, manufacturing, and the expansion of charging infrastructure require continuous support and clear policies to ensure a sustainable return.

8.2. Canada

8.2.1. Urban Mobility Policies Related to the Transition to Electromobility

According to the "Urban Mobility Task" Report prepared by the Council of Ministers Responsible for Transport and Road Safety[187], more than 80% of Canadians live in urban centers or their surrounding suburbs. With the increasing concentration of people and economic activities in urban regions, the demand for the transportation of goods and people is rising. Population growth leads to passenger flows on transportation networks exceeding design capacity, often resulting in a loss of economic productivity due to congestion and overcrowding in certain modes of transport. In 2023, Canada experienced record population growth, reaching an estimated population of 40.5 million by the end of the year. It is projected that by 2036 the population will increase by more

[187] Council of Ministers Responsible for Transportation and Highway Safety. (2021). Urban Mobility Task Force Report. Available at: https://www.comt.ca/Reports/Urban%20Mobility%202021.pdf

than an additional 2.5 million, mainly concentrated in urban centers[188]. This growth will increase the demand for urban travel and its negative externalities.

Transportation has substantial impacts on the economy, the environment, the livability of urban centers, and the health of Canadians. Therefore, all levels of government in Canada are working to address urban mobility issues through various measures such as infrastructure investments, new and adaptive regulations, the assessment and deployment of new technologies, transportation demand management initiatives, and greater integration of transportation modes.

Across Canada, initiatives and approaches may vary, but all governments at all levels are working towards similar goals in their efforts to improve safe and sustainable urban mobility, support job creation and economic prosperity, reduce pollution and minimize environmental impacts, alleviate congestion, and enhance community livability by providing access to workplaces, leisure activities, and promoting social equity.

To achieve a more equitable and low-carbon transportation system, the Affordability Action Council[189] recommends that the federal government take two key actions outlined below.

- **ZEV Incentive Program:**

Objective: Support the purchase of more affordable zero-emission transportation options and better target incentives towards low- and middle-income households.

Specific actions:

- ✓ Include used EV, electric bicycles, mopeds, and electric scooters in the incentive program.
- ✓ Prioritize incentives for low- and middle-income households, making them the primary beneficiaries.
- ✓ Gradually phase out point-of-sale discounts for higher-income households.
- ✓ Gradually reduce the existing price limits on vehicles eligible for the program.

[188] Transport Canada. (2023). Transportation in Canada 2023. Government of Canada. Available at: https://tc.canada.ca/en/corporate-services/transparency/corporate-management-reporting/transportation-canada-annual-reports
[189] Affordability Action Council. (2024). Rethinking Urban Mobility: Providing More Affordable and Equitable Transportation Options. Institute for Research on Public Policy. https://irpp.org/research-studies/rethinking-urban-mobility/

- **Leveraging Federal Transit Funds:**

Objective: Expand accessible and affordable public transportation services to increase ridership.

Specific actions:

- ✓ Provide operational funding so transit systems can adapt to new travel patterns and recover from ridership losses caused by the pandemic.
- ✓ Increase service frequency and improve fare affordability.
- ✓ Accelerate the deployment of the Permanent Public Transit Fund.
- ✓ Establish housing density requirements near transit stations to promote more efficient and accessible use of public transportation.

These combined actions aim not only to make zero-emission transportation options more accessible but also to improve and expand public transportation to support sustainable and equitable ridership growth, especially in low- and middle-income communities.

Regarding pollution reduction and minimizing environmental impacts, Canada's 2030 Emissions Reduction Plan (ERP), launched in March 2022, sets out several commitments and investments aimed at reducing road vehicle emissions. In December 2023, the Government of Canada published the 2023 Progress Report on the ERP, showing Canada's advancements in this endeavor. These advancements are reflected in the following table.

Table 7. Commitments and Progress of the ERP

ERP Commitment	Progress Achieved
Develop zero-emission vehicle sales regulations for the light-duty vehicle sector and the medium- and heavy-duty vehicle sector.	The final regulations for LDV were published in December 2022. The proposed regulations for medium- and heavy-duty vehicles are scheduled for Part I of the Canada Gazette in 2024. The final regulations are expected to be implemented in 2025.
Invest CAD1.7 billion to extend and expand the Incentives for Zero-Emission Vehicles (iZEV) Program for LDV for 3 years until March 31, 2025.	The Incentives for Zero-Emission Vehicles Program for LDV was extended for 3 years until March 31, 2025. The eligibility of several larger vehicles was expanded. Since May 2019, more than 330,000 vehicles have been incentivized through the Program. In 2023, Transport Canada made 2 key changes to the Incentives for Zero-Emission Vehicles Program: • A new mandatory pre-eligibility assessment to streamline the claims process and ensure dealers do not exceed incentive limits. • Expanded the annual incentive limit for carsharing companies from 10 per year to 50 following the 2023 Budget decision.

Investing CAD547.5 million to launch the Incentives for Medium- and HeavyDuty Zero-Emission Vehicles (iMHZEV) Program	In October 2023, adjustments were made to better ensure program integrity and efficient use of funding towards commercial vehicles. The adjustments include:
	• Revised vehicle eligibility criteria to determine if vehicles in classes 2B and 3 are considered commercial vehicles or medium duty passenger vehicles.
	• A new incentive rate of CAD5,000 for class 2B and 3 medium-duty passenger vehicles.
	• CAD100,000 manufacturer's suggested retail price limit for medium-duty passenger vehicles.
	  o Vehicles with a retail price below the limit are eligible for the new incentive rate
	  o Vehicles with a retail price above the limit are ineligible

ERP Commitment	Progress Achieved
Invest CAD75.8 million to contribute to the safe deployment of medium- and heavy-duty zero-emission vehicles on Canadian roads.	Over CAD1.3 M in contribution funding was approved to gather data on zero-emission truck performance to support the safe deployment of zero-emission trucking technologies. A CAD1.5 million Trucking Testbed contract was issued to deploy heavy-duty zero-emission trucks into Canadian commercial freight haul operations. Three Zero-Emission Trucking Workshops were hosted to share information and guide future program activities.
Invest CAD199.6 million to retrofit large trucks currently on the road.	Two streams of the Green Freight Program have been launched to accept applications for funding: • Stream 1 (December 2022 to March 2027) is accepting applications for fleet energy assessments and retrofits that would result in lower greenhouse gas emissions. • Stream 2 (August 2023 to November 2023) accepted applications for projects that repower existing medium- and heavy-duty fleets and offset the incremental cost of new trucks powered by lower carbon fuels.
Invest CAD400 million in support of the Government's objective of adding zero-emission vehicle chargers to Canada's network aided by an additional CAD500 million from the Canada Infrastructure Bank (CIB).	As of June 2023, over 42,000 electric chargers and 16 hydrogen refuelling stations have been selected for funding (over 6,000 have been installed) under the Zero-Emission Vehicle Infrastructure Program (ZEVIP). A continuous intake pilot for Indigenous streams of ZEVIP and Awareness programs was also launched in April 2023.
Investing CAD2.2 million to support Greening Government fleet electrification commitments.	The proportion of green vehicles in the Government of Canada's light duty conventional fleet continues to grow. In 2022-23, 14% of the light duty conventional fleet was green vehicles, up from 10.8% in 2021-2022.

Source: Transport Canada. (2023). Transportation in Canada 2023.[190]

Canada achieved a zero-emission light-duty vehicle market share of 11.7% in 2023, an increase of 8.9% compared to 2022. Similarly, the market share of zero-emission medium- and heavy-duty vehicles reached 2.1% in 2023, an increase of 0.8% compared to 2022.

By 2030, the Government of Canada, through the EV Action Plan[191], proposes a series of urban mobility policies related to the transition to electromobility. These policies are designed to encourage the adoption of EV and transition towards more sustainable and equitable mobility. Notable policies include:

- **iZEV Program**[192]

The Government of Canada's Incentives for Zero-Emission Vehicles (iZEV) Program aims to make the adoption of clean technologies more affordable through financial incentives. It offers point-of-sale incentives for consumers who purchase or lease zero-emission vehicles. Eligible vehicles include: i) battery EV, ii) hydrogen fuel cell vehicles, and iii) longer-range PHEV.

Available Incentives

✓ **Battery EV and hydrogen fuel cell vehicles:** Up to CAD5,000.

[190] Transport Canada. (2023). Transportation in Canada 2023. Government of Canada. https://tc.canada.ca/en/corporate-services/transparency/corporate-management-reporting/transportation-canada-annual-reports
[191] https://2030evactionplan.ca/#about-emc
[192] https://tc.canada.ca/en/road-transportation/innovative-technologies/zero-emission-vehicles/incentives-zero-emission-vehicles/program-overview

- ✓ **Longer-range PHEV:** Up to CAD5,000 (electric range of 50 Km or more).
- ✓ **Shorter-range PHEV:** Up to CAD2,500 (electric range of less than 50 Km).

To receive the incentive, the dealer applies the discount directly to the sales invoice or lease contract after confirming the consumer's eligibility. Additionally, the program allows for additional incentives provided by provincial or territorial governments. Each individual consumer can benefit from one incentive per year, while businesses and governments can receive up to 10 incentives annually, and pre-approved carsharing companies can receive up to 50 incentives per year.

The iZEV program not only aims to reduce the initial cost of ZEV but also to promote cleaner air and reduce greenhouse gas emissions. By setting limits on the number of incentives per year, the program ensures an equitable distribution of resources and maximizes the positive environmental impact. This program is a key component of Canada's efforts to achieve its sustainability goals and improve air quality for all its citizens.

- **Incentives for Medium- and Heavy-Duty Zero-Emission Vehicles (iMHZEV) Program**

The Government of Canada has recognized that the high initial cost of acquiring medium- and heavy-duty zero-emission vehicles (MHZEV) is a significant barrier to the adoption of this clean technology. To address this issue, the Incentives for Medium- and Heavy-Duty Zero-Emission Vehicles (iMHZEV) Program has been implemented. This program aims to make these vehicles more affordable for Canadian organizations and businesses.

The iMHZEV Program offers point-of-sale incentives for Canadian organizations and businesses that purchase or lease an eligible MHZEV. Only companies with registered offices in Canada are eligible. The vehicles must be on the program's eligibility list and be acquired or leased for a minimum of 12 months from the eligibility date. For leases shorter than 48 months, incentives will be prorated according to the contract duration.

The incentive will be applied at the point of sale by authorized dealers or sellers, who will verify the buyer's eligibility. Taxes and fees must be applied before granting the incentive, which will be directly reflected on the sales invoice or lease contract. Beneficiary organizations do not need to submit reimbursement applications; only registered dealers can do so.

Eligible organizations can receive up to 10 incentives or a maximum of CAD1,000,000 per calendar year, whichever comes first. These limits apply at the organizational level and cannot be transferred to future years.

To be eligible under the iMHZEV Program, a vehicle must be zero-emission, which includes battery EV, PHEV, and hydrogen fuel cell vehicles. The vehicles must have a gross weight of more than 8,500 pounds to be considered medium- or heavy-duty. Specific incentive categories are determined by the vehicle's configuration and class, with amounts ranging from CAD10,000 to CAD200,000. Incentives vary according to the vehicle class.

- ✓ **Medium-duty commercial and passenger vehicles:** Maximum incentives for different vehicle classes range from CAD10,000 for Class 2B vehicles to CAD200,000 for Class 7/8 fuel cell buses and trucks.
- ✓ **PHEV:** Receive 50% of the total incentive per vehicle weight class, up to a maximum of CAD50,000.

In conclusion, the iMHZEV Program is a key initiative of the Government of Canada to promote the adoption of cleaner and more sustainable transportation technologies, making zero-emission vehicles more accessible and affordable for Canadian businesses and organizations. By reducing financial barriers and offering significant incentives, this program supports the transition to a greener and more efficient transportation future in the economy.

- **Zero Emission Transit Fund**[193]

The Zero-Emission Transit Fund (ZETF) is a program launched by the Canadian government in 2021 as part of new investments in public transportation. This program, with a budget of CAD2.75 billion, is designed to help public transit agencies and school bus operators plan for and acquire zero-emission buses, as well as the related infrastructure. The fund works in coordination with the Canada Infrastructure Bank's Zero-Emission Bus Initiative (CIB), which offers flexible financing solutions that leverage operational savings over the lifecycle to offset higher upfront costs.

The ZETF has two main components of projects eligible for funding:

✓ **Planning Projects:** Include studies, modeling, and feasibility analysis that support the future deployment of zero-emission buses. These projects help transit and school bus operators establish comprehensive electrification plans for future capital projects.

✓ **Capital Projects:** Include the acquisition of buses, charging and refueling infrastructure, and other related infrastructure needs for the deployment of ZEBs. ZEBs are vehicles that produce no tailpipe emissions, such as electric and hydrogen fuel cell buses.

The primary objective of the ZETF is to advance the Government of Canada's commitment to help acquire zero-emission public and school buses, in close partnership with the CIB. Additionally, this funding will help communities electrify their school and public transit bus fleets, reducing emissions and long-term operational costs. Investments are aimed at supporting clean transportation by investing in vehicles, infrastructure, and organizational readiness to enable fleet electrification.

The ZETF also closely coordinates with the CIB's commitment to invest in zero-emission buses as part of its three-year Growth Plan. The application process includes two stages:

1. **Expression of Interest:** To determine the applicant's eligibility and assess the current level of project planning.
2. **Project Application:** Depending on the level of planning, applicants can apply for planning or capital project funding.

The ZETF is crucial for Canada's transition to more sustainable and clean public transportation. By providing significant funds for the planning and acquisition of zero-emission buses, the program addresses several key challenges:

✓ **Emission Reduction:** By replacing conventional buses with ZEBs, greenhouse gas emissions and other pollutants are significantly reduced, contributing to improved air quality and public health.
✓ **Long-Term Cost Savings:** The flexible financing from the CIB allows operators to leverage operational savings over the life cycle of zero-emission buses to offset the higher initial costs, making the transition financially viable.

[193] Transport Canada. (n.d.). *Applicant guide: Zero Emission Transit Fund*. Available at: https://housing-infrastructure.canada.ca/alt-format/pdf/zero-emissions-trans-zero-emissions/applicant-guide-demandeur-en.pdf

- ✓ **Innovation and Competitiveness:** Supporting the planning and infrastructure necessary for the deployment of ZEBs fosters innovation in the transportation sector and ensures that Canada maintains its leadership in clean technologies.
- ✓ **Equity and Accessibility:** By including a wide range of eligible applicants, from municipalities and regional governments to school bus operators and Indigenous organizations, the ZETF ensures that the benefits of transportation electrification are accessible to all Canadian communities.

In summary, the ZETF plays a fundamental role in Canada's strategy to achieve its emission reduction goals and transition towards a cleaner and more efficient transportation system.

- **Zero-Emission Passenger Vehicle Policy for 2030**[194]

The policy proposes adopting a mandate requiring that 90% of passenger vehicle sales in Canada be ZEV by 2030. This represents a more stringent standard compared to the current one, which aims for 100% of vehicle sales to be ZEV by 2035 but only 60% by 2030. With the right policies, Electric Mobility Canada believes that Canada can achieve this goal sooner, resulting in cleaner air and a significant reduction in greenhouse gas pollution.

In addition to improving air quality, the implementation of a strict target would encourage manufacturers to introduce more EV models, expanding options for consumers and reducing wait times to acquire these vehicles. This policy also aims to level the playing field across Canada, ensuring that the supply of EVs is not concentrated solely in provinces with pre-existing standards, such as British Columbia and Quebec, but is extended across the entire economy. As a result, vehicle costs would decrease, infrastructure programs would offer better value, and industrial production and innovation would be boosted, contributing to sustainable economic growth and the achievement of local emission reduction targets.

- **Incentive Policy for New EVs** [195]

The policy proposes imposing a fee on new vehicles that generate higher emissions. The revenue generated from these fees will be used to fund incentives for the purchase of new EV. This system offers consumers a choice: they can opt for a less polluting vehicle and benefit from the incentives, or they can purchase a more polluting vehicle and contribute with the fee that will fund the incentives for EV.

Additionally, the policy includes the possibility of exemptions for large families and individuals who need larger vehicles for work-related reasons, ensuring that the financial burden does not unfairly fall on those who rely on more polluting vehicles out of necessity. In this way, the aim is not only to incentivize the purchase of EV but also to promote a just and equitable transition towards more sustainable mobility.

- **Zero Emission Bus Initiative**[196]

The CIB has launched the Zero Emission Bus (ZEB) Initiative, aimed at providing financing for the acquisition and deployment of electric buses. This initiative is designed to financially support transit agencies and municipalities by covering the initial costs of both the EV and the necessary infrastructure for their operation. In addition to offering financial support, the CIB provides technical assistance and advisory services to ensure

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[194]https://2030evactionplan.ca/policy-recommendations/policy-details-2030-electric-vehicle-strategy-and-ev-regulation-national-zev-mandate/

[195] https://2030evactionplan.ca/policy-recommendations/policy-details-light-duty-ev-consumer-adoption-polluting-vehicles/

[196] Canada Infrastructure Bank. (2023). *Zero emission bus initiative.* Available at: https://cib-bic.ca/en/zero-emission-buses-initiative/#:~=Zero%2Demission%20buses%20(ZEBs),modernization%20of%20the%20bus%20fleets

the effective and efficient implementation of electric buses. This effort aligns with the federal government's commitment to facilitate the acquisition of 5,000 ZEB and to support the construction of the necessary charging infrastructure, as well as the improvement of support facilities.

Among the strategic partnerships highlighted within this initiative are several Canadian cities and regions. For instance, Brampton has received CAD400 million in financing for the acquisition of 450 ZEB. Ottawa has secured CAD380 million to fund 446 ZEB. The York region has obtained CAD136 million to support the purchase of 180 ZEB. Additionally, Highland Electric Fleets has received CAD50 million to facilitate the acquisition of hundreds of electric school buses. These investments underscore Canada's commitment to reducing emissions in public and school transportation and developing a more sustainable transportation infrastructure.

- **Zero Emission Vehicle Infrastructure Program (ZEVIP)**[197]

Since 2016, Canada has invested over CAD1 billion to make EV more affordable and chargers more accessible to Canadians. Specifically, in the 2019 budget and the 2020 Fall Economic Statement, CAD280 million was committed to the ZEVIP over five years to support the deployment of 33,500 EV chargers and ten hydrogen refueling stations in public places, on-street, in multi-unit residential buildings, and workplaces, as well as strategic infrastructure projects for urban delivery and fleet applications.

Subsequently, in the 2022 budget, an additional CAD400 million was recapitalized for ZEVIP and the program was extended until 31 March 2027, complemented by CAD500 million that the CIB will invest in large-scale EV charging and refueling infrastructure. The Government of Canada's zero-emission vehicle charging and refueling infrastructure goals are currently 84,500 chargers and 45 hydrogen stations to be deployed by 2029.

As of July 2024, the funding opportunity for ZEV infrastructure owners/operators is open for applications. Specifically, the funding focuses on deploying EV chargers in public places, on-street, in multi-unit residential buildings, workplaces, and for vehicle fleets. Additionally, NRCan's contribution will be limited to fifty percent (50%) of the total project cost, up to a maximum of CAD5 million per project.

On the other hand, applications for delivery organizations and Indigenous organizations are temporarily closed and closed, respectively. Finally, ZEVIP establishes the following guidelines:

- ✓ Funding for smaller EV charging projects with fewer than 20 Level 2 connectors or 2 fast chargers can be found through organizations authorized to redistribute a component of ZEVIP funding.
- ✓ Larger EV charging or hydrogen refueling projects exceeding CAD20 million and undertaken by the private sector will be redirected to the CIB’s Hydrogen and EV Charging Infrastructure Initiative for funding consideration.

- **Standards Promoting or Accelerating the Transition to Electromobility**

  - ✓ **Motor Vehicle Safety Regulations (C.R.C., c. 1038)**

The "Motor Vehicle Safety Regulations," under chapter C.R.C., c. 1038, is an essential set of standards in Canada that establishes the safety and emission requirements for motor vehicles. Its primary objective is to ensure that all vehicles on the road comply with the necessary standards to protect users and minimize road risks.

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[197] Natural Resources Canada. (n.d.). Zero-emission vehicle infrastructure program. Available at: https://natural-resources.canada.ca/energy-efficiency/transportation-alternative-fuels/zero-emission-vehicle-infrastructure-program/21876

The key aspects of this regulation are detailed below:

1. **Interpretation and Application:** The regulation defines key terms and establishes the applicability of the regulations for different types of vehicles, including passenger cars, multipurpose vehicles, trucks, and buses. This section ensures that all vehicle types are subject to the same safety and emission standards.
2. **Safety and Emission Requirements:** It sets detailed standards for the strength and labeling of safety components such as seat belts and child restraint systems, as well as emission standards to minimize air pollution. This includes technical specifications to ensure occupant safety in the event of accidents and the reduction of harmful emissions.
3. **Importation and Compliance:** It regulates vehicle importation, requiring that all imported vehicles meet the same safety standards as vehicles produced in Canada. It includes specific requirements for vehicles imported temporarily and for special purposes, ensuring that all vehicles in the Canadian market are safe and efficient.
4. **Compliance Labels:** It stipulates that vehicles must have a compliance label indicating adherence to safety regulations. This label is essential for the sale and use of vehicles in Canada, providing a visible guarantee of safety and regulatory compliance.
5. **Technical Requirements:** It details the technical requirements for various vehicle parts, including glass materials, noise emission standards, and occupant protection in case of accidents. These specifications ensure that all vehicle components contribute to overall vehicle safety and efficiency.

The "Motor Vehicle Safety Regulations" also includes specific provisions for electric and hybrid vehicles, thereby promoting electromobility. These standards recognize the importance of EV in reducing carbon emissions and transitioning towards a more sustainable economy. For example, noise requirements for EV are established to ensure they meet auditory safety standards on the roads. Additionally, the regulation facilitates the adoption of clean technologies by providing a clear and specific regulatory framework for EV, incentivizing their production and use.

By fostering a favorable regulatory environment for the expansion of electromobility, the regulation significantly contributes to Canada’s environmental sustainability goals, supporting the reduction of greenhouse gas emissions and promoting a cleaner and more efficient transportation infrastructure.

8.2.2. Energy Policy Related to the Transition to Electromobility

Transforming Canada’s energy systems is essential to achieving a net-zero emissions economy by 2050. Electrification will not be the only pathway to a net-zero economy. The challenge is that there is a risk that increased electricity demand, if met by carbon-generating sources, could lead to a rise in GHG emissions from the electricity sector. In this regard, it is crucial to take action now to prevent this scenario[198].

To achieve a net-zero emissions electrical system, coordinated efforts are required between the provinces and territories, which have jurisdiction over the planning and operation of the electrical system, and the federal government, which regulates emissions reduction and interprovincial transmission projects. Canada’s electrical sector has already made significant contributions to reducing GHG emissions, with 82% of current generation coming from non-emitting sources. Since 2005, emissions from the sector have been reduced[199].

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[198] Environment and Climate Change Canada. (2022). *Clean Electricity Standard Discussion Paper*. Available at: https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/achieving-net-zero-emissions-electricity-generation-discussion-paper.html
[199] Ibid.

Despite these advancements, electricity generation remains the fourth largest source of emissions in Canada, accounting for 8.4% of total GHG emissions in 2019. Without additional measures, there is a risk that current emission reduction trends could be reversed. The phase-out of coal-fired electricity generation by 2030 will reduce emissions[200].

The increase in electricity demand, as other sectors of the economy decarbonize, could lead to higher emissions if the new generating capacity comes from emitting sources. Various pathways to a net-zero emissions goal for 2050 conclude that electricity generation may need to double in the coming decades. To ensure that the entire economy reaches the net-zero target by 2050, it is essential that this additional generation comes almost entirely from non-emitting or low-GHG emission sources.[201].

The transition to low and zero-emission vehicles is a crucial component in the evolution toward a more sustainable and equitable energy system. However, this shift must be viewed as part of a broader transformation of the energy system, which includes essential improvements to the electricity grids of the economy to handle increased demand and the implementation of innovations in urban planning and design. Integrating these technologies within the urban and energy context not only requires policies that promote the adoption of EV but also a holistic approach to ensure that infrastructures are prepared to support this change[202].

According to the "Canada's Clean Road Transportation Action Plan"[203], in 2016, the Government of Canada established a Task Force on Infrastructure and Grid Readiness to address the increasing electricity demand caused by the adoption of ZEV. This task force has monitored the additional load and its impact on the grid, assessed changes in behaviors towards the adoption of EV, and developed tools to enhance electrical infrastructure. In 2020, a government-commissioned study helped utility companies better understand the future energy demands of EV fleets.

The insights gained from these initiatives have been essential for planning grid readiness, ensuring that Canada can support the growing adoption of new EV. In this context, transitioning to a low-carbon future will require circular economy solutions to minimize waste and mitigate pressure on critical resources, thus supporting the sustainability and resilience of the electrical and transportation systems.

Policy for Condominiums and Apartments for EVs[204]

The policy for condominiums and apartments for EV aims to achieve one million homes with charging capability within five years. This policy seeks to overcome a critical barrier to the adoption of EV: access to charging infrastructure in residential buildings. With nearly 30% of Canadians living in apartments or condominiums, the lack of charging stations in these locations constitutes a significant obstacle. To address this challenge, the government proposes an investment of CAD1 billion over five years, which equates to CAD200 million annually. This funding is intended to prepare one million parking spaces in these buildings to be suitable for EV. The policy includes covering 50% of the costs for upgrading and preparing the electrical infrastructure in existing multi-family residential buildings. By facilitating access to charging, this initiative will not only promote the adoption of EV among apartment and condominium residents but will also

[200] Ibid.
[201] Ibid.
[202]Transport Canada. (2022). *Canada's Action Plan for Clean On-Road Transportation*. Available at: https://tc.canada.ca/en/road-transportation/publications/canada-s-action-plan-clean-road-transportation
[203] Ibid.
[204] https://2030evactionplan.ca/policy-recommendations/policy-details-national-ev-infrastructure-deployment-plan/

significantly contribute to reducing emissions and transitioning towards more sustainable mobility in Canada.

Positive Charging Policy[205]

The Positive Charge document aims to maximize the ecosystem for recycling and reusing EV batteries. This policy document addresses the critical importance of safely and sustainably managing EV batteries at the end of their life cycle. In an effort to advance toward decarbonized transportation, the Government of Canada, along with the provinces of Ontario and Quebec, has invested nearly CAD40 billion to incentivize global battery companies to establish manufacturing plants in the economy. Despite these efforts, the current operational capacity for EV battery recycling in Canada remains limited, with few active commercial facilities.

The document identifies several economic, regulatory, and technical challenges in managing EV batteries. Economically, the lack of a comprehensive regulatory framework leaves battery management at the mercy of market forces, which could compromise environmental and safety considerations. In terms of regulation, the fragmented jurisdiction between provinces and territories may result in an inconsistent approach across the economy. Additionally, the technical complexity and variability in EV battery design make efficient recycling and reuse difficult.

The role of energy is fundamental in the context of repurposing[206] and recycling EV batteries. Once EV batteries reach the end of their life cycle, they can be repurposed for renewable energy storage, thus replacing fossil fuel-based systems and significantly contributing to the reduction of greenhouse gas emissions. The integration of repurposed batteries into energy storage infrastructure can optimize the electrical grid by providing stability and responsiveness to fluctuating demand. Additionally, a domestic supply of critical minerals recovered from recycled batteries can enhance Canada's energy security by reducing reliance on international supply chains and supporting the development of a more resilient and sustainable energy economy.

To address these challenges, the document proposes several key recommendations:

1. **Market Conditions and Capacity:** Encourage market conditions to support the repurposing and recycling sector for batteries, including specific subsidies and tax credits.
2. **Design for Circularity:** Promote that battery manufacturers adopt circular economy principles, facilitating dismantling, reuse, and recycling.
3. **Research and Development:** Accelerate research and development in repurposing and recycling technologies, supporting collaboration between government, industry, and academia.
4. **Coordinated End-of-Life (EoL) Management Approaches:** Implement a coordinated battery recovery approach, ensuring that producers are responsible for the sustainable management of discarded batteries.
5. **State of Health (SoH) Assessments:** Standardize and make accessible the assessments of battery state of health for all actors in the EV battery ecosystem.
6. **Battery Passport System:** Introduce a battery passport system that includes information on the model, capacity, and chemical composition of the battery, enhancing confidence in secondary markets.
7. **Training Programs:** Develop and promote training programs for the safe handling of EV batteries, ensuring a well-trained workforce.

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[205] Action Canada. (2024). Positive Charge: Maximizing Canada's EV Battery Repurposing and Recycling Ecosystem. Public Policy Forum. https://actioncanada.ca/wp-content/uploads/2024/02/Positive-Charge-EN-WEB.pdf

[206] Repurposing refers to the process of reusing a product for a purpose different from its original design, without undergoing a complete recycling process. In the context of EV batteries, repurposing involves giving them a second life by using them in applications other than powering a vehicle.

8. **Simplification of Transport and Storage Regulations:** Simplify and harmonize transport and storage regulations for EV batteries with U.S. standards to avoid inefficiencies and additional costs.

In conclusion, Canada's transition to EV adoption is underway, but to ensure long-term sustainability, it is crucial to establish a robust sector for repurposing and recycling batteries. The policy recommendations in the document highlight the need for a holistic and coordinated approach that maximizes the economic and environmental benefits of this transition, positioning Canada as a leader in the global EV battery ecosystem.

Norms Promoting or Accelerating the Transition to Electromobility

- **The Canadian Net-Zero Emissions Accountability Act**

The Canadian Net-Zero Emissions Accountability Act was enacted on 29 June 2021. This legislation establishes a legal framework for Canada to achieve net-zero emissions by 2050. Published by the Minister of Justice, it represents a concerted effort involving multiple levels of government, including Indigenous communities, the private sector, and civil society, with the goal of ensuring transparency and accountability in efforts to reduce GHG.

Key highlights of the act include:

- ✓ **Setting Targets:** The act requires the establishment of greenhouse gas emission reduction targets for the years 2030, 2035, 2040, and 2045, with the ultimate goal of achieving "net-zero" by 2050. These targets align with Canada's international climate change commitments.

- ✓ **Emission Reduction Plan:** A detailed plan is developed that outlines the strategies and measures needed to reduce emissions across various sectors, including transportation, industry, and energy generation. This plan includes promoting clean technologies, improving energy efficiency, and transitioning to renewable energy sources.

- ✓ **Public Participation and Consultation:** The act emphasizes the importance of public participation and consultation with provincial, territorial, Indigenous governments, and other stakeholders. This ensures that policies and actions are inclusive and reflect the needs and priorities of all Canadians.
- ✓ **Progress Reports and Assessment:** The Minister of the Environment must prepare and publish periodic reports evaluating progress towards the established targets and the effectiveness of implemented measures. These reports provide transparency and allow for policy adjustments as needed to ensure the achievement of the objectives.

This act plays a crucial role in promoting electromobility in Canada. By setting clear targets and a structured action plan for emission reduction, it creates a favorable environment for the adoption of EV and other zero-emission technologies. The act includes incentives for the purchase of EV, investments in charging infrastructure, and the promotion of research and development in clean technologies, all of which are essential to support this transition.

The focus on transparency and accountability ensures that efforts are measurable and adjustable as needed, which is vital for staying on track towards net-zero. Additionally, involving all levels of government and Indigenous communities ensures that actions are inclusive and equitable, promoting a just transition for all Canadians. Therefore, this legislation not only contributes to the reduction of greenhouse gas emissions but also fosters the development of a sustainable and resilient economy.

- **Clean Fuel Regulation**

The Clean Fuel Regulations SOR/2022-140, enacted on 21 June 2022, under the Canadian Environmental Protection Act, 1999, establishes a comprehensive regulatory framework to reduce the carbon intensity of liquid and gaseous fuels used in Canada. The primary objective of this regulation is to mitigate air pollution from fossil fuel combustion by implementing strict carbon intensity limits and promoting low-carbon fuels. Additionally, the regulation introduces a compliance unit system that allows fuel producers to meet the new standards through emission reduction credits. The regulation sets progressive targets for reducing the carbon intensity of fuels, starting in 2023. The goal is to reduce the carbon intensity of liquid fuels to 80.1 gCO_2e/MJ by 2030, thereby incentivizing the production and use of cleaner fuels. This regulation requires fuel producers to submit annual and quarterly reports detailing the creation and use of compliance credits. These reports must be verified by accredited organizations to ensure compliance and transparency in the process.

One of the most innovative components of the regulation is the creation of compliance credits[207], which can be generated through the production of low-carbon intensity fuels, the use of renewable energy, and the implementation of projects that reduce CO_2 equivalent emissions. This system not only motivates producers to adopt more sustainable practices but also establishes a market mechanism for the transfer of these credits among participants. This credit trading facilitates innovation and investment in clean technologies.

The regulation also recognizes the use of electricity as a valid energy source for EV. This allows for the creation of specific compliance credits for electricity used in EV charging, thereby incentivizing the adoption of these vehicles and promoting the expansion of electric charging infrastructure across the economy. By doing so, the regulation not only supports the reduction of emissions in the transportation sector but also drives the transition towards a more sustainable and low-carbon economy. This policy plays a crucial role in promoting electromobility in Canada. By encouraging the reduction of carbon intensity and the adoption of cleaner fuels, it creates a favorable environment for the transition to EV. The recognition of electricity as an energy source for EV and the possibility of generating compliance credits for electricity used in charging these vehicles significantly incentivizes EV adoption. This not only reduces greenhouse gas emissions in the transportation sector but also boosts investment in electric charging infrastructure and related technologies.

8.2.3. Specific Electromobility Policies

Passenger transportation by pickup trucks has had a significant impact on greenhouse gas emissions in Canada. In 2021, the use of these trucks accounted for one-third of total emissions in the transportation sector. This figure reflects the growing trend in preference for these vehicles, with their sales share increasing dramatically from 53% in 2010 to 80% in 2022[208]. The growing dominance of pickup trucks in Canada's passenger vehicle market has had several negative consequences. Compared to other car models, pickup trucks have significantly lower fuel efficiency, contributing to higher greenhouse gas emissions. This trend is hindering progress in improving fuel efficiency and reducing

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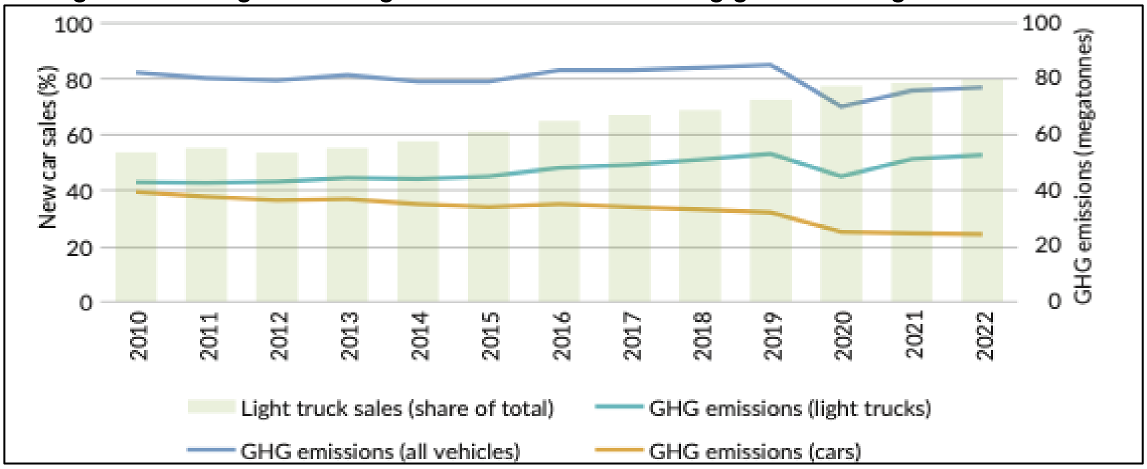
[207] Compliance credits are a key tool within the "Clean Fuel Regulations" that allow for flexibility in meeting carbon reduction goals. They encourage innovation and investment in clean technologies by creating a market for emission reductions, thereby incentivizing more sustainable behavior in the fuel sector.

[208] Affordability Action Council. (2024). Rethinking Urban Mobility: Providing More Affordable and Equitable Transportation Options. Institute for Research on Public Policy. Available at: https://irpp.org/research-studies/rethinking-urban-mobility/

emissions. Canada's passenger vehicle fleet has the worst fuel economy of any major automotive market globally, due to the popularity of light-duty trucks[209].

Additionally, the operating costs for pickup truck owners are higher than for other vehicles due to greater fuel consumption and increased emissions. This situation is concerning as it undermines efforts to mitigate climate change by promoting more efficient vehicles. To illustrate this issue, Figure 53 clearly shows the evolution of pickup truck sales and its impact on greenhouse gas emissions and fuel efficiency over the years.

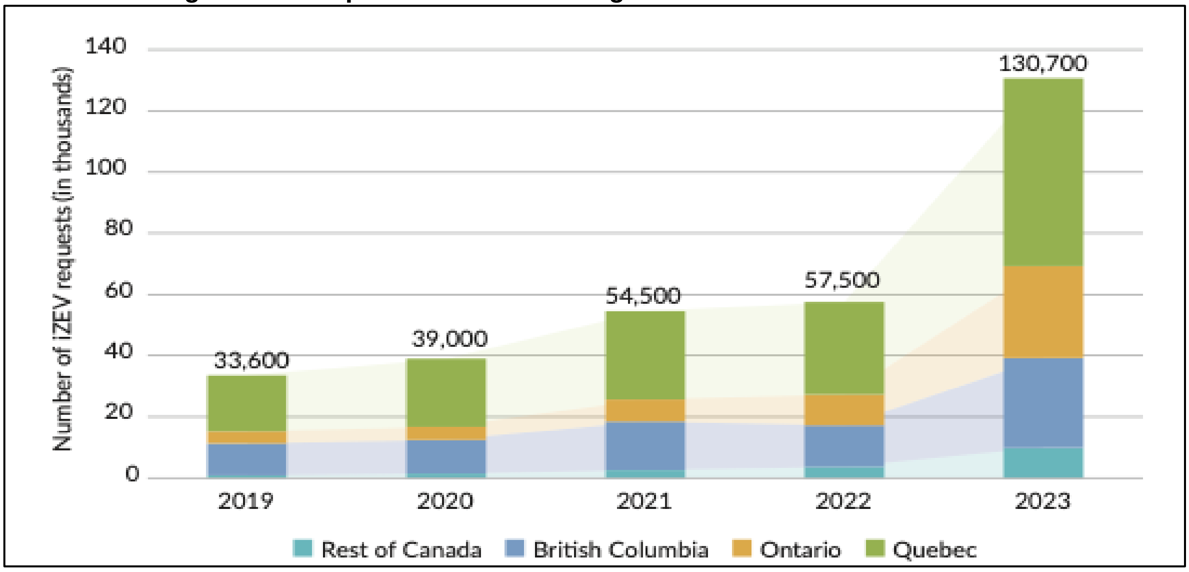
Figure 53. The growth in light truck sales is offsetting greenhouse gas reductions.



Source: Affordability Action Council. (2024). Rethinking Urban Mobility: Providing More Affordable and Equitable Transportation Options.

In the report "Rethinking Urban Mobility: Providing More Affordable and Equitable Transportation Options," prepared by the Affordability Action Council[210], the evolution of EV and PHEV adoption in Canada is presented. Registrations for these types of vehicles have shown a steady increase, reaching a 13.3% market share in the third quarter of 2023. S&P Global Mobility (2023) projects that zero-emission vehicles will represent 25% of new sales in the Canadian market by 2025.

Figure 54. Adoption of the iZEV Program between 2019 and 2023



Source: Affordability Action Council. (2024). Rethinking Urban Mobility: Providing More Affordable and Equitable Transportation Options.

[209] Ibid.

[210] Affordability Action Council. (2024). Rethinking Urban Mobility: Providing More Affordable and Equitable Transportation Options. Institute for Research on Public Policy. Available at: https://irpp.org/research-studies/rethinking-urban-mobility/

The federal government's Zero Emission Vehicle Incentive Program (iZEV) offers up to CAD5,000 to individuals who purchase new zero-emission vehicles through registered dealerships in Canada. It is noteworthy that between 2019 and 2023, annual incentive applications increased from approximately 34,000 to 131,000, as shown in Figure **54**. This growth reflects a significant rise in the program's uptake, with Ontario and Quebec showing the highest participation in utilizing these incentives.

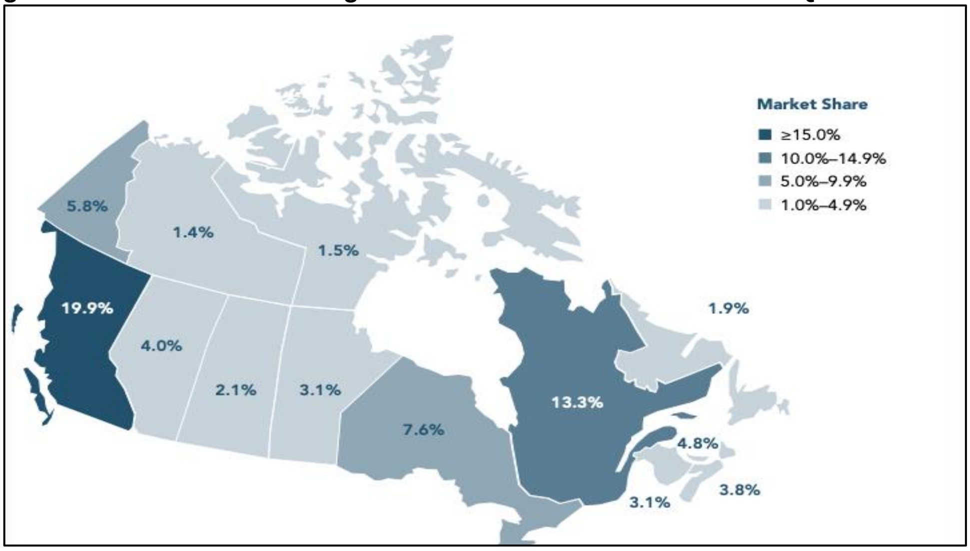
As the EV market in Canada expands, it is crucial for the iZEV program to evolve to provide more targeted support to low- and middle-income households. This would not only facilitate a more equitable adoption of zero-emission vehicle technology but also contribute to achieving Canada's environmental goals by reducing greenhouse gas emissions and promoting sustainability in transportation. As illustrated in the following figure, the adoption of zero-emission vehicles in Canada varies significantly across different jurisdictions.

EV Action Plan by 2030[211]

The 2030 EV Action Plan, led by Electric Mobility Canada (EMC), is a comprehensive strategy aimed at accelerating the adoption of EV in Canada and achieving ambitious emission reduction targets. Initially published at the end of 2021 and last updated in August 2023, this plan outlines a series of policies and actions designed to facilitate the transition to a more sustainable and emission-free mobility.

According to EMC, achieving 100% electric passenger vehicle sales by 2030 and extending this goal to all other types of vehicles by 2040 would have multiple benefits for Canada in terms of economic, environmental, and public health outcomes.

Figure 55. Market Share of Light Zero-Emission Vehicles – Third Quarter of 2022



Source: Transport Canada. (2022). *Canada's Action Plan for Clean On-Road Transportation*.

Economic Objectives:

1. Job Creation: The transition to EV will create thousands of new jobs in various areas, including manufacturing, maintenance, charging infrastructure, and associated services. This job growth will not only benefit the local economy but also position Canada as a leader in the global EV market.
2. Manufacturing Leadership: Canada will establish itself as a global leader in EV manufacturing. This leadership will attract foreign direct investment and foster innovation and the development of new technologies within the economy.

[211] Electric Mobility Canada. My Canada drives electric. Available at https://2030evactionplan.ca/#about-emc

Environmental Objectives:

1. Carbon Emission Reduction: Widespread adoption of EVs will significantly reduce carbon pollution, helping Canada meet its international emission reduction commitments and mitigate climate change.
2. Air Quality Improvement: The decrease in the use of ICE vehicles will lower the emission of air pollutants, improving air quality in both urban and rural areas.

Public Health Objectives:

1. Improved Public Health: Reducing emissions from transportation will lead to significant improvements in public health by decreasing the incidence of respiratory and cardiovascular diseases related to air pollution.
2. Reduced Exposure to Pollutants: With fewer ICE vehicles on the roads, public exposure to harmful substances such as nitrogen dioxide and fine PM will decrease substantially.

The plan comprises six key pillars, which are detailed as follows:

Table 8. Solutions and Strategies for EV Adoption in Canada

Pillar	Description
Adoption of Light EVs by Consumers	Policy solutions to overcome barriers to consumer adoption of EVs focus on three main areas: affordability and value, education and awareness, and financing mechanisms based on the "polluter pays" principle.
Electrification of Medium, Heavy and Off-Road Fleets	The transition to electromobility in the fleet segment, including electric public transportation, truck and school bus fleets, and electric off-road vehicles, faces several challenges. To overcome these barriers, various solutions focusing on affordability, infrastructure, and regulation can be implemented.
EV Infrastructure Deployment Plan	The transition to electric mobility requires a new perspective on future fueling infrastructure: EV charging. Below are solutions to overcome the challenges of charging in various environments, such as multi-unit buildings, remote areas, highways, and public spaces.
Strategy and Regulation for EVs	To achieve the adoption of EV in Canada, a coordinated strategy is needed to address several key challenges, including vehicle availability and supply, as well as ensuring inclusion for all communities, particularly rural, remote, and Indigenous ones.
Employment and EV Manufacturing Capacity in the Economy	To ensure a successful transition to an electric mobility economy, Canada is implementing a strategy that combines economic development, investment attraction, focused Research and Development (R&D) efforts, and measures to protect Canadian industry and workers from foreign protectionist policies.
Federal Leadership	The government plays a crucial role in accelerating the transition to electric mobility, using its own facilities, convening power, and internal processes to lead by example and promote widespread market and societal change.

Source: Electric Mobility Canada. (n.d.). 2030 EV Action Plan.

The policies developed for each of the described pillars will be presented below. This analysis will include the expected impacts and the relevance of these policies in achieving the goals of the 2030 EV Action Plan.

Pillar 1: Consumer Adoption of Light EVs

Pillar 1 includes the following policies:

1. Continue with purchase incentives for new passenger EV but focus on the value of all-electric range to include long-range electric cars, SUV, and trucks.
2. Ensure that the most polluting vehicles fund incentives for new EV.

3. Make EV more accessible to low- and modest-income households.
4. Facilitate the transition of taxi companies, car-sharing, ride-sharing, and other on-demand transportation services to EV.
5. Support consumer education on EV.

The collective impact of these policies is significant. They not only provide immediate financial incentives to make EV more affordable but also create a long-term shift in market dynamics by discouraging the purchase of high-emission vehicles. The emphasis on inclusivity ensures that the benefits of the transition to EV are accessible to all socioeconomic groups, not just the more affluent.

Additionally, directing electrification toward commercial and high-use transportation sectors can lead to substantial reductions in greenhouse gas emissions, given the high mileage and frequent use of vehicles in these sectors. The focus on consumer education is crucial to overcoming misconceptions and knowledge gaps, which are often significant barriers to EV adoption.

Pillar 2: Electrification of Medium, Heavy, and Off-Road Fleets

Pillar 2 includes the following policies:

1. Make electric buses, trucks, and off-road vehicles more affordable.
2. Work across all jurisdictions to accelerate the adoption of electric school buses.
3. Accelerate the integration of electric trucks into commercial fleets.
4. Electrify vehicles at ports, airports, and similar federal facilities.
5. Make off-road EV more affordable.
6. Support the electrification of Canada’s ferry service.

The collective impact of these policies is significant. Initiatives to reduce initial costs and provide predictable funding ensure that commercial and public fleet operators can adopt zero-emission technologies without facing insurmountable financial barriers. Electrifying vehicles at ports, airports, and federal facilities has the potential to significantly reduce greenhouse gas emissions in key areas. Additionally, supporting the electrification of school buses and ferries ensures that the benefits of electric mobility extend to various areas of public and commercial transportation, improving air quality and reducing pollution across the economy.

Pillar 3: EV Charging Infrastructure Deployment Plan

Pillar 3 includes the following policies:

1. Set targets for EV charging facilities for all types of vehicles.
2. Prepare one million condominiums and apartments for EV within five years.
3. Add EV charging requirements to building codes.
4. Utilize underutilized government lands: establish public charging “hubs.”
5. Offer a connection rebate to cover costs charged by utilities for large-scale charging station construction.
6. Include EV charger installation in home energy retrofit programs.
7. Provide funding programs for medium and heavy-duty vehicle (MHDV) charging infrastructure.
8. Leverage technology-based solutions to add value and reduce costs for EV drivers and the grid.
9. Support standards for the right to charge in multi-family properties.
10. Support access to charging in rural, remote, and off-road areas.

The third pillar focuses on developing accessible and efficient charging infrastructure to facilitate the adoption of EV in Canada. Setting ambitious targets for installing chargers at various locations, from residential buildings to rural and remote areas, is crucial for eliminating the logistical barriers faced by potential EV users. Including these chargers in building codes and utilizing underutilized government lands to establish public charging hubs ensures that infrastructure expands equitably and efficiently.

Additionally, policies offering financial incentives, such as connection rebates and funding programs for MHDV charging infrastructure, are essential for encouraging private and public investment in the charging network. By supporting the integration of chargers into home energy retrofit programs and promoting technological solutions to optimize charging, these initiatives not only facilitate the adoption of EV but also promote a more efficient and sustainable use of energy. Together, these policies create a conducive environment for the transition to electric mobility, ensuring that all Canadians, regardless of their location, can benefit from this technological transformation.

Pillar 4: EV Strategy and Regulation

Pillar 4 includes the following policies:

1. Immediately launch a Canadian EV strategy.
2. Adopt regulations on zero-emission passenger vehicle sales.
3. Implement strict tailpipe emission standards.
4. Adopt a zero-emission mandate for trucks and buses.
5. Develop a plan to assist rural and Indigenous communities.
6. Offer a vehicle scrappage[212] program.

The collective impact of these policies is substantial. They not only provide a regulatory framework that encourages the widespread adoption of EVs but also ensure that this transition is equitable, reaching both urban areas and Canada's more remote communities. By implementing clear mandates and strict standards, Canada is positioned to drastically reduce its carbon emissions, improve air quality, and ensure a just and accessible transition for all citizens. Additionally, the creation of support and scrappage programs strengthens EV infrastructure and promotes a sustainable shift in the automotive market.

Pillar 5: Jobs and EV Manufacturing Capacity in the Economy

Pillar 5 includes the following policies:

1. Support and attract businesses and investments related to EV in Canada.
2. Focus investment in R&D on strategic EV technologies.
3. Work with provinces to accelerate the training of service technicians specializing in EV.
4. Support training programs and help workers transition to a zero-carbon emissions industry.
5. Adopt a North American approach to EV manufacturing and supply chains.
6. Support electrification in the mining sector.
7. Support the circular economy for EV batteries.

Pillar 5 is crucial to ensure that Canada not only adopts EV at the consumer level but also becomes a global leader in EV manufacturing and technology. Attracting investments and promoting businesses related to electric mobility are essential to creating sustainable, high-quality jobs within the economy. Additionally, focusing efforts

[212] In the context of the 2030 EV Action Plan, a scrappage program would involve taking fossil fuel-powered vehicles off the road and replacing them with zero-emission vehicles, thus contributing to the reduction of greenhouse gas emissions and improving air quality.

on the research and development of strategic technologies allows Canada to reduce the production and operation costs of EVs, making them more accessible to all Canadians.

Collaboration with provinces and investment in training programs ensure that the workforce is prepared for the demands of this emerging industry. This involves not only technical training for mechanics and service technicians but also support for workers transitioning from traditional sectors to the zero-emissions industry. Cooperation with the United States on manufacturing and supply chains is critical to maintaining a competitive position in the North American and global markets.

The electrification of the mining sector and support for the circular economy of batteries complement this approach by ensuring that the entire value chain, from mineral extraction to battery recycling, is managed sustainably and efficiently. This not only reduces the environmental impact of the transition to EV but also promotes Canada's energy independence and security.

Pillar 6: Federal Leadership

Pillar 6 includes the following policies:

1. Establish a "Privy Council Office for Electric Transportation."
2. Convene electric sector stakeholders to develop EV solutions for our grid.
3. Ensure that federal fleets and buildings are 100% electric and EV-ready.
4. Create a zero-emissions zone in the city of Ottawa.
5. Adopt "clean procurement" policies across Canada.

Pillar 6 focuses on actions the government can take to exemplify and accelerate the transition to electric mobility. It highlights the establishment of a "Privy Council Office for Electric Transportation" to coordinate responsibilities across departments and advise the Prime Minister, emphasizing electric mobility as a governmental priority. Additionally, education and awareness about EV for governments and legislators are essential, proposing collaboration with leading organizations to establish learning opportunities. Solutions with electric sector stakeholders are also proposed to develop efficient charging infrastructure through guidelines and intergovernmental panels.

Furthermore, it is proposed to electrify federal fleets and buildings, with a target of having at least 10% of parking spaces electrified by 2025. This, along with the creation of a zero-emission zone in Ottawa and the adoption of "clean procurement" policies, aims to discourage the use of polluting vehicles and promote the purchase of zero-emission vehicles. Together, these initiatives position the government as a leader in the transition to cleaner and more sustainable mobility, setting precedents and regulatory frameworks for other sectors to follow.

Canada's EV Availability Standard[213]

The "Canada's EV Availability Standard" is a crucial component of Canada's plan to reduce greenhouse gas emissions. This standard was announced in its preliminary form on 21 December 2022, and applies to LDV, such as passenger cars, SUVs, and light trucks. These vehicles account for approximately half of the greenhouse gas emissions from the transportation sector in Canada, which together contributes about 25% of the economy's total greenhouse gas emissions.

[213] Government of Canada. (2023). Canada's EV Availability Standard: Regulated Targets for Zero-Emission Vehicles. Environment and Climate Change Canada. Available at: https://www.canada.ca/en/environment-climate-change/news/2023/12/canadas-electric-vehicle-availability-standard-regulated-targets-for-zero-emission-vehicles.html

The final regulations for this standard were published in the Canada Gazette, Part II, on 20 December 2023. Under these new regulations, vehicle manufacturers and importers must meet annual sales targets for ZEV. The targets start in 2026, requiring that at least 20% of new LDV sold be ZEV, and increase progressively to reach 100% by 2035.

The standard includes a series of credits and flexibilities for manufacturers, including credits for early sales of ZEV and investments in fast-charging infrastructure. These credits can be accumulated or traded, assisting manufacturers in meeting the regulated targets.
The "Canada's EV Availability Standard" is a fundamental piece in Canada's strategy to promote electromobility and reduce greenhouse gas emissions. By setting clear and gradual targets for ZEV adoption, the standard ensures a steady increase in the availability of these vehicles, aligning supply with market demand.

Additionally, by combining these regulations with economic incentives, such as the Zero-Emission Vehicle Incentives Program, which offers up to CAD5,000 in incentives for the purchase of new ZEV, the government is reducing the upfront cost of these vehicles, making them more accessible to a greater number of Canadians. These incentives, along with the lower operating and maintenance costs of ZEV, contribute to a lower carbon footprint over the vehicle's lifecycle.

Finally, the development of a robust charging infrastructure is another crucial component. With over 25,000 public charging stations already installed and plans to significantly increase this number, the government is ensuring that ZEV are a viable and convenient option for Canadians across the economy, including in rural and northern areas.

EV and Alternative Fuel Infrastructure Deployment Initiative (EVAFIDI)[214]

In 2016, Natural Resources Canada launched the EV and Alternative Fuel Infrastructure Deployment Initiative (EVAFIDI). This initiative aims to provide funding to organizations to help establish three types of infrastructure:

1. A network of fast chargers for EV spanning coast to coast along major routes and highways.
2. Natural gas refueling stations located along key fueling corridors.
3. Hydrogen refueling stations in major cities.

This public infrastructure aims to facilitate Canadians' transition to electromobility by providing a safe and sustainable electric ecosystem. Eligible vehicle chargers for the program must meet the following characteristics:

- DCFC Chargers of 50 kW: Must comply with specific standards (CHAdeMO and SAE Combo) and be certified in Canada.
- DCFC Chargers of 20 kW: Must also meet the same standards and can be funded if accompanied by a Level 3 charger.
- Level 2 Chargers (208/240 V): Must comply with the SAE J1772 standard and have a minimum power of 3.3 kW to be eligible for additional funding when placed alongside a Level 3 fast charger.

[214] Natural Resources Canada. (n.d.). EV and alternative fuels infrastructure deployment initiative. Available at: https://natural-resources.canada.ca/energy-efficiency/transportation-alternative-fuels/infrastructure/electric-vehicle-alternative-fuels-infrastructure-deployment-initiative/18352

As of 2024, the program is not in effect. However, the results achieved by EVAFIDI were as follows:

- 58 organizations received funding to install chargers or build service stations.
- The funding catalyzed projects that otherwise would not have occurred.
- The program helped organizations develop the business case for investment.
- Participants showed a high level of overall satisfaction with the program.
- Participants appreciated the daily support from NRCan staff.
- NRCan's risk management helped ensure the success of the projects.
- For every dollar invested by NRCan, two dollars of external funding were secured.
- A total of CAD260 million in total investments was achieved.

Recommendations from the EV Action Plan 2030 on a EV Strategy for Canada

One of the main recommendations of the EV Action Plan 2030 is for Canada to promptly enact legislation that establishes a strategy for the adoption of EV. This strategy involves creating a legislative framework that mandates the federal government to develop and maintain an updated action plan periodically until 2035 for the adoption of EV. The legislation should require the government to implement sufficient measures to achieve 100% of passenger vehicle sales being electric by 2030 and 100% of bus and truck sales being electric by 2040 at the latest.

The plan not only proposes the formulation of a strategy but also emphasizes the need for accountability and audits to ensure compliance with the established goals. This comprehensive approach is crucial to ensuring that necessary actions are taken to decarbonize the transportation sector in Canada[215]. Additionally, it suggests that both the strategy and initial plans should include the actions described in the Platform document to ensure an effective transition to a more sustainable and emission-free mobility.

8.2.4. Success Cases

Canada has made significant progress in adopting electromobility, becoming a leader in implementing sustainable transportation technologies. Various cities and regions across the economy have launched a series of successful initiatives that have not only reduced greenhouse gas emissions but also improved energy efficiency and created new economic opportunities. At a broader level, programs such as the EV 2030 Action Plan, the iZEV, and the Compliance Credits Program for Emission Reduction stand out. At the regional level, cities like Vancouver, Toronto, Ottawa-Gatineau, and Montreal have implemented innovative strategies to promote electromobility. Below are some of the most notable success stories demonstrating the economy's commitment and achievements in this area.

- **EV 2030 Action Plan**

Canada's EV 2030 Action Plan is a key initiative aimed at achieving 100% EV sales by 2030 and for all other vehicles by 2040. This plan not only supports Canada's economic, environmental, and public health goals but is also designed to create thousands of new jobs, secure Canada's leadership in global EV manufacturing, improve public health, and significantly reduce carbon pollution. The plan was updated in August 2023 to adapt to the evolving context, reflecting a continued commitment to transportation electrification [216].

[215] Electric Mobility Canada. (2023). About EMC: 2030 EV Action Plan. Available at: https://2030evactionplan.ca/#about-emc
[216] Electric Mobility Canada. (2023). 2030 EV Action Plan. Available at: https://2030evactionplan.ca/

- **iZEV**

The iZEV program from the federal government has been crucial in increasing the adoption of EVs across Canada. This program includes two main plans: one for light vehicles and another for medium and heavy vehicles. The financial incentives provided to buyers of light EVs have led to a significant increase in EV sales economy-wide. Additionally, a specific plan for medium and heavy vehicles has been implemented, promoting the adoption of clean technologies in key sectors such as freight transport and public transit. This comprehensive approach has facilitated the transition of thousands of Canadians to more sustainable vehicles, reducing carbon emissions and strengthening the EV market in the economy.

According to statistics provided by the Canadian government program, as of the 2023 fiscal year, Quebec stands out as the province with the highest number of incentives, totaling approximately CAD471 million. Furthermore, this province has recorded a total of 108,000 incentives granted. The following table details the evolution of both the dollar amount and the number of incentives distributed, broken down by province or territory of the dealership.

Table 9. Number of iZEV Program Incentives by Province or Territory of the Dealership

Province or territory of the concessionaire	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25
Quebec	23,079	22,826	30,816	31,807	79,942	30,455
British Columbia	14,220	10,728	16,364	13,230	37,382	9,600
Ontario	5,379	4,347	8,134	11,396	36,962	10,583
Alberta	673	597	1,178	1,588	5,281	1,567
Nova Scotia	129	228	499	691	1,865	576
Manitoba	182	209	343	463	1,754	672
New Brunswick	113	120	352	589	1,371	532
Saskatchewan	93	112	235	295	781	233
Newfoundland and Labrador	30	58	127	305	706	192
Prince Edward Island	42	49	209	186	541	197
Yukon	7	30	55	68	149	58
Northwest Territories	2	5	10	7	21	8
Nunavut	0	0	0	1	2	1
Total	**43,949**	**39,309**	**58,322**	**60,626**	**166,757**	**54,674**

Source: Government of Canada. (2023). iZEV Program Statistics.[217]

Table 10. Amount of Incentives under the iZEV Program by Province or Territory of the Dealership (CAD)

Province or territory of the concessionaire	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25
Quebec	94,880,983.00	97,938,069.00	131,334,372.00	147,660,310.00	390,862,891.00	147,942,573.00
British Columbia	62,684,469.00	48,118,848.00	73,673,121.00	62,097,598.00	184,454,364.00	46,209,682.00
Ontario	22,604,786.00	18,974,581.00	36,378,851.00	51,531,970.00	179,516,965.00	50,632,856.00
Alberta	2,663,906.00	2,456,562.00	4,876,406.00	7,011,562.00	25,634,792.00	7,556,406.00
Nova Scotia	469,375.00	911,250.00	2,084,062.00	3,163,906.00	9,006,249.00	2,767,968.00
New Brunswick	420,000.00	500,000.00	1,508,594.00	2,623,437.00	8,508,958.00	3,247,031.00
Manitoba	684,062.00	863,906.00	1,394,531.00	2,102,812.00	6,631,249.00	2,602,812.00
Saskatchewan	365,000.00	449,375.00	985,000.00	1,344,062.00	3,745,625.00	1,119,062.00
Newfoundland and Labrador	106,875.00	226,875.00	519,375.00	1,360,625.00	3,416,875.00	932,500.00

[217] Government of Canada. (2023). iZEV Program Statistics. Available at: https://open.canada.ca/data/en/dataset/42986a95-be23-436e-af15-7c6bf292a2e1

Province or territory of the concessionaire	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25
Prince Edward Island	147,083.00	186,250.00	917,969.00	856,562.00	2,610,000.00	951,250.00
Yukon	25,000.00	105,000.00	215,000.00	321,250.00	733,750.00	288,750.00
Northwest Territories	10,000.00	20,000.00	37,500.00	32,500.00	101,250.00	40,000.00
Nunavut	0.00	0.00	0.00	5,000.00	10,000.00	5,000.00
Total	**185,061,539.00**	**170,750,716.00**	**253,924,781.00**	**280,111,594.00**	**815,232,968.00**	**264,295,890.00**

Source: Government of Canada. (2023). iZEV Program Statistics.[218]

- **Compliance Credit Program for Emission Reduction**

The Clean Fuel Regulations (SOR/2022-140), enacted on 21 June 2022, under the Canadian Environmental Protection Act, 1999, introduces an innovative compliance credit system aimed at reducing the carbon intensity of liquid and gaseous fuels in Canada. These credits are generated through the production of low-carbon-intensity fuels, the use of renewable energies, and the implementation of projects that reduce CO_2 equivalent emissions. Fuel producers can sell surplus credits to other companies, creating a market mechanism that incentivizes the adoption of more sustainable practices and promotes investment in clean technologies[219].

This credit system also promotes electromobility by allowing the generation of specific credits for electricity used in the charging of EVs (EVs). This recognition encourages the adoption of EVs and the expansion of electric charging infrastructure across the economy. Thus, the regulation not only contributes to emission reductions in the transportation sector but also supports the transition to a more sustainable, low-carbon economy, significantly incentivizing the adoption of EVs and promoting investments in charging infrastructure. This comprehensive approach demonstrates how regulatory policies can facilitate a cleaner and more efficient transportation future in Canada[220].

Across Canada, various cities have implemented innovative strategies to promote electromobility and reduce greenhouse gas emissions. These initiatives, led at the regional level, stand out for their focus on sustainability and the adoption of clean technologies. Below are some success stories from Vancouver, Toronto, Ottawa-Gatineau, and Montreal, demonstrating the commitment and achievements in the transition towards cleaner and more efficient transportation[221].

- **Vancouver and its Comprehensive Electromobility Strategy**

The city of Vancouver has implemented a series of innovative policies to reduce car dependence and promote the adoption of EV. In 2020, it adopted the Climate Emergency Action Plan, which mandates: i) EV infrastructure in all new non-residential buildings, ii) access to public charging stations, and iii) a parking plan for zero-emission vehicles. Vancouver also completed a feasibility study for street charging from light posts and a pilot sidewalk charging program for residential areas. Additionally, the city has one of the most progressive carsharing policies in North America, offering up to two hours of free parking for shared cars and fee exemptions for zero-emission shared vehicles.

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[218] Government of Canada. (2023). iZEV Program Statistics. Available at: https://open.canada.ca/data/en/dataset/42986a95-be23-436e-af15-7c6bf292a2e1

[219] Environment and Climate Change Canada. (2022). Clean Fuel Regulations (SOR/2022-140). Canadian Environmental Protection Act, 1999. Available at: https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-standard.html

[220] Ibid.

[221] Success Cases at the Subnational Level Have Been Analyzed Based on the Document: Faid, J., Kapitsila, B., & Cooper, D. (2022). *Canadian Urban Mobility 2.0*. Transport Canada. Available at : https://static1.squarespace.com/static/57b25a1d579fb3a225546f2e/t/620358bb1588e053ea2cad52/1644386523389/Canadian+Urban+Mobility+Report.pdf

In the realm of public transport, Metro Vancouver has advanced with the Battery Electric Bus Program of TransLink, in collaboration with CUTRIC, the Government of Canada, and BC Hydro, being the world's first interoperable charging pilot. TransLink has a Low Carbon Fleet Strategy, which plans to acquire 677 electric buses by the end of the decade and is now only purchasing BEB. In 2019, it tested on-demand transit services on Bowen Island, accessible via phone or mobile app, and incorporated artificial intelligence into its travel planning. Starting in the fall of 2021, children aged 12 and under can travel for free on all public transport in British Columbia. These initiatives underscore Vancouver’s commitment to sustainable mobility and carbon emission reduction.

- **Toronto and its Comprehensive Electromobility Strategy**

Toronto adopted an EV strategy in 2020 with clear objectives: i) increase the EV share to 5% by 2025, ii) to 20% by 2030, and iii) to eliminate carbon-emitting vehicles entirely by mid-century. Among the incentives for promoting electromobility are the Home Energy Loan Program and Toronto’s Green Standard, which requires new multi-family and non-residential developments to equip one-fifth of parking spaces with EV supply equipment.

In public transport, Toronto’s TransformTO strategy advocates for the electrification of all buses in the Toronto Transit Commission (TTC) by 2040, aiming to reduce greenhouse gas emissions by 80% by 2050. By 2020, Toronto had 60 electric buses, the largest fleet in North America, and the TTC has recommended the purchase of 300 more buses between 2023 and 2025.

- **Ottawa-Gatineau and its Electromobility Strategy**

The Ottawa-Gatineau region has made significant strides toward transport electrification. The city of Ottawa plans to add 24 additional public charging stations for EVs to its existing network and has recently added fully EVs to its municipal fleet. Hydro Ottawa, in collaboration with a Quebec company, is testing the impact of EV charging on the city’s electrical grid. Gatineau, for its part, is installing 17 new electric chargers alongside municipal buildings as part of its plan to fully convert its fleet to EVs.

In the realm of public transportation, Ottawa has converted a dedicated bus transitway into a 12.5 Km light rail transit (LRT) system with 34 electric trains, becoming the first city in North America to undertake this conversion. The city plans to add another 44 Km of LRT by 2025 and has announced its goal to have a fully electric bus fleet by 2036. Gatineau has received funds to study options for rapid transit expansion and has tested electric buses, confirming their ability to complete a typical eight-hour shift with a single overnight charge. These initiatives reflect the region's commitment to reducing greenhouse gas emissions and promoting electromobility.

- **Montreal and its Electromobility Strategy**

Montreal has made significant strides in promoting electromobility. The city launched its public charging program in 2014 with two successful pilot stations, and by 2021, it had more than 1,200 stations, of which 900 were installed by the city. Quebec, the province where Montreal is located, represents nearly half of all electric cars sold in Canada, with 92,000 vehicles in 2020. This has been driven by the provincial Roulez Vert program, which offers a range of rebates for purchasing EVs and installing charging stations, amounting to up to CAD13,000 in savings when combined with federal subsidies. Montreal is also converting its municipal fleet and aims to replace 250 municipal vehicles with EVs, representing approximately one-third of its subcompact vehicles. Additionally, Montreal has included public electric charging as part of its Climate Plan 2020-2030 and is developing a zero-emission zone in the city center by 2030.

In public transportation, the Société de transport de Montréal (STM) has been investing in hybrid buses since 2016, and by 2019, it had hybridized approximately one-third of its fleet of 550 buses, with plans to convert another 300 buses. STM has tested several models of electric buses, and by 2020, it had seven fully electric buses in operation, two of which were part of an order of 30 long-range electric buses produced by New Flyer, with the rest delivered in 2021. STM plans to begin purchasing only electric buses from 2025 and to replace all its diesel buses by 2029. Another major project in the region is the Réseau express métropolitain (REM), a 67 Km automated LRT, with the first segment opening in 2022. These efforts reflect Montreal's commitment to reducing emissions and promoting sustainable urban mobility.

8.2.5. Limitations, Opportunities, and Challenges for the Automotive Industry in the Transition to Electromobility[222]

In the last four years, EV manufacturers and supply chain partners in Canada have announced investments totaling CAD46 billion with the goal of expanding production capacity in Canada. These investments cover the entire supply chain, from refining critical minerals to battery production and final vehicle assembly. This effort will play a crucial role in both building a clean economy in Canada and generating long-term opportunities for Canadian automotive workers.

Furthermore, it is relevant to highlight that Canada is the only economy in the Western Hemisphere with a complete supply chain for EVs (EVs). Global companies are choosing Canada to access the materials and clean energy needed to manufacture cathodes, anodes, batteries, and parts for the North American market. Therefore, if your company is looking to integrate into the EV supply chain, Canada is the ideal place.

According to the Canadian government, the automotive manufacturing sector directly supports over 125,000 paid jobs in the economy. Additionally, in terms of opportunities for the Canadian economy in the EV industry, the following achievements are highlighted:

- Canada is number one in the world for the global lithium-ion battery supply chain.
- It ranks fourth globally in EV raw materials capabilities.
- It is among the top 10 producers of nickel, cobalt, graphite, and aluminum.

According to the Government of Canada[223], workers and the EV automotive sector in Canada face challenges due to competition in the global market, particularly from economies with greater production capacities and more extensive promotional measures, such as China. China's policy of expanding its production capacity, along with its different labor and environmental regulatory frameworks, has contributed to a growing global supply, putting pressure on the profit margins of EV producers in economies like Canada. This situation has affected competition, especially in terms of production costs and market access.

As a result, there is a risk that the growth of imports of EVs produced in China could impact investments and the development of Canada's automotive sector. In 2023, a significant increase in these imports was observed, reaching CAD2.3 billion. Additionally, it is important to consider the potential cybersecurity and data protection risks associated with the technology used in connected EVs, particularly when they come from economies with different regulatory frameworks.

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[222] Canada, Department of Finance. (2024). Consultations on potential policy responses to unfair Chinese trade practices in EVs. Avialable at https://www.canada.ca/en/department-finance/programs/consultations/2024/consultations-on-potential-policy-responses-to-unfair-chinese-trade-practices-in-electric-vehicles.html and Invest in Canada. (2024). EV supply chain. Available at: https://www.investcanada.ca/industries/ev-supply-chain

[223] Ibid

For this reason, on 24 June 2024, the federal government announced the start of a 30-day consultation, from 2 July 2024, to 1 August 2024, on potential responses through policies aimed at leveling the playing field and supporting conditions for the Canadian EV industry to grow and compete in both domestic and global automotive markets, as well as to safeguard Canada's security interests. The possible response measures are as follows:

- **Tariff:** A tariff could be implemented on all or some products when imported from China. This tariff would be applied under the authority of Section 53 of the Customs Tariff, which provides for the application of trade measures, including surtaxes, aimed at leveling international competition.

- **Program Eligibility:** The iZEV Program is currently scheduled to end on 31 March 2025, while the iMHZEV Program is scheduled to end on 31 March 2026, subject to the availability of funds for both programs. Currently, zero-emission vehicles (including battery EV, PHEV, and fuel cell EV) that meet program requirements are eligible for incentives, subject to Transport Canada approval. The consultation addresses whether zero-emission vehicles manufactured in China should be excluded from eligibility for the iZEV and/or iMHZEV programs.

- **Investment:** Chinese companies might seek to establish facilities to manufacture EV within Canada, for example, to access the North American market considering potential tariff measures. The Investment Canada Act requires prior approval of significant foreign investments to ensure a probable net economic benefit. Additionally, all foreign investment is subject to security review regardless of its value, including new investments in projects and non-controlling minority investments. The Government of Canada has also provided greater policy clarity on how the Investment Canada Act will apply to investments in Canadian entities and assets in critical minerals sectors by foreign state-owned enterprises. Therefore, the consultation addresses whether additional actions such as greater policy guidance, monitoring, or restrictions related to Chinese transactions and investments in Canada’s EV supply chain are required or desirable to safeguard net benefits for Canadians and Canada’s security.

- **Cybersecurity and Data Security Issues in Connected Vehicles**: Although Canada has a robust private sector privacy regime for personal information, and proposals are currently being presented to Parliament to improve this regime and cybersecurity, it is recognized that information and communication technology (ICT) developed, manufactured, or supplied by entities subject to Chinese jurisdiction or control presents significant risks to Canadian privacy, data, and security interests. This includes situations where vulnerabilities in ICT could be exploited. Furthermore, beyond the vehicles themselves, the adoption of EV also involves interconnected infrastructure, such as charging stations, which could also be at risk.

- **Other Measures:** The government is also seeking input on other potential policy responses that Canadians and stakeholders may wish to propose, including proposals related to protecting Canada’s broader EV supply chains, including steel and aluminum.

8.3. Chile

8.3.1. Urban Mobility Policies Related to the Transition to Electromobility

According to the document "National Sustainable Mobility Strategy"[224] (NSMS), sustainable mobility is defined as follows:

"A set of actions that allows individuals, collectives, and communities to satisfy the needs of movement, access, communication, and coexistence, prioritizing social equity, urban integration, the improvement and proper use of public spaces through means of locomotion with low social, environmental, and energy costs without compromising the well-being of future generations."

In the realm of urban mobility, a sustainable transport system must meet several essential objectives, which are detailed below[225]:

- Ensure that individuals involved in productive activities can reach their destinations quickly and safely, thus promoting both economic and social sustainability.
- Facilitate the efficient transport of goods and economic exchange, which contributes to economic sustainability.
- Provide equitable access to opportunities for all, regardless of their socioeconomic status, gender, or mobility condition, promoting social sustainability.
- Offer a uniform quality of service for all users, without differences based on income level or urban location.
- Reduce GHG emissions, particulates, and other negative externalities such as noise, favoring environmental sustainability. It is crucial to use limited resources, such as urban land, efficiently to guarantee sustainability in economic, social, and environmental aspects.

The document emphasizes that, in order to achieve sustainable mobility, it is essential to optimize the use of road and public space by prioritizing vehicles that occupy less space per passenger. It is also fundamental to reduce travel time, thereby allowing people to have more time for other activities, which improves both quality of life and productivity. Finally, it is important to prioritize vehicles with higher energy efficiency to minimize environmental impact.

Current Situation of Public Transport in Chile

Public transport, which includes shared taxis, buses, and urban trains, is the most economical motorized means of transportation and, therefore, the most used by lower-income individuals. Approximately 30% of trips nationwide are made using public transport, representing one out of every three trips. Lower-income individuals are not only further away from opportunities but also tend to receive lower-quality services compared to higher-income individuals[226]. Additionally, higher-income individuals are responsible for energy consumption and emissions up to seven times greater[227]. This suggests that efforts to reduce emissions should focus on areas and groups with the highest impacts.

[224] Ministry of Transport and Telecommunications of Chile. (2023). National Sustainable Mobility Strategy (ENMS). Road and Urban Transport Program, with the support of the EUROCLIMA+ Project. Available at: https://www.subtrans.gob.cl/wp-content/uploads/2022/11/Documento-oficial-ENMS-2023-SECTRA.pdf.
[225] Ibid.
[226] Tiznado-Aitken, I., Muñoz, J.C., and Hurtubia, R. (2021). Public transport accessibility accounting for level of service and competition for urban opportunities: An equity analysis for education in Santiago de Chile. Journal of Transport Geography, 90, 102919
[227] Iglesias, V., Giraldez, F., Tiznado-Aitken, I., & Muñoz, J. C. (2019). How uneven is the urban mobility playing field? Inequalities among socioeconomic groups in Santiago De Chile. Transportation research record, 2673(11), 59-70.

National Sustainable Mobility Strategy

The document titled "National Sustainable Mobility Strategy (NSMS)" was developed by the Ministry of Transport and Telecommunications of Chile[228] with the support of the EUROCLIMA+ program, funded by the European Union. This strategy aligns with other policies of this economy, such as the Urban Development Policy and the Electromobility Strategy, and aims to advance towards integrated and sustainable urban and transport development.

The NSMS is developed in response to the need to address the global climate crisis and promotes an urban mobility model that combines environmental sustainability, social equity, and economic efficiency. It presents a clear vision for the year 2050, along with specific objectives and measures to transform urban mobility in Chile.

The strategy adopts the "Avoid-Shift-Improve" approach, which focuses on reducing the need for motorized vehicle trips (Avoid), encouraging the shift towards more sustainable modes of transport (Shift), and improving transportation technologies to decrease emissions (Improve). This comprehensive approach allows addressing urban mobility challenges from various angles and adapting solutions to the specific conditions of each city.

The main objective of the NSMS is to reduce GHG emissions from the transport sector, promote more sustainable modes of transport, and improve urban quality of life. In this context, electromobility plays a crucial role. To achieve these objectives, several specific objectives and associated measures have been defined (see Table 11).

Measures related to the promotion of vehicle electrification

Below are the measures established in the NSMS that are linked to promoting vehicle electrification, aiming to achieve the objectives proposed in the previous table:

- **Disincentives for the use of polluting vehicles**

This measure encompasses a series of public policies and actions aimed at discouraging and restricting the use of polluting vehicles. These measures include, but are not limited to, the imposition of taxes on fossil fuels, the implementation of urban tolls, the creation of low-emission zones and areas exclusive for non-motorized vehicles, efficient parking management, and circulation restrictions through daily passes.

The described policies must be adapted to the needs and characteristics of each urban area. The responsibility for their implementation primarily lies with local and municipal governments, who define specific measures according to the geographical area. The effectiveness of these measures depends on clear execution processes and well-defined funding sources, along with proper justification and planning.

Table 11. Objectives and Measures of the National Sustainable Mobility Strategy (NSMS)

Objective	Description	Types of Measures
1. Territory-Integrated Mobility	Promote the integration between land use planning and mobility, advancing towards more compact and accessible cities.	• Territorial planning instruments oriented towards public transport and active mobility. • Urban management and design oriented towards public transport and active mobility. • Intersectorality with a territorial approach. • Sustainable urban logistics.

[228] Ministry of Transport and Telecommunications of Chile. (2023). National Sustainable Mobility Strategy (ENMS). Road and Urban Transport Program, with the support of the EUROCLIMA+ Project. Available athttps://www.subtrans.gob.cl/wp-content/uploads/2022/11/Documento-oficial-ENMS-2023-SECTRA.pdf.

Objective	Description	Types of Measures
2. Clean Mobility	Reduce negative impacts on the environment by strengthening actions to mitigate climate change and local negative externalities.	• Social evaluation of projects oriented towards climate change. • Disincentives for the use of polluting vehicles. • Disincentives for the acquisition of polluting vehicles. • Monitoring of polluting vehicles. • Fleet decarbonization. • Promotion of technological changes in private vehicles.
3. Efficient Mobility	Promote a more efficient use of road and urban space, fostering better travel demand management and improving access to opportunities by prioritizing the most efficient modes of transport.	• Reduction of the need to travel. • Redistribution of road space. • Improvement of service levels of public transport. • Incentives for public transport operation and users. • Promotion and facilitation of intermodality. • Disincentives for the acquisition and use of inefficient vehicles.
4. Active and Safe Mobility	Promote the use of active and healthy modes, ensuring that their use is convenient and safe, making them a more attractive alternative than private motorized modes for relatively short distances.	• Infrastructure for pedestrians and cyclists. • Road safety initiatives that prioritize pedestrians and cyclists. • Promotion of intermodality between cyclists and public transport. • Incentives for active mobility.
5. Inclusive Mobility	Promote inclusion, universal accessibility, and gender equity in mobility systems.	• Universally accessible infrastructure and public spaces. • Universally accessible public transport. • Safe and inclusive public transport.
6. Participatory Mobility	Integrate the vision of citizens in decision-making, highlighting the experience of users and communities.	• Timely and transparent participatory processes that lead to agreements. • Decentralized governance for sustainable mobility. • Mechanisms for citizens to raise issues and be informed about processes.
7. Informed and Transparent Mobility	Advance towards greater integration and transparency of mobility data, improving access to information for users and strengthening the technological base for planners, operators, and decision-makers.	• Improvement of mechanisms for capturing, processing, and analyzing mobility data. • Digital transformation for comprehensive traffic management. • Strengthening of information services for citizens. • Development of integrated transport services.

Source: Ministry of Transport and Telecommunications of Chile. (2023). National Sustainable Mobility Strategy (NSMS).

- **Disincentives for the acquisition of polluting vehicles**

This measure focuses on establishing taxes that discourage the importation, sale, and acquisition of polluting and low-efficiency vehicles. For example, it proposes classifying the different types of vehicles available in the market according to their levels of pollutant emissions and energy efficiency, and applying fiscal schemes that penalize the purchase of vehicles in the most polluting or least efficient categories.

Additionally, this measure could include the enactment of laws regulating the use of certain polluting technologies, such as two-stroke engines, or eventually the total elimination of internal combustion engines, as suggested in the National Electromobility Strategy.

The implementation of these measures requires central-level impetus through coordinated actions among various ministries. Although emission standards fall under the jurisdiction of the Ministry of Transport and Telecommunications, any fiscal adjustment primarily depends on the Ministry of Finance and could involve the Presidency if legislative reform is necessary.

- **Monitoring of polluting vehicles**

This measure includes a variety of actions and public policies aimed at supervising and controlling the importation, modification, and use of vehicles with polluting technologies. It is proposed to intensify customs controls to prevent the entry of vehicles that do not comply with environmental regulations, such as certain low-displacement engines and unregulated motorcycles. Additionally, street monitoring will be strengthened, allowing police officers and municipal inspectors to stop and sanction vehicles that exceed established emission limits. It is essential that emission standards be continuously reviewed and updated.

The responsibility for defining and enforcing emission standards primarily lies with the central government. However, local governments play a crucial role in implementing awareness campaigns and promoting compliance with these standards. The use of advanced technology for automated or remote-control systems, as well as active citizen involvement in reporting violations, can significantly increase the effectiveness of these measures. Strategies should focus on encouraging citizen participation and adapting at the local level to build a community committed to emission reduction.

- **Fleet Decarbonization**

This measure focuses on renewing passenger and cargo transport fleets, both public and private, to replace polluting vehicles with cleaner options. It proposes implementing subsidies and regulations to encourage the modernization of outdated fleets by defining stricter standards for age and emissions, especially for public transport. Incentives are also considered to encourage commercial fleets to adopt light electric and non-motorized vehicles, such as electric-assist cargo bicycles, facilitating the creation of smaller-scale cargo distribution centers in cities.

These initiatives should be promoted by the central government through coordinated action involving the Ministry of Transport and Telecommunications, in collaboration with the Ministries of Finance, Economy, and CORFO, among others.

- **Promotion of Technological Changes in Private Vehicles**

This measure includes a series of actions and public policies aimed at promoting the replacement of polluting private vehicles with those equipped with cleaner technologies. Examples of these actions include subsidies for the purchase of electric cars, the relaxation of certain restrictions for non-polluting vehicles, and the promotion of alternatives for converting diesel engines to electric.

The implementation of these policies should be led by the central government, given their potentially high cost. It is crucial to conduct a cost-efficiency analysis to evaluate these measures compared to other options that might be more economical and effective.

The NSMS proposes to encourage the acquisition of private EV through fiscal policies and the creation of electric charging infrastructure. Measures are included to discourage the use and purchase of highly polluting vehicles through the implementation of specific taxes and circulation restrictions in sensitive urban areas, thus promoting a shift towards more sustainable modes of transport. The strategy also includes the expansion of the necessary infrastructure for the mass use of EV, such as the installation of fast charging stations in urban and rural areas, and the integration of this infrastructure into urban and transport design.

In addition to electromobility, the NSMS promotes the use of non-motorized modes of transport, such as bicycles and walking, through the creation of safe and adequate infrastructure, such as bike lanes and pedestrian zones. This contributes to an additional reduction in emissions and improves the quality of life for citizens.

To ensure the success of the NSMS, the need for effective governance and collaboration between different levels of government and private sectors is emphasized. The document highlights the importance of a metropolitan transport authority to coordinate and oversee the implementation of measures, as well as the active participation of citizens in planning and decision-making processes.

Standards Promoting or Accelerating the Transition to Electromobility

Among the urban mobility regulations that promote the transition to electromobility are the following:

- **Decree 212 (21-NOV-1992)**[229]

Decree 212 establishes the regulations for public passenger transport services in Chile, applicable to all motorized vehicles operating on streets, roads, and public ways throughout the economy. This regulation aims to regulate the operation of public transport services, both collective and individual, ensuring they meet the established standards and regulations for their operation. Special emphasis is placed on supervising and controlling these services to ensure the safety and efficiency of both urban and rural transport.

A notable provision of Decree 212 is that it stipulates that the minimum power of the electric motor for taxis and shared taxis must be at least 70 Kw. If this requirement is not met, the vehicle cannot be registered for these public passenger transport modes. This regulation is crucial for ensuring that EVs used in public transport have the necessary performance to operate efficiently and safely, thus promoting the adoption of cleaner and more sustainable technologies in the sector.

- **Law 21088 (10-MAY-2018)**[230]

Law 21088 introduces modifications to the Traffic Law to include provisions on the coexistence of different modes of transport and to harmonize the use of road space shared by various mobility modes. In this context, the law recognizes "electric cycles" as a mode of transport, defined as vehicles with pedals and electric assistance provided by a motor with a maximum power of 0.25 kW. Additionally, it establishes that these cycles must not exceed a speed of 25 km/h.

[229] Ministry of Transport and Telecommunications of Chile. (1992). Decree 212, Regulation of National Public Passenger Transport Services. National Congress Library of Chile. Available at: https://www.bcn.cl/leychile/navegar?idNorma=11043.
[230] National Congress Library of Chile. (2018). Law 21088, Amends the Traffic Law to Incorporate Provisions on the Coexistence of Different Modes of Transport. Available at: https://www.bcn.cl/leychile/navegar?idNorma=1118358.

This law is crucial for promoting electromobility as it encourages the use of electric cycles as a sustainable transportation alternative. By regulating and promoting these vehicles, it facilitates their adoption and contributes to reducing emissions in urban areas. The law also aims to balance road space usage and enhance the safety of all road users, promoting cleaner and more efficient mobility.

- **Resolution 1555 EXEMPT (30-ABR-2020)**[231]

Resolution 1555 EXEMPT implements a series of vehicle restrictions aimed at reducing emissions and improving air quality during critical pollution episodes in the Metropolitan Region of Santiago. This resolution specifies the categories of vehicles subject to restrictions, the days and times of application, and the special areas where these restrictions will be in effect. It prohibits the circulation of vehicles without a green sticker and those registered before certain years during specific hours and areas, primarily within the Américo Vespucio ring. The measure seeks to reduce the number of polluting vehicles on the road during periods of high pollution.

Additionally, this resolution exempts EV and hybrids from the vehicle restrictions, encouraging their adoption. This exemption allows these vehicles to circulate freely during restriction periods, promoting their use as a cleaner and more sustainable alternative to traditional vehicles with internal combustion engines. The resolution highlights the importance of promoting less polluting technologies and facilitating their integration into the vehicle fleet.

- **Decree 145 (12-NOV-2018)**[232]

Decree 145 establishes the technical, construction, and safety requirements for EV in Chile. It defines the standards that these vehicles must meet to ensure their safety and efficiency, including aspects related to protection against electric shocks, safety signaling, and acoustic alert systems. This regulation is essential to ensure that EV operate safely.

The implementation of this decree is crucial for promoting electromobility as it provides a clear and detailed regulatory framework for the manufacture, import, and use of EV. By establishing these standards, the decree facilitates the adoption of EV and promotes an orderly and safe transition to more sustainable mobility in Chile.

8.3.2. Energy Policies Related to the Transition to Electromobility[233]

Energy supply is essential for achieving Chile's economic and social development goals. Ensuring this supply meets societal expectations is crucial. However, market solutions, which dominate the sector, do not always consider the common good or reflect social preferences regarding this vital resource. Therefore, it is essential for the State to take an active role in planning and directing, involving all stakeholders to create a robust and coherent strategy that guides the market.

Chile has immense potential for renewable energy production, with the capacity to generate 80 times more electricity than it currently produces[234]. Turning this abundance

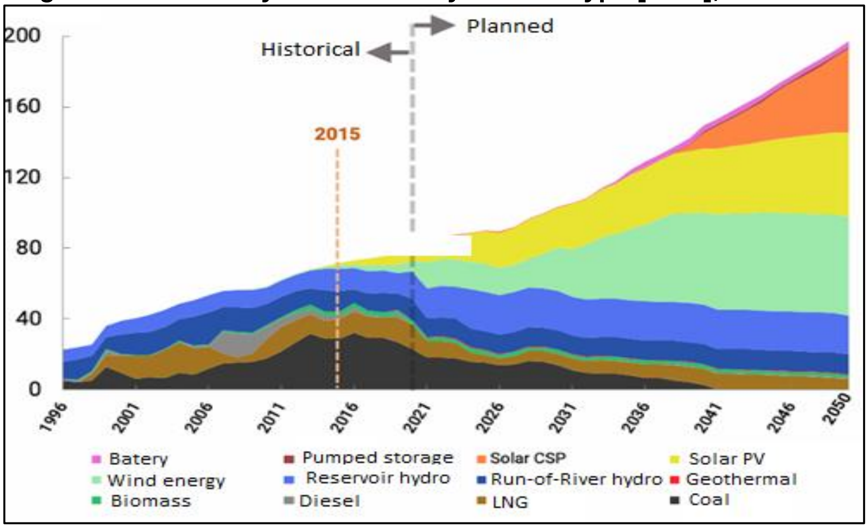
[231] Ministry of Transport and Telecommunications of Chile. (2020). Resolution 1555 EXEMPT, Prohibits the Circulation of Motor Vehicles under the Specified Conditions. National Congress Library of Chile. https://www.bcn.cl/leychile/navegar?idNorma=1144750.
[232] Ministry of Transport and Telecommunications of Chile. (2018). Decree 145, Establishes Technical, Construction, and Safety Requirements for the Specified EVs. National Congress Library of Chile. https://www.bcn.cl/leychile/navegar?idNorma=1125120&idParte=9964575&idVersion=2021-06-12.
[233] This section has been prepared on the basis of the document: Ministry of Energy of Chile. (2022). National Energy Policy: 2022 Update. Santiago, Chile: Ministry of Energy of Chile. Available at: https://energia.gob.cl/sites/default/files/documentos/pen_2050_-_actualizado_marzo_2022_0.pdf
[234] Ministry of Energy of Chile. (2022). National Energy Policy: Update 2022. Santiago, Chile: Ministry of Energy of Chile https://energia.gob.cl/sites/default/files/documentos/pen_2050_-_actualizado_marzo_2022_0.pdf.

into a key element for the economy's future well-being is crucial. In this context, energy is not only a strategic resource but also an opportunity to drive significant improvements in quality of life. Efficient management of this resource can foster a virtuous cycle that promotes economic growth, supports environmental protection, and facilitates human development.

Good energy management can become a driver of progress, allowing society to move towards equitable and sustainable development. This involves not only meeting current needs but also significantly improving the living conditions of the population, ensuring a prosperous and sustainable future for all Chileans.

In recent years, Chile has significantly promoted the development of renewable energies, especially solar and wind, achieving massive deployment of these technologies. Since 2015, renewable electricity generation capacity has nearly doubled. Figure 56 shows this growth, highlighting the historical evolution and future projections of electricity generation by type of source from 1996 to 2050. A sustained increase in renewable energy participation is observed, with a notable reduction in the use of conventional sources such as coal and diesel. Projections indicate that solar PV, wind, and other renewable energies will continue to increase their contribution, while fossil sources will gradually decrease.

Figure 56. Electricity Generation by Source Type [TWh], 1996-2050



Source: Ministry of Energy of Chile. (2022). National Energy Policy: Update 2022.

In this new context, it is crucial to adapt the Energy Policy to emerging challenges, as the development paradigm is shifting. It is essential to integrate environmental and social aspects to achieve sustainable energy development, balanced with nature and communities. Chilean society has reoriented its priorities, focusing on citizens' well-being and quality of life, and demanding a comprehensive consideration of the various dimensions of human development. Citizen participation and a focus on diversity are now fundamental values guiding the process of agreements for the future of the energy sector.

The climatic and environmental context has imposed new urgencies, and the update to the Energy Policy reflects the sector’s commitment to driving a transition towards "carbon neutrality." New development paradigms and emerging technologies, such as the expansion of electromobility and the introduction of green hydrogen as an alternative fuel, have opened new opportunities for sustainable development. By leveraging the advantages of renewable energy resources, the Chilean energy sector has the potential to lead the development of a sustainable economy, building a better future for all.

Chile has unparalleled renewable energy resources that enable emission-free energy production, presenting significant potential for the sustainable development of its economy. In the past five years, this economy has made notable progress in the share of renewable energy within the electricity system, increasing from 42% to 55% in 2020. Non-conventional renewable energies, excluding large hydroelectric plants, saw their share increase from 8% to 20% during the same period. This progress advanced by five years the target established by Law No. 20257 of 2008, which aimed to achieve a 20% share of renewable generation by 2025[235].

Despite these significant advances in renewable energy, it is essential to continue integrating technologies that have not yet been widely adopted, such as Concentrated Solar Power (CSP), geothermal energy, and various forms of energy storage. Modernizing regulations in electricity generation, transmission, and distribution, as well as in the production and transportation of emission-free fuels, is crucial. Additionally, flexibility in the electrical system is needed to facilitate the integration of new energies and technologies, developing a resilient and sustainable system.

Although Chile has vast renewable resources and aims to increase their share in the energy matrix, 65% of energy consumption still depends on fossil fuels, which will remain relevant in the coming decades. Therefore, energy policies must address security and market aspects to facilitate the transition to a future with clean energy. Achieving this vision requires designing and promoting economic instruments, improving existing ones to integrate cost-effective and low-emission solutions into the economy's economic activities. In the next decade, an integrated and efficient carbon pricing system and other externalities should be implemented, including taxes on emissions and fossil fuel use, complemented by market mechanisms that provide coherent and predictable economic signals.

Energy Policy of Chile by 2050[236]

Chile's Energy Policy by 2050 is based on a shared and consensual vision, developed through a participatory process that includes diverse voices and represents the diversity of the territory. This policy establishes a roadmap for the economy's energy development, with the goal of ensuring a sustainable energy supply adapted to the changing needs of society. The policy is updated every five years, reflecting the dynamic nature and constant challenges facing the energy sector.

A fundamental pillar of this policy is the promotion of sustainability. Chile is committed to being a leader in the fight against climate change by setting ambitious emission reduction targets and adopting clean and efficient technologies. The vision for 2050 includes increasingly renewable energy development, with a significant transition towards energy sources such as solar and wind. Figure 56 projects an increase in the use of renewable energies, reducing dependence on fossil fuels and contributing to the goal of carbon neutrality by 2050.

Inclusion and equity are also central aspects of Chile's Energy Policy. The policy aims to ensure equitable access to energy and to actively involve local communities in the development of the energy sector. Citizen participation is key, promoting an inclusive approach that respects human rights and the economy's cultural diversity. This is reflected in public policies developed by and for the citizens, ensuring high-standard participatory processes with a focus on gender and interculturality.

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[235] Ministry of Energy of Chile (2022). National Energy Policy: Update 2022. Santiago, Chile: Ministry of Energy of Chile. Available at: https://energia.gob.cl/sites/default/files/documentos/pen_2050_-_actualizado_marzo_2022_0.pdf.

[236] Ministry of Energy of Chile (2022). National Energy Policy 2050 (March 2022 Update). Santiago, Chile: Ministry of Energy. Available at: https://energia.gob.cl/sites/default/files/documentos/pen_2050_-_actualizado_marzo_2022_0.pdf.

The general objectives of the updated Energy Policy are as follows:

1. Emission-free energy.
2. Universal and equitable access.
3. Energy-sustainable cities.
4. Sustainable transportation.
5. Citizen energy education.
6. Inclusive economic development.
7. Increased human capital.
8. Social and environmental sustainability of energy development.
9. Efficient and sustainable industry.
10. Local development and decentralization.
11. Reliable and quality energy supply.
12. Electric system for empowering individuals.
13. Participatory public policies.
14. Balanced integration in territories.
15. Information for the energy transition.
16. Coordination between institutions.
17. Institutional framework and energy governance.
18. Interculturality and ongoing dialogue.

The three main purposes guiding this policy are: i) to lead climate ambition by providing leadership in the fight against climate change; ii) to ensure that energy contributes to a better quality of life by guaranteeing an accessible and affordable supply for all households; and iii) to foster a new productive identity for Chile by promoting innovation and sustainable development in the energy sector. These purposes are supported by essential pillars such as sustainability, resilience, inclusivity, accessibility, efficiency, and respect for human rights and cultural diversity.

Within the framework of the second purpose (Energy for a Better Quality of Life), General Objective Four stands out: "Promote the adoption of zero-emission vehicles, technologies, and fuels with the best performance and standards across different modes of transportation, to achieve a sustainable and energy-efficient mobility system, ensuring the necessary infrastructure for its implementation." The transportation sector currently accounts for one-third of the economy's final energy consumption and is responsible for 26% of greenhouse gas emissions. Therefore, it is crucial to implement public policies that encourage efficient and sustainable energy use in this sector, optimizing operations, infrastructure, and fuels used.

To move towards a future with zero emissions in transportation, it is essential to reduce energy consumption from fossil sources and promote more sustainable alternatives. Public policies should focus on eliminating tax exemptions for fossil fuels and encouraging the use of clean technologies such as electromobility and green hydrogen. Additionally, it is necessary to improve infrastructure conditions and establish incentives for the adoption of more efficient technologies in the transportation sector.

Chile also seeks to position itself as an exporter of low-carbon footprint products, which involves making commitments across the entire value chain, including maritime and air transportation. The economy has joined international efforts to reduce emissions in these sectors, committing to a significant reduction in greenhouse gas emissions in maritime transport by 2050 and in air transport starting from 2030.

The specific goals for sustainable transportation include:

1. 2035: Ensure that 100% of new sales of light and medium vehicles, as well as new additions to urban public transportation (buses and taxis), are ZEV.

2. 2040: Achieve 100% ZEV in the fleet of urban public and private transportation buses and taxis.
3. 2050: Reach at least 60% ZEV participation in the private and commercial vehicle fleet.

Finally, Chile's Energy Policy by 2050 aspires to transform the energy sector into a model of reliability and resilience, with high standards of quality and supply security. The shared vision of this policy, grounded in sustainability, resilience, inclusivity, accessibility, and efficiency, aims to lead the energy transition and overcome the climate crisis, contributing to a more prosperous and sustainable future for all Chileans.

Chile's Long-Term Climate Strategy (LTCS) [237]

The LTCS is an essential document that outlines the roadmap for the economy to achieve carbon neutrality and climate resilience by 2050 at the latest. This strategy, framed within the Framework Climate Change Bill, sets medium- and long-term objectives, targets, and guidelines regarding climate change. The ECLP aims to align Chile's climate policy with global efforts to prevent a rise in global temperatures, as stipulated in the Paris Agreement. Chile's long-term vision includes incorporating climate change into the daily management of all economic sectors and territories, ensuring sustainable development that respects ecosystem limits.

One of the central elements of the LTCS is the goal of achieving carbon neutrality by 2050. This goal is supported by the commitments established in the Nationally Determined Contribution (NDC), which includes actions for mitigation, adaptation, and resilience. The strategy includes significant reductions in emissions from key sectors such as energy, transportation, and agriculture, as well as increasing carbon sequestration through sustainable forest and other ecosystem management. To achieve these goals, the LTCS will be updated every ten years through a multisectoral participatory process, ensuring coherence and commitment from all involved parties.

Transportation is one of the most critical sectors in Chile's climate strategy, as it represents a significant portion of the economy's energy consumption and greenhouse gas emissions. The LTCS promotes the transition to a sustainable and zero-emissions transportation system by encouraging the adoption of EV and other clean technologies. EVs not only offer greater energy efficiency but also contribute to reducing local pollutants and noise levels in urban areas. Additionally, the strategy emphasizes the need to develop the necessary infrastructure to support the expansion of electromobility, as well as to enhance intermodality and the integration of different modes of transportation.

The strategy also recognizes the importance of promoting the use of alternative fuels, such as green hydrogen, which can play a crucial role in decarbonizing the transportation sector. Chile is committed to phasing out the use of fossil fuels in transportation, with concrete goals such as achieving full adoption of ZEVs in the urban bus and taxi fleets by 2040, and at least 60% participation of these vehicles in the private and commercial vehicle fleet by 2050. This comprehensive approach aims not only to reduce emissions but also to improve quality of life in cities and contribute to sustainable economic development.

[237] Ministry of the Environment of Chile (2021). Chile's Long-Term Climate Strategy. Available at: https://cambioclimatico.mma.gob.cl/wp-content/uploads/2021/11/ECLP-LIVIANO.pdf.

Energy Sector Emissions Mitigation Plan[238]

Chile's Energy Sector Mitigation Plan was designed to contribute to the economy's overall mitigation goals, in line with the National Climate Change Action Plan (PANCC) 2017-2022 and the National Energy Policy (PEN). This plan addresses direct emissions from energy-consuming sectors, such as electricity generation, the industrial and mining sector, the commercial, public, and residential sectors, and transportation. Its development included an analysis of mitigation measures for these sectors, estimating their emission reduction potential, costs, and implementation feasibility.

The plan provides clear guidance on the measures to be implemented in the energy sector up to 2030, with the goal of significantly reducing greenhouse gas (GHG) emissions. It includes an estimate of the emission reductions required to meet the Nationally Determined Contribution (NDC), specific policies that can contribute to this goal, and an estimate of the additional investment required for their development. Mechanisms for monitoring and verifying mitigation results are also defined, ensuring that the economy remains on track to meet its international commitments.

The development process for the plan was thorough and participatory, involving representatives from various ministries, academia, civil society, and the private sector, as well as local and international experts. This approach helped identify a robust set of policies for the energy sector, aligned with the PEN and Chile's climate change initiatives. The measures identified were discussed in workshops and interviews, where their feasibility was assessed, and barriers to implementation were identified.

In terms of specific sectors, the plan places a strong emphasis on electricity generation, transportation, and the industrial and mining sectors, which are the main GHG emitters in Chile. Implementing measures in these sectors will significantly reduce emissions, complementing other actions defined in the PEN for sustainable and competitive energy development. Renewable energy, energy efficiency, and the electrification of energy demand are highlighted as crucial elements in this transition.

Norms Promoting or Accelerating the Transition to Electromobility

Among the energy regulations that promote the transition to electromobility are the following:

- **Decree 107 (28 December 2016)**[239]

Decree 107 amends Supreme Decree No. 61 of 2012 from the Ministry of Energy, which approves the regulation for energy consumption labeling for light motor vehicles. This decree introduces a vehicle labeling system with the aim of providing consumers with standardized information about energy consumption and CO_2 emissions of new vehicles. The amendment extends the labeling to include light commercial vehicles, medium-sized vehicles, pure electric, and hybrid vehicles, which is crucial for overcoming the information barrier in the automotive market and promoting more informed and sustainable purchasing decisions.

One of the main innovations of this decree is the inclusion of specific requirements for EV and hybrids. It stipulates that EV must report their energy performance in Km per kilowatt-hour (Km/KWh), while hybrids must report both fuel and electric performance.

[238] Ministry of Energy of Chile (2017). Emissions Mitigation Plan for the Energy Sector. Government of Chile. Available at: https://energia.gob.cl/sites/default/files/plan-mitigacion-gei-sector-energia-2017.pdf.

[239] Ministry of Energy of Chile (2016). Decree 107, Amends Supreme Decree No. 61, of 2012, from the Ministry of Energy, which approves the energy consumption labeling regulation for light motor vehicles. National Congress Library of Chile. Available at: https://www.bcn.cl/leychile/navegar?idNorma=1098323&idParte=9757363&idVersion=2016-12-28.

This regulation aims to incentivize the adoption of cleaner and more efficient technologies by providing consumers with tools to compare the energy performance of different types of vehicles, thus fostering a transition towards more sustainable mobility and reducing the carbon footprint in the transportation sector.

Decree 107 plays a crucial role in promoting electromobility by establishing a regulatory framework that encourages transparency and comparability of energy consumption for EV and hybrids. By requiring these vehicles to display detailed energy consumption labels, it facilitates the adoption of vehicles with lower environmental impact. Additionally, by extending labeling requirements to a broader range of vehicles, including pure electric and hybrid models, the decree not only drives technological innovation in the automotive sector but also supports local goals for reducing greenhouse gas emissions and improving air quality. This regulatory approach, aligned with international best practices, is essential for positioning Chile as a regional leader in the transition to electromobility and sustainable development.

- **Exempt Resolution 2243 (3 August 2018)**[240]

Resolution 2243 EXENTA, issued by the Ministry of Transport and Telecommunications of Chile, approves a technical protocol to determine energy consumption in urban public transport buses in Santiago. This protocol establishes the characteristics and methodology for measuring the "TS-STGO" driving cycle, which simulates the real operation of an urban bus as an integrated unit (chassis and body) under the specific conditions of the city of Santiago. The resolution aims to provide a standardized and accurate basis for assessing the energy efficiency of various bus technologies used in public transport.

The implementation of this protocol is crucial for promoting the adoption of more efficient and sustainable technologies in urban public transport. By providing reliable data on bus energy consumption, it facilitates comparison between different technologies and encourages the adoption of those offering better energy performance. This not only contributes to the reduction of greenhouse gas emissions but also supports the energy and transport efficiency objectives set out in the energy and transport policy.

Resolution 2243 EXENTA plays a crucial role in promoting electromobility within Santiago's public transport system. By standardizing the methodology for measuring energy consumption, this regulation facilitates the integration of electric buses into the public transport fleet, allowing for a fair and accurate assessment of their energy performance compared to traditional buses. This measure is essential for driving the adoption of electric buses, which are significantly more efficient and less polluting than ICE vehicles.

Furthermore, the technical protocol approved by the resolution provides a valuable tool for decision-makers and public transport operators. With accurate data on energy consumption and emissions, more effective policies can be designed and implemented to promote the transition to electric and sustainable mobility, aligned with the objectives of emission reduction and improved air quality in urban areas. Thus, the resolution not only supports the adoption of cleaner technologies but also reinforces Chile's commitment to sustainability and innovation in the transport sector.

[240] Ministry of Transport and Telecommunications of Chile. (2018). Resolution 2243 EXEMPT, approves technical protocol for obtaining energy consumption in urban public transport buses in the city of Santiago. National Congress Library of Chile. Available at: https://www.bcn.cl/leychile/navegar?idNorma=1121384.

- **Law 21.305 (13 February 2021)**[241]

Law 21305 on Energy Efficiency of Chile establishes a comprehensive regulatory framework to improve energy efficiency across various sectors, including transportation, building, and production sectors. The law requires the Ministry of Energy, in collaboration with other sectoral ministries, to develop an Energy Efficiency Plan every five years. This plan must include short, medium, and long-term goals, as well as specific programs and actions to enhance energy efficiency. Additionally, the law introduces the concept of "Energy Management Capable Consumers" (EMCC), which are companies required to implement energy management systems and report their consumption and improvement opportunities annually.

Law 21305 sets energy efficiency standards for new motor vehicles, including EV and PHEV. These standards are based on average energy performance targets, measured in Km per liter of gasoline equivalent and grams of CO_2 per Km. To incentivize the availability of EV, the law allows counting each EV or hybrid vehicle's performance up to three times in the calculation of this average. Furthermore, the law defines hydrogen as a fuel, permitting its regulation by the Ministry of Energy, and establishes the possibility of applying accelerated depreciation to EV, with differentiated useful lives of 3 years for normal depreciation and one year for accelerated depreciation.

- **Exempt Resolution SII No. 56 (9 June 2021)**[242]

Exempt Resolution SII No. 56, issued by the Internal Revenue Service (SII), incorporates EV, PHEV, and other vehicles classified as zero-emissions by a substantiated resolution from the Ministry of Energy into the table for normal useful life and accelerated depreciation. This measure aims to promote the adoption of cleaner technologies in the Chilean vehicle fleet by providing fiscal benefits for vehicles that help reduce pollutant emissions.

The resolution specifies that the normal useful life of these vehicles, previously set at seven years, is reduced to three years. Additionally, the accelerated depreciation, which was previously two years, is reduced to one year. This regulatory change allows taxpayers to apply a faster depreciation for these vehicles, which financially incentivizes their acquisition and use. EV and PHEV, by being depreciated over a shorter period, offer an additional economic advantage, contributing to the transition towards more sustainable mobility in Chile.

The inclusion of EV and PHEV in the accelerated depreciation table underscores Chile's commitment to electromobility. By offering the possibility of accelerated depreciation, the regulation lowers the financial cost associated with these vehicles, encouraging businesses and individuals to opt for cleaner and more efficient transport alternatives. This fiscal incentive is crucial for accelerating the adoption of EV, reducing the initial economic barrier, and promoting a quicker renewal of the vehicle fleet towards more sustainable options.

Additionally, by defining hydrogen as a fuel and permitting its regulation by the Ministry of Energy, the resolution paves the way for new zero-emissions technologies, expanding the range of clean energy options available in the economy. This comprehensive approach not only supports the transition to electromobility but also reinforces Chile's commitment to reducing greenhouse gas emissions, significantly contributing to the environmental sustainability and energy efficiency goals outlined in the Energy Policy.

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[241] National Congress Library of Chile. (2021). Law 21305, On Energy Efficiency. https://www.bcn.cl/leychile/navegar?idNorma=1155887.

[242] Internal Revenue Service of Chile. (2021). Resolution Ex. SII No. 56, Incorporates Electric or Plug-in Hybrid Vehicles, and Others Qualified as Zero Emissions by a Justified Resolution of the Ministry of Energy, into the Depreciation Table of Resolution Ex. SII No. 43 of 2002. https://www.sii.cl/normativa_legislacion/resoluciones/2021/reso56.pdf.

8.3.3. Specific Electromobility Policies

The expansion of electromobility in Santiago, Chile, which has led the city to have the largest electric bus fleet outside of China, is the result of a set of strategic conditions implemented over time. First, stability in public policies has been crucial, allowing long-term projects to continue regardless of changes in government administration. Alongside this, a flexible yet robust legal framework has provided the necessary certainty to attract investments and adapt to new technologies without creating excessive barriers.

Financial support through subsidies has also been a determining factor, reducing financial risk for operators and facilitating the acquisition of advanced technologies. This aspect has been complemented by the creation of public-private partnerships, enabling collaboration between various market players and ensuring the efficient and coordinated implementation of the necessary infrastructure for electromobility.

Finally, competitive bidding processes have played a fundamental role by establishing conditions that incentivize the incorporation of electric buses. These processes have offered longer concessions and introduced criteria that favor electric technology, resulting in the significant expansion of the city's electric fleet. This comprehensive approach has been key to the success of electromobility in Santiago, positioning the city as a reference in the transition toward more sustainable urban transportation. The following sections detail each of the implemented strategies.

Stable Public Policies

The successful implementation of electromobility in Santiago, Chile, has been significantly driven by stable and consistent public policy over time. In 2017, the First Electromobility Strategy marked a milestone by promoting the arrival of the first electric buses and the installation of the necessary charging infrastructure. This initial pilot demonstrated that the technology was viable and suitable for the distances and routes of the city's public transportation system, laying the groundwork for future expansion.

In 2021, the Second Electromobility Strategy reinforced the role of public transport as a driver of technological development. Ambitious goals were set, such as the incorporation of fully electric large and small public transport vehicles by 2035, the full electrification of public transport by 2040, and the aspiration for Chile to become a carbon-neutral economy by 2050. These goals reflect a clear and long-term commitment to sustainability and innovation in transportation.

Furthermore, the coordination in planning new electric terminals and the energy demand associated with public transport, along with the planning of electrical grids, are crucial components that underscore the need for a holistic and well-planned approach to integrating electromobility in Santiago.

Flexible Legal Framework and Legal Certainty

The success of the public transportation system in Santiago, Chile, especially in the implementation of electromobility, is largely due to the existence of a robust yet flexible legal framework that provides the legal certainty needed to attract investments and facilitate the operation of concessions. Law No. 18,059, which establishes the Ministry of Transport and Telecommunications (MTT) as the supreme authority in transportation matters, is a clear example of this legal structure. This law grants the MTT the primary function of regulating the transportation system and the power to grant concessions for the use of roads to private companies, particularly in cases of market failures such as pollution, accidents, and lack of coverage.

The purpose of this legal framework is to serve the public interest, ensure the continuity of services, and promote the provision of efficient, safe, and high-quality transportation. To achieve these objectives, the MTT has several key tools at its disposal, including: i) competitive bidding processes, ii) the figure of concession-related assets, iii) supply contracts, iv) the acquisition of bus terminals, and v) the use of experimental regulatory environments, known as "sandboxes."

Concession-related assets are an essential aspect of this legal framework, as they ensure that both movable and immovable assets (e.g., buses and terminals) remain part of the transportation system even if the concession contract ends. This mechanism ensures service continuity and facilitates financing, as the assets retain their utility within the system throughout their useful life.

Supply contracts, on the other hand, allow concessionaires to obtain a qualifying title to use buses and charging infrastructure, typically through leasing agreements. These contracts are structured so that, at the end of the concession, buses can be transferred to other operators, ensuring that the vehicles remain operational within the system. This model also positively impacts financing by reducing risk for financiers and improving financial conditions for operators.

The acquisition of terminals by the MTT is another key tool that lowers barriers to market entry, facilitating operations for new concessionaires. Finally, the implementation of regulatory "sandboxes" allows for the testing of new technologies within a flexible regulatory framework, exempting them from certain standards during their evaluation phase, thereby accelerating innovation in the transportation system.

Supply contracts improve financing opportunities, as they allow bus leasing contracts to extend beyond the duration of the road operator's concession contract. This reduces risk for financiers and encourages competition in the market, resulting in more favorable financial conditions for operators. Moreover, the incorporation of new actors in the market, with differentiated roles based on various management strategies and models, has led to the formation of diverse associations within the industry, including bus operators, fleet providers, energy suppliers, financiers, and maintenance providers, among others

Subsidies and Financing

The role of subsidies in Santiago, Chile's public transportation system has been crucial in ensuring not only the financial sustainability of the system but also facilitating the transition to electromobility. Law 20.378, enacted in 2009, established a permanent subsidy aimed at financing the public transportation system. This subsidy should not be seen as an expense but rather as a strategic investment that has allowed transportation fares to remain at moderate levels, thereby ensuring accessibility for users.

In addition to stabilizing fares, subsidies have played a key role in the acquisition of electric buses, enabling concessionary companies to obtain favorable financing rates without compromising service quality. The structure of the new bidding models reinforces this approach, assigning the Ministry of Transport and Telecommunications (MTT) the responsibility of paying for fleet installments. This provision provides greater certainty to financiers, resulting in more favorable and secure financing conditions for public transportation operators. The system's financial management is handled by a technical entity (AFT), ensuring that payments are managed transparently and overseen by the Office of the Comptroller General of the Republic.

Public-Private Partnerships

The development and success of electromobility in Santiago, Chile, would not have been possible without the creation of a favorable ecosystem for public-private partnerships. These collaborations have been essential for the large-scale implementation of sustainable technologies in public transportation. A notable example of this approach is the implementation of the first large-scale electric bus fleet in 2018, consisting of 100 units, where the concessionary company Metbus played a central role.

In this collaborative model, various private entities, such as energy providers and financiers, along with the activation of electric terminals, worked hand-in-hand with fleet operators to ensure the successful integration of electric buses. The synergy between these actors not only facilitated the acquisition and operation of the vehicles but also established the necessary infrastructure for their operation, demonstrating that cooperation between the public and private sectors is an essential catalyst for innovation and sustainability in urban transportation.

Competitive Bidding Processes

The bidding processes in Santiago, Chile, have been strategically designed to promote the incorporation of electric buses into the public transportation system. In 2019, bidding rules granted a longer concession period to operators who offered electric buses, and additional points were awarded for the use of this technology. This strategy resulted in the entry of approximately 1,000 new electric buses into the system, marking an important milestone in the transition to cleaner transportation.

Additionally, fleet quotas and charging infrastructure are paid independently of the concessionaire’s revenues and are charged to the budget of the Ministry of Transport and Telecommunications (MTT), reducing financial risk and eliminating significant entry barriers for new operators. The MTT also provides bus terminals, further facilitating the participation of more operators in the market. Another crucial aspect introduced during this period was the mandatory third-party certification of bus maintenance, ensuring the quality and safety of the service.

Following this successful experience, changes were introduced to the evaluation model in 2023 to increase competition. The new bidding rules only considered offers that included electric buses, reflecting the city’s commitment to sustainability. Additionally, these changes allowed less-experienced operators to compete if they presented innovative and efficient proposals.

With these measures, it is expected that an additional 1,100 electric buses will be incorporated into the system, reaching 50% of zero-emission vehicles in the total fleet by 2026, which represents approximately 3,600 electric buses. These bidding processes have not only facilitated the expansion of Santiago's electric bus fleet but also set a high standard for future tenders, ensuring that the transition to a cleaner and more efficient transportation system continues to progress steadily.

In particular, electric buses play a crucial role in the transition to more sustainable mobility. FCEVs emit significantly less CO_2 per passenger-kilometer compared to their internal combustion counterparts. This reduction in emissions not only helps to lower the carbon footprint of urban transportation but also improves air quality in cities, benefiting public health and the quality of life of their residents.

National Electromobility Strategy[243]

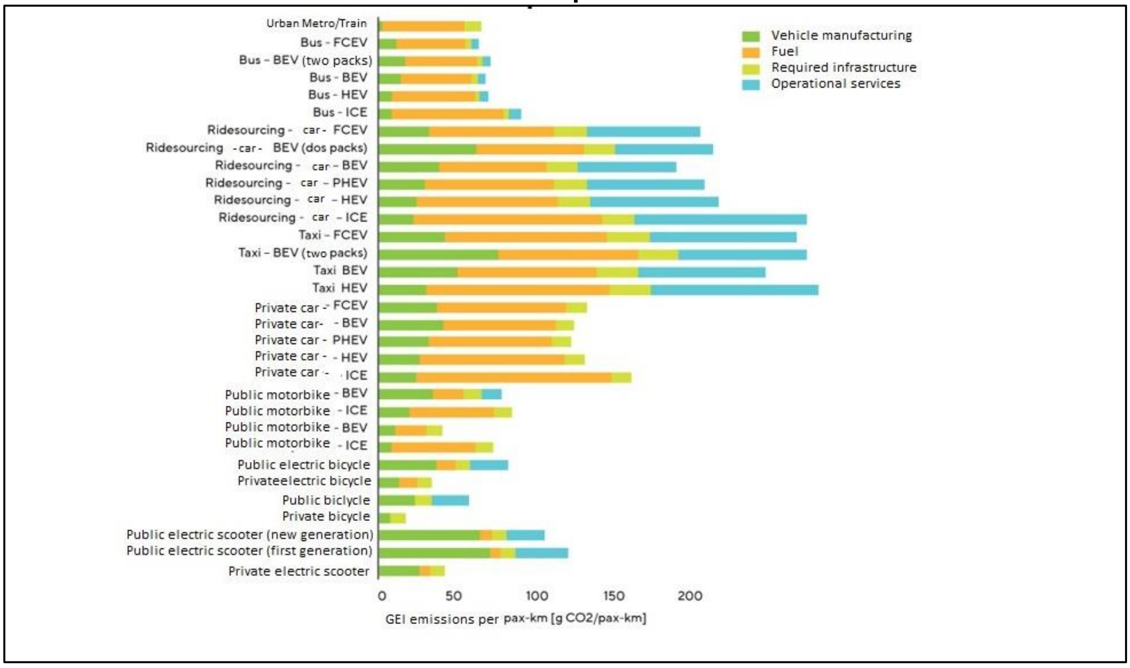
[243] Ministry of Energy of Chile. (2021). National Electromobility Strategy. Available at: https://energia.gob.cl/sites/default/files/documentos/estrategia_nacional_de_electromovilidad_2021_0.pdf.

In the context of Chile's National Sustainable Mobility Strategy, the National Electromobility Strategy emerges as a key initiative to promote the transition to cleaner and more efficient transportation. This document, developed by the Ministry of Energy, sets forth a series of objectives, targets, and measures aimed at fostering the adoption of EVs in the economy, with the goal of reducing GHG emissions and improving air quality in urban areas.

The primary goal of the strategy is to promote EV as a viable solution to decrease dependence on fossil fuels and reduce emissions from the transportation sector, one of the main contributors to air pollution in Chile. Specific objectives include reducing CO_2 emissions, improving energy efficiency in transportation, and increasing the share of renewable energy in the economy's energy matrix. By 2035, the goal is for 100% of new light and medium vehicle sales, as well as all new additions to urban public transport, to be zero-emission.

To achieve these goals, the strategy proposes a series of promotion measures and policies ranging from economic incentives to the creation of appropriate infrastructure for EV charging. Key measures include financial and fiscal incentives, such as tax exemptions and the possibility of accelerated depreciation for EV. These incentives aim to reduce the initial acquisition cost and encourage widespread adoption. Additionally, up to three times the efficiency performance of each electric or PHEV can be counted in the calculation of the average energy efficiency, incentivizing importers to include these vehicles in their sales mix.

Figure 57. Emissions per pax-Km associated with the full life cycle of different modes of transport



Source: Ministry of Transport and Telecommunications of Chile. (2023). National Sustainable Mobility Strategy (ENMS).

The strategy also promotes the installation of fast-charging stations in urban and rural areas, ensuring that EV users have access to the necessary infrastructure for operation. The Ministry of Energy is empowered to regulate the interoperability of the EV charging system, ensuring an integrated and accessible charging infrastructure nationwide. Furthermore, regulations are developed to establish energy efficiency and emissions standards for new vehicles, including mandatory energy labeling to enable consumers to make informed purchasing decisions.

The implementation of these measures has a significant impact not only on reducing GHG emissions but also on improving air quality, especially in large cities. Promoting electromobility contributes to the reduction of local pollutants such as PM and NOx, which has a direct effect on public health.

The role of electromobility in this strategy is crucial for meeting Chile's emission reduction commitments. The adoption of EV, both for personal use and for commercial and public transport fleets, is seen as one of the most effective solutions for decarbonizing the transportation sector. Additionally, the development of electromobility is expected to drive technological innovation and create new jobs in the automotive and energy sectors.

In conclusion, the National Electromobility Strategy represents a significant step towards building a more sustainable and efficient transportation system. Through the implementation of incentives, the creation of infrastructure, and the establishment of clear regulations, Chile is positioning itself as a regional leader in the transition to electric mobility, with tangible benefits for the environment and the quality of life of its citizens.

8.3.3.1. Bus Procurement Models for Electromobility[244]

Initial Challenges to Electric Bus Implementation (2017)

In 2017, the implementation of electromobility faced significant challenges, particularly in the electric bus sector. At that time, China was the only economy that had achieved considerable mass adoption of electromobility, including electric buses. Outside China, efforts were limited to small pilot projects in various parts of the world, complicating a full understanding of the risks and challenges involved in this emerging technology.

One of the main obstacles was the high cost of electric buses compared to Euro VI diesel vehicles, which were required to meet standards in Santiago. In many cases, the price of an electric bus could be twice or even more than that of its diesel counterpart, posing a significant barrier to adoption. Additionally, there was considerable lack of information about batteries, particularly regarding critical aspects such as lifespan, charge cycles, and degradation. The uncertainty around these factors increased the perceived risk among transport operators.

Another crucial challenge was the charging infrastructure, where there was a widespread lack of knowledge about the requirements and regulations necessary for its implementation. In Santiago, as in many other parts of the world, there were no clear regulations on charging infrastructure, adding another layer of complexity to the adoption of electric buses.

Finally, the range of electric buses raised serious concerns. There was uncertainty about whether the range would be sufficient to meet operational schedules without requiring frequent recharges, which could increase the downtime of buses. This situation raised the possibility that overnight charging would be preferable to daytime charging, implying an adjustment in operations to adapt to the technological limitations of the time.

Evaluation of Operating Conditions for E-buses (2017)

[244] Esta subsección se ha construido sobre la base de tres presentaciones: Tamblay, S. (2024). *Implementation of E-buses in Santiago de Chile: From initial experiences in 2017 to large scale tendering processes in 2023 and 2025*. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Centro de Convenciones de Lima, San Borja, Lima, Perú; Vilches, A. (2024). *METBUS and the transformation of public transportation in Santiago de Chile*. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Centro de Convenciones de Lima, San Borja, Lima, Perú y Steinmeyer, A. (2024). *Normative aspects of the implementation of electromobility in Santiago de Chile*. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Centro de Convenciones de Lima, San Borja, Lima, Perú.

In 2017, Santiago, Chile, took its first step toward electrifying its public transportation system with the introduction of its first two electric buses, marking the beginning of a transformative shift towards sustainable urban mobility. This experience allowed to evaluate the efficiency and adaptability of these vehicles to local operating conditions, resulting crucial to understanding how electric buses would perform in a complex and challenging urban environment.

Santiago's transportation system is characterized by having between 3 and 4 stops per kilometer, implying frequent acceleration and braking in non-segregated lanes. This situation could present a significant challenge for buses, as traffic conditions can affect energy consumption and the operational efficiency of EVs. Additionally, the routes include round trips of up to 100 kilometers, so E-buses must be able to cover large distances in the city.

Another critical variable evaluated was the average operating speed, which remained around 18 km/h. This relatively low speed, when compared to a closed BRT system, reflects the typical urban congestion of a large city like Santiago and is an important factor to consider in planning the use of electric buses, as it influences the vehicles' range and energy management.

Finally, the different routes that were operated considered the electric buses' ability to handle slopes with gradients of up to 18%. This is a significant condition in Santiago, a city surrounded by hills and mountains, where topography can directly impact the performance of the electric motor and battery life.

The results of these experiences were positive, confirming that electric buses were not only efficient but also well adapted to Santiago's local operating conditions. This laid the groundwork for a broader expansion of the electric fleet in the city, establishing Santiago as a regional leader in implementing sustainable public transportation.

First Electric Bus Supply Contract (2018)

In 2018, with the implementation of the first electric bus supply contracts, Santiago took a significant step toward modernizing its public transportation system by incorporating a new technological standard. The electric buses acquired under these contracts were equipped with advanced systems designed to improve both operations and the user experience. Notable innovations included multi-variable information screens, proximity detection systems, speed controls, and panic buttons that ensure safe and efficient operation.

Additionally, these buses integrated security cameras, USB chargers, and onboard Wi-Fi, enhancing passenger connectivity and safety. Air conditioning ensures a comfortable ride in all seasons, and the telemetry system allows operators to monitor vehicle performance in real-time, optimizing maintenance and use.

The year 2018 marked a turning point in Santiago's fleet renewal strategy with the introduction of the first E-bus provision contracts, an innovative model that linked electric buses as assets within concession contracts. This contractual structure helped mitigate financial risks and opened new financing opportunities, facilitating large-scale adoption of electric buses.

The success of this model is not only reflected in the acquisition of more than 1,500 electric buses via provision contracts, but also in the creation of a robust ecosystem involving various private companies, from fleet operators to energy providers and financiers.

E-bus Bidding Model in Santiago (2019-2023)

The bidding model implemented in 2023 in the first E-bus tendering process in Santiago, Chile, established a detailed framework for public transportation service concessions. This model is based on a hierarchical structure where the Ministry of Transport and Telecommunications (MTT) acts as the governing body, overseeing and regulating the road concessionaires responsible for the system's daily operations.

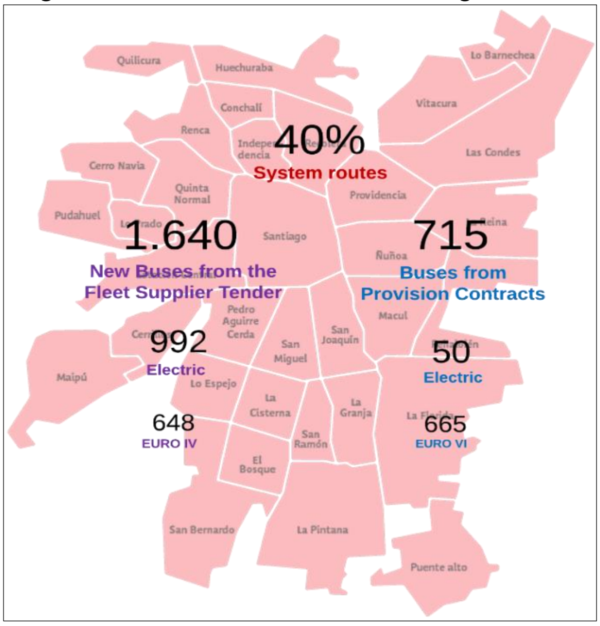
At the core of this model is the Road Concessionaire, who, under a concession contract with the MTT, manages the operation, maintenance, and bus fleet, as well as the charging infrastructure and bus depots. This concession contract sets out the concessionaire's responsibilities and the conditions under which they must operate.

Under the 2019-2023 model, the bus fleet is divided into two main categories: buses transferred from previous concessionaires and new buses. The transferred buses are managed under an existing provision contract, ensuring the continued use of these vehicles in the system. For the new buses, a new supply contract was established through an independent bidding process, detailing the usage and maintenance conditions required for these vehicles, ensuring that all buses meet the necessary standards to operate in the public transportation system.

The infrastructure required for charging electric buses is a critical component of the model. This infrastructure is covered in Appendix 11 of the concession contract and is managed through a specific supply contract. This contract ensures that charging stations are available and operational to maintain the efficiency and reliability of the electric fleet.

The model also includes provisions for bus depots, which are essential for storing and maintaining the vehicles. The main depots are provided by the MTT under the bidding conditions specified in Appendix 17 of the contract (commodatum contract). However, if a concessionaire requires additional depots, these must be acquired and managed under the bidding conditions specified in Appendix 14 of the contract.

Figure 58. First Electric Bus Bidding Process



Source: Tamblay, S. (2024). *Implementation of E-buses in Santiago de Chile: From initial experiences in 2017 to large scale tendering processes in 2023 and 2025*. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Lima Convention Center, San Borja, Lima, Peru.

Lessons Learned from the First E-bus Bidding Process

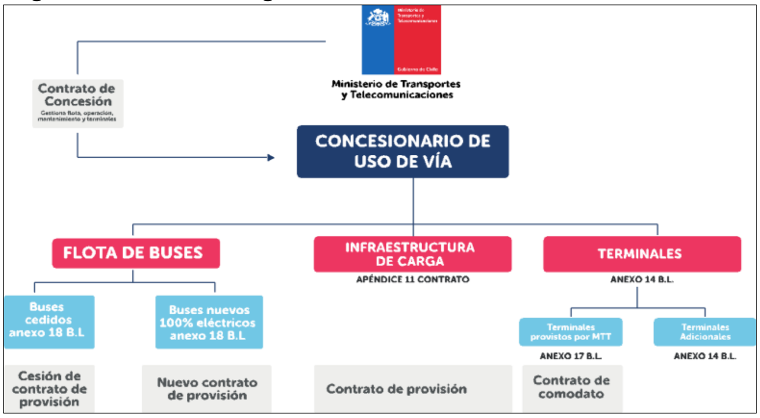
The large-scale implementation of the first electric bus bidding process in 2023 presented significant challenges, particularly in terms of institutional coordination. This process involved not only the introduction of new contracts and routes but also the integration of new operators and buses into the existing system. The main challenges included coordination between incoming and outgoing operating companies, fleet and energy suppliers, as well as the management and acquisition of bus depots. Additionally, the participation of local municipalities was crucial to ensure effective and equitable implementation across the city.

Despite these challenges, certain elements of the process worked particularly well. The new incentives implemented were successful, as reflected in quality indicators, and the new powers and responsibilities granted to the authorities facilitated better oversight and control of the process. However, areas needing improvement were also identified. Part of the city lagged in fleet renewal, raising concerns about territorial equity. Moreover, the fleet supplier bidding model could benefit from improvements to optimize efficiency and competition in future tenders.

Second Electric Bus Bidding Process (2023-2025)

In 2025, Santiago will implement its second bidding process for the acquisition of electric buses, building on the progress made in transitioning to a sustainable public transportation system. This process started in 2023 and aims to directly benefit 3.5 million citizens and will cover 30% of the system's routes, extending to over 20 municipalities. The tender will incorporate a new fleet of 2,100 buses, of which at least 1,100 must be fully electric.

Figure 59. Bidding Model for Santiago, Chile in 2023-2025: Second E-bus bidding process



Source: Steinmeyer, A. (2024). Normative aspects of the implementation of electromobility in Santiago de Chile. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Lima Convention Center, San Borja, Lima, Peru.

This bidding process will integrate the best aspects of previous models while introducing key changes to optimize the operation and management of the transport system. The new bidding model requires bidders to offer the fleet through provision contracts, but with stricter requirements for supply and maintenance contracts. These changes include stronger payment guarantees for financiers, as fleet payments are explicitly separated, reducing financial risk for suppliers.

Additionally, bus depots will be provided by the system, and charging infrastructure will be funded by the authorities, reducing administrative and supervisory costs and allowing for more efficient utilization of economies of scale. This approach also offers greater flexibility in private contractual regulation and facilitates the gradual renewal of the fleet during the contract term. Although the bidding process is still underway, the model has been considered attractive, as evidenced by the submission of 86 bids from 9 bus operators.

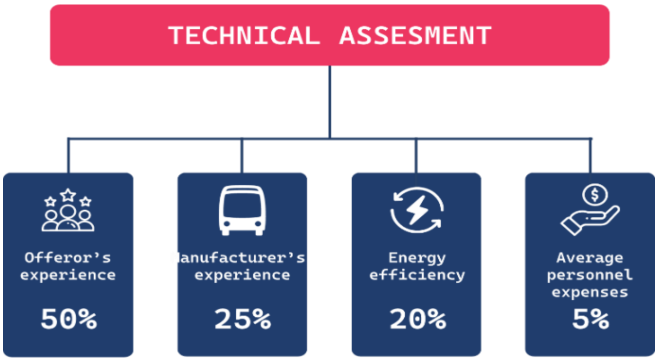
Offer Evaluation Process

The evaluation process in the 2025 public transport bidding model for Santiago is designed to ensure that the offers submitted by concessionaires meet high technical and economic standards, guaranteeing the sustainability and efficiency of the system. This process is carried out in several key stages, each with a specific focus.

- **Admission Evaluation:** The first stage involves the opening of technical bids and admission evaluation, checking that the proposals meet the basic requirements and the admissibility criteria outlined in the bidding terms.

- **Technical Evaluation:** At this stage, the technical aspects of the offers are thoroughly analyzed. The criteria are divided into four main components: the bidder's experience, the bus manufacturer's experience, the energy efficiency of the proposed vehicles, and the average personnel expenses. This evaluation ensures that the operators have the necessary technical capacity and experience to efficiently manage the transport system, while also guaranteeing that the proposed buses are energy efficient.

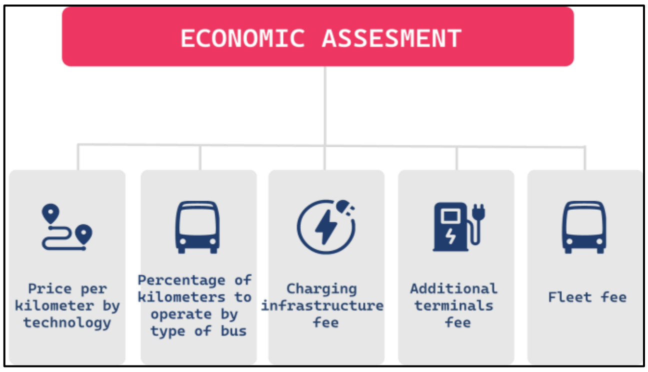
Figure 60. Technical Evaluation Criteria in the 2023-2025: Second E-bus bidding process



Source: Steinmeyer, A. (2024). Normative aspects of the implementation of electromobility in Santiago de Chile. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Lima Convention Center, San Borja, Lima, Peru.

- **Economic Evaluation:** After the financial bids are opened, the economic evaluation is conducted. This phase considers the price per kilometer based on the proposed technology, the percentage of kilometers to be operated according to the type of bus, the fees associated with charging infrastructure, the fees for additional terminals, and fleet fees. The aim of this evaluation is to ensure that the proposals are economically viable and competitive, taking into account all the costs involved in the operation.

Figure 61. Economic Evaluation Criteria in the 2023-2025: Second E-bus bidding process



Source: Steinmeyer, A. (2024). Normative aspects of the implementation of electromobility in Santiago de Chile. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Lima Convention Center, San Borja, Lima, Peru.

- **Final Evaluation:** The final stage of the evaluation process primarily weighs the economic value of the offer, which accounts for 97% of the total score, followed by a smaller but significant consideration of personnel expenses (1.5%) and energy efficiency (1.5%). Additionally, specific conditions for awarding contracts are established, such as a maximum of two awarded units and the restriction that no concessionaire may control more than 50% of the total fleet, promoting competition and preventing market monopolization.

This detailed and multifaceted evaluation process ensures that concessions are awarded to operators who not only offer competitive prices but also possess the technical and operational capacity to manage an efficient and sustainable public transport system, in line with Santiago's electromobility objectives.

Technical Specifications for E-buses

In the second E-bus bidding model, electric buses must meet a series of technical specifications to ensure their suitability and efficiency within Santiago's public transportation system. First, a minimum operational range is established, requiring the buses to achieve at least 200 km with a standard (trickle) charge and 50 km with a fast (opportunity) charge. This ensures that the vehicles have sufficient autonomy to cover their daily routes, even under high-demand conditions.

Charging time is also a critical factor: buses must be able to reach 100% charge within a maximum of 5 hours using a standard charge, while a fast charge must provide minimum autonomy in just 9 minutes. Additionally, bus batteries must be guaranteed for a minimum of 10 years or 800,000 km, ensuring their long-term durability and efficiency.

Finally, it is essential that the bus supplier or their designated representative provides local support and has the appropriate infrastructure for vehicle maintenance and repair. This not only ensures that the buses remain operational but also provides crucial backup in case of technical issues during their service life in the system.

Evaluation of the Bidding Model

The second E-bus bidding model has generated considerable interest from sector operators, as evidenced by the submission of 86 bids in the process. While the evaluation of these offers is still ongoing, the high number of proposals submitted is a positive indication of the model's effectiveness and attractiveness. This level of participation suggests that the adopted approach, with its well-defined technical and economic criteria, has successfully captured the interest of a wide range of market players, which is essential to ensuring competition and quality in public transportation services.

8.3.3.2. Lessons Learned[245]

Consistent Policy and Synergy in Red Mobility

The successful implementation of a sustainable public transportation system, like Red Mobility in Santiago, requires consistent policy and continuous synergy efforts to improve

[245] This subsection has been prepared based on the following two documents: Tamblay, S. (2024). *Implementation of E-buses in Santiago de Chile: From initial experiences in 2017 to large scale tendering processes in 2023 and 2025*. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Lima Convention Center, San Borja, Lima, Peru.; Vilches, A. (2024). *METBUS and the transformation of public transportation in Santiago de Chile*. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Centro de Convenciones de Lima, San Borja, Lima, Peru y Steinmeyer, A. (2024). *Normative aspects of the implementation of electromobility in Santiago de Chile*. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Lima Convention Center, San Borja, Lima, Peru.

multiple dimensions of the system. These dimensions include social equity, technological innovation, bus infrastructure, road safety, and working conditions for drivers, among others. It is essential to prioritize policies appropriately, as the efficient functioning of the system and the travel experience for users depend on the integrated management of all these factors.

A significant example of synergy in Red Mobility is the Women Drivers Program, which reflects a clear commitment to inclusion and gender equity in the transportation sector. Currently, Red Mobility employs 1,739 women drivers, representing 10% of the system's total drivers. This 62% increase in the number of women drivers in just two years not only represents progress toward gender equality but also offers these women dignified, formal employment in a safe and sustainable work environment.

Moreover, electromobility presents an opportunity to include more women in the transportation sector, traditionally dominated by men. The current bidding process includes a historic requirement that the percentage of women drivers must gradually reach 18% by the eighth year of the concession. This measure not only promotes gender equity but also ensures that the transition to a more modern and sustainable transportation system is inclusive.

Bus Stop Infrastructure and Universal Accessibility

The plan to improve bus stops in Santiago is a key initiative in the pursuit of a safer, more accessible, and more efficient public transportation system. This plan is implemented in collaboration with local municipalities, allowing for more direct management tailored to the specific needs of each community. The goal is to build 500 high-quality bus stops by 2025, incorporating advanced safety and accessibility features to ensure an inclusive service for all citizens.

Key improvements include enhanced lighting, which increases safety during nighttime hours and in low-visibility conditions, and additional safety measures, such as SOS emergency buttons, which provide immediate access to help in critical situations. Moreover, the bus stops are equipped with variable information panels that provide users with real-time data on bus arrival times, improving travel planning and user experience. The inclusion of auditory information is another crucial aspect, ensuring that visually impaired individuals can also easily access system information.

Universal accessibility is a fundamental pillar of this project, aiming to ensure that all bus stops are easily accessible to people with reduced mobility and other vulnerable groups. The bus stop infrastructure, with these improvements, not only meets the current needs of users but also anticipates the future demands of an evolving public transportation system. In addition to the construction of new bus stops, the plan also includes permanent maintenance of all existing infrastructure, ensuring long-term functionality and safety.

Strengthening Technical Capacity and Coordination in Santiago

The success of the implementation and operation of Santiago's public transportation system largely depends on strengthening technical capacity and effective coordination among the various actors involved. Both operating companies and the Ministry of Transport and Telecommunications have intensified their technical capacities for planning and scheduling, allowing them to develop more efficient charging and operational strategies. This strengthening is essential to ensuring the system functions optimally, particularly in a complex urban environment like Santiago.

A crucial aspect of this process is the need to establish clear rules for service scheduling, covering aspects such as permitted speeds, authorized stops, and depot usage. Clarity in these rules not only ensures transparency but also improves operational efficiency by avoiding misunderstandings and ensuring that all parties involved work under the same parameters.

Proper coordination is also necessary at both the macro and micro levels. At the macro level, it is essential that key government institutions work together, but it is equally vital to have strong territorial networks that facilitate the planning, validation, and monitoring of system changes. Coordination at this level ensures that policies and strategies are implemented coherently throughout the city, adapting to the specific needs of each community. Finally, citizen participation and coordinated work with municipal and neighborhood representatives are fundamental components of this process.

Strategy for E-bus Implementation

The strategy for implementing electric buses (E-buses) in a public transportation system can vary significantly depending on the number and percentage of electric buses planned for acquisition in each city, as well as the specific local conditions. It is crucial that this strategy be flexible and adaptable to face the challenges that may arise during the transition to electromobility.

One of the determining factors in the strategy is the institutional and industrial structure, which includes the size of operating companies, bus depots, and charging infrastructure. These variables directly affect the feasibility and efficiency of E-bus implementation, as a well-structured system can facilitate a smoother transition.

Gradual implementation is a viable alternative, suggesting the mix of diesel and electric buses in depots and routes, starting with the simpler routes in terms of operating conditions and energy requirements. This approach allows cities to progressively adapt to new technologies, minimizing the risks and costs associated with a more abrupt transition.

However, increasing the size of the E-bus fleet also brings new challenges, particularly regarding charging times and operational flexibility. It is necessary to have robust contingency plans to address potential disruptions in charging or infrastructure failures, especially in the context of climate crises and potential blackouts. These backup systems are essential to ensure service continuity and user safety.

Finally, it is crucial to learn from the experiences of other cities that have already implemented E-buses, complementing this learning with a thorough study of the specific characteristics of each city.

Key Factors for Investment in Charging Infrastructure

The process of investing in charging infrastructure for electric buses requires a detailed consideration of several key factors that can influence its success and operational efficiency. First, it is essential to evaluate the operational profile of the buses, meaning their availability to operate. This includes analyzing the energy consumption necessary to keep the buses running continuously, which directly impacts the planning of the charging infrastructure.

Another crucial factor is the opportunity for charging and the energy tariff at different times. This involves determining when the buses can be charged, how many chargers are required, and how much power is needed at those times. Additionally, it is essential to consider the cost of energy (in kWh) and the power required (in kW) at the time of charging, as well as the charging speed, i.e., the time needed to fully charge the batteries, which depends on the charging capacity of the chargers (measured in kW).

Finally, the autonomy of electric buses plays a decisive role in determining the charging infrastructure. The battery capacity (measured in kWh) and the performance of the buses (measured in km/kWh) determine the energy consumption required to operate, which in turn influences the charging needs. Proper planning of these aspects allows for optimizing the investment in infrastructure, ensuring that the buses can meet operating schedules without unnecessary interruptions.

In the following example, it is illustrated how distributing the charging throughout the day can significantly reduce the need for infrastructure. In a real case, it was shown that charging the buses during the day, instead of exclusively at night, allowed the use of fewer chargers, thus reducing the investment needed in charging infrastructure. The strategy consisted of distributing 40% of the charging during the day and 60% at night, optimizing the use of available resources and ensuring sufficient autonomy to operate during the afternoon peak hours.

Additionally, energy contracting is a critical factor, as it involves projecting the maximum energy and power required for each terminal or depot. It is necessary to understand how the charging strategy will be implemented at each location, considering the maximum power required by time interval and the energy needed for each of these intervals.

The number of chargers is also a fundamental consideration, as it is directly related to the projection of energy and power. Charging speed, charger prices, the number of buses per charger, and the risk associated with moving buses between charging stations must be evaluated.

Finally, electricity tariffs, which vary throughout the day, and energy availability restrictions at terminal locations must be carefully managed to ensure efficient and economical operation.

Relationship between Fleet Operation and its Charging System

The operation of an electric bus fleet is intrinsically linked to the efficiency and strategy of the charging system, requiring a coordinated and detailed approach. A fundamental aspect is monitoring battery charge levels before dispatching the vehicles. This pre-check ensures that the buses have sufficient capacity to complete their routes without interruptions, minimizing the risk of unscheduled stops and maximizing operational availability.

Operational planning, in turn, must carefully integrate the time needed to recharge the batteries during the day. This approach not only ensures that the buses can remain in continuous operation but also optimizes the use of the available charging infrastructure, thereby reducing the need for additional investments in charging equipment and improving the overall energy efficiency of the system.

Finally, it is crucial to consider the data collected through the telemetry and charging systems of electric buses. This information, when adequately integrated with operational needs, provides a clear and real-time view of the fleet's status, allowing dynamic adjustments in the operation that can improve both efficiency and vehicle lifespan. Utilizing this data for operational decision-making is a key component of the long-term success of electromobility in urban transportation systems.

Impact of Driving on E-bus Efficiency

The efficiency and safety of electric bus operation heavily depend on the drivers' driving style, which differs considerably from that required for traditional diesel buses. It is essential to provide specialized training to drivers to maximize the benefits of electromobility. In the case of METBUS, a comprehensive training program was implemented in collaboration with the University of Chile, which resulted in a significant improvement in driver performance and vehicle operation.

A crucial aspect is the ability of electric buses to regenerate energy during braking, which increases the vehicle's autonomy. It is estimated that proper driving can increase autonomy by up to 18%, highlighting the importance of educating drivers on driving techniques that optimize this energy regeneration.

Additionally, electric buses present unique safety challenges. Since they emit no noise, drivers must be especially cautious in public areas. Furthermore, the advanced technology of these vehicles prevents drivers from tampering with critical systems such as maximum speed or door locking, increasing safety for both passengers and the bus itself. This computerized control prevents inappropriate interventions that were common in traditional buses, thereby improving the integrity of the transportation system.

8.3.4. Success Cases

On the path toward sustainable mobility, Chile has taken significant steps through the implementation of the National Electromobility Strategy. This effort has resulted in a series of success stories that highlight the economy's commitment to reducing GHG emissions and improving air quality in its cities. Below are some notable examples of Chile’s transition to electromobility.

METBUS[246]

In 2017, Santiago's public transportation system faced significant challenges and opportunities that shaped the framework for the implementation and expansion of electromobility, with METBUS playing a key role. The company was responsible for both the acquisition and management of terminals, as well as the purchase and ownership of buses, which were subject to concession contracts that ensured their integration into the system. Under this scheme, METBUS had to secure financing for the vehicles through a supply contract, a financial leasing model in which the financier and the operator agreed to link the buses to a concession contract, thereby ensuring the financial and operational stability of the service. (See
Figure ***62***).

The operational context also required METBUS, as the operator, to organize the entire operation and maintenance of the fleet, as well as to manage the infrastructure necessary for its functioning. This comprehensive approach, where the company owned both the terminals and the buses, entailed significant responsibility in terms of asset and resource management.

One of the main motivations for this restructuring was the mandatory fleet renewal, as in 2017, over 400 Euro III diesel buses had reached their 10-year lifespan, necessitating urgent replacement. This renewal process not only focused on complying with environmental regulations but also on responding to the growing demands of users, who called for a significant improvement in service quality. Thus, the new buses needed to include advanced features, such as USB chargers, Wi-Fi connectivity, more comfortable seating, air conditioning, and a more attractive design, with the aim of enhancing user experience and making public transportation more competitive and efficient.

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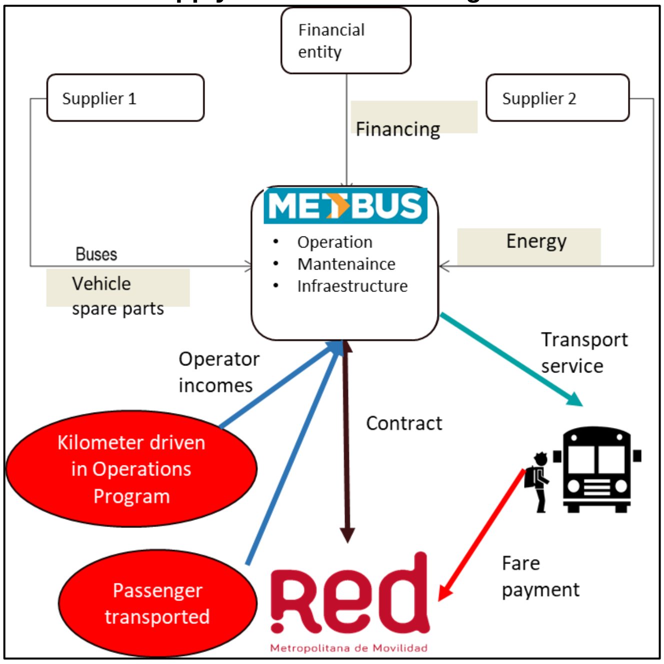
[246] This subsection has been prepared based on the following two documents: Tamblay, S. (2024). Implementation of E-buses in Santiago de Chile: From initial experiences in 2017 to large scale tendering processes in 2023 and 2025. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Lima Convention Center, San Borja, Lima, Peru; Vilches, A. (2024). METBUS and the transformation of public transportation in Santiago de Chile. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Lima Convention Center, San Borja, Lima, Peru.

This business model, with fixed income for operators based on kilometers traveled and passengers transported, was reinforced by the need to improve infrastructure and modernize the fleet, ensuring that the service not only met user expectations but also remained sustainable in the long term.

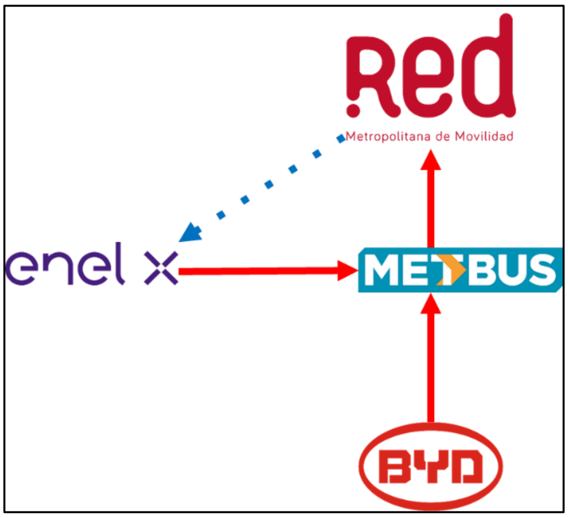
Figure 62. Outline of the Supply Contract in Santiago's Public Transport System



Source: Vilches, A. (2024). *Accelerating Sustainable Mobility: The Metbus Case Study in Electric Bus Adoption*. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Lima Convention Center, San Borja, Lima, Peru.

The business model implemented by METBUS in 2017 stood out for its innovative approach, which allowed for the incorporation of electric buses without requiring additional funding from the RED public transport system. At the heart of this scheme (See Figure 63) is METBUS as the operator, which had to face the challenge of adapting its operations to the new demands imposed by electromobility, such as the availability of buses during charging times.

Figure 63. Collaboration Structure in METBUS's Business Model



Source: Vilches, A. (2024). *Accelerating Sustainable Mobility: The Metbus Case Study in Electric Bus Adoption*. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Lima Convention Center, San Borja, Lima, Peru.

In this context, Enel X, a private company with experience in electric energy, emerged as a key strategic partner. Enel X took on the financial risk of this project by providing funding for the acquisition of electric buses and the construction of the necessary charging infrastructure. This agreement was based on the supply contract guaranteed by the RED system, which ensured a steady flow of payments over a period of eight years. This guarantee was crucial for both Enel X, which could be confident in recovering its investment, and for METBUS, which did not assume ownership of the buses, allowing for greater flexibility in the event of early contract termination.

A critical element of the model was the incorporation of BYD, the manufacturer of the electric buses, which not only offered an 80% battery degradation warranty for eight years but also committed to maintaining the buses, with the first year of service provided free of charge. This was fundamental for METBUS, as BYD took on the responsibility of maintenance, alleviating the operator's concerns regarding the durability and reliability of the new technology.

Thanks to this approach, METBUS not only managed to incorporate electric buses into its fleet without increasing costs to the system but also gained international recognition from the International Association of Public Transport (UITP), receiving an award for the best innovative business model in 2017. This success was based on METBUS's ability to offset the financial costs of the project through operational savings compared to the use of diesel buses, thus demonstrating the economic viability of the transition to electromobility in Santiago, Chile.

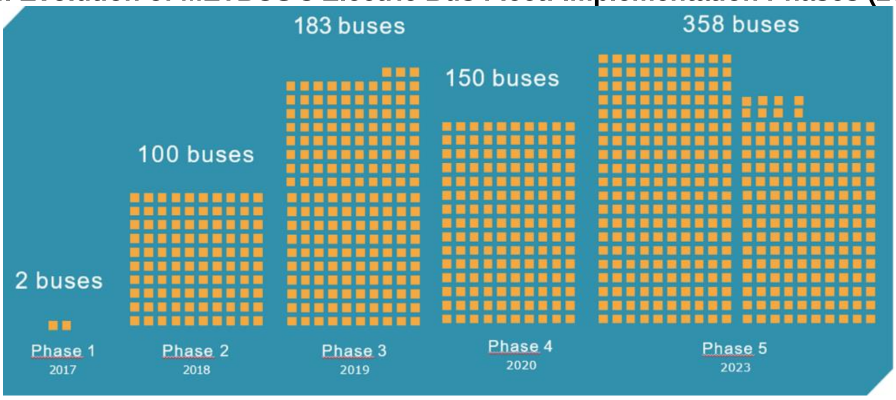
METBUS's business model for implementing electric buses in Santiago is grounded in the operational savings that cover financing fees, highlighting the economic feasibility of the transition to electromobility. A comparative analysis between electric propulsion technologies and Euro VI diesel reveals that, with an operating cost of USD0.12 per kilometer, an electric bus is significantly more economical than a diesel bus, which costs USD0.65 per kilometer. Considering an average monthly route of 5,500 kilometers, electric buses generate a monthly savings of USD2,915 compared to diesel buses, substantially reducing operating costs and allowing those savings to be used to finance the initial investment in the vehicles.

Moreover, electric buses offer additional advantages in terms of maintenance, which is 55% less costly compared to diesel buses. This is because electric buses require less time for preventive maintenance (approximately one-third of the time needed for a diesel bus), use fewer replacement parts, and utilize cleaner, more durable fluids. A crucial factor contributing to operational efficiency is the agreement with BYD, which provides free maintenance service during the first year of operation, further minimizing initial maintenance costs and ensuring service reliability.

Relevant Facts

Since the beginning of its foray into electromobility in 2017, METBUS has made significant strides in implementing electric buses in Santiago. The process started with a modest pilot of 2 buses in Phase 1 of 2017 and has progressively scaled through five phases to reach a total of 798 electric buses in operation by July 2024. This growth has unfolded within a framework of gradual adoption that included the introduction of 100 buses in Phase 2 in 2018, followed by 183 buses in Phase 3 in 2019, 150 buses in Phase 4 in 2020, and finally, 358 buses in Phase 5 in 2023. (See Figure 64).

Figure 64. Evolution of METBUS's Electric Bus Fleet: Implementation Phases (2017-2023)



Source: Vilches, A. (2024). *Accelerating Sustainable Mobility: The Metbus Case Study in Electric Bus Adoption*. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Lima Convention Center, San Borja, Lima, Peru.

Environmental Impact

The environmental and operational impact of this transition has been remarkable. In total, METBUS's 798 electric buses have traveled approximately 136 million kilometers, resulting in a savings of 76 million liters of diesel fuel. Furthermore, this initiative has prevented the emission of 270,000 tons of CO2, significantly contributing to the reduction of the carbon footprint in the metropolitan region of Santiago.

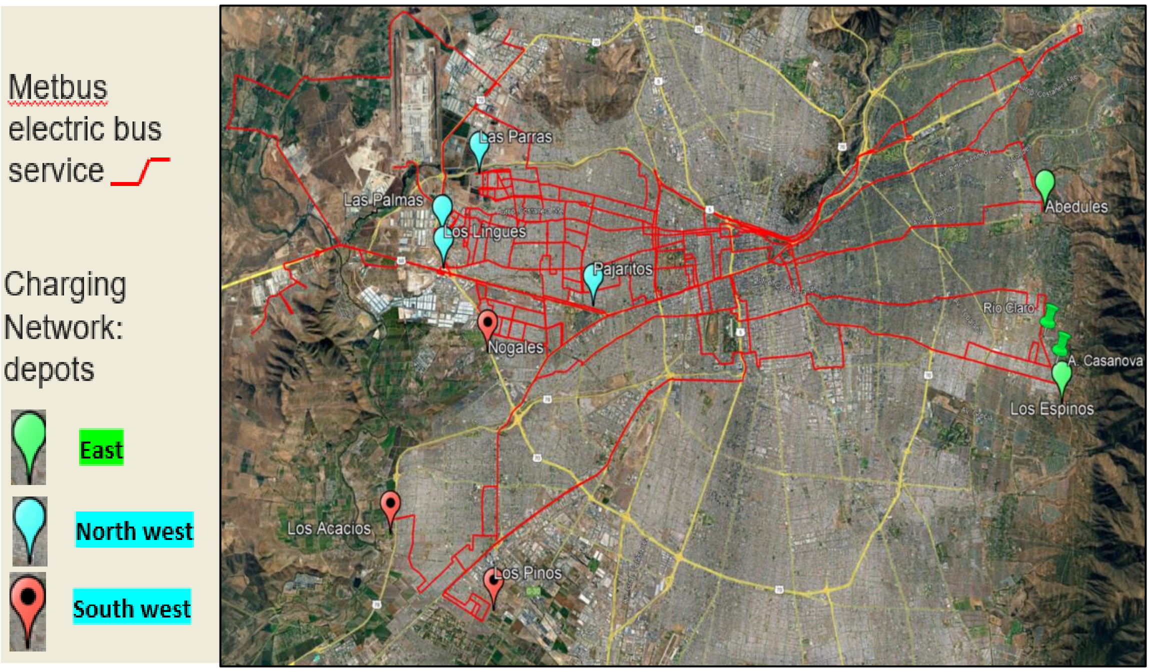
Fleet Characteristics

METBUS's fleet primarily consists of 12-meter buses manufactured by BYD, representing 781 units. Additionally, the fleet has diversified with the incorporation of 10 double-decker buses, 1 articulated bus, and 2 12-meter buses from the Foton brand. The fleet also includes 1 12-meter bus from King Long and 3 8-meter buses from Zhong Tong Bus, showcasing a diversified strategy in terms of suppliers and types of vehicles.

Geographical Distribution of the Service

Figure 65 shows the geographical distribution of Metbus's electric bus services in Santiago, Chile, as well as the associated charging depot network. The red lines represent the routes of services operated exclusively by electric buses, covering a vast area of the city. These services are strategically supported by a network of 294 chargers distributed across nine depots, totaling an installed capacity of 24 megawatts. The depots are located at various points in the city, divided into three key regions: the east, northeast, and southwest. This charging infrastructure not only ensures the continuous operation of electric buses but also reflects the scale and importance of Metbus's commitment to electromobility in the Chilean capital. The strategic location of the depots and the extensive coverage of the services are essential for ensuring sustainable and efficient public transportation in Santiago.

Figure 65. Network of Electric Bus Services by Metbus and Distribution of Charging Depots in Santiago



Source: Vilches, A. (2024). *Accelerating Sustainable Mobility: The Metbus Case Study in Electric Bus Adoption*. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Lima Convention Center, San Borja, Lima, Peru.

"My Electric Taxi" Program

The "My Electric Taxi" program, launched in 2021, supports taxi owners in transitioning to EV adoption. This program provides concrete financial incentives for taxi drivers to switch their vehicles to electric models, starting in the Metropolitan Region with the intention of expanding to other regions of the economy. Benefits include subsidies that cover part of the cost of new vehicles, which has encouraged many drivers to adopt this technology. This program offers significant economic benefits for drivers, especially those with annual mileage exceeding 35,000 Km[247].

It is important to note that before its implementation; only 74 electric taxis were operating in Chile, the majority of which were part of executive taxi fleets[248]. In its first version, during 2021, the program managed to incorporate 50 EV in the city of Santiago. This led to the avoidance of approximately 454 Mt of CO_2 equivalent emissions and spurred the development of a second version territorially extended to the regions of Valparaíso, Metropolitan, La Araucanía, Biobío, and Los Ríos. In this second version, 93 combustion vehicles were replaced by EV, thus consolidating an important step towards the decarbonization of transportation in Chile[249].

"Electromobility Accelerator" Program[250]

The Electromobility Accelerator (AEM) is a program implemented by the Energy Sustainability Agency and funded by the Ministry of Energy. This program targets companies and offers consulting services that include knowledge training, opportunity

[247] Ministry of Energy of Chile. (2017). Emissions Mitigation Plan for the Energy Sector. Government of Chile. Available at: https://energia.gob.cl/sites/default/files/plan-mitigacion-gei-sector-energia-2017.pdf.
[248] Ministry of Energy of Chile. Lessons from the My Electric Taxi program. Available at: https://www.mitaxielectrico.cl/wp-content/uploads/2024/03/Estudio-de-caso-1-Programa-Mi-Taxi-Electrico.pdf
[249] Ministry of Energy of Chile. My Electric Taxi. https://www.mitaxielectrico.cl/
[250] Ministry of Energy of Chile. (2022). National Electromobility Strategy. Santiago, Chile. Available at: https://energia.gob.cl/sites/default/files/documentos/estrategia_nacional_de_electromovilidad_2021_0.pdf. (p. 32)

identification, and the design of Roadmaps for specific projects. Its goal is to accelerate the development of electromobility in the private sector.

Since its launch in 2019, the AEM has engaged around 40 public and private organizations. In recent years, approximately 40 plans and pilots have been developed, with 16 already executed with positive results. These success stories not only demonstrate the tangible impact of the program but also serve as replicable models to promote electromobility on a large scale.

Electrologistics and “Clean Turn” Program

The Ministry of Transport and Telecommunications, in collaboration with the Energy Sustainability Agency, has launched the Electrologistics program and the “Clean Turn” program. These initiatives promote the use of electric vans and trucks in urban logistics and freight transport, respectively. As of July 2021, the “Clean Turn” program had approximately 180 transporters representing 15% of Chile's freight. These initiatives not only encourage the adoption of EVs in the logistics sector but also generate and provide data that facilitates decision-making for companies interested in transitioning to electromobility[251].

Additionally, during the 2022 Electrologistics Experience, several significant results were highlighted. In this version of the program, four EV were monitored, revealing a total distance traveled of 8,294 Km and an energy consumption of 3,058 KWh over the four weeks of operation. Based on the costs of similar vehicles using diesel, it was observed that each Km traveled by the EV represented a saving of USD108, accumulating a total of USD900,794 in operational savings. This reflects an average operational cost saving of 69% compared to diesel options. Furthermore, the initiative contributed to a net reduction in 2.4 Mt of CO_2 equivalent emissions, demonstrating the environmental benefits of adopting EV in this specific context[252].

[251] Ministry of Energy of Chile (2017). Energy Sector Emissions Mitigation Plan. Government of Chile. Available at: https://energia.gob.cl/sites/default/files/plan-mitigacion-gei-sector-energia-2017.pdf

[252] Ministry of Transportation and Telecommunications of Chile (2022). Electrologistics Guide 2. Available at:https://www.conectalogistica.cl/content/uploads/2023/10/guia-electrologistica-concepcion-2022.pdf (p. 22).

Financial and Fiscal Incentives

Chile has implemented a series of financial and fiscal incentives to support the transition to electromobility. The most notable incentives include:

- Tax Exemption: EV are exempt from certain taxes, reducing the TCO.
- Accelerated Depreciation: Accelerated depreciation is allowed for EV, decreasing the initial acquisition cost.
- Energy Efficiency Law: This law establishes energy efficiency standards for new motor vehicles and allows up to three times the performance of each electric or PHEV to be counted in the calculation of the average energy efficiency of sales[253].

Development of Charging Infrastructure

A crucial component of the success of electromobility in Chile has been the development of adequate charging infrastructure. The National Electromobility Strategy includes the installation of fast-charging stations in both urban and rural areas. Following the Energy Efficiency Law, the interoperability of EV charging systems has been regulated, ensuring integrated and accessible charging infrastructure economy-wide. This includes the implementation of 150 fast-charging stations across the economy[254], with a particular focus on major transportation routes and cities with high concentrations of EV. Additionally, regulations have been developed to ensure that charging stations are compatible with various types of EV and provide efficient and safe charging[255].

8.4. China

8.4.1. Urban Mobility Policies Related to the Transition to Electromobility

Urban Mobility Transformation

To reduce carbon emissions and transportation pollutants in cities, China has been working on vehicle electrification since 2009. Between 2015 and 2022, China has maintained the global leading position in EV production and sales for eight consecutive years. Additionally, China has developed a comprehensive and high-capacity urban mobility system that includes public transportation and active mobility, such as bicycles and two- and three-wheeled vehicles (2/3Ws). In 2019, buses and urban trains accounted for 72% of the urban passenger volume, with 93 billion trips, a figure nine times greater than that of the United States. China leads the global bus market, with a fleet representing a quarter of the world's buses and a high proportion of EV.

Expansion of Public Transport Infrastructure

China also has the world's largest urban rail network in terms of length and number of cities with metro systems. In 2022, 41 cities had metro systems totaling 8,448 Km, with a daily demand of 53 million trips. Additionally, China has made significant strides in implementing Bus Rapid Transit (BRT) systems, with over 7,000 Km in operation. The economy is also a leader in the use of shared bicycles and two- and three-wheeled EV, with a stock exceeding 420 million units.

Supportive Policies and Priority for Public Transportation

[253] Ministry of Energy. (2017). Emission Mitigation Plan for the Energy Sector. Government of Chile. Available at: https://energia.gob.cl/sites/default/files/plan-mitigacion-gei-sector-energia-2017.pdf

[254] Electromobility Platform. Increase the Availability of Charging Stations for EVs. Available at: https://energia.gob.cl/electromovilidad/compromiso-publico-privado/estaciones_de_carga

[255] Electromobility Platform. Charging Systems. https://energia.gob.cl/electromovilidad/reglamentacion/normativa-sistemas-de-carga

The Chinese government has legally prioritized public transportation over other modes since 2005. These policies have led to a significant increase in public transport usage, reducing the use of private cars and contributing to emission reductions. China is also implementing Transit-Oriented Development (TOD) to integrate transportation with land-use planning, reducing travel demand and distances.

Urban Growth and Increased Transportation Demand

Urban expansion in China has increased daily commuting distances, with an average of 11.7 Km in Beijing in 2022. With a projected urbanization rate of 70% by 2030, it is expected that 980 million people will live in cities, raising transportation demand. To address this growth, China has been developing EV, adopting cleaner internal combustion engines, optimizing transport mode structures, and managing transit demand.

Support Policies and Priority for Public Transport

The Chinese government has legally prioritized public transport over other modes since 2005. These policies have led to a significant increase in the use of public transport, reducing private car use and contributing to emission reductions. China is also implementing TOD to integrate transportation and land use planning, reducing demand and travel distances.

Among the most notable TOD policies and models in China are:

- **"Rail + Property" (R+P) Model:** This model integrates real estate development with the construction of rail systems, encouraging the use of public transportation and reducing reliance on private cars.

- **Integrated Development of Central Stations:** This approach promotes the creation of multifunctional complexes around major transportation stations, combining residential, office, commercial, and public service spaces to maximize accessibility and minimize travel distances.

- **Metro-Centered Development Complexes:** Similar to the R+P model, this approach focuses on the development of properties around metro stations, aiming to promote the use of public transportation and improve urban connectivity.

These TOD strategies have been implemented to support the sustainable growth of Chinese cities, enhancing the accessibility of public transportation and contributing to emission reductions by limiting the need for private vehicle trips.

Pilot Programs and Public Vehicle Electrification

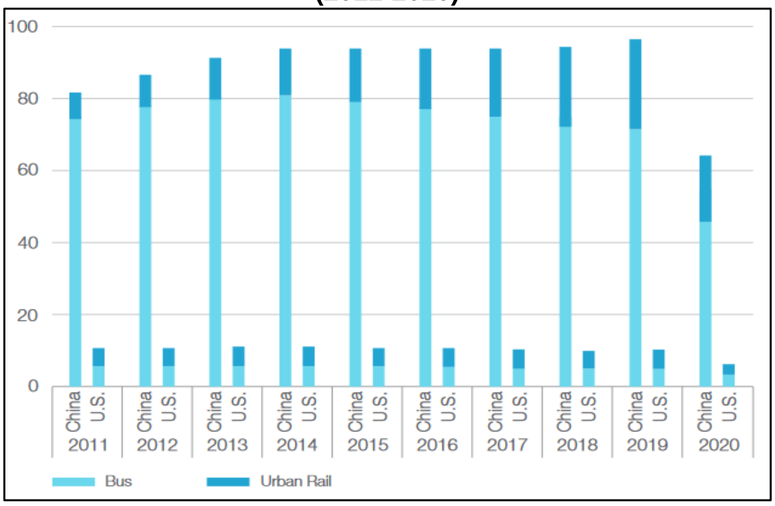
Additionally, the economy has established pilot programs aimed at achieving full electrification of public vehicles, with a goal of reaching an 80% penetration of new energy vehicles (NEV) by 2025. To ensure the financial sustainability of these advancements, China needs to carefully analyze cost structures and refine subsidy policies. Barrier-free mobility is also gaining importance in China, with a focus on providing equitable transportation access for people with disabilities and the elderly. Considering that the economy has approximately 85 million people with disabilities and 210 million individuals over the age of 65, accessibility in transportation is crucial. Developing accessible facilities and services can ensure equitable access to transportation, employment, social activities, and personal fulfillment for these vulnerable groups. Promoting barrier-free mobility will not only encourage public transportation use but also contribute to building a more inclusive society.

In summary, China is advancing towards zero-emission mobility through comprehensive policies that include overall planning, financial sustainability, contextualized policies, and inclusive accessibility. These experiences provide valuable lessons for sustainable mobility transitions worldwide.

Figure 66 shows the evolution of passenger volume on urban buses and trains in China and the United States between 2011 and 2020. During this period, China has consistently maintained a significantly higher passenger volume compared to the United States. In 2019, the volume of passengers on urban buses and trains in China reached 93 billion trips, which is more than nine times the volume recorded in the United States. This notable passenger volume underscores the strong reliance on and efficiency of public transportation in China, highlighting the effectiveness of its policies to prioritize public transportation over other modes. This trend not only contributes to emission reductions but also enhances urban mobility and accessibility.

In Figure 67 the ten longest municipal metro/subway networks in the world in 2020 are compared. China stands out significantly, as half of the ten longest networks are located in the economy. Cities such as Shanghai, Beijing, Chengdu, and Guangzhou lead the ranking, each with networks exceeding 500 Km in length. By 2022, metro systems in 41 cities across China had a total length of 8,448 Km. This extensive metro network not only facilitates efficient urban mobility but also reduces reliance on private vehicles.

Figure 66. Passenger Volume on Urban Buses and Trains in China and the United States (2011-2020)



Source: Yin, L., Zheng, B., Wang, M., Gong, H., & Sun, X. (2023). China is racing towards zero emission transport: urban mobility beyond cars.

Figure 67. The Longest Metro/Subway Networks in the World in 2020

Source: Yin, L., Zheng, B., Wang, M., Gong, H., & Sun, X. (2023). China is racing towards zero emission transport: urban mobility beyond cars.

The main drivers behind China's shift towards zero-emission transportation are as follows: i) reducing carbon emissions to address climate change, ii) decreasing pollutants to improve air quality and public health, and iii) advancing its automotive industry towards sustainability and competitiveness. Urban mobility plays a crucial role in achieving these objectives.

Congestion as a Problem Affecting Urban Mobility

Traffic congestion is another pressing issue in densely populated major cities in China and is widely considered a serious "urban disease." In 2022, the average travel speed in the 36 largest cities in China during peak hours on weekdays was only 22.7 Km/h. Eighty-nine percent of these cities experienced moderate congestion, with vehicles traveling at speeds between 18 and 25 Km/h. The development of public transportation and active mobility not only provides an alternative to driving but also effectively reduces congestion.

The Role of Urban Transportation[256]

Urban transportation has gained increasing importance in China. In 2004, the Ministry of Housing and Urban-Rural Development (MOHURD) issued the "Opinions on Prioritizing the Development of Urban Public Transportation". Furthermore, the electrification of buses has been a priority since the "Ten Cities × Thousand EV" pilot program in 2009, with cumulative purchase subsidies amounting to approximately RMB200 billion (USD3.36 billion). The government provides substantial support for public transportation, which has resulted in cleaner transport despite its growing scale. However, since 2023, China has halted the purchase subsidies for NEV.

The Table 12 highlights the main fiscal incentives provided by the Chinese government to promote public transportation and the adoption of NEV. The incentives include tax exemptions and direct subsidies for both the purchase and operation of EV and public transportation systems. These incentives have been crucial for the expansion and electrification of public transportation in China, promoting more sustainable mobility and reducing carbon emissions. Fiscal incentives in China generally fall into two categories, detailed as follows:

Purchase Tax Exemption and Purchase Subsidy: These incentives have been fundamental in reducing the initial cost of NEV, making them more accessible to consumers and encouraging their widespread adoption.

Operational Subsidies: Subsidies for the operation of buses and metros have helped maintain affordable fares and ensure that public transportation services are financially sustainable. These subsidies have also encouraged cities to invest in cleaner and more efficient public transportation infrastructure.

Table 12. Major Fiscal Incentives for Public Transit

Major Incentives	Annual Average (Billion RMB)	Cumulative Amount (Billion RMB)	Provider	Period
Vehicle purchase tax exemption for all NEV	22	200	Central Government	2014-2022

[256] This section has been prepared based on the document: Yin, L., Zheng, B., Wang, M., Gong, H., & Sun, X. (2023). China is racing towards zero emission transport: urban mobility beyond cars. Energy Foundation China. Available at: https://www.efchina.org/Reports-en/report-ctp-20231201-en

Purchase subsidy for all NEV	15	200	Central Government	2010-2022
Bus operation subsidy	100	/	Local Government	In 2019
Subway operation subsidy	110	/	Local Government	In 2019

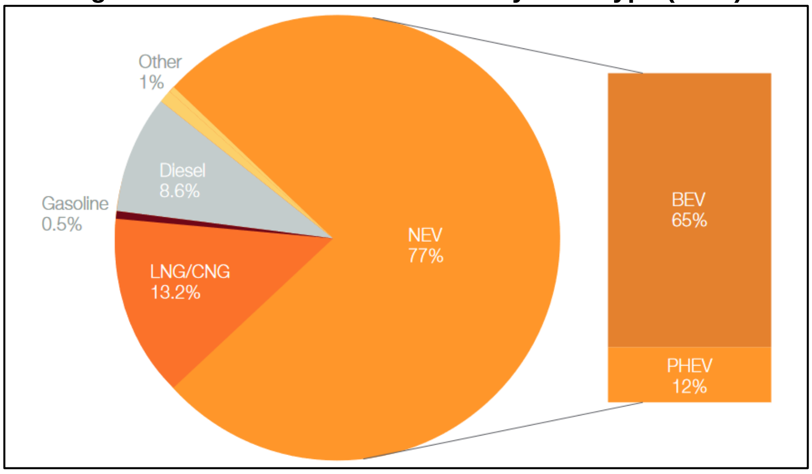
Source: Yin, L., Zheng, B., Wang, M., Gong, H., & Sun, X. (2023). China is racing towards zero emission transport: urban mobility beyond cars.

Transformation Towards Zero Emissions in Bus Transportation in China[257]

Urban transportation is a popular and widely used form of public transport throughout China. Since the inauguration of the first bus route in 1906, the economy has established and operated the largest and cleanest bus system in the world. Over the past decade, China has significantly reduced the use of fossil fuel buses. The total proportion of diesel, gasoline, and LNG/CNG buses in the fleet plummeted to 23% in 2022, down from 87% in 2013. Additionally, China holds the largest market and fleet of new energy buses in the world, including BEV, PHEV, and FCV. Notably, China is a pioneer in the implementation of BRT. By 2020, more than seven thousand Km of BRT networks were in operation throughout the economy.

A crucial fact to highlight is that 77% of the transit bus fleet in China is electrified. In 2022, the shares of BEV and PHEV in the total transit bus stock were 65% and 12%, respectively (See Figure 68). This notable transformation underscores China's commitment to emission reduction and the promotion of cleaner and more sustainable public transportation. In comparison, the share of electric buses in the European Union fleet is approximately 1%, highlighting China's leadership in public transportation electrification.

Figure 68. Transit Buses in China by Fuel Type (2022)



Source: Yin, L., Zheng, B., Wang, M., Gong, H., & Sun, X. (2023). China is racing towards zero emission transport: urban mobility beyond cars.

Reasons to Prioritize the Shift to Zero Emissions in Buses

The bus is one of the best options for mass urban transportation, considering air pollution control, congestion mitigation, financial capacity, social equity, and operational flexibility. Additionally, buses can serve as pilot vehicles for demonstrating new technologies, which can help scale the transition to zero emissions in other vehicle categories. Like other economies, China prioritizes the development of buses primarily because they are naturally more environmentally friendly as a mode of public transportation. On average, a bus can replace at least 30 cars on the road. Due to this low road occupancy per

[257] This section has been prepared based on the document: Yin, L., Zheng, B., Wang, M., Gong, H., & Sun, X. (2023). China is racing towards zero emission transport: urban mobility beyond cars. Energy Foundation China. Available at: https://www.efchina.org/Reports-en/report-ctp-20231201-en

passenger, developing buses can free up road space and help alleviate traffic congestion, as well as reduce fuel consumption, carbon footprint, and air pollution per passenger.

Standards Promoting or Accelerating the Transition to Electromobility

China has implemented a series of progressive regulations and standards to improve fuel economy and reduce emissions from vehicles, especially heavy-duty vehicles. The following outlines some of the key regulations and official documents:

Fuel Economy Standards[258]:

China has implemented a series of progressive fuel economy standards to improve the energy efficiency of vehicles and reduce greenhouse gas emissions. The development and key features of each phase of these standards are outlined below:

1. Phases I and II (2005):

- ✓ Implementation: Introduced in 2005, these phases established specific fuel consumption thresholds for each vehicle model.
- ✓ Objective: To ensure that all vehicle models met specific fuel consumption limits, promoting efficiency from the design stage.

2. Phase III (2011):

- ✓ Introduction of Corporate Average Fuel Consumption (CAFC): In 2011, Phase III introduced CAFC targets, which set average goals for the fleet in addition to the existing model-specific limits.
- ✓ Impact: Manufacturers were now required to meet average targets for their entire fleet, incentivizing the production of more fuel-efficient vehicles.

3. Phase IV (2016):

- ✓ New Target for 2020: Phase IV, which came into effect in 2016, set a new fleet average fuel consumption target of 5.0 L/100 km for the year 2020.
- ✓ Advancements: This standard further promoted fuel efficiency and paved the way for the adoption of more advanced and efficient technologies.

4. Phase V (2025 y 2030):

- ✓ Long-Term Goals: China has currently implemented Phase V standards, with fleet average targets set at 4.0 L/100 Km (NEDC) for 2025 and 3.2 L/100 Km for 2030.
- ✓ Focus on Innovation: These targets are more stringent and aim to drive innovation and the adoption of cleaner and more efficient technologies in the automotive sector.

Emissions Standards

China has implemented a series of progressive standards to control emissions from heavy-duty vehicles (HDV), known as China VI standards. These standards are divided into two phases: China VI-a and China VI-b. Below is a detailed analysis of these standards and their key features.

China VI-a (Implementation in 2019-2021)

[258] This section has been prepared based on the document: Transport Policy. (n.d.). *China: Heavy-duty: Emissions*. Available at: https://www.transportpolicy.net/standard/china-heavy-duty-emissions

- ✓ **Emission Reductions:** China VI-a is similar to the Euro VI standard and includes strict limits for NOx and PM, reducing these emissions by approximately 70% compared to the China V standard.

- ✓ **Particle Number Limits (PN):** Introduces PN limits of $6x10^{11}$ #/KWh for transient cycle testing, requiring the installation of diesel particulate filters (DPF) on all new diesel HDV.

- ✓ **Representative Test Cycles:** Replaces European test cycles (ESC and ETC) with more representative and dynamic cycles, such as the Worldwide Harmonized Stationary Cycle (WHSC) and the Worldwide Harmonized Transient Cycle (WHTC).

- ✓ **World Harmonized Not-to-Exceed (WNTE) Tests:** Introduces WNTE to ensure that vehicle emissions do not exceed established limits under real-world driving conditions.

China VI-b (Implementation in 2021-2023)[259]

- ✓ Remote Emissions Monitoring: China VI-b introduces an onboard remote emissions monitoring system (Remote OBD), a unique requirement in global vehicle regulations. This system ensures the performance of emissions after treatment systems under real-world conditions.
- ✓ PEMS Testing: Requires the adoption of Portable Emissions Measurement Systems (PEMS) for type approval, new production, and in-service compliance testing, with stricter limits and modifications adapted to driving conditions in China.
- ✓ Durability and Emissions Warranty: Establishes extended durability requirements and an emissions warranty program, where manufacturers must guarantee emissions control components for a minimum distance traveled or service time.

It is important to note that China VI standards are among the strictest adopted to date, aligning with emissions standards in Canada; Japan; the U.S; and the EU. The full implementation of these standards will bring China in line with the most advanced international regulations, significantly improving air quality and reducing emissions from heavy-duty vehicles[260].

8.4.2. Energy Policies Related to the Transition to Electromobility

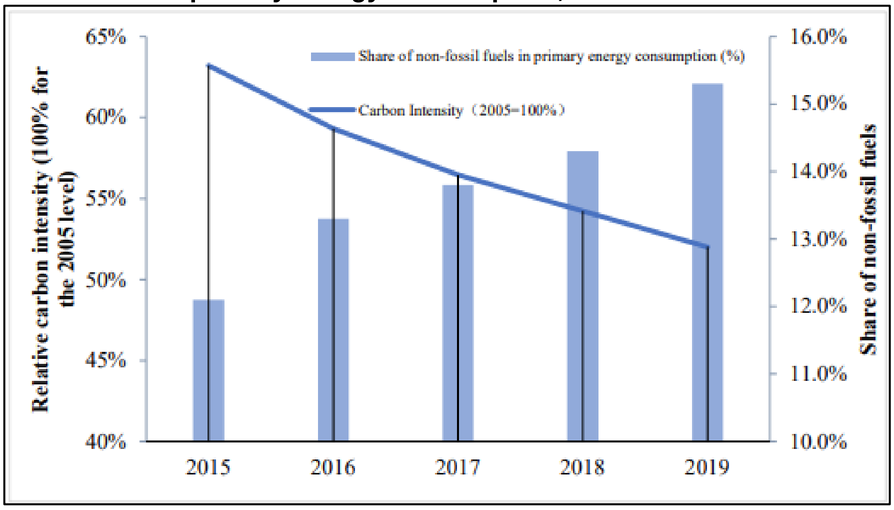
China has made positive progress in implementing its NDC through a series of measures such as industrial restructuring, optimization of the energy mix, promotion of energy conservation, improvement of energy efficiency, use of market mechanisms, and increase in carbon sinks. According to preliminary calculations, China's carbon intensity (CO_2 equivalent emissions per unit of GDP) in 2019 was 51.9% of the 2005 level, a reduction of 48.1% since 2005. This represents a cumulative reduction of approximately 5.7 billion of $MtCO_2$ equivalent emissions, reversing the trend of rapid growth in CO_2 equivalent emissions and significantly contributing to the global response to climate change[261].

[259] This section has been prepared based on the document: Yang, L., & He, H. (2018). *China's Stage VI Emission Standard for Heavy-Duty Vehicles (final rule)*. International Council on Clean Transportation (ICCT). https://theicct.org/sites/default/files/publications/China_VI_Policy_Update_20180720.pdf

[260] MPR (29 June 2023). Announcement on the Implementation of China VI Emission Standards for Automobiles. https://www.china-certification.com/en/announcement-on-the-implementation-of-china-vi-emission-standards-for-automobiles/

[261] United Nations Framework Convention on Climate Change (UNFCCC). (2022). China's achievements, new goals and new measures for nationally determined contributions. Available at: https://unfccc.int/sites/default/files/NDC/2022-06/China%E2%80%99s%20Achievements%2C%20New%20Goals%20and%20New%20Measures%20for%20Nationally%20Determined%20Contributions.pdf

Figure 69. Changes in China's carbon intensity and its share of non-fossil fuels in primary energy consumption, 2015–2019



Source: United Nations Framework Convention on Climate Change (UNFCCC). (2022)

The actions taken to achieve emission reductions between 2015 and 2019, aimed at transitioning to electromobility, focused on the initial construction of a low-carbon energy system. In 2019, non-fossil fuels accounted for 15.3% of energy consumption, marking a significant increase of 7.9 percentage points compared to 2005. Additionally, the share of coal in the energy mix decreased from 72.4% in 2005 to 57.7% in 2019[262].

As a result, the installed capacity for energy generation from renewable sources reached 794 GW, with wind, solar, and biomass energy contributing 210 GW, 204 GW, and 23.69 GW, respectively. Between 2015 and 2019, China's annual investments in renewable energy were 480.1, 435.4, 522.5, 509.2, and 503.4 billion yuan, respectively[263].

On the other hand, promoting energy conservation and improving energy efficiency have been key priorities. Between 2016 and 2019, China's energy intensity decreased by 13.1%, with an average annual growth of 2.9% in energy use, while the average annual economic growth was 6.6%. This indicates a substantial increase in energy efficiency. Additionally, demonstrations of energy and resource measurement services have been carried out to encourage conservation and intensive resource use[264].

Finally, the formation of a low-carbon transportation system has been actively promoted in China. This includes reducing coal use in key areas such as the Beijing-Tianjin-Hebei region, where total coal consumption has been controlled at around 300 MMT. Additionally, pilot projects for EV battery recycling have been implemented in regions such as Beijing-Tianjin-Hebei[265].

China's energy landscape is undergoing transformation through a series of key strategic policies aimed at balancing economic development with environmental sustainability. Among these policies are the "14th Five-Year Plan for China's Energy Sector," which lays the foundation for a modern and secure energy system; the "Grid Parity Policy (2019)" which promotes the competitiveness of renewable energies compared to traditional ones without subsidies; and the ambitious "Carbon Neutral Commitment for 2060" which marks a milestone in the economy's efforts to reduce CO_2 equivalent emissions and lead the global fight against climate change. The following details these initiatives and their implications for China's future energy landscape.

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[262] Ibid.
[263] Ibid.
[264] Ibid.
[265] Ibid.

XIV Five-Year Plan for China's Energy Sector[266]

The National Development and Reform Commission (NDRC), along with the National Energy Administration (NEA) of China, has issued the "XIV Five-Year Plan for China's Energy Sector." This strategic document aims to establish a "modern energy system" that ensures the economy's energy security while pursuing the goal of reaching peak CO_2 equivalent emissions by 2030 and achieving total decarbonization by 2060.

China, as the largest emitter of GHG and the world's leading oil consumer, presents global significance in its energy plans. Although the recently published plan outlines CO_2 equivalent emission reduction targets and an increase in the share of non-fossil and renewable energies, its primary focus remains on energy efficiency and security, with oil, coal, and natural gas continuing to be the main energy sources until 2030.

The document consists of nine sections that address topics such as the stability and security of the energy supply chain, the promotion of green and low-carbon energy, the optimization of energy development, efficiency in sector governance, and the establishment of a new pattern of mutually beneficial international energy cooperation. Some objectives related to the transition to electromobility are as follows:

1. Production and Energy Security:
   - Production Capacity: Increase the annual energy production capacity to over 4,600 MMT of standard coal.
   - Oil and Gas Production: Maintain annual crude oil production at 200 MMT and natural gas production at over 230 billion cubic meters.
   - Nuclear Energy: Raise the installed operational capacity of nuclear energy to approximately 70 million kilowatts by 2025.
   - Emission Reduction: Reduce CO_2 emissions per unit of GDP by 18% by 2025.
   - Energy Consumption: Decrease energy consumption by 13.5% by 2025.

2. Development of Renewable and Non-Fossil Energies:
   - Non-Fossil Energy Consumption: Gradually increase the consumption of non-fossil energy to 20% by 2025 and 25% by 2030.
   - Electricity Supply: Raise the share of non-fossil fuels in the electricity supply to 39% by 2025.
   - Hydropower: Achieve an installed capacity of conventional hydropower of 380 million Kw.
   - Wind and Solar Energy: Promote the large-scale and high-quality development of wind and solar power generation.

3. Transportation and EV:
   - Transportation Electrification: Promote the electrification of transportation, with the goal of having EVs represent 20% of total vehicle sales by 2025.
   - Charging Infrastructure: Expand the charging infrastructure for EVs to support the growth of the EV market.

The document also encourages carbon reduction and energy efficiency through the implementation of advanced technologies for emission reduction in energy generation and industry, as well as promoting the efficient use of energy across all sectors, including construction and transportation.

[266] Government of China. (2022). XIV Five-Year Plan for the Energy Sector. Available at: https://latsustentable.org/wp-content/uploads/2022/06/XIV-Plan-Quinquenal-para-el-sector-energetico.pdf.

Grid Parity Policy (2019)

In 2019, China implemented the Grid Parity Policy[267], a crucial step towards achieving price parity for renewable energies, particularly solar and onshore wind energy. This policy stipulates that, starting in 2021, all new projects from these energy sources must compete on equal terms with traditional power plants without relying on government subsidies. This measure represents a significant milestone in China's transition to a greener and more sustainable economy.[268]

The NEA and the NDRC issued a joint circular outlining the objectives and mechanisms of this policy. The circular emphasizes the need to connect more wind and photovoltaic (PV) projects to the grid at competitive prices, thereby boosting the installed capacity and production of renewable energy. In 2020, the installed capacity connected to the grid reached 11.4 million Kw for wind energy and 33.1 million Kw for solar PV energy.

This policy aims not only to increase the efficiency and competitiveness of renewable energies but also to attract significant investments. It is estimated that these projects will generate a total investment of approximately CNY220 billion (USD31.54 billion) and create numerous new jobs[269].

In conclusion, this policy aims to equalize the price of local coal-fired power generators or set their grid price through market trading by 2021.

China's Carbon Neutral Commitment for 2060[270]

In September 2020, President Xi Jinping announced a historic commitment to global climate policy: China will strive to peak its CO_2 equivalent emissions before 2030 and achieve carbon neutrality before 2060. This announcement represents one of the most ambitious pledges by any developing economy, highlighting China's crucial role in mitigating global climate change.

To achieve this goal, China is implementing a series of strategies and measures, including increasing renewable energy capacity, improving energy efficiency across all sectors (reducing energy consumption per unit of GDP), technological innovation (research and development of clean and sustainable technologies), strengthening infrastructure (smart grids and advanced energy storage systems), and international cooperation.

This commitment marks a potential turning point in the global fight against climate change, underscoring the need for all economies, both developed and developing, to adopt ambitious and coordinated measures to reduce carbon emissions and promote a sustainable future.

8.4.3. Specific Electromobility Policies

China has demonstrated a firm commitment to electromobility through various innovative policies and programs aimed at accelerating the adoption of EV and improving supporting infrastructure. Two of the most notable examples of these policies are the

[267] The concept of grid parity is defined as the point in time when a renewable energy source produces electricity at a cost equal to or less than the purchase price of power from the electrical grid.

[268] Library of the National Congress of Chile. (n.d.). Renewable Energy in China.Available at: https://obtienearchivo.bcn.cl/obtienearchivo?id=repositorio/10221/34457/1/Energ%C3%ADas%20Renovables%20en%20China.pdf

[269] Ibid.

[270] European External Action Service. (n.d.).
Carbon neutrality in China by 2060: a possible turning point in the fight against climate change. EEAS. Available at: https://www.eeas.europa.eu/eeas/neutralidad-de-carbono-en-china-en-el-a%C3%B1o-2060-un-posible-punto-de-inflexi%C3%B3n-%C2%A0en-la-lucha_es

"Ten Cities × One Thousand EVs" Pilot Program and the Orderly Charging and Vehicle-to-Grid initiative (VGI).

Pilot Program "Ten Cities × One Thousand EV"

In 2009, China launched the ambitious "Ten Cities × One Thousand EV" Pilot Program with the goal of accelerating the adoption of NEV in urban areas. During the first three years of the program, more than 27,400 NEV were deployed in 25 pilot cities, of which 84% were public service vehicles, especially buses. This program promoted the use of three types of new technologies: BEV, PHEV, and fuel cell vehicles.[271]

The success of the "Ten Cities × One Thousand EVs" pilot program was a significant catalyst for the EV market in China. The implementation of these technologies in public transportation not only improved urban air quality and reduced carbon emissions but also stimulated the development of charging infrastructure and the supporting ecosystem necessary for mass EV adoption. As a result, China's EV market took off, establishing the economy as a global leader in the transition to electromobility. This program also enabled China to develop the world's largest fleet of electric buses, surpassing those of diesel and natural gas buses in number.[272]

Orderly Charging and VGI

The concept of Orderly Charging and VGI refers to an innovative strategy that enables EVs to interact efficiently with the electrical grid. This technology turns EVs into responsive mobile energy sources, capable of drawing energy from the grid or supplying it as needed. China has implemented various policies and pilot projects to support VGI, particularly in regions with high EV adoption, such as Shanghai, Beijing, and Guangdong Province. For example, in Beijing, there is a VGI pilot project for BEB that has completely shifted bus charging to off-peak hours, demonstrating the value of VGI operations for peak demand reduction (Li et al., 2022).

The benefits of VGI and orderly charging are multiple and essential for maximizing the efficiency and sustainability of electrical infrastructure. These systems allow EV not only to consume energy efficiently but also to return it to the grid during high-demand periods, providing a flexible and dynamic solution for energy management. This is especially beneficial for grid stabilization, as it reduces operational costs and enhances the resilience of the electrical system. The successful implementation of these programs in China underscores its commitment to the transition to electromobility and emission reduction, positioning the economy as a leader in innovative solutions for sustainable urban mobility.

Financing Strategies and Preferential Fiscal Policies for Electric Mobility in Public Transport[273]

China's public transport priority strategy has established various financing mechanisms for urban transport service providers, including a set of subsidies and preferential fiscal policies. Since the launch of the "Ten Cities × One Thousand EV" pilot program in 2009, approximately RMB200 billion in purchase subsidies have been provided, significantly boosting the adoption of new energy EV. In 2019, the government allocated RMB100 billion in subsidies to support transit bus operations economy-wide. Additionally, public

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[271] Yang, L., & He, H. (2018). *China's Stage VI Emission Standard for Heavy-Duty Vehicles (final rule)*. International Council on Clean Transportation (ICCT). Available at: https://theicct.org/sites/default/files/publications/China_VI_Policy_Update_20180720.pdf

[272] Bell, D., & Horwitch, M. (2017). *EVs: Driving the Future*. Harvard Business School. Available at: https://www.hbs.edu/ris/Publication%20Files/Electric%20Vehicles_89176bc1-1aee-4c6e-829f-bd426beaf5d3.pdf

[273] This section has been prepared based on the document: Yin, L., Zheng, B., Wang, M., Gong, H., & Sun, X. (2023). China is racing towards zero emission transport: urban mobility beyond cars. Energy Foundation China. Available at: https://www.efchina.org/Reports-en/report-ctp-20231201-en

transport operators are exempt from value-added tax, and NEV transit buses are exempt from vehicle registration tax and vehicle purchase tax.

Preferential Fiscal Policies for NEV

Preferential fiscal policies have played a crucial role in promoting NEV in China. Since 2012, NEV buses have been exempt from vehicle and vessel registration taxes, with updates in 2015, 2018, and 2022 that tightened criteria on fuel efficiency, range, and emission reductions to encourage technological development. Since 2014, NEV buses have also benefited from exemptions from vehicle purchase taxes. Between 2014 and 2022, tax exemptions for all NEV totaled RMB200 billion , and it is estimated that they will reach RMB520 billion between 2024 and 2027.

Subsidies for Electric Buses

Favorable subsidies for the acquisition and operation of NEV buses have helped offset the high initial costs. Between 2010 and 2022, subsidies for NEV purchases are estimated to total RMB200 billion, with many municipal governments providing additional subsidies. For instance, Beijing has offered a local subsidy equal to the central one since 2015 and at half the rate since 2018. Additionally, a key policy has been the transition from oil subsidies to electricity subsidies, incentivizing the initial market for BEV and PHEV buses in China. In 2015, the central government began gradually phasing out the "oil subsidy" and implementing the "electricity subsidy". By 2019, the fuel subsidy fund for fossil fuel buses had been reduced by 60% compared to 2013 levels, with many large cities also offering local subsidies for the operation of NEV buses. For example, Beijing provides an annual operational subsidy of RMB80,000 for each qualified BEV bus.

8.4.4. Success Cases

Pilot Program "Ten Cities × One Thousand EVs"

This program, launched in 2009 with cumulative purchase subsidies nearing RMB200 billion (USD3.36 billion), was crucial for the adoption of EV in China. The program's primary objective was to promote new EV, both in urban public transportation and taxi services, aiming to achieve initial market development in key and selected pilot areas[274].

Thus, during the first three years of the program, more than 27,400 new EV were introduced in 25 pilot cities, with 84% allocated to public transportation, mainly buses. Particularly in Beijing, one of the pioneering cities in this program, 50 electric buses were introduced in 2010. By 2022, over 90% of its total bus fleet was electrified. This program not only improved urban air quality but also boosted the development of charging infrastructure and the necessary support ecosystem for the mass adoption of EV. China now boasts the largest fleet of electric buses in the world[275].

Orderly Charging and VGI[276]

The development of orderly charging and VGI systems has transformed EVs into responsive energy resources capable of absorbing or injecting energy into the grid as needed. In China, policies and pilot projects have been implemented to support VGI, especially in areas experiencing rapid adoption of EVs such as Shanghai, Beijing, and Guangdong Province.

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[274] Deutsche Gesellschaft für Internationale Zusammenarbeit (2020). New Energy Buses in China Overview on Policies and Impacts. Available at: https://www.changing-transport.org/wp-content/uploads/2020_GIZ_New-Energy-Buses-in-China.pdf (p. 6)

[275] Yin, L., Zheng, B., Wang, M., Gong, H., & Sun, X. (2023). China is racing towards zero emission transport: urban mobility beyond cars. Energy Foundation China. Available at: https://www.efchina.org/Reports-en/report-ctp-20231201-en

[276] https://news.cgtn.com/news/2022-03-12/How-China-is-advancing-global-electric-mobility--18kWGYwLOrC/index.html

Specifically, in Beijing, a VGI pilot program has been launched for BEV, with their charging completely shifted to off-peak hours. This initiative highlights the usefulness of VGI for mitigating electrical demand peaks, demonstrating its potential to optimize energy use and strengthen the stability of the power system.

Electrification of Public Transportation in Shenzhen[277]

Shenzhen has emerged as a notable success story in the electrification of public transportation. The city leads the process of adopting EVs with the largest fleet of fully electric buses and taxis in China and globally. Since 2009, Shenzhen has implemented electric buses as part of a program that challenged ten Chinese cities to deploy at least 1,000 EV within three years. In 2017, Shenzhen achieved a global milestone by completing the total electrification of its urban transit fleet, comprising 16,359 electric buses. This was made possible through generous subsidies from both central and local governments, which significantly reduced the initial cost and supported the rapid and complete electrification of the bus fleet.

By the end of 2019, 99% of the city's taxi fleet was electric, totaling 21,485 vehicles. Shenzhen is also making progress in the transition to electrifying private cars, garbage trucks, and other heavy vehicles. This evolution has resulted in a significant reduction in carbon emissions and an improvement in urban air quality.

8.4.5. Limitations, Opportunities, and Challenges for the Automotive Industry in the Transition to Electromobility

China has positioned itself as a leader in the global EV market, supported by a well-developed domestic industry and an extensive supply chain. This robust environment has enabled Chinese manufacturers to produce EV at a competitive cost, making them highly attractive to consumers in other economies.[278] Between 2018 and 2023, Chinese EV exports experienced notable growth in both quantity and value. In 2023, China exported over 1.2 million EV, marking an 80% increase in units exported compared to the previous year. The primary export destinations for these vehicles are Europe and APEC economies such as Thailand and Australia, highlighting the successful expansion of Chinese manufacturers into key international markets.[279]
Government policies and subsidies have played a crucial role in the development of the EV industry in China, making it the largest market in the world for this segment. These policies have included the relaxation of joint venture requirements for EV manufacturers, allowing foreign manufacturers to establish significant operations in China without the need for a local partner with equal shares. Tesla, BMW, and Renault are notable examples that have leveraged these regulations to export large volumes of EV from the economy. In 2019, Tesla became the leading exporter of EV from China following the construction of a 750,000-unit assembly plant in Shanghai.[280]

This strategic approach has not only boosted exports but also strengthened the global competitive position of Chinese EV manufacturers. Local companies such as BYD and Nio, along with emerging startups, have enhanced the quality and competitiveness of their EVs, expanding their operations both domestically and internationally.[281] This development reflects the positive impact of government policies on the sector,

[277] The World Bank (2021). Electrification of public transport: A Case Study of the Shenzhen Bus Group. Available at: https://documents1.worldbank.org/curated/en/708531625052490238/pdf/Electrification-of-Public-Transport-A-Case-Study-of-the-Shenzhen-Bus-Group.pdf.
[278] BBVA Research (2023). The rise of China's EV sector and its implications for the world. Available at: https://www.bbvaresearch.com/wp-content/uploads/2023/04/The_rise_of_China_s_EV_sector_and_its_implications_for_the_world_WB.pdf
[279] IEA. Global EV Outlook 2024
[280] Coffin, D. & Walling, J. (2024). Chinese Vehicle Exports: Electrified. Available at: https://www.usitc.gov/publications/332/executive_briefings/ebot_china_ev_exports.pdf
[281] Idem.

stimulating innovation and investment in sustainable technologies that promote the continued growth of the Chinese EV market.

However, despite these positive aspects, China also faces significant challenges in sustaining the development of its EV production industry. As the world's largest consumer of lithium, cobalt, and nickel, it encounters serious limitations in its domestic supply of these metals due to the scarcity of local resources. The accelerated development of the EV industry has led China to rely on imports for 80% of its total supply of lithium and cobalt in recent years. Similarly, it depends on imports for over 90% of its nickel and around 75% of its manganese. This situation highlights the vulnerability of the critical metal supply chain for the sustained expansion of the EV industry in the economy.[282]

Moreover, projections indicate that China's current mineral resources will not be able to meet the growing demand arising from the EV industry's development goals. It is estimated that between 2022 and 2050, metal shortages will significantly reduce the accumulated production potential of EV, underscoring the critical importance of securing a stable and sufficient supply of raw materials to sustain sector growth. Specifically, lithium shortages are expected to materialize in 2026 and 2034 under different metal supply scenarios, which could pose a significant obstacle to the continued expansion and production of EV in China[283].

On the other hand, another challenge to address is that the growing dominance of Chinese EV manufacturers globally has led governments such as that of the United States to implement protectionist policies to counteract competition. In the U.S., authorities have restricted tax incentives for EV adoption to only those vehicles manufactured locally, excluding those with components or batteries from Chinese sources. Additionally, the U.S. government is exploring measures to block tax credits intended for an EV battery plant Ford plans to establish, which would use technology from CATL, a renowned Chinese battery manufacturer. These actions reflect efforts to maintain competitiveness and economic security in the automotive sector in the face of the increasing influence of Chinese EV manufacturers in the global market.[284]

8.5. Indonesia

On 17 January 17 2020, the government of Indonesia approved Presidential Regulation Number 18 on the National Medium-Term Development Plan 2020-2024 (National RPJM 2020-2024). This planning document sets out five main guidelines for a five-year period: i) human resource development, ii) infrastructure development, iii) regulatory simplification, iv) bureaucratic simplification, and v) economic transformation. In particular, as part of infrastructure development, the National RPJM 2020-2024 promotes the development of urban transportation using sustainable energy to mitigate sector emissions. This plan urges ministries to propose specific plans aimed at materializing each of these sustainable development guidelines[285].

Thus, within the framework of the aforementioned regulation, in 2020, the Ministry of National Development Planning established priority programs for the development of urban mobility in six metropolitan areas of Indonesia:

1. Bandung

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[282] Boyu, L., Qi, Z., Jiangfeng, L., Yawei, H., Yanyan, T. & Yaoming, L. (2022). The impacts of critical metal shortage on China's EV industry development and countermeasure policies. Energy. 248. Available at: https://doi.org/10.1016/j.energy.2022.123646
[283] Ibid.
[284] BBVA Research (2023). The rise of China's EV sector and its implications for the world. Available at: https://www.bbvaresearch.com/wp-content/uploads/2023/04/The_rise_of_China_s_EV_sector_and_its_implications_for_the_world_WB.pdf.
[285] Republic of Indonesia (2020). The national medium-term development plan for 2020-2024. Available at: https://faolex.fao.org/docs/pdf/ins204723.pdf

2. Jakarta
3. Makassar
4. Medan
5. Semarang
6. Surabaya

The selection of these areas is based on their representation of 41% of the GDP, thus constituting the main economic drivers of the economy[286].

The main purpose of the Action Plans is to guide the member cities of each metropolitan area towards a gradual transformation into green cities, ensuring the integration of sustainability principles into all development initiatives. The development of these six urban mobility plans is based on a diagnosis carried out between 2020 and 2021, which assessed the particular context, needs, and immediate priorities of the cities and provinces that make up each metropolitan area. In this context, innovative technologies are proposed, such as the use of alternative fuels derived from palm oil, the adoption of EV using lithium-ion batteries and fast-charging systems, high-speed trains, and other solutions that facilitate progress towards sustainable development[287].

8.5.1. Urban Mobility Policies Related to the Transition to Electromobility

The following describes the Sustainable Urban Mobility Planning in Indonesia.

Sustainable Urban Mobility Planning [288]

Sustainable Urban Mobility Planning (SUMP) is a strategic process designed to meet the mobility needs of people and businesses in cities and their surroundings. SUMP integrates principles of participation, evaluation, and integration, focusing on improving the transportation system and the complementary interaction of its various modes.
In 2020, this methodology began its development based on the experience of planners and experts in Europe, Latin America, and Asia. SUMP is distinguished by its emphasis on stakeholder and citizen participation, promoting the coordination and alignment of policies across various sectors (transport, land use, environment, economic development, social policy, health, safety, energy).

It is important to mention the minimum requirements of SUMP that ensure its effectiveness. Among them are the following:

- Key steps and activities must occur in a timely and participatory manner. These include defining a long-term vision, objectives, and goals; thoroughly analyzing the problems and opportunities of the functional urban area; developing scenarios and a strategy; and creating action plans that include a timeline and funding.
- The process must be closely monitored and adapted as necessary, with citizens and stakeholders actively informed about progress.
- Adapting and adjusting the SUMP process to meet the conditions in Indonesian cities has involved examining two important issues: the growth in motorcycle ownership and use, and the participation of citizens and stakeholders in the SUMP design process through consultation.

[286] Kemitraan Indonesia Australia Untuk Infrastruktur (2022). Sarbagita Metropolitan Area (SMA). Sustainable Urban Mobility Baseline Assessment – Volume I
[287] Egis Rail (2022). Sustainable Urban Mobility Plan for Medan Metropolitan Area (SUMP Mebidangro). Available at: https://www.mobiliseyourcity.net/sites/default/files/2022-12/SUMP%20MEBIDANGRO%20FINAL%20REPORT_DRAFT%206_ENG.pdf
[288] Midgley, P., Ingham, D., Aldian, A., Samantha, R. A., Dillon, H. S., Chandra, A., Darido, G. B., & Kishiue, A. (2021). Indonesia: Sustainable Urban Mobility Planning Guidelines: Executive Summary. International Bank for Reconstruction and Development/The World Bank.

On the other hand, SUMP proposes innovation initiatives that should be directed at both metropolitan and broader levels. At a broader level, these innovative approaches require the creation of a National Working Group (NWG) composed of members from key ministries, such as BAPPENAS, the Ministry of Transportation, and the Ministry of Public Works. The NWG should establish a knowledge base and a website to disseminate information on sustainable urban mobility, provide training to local government unit employees, and review sustainable urban mobility strategies developed by the metropolitan areas identified in the RPJMN 2020-2024. Below are the innovations proposed by SUMP.

1. Focus on the Functional Urban Area (FUA): Refers to the daily flows of people and goods, beyond administrative boundaries.
2. Long-term and sustainable vision: Considers socio-economic aspirations, livability, and citizen well-being.
3. Integration of mobility measures with spatial planning and urban development: To achieve improved mobility with less traffic and effort.
4. Development of long-term "Strategies" (10 years): Providing a framework to guide the implementation of improvements in integrated urban and mobility planning.

Among the benefits proposed by SUMP are the following:

- Improved accessibility for all, regardless of income and social status.
- Increased quality of life and attractiveness of the urban environment.
- Effective use of urban space and existing transport infrastructure.
- Optimization of efficiency and cost-effectiveness.
- Reduction of air and noise pollution, greenhouse gas emissions, and energy consumption.

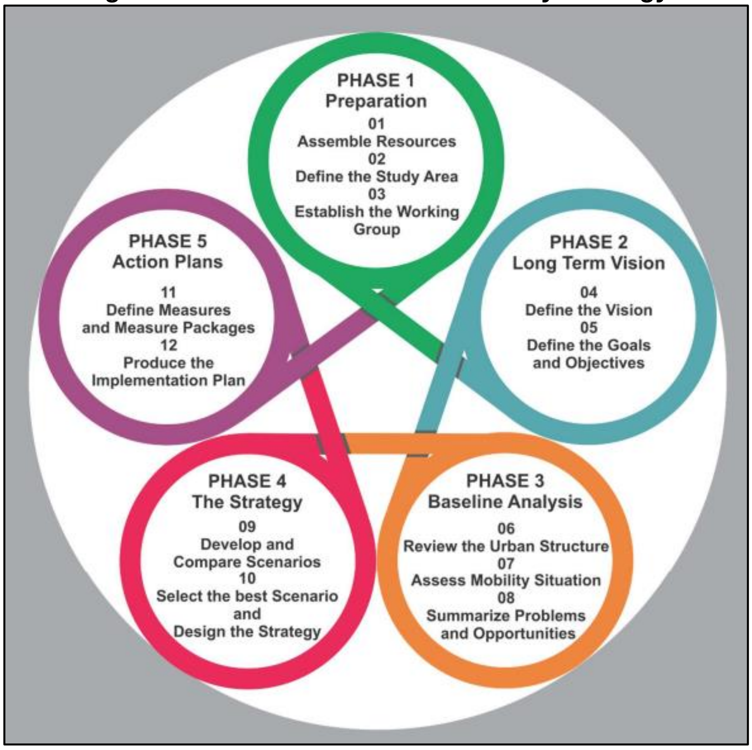
Indonesia's economy and urban mobility face three main challenges: i) severe congestion (traffic of cars and motorcycles in major urban centers), ii) pollution and loss of public space (decreased quality of life and productivity losses), and iii) dependence on private motorized transport.

Regarding the dependence on private motorized transport, it has increased significantly, while the use of public transport has decreased. In Jabodetabek, the share of public transport dropped from 38% in 2002 to 12% in 2010. Meanwhile, motorcycle ownership and use reached 53% in metropolitan areas, 73% in large cities, and 80% in medium-sized cities.

To address these challenges, mass transit systems and sustainable urban mobility strategies are being developed. In the RPJMN 2020-2024, BAPPENAS developed guidelines to assist local authorities in six metropolitan areas (Bandung, Jakarta, Makassar, Medan, Semarang, and Surabaya) in developing sustainable urban mobility strategies, thus providing a framework for investments in mass public transport. For this purpose, the SUMP process must be adapted and adjusted to the specific conditions of Indonesian cities, considering two relevant aspects: i) the growth in motorcycle ownership and use, and ii) the participation of citizens and stakeholders in the SUMP design process through consultations.

Finally, the plan is designed to help fund mass transit proposals that meet eligibility, preparation, and feasibility criteria. One of the conditions is the availability of an urban mobility strategy that provides a comprehensive and integrated framework for such mass transit systems. Developing a Sustainable Urban Mobility Strategy and Action Plan is a twelve-step process divided into five main phases of activity (See Figure 70).

Figure 70. Sustainable Urban Mobility Strategy



Source: World Bank (2021)

8.5.2. Energy Policies Related to the Transition to Electromobility

According to the report "An Energy Sector Roadmap to Net Zero Emissions in Indonesia," prepared by the IEA, Indonesia, with the aim of fulfilling its international and domestic commitments towards the development of sustainable energy for emission reduction, has developed various action plans[289]. The framework within which the plan for the development of electricity and sustainable energy in the economy has been deployed is based on Government Regulation of the Republic of Indonesia Number 79 of 2014 on National Energy Policy. Additionally, according to Article 5 of this regulation, the energy policy is configured as a guiding framework that directs the economy's energy management towards achieving energy independence and security, essential elements to promote sustainable development at the local level.

In this context, it is proposed that the priority of energy development will be based on the following fundamental principles:

- Maximize the use of renewable energy, always considering the economic level to ensure its viability and sustainability.
- Minimize the use of oil to reduce dependence on non-renewable sources and mitigate environmental impact.
- Optimize the utilization of natural gas and new energy, leveraging its efficiency and innovative potential.
- Use coal as a reliable energy supply, ensuring energy stability while moving towards a more sustainable energy matrix.

This section will thoroughly evaluate the National Electricity Plan (RUKN 2019-2038) and the Long-Term Strategy for Climate Resilience and Low Carbon Emission 2050 (LTS-LCCR 2050). These strategic documents are fundamental for Indonesia's sustainable

[289] IEA (2023). An Energy Sector Roadmap to Net Zero Emissions in Indonesia. Available at: https://iea.blob.core.windows.net/assets/b496b141-8c3b-47fc-adb2-90740eb0b3b8/AnEnergySectorRoadmaptoNetZeroEmissionsinIndonesia.pdf.

development and climate resilience, establishing key guidelines for the transition to cleaner and more efficient energy.

National Electricity Plan (RUKN 2019-2038)[290]

In 2019, the National Electricity Plan (RUKN 2019-2038) was promulgated by Decree No. 143/2019 of the Ministry of Energy and Mineral Resources. This Plan serves as a comprehensive guide for electricity planning, integrating emission reduction targets in line with the First Nationally Determined Contribution (NDC). Thus, it constitutes a document that has established the foundations for the development of subsequent plans such as the Electricity Supply Business Plan (RUPTL) and the Regional Energy Plan (RUED).

The achievement of renewable energy quotas in the electricity sector is reinforced through RUKN 2019-2038 and supported by the promulgation of Presidential Regulation (PR) 112/2022. However, the government has not provided clear and credible policy direction for its implementing institutions to meet the target under these regulations.

Additionally, RUKN 2019-2038 emphasizes the importance of investing in infrastructure between 2019 and 2038. The majority of the funds from this investment should be directed towards sustainable energy generation. Thus, in 2023, the government allocated approximately USD57.6 million for rural electrification through solar and micro-hydro plants, which constitutes less than 1% of the total infrastructure budget.

By 2025, the aim is to achieve a minimum renewable energy share of 23%, with gas accounting for around 22%, coal about 55%, and liquid fuels approximately 0.4%. By 2038, the goal is to increase the renewable energy share to a minimum of 28%, with gas constituting around 25%, coal about 47%, and liquid fuels around 0.1%. These targets are binding for PT PLN (Persero) and other sector operators, fostering collaboration for their achievement.

Long-Term Strategy for Low Carbon and Climate Resilience 2050 (LTS-LCCR 2050)[291]

The LTS-LCCR 2050 outlines specific measures to achieve emission reductions in each sector of the Indonesian economy. Particularly, the strategies developed for the energy sector are based on four main pillars. Their formulation considers both previous outcomes and the future projection of energy demand and supply in the areas of transportation, electricity, industry, and construction. These pillars consist of the implementation of energy efficiency measures to optimize consumption, the use of decarbonized electricity in transportation and buildings to reduce direct emissions, a shift in the fuel used in the industry from coal to gas and renewable energy, and the strengthening of renewable energy in the electricity, transportation, and industrial sectors to further diversify and decarbonize the economy's energy mix.

On the other hand, regarding the transportation sector, it is expected that by 2050, it will have undergone a drastic process of change from the current model. The mode of passenger transport will mostly consist of mass public transport (buses, MRT, LRT) in metropolitan areas; buses in smaller cities; trains and large buses for intercity transport; and air transport for travel between metropolitan areas and islands (boats and ferries). This will not only be due to changes in the distribution of energy types used in the sector but also because of the proportion that transportation represents in the total household

[290] Climate Transparency (2024). Policy assessment: renewable energy development in Indonesia's power sector. Available at: https://www.climate-transparency.org/wp-content/uploads/2024/01/Implementation-Check-Renewable-Energy-Development-in-Indonesia-2024.pdf
[291] Government of Indonesia. (2021). Indonesia Long-Term Strategy for Low Carbon and Climate Resilience 2050. Available at: https://unfccc.int/sites/default/files/resource/Indonesia_LTS-LCCR_2021.pdf

expenditure. By the specified year, this proportion should not exceed 20%. Meanwhile, regarding freight transport, it is expected to be carried out by train for intercity transport, trucks/trailers, air and maritime transport for inter-island cargo, as well as small trucks in cities.

As for the energy distribution in the transportation sector, it is projected that by 2050, the main energy sources for transportation will be biofuels (46%) and electricity (30%), though there will still be vehicles that require petrol fuels (20%), followed by the use of natural gas (4%). In this sense, mitigation goals in transportation will be achieved through the electrification of transport; the supply of more biofuels as diesel substitutes (e.g., fatty acid methyl ester and biofuels or green diesel); and gasoline substitutes (e.g., bioethanol and CPO-based gasoline). In the last ten years, the government has been introducing biofuels made from CPO, which are mixed with petrol diesel and called B20 (20% biodiesel plus 80% petrol diesel). It is expected that, in the future, biofuels with higher proportions of biodiesel (B30, B40, B50) will be supplied, produced from sustainable sources.

8.5.3. Specific Electromobility Policies

The decarbonization of road transport is aimed at changing travel behaviors to reduce demand. This includes reducing unnecessary trips, transitioning to low-emission modes of transport, and adopting clean energy vehicles. In this context, the adoption of EV also presents the opportunity to accelerate the deployment of renewable energy and, in the long term, can provide demand flexibility through V2G technology. EVs generate 7% fewer emissions and have a 14% lower cost per Km compared to ICE vehicles. On the other hand, fiscal and non-fiscal incentives provided by the government play a crucial role in reducing greenhouse gas emissions and the TCO of EV.[292]

The following table lists the strategic documents promoting electromobility that were issued between 2017 and 2019.

Table 13. Strategic Documents and Objectives for Two- and Four-Wheeled EVs Issued Between 2017 and 2019

Document	Relevance of EV
General Energy Plan (2017)	Adoption targets of 2,200 electric and hybrid vehicles (without specification regarding the type of hybrid) and 2.1 million electric motorcycles by 2025.
PR 55/2019 about BEV	Launched in 2019 with the goal of accelerating the adoption of BEV, but without a quantified target.
Automotive Production Target of the Ministry of Industry (MoI)	• LCEV, including hybrid vehicles, PHEVs, BEVs, and FCEVs, to cover 20% of annual vehicle production by 2025 and 30% by 2035. • Production target of 7,700,000 electric motorcycles by 2025.
Grand Energy Strategy, MEMR	The timeline of this strategy is 2020-2024. It includes plans to reduce oil imports and promote the development of EV. The EV adoption targets in the strategy are as follows: • 2,195,000 EV by 2023 (cumulative number) • 13,002,000 electric motorcycles by 2030 (cumulative number)

Source: International Council on Clean Transportation (2021)

The following plans, programs, and policies have emerged since 2019 and remain in effect to the present day.

[292] Institute for Essential Services Reform (IESR). (2023). Indonesia EV Outlook 2023. Available at: https://iesr.or.id/wp-content/uploads/2023/02/Indonesia-Electric-Vehicle-Outlook-2023.pdf

Master Plan for the Industry 2015–2035[293]

Master Plan for the Industry, enacted in 2015, establishes essential guidelines for the development of the automotive industry. The Automotive Industry Roadmap, implemented by the Ministry of Industry, promotes greater synergy among car manufacturers. The Master Plan is structured into three distinct phases:

- First Phase (2015-2019): This phase aims to consolidate the domestic manufacturing of automotive components, more precise and efficient powertrains, heavy equipment, and both conventional and electric engines.
- Second Phase (2020-2024) and Third Phase (2025-2035): These phases focus on the development of electric and fuel cell engines.

Continuous progress in the implementation of new technologies for the development of electric engines aligns with the Master Plan's objective of improving the efficiency and competitiveness of Indonesia's automotive industry, both domestically and globally. This industry ranks fourth in the classification of priority industries due to its relevance in addressing key interests, challenges related to economic development, and reducing the gap with developed economies through increased productivity.

Among the primary needs addressed by the technology of these engines is the development of hybrid-powered armored military vehicles and trains, which use conventional fuel, gas, electricity, and fuel cells.

Fiscal Policies Promoting Electromobility[294]

Fiscal policies in Indonesia's economy are primarily designed to incentivize consumers and make EV more attractive. Currently, fiscal incentives for the EV industry (supply) are limited, as the government's focus is on boosting sales (demand).

First, the issuance of Presidential Regulation No. 55/2019[295] for the acceleration of BEV adoption in 2019 has been a significant milestone for electromobility. This regulation provided support to the battery EV industry in four main areas:

- Lead ministries/agencies responsible for implementation.
- Definition of BEV and development of their technical specifications.
- BEV manufacturing capacity.
- Transition of the ICE vehicle market to BEV.

Following this, various ministries have issued regulations to support EV in response to this regulation. These include:

1. Ministry of Industry

- Regulation No. 27/2020: Establishes the specifications, development roadmap, and calculation of local content for BEVs.
- Regulation No. 28/2020: Regulates completely knocked down (CKD) and incompletely knocked down (IKD) vehicles for BEVs. The Ministry of Transport issued Regulation No. 45/2020 on specific vehicles with electric motors.

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[293] Indonesia. (2015). Regulation No. 14 of 2015 on National Energy Policy. Peraturan BPK. Available at: https://peraturan.bpk.go.id/Details/5577/pp-no-14-tahun-2015

[294] Institute for Essential Services Reform (IESR). (2023). Indonesia EV Outlook 2023. Available at: https://iesr.or.id/wp-content/uploads/2023/02/Indonesia-Electric-Vehicle-Outlook-2023.pdf

[295] International Council on Clean Transportation (ICCT). (2021). India electrification strategy. Availabe at: https://theicct.org/wp-content/uploads/2021/12/india-electrification-strategy-oct21.pdf

2. Ministry of Transport

- Regulation No. 45/2020: Regulates specific vehicles with electric motors, ensuring they meet the necessary safety and operational standards for integration into the transportation system.

3. Ministry of Energy and Mineral Resources

- Regulation No. 13/2020: This regulation addresses the charging infrastructure for BEVs. It provides detailed requirements for charging stations and battery exchange stations, including legal aspects for service providers, references for business models, and electricity tariffs for charging and battery exchange. Additionally, it includes incentives for operators, thus promoting the expansion and accessibility of charging infrastructure.[296]

On the other hand, fiscal incentives to bridge the price gap between EV and ICEV are limited to exemptions from the luxury tax (PPNBM), the title transfer fee (BBNKB), and the vehicle tax (PKB). However, the Indonesian government included the exemption of BBNKB and PKB for EV in Law No. 1/2022, although this will only come into effect starting in 2025. Additionally, the government has yet to introduce further disincentives for ICEV, aside from the existing PPNBM scheme.

Government Regulation No. 73/2019 on the PPNBM scheme, issued in 2019, replaces previous regulations governing the automotive luxury tax. For ICE vehicles, luxury tax rates are no longer calculated solely based on engine capacity but also consider efficiency and emissions. This regulation clearly favors the transition to electric mobility by reducing the luxury tax rate to 0% for PHEV, BEV, and FCEV.[297] Finally, the regulatory framework specifically oriented towards the transition to electromobility is as follows:

First, the Circular from the Financial Services Authority (OJK) establishes two key measures to incentivize the financing of EV. Risk-Weighted Assets (RWA/ATMR) for the financing of the production and purchase of EV are reduced from 75% to 50%, thereby facilitating more favorable access to credit. Additionally, the purchase of EV on credit could be made with an initial cost of 0%, meaning no down payment is required, making the acquisition of these vehicles more accessible.

Similarly, Government Regulation No. 74/2021 exempts BEV from the luxury goods tax (PPnBM), significantly reducing the total cost of acquiring these vehicles and encouraging their adoption in the market.

Additionally, Ministry of Home Affairs (MoHA) Regulation No. 1/2021 establishes that the maximum annual vehicle tax (PKB) and the title transfer fee (BBNKB) for BEV will be only 10% of their standard tax rate calculation, providing substantial tax relief to EV owners.

Ministry of Finance (MoF) Regulation No. 138/PMK.02/2021 addresses the costs associated with Vehicle Type Testing for BEV, which are notably lower than for ICEVs. The cost of this test is IDR4.5 million for two-wheeled vehicles (E2W) and IDR13.2 million for four-wheeled vehicles (E4W) and electric buses (E-bus). Additionally, the Type Test Certification (Sertifikat Uji Tipe/SUT) is significantly cheaper for BEV: 25 times cheaper for E2W and 6 times cheaper for E4W and E-buses compared to ICV.

[296] Ibid.
[297] Ibid.

Non-Fiscal Policies Promoting Electromobility[298]

Existing non-fiscal policies mainly establish the rules of the game for EV, including the standardization of charging and battery swapping stations, as well as local content requirements. These policies are fundamental for creating a favorable regulatory environment and promoting the adoption of EVs in Indonesia.

In 2022, the government issued three key non-fiscal policies to support EV:

1. Adoption of EV as Government Official Vehicles: An instruction was issued to adopt EV as government official vehicles, promoting institutional use and demonstrating the government's commitment to electromobility.
2. Expansion of ICEV to EV Conversions: The expansion of ICEV to EV conversions was regulated beyond the two-wheeled segment (2W), complementing the 2020 E2W conversion policy. This allows for greater diversification in EV adoption and facilitates the transition of different types of vehicles to electric technology.
3. Support for Local Component Manufacturers: The Ministry of Industry issued a regulation covering technical requirements, the roadmap for EV, and local content requirement (LCR) guidelines. This regulation aims to strengthen the local industry and ensure that EV components are produced domestically, fostering industrial development and self-sufficiency.

In addition to these policies, several regulations complement the non-fiscal regulatory framework for EVs:

- MEMR Regulation No. 13/2020: This regulation establishes the standardization of charging plugs and the electricity tariff policy for public EV charging stations and public EV battery replacement. This ensures a uniform and accessible charging infrastructure.
- MoT Regulation No. 44/2020: Regulates the testing and certification process for EV, ensuring that EV meet safety and performance standards before commercialization.
- MoT Regulation No. 45/2020: Regulates special vehicles with electric motors, including safety requirements, driving behavior, and specific vehicle lanes, which are crucial for the safe integration of EV into the transportation system.
- MoT Regulation No. 65/2020: Legalizes the conversion of E2W and regulates the components of the converted vehicle, the requirements for conversion in small and medium enterprises (SMEs) workshops, along with safety requirements and the administrative process. This regulation facilitates the transition of two-wheeled vehicles to electric technology, promoting electromobility in more accessible transportation segments.

E2W Conversion Program[299]

In 2020, Indonesia's MEMR launched a motorcycle conversion program to reduce initial costs and increase the adoption of E2W. This program aims to address the high investment costs and limited options available in the market for consumers. However, the high initial costs are transferred to conversion costs. Additionally, the program faces challenges such as low consumer confidence and shorter warranty periods (6 months to 1 year) compared to the 2-year warranty for spare parts for new E2W. As a result, the adoption of EV has been delayed in the economy.

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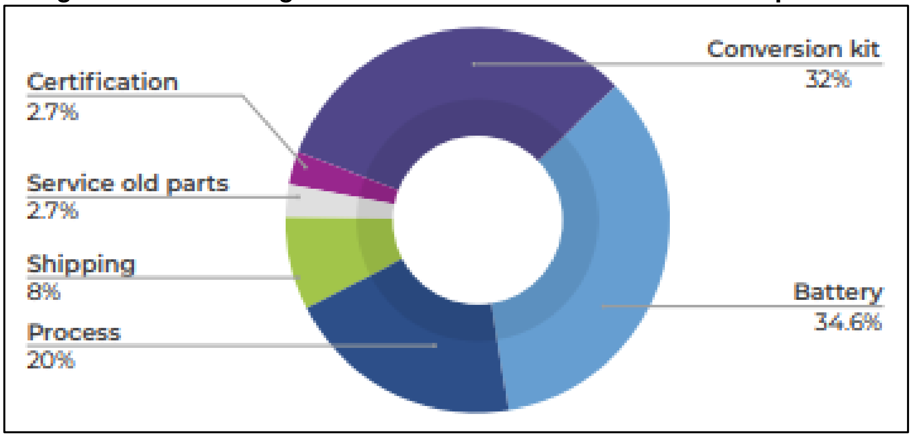
[298] Institute for Essential Services Reform (IESR). (2023). Indonesia EV Outlook 2023. Available at: https://iesr.or.id/wp-content/uploads/2023/02/Indonesia-Electric-Vehicle-Outlook-2023.pdf

[299] Institute for Essential Services Reform (IESR). (2023). Indonesia EV Outlook 2023. Available at: https://iesr.or.id/wp-content/uploads/2023/02/Indonesia-Electric-Vehicle-Outlook-2023.pdf

Figure 71 shows the percentage distribution of each component of the 2EW conversion program. It is observed that the battery and conversion kit, generally imported, account for about 60% of the total cost. The total conversion cost of motorcycles is around IDR15-23 million per unit, which is only about 20% less than a new motorcycle. This high cost has hindered the program's market penetration, as consumers are willing to pay only between IDR5-8 million for the conversion. Additionally, it is important to note that the conversion cost in Indonesia is higher than the price of a new E2W in India, where the conversion cost is only one-third of the price of a new E2W.

Figure 71. Percentage of the Cost of E2W Conversion Components



Source: Indonesia EV Outlook (2023)

Regarding the program's results, in 2022, in collaboration with other government institutions, including the police forces, the MEMR licensed 13 conversion workshops and established cooperation with 3 conversion component manufacturers to reduce conversion costs. However, by December of the same year, the total number of registered conversions reached only 126 units, far below the target of 1,000 units.

Finally, it is estimated that between 2022 and 2030, an average of 6 million motorcycles per year will be eligible for conversion to E2W. This projection considers motorcycles purchased between 2012 and 2020, assuming a lifespan of 10 years.

8.5.4. Success Cases

Regional Support Policies for EVs[300]

Just like the central government, some regional governments have achieved notable successes in the implementation of EV since 2019. These initiatives not only complement the central government's efforts but also create a more favorable environment for the adoption of EV throughout the economy, promoting an integrated approach to electromobility. Figure 72 presents the successful cases of policies and measures adopted by different regional governments, highlighting the strategies that have driven the transition towards more sustainable and efficient mobility.

[300] Ibid.

Figure 72. Legalized Regional EV Policies

Sub-national	Fiscal policy	Non-fiscal policy				
	BBNKB (vehicle title transfer fee) discount	Bus electrification	Odd-even traffic exemption	EV zones/sites	SPKLU obligation for buildings	Government official vehicle
DKI Jakarta	Legalized	Legalized	Legalized		Proposed	Proposed
Bali	Legalized			Proposed		
Surabaya		Legalized				Proposed
Bandung		Legalized				Proposed
Medan		Proposed				Proposed

Legalized Proposed

Source: Indonesia EV Outlook (2023)

On the fiscal regulations side, the tax incentive in the form of a BBNKB discount is the most common policy adopted by regional governments to promote the adoption of EV, following the issuance of Ministerial Regulation No. 1/2021 by the Ministry of Home Affairs (MoHA). Each province has a different tax reduction rate: 30% in Central Java, West Nusa Tenggara, East Kalimantan, and the Special Region of Yogyakarta; 10% in Bali, Banten, and East Java; unspecified in South Sulawesi; and 10% for E4W and 2.5% for E2W in West Java. In 2020, the Jakarta government provided tax incentives for EV through a 0% transfer tax for both two-wheeled and four-wheeled vehicles, and non-fiscal incentives by excluding EV from the odd-even license plate driving restrictions.

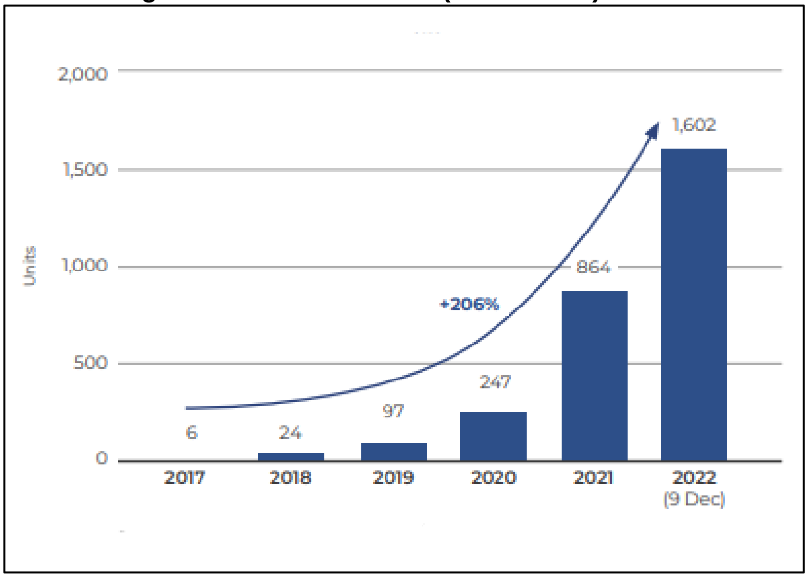
Regarding non-fiscal regulations, through TransJakarta, the first and largest BRT service in Indonesia, the province of Jakarta has more than 30 electric buses (E-buses), representing nearly half of the total E-buses in Indonesia. Jakarta planned to add another 300 units by 2023 and has signed a memorandum of understanding (MoU) to convert hundreds of ICEV buses into E-buses. Other cities such as Bandung, Surabaya, and Medan are becoming pilot regions for BRT electrification. Additionally, starting in 2023, Bandung and Surabaya will also receive 30 E-bus units. The Ministry of Transport (MoT) will manage the allocation of E-buses using the Buy the Service (BTS) mechanism.

Rapid Growth of EVs in Bali as a Result of an Intensive Campaign and Supportive Ecosystem[301]

The province of Bali implemented an independent policy on EV in line with Presidential Regulation No. 55/2019 through the enactment of Bali Governor Regulation No. 48/2019. Since the implementation of this regulation, the adoption of EV in Bali has seen a remarkable increase, rising from 24 units to 1,600 vehicles in 2022. This growth represented approximately 6% of the regional EV adoption. (See Figure 73). It is worth noting that, as EV were used as official vehicles, around 300 additional vehicles were registered and put into circulation.

[301] Institute for Essential Services Reform (IESR). (2023). Indonesia EV Outlook 2023. Available at: https://iesr.or.id/wp-content/uploads/2023/02/Indonesia-Electric-Vehicle-Outlook-2023.pdf

Figure 73. Growth of EVs (2W and 4W) in Bali



Source: Indonesia EV Outlook (2023)

On its part, Bali's ecosystem facilitates the development of converted EV. Specifically, this province hosts two of the thirteen licensed workshops for electric motorcycle conversion in Indonesia. Additionally, the presence of EV community clubs in Bali helps spread awareness about EV conversion and supports the granting of new licenses to electric conversion establishments. Notably, there are groups willing to pay significantly more than the standard conversion price, even up to five times more.

Finally, in 2023, Bali implemented the Regional Action Plan (RAD). The plan includes the establishment of 5 EV zones, where two types of infrastructure will be prepared:

- Hard Infrastructure: This includes fast and ultra-fast charging stations (SPBKLU), essential for ensuring the efficiency and accessibility of energy supply for EV.
- Soft Infrastructure: This refers to public awareness and education about EV promoting greater acceptance and adoption of this technology in society.

8.5.5. Limitations, Opportunities, and Challenges for the Automotive Industry in the Transition to Electromobility

While Indonesia has a significantly developed automotive industry, it operates in an underdeveloped domestic market predominantly oriented towards vehicles and components of lower standards compared to international levels. In recent years, EV production in the economy has seen an average annual increase of 392% between 2019 and 2022, surpassing 6,000 units manufactured in the last-mentioned year.[302] However, Indonesia's share in the international EV market remains modest, representing just 2% of global sales in 2023[303].

The development of the EV production industry in Indonesia is affected by several structural limitations. The geographical distribution of the Indonesian archipelago presents significant logistical challenges, which can increase production costs by up to 25% due to the high transportation costs between islands and regions. Additionally, the local market shows a marked preference for mid-to-low-range vehicles, limiting the

[302] ICEX Spain Export and Investment. EV in Indonesia. Available at: https://www.icex.es/content/dam/es/icex/oficinas/132/documentos/2022/12/fichas-sector/FS_Veh%C3%ADculo%20el%C3%A9ctrico%20en%20Indonesia%202022_REV.pdf
[303] IEA. Global EV Outlook 2024

demand for high-end models. Japanese brands dominate the market, further hindering the ability of domestic companies to increase their market share.[304]

However, despite these limitations, the government policies implemented in Indonesia represent a significant opportunity for the development of the economy's domestic market. The implementation of a series of incentives to both foster EV production and stimulate market demand is being pursued ambitiously. Regarding production, the government has established tariff reductions for the import of components destined for EV and related capital goods. Additionally, significant tax exemptions are offered for investments in EV, batteries, motors, and control systems, which can reach up to 100% exemption from income taxes for periods ranging from 5 to 20 years, depending on the size of the investment, which ranges from USD7.2 million to USD2.1 billion.[305]

On the demand side, tax reductions have been implemented for both the acquisition and use of EV. Additionally, tariff reductions have been established for the import of complete EV, and direct subsidies are offered for the purchase of these vehicles, all with the goal of accelerating EV adoption in the economy. These combined policies are intended to strengthen both the local production infrastructure and the market acceptance of EV in Indonesia.[306]

Additionally, Indonesia's position as a key producer of critical materials for EV battery cells is another significant aspect for the development of its EV industry. With substantial nickel reserves, Indonesia plays a crucial role in the global production of this material, and consequently, in the production of EV batteries. To further strengthen its position in the global market, the economy has been developing strategic agreements with various multinational companies for extraction, refining, and manufacturing.[307] Such initiatives position the economy as a relevant player in the global supply chain of essential components for EV manufacturing.

8.6. Mexico

8.6.1. Urban Mobility Policies Related to the Transition to Electromobility

In Mexico, prior to the COVID-19 pandemic, 103 million people traveled daily in urban centers through public and private means, according to data from the Secretariat of Agrarian, Territorial, and Urban Development (SEDATU)[308].

The recognition of mobility as a human right is established in Article 4 of the Political Constitution, emphasizing that all people should have access to mobility under conditions of road safety, accessibility, efficiency, sustainability, quality, inclusion, and equality[309]. This legal framework reinforces the commitment to continuously improving the public transportation system.

In 2022, the National Institute of Statistics and Geography (INEGI) reported that approximately 50%[310] of urban travel is carried out using public transportation. In Mexico

[304] BasqueTrade & Investment (2020). Overview of the Automotive Sector in ASEAN Countries. Available at: https://basquetrade.spri.eus/wp-content/uploads/2020/11/2011-BTI-INFORME-Automocion-ASEAN-cas.pdf
[305] Rubio, J., Gutman, M., Pérez, B. & Delbuono V. (2024). Transition Policies to Electromobility in Middle-Income Countries. Available at: https://fund.ar/wp-content/uploads/2024/03/Fundar_Politicas-de-transicion-a-la-electromovilidad-en-paises-de-ingresos-medios_CC-BY-NC-ND-4.0.pdf
[306] Ibid.
[307] Ibid.
[308] Secretariat of Environment and Natural Resources (SEMARNAT). (2022). National Electromobility Strategy. General Directorate of Policies for Climate Action, SEMARNAT. Available at: https://transformative-mobility.org/wp-content/uploads/2023/04/MEX_Semarnat.pdf (p.3).
[309] https://www.dof.gob.mx/nota_detalle.php?codigo=5608174&fecha=18/12/2020#gsc.tab=0
[310] Secretariat of Environment and Natural Resources (SEMARNAT). (2022). National Electromobility Strategy. General Directorate of Policies for Climate Action, SEMARNAT. Available at: https://transformative-mobility.org/wp-content/uploads/2023/04/MEX_Semarnat.pdf (p.2).

City, the most used means are the metro and Metrobús. In Guadalajara, the electric train and Macrobús are prominent, while in Pachuca, the Tuzobús, and in Monterrey, the STC Metrorrey, are the main public transportation means[311].

It is important to highlight that between 1990 and 2015, the vehicle fleet in Mexico grew at a rate 3.5 times greater than the population, according to the Urban Mobility Index[312]. This significant increase occurred especially in areas where public transportation is insufficient. The peripheral areas of cities are the most affected, being vulnerable, unsafe, and with limited quality public transportation options.

Mexico finds itself at a critical juncture for urban mobility, facing the urgent need to reduce greenhouse gas emissions, of which motor vehicle use is responsible for 22.9% of the total[313]. Additionally, the high costs associated with car use, including emissions, congestion, accidents, and sedentarism, contribute to social costs that can represent up to 5% of the GDP in urban areas[314]. This situation underscores the importance of adopting comprehensive measures to improve the sustainability of transportation and mitigate its negative impacts on the economy and public health.

Regulatory and Programmatic Proposals for Achieving Sustainable Urban Mobility in Mexico

The technical-legal report titled "Sustainable Urban Mobility in Mexico; Regulatory and Programmatic Proposal," developed by the institution POLEA, is part of the project "Strengthening Legislative-Executive-Interested Party Dialogue on Mexico's Climate and Energy Goals." Supported by the Embassy of the United Kingdom in Mexico, this document addresses mobility, green financing, and climate change issues. Its main objective is to propose regulatory reforms and programmatic actions that promote sustainable urban mobility in Mexico as a key strategy for reducing greenhouse gas emissions.

Regulatory reforms, particularly those implemented at the local level, have significantly advanced in establishing mobility as a recognizable and enforceable right within legal frameworks. This progressive recognition ensures that all individuals have access to a high-quality, sufficient, and accessible mobility system that, under conditions of equality and sustainability, facilitates efficient movement within any territory, meeting their needs and promoting their full development. Despite variations in definitions, this right has been incorporated into all new Mobility Laws at the state level.

Moreover, the mobility system is conceived as an intricate network of interconnected components and resources whose structure and operation enable the transportation of people and goods. These systems include four main subsystems: 1) Road Infrastructure, 2) Mobility Services, 3) Operation and Traffic, and 4) Sustainable Urban Development.

Balancing the concept of "mobility as a social and environmental cost" with the idea of "mobility as a right" requires an innovative regulatory framework. Therefore, regulatory and programmatic reforms are proposed to promote sustainable urban mobility. This proposal envisions shared responsibilities between the Congress of the Union and the Government of Mexico. The following table lists all the proposed reforms in the report.

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[311] Ibíd.
[312] Ibíd.
[313] Céntrico. (2019). Sustainable Urban Mobility in Mexico: Regulatory and Programmatic Proposal. POLEA Policy and Environmental Legislation. Available at: https://comisiones.senado.gob.mx/desarrollo_urbano/docs/climatico/p2_5_131119.pdf (p.2).
[314] Ibíd.

Table 14. Proposed Regulatory Reforms for Sustainable Urban Mobility in Mexico

Proposal	Description
Constitutional Recognition of the Right to Mobility	Integrate the right to mobility into the Constitution, complementing the right to a healthy environment in Article 4°. Currently, three different initiatives have been presented for this purpose.
General Law on Mobility and Road Safety	Create a law to protect the right to mobility, establish goals for reducing automobile use, increase infrastructure and services for public transport, walking, cycling, and micromobility services. Include a sustainable urban mobility strategy, create funds and subsidy programs for public transport users, and set guidelines to reduce injuries and fatalities from traffic accidents.
Reform of the General Law on Climate Change	Adjust emission reduction targets to the current climate emergency, expand budgetary, financial, regulatory, and fiscal instruments, define urban mobility systems and their subsystems, establish compliance controls for objectives, and ensure independent evaluations of emission reductions.
Reform of the Special Tax Law on Production and Services	Adjust the value of carbon to the environmental costs of burning fuels to USD30 per ton, increase revenue for combating climate change, and adjust gasoline taxes to the environmental and social costs of its combustion.
Reform of the General Law of Ecological Balance and Environmental Protection	Include the obligation to evaluate the carbon emission impact of infrastructure projects financed with federal funds.
Reform of the Federal Budget and Fiscal Responsibility Law	Include the evaluation of carbon emission impacts in the programming and evaluation of resources allocated to programs and investment projects, considering the social return rate.
Reform of the Organic Law of the Federal Public Administration	Create the Undersecretariat of Urban Mobility in SEDATU to provide technical and financial assistance to local governments.
Reform of the General Law on Human Settlements, Land Use Planning and Urban Development	Develop a metropolitan coordination scheme between state, municipal, and federal agencies to address mobility issues more effectively.
Adoption of Indicators and Targets for Planning	Define and adopt five indicators and targets to guide public mobility policy, using results-based planning methodologies, and define categories of inputs-activities-products-results-impacts.
Creation of a Sustainable Urban Mobility Program	Finance and support projects in cities that reduce barriers to investment in sustainable urban mobility, increasing demand for projects and budgetary momentum.
Modification of Guidelines and Operating Rules	Adjust guidelines and operating rules of 11 federal funds, trusts, and programs to support projects, actions, and strategies for urban mobility in cities, with minimum standards and flexibility for local innovation.

Source: Céntrico. (2019). Sustainable Urban Mobility in Mexico: Regulatory and Programmatic Proposal (p.8).

The document emphasizes that achieving a significant reduction in emissions necessitates a substantial decrease in both the purchase and use of automobiles. This approach remains crucial even amidst efforts to electrify engines. Therefore, it is imperative to adopt a mobility model that prioritizes: i) the adoption of EVs in public transport, ii) the use of bicycles, and iii) pedestrian travel. The expected benefits include reduced traffic congestion, decreased pollutant emissions, fewer traffic accidents, and the promotion of more active lifestyles.

Additionally, the document highlights Mexico as a global leader in promoting, signing, and ratifying international agreements to reduce greenhouse gas emissions and incorporating these agreements into its legal and planning frameworks. However, the effective implementation of these policies remains pending, with a noticeable lack of effective instruments. The primary challenge for Mexico lies in strengthening the recognized rights, strategies, institutions, and legal frameworks to implement programs and projects that effectively reduce emissions.

Policies to Promote the Use of Zero-Emission Vehicles According to the PND 2019-2024

The National Development Plan (PND) is the guiding document for public policies in Mexico, outlining objectives, strategies, and priorities for comprehensive, equitable, inclusive, sustainable, and sustainable development. Approved for the period 2019-2024, the PND establishes several cross-cutting themes; however, there are only brief references to sustainable mobility in the third axis, "Territory and Sustainable Development," which mentions the mitigation of GHG.

Table 15. Axis and Criteria of the Zero Emissions Policies in the National Development Plan (PND)

Axis	Criteria
III.3 Transversal Axis 3 "Territory and Sustainable Development”	• All public policies should consider, among their various considerations, vulnerability to climate change, the strengthening of resilience, and adaptation and mitigation capacities, especially if they impact the most vulnerable populations or regions.
	• Where applicable, the determination of public policy options should favor the use of low-carbon technologies and renewable energy sources; the reduction of pollutant emissions into the atmosphere, soil, and water; as well as the conservation and sustainable use of natural resources.

Source: Céntrico. (2019). Sustainable Urban Mobility in Mexico: Regulatory and Programmatic Proposal

The Specialized Technical Committee on Sustainable Development Goals (CTEODS) has defined the axes, objectives, and strategies of the SDGs related to mobility. These goals are also reflected in the National Development Plan.

Table 16. Axis, Objectives, and Strategies

Axis	Objectives
1. Justice and Rule of Law	
2. Wellbeing • **Objective**: Guarantee the effective exercise of economic, social, cultural, and environmental rights, with an emphasis on reducing inequality gaps and conditions of vulnerability and discrimination in populations and territories. • Indicator E2.A: Number of people who move out of poverty according to the multidimensional methodology.	• Objective 2.4: Promote and guarantee the effective, universal, and free access of the population to health services, social assistance, and medications, based on principles of social participation, technical competence, medical quality, cultural relevance, and non-discriminatory treatment. o Strategy 2.4.8: Design and implement articulated public policies to prevent, control, and reduce non-communicable chronic diseases (NCDs), primarily diabetes, cardiovascular diseases, and cancer, throughout all stages of the life cycle.
	• Objective 2.5: Guarantee the right to a healthy environment with a focus on the sustainability of ecosystems, biodiversity, heritage, and biocultural landscapes. o Strategy 2.5.8: Promote management, regulation, and monitoring to prevent and control pollution and environmental degradation.
	• Objective 2.7: Promote and support access to adequate and affordable housing in an orderly and sustainable environment. No mobility-related indicator. o Strategy 2.7.2: Foster the production of housing in its various modalities with a focus on sustainability and resilience, and improve conditions of accessibility, habitability, and access to basic services and connectivity.
	• Objective 2.8: Strengthen the governance and linkage of territorial and ecological planning of human settlements and land tenure through the rational and balanced use of territory, promoting accessibility and efficient mobility.

Axis	Objectives
- Baseline: Not applicable - Goal 2024: 20 million people	- Indicator 2.8.1: Efficiency in land use: the ratio between the land consumption rate and the urban population growth rate. Baseline (2017): 2.25, Target 2024: 2.25. - Strategy 2.8.1: Promote planning actions at the regional, state, metropolitan, municipal, and community levels in urban development and territorial and ecological planning with sustainability, accessibility, climate change mitigation and adaptation criteria, ensuring the participation of the three levels of government, social and private sectors, academia, and indigenous peoples and communities. - Strategy 2.8.2: Implement comprehensive interventions that improve the habitability, accessibility, and mobility conditions of human settlements, and the enjoyment and social production of public and common spaces with universal design. - Strategy 2.8.3: Encourage, together with local governments, schemes that promote accessible and sustainable mobility, prioritizing efficient and low-emission public transport modes and non-motorized mobility.
	- Objective 2.10: Ensure physical culture and sports practice as means for the integral development of people and the integration of communities. - Indicator 2.10.1: Population aged 18 and over physically active in the urban aggregate of 32 cities with 100,000 or more inhabitants. - Women: Baseline 2018: 35.6%, Target 2024: 35.6% - Men: Baseline 2018: 48.4%, Target 2024: 48.4% - No mobility-related strategy.
3. Economic Development - Objective: Increase productivity and promote the efficient and responsible use of resources to contribute to balanced economic growth that guarantees equal, inclusive, and sustainable development throughout the territory. - No indicators related to mobility.	- Objective 3.5: Establish a sovereign, sustainable, low-emission, and efficient energy policy to guarantee accessibility, quality, and energy security. - Strategy 3.5.4: Guide the use of hydrocarbons to produce higher value-added products, promoting the use of energy efficiency techniques. - Strategy 3.5.5: Ensure the sustainable supply of quality energy to consumers at affordable prices.
	- Objective 3.6: Develop a transparent, accessible, safe, efficient, sustainable, inclusive, and modern communications and transport network with a vision of regional development and logistic networks that connect all people, facilitate the movement of goods and services, and contribute to safeguarding security. - Strategy 3.6.1: Establish a safe and efficient road network that connects population centers, ports, airports, logistic centers, and modal interchange hubs, preserving its patrimonial value. - Strategy 3.6.3: Develop an accessible transport infrastructure with a multimodal approach (rail, airport, maritime, mass transport), sustainable, at competitive and accessible costs that expand the coverage of transport at both regional and broader levels.
	- Objective 3.10: Foster economic development that promotes the reduction of greenhouse gas emissions and adaptation to climate change to enhance the quality of life for the population. - Indicator 3.10.1: CO_2 emissions from fossil fuel combustion per USD of purchasing power parity GDP (PPP GDP). Baseline (2016): 0.21 kilograms of CO_2 from fossil fuel combustion per USD of PPP GDP. Target 2024: 0.13. - Strategy 3.10.1: Promote policies to reduce greenhouse gas emissions in productive sectors and to promote and conserve carbon sinks.

Axis	Objectives
	○ Strategy 3.10.2: Encourage public investment and foster the transfer of other sources of funding to invest in climate change mitigation and adaptation measures. ○ Strategy 3.10.3: Promote economic and market instruments that drive the reduction of greenhouse gas emissions in strategic sectors. ○ Strategy 3.10.4: Promote the development of institutional capacities for planning, designing, executing, communicating, and evaluating climate change mitigation and adaptation measures.

Source: Céntrico. (2019). Sustainable Urban Mobility in Mexico: Regulatory and Programmatic Proposal

Programs, Policies, and Measures to Discourage the Use of Private Vehicles

The following are various measures implemented for the management of private vehicles in Mexico, focused on promoting electromobility and improving urban mobility. These include the "Hoy No Circula" program, which restricts the circulation of vehicles with higher emission levels and exempts electric and hybrid vehicles; the ECOPARQ parking meter system, designed to regulate public street parking and encourage the adoption of clean technologies; and urban toll highways, which aim to optimize vehicle flow in metropolitan areas through electronic toll systems and offer specific benefits for EV, such as toll discounts.

- **Program: Today No Circulate[315]**

The "Today No Circulate" program is a measure implemented in Mexico City to limit the circulation of motor vehicles with the aim of preventing, minimizing, and controlling the emission of pollutants. Established in 1989 and periodically updated, this program applies to all vehicles based on a system of holograms obtained through vehicle verification. Vehicles are classified into various categories, with those emitting higher levels of pollutants facing stricter restrictions.

A notable feature of the " Today No Circulate" program is its explicit support for electromobility. Electric and hybrid vehicles are exempt from circulation restrictions, which promotes the adoption of cleaner technologies. This exemption not only encourages owners to opt for lower-emission vehicles but also aligns with global policies for reducing greenhouse gas emissions. The program grants "00" and "0" holograms to these vehicles, allowing them to circulate without limitations (see Table 17).

Table 17. Key Features of the "Today No Circulate" Program

Hologram / Sticker	Vehicle Characteristics	Circulation Limitation
Exempt	Hybrids and EVs	None
00 (double zero)	0 to 2 years	None
0 (zero)	0 to 8 years	None
1	9 to 15 years	One weekday 2 Saturdays per month
2	Over 15 years	One weekday Every Saturday
Foreign	Any vehicle regardless of age or model	One weekday Time restriction (08:00 – 11:00) from Monday to Friday Every Saturday

Source: Marín, A. (2022). *Situación financiera de la movilidad urbana en Ciudad de México*.

315 Government of the Federal District. (2014). Decree Issuing the "Today No Circulate" Program in the Federal District. Official Gazette of the Federal District. Available at: https://www.sedema.cdmx.gob.mx/storage/app/media/programas/hoy-no-circula/decreto-programa-hoy-no-circula-segundo-semestre-2016.pdf

"Today No Circulate" Program has a significant impact on reducing vehicular congestion and improving air quality. By encouraging the use of electric and hybrid vehicles, the program helps decrease pollutant emissions and promotes a more sustainable urban environment. Additionally, the program remains a crucial tool in Mexico City's environmental policy. Over time, it is expected that the restrictions will be adjusted to continue incentivizing the adoption of EVs and other green technologies. It is important to highlight that the program's effectiveness relies on strengthening verification mechanisms and maintaining a continuous commitment to reducing emissions and improving air quality.

- **ECOPARQ System**

ECOPARQ is the parking meter system operated by the Public Space Authority of the Government of Mexico City. Its main objective is to regulate public street parking to improve urban mobility, reduce vehicular congestion, and generate revenue that is reinvested in improving public spaces in the areas where the program is implemented. Since its inception in 2011, ECOPARQ has been effective in reducing vehicular congestion and CO_2 emissions, as well as providing funds for urban development[316].

While ECOPARQ does not offer specific preferential treatment for EVs in terms of rates or exemptions from parking meter payments, this system has proven effective in reducing the time drivers spend searching for parking. This, in turn, decreases pollution[317] and improves urban quality of life. The revenue generated is invested in significant improvements in the areas where the program operates, benefiting the local community and promoting greater acceptance of the program.

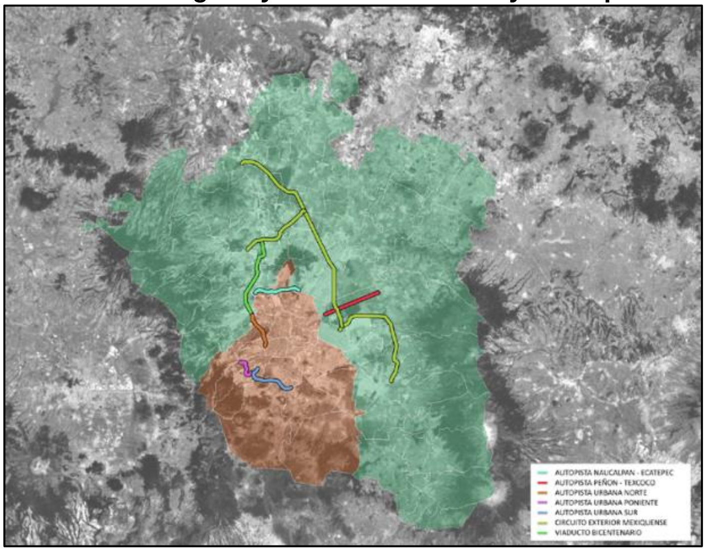
- **Urban Toll Highways in Mexico**

Urban toll highways in Mexico are controlled-access roads designed to facilitate mobility in densely populated metropolitan areas. These highways feature specific infrastructure such as viaducts and toll booths and require payment for use[318]. The primary objective of these roads is to reduce travel times compared to ordinary road networks, thereby improving vehicle flow in cities.

In the Mexico City Metropolitan Area (ZMVM), there are nine urban toll highways. The longest is the Circuito Exterior Mexiquense, with 110 km, followed by the Toluca-Zitácuaro highway with 54.9 km, and the Tenango-Ixtapan de La Sal highway with 42.7 km[319] (see Figure 74). These highways are equipped with electronic toll collection systems, such as TAG PASE, which allow drivers to pay the toll automatically when entering and exiting the highways.

[316] https://centrourbano.com/revista/reportajes/ecoparq-una-estrategia-de-movilidad-del-futuro/
[317] According to the Institute for Transportation and Development Policy (ITDP), parking search time was reduced by 78% in the first year of operation of the program in Polanco, which is equivalent to a significant reduction in emissions.
[318] Marín, A. (2022).
Financial situation of urban mobility in Mexico City. Economic Commission for Latin America and the Caribbean (ECLAC). Santiago: United Nations. Project Document (LC/TS.2022/212). Available at: :https://repositorio.cepal.org/server/api/core/bitstreams/d3e8c822-9142-43de-b934-c9eaa04f4a93/content (p.26).
[319] Ibid. .

Figure 74. Urban Highways in the Mexico City Metropolitan Area



Source: Marín, A. (2022). *Financial Situation of Urban Mobility in Mexico City*

The toll rates for these highways vary depending on the section and the time of day. For instance, the Autopista Urbana Norte charges approximately USD0.18 per Km, while the Supervía Poniente charges around USD0.51 per Km[320]. These rates may be adjusted according to peak and off-peak hours as well as the direction of travel, helping to manage infrastructure use and reduce congestion during peak demand times.

Despite their benefits in terms of efficiency and reduced travel times, urban toll highways have been criticized for not directly promoting sustainable mobility. They are more oriented towards improving the efficiency of private vehicle traffic rather than encouraging the use of more ecological alternatives such as public transportation or active mobility (cycling and walking). However, these tolls generate revenue that is used for the maintenance and expansion of road infrastructure, which is beneficial for the city as a whole.

In Mexico, EV enjoy certain benefits that promote their use, especially in the context of urban toll highways. These benefits include discounts and exemptions that make the adoption of sustainable mobility technologies more attractive. One notable program is the EcoTag TeleVía, which offers a 20% discount on toll fees for electric and hybrid vehicles on urban highways in Mexico City. This tag allows users to obtain reduced rates when using the Supervía Poniente and the Autopista Urbana Norte and Sur (second level of Periférico)[321].

EV owners can request the EcoTag TeleVía for free by associating it with a credit card and registering their vehicle by presenting the registration card that confirms the vehicle is hybrid or electric. The tag is sent to the user's home, and its use facilitates more efficient and economical transit on urban highways.

Norms Promoting or Accelerating the Transition to Electromobility

Mexico has implemented various regulations to control emissions and improve vehicle efficiency, promoting the transition to more sustainable mobility. These regulations, such as NOM-044-SEMARNAT-2017 and the General Law of Mobility and Road Safety, align with international standards from the European Union and the United States. Their main objective is to significantly reduce atmospheric pollutants and encourage the adoption of cleaner technologies. By establishing strict emission limits and offering tax incentives

[320] Ibíd.
[321] https://seresponsable.com/ecotag-televia/

and additional benefits, these laws support air quality improvement and facilitate the transition to EVs and other sustainable modes of transportation in Mexico.

- **The Official Mexican Standard NOM-044-SEMARNAT-2017**[322]

The Official Mexican Standard NOM-044-SEMARNAT-2017 is a key regulation that sets maximum permissible limits for pollutant emissions from diesel engines and heavy vehicles in Mexico. Promulgated on 15 December 2017, its main objective is to significantly reduce emissions of pollutants such as CO, NOx, NMHC, PM, and ammonia (NH3) from these vehicles' exhaust.

NOM-044-SEMARNAT-2017 aims to align Mexico's emission standards with the most advanced international levels, such as Euro VI and EPA 2010 standards. This alignment involves adopting advanced emission control technologies, such as DPF and Selective Catalytic Reduction (SCR) systems. The regulation applies to all new diesel engines installed in vehicles with a gross vehicle weight exceeding 3,857 kilograms.

The high level of pollutant emissions from diesel vehicles has been a constant concern due to their negative impacts on public health and the environment. Exposure to pollutants like NOx and PM is associated with respiratory and cardiovascular diseases and premature mortality. NOM-044-SEMARNAT-2017 addresses this urgent need to update regulations, setting stricter limits that compel manufacturers to adopt cleaner and more efficient technologies.

- **Reduction of Pollutant Emissions:** Implementing NOM-044-SEMARNAT-2017 results in a significant decrease in NOx, PM, and other pollutant emissions, improving air quality and reducing rates of pollution-related diseases.

- **Alignment with International Standards:** The regulation positions Mexico on par with economies having the most advanced emission regulations, such as the European Union and the United States. This not only enhances air quality but also facilitates the entry of cleaner technologies and vehicles into the Mexican market.

- **Promotion of Clean Technologies:** By requiring advanced emission control technologies, the standard drives innovation and the development of more efficient and less polluting vehicles. This includes adopting DPF, SCR, and On-Board Diagnostic (OBD) systems that ensure the correct operation of emission control systems.

Although NOM-044-SEMARNAT-2017 primarily focuses on regulating diesel engines, its implementation indirectly supports the transition to electromobility. By setting stricter standards for internal combustion vehicles, it creates an incentive to adopt EVs, which produce no pollutant emissions at the point of use. This standard, by raising emission requirements, contributes to a regulatory environment that promotes cleaner and more sustainable mobility technologies.

NOM-044-SEMARNAT-2017 is a fundamental component of Mexico's strategy to improve air quality and reduce pollutant emissions from heavy vehicles. Its alignment with the most advanced international standards reflects the economy's commitment to environmental protection and public health. Furthermore, although it does not directly address electromobility, its implementation creates a favorable framework for transitioning to EV, thereby accelerating the shift towards more sustainable mobility.

[322] Secretariat of Environment and Natural Resources. (2017). Official Mexican Standard NOM-044-SEMARNAT-2017. Available at: https://www.cofemersimir.gob.mx/expediente/13896/mir/43841/archivo/4104244

- **General Law of Mobility and Road Safety (GLMRS)**[323]

Mexico's General Law of Mobility and Road Safety (GLMRS) establishes a comprehensive regulatory framework to promote safe, efficient, and sustainable mobility economy-wide. This law focuses on reducing pollutant emissions and promoting cleaner and more sustainable modes of transportation, aligning with international and domestic environmental protection and public health objectives.

GLMRS addresses several key aspects to improve urban and rural mobility in Mexico:

Vehicle Emissions Regulation: The law sets strict limits on vehicle pollutant emissions, especially for those using internal combustion engines. This includes regulating emissions of CO, NOx, NMHC, PM, and other atmospheric pollutants.

Promotion of Electromobility: GLMRS encourages the transition to electric and hybrid vehicles through fiscal benefits, subsidies, and exemptions from certain taxes. This aims to reduce dependence on fossil fuels and lower greenhouse gas emissions.

Promotion of Clean Technologies: The law drives the adoption of advanced emission control technologies, such as DPF and Selective Catalytic Reduction (SCR) systems. These technologies are essential for meeting stricter emission standards and reducing the environmental impact of heavy vehicles.

Infrastructure for Sustainable Mobility: GLMRS mandates the development of adequate infrastructure to support sustainable mobility, including charging stations for EVs, exclusive bicycle lanes, and safe pedestrian pathways. This not only improves accessibility and safety but also promotes non-polluting modes of transportation.

Education and Awareness: The law includes education and awareness programs to encourage sustainable mobility habits among citizens. This includes campaigns on the benefits of electromobility and the importance of reducing vehicle emissions.

The Implementation of GLMRS has several direct benefits for the promotion of electromobility in Mexico:

Exemptions and Subsidies: Electric and hybrid vehicles are exempt from certain taxes, such as the Vehicle Ownership or Use Tax. This significantly reduces the ownership and operating costs of these vehicles, making their adoption more attractive.

Financial Incentives: The law provides financial incentives for the acquisition of electric and hybrid vehicles, including direct subsidies and preferential financing. This facilitates the transition to cleaner mobility technologies.

Infrastructure Development: GLMRS promotes the development of charging infrastructure for EVs, ensuring that drivers have access to charging stations in urban and rural areas. This is crucial for the long-term viability of electromobility.

The General Law of Mobility and Road Safety is a significant step towards reducing emissions and promoting sustainable mobility in Mexico. By establishing strict emission regulations and offering incentives for adopting EVs, the law not only improves air quality and reduces negative public health impacts but also positions Mexico as a leader in the transition to cleaner transportation technologies. Effective implementation of this law is essential for meeting domestic and international sustainability and environmental protection goals.

[323] Secretariat of Environment and Natural Resources (SEMARNAT). (2017). General Law on Mobility and Road Safety. Mexico: Official Federal Gazette. Available at: https://www.diputados.gob.mx/LeyesBiblio/pdf/LGMSV.pdf

- **Vehicle Ownership or Use Tax Law** [324]

The Vehicle Ownership or Use Tax Law, initially introduced on 30 December 1980, and last reformed on 31 December 2008, regulates the taxation of motor vehicle owners and users in Mexico. The primary purpose of this tax is to raise necessary funds for the maintenance and development of the economy's road infrastructure, thereby ensuring an efficient and safe transportation network.

The calculation of the vehicle ownership tax is based on several factors, such as the vehicle's cost, year of manufacture, model, version, and line. Taxpayers must pay this tax annually, during the first three months of the year, at authorized offices or through online platforms. For new or imported vehicles, the tax must be paid at the time of initial registration. A notable feature of this law is the complete exemption of the tax for EVs, which serves as a significant incentive for the adoption of cleaner and more sustainable technologies.

In addition to these exemptions, the law allows for certain subsidies and reductions in the tax payment, especially for vehicles that comply with specific environmental standards. This includes not only EVs but also hybrids and other low-emission types of transportation. Thus, the law aims to promote a more modern and less polluting vehicle fleet.

One of the most significant benefits for EV under the law is the exemption from the vehicle ownership tax. This financial incentive encourages owners to opt for EV, significantly reducing ownership and operating costs. This measure benefits not only individual owners but also public transportation companies, prompting them to modernize their fleets by adopting technologies that minimize pollutant emissions and improve air quality in urban areas.

The law also provides additional incentives, such as discounts on other types of taxes and fees related to the ownership and use of EV. These benefits make the acquisition and use of EV more attractive, thereby supporting the transition to more sustainable mobility.

The Vehicle Ownership or Use Tax Law is essential for promoting the transition to electromobility in Mexico. By offering tax exemptions and other incentives for EVs, the law significantly reduces ownership costs, motivating users to choose cleaner and more efficient options. This regulation is crucial for reducing greenhouse gas emissions, aligning with sustainability goals, and improving air quality in cities. The implementation of these exemptions reflects the government's commitment to promoting electric mobility and creating a healthier and eco-friendlier urban environment for all citizens.

8.6.2. Energy Policies Related to the Transition to Electromobility

The document titled "National Electric System Development Program (PRODESEN) 2024-2038," prepared by Mexico's Ministry of Energy[325], includes a series of key initiatives and strategies for the transition towards a more sustainable and efficient energy matrix. These policies focus not only on internal development but also align policy objectives with global commitments such as the UNFCCC, the Paris Agreement, and the 2030 Agenda for Sustainable Development.

[324] Chamber of Deputies of the H. Congress of the Union. (2009). Vehicle Ownership or Use Tax Law. Available at: https://www.diputados.gob.mx.

[325] Secretariat of Energy. (2024). National Electric System Development Program 2024-2038. Mexico: Official Federal Gazette. Available at: https://www.cenace.gob.mx/Docs/16_MARCOREGULATORIO/Prodecen//20%202024-2038%20Cap%C3%ADtulos%201%20al%206.pdf

These international agreements set ambitious goals for stabilizing greenhouse gas concentrations, limiting the increase in global temperature, and promoting sustainable economic development that does not compromise food security or natural ecosystems.

The UNFCCC (signed by the Mexican Government in 1992 and ratified in 1994) and the Paris Agreement (ratified in 2016) are fundamental pillars in the economy's climate policy. These agreements commit Mexico to reducing its greenhouse gas emissions and implementing climate change adaptation measures. The 2030 Agenda, with its 17 SDGs, reinforces these commitments by including specific targets for affordable and sustainable energy access, urgent measures to combat climate change, and the promotion of sustained economic growth. Together, these international frameworks guide local policies towards energy transition and electromobility, highlighting the importance of an integrated and sustainable approach in energy planning and the implementation of clean technologies.
PRODESEN highlights that some of the benefits of using EVs, HEVs, and PHVs for a 300 km trip include energy savings ranging between 40% and 81%. Additionally, there is a significant reduction in GHG emissions, which can range between 39% and 70% compared to an internal combustion vehicle[326]. These benefits underscore the importance of electromobility as an effective solution for meeting the climate and sustainability goals established in the aforementioned international frameworks.

It is important to mention that the annual electricity consumption of mass electric transportation services for passengers, according to PRODESEN 2024-2038, amounts to just over 528 GWh, representing approximately 0.2% of the net consumption of the National Electric System (SEN) in 2023[327].

PRODESEN 2024-2038 has identified the following actions in the 2021-2024 Special Climate Change Program to support the achievement of pollutant emission reduction targets:

- ✓ Develop and publish the National Electric Mobility Strategy: Promote and position electric mobility as a viable and sustainable alternative nationwide to mitigate GHG and black carbon emissions in the transport sector.
- ✓ Include standards, guidelines, criteria, and actions directed at GHG reduction: Integrate these into territorial, urban, and metropolitan planning programs to strengthen resilience in human settlements and territories.
- ✓ Foster the construction of collective transport systems: Collaborate with states and municipalities to support this effort.
- ✓ Promote and implement rail infrastructure projects for passenger transport.
- ✓ Modify the CO_2 emissions standard applicable to new motor vehicles with a gross vehicle weight of up to 3,857 kilograms (NOM-163 SEMARNAT-SCFI-2023).
- ✓ Promote low-carbon public and local freight transport projects: This includes electric mobility initiatives.
- ✓ Reduce CO_2 and other pollutant emissions: Achieve this through the Clean Transport Program.
- ✓ Participate in working groups: Focus on implementing sustainable mobility projects in metropolitan areas in accordance with the National Electric Mobility Strategy, with specific plans to reduce the carbon footprint of commutes.

[326] Secretariat of Energy. (2024). National Electric System Development Program 2024-2038. Mexico: Official Federal Gazette. Available at: https://www.cenace.gob.mx/Docs/16_MARCOREGULATORIO/Prodecen//20%202024-2038%20Cap%C3%ADtulos%201%20al%206.pdf (p.43)

[327] Secretariat of Energy. (2024). National Electric System Development Program 2024-2038. Mexico: Official Federal Gazette. Available at: https://www.cenace.gob.mx/Docs/16_MARCOREGULATORIO/Prodecen//20%202024-2038%20Cap%C3%ADtulos%201%20al%206.pdf (p.45)

- **Energy Saving Program of the Electric Sector (ESPE)**

The Energy Saving Program of the Electric Sector (ESPES) is a business unit established by the Federal Electricity Commission (CFE) in Mexico. Its primary objective is to promote a culture of energy saving and efficient use of electrical energy within CFE installations, its subsidiaries and affiliates, as well as among its customers. ESPES is responsible for evaluating devices, techniques, control systems, and technologies that foster energy savings, thereby contributing to a more efficient and sustainable management of electrical energy in the economy[328].

In this context, the CFE designs and implements public policies that promote the development of the electric mobility market. Among these policies is the Project for the Promotion of Electric Mobility through Investment in Charging Infrastructure. This project is operated by ESPES in collaboration with the Ministry of Energy (SENER) and the Energy Transition and Sustainable Energy Use Fund (FOTEASE). These initiatives aim to strengthen the necessary infrastructure for electric mobility, thereby promoting cleaner and more efficient transportation in Mexico.

Through this project, 100 universal public and free charging stations will be installed in Mexico City, Monterrey, and Guadalajara, the three cities most affected by vehicular pollution in the economy. Additionally, 9 electric corridors will be established across 10 states of the republic, covering regions such as Morelos, Mexico City, State of Mexico, Querétaro, Guanajuato, Jalisco, and Aguascalientes. The northern corridor will extend from McAllen, USA, to Reynosa, Tamaulipas, and will continue through Monterrey, Nuevo León, and Saltillo, Coahuila[329].

Energy Consumption of EVs

Regarding the energy consumption of EVs, HEVs, and PHVs, only 38.5% of the energy used by an internal combustion vehicle is required to cover the same distance. For the year 2024, it is estimated that the energy consumption in this sector will be 246 GWh. However, as the adoption of these vehicles increases, it is projected that consumption will reach 17,988 GWh by the end of the study period (2038), representing 3.6% of the net consumption of the National Electric System (SEN)[330].

The document titled "Towards Public Electromobility in Mexico," prepared by ECLAC[331], lists the main issues of current business models for electric buses (see Table 18). Among these issues, one related to energy is highlighted, specifically the projections of energy demand that could affect the operability of the fleets. This challenge underscores the need for proper energy planning to ensure that charging infrastructure and energy supply are sufficient to support the expansion and continuous operation of electric bus fleets. In view of the aforementioned, PRODESEN indicates that this charging infrastructure must be safe for both users and vehicles.

Norms Promoting or Accelerating the Transition to Electromobility in Mexico

To address climate change and promote sustainable development, Mexico has implemented various key regulations that govern vehicle emissions and encourage the use of clean technologies. Among these regulations are the creation of the Special Program on Climate Change 2021-2024 (PECC) and the NOM-163-SEMARNAT-SCFI-

[328] https://www.cfe.mx/paese/pages/paese.aspx
[329] Secretariat of Energy. (2024). National Electric System Development Program 2024-2038. Mexico: Official Federal Gazette. Available at: https://www.cenace.gob.mx/Paginas/SIM/Prodesen.aspx (p.72).
[330] Secretariat of Energy. (2024). National Electric System Development Program 2024-2038. Mexico: Official Federal Gazette. Available at: https://www.cenace.gob.mx/Paginas/SIM/Prodesen.aspx (p.74).
[331] Carrillo, J., de los Santos Gómez, J. S., & Briones, J. (2020). Towards Public Electromobility in Mexico. Economic Commission for Latin America and the Caribbean (ECLAC). Available at: https://repositorio.cepal.org/server/api/core/bitstreams/a9f6dc15-7e04-4d75-b676-b131e99b3c44/content

2023. These standards establish specific strategies and actions to reduce greenhouse gas emissions and improve vehicle efficiency. Below are the features and roles of these regulations in promoting electromobility in the economy.

- **Special Program on Climate Change 2021-2024 (SPCC)[332]**

The Special Program on Climate Change 2021-2024 (SPCC), developed by the Secretariat of Environment and Natural Resources (SEMARNAT), constitutes a comprehensive response from Mexico to the global challenges of climate change. This document is based on the National Development Plan 2019-2024 and is framed within the General Climate Change Law, thus providing a regulatory guide for the economy's environmental public policies. Through the PECC, Mexico aims not only to meet its international commitments but also to promote a transition toward a greener and more sustainable economy.

Table 18. Main Problems of Current Business Models in Mexico

Activity	Type of System	Current Business Model	In the case of Electric Buses
Land for Infrastructure Construction	Structured	Provided by local government	Local governments have access to land for building charging infrastructure. Private companies do not have access to the same land.
	Semi-structured and unstructured	If available, provided by local government	
Charging Infrastructure	Structured	Funded by local government	Private operators and the government are unfamiliar with this type of infrastructure, which is much more expensive than the current one. There is no available funding for its construction, but the government has more financial backing than private operators.
	Semi-structured and unstructured	Funded by private operators	
Bus Ownership	Structured	Funded by local government	Electric buses are more expensive, and neither private operators nor the government has the funds to pay for them. However, the government has more financial backing.
	Semi-structured and unstructured	Funded by private operators	
Maintenance	Structured	Directly managed by local government	Maintenance depends on the responsible authorities that own the vehicles, ensuring it is regulated and compliance is maintained.
	Semi-structured and unstructured	Directly managed by private operators	Maintenance becomes crucial due to the high cost of buses. However, due to the absence of contracts and unfamiliarity with the new technology, private operators are not obliged to provide maintenance.
Energy Provision	Structured	Managed by local government	The implementation of electric buses introduces new energy needs that did not previously exist.
	Semi-structured and unstructured	Managed by private operators	

332 Secretariat of Environment and Natural Resources. (2021). Special Climate Change Program 2021-2024. Official Federal Gazette. Available at: https://dof.gob.mx/2021/SEMARNAT/SEMARNAT_081121_EV.pdf

Activity	Type of System	Current Business Model	In the case of Electric Buses
Service Planning	Structured	Managed by local government	If service planning needs to change, the process is straightforward because it depends on the public sector.
	Semi-structured and unstructured	Generally managed by the operators	Implementing any kind of improvement in planning is difficult.
Revenue Collection	Structured	Managed by an external agent	If new actors are integrated into the system, the distribution of profits is easy because it is managed by a centralized external agent.
	Semi-structured and unstructured	Managed by private operators	If new actors are integrated into the system, revenue distribution becomes impossible because each bus collects its own profits.

Source: Carrillo, J., de los Santos Gómez, J. S., & Briones, J. (2020). *Towards Public Electromobility in Mexico*

The SPCC is supported by various key regulations in the economy, including: i) the Political Constitution of the United Mexican States, ii) the Planning Law, iii) the General Climate Change Law, iv) the Electric Industry Law, and v) the Energy Transition Law. These laws provide the legal framework necessary for the development and execution of public policies aimed at mitigating climate change. By relying on these regulations, the PECC ensures that the strategies implemented have a solid legal backing, which is crucial for their effectiveness and long-term sustainability.

The document presents a thorough analysis of the current state of climate change in Mexico, highlighting the economy's vulnerability due to its geographical and socio-economic characteristics. Adverse effects of climate change are noted, such as temperature increases, variability in precipitation, and impacts on biodiversity and food security. This analysis not only provides a clear diagnosis of the current situation but also justifies the urgency of the measures proposed in the SPCC.

The SPCC establishes four priority objectives:

Decrease Vulnerability to Climate Change: This objective aims to protect the population, ecosystems, and strategic infrastructure from the adverse effects of climate change.

Reduce Greenhouse Gas Emissions: The goal here is to foster development with social well-being and low carbon emissions, which is essential for meeting Mexico's international commitments.

Promote Synergistic Actions and Policies: This involves promoting measures that simultaneously mitigate and adapt to climate change, optimizing resources and efforts.

Strengthen Coordination, Financing, and Implementation Mechanisms: This objective focuses on improving cooperation among different levels of government and securing the resources needed for implementing climate policies.
To achieve these objectives, the PECC proposes several specific strategies and actions. These include:

Promotion of Emission Reduction Standards and Criteria: This aims to incorporate these elements into land use and urban planning programs to enhance the resilience of human settlements.

Encouragement of the Construction of Collective and Railway Transport Systems: These infrastructures are crucial for reducing emissions in the transport sector.

Modification of Vehicle Emission Regulations: Specifically, the modification of NOM-163-SEMARNAT-SCFI-2023 for light vehicles.

Promotion of Low-Carbon Public and Local Freight Transport Projects: Including electric mobility initiatives that contribute to reducing CO_2 emissions.

SPCC plays a crucial role in Mexico's transition to electromobility by setting stricter standards for vehicle emissions and promoting the use of clean technologies. This program encourages the adoption of electric and hybrid vehicles and is complemented by the development of charging infrastructure and electric transportation systems, creating a favorable environment for sustainable mobility. These measures not only contribute to reducing greenhouse gas emissions but also support sustainable and resilient economic development. In particular, SPCC highlights the importance of adequate energy planning to ensure that charging infrastructure and energy supply are sufficient to support the expansion and ongoing operation of electric bus fleets. With projections including the installation of approximately 21,799 charging stations by 2038, the program prioritizes the need for safe and efficient infrastructure. Collectively, these actions reflect Mexico's significant commitment to the development of electromobility and the reduction of its carbon footprint.

In conclusion, the SPCC represents a comprehensive and multifaceted effort to address climate change in Mexico. Through a focus on clear objectives and well-defined strategies, the SPCC not only seeks to mitigate the effects of climate change but also to adapt to its inevitable impacts. In the context of electromobility, this program is essential for creating a regulatory and operational environment that promotes the use of cleaner and more sustainable transportation technologies, thus aligning Mexico with best international practices and contributing significantly to the global fight against climate change.

- **NOM-163-SEMARNAT-SCFI-2023**[333]

The NOM-163-SEMARNAT-SCFI-2023, published in the Official Federal Gazette, establishes the parameters and methodology for calculating CO_2 emissions from the exhaust of new motor vehicles with a gross vehicle weight of up to 3,857 kilograms. This standard aims to reduce CO_2 emissions from new LDV, aligning with Mexico's international climate change commitments, such as the UNFCCC and the Paris Agreement.

The standard applies to a variety of vehicles, including those using gasoline, diesel, and alternative fuels, as well as hybrid, PHEV, extended-range, and fuel cell vehicles. Corporations must comply with the established CO_2 emission limits and report their data annually, using specific methodologies to calculate the corporate fleet's weighted average emissions. The regulation also includes provisions for generating and transferring credits for introducing technologies that improve fuel efficiency and reduce emissions.

Key specifications of the standard include vehicle classification based on the area between the tires, the methodology for calculating CO_2 emissions per Km, and the procedures for assessing compliance. Additionally, it includes mechanisms for

[333] Secretariat of Environment and Natural Resources (2024). NOM-163-SEMARNAT-SCFI-2023. Official Federal Gazette. Available at: https://www.dof.gob.mx/nota_detalle.php?codigo=5713555&fecha=03/01/2024

compensation and credit transfer between corporations, thereby incentivizing compliance and the adoption of clean technologies.

The role of this standard in the transition to electromobility is significant; by imposing strict CO_2 emission limits, NOM-163-SEMARNAT-SCFI-2023 promotes the adoption of electric and hybrid vehicles, which have lower or zero emissions compared to internal combustion vehicles. The standard also encourages the incorporation of advanced technologies in new vehicles, facilitating the transition to a cleaner and more efficient vehicle fleet.

8.6.3. Specific Electromobility Policies

Considerations on the National Electromobility Program[334]

The document titled "Towards Public Electromobility in Mexico," prepared by the Economic Commission for Latin America and the Caribbean (ECLAC), highlights the importance of establishing an electromobility development program in the economy. This program should include strategies and actions aimed at promoting the use of electric buses in urban areas as an efficient and eco-friendly means of transportation, which not only improves citizens' quality of life but also significantly contributes to the reduction of pollutants produced by fossil fuels. Additionally, the program should position Mexico as a leading manufacturer of electric buses as well as energy storage and charging equipment.

In line with these objectives, it is essential that the National Electromobility Program (NEP) outlines a set of specific goals and corresponding strategies around four fundamental axes. The first is promoting the adoption of electromobility, encouraging both users and companies to opt for electric transportation solutions. The second axis focuses on developing a robust industry of electric buses and energy storage and charging equipment, fostering innovation and domestic production. The third axis addresses the need for effective coordination and communication among the various institutions involved, ensuring coherent and collaborative implementation of the program. Finally, the fourth axis refers to establishing clear goals and precise indicators to evaluate the progress and impact of the program, ensuring its effectiveness and long-term sustainability.

Table 19. Axes and Lines of Action of PNE

Axis	Objective	Action Line
Axis 1. Promotion of Electromobility Adoption Establishment of Gradual Parameters to Reduce Environmental Impact from Urban Transport	Accelerate the reduction of environmental contaminants from public transport by updating existing diesel-based transport standards and/or generating new, specific standards for public transportation, in line with international parameters and mandatory compliance monitoring.	Action Line 1: Definition and/or modification of energy efficiency standards with gradual increases for public transport.
		Action Line 2: Gradual establishment of stricter air quality guidelines for maximum emissions into the environment.
		Action Line 3: Establishment of normative instruments to ensure compliance with energy efficiency and air quality standards.
		Action Line 4: Development of a phased plan to replace diesel combustion units with electric technology in public transport, considering projections and impact

[334] Carrillo, J., de los Santos Gómez, J. S., & Briones, J. (2020). Towards Public Electromobility in Mexico. Economic Commission for Latin America and the Caribbean (ECLAC). Available at: https://repositorio.cepal.org/server/api/core/bitstreams/a9f6dc15-7e04-4d75-b676-b131e99b3c44/content

Axis	Objective	Action Line
		assessments to exceed 40% of the total units within 10 years.
Development of Electric Charging Infrastructure	Ensure the availability of electric charging infrastructure for the operation and supply of electric urban buses in major metropolitan areas, based on the projected number of operational units (Monterrey, Guadalajara, and the Mexico City Valley).	Action Line 1: Planning of a network of strategic locations for the installation of electric charging stations in corridors and overnight facilities.
		Action Line 2: Installation of charging stations by the federal government for supplying electric energy to buses.
Incentive Schemes to Promote the Use of Electric Public Transport Units	Boost the use of electric buses through incentive schemes that mitigate the initial high cost of electric units for mass adoption, offering various alternatives for conversion, importation of used electric buses, and/or acquisition of new units.	Action Line 1: Provision of free and/or subsidized electric energy for charging electric buses for a decade in the metropolitan areas of Monterrey, Guadalajara, and the Mexico City Valley, with a possible gradual reduction of the subsidy over time.
		Action Line 2: Develop a federal scheme to facilitate the importation of electric buses with zero tariffs.
		Action Line 3: Design a soft financing program for the purchase of new electric buses.
Axis 2: Promotion of the Electric Bus Industry and Energy Storage and Charging Equipment (The manufacturing and assembly strategy for these units should focus on producing units for both export and domestic market consumption) Promote the Manufacturing and Conversion of Electric Buses in the Economy	Promote the Manufacturing and Conversion of Electric Buses in the Economy	Action Line 1: Develop an automotive sector promotion program focused on the manufacturing of electric buses, which allows for the importation of various goods with a preferential ad-valorem tariff for incorporation and use in the production process.
		Action Line 2: Establish a federal subsidy scheme for private bus operators to convert diesel units to electric within the economy. This program should provide a "Federal Bonus," potentially saving up to 50% compared to the purchase of new units, for diesel-to-electric conversions with a lifespan of a decade and economic viability.
Development of Training and Specialized Technical Education Programs	Foster the development of skills within the industry through academic programs and specialized technical training in electric mobility, to support the long-term growth of the industry.	Action Line 1: Review and update the curricula in engineering programs at universities, as well as at the higher technical level, to strengthen topics related to electric mobility.
		Action Line 2: Develop specialized training programs for operational staff in the industry to facilitate the technological adoption of electric mobility.
		Action Line 3: Create a certification program for competencies in the maintenance and repair of EVs.
		Action Line 4: Develop a certification program for competencies in the

Axis	Objective	Action Line
		systems and charging stations for EVs.
		Action Line 5: Establish a certification program for competencies in the manufacturing of EVs.
Promotion of Investment	Domestic and foreign investment plays a crucial role as a driver for the development of the automotive industry in Mexico, which is characterized by its high export dynamism. Therefore, it is necessary to align investment promotion policies with the objective of developing a national industry for the manufacturing and assembly of EVs.	Action Line 1: Promote strategic domestic and foreign investment in the uncovered segments of the production chain for the manufacturing and assembly of electric buses. This includes the production of electric motors and generators, accumulators, charge inverters, and charging ports. This will be achieved by including special incentives in the automotive decree for the installation of companies manufacturing components for electric buses and coordinating with federal entities to facilitate the installation and operational start-up processes (softlanding).
Research and Development Applied to Electromobility	Direct research efforts towards promoting the development of electromobility in the economy, leveraging the base of both private and public research centers.	Action Line 1: Prioritize the allocation of existing funds to technological development projects in electric technologies, particularly focusing on research and development in key component areas such as batteries, accumulators, and inverters, among others.
		Action Line 2: Prioritize the provision of scholarships for the training of specialized human resources in research and development in electric technologies.
Axis 3: Interinstitutional Coordination and Communication Design an Interinstitutional Governance Structure for Managing the Electromobility Program	Establish an entity responsible for coordinating and advancing the strategic axes outlined in the development plan and ensuring compliance with performance metrics.	Action Line 1: Form a public-private coordination body to manage the interinstitutional agenda and ensure the proper implementation of projects and actions derived from it.
		Action Line 2: Establish communication channels and discussion forums among public and private stakeholders to facilitate the deployment of this technology in the economy, and develop public awareness campaigns to promote the concept and benefits of electromobility.

Source: Carrillo, J., de los Santos Gómez, J. S., & Briones, J. (2020). *Towards Public Electromobility in Mexico*

The Axis 4, titled "Indicators or Impact Goals of the Program," establishes objectives for the three metropolitan areas collectively, with a long-term horizon of 10 to 20 years. It proposes conducting periodic measurements to evaluate the progress and impact of the program, as detailed in the following table.

Table 20. Axes and Lines of Action of PNE

Indicator	Description	Suggested Target
Black Carbon and GHG Emissions	This indicator assesses the reduction of black carbon and GHG emissions generated by transportation, in line with Mexico's Nationally Determined Contribution (NDC) submitted to the United Nations on 27 March 2015. This contribution represents Mexico's commitment to the global agreement from the Paris Climate Summit. The targets are based on unconditioned trend scenarios. The replacement of converted electric units and the acquisition of new units could help achieve the proposed goals.	52,000 Mt of black carbon by 2025 58,000 Mt of black carbon by 2030 237 $MtCO_2e$ of GHG by 2025 266 $MtCO_2e$ of GHG by 2030
Industrialization	Create the conditions for the development of a industry for the manufacturing and conversion of electric buses.	Within 10 years, 50% of all electric buses are to be manufactured domestically. Additionally, 42.64% of the total bus fleet in operation is to be replaced.
Manufacturing employment	Conditions are created to maintain the automotive sector's labor base and generate new jobs.	There is sufficient qualified personnel available for the manufacturing process of units and the supply chain.
Technical Operation Employment	Generate conditions to increase the number of technical jobs in the areas of driving, maintenance, conversion, and services for units.	Technical staff is certified based on labor competencies. Sufficient experienced personnel will be available within 10 years to drive, maintain, and convert electric units.
Infrastructure / Charging Stations	Fast-charging stations are installed along the operational routes of the units in the three metropolitan areas.	In 10 years, a sufficient network is available to meet the charging needs; the energy source for these stations is clean.
Supply Chains	Development of a supply base that addresses the manufacturing of parts and components for electric buses, as well as support services, and includes suppliers from industries such as metalworking, plastics, automotive, auto parts, and chemicals.	60% local content in 5 years 80% local content in 10 years
Public Health	Expected Outcome: • Effects on the Central Nervous System: Reduction in headaches and anxiety associated with PM. • Cardiovascular Diseases: Decrease in cases linked to SO_2, PM, and O_3. • Reproductive System Effects: Mitigation of issues caused by PM. • Respiratory Problems: Reduction in conditions related to sulfur dioxide (SO_2), PM, benzo[a]pyrene (BaP), NO_2, and O_3. • Lung Cancer: Lower incidence of lung cancer associated with PM and benzo[a]pyrene (BaP). • COPD: Decrease in cases related to PM.	Goal to be specified by the relevant authority.

Indicator	Description	Suggested Target
	• Effects on the Liver, Spleen, and Blood: Reduction in health impacts related to NO_2. Source: WHO, EEA (European Environment Agency).	
Noise	Noise generated by public transportation from buses is reduced in the transit corridors of electric buses.	In 10 years, noise generated by public transportation from buses is significantly reduced, particularly in designated corridors. (Target to be specified by the relevant authority.)

Source: Carrillo, J., de los Santos Gómez, J. S., & Briones, J. (2020). *Towards public electromobility in Mexico.*

The program emphasizes the need for significant support from the federal government and legislative power for the transition to electromobility, especially in the Mexico City Metropolitan Area, where the highest number of transit units is concentrated, most of which are operated by private entities. The policy should focus on significantly reducing environmental emissions and promoting the development of a electric bus industry.

Among the proposed alternatives, the development of an export-oriented manufacturing industry and the conversion of units for the domestic market stand out, as well as a technological innovation program to improve and reduce the costs of technologies associated with electric buses.

National Electric Mobility Strategy (NEMS)[335]

The National Electric Mobility Strategy (NEMS) of Mexico is a comprehensive initiative developed by SEMARNAT with the goal of promoting the adoption of electric transportation technologies. This strategy is crucial for meeting Mexico's international environmental commitments, including those set forth in the Paris Agreement. The NEMS aims to reduce greenhouse gas emissions and improve air quality in urban areas, thereby contributing to sustainable development and the modernization of the economy's transportation system.

The NEMS seeks to establish the environmental, technical, technological, financial, legal, institutional, and administrative foundations and guidelines to position electric mobility at the local level. Its purpose is to provide a viable and sustainable alternative that significantly contributes to the reduction of GHG emissions and other pollutants. Its specific objectives include:

• **Emission Reduction:** Contributing to meeting the greenhouse gas emission reduction targets established in the General Climate Change Law, in accordance with the Nationally Determined Contributions as part of the Paris Agreement.

• **Air Quality:** Reducing pollution from internal combustion vehicles to improve air quality as a result of reducing atmospheric emissions that directly impact public health.

• **Energy Consumption Optimization:** Strategically leveraging existing mobility systems to optimize energy consumption and promote the use of energy from renewable sources.

The NEMS is organized into four sectoral axes and four transversal axes, comprising a total of 64 short-term actions, 28 medium-term actions, and 9 long-term actions.

[335] Secretariat of Environment and Natural Resources (SEMARNAT). (2023). Agreement Issuing the National Electromobility Strategy. Official Federal Gazette. Available at: https://www.cofemersimir.gob.mx/portales/resumen/55366

Sectoral Axes:

1. Promotion of Electric Public Transportation for Sustainable Urban Mobility.
2. Promotion of the Integration of EVs in Freight Transport.
3. Promotion of the Market for Light EVs and Motorcycles.
4. Promotion of the Market for Alternative Electric Mobility.

Transversal Axes:

1. Standardization and Promotion of Strategic Infrastructure for the Charging Network.
2. Strengthening Interinstitutional and Multiactor Coordination.
3. Promotion of Research and Development for an Industry in Mexico and Human Capital in Electric Mobility.
4. Management of Communication and Dissemination.

The ENME aligns with the Glasgow Climate Pact of COP26 and sets key aspirational goals:

Table 21. Goals for 2030, 2040, and 2050 of the NEMS

Goal	2030	2040	2050
Vehicle Sales	50% of light and heavy vehicles will be zero-emission units, consisting of electric and PHEV.	100% of light and heavy vehicle sales and passenger vehicles will be electric or PHEV.	100% of light and heavy vehicle sales and passenger vehicles will be EVs.
Emission Reduction	30 MMT of accumulated CO_2 equivalent, thanks to the introduction of at least 7 million light vehicles (21.3 $MtCO_2e$) and 338,000 heavy vehicles (2.8 $MtCO_2e$ for electric buses and 5.8 $MtCO_2e$ for electric freight vehicles).	129 MMT of accumulated CO_2e, thanks to the additional introduction to the 2030 fleet of 22 million light vehicles (75.8 $MtCO_2e$) and 894,000 heavy vehicles (7.6 $MtCO_2e$ for electric buses and 15.3 $MtCO_2e$ for electric freight vehicles).	272 MMT of accumulated CO_2e, thanks to the additional introduction to the 2040 fleet of 31 million light vehicles (117 $MtCO_2e$) and 987,000 heavy vehicles (8.4 $MtCO_2e$ for electric buses and 17 MtCO2e for electric freight vehicles).
Public Transport Integration	Development of a public electric charging system for light and heavy vehicles, both in cities and on major roads.	Sufficient, open, and homologated electric chargers on federal highways for light and heavy vehicles.	
Charging Infrastructure	Development of a public electric charging system for light and heavy vehicles, both in cities and on major roads.	Sufficient, open, and homologated electric chargers on federal highways for light and heavy vehicles.	
Normativity	Promulgation of regulations for the standardization of electric chargers.		

Source: Secretariat of Environment and Natural Resources (SEMARNAT). (2023). Agreement Issuing the National Electromobility Strategy.

NEMS aligns with various strategic policies, such as the Sonora Sustainable Energy Plan and the General Law on Mobility and Road Safety (LGMSV), which seek to integrate electric mobility within Mexico's sustainable development objectives. Additionally, the strategy recognizes the importance of lithium as a strategic resource for battery manufacturing and promotes its sustainable utilization through the "Litio para México" organization.

Internationally, NEMS responds to global commitments such as the Paris Agreement and the Driving Change Together Declaration, signed at COP 24. These agreements underscore the need to transition to a sustainable and emission-free transportation system to mitigate the effects of climate change.

The implementation of the ENME promises multiple environmental, social, and economic benefits:

Environmental: The reduction of GHG emissions and criteria pollutants will significantly improve air quality in cities, contributing to the fight against climate change.

Social: The electrification of public transport will make transportation systems more accessible and equitable, improving the quality of life for citizens, especially in densely populated urban areas.

Economic: The development of a EV industry will generate employment and promote technological innovation, positioning Mexico as a leader in clean technology manufacturing.

NEMS is an ambitious and multifaceted strategy that addresses the challenges of electric mobility from a comprehensive perspective. Its success will depend on the collaboration between the government, private industry, and civil society, as well as the effective implementation of its strategic axes. Creating adequate charging infrastructure, promoting research and development, and adopting inclusive and accessible policies are essential for achieving an orderly and equitable transition to sustainable mobility.

Furthermore, ENMS stands out for its focus on energy and technological sovereignty, which is crucial for reducing dependency on fossil fuels and strengthening Mexico's autonomy in the energy sector. The strategy also emphasizes the importance of social justice in the transition to electric mobility, ensuring that the benefits are accessible to the entire population.

According to Hernandez-Nochebuena, M. A. (2024), in his presentation titled "Incentives for Electromobility," delivered during the workshop "Electromobility Towards a Sustainable and Safe Mobility," in Mexico, there are various incentives aimed at promoting electromobility, which are applied at different levels of government: federal, regional, and local. These incentives include fiscal, financial, and infrastructure measures that seek to facilitate the adoption of EVs and the development of the necessary infrastructure. The incentives are designed to accelerate the transition towards more sustainable mobility, benefiting businesses and citizens who invest in clean technologies and the infrastructure that supports this shift.

Infrastructure Incentives

Mexico has implemented a series of incentives focused on developing charging infrastructure, considered the backbone of any electromobility system. One of the main incentives is the 30% tax credit on the total amount of investments made in EV charging infrastructure during the fiscal year, as stipulated in Article 204 of Chapter XI of the Income Tax Law. This credit is applicable as long as the charging equipment is connected and permanently installed in public spaces.

This incentive has been fundamental in establishing the necessary foundation for both the government and businesses to develop charging infrastructure at the local level. The measure aims not only to promote the greater installation of charging stations but also to ensure that these facilities are accessible in public spaces, facilitating their use and encouraging the adoption of EVs in Mexico.

Fiscal Incentives

Mexico has implemented a series of fiscal incentives designed to promote the adoption of EVs and the development of the necessary infrastructure to support this transition to electromobility. These incentives apply at different levels of government, ranging from federal measures to specific benefits in certain regions and states.

Federal Fiscal Incentives

At the federal level, one of the main fiscal incentives is the exemption of import duties for battery-electric and hydrogen fuel cell vehicles. This exemption applies to vehicles priced up to 1,121,873 Mexican pesos (approximately USD65,000). The applicable tariffs on different types of EVs are:

i) **EVs for transporting more than ten people (vans):** A 20% import duty is applied, compared to the 50% imposed on non-electric vehicles in this category.

ii) **Light vehicles with electric motors:** These vehicles are subject to a 15% import duty, while non-electric light vehicles face a 50% duty.

iii) **EVs for transporting goods:** These vehicles also benefit from a reduced 15% import duty, compared to the 50% applied to non-electric vehicles in the same category.

This means that EVs benefit from significantly lower import duties compared to their non-electric counterparts, reducing the cost of importing them and thereby acting as a direct incentive for businesses and consumers to opt for EVs. This differential in tariff rates is a clear incentive to promote the transition to more sustainable and environmentally friendly vehicles, making electric vehicles financially more attractive compared to fossil fuel-powered vehicles.

Regional Fiscal Incentives

In certain strategic regions, the Mexican government has established additional fiscal incentives to foster the development of electromobility. A notable example is the Interoceanic Corridor of the Isthmus of Tehuantepec, a key region for the development of charging infrastructure and EV manufacturing. The incentives in this region include:

i) **Value Added Tax (VAT):** Operations within the development hubs and between them are exempt from VAT for the first four years. Additionally, VAT paid on purchases outside the hubs can be recovered.

ii) **Income Tax (ISR):** A 100% ISR discount during the first three years of operation, and 50% in the following three years. If employment targets are exceeded, the discount can reach up to 90%.

These incentives aim to attract industries related to electromobility, from EV manufacturing to the construction of the necessary infrastructure.

Local Fiscal Incentives

At the local level, several states have implemented specific incentives to promote electromobility. Some examples include:

i) **Mexico City (CDMX):** EVs and some hybrids can access preferential rates for the use of urban and interurban roads. Additionally, these vehicles are exempt from certain local taxes, such as vehicle ownership taxes and other fees.

ii) **Jalisco:** Hybrid vehicles receive a 50% discount on taxes established in the Revenue Law, while EVs are completely exempt from these payments.

iii) **Nuevo León:** A reduction of up to 95% in the Payroll Tax (ISN) is offered to assembly companies in the electromobility sector and 70% for direct suppliers of these companies. This incentive is designed to attract new businesses to the region.

iv) **Yucatán:** In this region, an immediate deduction of 100% of investments in new fixed assets used in development hubs is allowed for six fiscal years, incentivizing the installation of new infrastructure related to electromobility.

Financial Incentives

Mexico has implemented several financial incentives to support the transition to electromobility, targeting both businesses and individuals. These incentives are designed to reduce the costs associated with adopting EVs and to encourage the development of the necessary infrastructure to support this transition. Below are some of the main financial incentives available:

Scrappage Bonus

One of the most notable incentives is the Scrappage Bonus, a financial aid primarily aimed at the public transport sector. This incentive applies to the replacement of old and polluting vehicles with hybrid or electric taxis, with the goal of renewing the fleet and reducing emissions. Depending on the type of vehicle and technology adopted, the bonus covers between 10% and 20% of the final cost of the new vehicle. Specifically, the financial support is distributed as follows:

- ✓ Hybrid taxi: MXN70,000 (approximately USD3,600).
- ✓ Electric taxi: MXN175,000 (approximately USD9,000).

This incentive has been widely used by transportation platforms such as Uber, which have collaborated with automotive companies to introduce EV fleets into their operations, thus facilitating a faster transition to more sustainable mobility.

NAFIN Sustainable Fund

The "Sustainable Fund of Nacional Financiera" (NAFIN) is another key instrument that Mexico has launched to support sustainable development in the economy. This public trust is designed to receive and distribute non-reimbursable resources aimed at projects that contribute to sustainable development, including those related to electromobility. The fund is open to federal institutions, as well as other agencies and entities of the Federal Public Administration, and even the private sector.

The fund is characterized by an agile, transparent, reliable, and competitive approach, ensuring that resources are used efficiently and effectively. Additionally, it provides support throughout the entire project lifecycle, from planning to implementation, facilitating the development of electromobility projects across the economy.

8.6.3.1. Bus Contracting Models for Electromobility

First Financial Model for E-buses

The first financial model for the transition to electromobility in Mexico City's Metrobus System was designed to separate the operation of the fleet from the ownership of the vehicles and charging infrastructure. Under this scheme, the company ENGIE was responsible for providing the electric bus fleet and the charging infrastructure at the depot through a leasing contract, while the concessionaire MIVSA assumed the daily operating costs. This model allowed for the mitigation of financial risks associated with the direct acquisition of vehicles and infrastructure, while ensuring the project's economic viability.

Financial Results Analysis

The financial results of the first model implemented in Mexico City's Metrobus System were highly positive, demonstrating the economic viability of the transition to electromobility. The analysis of the Total Cost of Ownership (TCO) for a 10-year project revealed that using electric buses is 19% cheaper compared to traditional diesel buses. This savings is further expanded over a 15-year horizon, where electric buses are 33% cheaper than their diesel equivalents. Additionally, significant savings were achieved in fuel costs, estimated at 75%, and maintenance costs, which were reduced by approximately 30%.

Operational Results of the Electric Fleet

The operational results of the implementation of the electric fleet in Mexico City's Metrobus System were equally impressive. The electric buses demonstrated an average energy consumption of 0.9 kWh per kilometer, resulting in efficient and sustainable operation. With a projected range of 330 kilometers, the buses traveled an average of 247 kilometers per day, using only 44% of the total battery capacity—performance that exceeded initial expectations. Furthermore, 40% energy regeneration was achieved, contributing to extending the range and improving energy efficiency. This operational performance allowed the buses to operate for 19 hours per day, with a recharge time of only 3 hours, ensuring continuous and reliable service for users.

Final Financial Model

The final financial model for the transition to electromobility in Mexico City's Metrobus System was refined to ensure the project's long-term sustainability. One of the key elements was the extension of the concession to 15 years, which allowed the operating company to obtain more favorable financing conditions for the acquisition of electric buses, in this case, Yutong buses, under a financial scheme specifically designed to facilitate investment. Additionally, the charging infrastructure was managed through a leasing contract with Enel X, separating the ownership of the assets from daily operations, thereby reducing financial and operational risks.

8.6.4. Success Cases

The transition to electromobility in Mexico has been driven by a series of initiatives and programs known for their effectiveness and ability to promote the use of EVs in the economy. These initiatives not only address the need to reduce greenhouse gas emissions but also aim to improve air quality and encourage the adoption of cleaner and more sustainable transportation technologies. Below are some of the most relevant success stories that have significantly contributed to this transition.

EcoTag TeleVía

The EcoTag TeleVía is an electronic device that offers benefits for EV users in Mexico. This tag allows drivers of electric and hybrid vehicles to obtain significant discounts on urban highway tolls, thereby promoting the use of cleaner and more efficient vehicles. This system not only facilitates more economical transit for users but also contributes to reducing greenhouse gas emissions by incentivizing the use of sustainable mobility technologies[336]. Since the inception of this program, over 3,000 EcoTags have been issued, resulting in more than 1 million trips and preventing the emission of over 22 Mt of CO_2 into the atmosphere. This system not only makes transit more economical for users but also significantly contributes to the reduction of greenhouse gas emissions by promoting the use of sustainable mobility technologies.[337]

"Today No Circulate" Program

The "Today No Circulate" program implemented in Mexico City is another significant example. This program restricts vehicle circulation based on their emission levels and day of the week but exempts electric and hybrid vehicles from these restrictions. By doing so, it encourages the adoption of EV by offering direct benefits such as free circulation every day of the week[338]. This program presents multiple environmental and social benefits. In terms of emission reductions, the program is estimated to decrease CO_2 emissions by 5,732 Mt per day, CO by 269 Mt per day, NOx by 17 Mt per day, and PM10 particles by 2.32 Mt per day. Additionally, it reduces gasoline consumption by 5%, which also contributes to lower pollutant emissions. The temporary improvement in road conditions, by reducing the number of vehicles in circulation, decreases congestion and travel times. The program also promotes greater environmental awareness among citizens, encouraging the use of public transportation and other sustainable mobility alternatives, thereby reinforcing the importance of emission reduction and environmental protection[339].

Metrobús Electric Mobility Plan[340]

The Metrobus of Mexico City represents one of the greatest achievements in the implementation of electromobility in the economy. Line 3 of the Metrobus is completely electric, operating along a 330-kilometer route with a fleet of 60 buses equipped with 130 kWh batteries. This line transports over 190,000 passengers daily, underscoring its importance in the city's public transportation system. To support this operation, a robust charging infrastructure has been developed at the Júpiter Depot, which includes 6.5 MW of installed power and a set of high-capacity chargers: 20 chargers of 180 kW and 12 chargers of 150 kW. This infrastructure is essential to ensure the continuous and efficient operation of the electric buses, contributing significantly to emission reductions in the capital.

The Metrobus System of Mexico City is a mass public transport network that plays a crucial role in the urban mobility of the Mexican capital. Currently, the system has 7 operational lines, in addition to emergency services, extending over 164 kilometers of exclusive lanes. Along these lines, there are 280 bus stops that serve a fleet of 850 buses of different types.

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336 https://www.televia.com.mx/Media/Default/docs/BasesyCondicionesEcoTAGTeleV%C3%ADa.pdf
337 https://www.movilidad3.com.mx/2023/11/03/ecotag-televia-fomenta-la-sostenibilidad-ambiental/
338 https://sedema.cdmx.gob.mx/programas/programa/hoy-no-circula
339 Riveros Rotgé, H. G. (2009). Analysis of the "Today No Circulate" Program. Ciencia, January-March, 76-83. Faculty of Sciences, National Autonomous University of Mexico. Available at: https://www.fisica.unam.mx/personales/hgriveros/docu/10-HoyNoCircula.299122533.pdf
340 The information was extracted from the following presentation: Castro Escorcia, R. (2024). *Electromobility Towards Sustainable and Safe Mobility. Public Fleet Tender Schemes*. Workshop "*Electromobility Towards a Sustainable and Safe Mobility,*" Lima Convention Center, San Borja, Lima, Peru.

The Metrobus transports 1.8 million passengers on an average workday, consolidating itself as an essential component of the city's public transportation infrastructure. This system has undergone significant evolution, from an operation based on high-emission, low-capacity vehicles to a modern and regulated model where low-emission vehicles (Euro III, IV, V, and VI) predominate, including hybrid and electric buses.

The Metrobus System of Mexico City operates in conjunction with 17 concessionary companies, which are distributed along its different lines. These companies are responsible for managing and operating the buses on their respective routes, ensuring compliance with the service standards and regulations established by the system. The concessionaires include:

- Line 1: CISA, RECSA, RTP, VYCSA.
- Line 2: CE4-17M, COPSA, CTTSA, TSAJJ, RTP.
- Line 3: MIVSA.
- Line 4: CCA, COPATTSA.
- Line 5: CITEMSA, RTP.
- Line 6: CARSA, CURVIX, CE4-17M.
- Line 7: OL7, SKYBUS.

The Metrobus fleet is composed of a variety of vehicles designed to meet the diverse mobility needs of the city. Currently, the fleet includes 171 bi-articulated buses, which allow for high passenger capacity, crucial on routes with higher demand. Additionally, the system has 385 articulated buses, which are also used on the main lines due to their large capacity and efficiency.

A notable aspect of the fleet is the incorporation of 90 double-decker buses, offering an efficient solution to maximize capacity on certain routes. Additionally, 49 low-floor 12-meter buses have been included, suitable for routes with lower demand or that require improved accessibility. As part of its progress towards electromobility, the Metrobus has integrated 60 high-entry articulated electric buses, each with a capacity of 160 passengers, representing a significant step towards reducing emissions. These are complemented by 55 low-floor 15-meter electric buses, with a capacity of 130 passengers, further expanding the offering of sustainable transport in the city.

Finally, the system is also testing new technologies with 4 electric prototypes, which are in the testing phase to evaluate their performance and possible future integration into the fleet. For a detailed visualization of the Metrobus fleet composition, see Figure 75.

Path to Metrobus Electromobility

The transition to electromobility in the Metrobus System of Mexico City began in 2019, with the implementation of the first 100% electric corridor. This project was part of the city's mobility sector emissions reduction plan, aligned with the objectives of the city's Comprehensive Mobility Plan. Line 3 of the Metrobus, which connects the north and south of the city, was selected as the pioneer in this transformation due to the need to replace 54 buses that were reaching the end of their useful life. This renewal also provided the opportunity to expand the fleet, integrating electric technology as part of a significant shift towards more sustainable transport.

In January 2021, the first 18-meter articulated electric bus, with a capacity of 160 passengers and equipped with a 563 kWh battery, arrived. This milestone marked the beginning of EV operations on Line 3, allowing the performance of this new technology to be tested and adjusted in a demanding urban environment. Later, in September 2021, the fleet was expanded with the addition of 9 more electric buses, maintaining the same technical specifications, consolidating the operation of the electric line. Progress continued in 2023, with the addition of 50 new articulated electric buses, each with a 507 kWh battery and the capacity to transport 160 passengers.

Line 3 of the Metrobus was selected to become the first fully electric line due to several strategic and operational reasons. This line, which connects the north and south of Mexico City, is one of the most important routes in the system, transporting 190,000 passengers daily along 20.4 kilometers with 38 stations. Additionally, the existing fleet of 72 buses was reaching the end of its useful life, with 54 units needing to be replaced. This need for renewal provided an ideal opportunity to implement a technological shift towards electromobility. Another key factor in the decision was that only one concessionaire, MIVSA, operated this line, which facilitated the financial viability of making the necessary investment in the new electric fleet. These elements, combined with the importance of Line 3 in the city's transport system, justified its selection as the pioneer in the transition to more sustainable transport.

Figure 75. Current Composition of the Metrobus Fleet

Source: Castro Escorcia, R. (2024). *Electromobility Towards Sustainable and Safe Mobility. Public Fleet Tender Schemes*. Workshop "*Electromobility Towards a Sustainable and Safe Mobility,*" Lima Convention Center, San Borja, Lima, Peru.

In parallel, Line 4 also began its transition to electromobility in 2020. This line was selected for conversion due to its importance in connecting key areas of the city, transporting 120,000 passengers daily along 35 kilometers and 40 stations. The need to renew its fleet, which was also reaching the end of its useful life, provided an ideal opportunity to introduce electric buses as part of a pilot plan. The first low-floor electric buses that arrived in 2020 were 12-meter vehicles with a capacity for 100 passengers and operated with diesel and hybrid technologies. These buses operated for six months as part of the pilot, providing a foundation to evaluate the technology.

Finally, in 2024, Line 4 completed its transformation with the incorporation of 55 new low-floor electric buses, each 15 meters long with a capacity for 130 passengers. These buses, manufactured by BYD, are equipped with 380 kWh batteries, allowing them to have a range of 260 kilometers and to be fully recharged in just 3 hours. Additionally, they feature plug-type sliding doors that improve safety and efficiency in daily operations. For a detailed visualization of the transition to electromobility in Metrobus Lines 3 and 4, see Figure 76.

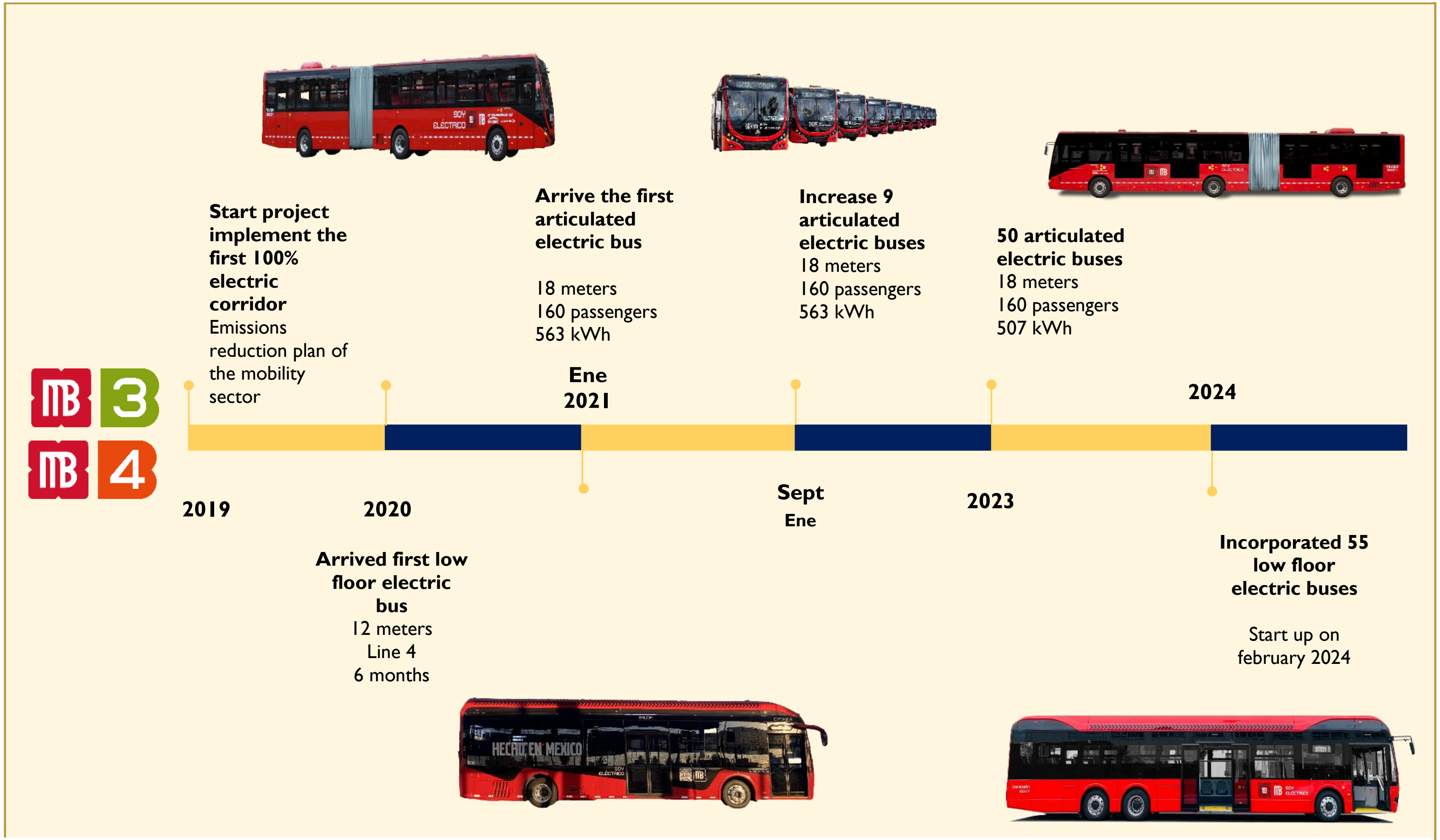
Role of International Experience in the Transition to Electromobility

International experience played a crucial role in the early steps toward electromobility in Mexico City's Metrobus System. From the beginning of the project, the Metrobus team worked closely with international organizations and electromobility experts, such as ZEBRA, ICCT, GGGI, and C40, to leverage best practices and regulations developed in other parts of the world. These collaborations allowed for a thorough review of available technologies and facilitated the implementation of global standards in the design and operation of electric buses. External consultancy was essential in defining the technical specifications of the vehicles, ensuring regulatory compliance, and guaranteeing that the transition to electromobility was carried out effectively and sustainably. This exchange of knowledge and experience was vital in overcoming initial challenges and establishing a solid foundation for the future expansion of the electric system in the city.

Characteristics of the Electric Buses on Line 3 of the Metrobus System

The electric buses on Line 3 of Mexico City's Metrobus System are designed to maximize energy efficiency and offer sustainable and comfortable public transport. These 18-meter articulated vehicles have a capacity for 160 passengers and are equipped with state-of-the-art batteries, initially 563 kWh and in the most recent models, 507 kWh, allowing them to operate for long periods without frequent recharges. One of the standout features is their ability to recover up to 40% of energy during operation, which helps extend their range and reduce overall energy consumption. Additionally, new telematics equipment has been incorporated to improve real-time management and monitoring of bus performance, thus optimizing their operation. These buses, which are completely emission-free, also provide a quieter and more comfortable travel experience thanks to reduced noise and vibrations, along with additional features such as USB ports for passengers and retractable doors that enhance safety. Their average energy consumption is 0.9 kWh per kilometer, reflecting their high efficiency in a demanding urban environment.

Figure 76. The path to electromobility for Metrobus Lines 3 and 4



Source: Castro Escorcia, R. (2024). *Electromobility Towards Sustainable and Safe Mobility. Public Fleet Tender Schemes*. Workshop "*Electromobility Towards a Sustainable and Safe Mobility,*" Lima Convention Center, San Borja, Lima, Peru.

Metrobus Charging Infrastructure

- **Line 3 Charging Infrastructure**

The charging infrastructure at the Line 3 depot of Mexico City's Metrobus system was designed to support the intensive operation of the electric fleet, ensuring efficient and fast recharging of the buses. This depot is equipped with 32 high-capacity chargers, each with a power output of up to 180 kW, allowing buses to be recharged in a reduced time, thus ensuring the continuous availability of the vehicles during long operational shifts. To supply the necessary energy, 6.5 MW of power was contracted from the Federal Electricity Commission (CFE), distributed through three transformers with capacities of 1.5 MVA, 2.5 MVA, and 3.0 MVA.

- **Line 4 Charging Infrastructure**

The charging infrastructure for Line 4 of the Mexico City Metrobus system has been designed to efficiently support the operation of the electric fleet. This line has a total of 28 chargers strategically distributed across two charging depots. Of these, 5 chargers have a capacity of 150 kW, while the remaining 23 chargers offer 180 kW of power, allowing for quick and effective recharging of the electric buses. The energy for these chargers is supplied by two main substations: the Aviación Depot, which provides 0.6 MW, and the North Depot, which supplies 1.5 MW.

Benefits of the Transition to Electromobility by Metrobus

The transition to electromobility in Mexico City's Metrobus system has achieved a significant reduction in CO_2 emissions, with an environmental impact equivalent to the elimination of 7,500 tons of CO_2 per year. This achievement can be compared to what 619,000 trees would be able to absorb in a year. Additionally, this reduction in emissions is equivalent to the amount emitted by 538,000 cars in a single day or the energy consumption of 10 million light bulbs left on for a full day. These figures highlight the importance and effectiveness of the transition to cleaner technologies in public transportation, contributing significantly to improved air quality and reduced environmental impact in the city.

Yucatán – "Va y Ven" Project

The "Va y Ven" project in Yucatán is another notable example of the expansion of electromobility in Mexico. This transportation system operates six routes with a fleet of 45 electric buses, each with 130 kW batteries, transporting more than 20,000 people daily. To support this operation, a charging depot with a total installed capacity of 4.3 MW has been built, including 16 plug-in chargers with a capacity of 2.8 MW and 3 on-route pantographs, with an additional 5, totaling 1.5 MW. This project has involved a total investment of USD146 million, funded 60% by the Yucatán government, 24% by the federal government, and 16% by the private sector, reflecting a joint effort to drive sustainable mobility in the region.

Fiscal Incentives and Subsidies

In various cities across Mexico, local governments have implemented fiscal incentives and subsidies for the purchase of EVs. For example, the government of Mexico City offers exemptions from the vehicle ownership or use tax for EVs, as well as other financial incentives. These policies facilitate the adoption of EVs by reducing the costs associated with their acquisition and use, thereby promoting a faster transition to electromobility.

Currently, the fiscal incentives in place for the use of hybrid and EVs in the economy are as follows:

1. Discount on Tolls and Elevated Highways: A significant discount of 20% has been implemented at toll booths and on elevated highways in Mexico City and the State of Mexico for electric and hybrid vehicles. This measure encourages their use and promotes more sustainable mobility.
2. Preferential Electricity Rates for Home Charging Stations: A preferential electricity rate has been established for individuals who install charging stations in their homes, reducing the charging costs of EVs and facilitating their adoption.
3. Free Installation of Meters for Home Charging Stations: The government offers free installation of the necessary meters for home charging stations, removing a financial barrier for EV owners.
4. Exemption from ISAN: Electric and hybrid vehicles are exempt from the New Vehicle Tax (ISAN), reducing the initial acquisition cost and making them more accessible to consumers.
5. Exemption from Vehicle Ownership Tax: In states where the vehicle ownership tax is applied, electric and hybrid vehicles are exempt, promoting their purchase and contributing to the transition to cleaner mobility.
6. Deductibility for Legal Entities: A higher deductibility limit, for example, up to MXN250,000, is established for companies that acquire electric and hybrid vehicles, encouraging their inclusion in corporate fleets and promoting the transition to sustainable mobility.
7. Other Incentives: In addition to the aforementioned incentives, other measures are implemented, such as discounts on public parking, benefits for access to congestion zones, or privileges for the use of exclusive lanes for electric and hybrid vehicles.
8. Exemption from Vehicle Verification in CAMe Zone: Electric, PHEV, and strong hybrid vehicles are exempt from the vehicle verification process in the Metropolitan Area of the Valley of Mexico (ZMVM), known as the CAMe Zone. This facilitates their circulation and promotes their use in urban areas with high pollutant concentrations.
9. Taxi Fleet Renewal: A scrappage bonus is established for each taxi unit that is replaced, providing an additional amount of MXN100,000 for taxis that are replaced by hybrid or EVs. This incentivizes the renewal of the taxi fleet towards cleaner and more efficient options[341].

These incentives have had a positive and measurable impact on the adoption of EVs in Mexico. During the first eleven months of 2021, 42,969 electrified vehicles were sold, including 838 EVs and 3,013 PHEV, representing a 105.8% increase compared to the previous year and accounting for 4.7% of total light vehicle sales in the economy. This remarkable adoption demonstrates how policies and subsidies can catalyze the transition to more sustainable mobility, improving air quality and reducing greenhouse gas emissions[342].

8.6.5. Opportunities and Challenges for the Automotive Industry in the Transition to Electromobility

According to Carrillo et al. (2020), Mexico is in a privileged position to become a regional leader in the production and assembly of EVs. This strategic advantage is the result of

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[341] Pérez Méndez, N. A., Jiménez García, J. A., & Gaspar Sánchez, N. (2024). Advances in the Implementation of Electromobility in Mexico. Diotima, Scientific Journal of Transdisciplinary Studies, 9(25), 1-25. Available at https://revista-diotima.com/wp-content/uploads/2023/12/02.-AVANCES-EN-LA-IMPLEMENTACION-DE-LA-ELECTROMOVILIDAD-EN-MEXICO.pdf (pp.12-13).

[342] Pérez Méndez, N. A., Jiménez García, J. A., & Gaspar Sánchez, N. (2024). Advances in the Implementation of Electromobility in Mexico. Diotima, Scientific Journal of Transdisciplinary Studies, 9(25), 1-25. Available at https://revista-diotima.com/wp-content/uploads/2023/12/02.-AVANCES-EN-LA-IMPLEMENTACION-DE-LA-ELECTROMOVILIDAD-EN-MEXICO.pdf (p.6).

several combined factors: i) its favorable geographic location, ii) a skilled workforce, iii) an extensive network of suppliers, and iv) numerous free trade agreements[343]. These conditions not only strengthen its traditional automotive industry but also prepare it for a future centered on electromobility. Mexico's potential to develop a robust EV industry could position it as a manufacturing hub for electric buses and other vehicles, driving the adoption of electric mobility in its metropolitan regions and mid-sized cities.

Historically, Mexico has been a key player in the global automotive industry, with over a century of experience. This sector not only represents a significant part of the GDP but is also an attractive destination for foreign direct investment, generates employment, and has high export dynamism. With the United States absorbing more than 83% of its automotive exports, the commercial relationship and geographic proximity to its northern neighbor are key factors that continue to drive the growth and relevance of the Mexican automotive industry[344].

Companies like Kia are leveraging these advantages to announce new investments in Mexican plants for the manufacture of EVs, highlighting the confidence in the economy's capacity and stability in this sector[345]. Additionally, the international firm BYD has considered Mexico as a destination for establishing an electric bus manufacturing operation under a phased scheme over three years, projecting the production of more than 2,000 units annually. This project is estimated to create more than 1,550 direct and indirect jobs and will require an investment in infrastructure and equipment of approximately MXN422 million (over USD22 million), further emphasizing Mexico's attractiveness as a production hub in the growing EV market[346].

As noted by Carrillo et al., the significant presence of electronic product manufacturing companies in Mexico, which include 910 economic units and generate 458,563 direct jobs, suggests that charging systems and energy conversion for electric propulsion systems can be manufactured domestically. Regarding the technical capabilities to produce the necessary components in the production chains of electric buses, Mexico faces no limitations. The existing infrastructure and experience in electronic product manufacturing support the technical feasibility of producing these components locally. However, the decision to relocate and/or source locally depends on the supply strategies of each company, considering factors such as volume and the location of current suppliers. This technical capacity highlights Mexico's potential to consolidate as a production center for advanced electromobility technology, leveraging its solid electronics industry[347].

However, the transition to electromobility is not without challenges. The Mexican automotive industry faces significant technological and infrastructure barriers that must be overcome to consolidate its position as a leader in this field. It is crucial for the economy to develop clear policies and regulations that support the transition to electromobility, ensuring the interoperability of charging systems and promoting public

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[343] Carrillo, J., de los Santos Gómez, J. S., & Briones, J. (2020). Towards Public Electromobility in Mexico. Economic Commission for Latin America and the Caribbean (ECLAC). Available at: https://repositorio.cepal.org/server/api/core/bitstreams/a9f6dc15-7e04-4d75-b676-b131e99b3c44/content (p.56).

[344] Carrillo, J., de los Santos Gómez, J. S., & Briones, J. (2020). Towards Public Electromobility in Mexico. Economic Commission for Latin America and the Caribbean (ECLAC). Available at: https://repositorio.cepal.org/server/api/core/bitstreams/a9f6dc15-7e04-4d75-b676-b131e99b3c44/content (p.15).

[345] https://www.forbes.com.mx/electromovilidad-la-nueva-ruta-de-mexico/

[346] Carrillo, J., de los Santos Gómez, J. S., & Briones, J. (2020). Towards Public Electromobility in Mexico. Economic Commission for Latin America and the Caribbean (ECLAC). Available at: https://repositorio.cepal.org/server/api/core/bitstreams/a9f6dc15-7e04-4d75-b676-b131e99b3c44/content (p.17).

[347] Carrillo, J., de los Santos Gómez, J. S., & Briones, J. (2020). Towards Public Electromobility in Mexico. Economic Commission for Latin America and the Caribbean (ECLAC). Available at: https://repositorio.cepal.org/server/api/core/bitstreams/a9f6dc15-7e04-4d75-b676-b131e99b3c44/content (p.18).

education and awareness about the benefits of electric mobility[348]. Additionally, the growing demand for strategic minerals such as lithium, necessary for battery production, represents both an opportunity and a challenge. Although Mexico has lithium deposits, they are in early exploration stages and require rapid acceleration in their development to fully seize the opportunities in the global EV market.

While the high initial investment for acquiring electric buses represents a significant barrier, domestic manufacturing of these vehicles in Mexico could be a viable solution to reduce costs and foster both economic and sustainable development. Local production of electric buses would generate considerable added value, surpassing that of diesel buses by 185%, positioning Mexico to capitalize on the growing global demand for sustainable transportation. Furthermore, successful initiatives like the manufacturing of the "Ridder E" model by DINA, in collaboration with UAM and CONACYT, demonstrate the economy's capacity to innovate and participate in the global value chain[349].

Endogenous industrial development in automotive manufacturing can mitigate the adverse employment effects from global economic uncertainty and promote new business opportunities in services related to electric mobility, such as vehicle maintenance and energy supply. To achieve this, it is crucial for the federal government to establish an adequate regulatory framework and incentive schemes to reduce emissions and encourage the acquisition of EVs. At the state level, policies should focus on modernizing public transportation and effectively implementing programs that promote electromobility, ensuring these measures have a measurable impact in metropolitan areas with the highest population concentration[350].

8.7. Singapore

The Singapore Green Plan 2030 (SGP 2030[351]) is based on key global commitments, such as the Paris Agreement, an international binding treaty that aims to limit the global temperature increase to less than 2 degrees Celsius above pre-industrial levels, with additional efforts to limit the increase to 1.5 degrees Celsius above pre-industrial levels. Although Singapore accounts for only 0.1% of global emissions, it has taken on its share of the responsibility of mitigating climate change. In March 2020, Singapore ratified its Nationally Determined Contribution (NDC) and its Long-Term Low-Emissions Development Strategy (LEDS). Additionally, in line with the Glasgow Climate Pact, Singapore is committed to reducing its emissions to 60 $MtCO_2e$ by 2030 and achieving net-zero emissions by 2050.

SGP 2030 also reinforces Singapore's commitment to the 2030 Agenda and the Sustainable Development Goals (SDGs) adopted by UN Member States in 2015. These goals provide a framework for sustainable development across its economic, environmental, and social dimensions. The implementation of the Green Plan aims to support SDGs 2 (Zero Hunger), 6 (Clean Water and Sanitation), 7 (Affordable and Clean Energy), 8 (Decent Work and Economic Growth), 9 (Industry, Innovation, and Infrastructure), 11 (Sustainable Cities and Communities), 12 (Responsible Consumption and Production), 13 (Climate Action), and 17 (Partnerships for the Goals).

[348] Carrillo, J., de los Santos Gómez, J. S., & Briones, J. (2020). Towards Public Electromobility in Mexico. Economic Commission for Latin America and the Caribbean (ECLAC). Available at: https://repositorio.cepal.org/server/api/core/bitstreams/a9f6dc15-7e04-4d75-b676-b131e99b3c44/content (p.23).
[349] Carrillo, J., de los Santos Gómez, J. S., & Briones, J. (2020). Towards Public Electromobility in Mexico. Economic Commission for Latin America and the Caribbean (ECLAC). Available at: https://repositorio.cepal.org/server/api/core/bitstreams/a9f6dc15-7e04-4d75-b676-b131e99b3c44/content (p.13).
[350] Carrillo, J., de los Santos Gómez, J. S., & Briones, J. (2020). Towards Public Electromobility in Mexico. Economic Commission for Latin America and the Caribbean (ECLAC). Available at: https://repositorio.cepal.org/server/api/core/bitstreams/a9f6dc15-7e04-4d75-b676-b131e99b3c44/content (p.23).
[351] Singapore Government. (2021). Singapore Green Plan 2030. Available at: https://www.greenplan.gov.sg/

In February 2021, in line with these global commitments, the SGP 2030 was launched. This plan is a joint effort of five ministries: The Ministry of Sustainability and the Environment (MSE), the Ministry of Trade and Industry (MTI), the Ministry of Transport (MOT), the Ministry of National Development (MND), and the Ministry of Education (MOE). As a national agenda for sustainable development with concrete and ambitious goals for the next decade, the Green Plan aims to mobilize the country towards a greener and more sustainable future.

The SGP 2030 sets ambitious and concrete targets to advance Singapore's sustainable development agenda. The five key pillars of the plan address essential aspects of life in Singapore, from urbanization and energy use to the economy and climate resilience. The following are the detailed pillars:

- **Pillar 1: City in Nature.** Enhance urban environments by expanding green spaces and integrating nature into the city.
- **Pillar 2: Sustainable Living.** Promote resource-efficient lifestyles and reduce waste generation.
- **Pillar 3: Energy Reset.** Increase the use of clean energy and improve energy efficiency across sectors.
- **Pillar 4: Green Economy.** Develop sustainable industries, jobs, and businesses, fostering innovation and economic growth.
- **Pillar 5: Resilient Future.** Strengthen climate resilience and enhance adaptive capacities to climate change.

8.7.1. Urban Mobility Policies Related to the Transition to Electromobility

The Sustainable Living pillar of the SGP 2030 focuses on reducing carbon emissions and adopting sustainable practices through responsible consumption, recycling, and the use of public transportation. This pillar supports the vision of making Singapore a zero-waste economy, driven by a circular economy where "Reduce, Reuse, and Recycle" become norms for citizens and businesses[352].

Singapore aspires to be a zero-waste economy through a high recycling rate, allowing resources to be used repeatedly. Currently, the water cycle has been closed by recycling used water to create NEWater, and similar efforts are being made towards circularity in waste materials, transforming trash into valuable resources. Initiatives like the extended producer responsibility scheme for electronic waste and the beverage container return scheme aim to establish circular business models where products are collected at the end of their life cycle for recycling. Additionally, more opportunities and behavioral incentives are being created to encourage everyone to live more sustainably by reducing waste and recycling correctly[353].

Singapore is progressing towards its goal of having 80% of households within a 10-minute walk of a train station by 2030. The rail network will expand to 360 km by the early 2030s, and the cycling network will be extended to around 1,300 km by the same timeframe. Measures will also be taken to repurpose roads and implement pedestrianization where possible[354].

The Sustainable Living pillar provides an essential framework for urban mobility policies related to the transition to electromobility. Promoting public transport and increasing cycling infrastructure are crucial components for reducing reliance on private vehicles

[352] Singapore Government. (n.d.). Sustainable living. In Singapore Green Plan 2030. Available at: https://www.greenplan.gov.sg/key-focus-areas/sustainable-living/
[353] Ibid.
[354] Ibid.

and encouraging more sustainable modes of transportation. In this regard, adopting sustainable habits and reducing waste will support the implementation of EVs, which require proper management of their components at the end of their life cycle. Initiatives like the extended producer responsibility scheme for electronic waste are particularly relevant for managing EV batteries, ensuring these materials are efficiently recycled and reused, contributing to a circular economy.

In summary, the Sustainable Living pillar not only drives a reduction in resource consumption and emissions but also directly supports the infrastructure and policies necessary for adopting and expanding electromobility in Singapore.

On its part, Singapore's Ministry of Transport[355] highlights the growing importance of managing the environmental footprint as the economy's transportation system increases in capacity and use. Under the Singapore Green Plan 2030, Walk Cycle Ride modes of transportation (walking, cycling, and using public transport) are actively promoted while facilitating the transition to cleaner energy vehicles. This approach aims not only to reduce carbon emissions and air pollution but also to encourage a healthier and more sustainable lifestyle among citizens.

Urban Transport Emission Reduction Policies

Singapore's Ministry of Transport[356] has identified sustainability as a crucial agenda and is committed to reducing emissions from the land transport system, which peaked in 2016. Since then, the focus has been on reducing these emissions through policies related to promoting public transport and active mobility, as well as transitioning to a cleaner energy vehicle population. This commitment aligns with Singapore's goal of achieving net-zero emissions by 2050. Below is a detailed analysis of each of these policies[357].

- **Greening Public Transport**

One of the most significant strategies to reduce emissions from the land transport sector is to promote a "car-lite" lifestyle by encouraging modes of transport such as walking, cycling, and using public transport ("Walk Cycle Ride").

The goal is to increase the public transport modal share during peak hours to 75% by 2030 and for "Walk Cycle Ride" modes to comprise 90% of peak period journeys by 2040. To further reduce emissions, measures are being implemented to make public transport operations greener. For example, the Circle Line and Downtown Line MRT lines have received the BCA Green Mark GoldPLUS certification for their environmental features. Additionally, stations such as Canberra, Upper Thomson, and Sungei Bedok have been awarded the Green Mark for Transit Stations Platinum for their sustainable practices.

Since 2020, all new public bus purchases have been for cleaner energy buses, either electric or hybrid. It is expected that half of the public bus fleet will be electric by 2030, and all existing diesel buses will be replaced with cleaner energy buses by 2040, in line with the Land Transport Master Plan 2040, providing quieter rides and cleaner air.

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[355] Singapore Ministry of Transport. (n.d.). Green transport. In Ministry of Transport. https://www.mot.gov.sg/what-we-do/green-transport

[356] Singapore Ministry of Transport. (n.d.). Sustainable land transport. In Ministry of Transport. https://www.mot.gov.sg/what-we-do/green-transport/sustainable-land-transport

[357] These policies have been identified by the Singapore Ministry of Transport. For more details, check the following link: Singapore Ministry of Transport. (n.d.). Sustainable land transport. In Ministry of Transport. Available at: https://www.mot.gov.sg/what-we-do/green-transport/sustainable-land-transport

- **Greening Private Vehicles**

In addition to regulating the ownership and use of private vehicles to ease pressure on road space, Singapore is also implementing measures to encourage more people to switch to cleaner fuels. The vision is for all vehicles to run on cleaner energy by 2040. New registrations of diesel cars and taxis will be prohibited from 2025, and all new car and taxi registrations will be for cleaner energy models from 2030. Electrification of vehicles, along with the decarbonization of the power grid, is a key measure to green the land transport sector. To support the adoption of EVs, policies and measures such as fiscal incentives, regulations and standards, and the expansion of the EV charging network are being implemented.

- **Promoting Active Mobility**

To build a sustainable city where walking and cycling are common transport options, Singapore is developing approximately 1,300 km of cycling paths across the island by 2030 under the Islandwide Cycling Network (ICN) program. Suitable road segments are also being repurposed into wider footpaths, cycling paths, or bus lanes to better support cycling and walking.

In conclusion, these policies reflect a comprehensive and proactive approach to addressing emissions from the land transport sector. By promoting public transport and active mobility, facilitating the transition to cleaner energy vehicles, and ensuring that transport infrastructures are green, Singapore is making significant progress toward its sustainability and emissions reduction goals.

- **Walk-Cycle-Ride**

According to Ng, Emmalene (2024) in her presentation titled "Singapore’s vehicular electrification journey," delivered during the workshop "Electromobility Towards a Sustainable and Safe Mobility" at the Convention Center in Lima, Peru, the "Walk-Cycle-Ride" initiative is a fundamental pillar in the strategy for decarbonizing the land transport system of the economy. This approach aims to promote walking, cycling, and riding public transport as the preferred modes of transportation for most Singaporeans, thereby reducing the reliance on private vehicles and the associated emissions. Key objectives of this initiative include ensuring that, by 2040, nine out of ten peak-hour journeys are made using these sustainable modes of transport. Additionally, by 2030, it is expected that 80% of households in Singapore will be within a 10-minute walk of a train station, thereby facilitating access to public transport and encouraging a more active and environmentally-friendly lifestyle[358].

Promoting and Accelerating the Transition to Electromobility

The document by Singapore's National Environment Agency (NEA) titled "Promoting The Adoption Of Cleaner Commercial Vehicles"[359] details various initiatives and schemes implemented to foster the adoption of cleaner commercial vehicles in Singapore. These initiatives aim not only to reduce pollutant emissions but also to be part of the broader effort to achieve the economy's sustainability and electromobility goals.

[358] Ng, Emmalene. (2024). Singapore’s vehicular electrification journey. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Lima Convention Center, San Borja, Lima, Peru.
[359] National Environment Agency. (n.d.). Promoting the adoption of cleaner commercial vehicles. In National Environment Agency. Available at: https://www.nea.gov.sg/media/news/news/index/promoting-the-adoption-of-cleaner-commercial-vehicles

Commercial Vehicle Emissions Scheme (CVES)[360]

The CVES classifies light goods vehicles (LGV), passenger and goods vehicles (GPV), and small buses into three bands (A, B, and C) based on their pollutant emission performance, including CO_2, CO, HC, NOx, and PM. Vehicles classified in Bands A and B, which are the least polluting, receive significant financial incentives. For example, vehicles in Band A receive an incentive of USD15,000, fully payable to the vehicle owner upon vehicle registration. This scheme incentivizes buyers to choose vehicle models that generate fewer emissions, thus promoting the adoption of cleaner and less pollutive vehicles.

Enhanced Early Turnover Scheme (ETS)[361]

The ETS incentivizes owners of older diesel commercial vehicles (Euro 2, 3, and 4) to replace them with newer, cleaner models. This scheme has been expanded to include Euro 4 vehicles starting from April 2021, significantly increasing the number of vehicles eligible for incentives. Owners who replace their old vehicles with Euro 6 or equivalent models classified in Bands A or B of the CVES can benefit from both the ETS and the CVES incentives.

8.7.2. Energy Policies Related to the Transition to Electromobility

The Energy Reset pillar of the SGP 2030[362] aims to use cleaner energy sources across all sectors. Singapore has positioned itself as one of the cities with the highest solar energy density in the world, even featuring a floating photovoltaic system at the Tengeh Reservoir with a capacity of 60 MWp, equivalent to the size of 45 football fields. By 2030, Singapore plans to reach at least 2 GWp of solar energy deployment, sufficient to meet the annual electricity needs of approximately 350,000 households.

The intermittent nature of solar energy, subject to weather conditions, has led Singapore to implement Energy Storage Systems (ESS) to address solar intermittency and enhance grid resilience.

In addition to maximizing the deployment of solar panels on rooftops, reservoirs, and other open spaces, Singapore aims to import up to 4 GW of low-carbon electricity by 2035, which would represent about 30% of the projected electricity supply. The economy is also exploring emerging low-carbon alternatives such as hydrogen, geothermal energy, and carbon capture, utilization, and storage (CCUS). In October 2022, the Hydrogen Strategy was announced to develop hydrogen as a key decarbonization pathway.

Finally, Singapore also plans to increase the efficiency of its gas-fired power plants to reduce emissions and is collaborating with regional power grids to access cleaner energy sources beyond its borders.

National EV Centre (NEVC)

The NEVC plays a crucial role in promoting electromobility in Singapore. Led by the LTA, the center brings together members from various government agencies and industry stakeholders to drive the adoption of EVs (EVs). The NEVC's mission is to accelerate the deployment of a comprehensive EV charging infrastructure, and develop new

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[360] Ibid.
[361] Ibid.
[362] Singapore Government. (n.d.). Energy reset. In Singapore Green Plan 2030. Available at: https://www.greenplan.gov.sg/key-focus-areas/energy-reset/

regulations and standards for EV, and cultivate a robust EV ecosystem that supports the transition to sustainable mobility[363].

NEVC has implemented several initiatives to meet these objectives, including supporting the installation of 60,000 EV charging points economy-wide by 2030, in tandem with EV adoption. This effort includes 40,000 points in public car parks and 20,000 in private premises. Additionally, awareness campaigns such as "Power EVery Move" have been launched to educate the public on the benefits of EVs and promote responsible use of EV charging infrastructure.

Net Zero Roadmap for the Singapore Public Sector[364]

The document "Net Zero Roadmap for the Singapore Public Sector" outlines a detailed plan for the public sector to achieve net-zero emissions by 2045, ahead of the national target of 2050. The transition is designed under the 3R framework: Reduce, Replace, and Remove carbon emissions. The key points of the document are highlighted below:

a) Reducing Emissions (Reduce)

- **Building Efficiency:** Over 75% of public sector facilities are buildings, and since 2021, all new buildings and existing ones undergoing major retrofitting must meet the Green Mark Platinum Super Low Energy (SLE) standard, promising at least 60% energy savings compared to 2005 levels. As of 31 March 2023, 39 buildings already comply with this standard.

- **Additional Measures:** These include installing smart energy management solutions, procuring energy efficient appliances, and adopting guaranteed energy savings performance contracts for upgrading chilled water plants. It also emphasizes raising awareness among officials about resource conservation and fostering a culture of sustainability.

- **Operational Synergies:** The Tuas Nexus project, with its integrated design for waste management and water reclamation, promises an annual reduction of over 200,000 Mt$\mathbf{CO_2}$ when it becomes operational in 2026.

b) Transforming Energy Sources

- **Transport:** From 1 April 2023, all newly acquired and registered cars must be clean energy vehicles with zero tailpipe emissions. By 2035, the goal is for 100% of cars to run on cleaner energy.

- **Public Buses:** As of 31 March 2023, 60 electric buses had been deployed, and it is expected that by 2030, they will make up half of the public bus fleet, with an eventual target of 100% cleaner energy public bus fleet by 2040.

- **Freight Vehicles:** Clean energy options for medium-and heavy-duty vehicles are being explored, with the government monitoring developments in this space and exploring ways to spur the market.

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[363] Ibid.
[364] Ministry of Sustainability and the Environment, Singapore. (2023). *Singapore's Net-Zero Government Initiative Roadmap*. Available at: https://www.sustainability.gov/pdfs/singapore-nzgi-roadmap.pdf

c) Carbon Removal

- **Innovative Solutions:** Technologies for carbon capture, utilization, and storage (CCUS) are being developed to address residual emissions from essential public services.

- **Solar Energy:** The SolarNova program has supported the installation of solar panels on approximately 30% of public housing blocks, with a national target of deploying at least 2 GWp by 2030. Additionally, the SolarRoof and SolarLand programs have been implemented to incentivize the installation of solar panels on rooftops of industrial buildings and temporary vacant land.

The Roadmap also mentions exploring low-carbon electricity imports and emerging technologies, such as hydrogen and advanced geothermal systems, to reduce emissions from the power grid, which is currently one of the main sources of emissions.

In conclusion, the document provides a comprehensive vision of how Singapore plans to achieve its net-zero emissions goals through a combination of energy efficiency, adoption of clean energy technologies, and innovative carbon capture and storage solutions. The commitment to sustainability and the implementation of specific strategies such as the adoption of EVs and the expansion of solar energy are key elements in this effort.

8.7.3. Specific Electromobility Policies

According to Singapore's Ministry of Transport[365], driving an electric car reduces the carbon footprint by more than half compared to driving a similar ICE car. Additionally, EV are less polluting and quieter, contributing to a more pleasant living environment. This is because EVs do not emit exhaust gases and operate with efficient electric motors, significantly reducing air and noise pollution in urban areas. This shift not only helps combat climate change but also improves quality of life by reducing exposure to harmful pollutants and decreasing ambient noise.

To support the transition and adoption of EVs, the Ministry of Transport of Singapore has implemented several policies aimed at reducing the purchase and ownership costs of an EV compared to a hybrid or ICE vehicle. These policies are as follows:

- **EV Early Adoption Incentive (EEAI)**

The EV EEAI is a government initiative designed to incentivize the early adoption of EVs. From 1 January 2024, to 31 December 2025, owners who register fully electric cars and taxis will receive a 45% rebate on the Additional Registration Fee (ARF), with a maximum cap of USD15,000. This incentive aims to reduce the initial cost of EVs compared to ICE vehicles, thus promoting a quicker transition to a cleaner and more sustainable vehicle fleet[366].

- **Enhanced Vehicular Emissions Scheme (VES)**

The VES is a program by the Singapore government designed to incentivize the adoption of cleaner, low-emission vehicles. Under the VES, buyers of newly registered cars and

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[365] Singapore Ministry of Transport. (n.d.). EVs. In Ministry of Transport. Available at: https://www.mot.gov.sg/what-we-do/green-transport/electric-vehicles

[366] Land Transport Authority. (2023). Sustained government support to encourage vehicle electrification. In News releases. Available at: https://www.lta.gov.sg/content/ltagov/en/newsroom/2023/9/news-releases/sustained_govt_support_to_encourage_vehicle_electrification.html

taxis can receive a rebate on the Additional Registration Fee (ARF) or pay a surcharge, depending on the vehicle's pollutant emissions. Vehicles are categorized into different bands based on their highest pollutant. For example, vehicles in Band A1 receive a USD25,000 rebate, while those in Band A2 receive USD5,000 (to be reduced to USD2,500 from 1 January 2025 to 31 December 2025). The VES aims to promote the adoption of cleaner energy cars and reduce emissions of carbon dioxide, hydrocarbons, CO, NOx, and PM. It is important to note that the VES, unlike the EEAI, is a broader program that aims to reduce emissions from all types of vehicles, not just electric ones[367].

- **Additional Registration Fee (ARF) floor reduction**

The ARF is a tax imposed when registering a vehicle, determined as a percentage of the vehicle's Open Market Value (OMV). The OMV represents the cost of a vehicle imported to Singapore. This value is assessed by Singapore Customs and includes the purchase price, freight, insurance, and all additional sale and delivery costs related to the vehicle's importation[368].

The reduction of the ARF floor to USD0 for fully electric cars and taxis is a measure implemented by the Singapore government to encourage the adoption of EVs. Initially in effect from 1 January 2022, to 31 December 2023, this policy has been extended until 31 December 2025[369]. The ARF is a tax based on the Open Market Value of the imported vehicle[370], and this reduction allows buyers to fully benefit from other incentives, such as the EEAI and VES, providing significant savings on the initial cost of EV.

- **Revision of road tax framework for electric cars**

The Revision of Road Tax Framework for Electric Cars is a measure implemented by the Singapore government to make road taxes for EVs more competitive compared to ICE vehicles. Since 1 January 2022, the tax bands of 30-90 kW and 90-230 kW have been merged, so electric cars in the 30-230 kW range are subject to the tax formula of the 30-90 kW band[371]. This has led to a reduction of up to 34% in road tax for electric cars in the 90-230 kW range. The goal of this revision is to ensure that road taxes for EVs are comparable to those of similarly sized ICE vehicles, thus promoting greater adoption of EVs[372].

According to Singapore's Ministry of Transport[373], developing a robust ecosystem for EVs requires clear and well-defined regulations. The EV charging standard, Technical Reference 25 (TR25), is periodically reviewed by industry, academia, and government representatives to ensure it remains aligned with industry best practices. This continuous review ensures that standards evolve in line with technological advancements and market needs.

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367 Ibid.

368 EVreporter. (2022). Singapore EV Landscape. Available at: https://evreporter.com/wp-content/uploads/2022/10/Singapore-EV-Landscape_2022_EVreporter.pdf (p.9).

369 Singapore Business Review. (n.d.). LTA and NEA impose two-year extension of EV incentives. In Singapore Business Review. Available at: https://sbr.com.sg/transport-logistics/news/lta-and-nea-impose-two-year-extension-ev-incentives

370 Land Transport Authority. (n.d.). Additional Registration Fee (ARF). In One Motoring. Available at: https://onemotoring.lta.gov.sg/content/onemotoring/home/buying/upfront-vehicle-costs/additional-registration-fee--arf-.html

371 Land Transport Authority. (2021). Revised road tax schedule (Annex B). In Land Transport Authority. Available at: https://www.lta.gov.sg/content/dam/ltagov/news/press/2021/210304_Revised_road_tax_schedule_AnnexB.pdf

372 Land Transport Authority. (2021). Encouraging the adoption of electric cars. In Land Transport Authority. Available at: https://www.lta.gov.sg/content/ltagov/en/newsroom/2021/3/news-release/Encouraging_the_adoption_of_electric_cars.html

373 Singapore Ministry of Transport. (n.d.). EVs. In Ministry of Transport. Available at: https://www.mot.gov.sg/what-we-do/green-transport/electric-vehicles

EVs Charging Act[374]

The EVs Charging Act, which came into force in December 2023, establishes the regulatory framework to ensure that Singapore's EV charging network is safe, reliable, and accessible. This act includes several key measures:

a. Compliance with Safety Standards:

All chargers must comply with safety standards set by the LTA and be certified and registered with the LTA. Registered responsible persons for EV chargers will be responsible for their proper use and maintenance.

b. Licensing Regime for EV Charging Operators:

A new licensing regime for EV charging operators will be introduced. Licensees will need to meet requirements such as maintaining service uptime, acquiring public liability insurance, and sharing data.

c. Requirements for New Buildings:

All new buildings and those undergoing significant construction and electrical works must install a minimum number of EV chargers and provide additional electrical capacity for charging.

d. Voting Threshold for Charger Installation in Condominiums:

The voting threshold for EV charger installation resolutions in condominiums has been reduced to 50% under the Building Maintenance and Strata Management Act, provided the lease contract with the EV charging operator does not exceed 10 years and the proposal does not use Management Corporation Strata Title (MCST) funds.

In conclusion, these regulations and standards are fundamental to developing an EV ecosystem that is safe, reliable, and accessible.

On the other hand, Technical Reference 25 (TR 25) is Singapore's standard designed to regulate EV charging systems, ensuring that all chargers meet strict safety requirements. This standard was developed in collaboration between the government, industry, and academia, and it is periodically reviewed by a joint working group to stay updated with the latest technologies. TR 25 encompasses both low-power and high-power charging, as well as battery storage systems, establishing a comprehensive framework for the safe and efficient operation of charging infrastructure. Singapore has adopted Type 2 AC and Combo 2 DC connectors as public charging standards, ensuring that all publicly accessible chargers are compatible with these connector types.

The periodic review of the charging standards (TR 25) and the implementation of the EV charging standard ensure that Singapore is well-positioned to handle the growth of EV adoption while maintaining the safety and reliability of the charging infrastructure. The introduction of a licensing regime for operators and charger requirements for new buildings further reinforces Singapore's commitment to sustainability and electric mobility.

According to Ng, Emmalene (2024), one of the most important points to highlight is that Singapore’s strategy for implementing EV charging infrastructure is designed to balance

[374] Íbid.

user demand with the capacity of the power grid, while ensuring adequate coverage and accessibility throughout the island. This comprehensive planning is based on the following three key approaches that ensure an efficient and sustainable recharging system.

Slow Night Charging as the Primary Mode

Singapore's EV charging strategy focuses on slow night charging as the primary recharging mode, in order to balance between power supply and demand. From the demand perspective, slow charging is sufficient to meet the needs of most private drivers, given that the average daily mileage of a driver in Singapore is approximately 50 kilometers, which generally requires a full recharge only every 5 to 7 days. Furthermore, since 80% of the population lives in high-rise public housing, it is expected that many of these slow charging points will be located in shared parking facilities, facilitating access to overnight recharging at their own residences. This strategy is not only efficient in minimizing demand peaks but also reduces the need for costly upgrades to electrical infrastructure and alleviates the strain on the power grid during peak hours.

Fast Charging as a Strategic Complement

While fast charging is not the primary recharging mode, it plays a crucial complementary role in Singapore's strategy, especially for segments with high mileage, such as commercial fleets and taxis. These fast chargers, installed in strategic locations like neighborhood centers, allow commercial vehicle drivers to recharge their EVs during short breaks, such as lunchtime. This infrastructure is paired with smart charging technologies that help mitigate the need for costly upgrades to the power grid. By focusing fast chargers on these high-mileage segments, Singapore achieves a balance between the need for fast recharging and the stability of the power grid.

Coverage and Accessibility

The coverage and accessibility of charging points are critical elements of Singapore's charging infrastructure. The government has ensured that there is an adequate number of publicly accessible chargers distributed throughout the island, avoiding concentration in specific areas and ensuring that all drivers have access to nearby charging points. Additionally, to facilitate the use of this infrastructure, a mobile application has been developed to map all the chargers in Singapore, providing real-time information on the location, operator, prices, and availability of charging points. This initiative is essential to ensure that drivers are well-informed and can plan their recharges efficiently, thereby reducing the perception of inadequacy in the charging infrastructure.

It is important to note that, regarding EV charging points, Singapore aims to deploy 60,000 points across the economy by 2030, with 40,000 of these in public car parks and 20,000 in private premises. This effort is part of the economy's commitment to sustainability and the transition to cleaner mobility. To ensure that every HDB town[375] is EV-ready by 2025, nearly 2,000 HDB car parks would be equipped with EV charging points.

As of the end of 2023, more than 700 HDB car parks, approximately one-third of the target, already have charging points installed. However, installing shared charging infrastructure in non-landed private residences, such as condominiums and private apartments, presents challenges. To address this, the EV Common Charger Grant was

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[375] HDB refers to the Housing and Development Board. The HDB is the government agency responsible for the planning and construction of public housing in Singapore. HDB apartments are subsidized public housing where a large portion of Singapore's population resides.

launched in July 2021, co-funding the installation costs of chargers in these premises. This subsidy will be available until 31 December 2025, or until 2,000 chargers have been co-funded, whichever comes first[376].

In addition to expanding the charging network, the Singapore government is working with motorists and the industry to foster a culture of responsible and courteous use of charging infrastructure. This initiative is crucial to ensuring that charging points are accessible to all users and used efficiently.

The LTA[377] is also committed to greening the land transport system and reducing emissions to support the economy's net-zero emissions goal. Under the Singapore Green Plan 2030, the LTA strongly promotes the electrification of Singapore's vehicle fleet, aiming for 100% of vehicles to run on clean energy by 2040.

To support the vehicle electrification effort, the LTA has launched the "Power EVery Move"[378] campaign to raise awareness about EVs, highlighting their benefits for both owners and the environment, and encouraging responsible use of charging infrastructure. The campaign has three main objectives: increasing awareness about EVs and their advantages, promoting EV adoption for a more sustainable future, and encouraging proper use of EV charging infrastructure. The logo and slogan "Power EVery Move" invite everyone to participate in the adoption of EVs, emphasizing the importance of individual contributions to transitioning to more sustainable transportation. Additionally, the campaign provides detailed information about EVs through the "Power EVery Move" website, encouraging citizens to stay informed and actively contribute to this transition.
The goals of the Power EVery Move campaign include:

By 2025:

- All HDB towns will be EV-ready: This means that the necessary infrastructure for charging EVs will be available in all Housing and Development Board (HDB) housing estates.
- No new diesel vehicle registrations: This applies to both cars and taxis, promoting a quicker transition to cleaner energy vehicles.

By 2030:

- Charging points distributed across the island: 40,000 charging points will be installed in public car parks and 20,000 in private premises, in tandem with EV adoption.
- Electrification of 50% of the public bus and taxi fleet: It is expected that half of the public buses and taxis will run on electric power.
- All new car and taxi registrations will be of cleaner energy models: From 2030, all newly registered cars and taxis must be of models that use cleaner energy.

By 2040:

- 100% clean energy vehicles: The goal is for all vehicles in Singapore to run on cleaner energy.

[376] Ibid.
[377] Land Transport Authority. (n.d.). EVs. In Land Transport Authority. Available at: https://www.lta.gov.sg/content/ltagov/en/industry_innovations/technologies/electric_vehicles.html
[378] Land Transport Authority. (n.d.). Power Every Move. In Power Every Move. Available at: https://www.powereverymove.gov.sg/

Electrification of Public Transport[379]

The LTA is firmly committed to transitioning towards a greener bus fleet. The LTA aims to electrify half of the bus fleet by 2030 and achieve a 100% cleaner energy bus fleet by 2040. This ambitious plan has commenced with the deployment of 60 electric buses and the replacement of 400 diesel buses with electric ones by 2025. With the incorporation of these 60 electric buses, an annual reduction of approximately 7,840 tonnes of CO_2 emissions is expected, equivalent to the annual emissions of 1,700 passenger cars. Additionally, taxi fleet operators have also committed to electrifying their fleets, aiming for at least half of the total taxi fleet to be electric by 2030.

Subsidy for Common EV Chargers (SCCVE)[380]

The EV Common Charger Grant (ECCG) is an initiative launched by the LTA to encourage the installation of shared charging infrastructure in non-landed private residences (NLPRs). This program aims to promote the adoption of EVs by facilitating the installation of charging points, a crucial step in developing a robust national charging network, in NLPRs. The grant co-funds up to 50% of the installation costs for smart chargers, with a maximum limit of USD4,000 per charger, applicable until a total of 2,000 chargers or until 31 December 2025, whichever comes first[381]

The chargers financed through this program must meet specific criteria, including the ability to receive and react to information, record and transmit energy consumption, and use the Open Charge Point Protocol (OCPP) version 1.6 or higher. This approach ensures efficient energy planning and proper integration into the domestic charging infrastructure. Additionally, the ECCG encourages installation in common areas accessible to all residents of NLPRs, thereby catalyzing the adoption of EVs by reducing barriers to access to charging[382].

These grant policies and associated regulations play a crucial role in advancing electromobility in Singapore, supporting the economy's goal of deploying 60,000 charging points by 2030 and promoting cleaner, more sustainable urban transportation.

According to Ng, Emmalene. (2024) in her presentation titled "Singapore's vehicular electrification journey," delivered during the workshop "Electromobility Towards a Sustainable and Safe Mobility" at the Lima Convention Center in Peru, Singapore has actively fostered a conducive environment for technological advancement and capacity building, which are key elements for the transition to electromobility. Below are additional efforts implemented to complement the incentives, aimed at supporting the industry in innovation and ensuring the safe and efficient adoption of new technologies.

- **Support for the Industry to Innovate Safely**

Technological advancement and capacity development are fundamental for the transition to electric mobility in Singapore. To support the industry in safe innovation, testing environments or "sandboxes" have been created to allow the demonstration of new technologies in a controlled setting. Among the technologies tested in these sandboxes are high-power chargers like Tesla V3 superchargers, pantograph chargers for electric buses, mobile charging systems, and battery swapping for heavy vehicles

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[379] This section has been developed based on the following source: Land Transport Authority. (n.d.). Our EV Vision. In Land Transport Authority. Available at: https://www.lta.gov.sg/content/ltagov/en/industry_innovations/technologies/electric_vehicles/our_ev_vision.html

[380] Land Transport Authority. (n.d.). EV Common Charger Grant. In Land Transport Authority. https://www.lta.gov.sg/content/ltagov/en/industry_innovations/technologies/electric_vehicles/ev_common_charger_grant.html

[381] https://www.lta.gov.sg/content/ltagov/en/industry_innovations/technologies/electric_vehicles/ev_common_charger_grant.html

[382] Íbid.

and motorcycles. These controlled environments enable the industry to test and refine these innovations before large-scale implementation, ensuring that they are safe and effective for use in Singapore's urban environment.

- **Development of a Comprehensive Plan to Address Battery-Related Issues**

At the same time, Singapore has developed a comprehensive approach to addressing battery-related issues for electric vehicles (EVs), focusing on safety and regulations. The Land Transport Authority (LTA) has established a specialized battery unit with the mission of gaining a better understanding of battery chemistries, managing battery-related fires, and staying updated on the latest battery technology developments. This unit also coordinates and enhances the EV incident response framework, ensuring more effective management of EV fires and other battery-related issues.

- **Training to Enhance the Workforce's Skills in Electric Vehicles**

In Singapore, capacity development and skills enhancement in the electric vehicle (EV) sector is a strategic priority to ensure a smooth transition to electric mobility. To achieve this, specialized certification courses have been implemented to equip workers with the necessary skills to safely and efficiently maintain and operate EVs.

- **Certification Course for EV Technicians**

One of the key programs is the National EV Specialist Safety (NESS) course, a certification course for EV technicians, offered by educational institutions under the Workforce Skills Qualification framework supported by SkillsFuture Singapore. This subsidized course provides participants with introductory knowledge about EV systems, with a special focus on safety and awareness of the dangers when working with high voltage systems. The goal is to prepare the workforce, particularly automotive technicians, with the basic competencies needed to work safely with EVs.

- **Certification Course for EV Charging Equipment Specialists**

Additionally, a specialized certification course is offered to train professionals in the installation, inspection, and maintenance of EV charging equipment. This program ensures that technicians are qualified to service EV charging equipment to meet the standards established under Technical Reference 25 (TR 25), which regulates the safety and operability of charging infrastructure in Singapore.

- **Capacity Development for the Transition to Clean Energy Buses**

To ensure that the public transport workforce is prepared for the transition to cleaner energy buses, Singapore's LTA, through the Singapore Bus Academy, has developed specific training programs in collaboration with industry partners and bus operators. One of the programs run by the Academy is a "Hybrid Electric and Diesel Bus Awareness Program," which trains drivers and technicians to understand the hazards associated with high voltages and the necessary safety precautions. Additionally, specific product training is conducted by bus manufacturers (OEMs) at the Singapore Bus Academy, ensuring that the workforce is equipped with the knowledge and skills needed to efficiently operate and maintain the new cleaner energy buses.

With a view to achieving the goal of having 100% of the vehicle population in Singapore operating on cleaner energy by 2040, the government maintains ongoing communication and collaboration with key stakeholders in the EV industry. This commitment includes regular dialogues to understand the latest technological needs and advancements in the sector, ensuring that Singapore remains at the forefront of innovation in sustainable mobility. Furthermore, close work is conducted with EV users to educate them on critical issues such as charging etiquette, preventing hogging of charging stations, and ensuring that charging spaces are used efficiently and respectfully. At the international level, Singapore collaborates with neighboring economies, such as Malaysia, to synchronize charging standards and facilitate cross-border travel, addressing Singaporean drivers' concerns about the availability of charging infrastructure beyond the borders[383].

Additionally, in order to increase understanding and acceptance of cleaner energy buses among the population, the public awareness campaign "Charging up the Singapore Bus Scene" was launched in 2023. This initiative aims to educate and inform the public about the benefits and importance of transitioning to more sustainable public transport, thereby enabling a greener and healthier transportation system for all citizens.

8.2.1.1 Bus Contracting Models for Electromobility [384]

Introduction to the Bus Contracting Model in Singapore

The public bus industry in Singapore is comprised of four main operators: i) Go-Ahead Singapore, ii) SBS Transit, iii) SMRT, and iv) Tower Transit. These operators manage a total of 14 packages covering different areas of the city, with a combined fleet of approximately 5,700 buses distributed across more than 300 bus routes. Each of these packages comprise between 300 and 500 buses. Bus fares are regulated by the Public Transport Council (PTC), while service standards have been overseen by the Land Transport Authority (LTA) since January 2016, ensuring a reliable and efficient service for public transport users in Singapore.

The initial model of the public bus industry in Singapore since her independence was based on a privatized model, where the government and bus operators worked together under a partnership approach (see Figure 77). Under this model, the government provided the necessary infrastructure and established service standards, while private operators were responsible for operating the services and, in turn, owned the buses, depots, and bus parks. Additionally, the Public Transport Council (PTC) regulated the quality of service (QOS) standards.

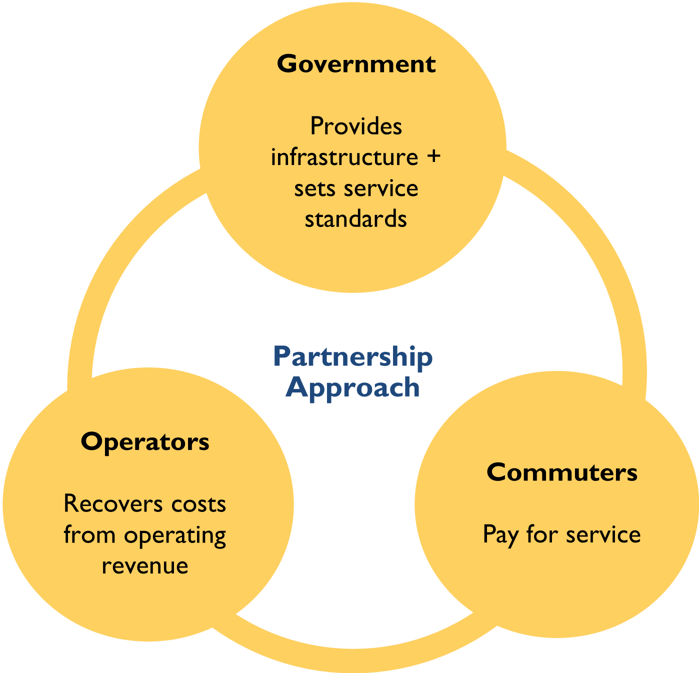
To help operators manage operational costs, the government granted certain concessions, such as exemption from the Certificate of Entitlement (COE) regime for public buses and provision of licensing agreements for the use of interchanges and commercial spaces at nominal rates. This model allowed operators to better recover their costs through the operating revenues generated from passengers who paid for the public transport services offered.

Bus Service Enhancement Programme (BSEP)

The Bus Service Enhancement Programme (BSEP) was launched in 2012 with the goal of increasing bus capacity and improving bus service levels in Singapore. This programme involved the introduction of 550 new buses and the operation of 40 new bus services, as well as the enhancement of existing services over a 10-year period.

[383] This information has been extracted from the following presentation: Ng, E. (2024). Singapore's vehicular electrification journey. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Lima Convention Center, San Borja, Lima, Peru. Ministry of Transport Singapore.
[384] The information has been extracted from the following presentation: Toh, E. J. (2024). Promoting use of electric buses in Singapore. Land Transport Authority of Singapore. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Lima Convention Center, San Borja, Lima, Peru.

Figure 77. Model for Public Bus Operations Partnership in Singapore



The programme received significant funding from the government through the Bus Service Enhancement Fund (BSEF), with an allocation of USD1.1 billion, in addition to grants for the construction, expansion, or improvement of bus depots, and additional financial support. One of the key aspects of the BSEP was the implementation of service standards that were higher than those stipulated by the Public Transport Council (PTC), thus ensuring greater service quality.

The programme also involved working with private operators to expand the capacity of the public bus system, particularly through the introduction of direct bus services to the city center (City Direct Services) and augmenting public bus services during peak hours (Peak Period Short Services). These services were managed under a gross-cost contract model. Finally, to improve the punctuality and reliability of services, the Bus Service Reliability Framework was implemented, a framework that incentivized operators to ensure that buses arrived at stops on time, according to established schedules.

The success of the first phase of the programme, which was completed ahead of schedule in 2014, allowed for the expansion of the project. This expansion resulted in the addition of 450 more buses and the creation of another 40 new bus services by the end of 2017, thus strengthening Singapore's public transport network.

Bus Contracting Model (BCM)

The Bus Contracting Model (BCM), launched in September 2016, represents a significant shift in the management of public bus services in Singapore. Unlike the previous model, where private operators were responsible for providing and maintaining the buses and their revenues depended directly on the fares collected from passengers, the BCM involved a more centralized approach. Under this new model, the Land Transport Authority (LTA) contracts operators to manage and operate packages of public bus services, while the LTA collects fare revenues and owns the bus assets.

This approach allows the LTA to maintain greater control over service quality, ensuring reliable and efficient transport for users while reducing financial risk for operators, who can now focus on operating the services instead of managing the risks of asset ownership and fare collection.

The bidding evaluation process for this model follows a two-envelope process. In this process, technical and financial proposals are submitted in separate envelopes, and the technical evaluation is completed before the financial evaluation begins. This ensures that the quality of the technical proposal is prioritized before considering cost. The base bid must meet all the tender requirements, and the evaluation takes into account both quality—including the capability and proposal of the bidder—and price. This approach allows for a balanced evaluation that prioritizes service quality while also considering financial aspects, thereby ensuring an efficient and cost-effective public transport service in Singapore.

It is important to mention that, in the bidding process for promoting electric buses in Singapore, sustainability criteria have been integrated as a fundamental part of the evaluation. This means that, in addition to traditional aspects such as price and quality, the proposal of solutions that promote sustainable public transport is significantly valued. Operators participating in the bidding are encouraged to present and implement environmentally friendly approaches that optimize and maximize the deployment of electric buses.

Initiative under the BCM to Promote EV

Singapore's strategy to expand the adoption of cleaner energy buses has focused on the implementation of structured pilot projects. In October 2017, the first pilot was awarded for the acquisition of 50 diesel-hybrid buses (DHBs), followed by another in October 2018 for the purchase of 60 electric buses (EBs). These pilot projects not only served as an initial testing phase but also had the main objective of assessing the operational and economic viability of these vehicles in Singapore's tropical conditions.

The central purpose of these pilots was to gather data that would allow for an understanding of energy efficiency, charging times, range, energy losses, maintenance costs, and battery health, among other aspects. This data is essential to determine not only the technical viability of the buses within Singapore's public transport network but also their cost-effectiveness compared to conventional diesel buses.

The analysis of this data has provided valuable operational and financial insights, facilitating informed decisions regarding the deployment strategy of the buses, the planning of charging infrastructure, and the structuring of electricity contracts with energy providers. With this evidence-based approach, Singapore aims to ensure that the transition to a cleaner energy bus fleet is efficient, cost-effective, and tailored to the specific needs of its economy.

From the pilots conducted with cleaner energy buses, important insights have been gained that will guide the future implementation and optimization of this technology. These are detailed below.

- Electric buses are more suitable for urban routes. This is due to range limitations, the benefits of regenerative braking, and the positive impact they have on reducing air and noise pollution in densely populated urban areas. Therefore, the current priority is to deploy these buses on urban routes first.

- Overnight slow charging is generally sufficient to meet the operational needs of electric buses. As a result, it has been recommended that overnight charging at depots be the predominant mode, thereby minimizing the need for costly infrastructure upgrades, while still being complemented by some fast charging options at interchanges to provide flexibility in electric bus deployment.

- Significant cost savings can be achieved by opting for overnight charging instead of daytime charging. This suggests that it is preferable to structure electricity contracts to benefit from cheaper overnight charging rates than daytime electricity rates, which could further optimize the operational costs of the electric bus fleet.

To support the transition to an electric bus fleet, Singapore's LTA has installed charging stations at key depots and interchanges and has improved the electrical network infrastructure to support the demands of these charging stations. These actions ensure a reliable and continuous energy supply, essential for the efficient operation of the electric fleet.

Regulatory Framework of the BCM in the Context of Singapore Green Plan

To fully explain the alignment of Singapore's public bus fleet with its climate goals, it is important to contextualize the economy's general climate policies and objectives. Singapore has established a set of ambitious targets under its Singapore Green Plan 2030, with a particular focus on achieving net zero emissions by around 2050 (see Figure 78).

Figure 78. Singapore Green Plan 2030

Source: Toh, E. J. (2024). *Promoting use of electric buses in Singapore*. Land Transport Authority of Singapore. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Lima Convention Center, San Borja, Lima, Peru.

Within the pillar of "Sustainable Living," under the Greener Commutes initiative, mass transit will play a crucial role in reducing emissions, and it is projected that by 2030, 75% of peak-hour commutes will be made using public transportation. Additionally, it is anticipated that by that date, 50% of the public bus fleet will consist of electric buses, while the cycling and rail networks will be significantly expanded, thus providing more sustainable mobility alternatives.

Simultaneously, under the pillar of “Energy Reset”, Singapore is moving towards an energy transition that prioritizes the use of cleaner and more efficient vehicles. Regulations will be implemented to ensure that, starting in 2030, all new registrations of cars and taxis are of models that operate on cleaner energy. Furthermore, incentives such as an Early EV Adoption Incentive (EEAI), as well as targets for the installation of 60,000 charging points across the island by 2030, have been established.

With these overarching goals in mind, the strategy to align the public bus fleet with these objectives becomes clearer.

8.7.4. Success Cases

The transition towards sustainable mobility in Singapore has been facilitated by various innovative policies and initiatives that have proven successful in promoting EVs (EVs) and reducing greenhouse gas (GHG) emissions. Notable success stories include programs like the Vehicular Emissions Scheme (VES), the Early Adoption Incentive (EEAI), the reduction of the Additional Registration Fee (ARF) floor, the Enhanced Early Turnover Scheme (ETS), and the BlueSG electric car-sharing scheme. These initiatives have not only provided economic incentives for adopting cleaner vehicles but have also created a favorable environment for charging infrastructure and promoted a cultural shift towards sustainability. Here is a detailed analysis of these programs and their impact on electromobility in Singapore.

- **The Electric Vehicle Centre (NEVC)[385]**

The NEVC (National Electric Vehicle Centre) is a key component of Singapore's strategy to promote the adoption of electric vehicles (EVs). Established under the Land Transport Authority, the NEVC comprehensively coordinates local efforts related to electromobility in collaboration with various government agencies responsible for land planning, infrastructure, energy market regulation, and industrial promotion. The main responsibilities of the NEVC include planning and deploying charging infrastructure, developing regulations and standards to ensure a safe and efficient transition, and actively supporting the automotive industry in adopting cleaner technologies. Additionally, the NEVC fosters ongoing dialogue with the industrial sector to identify its needs and facilitate the implementation of innovative solutions that accelerate the transition towards more sustainable mobility in Singapore.

- **Vehicular Emissions Scheme (VES)**

VES is a clear example of how fiscal policies can incentivize the adoption of cleaner vehicles. VES classifies vehicles based on their emissions of various pollutants and provides rebates or imposes surcharges accordingly. Analytically, VES achieves several strategic objectives: first, it lowers the economic barrier to purchasing electric and other low-emission vehicles by offering significant rebates on the Additional Registration Fee (ARF); second, it creates economic pressure on more polluting vehicles through surcharges, disincentivizing their purchase. This dual approach not only promotes the adoption of cleaner technologies but also accelerates the removal of highly polluting vehicles from the market, contributing to an immediate improvement in urban air quality and a reduction in greenhouse gas emissions.

Regarding the outcomes of VES, the registration of cleaner energy vehicles has reached approximately 70% of all new car registrations as of August 2023. Specifically, the

[385] This information has been extracted from the following presentation: Ng, Emmalene. (2024). Singapore’s vehicular electrification journey. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Lima Convention Center, San Borja, Lima, Peru.

registration of electric cars has shown a steady monthly increase since January of the same year, accounting for 23% of new car registrations in August 2023. Since 2021, more than 8,000 electric cars and taxis have received rebates under the VES.

- **Early EV Adoption Incentive (EEAI)**

The EEAI is designed to encourage the early adoption of EVs. It offers a rebate of 45% on the ARF for electric cars and taxis, capped at USD15,000. This incentive is crucial as it addresses the high initial cost of EVs, one of the main barriers to their widespread adoption. By reducing this cost, EEAI not only makes EVs more competitive with ICE vehicles but also accelerates the turnover of the vehicle fleet towards more sustainable options. This proactive approach benefits early adopters and creates a positive network effect: as the number of EVs increases, so does the charging infrastructure and public acceptance, facilitating a faster and more efficient transition to widespread electric mobility.

- **Enhanced Early Turnover Scheme (ETS)**

The ETS is a key policy for renewing the fleet of old diesel commercial vehicles with cleaner, more efficient models. This scheme not only incentivizes the removal of highly polluting vehicles but also offers additional benefits for adopting vehicles classified in CVES bands A or B. By combining ETS and CVES incentives, Singapore creates a powerful economic stimulus for commercial vehicle owners, incentivizing the upgrade to cleaner technologies.

Additionally, it is important to note that the ETS was first implemented in 2013 to encourage the early turnover of Pre-Euro and Euro 1 Cat C diesel vehicles to newer, cleaner models. Subsequently, in 2015, ETS was expanded to Euro 2 and 3 Cat C diesel vehicles, with an additional incentive for turnover to Euro 6 (or equivalent) models. As a result, by 31 December 2019, around 47,000 older commercial vehicles had been replaced early under this plan.

- **Private Taxi and Car Rental Companies in Singapore**

To better understand the initiatives and commitments of major fleet companies in Singapore towards adopting EVs, here is a summary of the specific actions each is implementing in their transition towards more sustainable mobility.

Table 22. Commitments in the Adoption of EVs by Fleet Companies in Singapore

Company	Actions
BlueSG	Service of 100% electric shared cars launched in 2017, in collaboration with the LTA and EDB. BlueSG operates a fleet of 1,000 vehicles Bluecar equipped with lithium-metal polymer batteries from Blue Solutions, part of the Bolloré Group. This membership-based service allows users to access EVs at self-service stations located in public housing, city centers, and commercial areas throughout Singapore.
ComfortDelGro	Plans to have up to 1,000 electric taxis by the end of 2023, representing 10% of its total fleet, as part of its commitment to sustainability and emission reduction. Additionally, 70% of its fleet will be hybrid vehicles by the same date.
Strides Mobility	Will convert its entire taxi fleet to 100% electric by 2026, with the first batch of 300 MG5 electric taxis progressively arriving since July 2021. This transition is part of a long-term strategy to reduce the carbon footprint of its fleet.
Tribecar	Will provide electric car rentals by the hour, day, or week and collaborate with Charge+ for fleet electrification, although no specific timeline has been indicated. This initiative aims to facilitate access to EVs and promote sustainable mobility.

Company	Actions
Grab	Has committed to transitioning to low-emission vehicles to achieve carbon neutrality by 2040. By 2030, it will replace its ride-hailing fleet in Singapore with cleaner vehicles and electrify 50% of the GrabRentals fleet.
SingPost	Will progressively replace its fleet of 700 motorcycles and three-wheelers, as well as 140 vans, with electric equivalents by 2026.
Ninjavan	Launched a pilot test with 10 EVs in October 2022, evaluating the feasibility of using EVs on a larger scale. This pilot will allow Ninjavan to explore the efficiency and sustainability of EVs in delivery operations.
GoJek	First to join the EVA - EV Accelerator program, with plans to operate an all-electric fleet by 2030. This participation demonstrates its commitment to innovation and emission reduction in its ride-hailing service.

Source: EVreporter. (2022). Singapore EV Landscape.

- **Specialized Training**

Singapore has made significant strides in its transition to electromobility through the implementation of specialized training programs. A notable initiative is the National EV Specialist Safety (NESS) certification course, which prepares workers to safely maintain electric and hybrid vehicles in high-voltage environments. Supported by educational institutions such as Ngee Ann Polytechnic, Singapore Polytechnic, and ITE, these courses offer subsidies of up to 70% on tuition fees. Additionally, the Career Conversion Program (CCP) for Sustainability Specialists enables companies to receive wage support during the training of their employees.

8.8. Chinese Taipei

8.8.1. Urban Mobility Policies Related to the Transition to Electromobility[386]

Urban mobility in Chinese Taipei is undergoing a rapid transformation driven by the integration of advanced technologies such as artificial intelligence (AI), big data, and innovative solutions that efficiently connect urban and remote areas. The vision for the future of mobility in this economy focuses on creating an intelligent transportation environment that not only enhances the user experience but also contributes to the development of smart cities. This holistic approach includes the implementation of intelligent transportation systems (ITS), which provide real-time traffic forecasting; urban mobility as a service (MaaS), which optimizes routes for users; and on-demand transportation services, which ensure equitable access to public transportation, especially in remote areas.

8.8.1.1. Development of Intelligent Transportation Systems (ITS)[387]

The development of the Intelligent Transportation System (ITS) has been significantly driven by advancements in smart technologies, as well as the integration of various disciplines such as computing, data analysis, and artificial intelligence. The ability to perform precise calculations and efficiently manage information is key within ITS, enabling more accurate, comfortable, and convenient mobility that effectively connects different locations. The use of these technologies is essential for planning and operating public transportation routes, ensuring that resources are used optimally and that services are accessible and reliable for all users.

[386] This section has been prepared based on the following document: Ministry of Transportation and Communications, R.O.C. (2020). 2020 ITS World Congress in Taipei: Innovation and Intelligent Transportation for Sustainability. CW LAB Advertisement Design and Production. Available at: https://event.cw.com.tw/2020its_en/

[387] Ministry of Transportation and Communications (MOTC). (2022). One touch to start the green riding formula. CommonWealth Magazine. Available at: https://english.cw.com.tw/article/article.action?id=2784

The implementation of connected and autonomous vehicle technologies has been a key component in modernizing the ITS. These technological innovations not only enhance safety on the roads but also optimize transportation efficiency by facilitating interaction between vehicles and smart road infrastructure. This technological integration helps reduce congestion and improves the user experience in both densely populated urban areas and rural zones.

Regarding the development strategies for the ITS, there is a strong emphasis on safety and traffic flow. The design of the ITS is aimed at addressing fundamental issues such as road safety and vehicular congestion. To achieve this, smart technologies have been incorporated into transportation infrastructure, such as sensors and early warning systems, which help reduce the incidence of accidents and improve traffic flow. Additionally, the integration of transportation resources through shared mobility platforms, such as bicycles and electric scooters, has proven to be an effective solution for providing users with greater flexibility in their movements, thereby reducing reliance on private vehicles and contributing to lower carbon emissions. Another fundamental aspect of the ITS is the implementation of the concept of Mobility as a Service (MaaS).

The development of the Intelligent Transportation System (ITS) has been made possible through close collaboration between the Ministry of Transportation and Communications and various institutions, such as the Institute for Information Industry. This collaboration has been key in carrying out innovative projects in areas such as scooter safety and the application of autonomous driving technologies in urban environments. Furthermore, the ITS has extended its impact to rural and remote areas, where efforts have been made to improve transportation access through projects like the "Happy Bus" and on-demand transportation services. These initiatives have proven effective in enhancing the quality of life in these areas, providing safe and convenient transportation solutions for residents.

Looking ahead, the ITS in Chinese Taipei is poised to capitalize on the opportunities presented by 5G technology, enabling the replication and scaling of existing technological outcomes while experimenting with new solutions to further improve transportation efficiency and safety. However, significant challenges remain, especially regarding the implementation of autonomous vehicles. The interaction between autonomous and non-autonomous vehicles, as well as these systems' ability to handle complex real-life situations, are areas that require ongoing attention to ensure the safety and effectiveness of the system.

In conclusion, the development of the ITS in Chinese Taipei has been a comprehensive process that combines technological innovation, interdisciplinary collaboration, and a user-centered approach. As technologies continue to evolve and integrate into daily life, the ITS not only enhances mobility in urban areas but also addresses the needs of rural regions, contributing to the creation of a more equitable, safe, and sustainable transportation system. The future of the ITS is closely tied to the evolution of emerging technologies, promising to continue transforming mobility in Chinese Taipei and beyond.

- **Intelligent Forecasting for Smooth Traffic Flow.**

Chinese Taipei has developed an Intelligent Transportation System as a key component of its urban mobility strategy. This system integrates various transportation modes through a public ticketing platform that centralizes ticket purchasing and facilitates efficient transitions between different means of transport. Additionally, the use of big data allows for the identification of mobility hotspots and real-time adjustments to routes and service frequencies, thereby responding more accurately to user demand. Multimodal integration is evident in plans such as the shuttle bus service for arrivals from the high-speed rail, which ensures seamless connections between different modes of transportation. Innovations like applications for automated or driverless vehicles reflect the region's commitment to modernizing transport, enhancing the safety and efficiency of the system. Moreover, intelligent traffic management relies on technologies for automated parking and automatic data collection, contributing to the reduction of road congestion. Fleet driving technology, which enables autonomous driving in vehicles that follow a leader, optimizes vehicle operation and reduces the need for human intervention. Finally, cooperation with passengers in flexible route planning allows for services to adapt to changing needs, thereby mitigating congestion issues. These elements reflect a comprehensive approach to creating a more efficient, connected urban transportation system that meets the contemporary mobility needs of Chinese Taipei.

- **Mobility as a Service (MaaS): Providing Better Routes.**

The concept of MaaS is a central piece in modernizing urban mobility in Chinese Taipei integrating all modes of transportation into a single platform accessible via mobile devices. Through a mobile app, users can manage their transport tickets and payments, combining options such as mobile payment, e-tickets, and credit cards for a seamless user experience. This platform connects all means of transportation, providing accurate information about the status and available routes, facilitating efficient trip planning.

Additionally, the MaaS system includes options like car-sharing rentals, which can be easily coordinated through the app, matching users to share rides and reduce costs. The option for scooters is also integrated, offering new personal mobility alternatives for road users. The system is designed to connect relevant infrastructure such as parking lots and EV charging stations, ensuring that users can access all necessary resources during their journey. Finally, the use of real-time information for route adjustments and traffic suggestions allows for dynamic adaptation to road conditions, improving efficiency and reducing travel time. This comprehensive approach not only optimizes the user experience.

On-Demand Transportation System: Equality in Traffic. Residents of remote areas can also enjoy public transportation.

Finally, the On-Demand Transportation System in Chinese Taipei is designed to respond to the specific mobility needs in areas with low population density or in remote communities. This system allows users to make flexible reservations via phone, mobile apps, and the Internet, facilitating accessibility and convenience in planning their journeys. The buses in the on-demand transportation system are designed to flexibly adjust to local demand, adapting their routes and schedules based on transportation needs, which include trips for work, medical treatments, and access to educational centers. Additionally, statistics on mobility hotspots are collected before establishing stops, ensuring that services are implemented efficiently and, in the places, where they are most needed. The system also incorporates autonomous driving technology for the transportation of both passengers and goods, enhancing operational efficiency and reducing the need for human drivers. By improving urban mobility services in these areas, the on-demand transportation system offers an effective solution to ensure that all areas, regardless of their population density, have access to quality public transportation that aligns with local demands and geographic realities.

- **Autonomous Buses[388]**

[388] Ministry of Transportation and Communications (MOTC). (2022). MIT self-driving buses drive you into a smart future. CommonWealth Magazine. Available at: https://english.cw.com.tw/article/article.action?id=2785

The development of autonomous bus technology is rapidly transforming the public transportation sector. The combination of autonomous technology with zero-emission and electric vehicle (EV) concepts aims to address traffic issues in metropolitan areas, altering the structure of urban transportation. This innovation not only provides a solution to congestion but also promotes the creation of a more efficient and eco-friendly transportation system.

Chinese Taipei has joined this global trend by forming teams known as 'Made in Chinese Taipei,' which collaborate with government ministries and local authorities to create autonomous transportation services, especially in tourist areas, communities, and university campuses. Autonomous buses are beginning to operate steadily and are making a significant impact on the public transportation economy. The development of these vehicles, driven by high computing technology, radar, LIDAR, and optical lenses, has equipped autonomous buses with advanced capabilities to manage traffic in real time and improve road safety.

In 2018, the Unmanned Vehicle Technology Experimentation Act was enacted, allowing for the establishment of a flexible regulatory framework to test these technologies in controlled and safe environments. A notable example is the WinBus, an electric autonomous bus developed in collaboration with the Automotive Research and Testing Center and more than 20 Chinese Taipei's companies. This vehicle not only meets level 4 autonomous capability according to the Society of Automotive Engineers but also operates without a steering wheel, driver's seat, brake, or accelerator, showcasing an innovative design with U-shaped seating, touch panels, and advanced safety systems.

The WinBus is designed to operate in real traffic conditions, with its first implementation taking place in the Changbin Industrial Park, where its ability to handle complex scenarios will be evaluated. This project not only strengthens the capabilities of autonomous vehicles regarding authentication and road testing but also aims to reduce production costs to make this type of transportation available to a broader audience. This represents a significant step toward creating a new generation of autonomous electric buses with considerable added value.

Furthermore, companies like Turing Drive, in collaboration with the Taipei City Government, are conducting tests of autonomous buses on specific routes at night. These projects focus on bridging the gap in nighttime public transportation and addressing the shortage of drivers, which is expected to further drive the application of autonomous driving technology in Chinese Taipei. Turing Drive has demonstrated success in multiple scenarios, providing services to over 57,000 passengers and accumulating more than 18,000 kilometers of autonomous operation at events such as the Taoyuan Agricultural Expo and the Lihpao Resort in Taichung.

The technology of autonomous vehicles in Chinese Taipei is also gaining traction in international markets, with cooperative projects such as a seven-year agreement with Singapore, positioning Chinese Taipei's companies in the global competition in autonomous driving. Companies like Turing Drive are leveraging their expertise and technology to expand their application to other unmanned vehicles, such as street-sweeping trucks and autonomous agricultural machinery, promising to improve operational efficiency and reduce costs.

- **Transportation in Remote Areas** [389]

The Ministry of Transportation and Communications of Chinese Taipei has committed to dedicating all its resources to the development of smart transportation that provides technological solutions tailored to mobility issues in remote areas. This way, transportation services will be available where they are most needed, ensuring that populations in remote areas of all ages can return home more quickly and efficiently. This approach seeks to overcome the barriers faced by communities in isolated areas, significantly improving their quality of life.

The reality for those living in remote areas is hard to imagine for those residing in metropolitan areas. The lack of transportation and connectivity directly affects these individuals' opportunities, impacting their well-being and happiness. Modern and intelligent technology has the potential to integrate available resources and labor, providing innovative solutions that enable people of all ages to share rides in rural areas.

In cities, boarding a bus or taxi is a common and easy occurrence, but in rural areas, children and the elderly must wait patiently for some form of transportation to satisfy their travel needs. In the future, the Ministry of Transportation and Communications will further promote the development of smart transportation for remote areas, applying technologies to ensure these services reach those who need them most. This aims to respect the transportation rights of people in rural areas and ensure equitable access.

In places like the indigenous tribes of Hualien and Taitung, many young people must leave their villages to work in urban areas, leaving children and the elderly at home. In these areas, transportation is extremely limited due to the dispersion of tribes and the scarcity of bus routes. Often, children must drive scooters to school, even without a license, while the elderly, who cannot drive, find themselves isolated in their homes, unable to visit doctors or shop. This situation leaves many elderly individuals suffering in loneliness and without access to basic services.

A potential solution to this problem is the promotion of ride-sharing services that leverage local resources and vehicles. In Yenping Township, Taitung County, the Ministry of Transportation and Communications, along with the local government, launched a project in 2017 to facilitate transportation for residents. Using medium-sized buses that already existed in the district office, fixed routes and weekly schedules were established to transport residents to schools, hospitals, or shopping. Subsequently, the service was expanded with the introduction of small yellow buses that connect scattered villages, offering a reservation service for residents wishing to be taken home.

Additionally, a "carpooling" system was implemented, where local residents use their own vehicles to transport others, which has been particularly useful for students needing to travel to school and for elderly individuals who need to leave home. Carpooling has helped address some of the most urgent needs of these communities, providing a flexible and accessible solution.
To facilitate this process, a local matching service platform was created to help coordinate shared rides. In many cases, elderly individuals do not know how to make online reservations, so social workers or staff from community associations assist them in making these arrangements by phone. In this way, residents can receive reminders about their reservations, and drivers can be easily found through the system.

[389] Ministry of Transportation and Communications (MOTC). (2022). **Remote areas are not remote and homes are just steps away**. CommonWealth Magazine. Available at: https://english.cw.com.tw/article/article.action?id=2786

Looking ahead, it is expected that these carpooling services could expand and offer broader services, addressing not only daily needs but also those times when transportation is more limited, such as during the night or on weekends. In an interview with the MOTC, Zheng-Jie Chen[390], the Director of the Eastern Transportation Research and Development Center and a professor at National Dong Hwa University, expressed that with more legally qualified drivers and vehicles, indigenous tribes will not only be able to meet their own transportation needs but also accommodate more tourists, promoting the development of local tourism and improving the economy of these areas.

8.8.2. Energy Policies Related to the Transition to Electromobility [391]

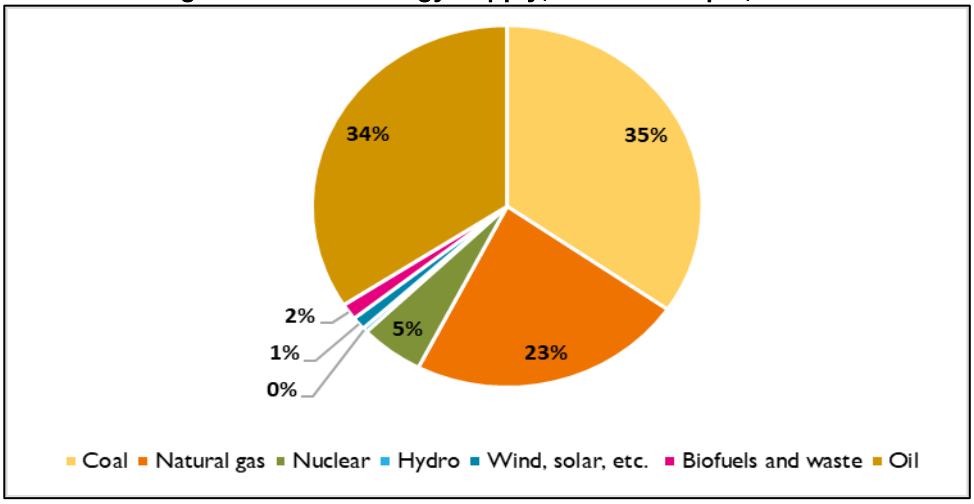
At the end of the 2010s, the government of Chinese Taipei enacted the Renewable Energy Development Statute, which is a key piece of legislation aimed at reducing CO2 emissions, improving energy diversification, and fostering the green energy industry. One of the main objectives of this regulatory framework is to increase the proportion of electricity generated from renewable sources, aiming for at least 8% of electricity to come from clean energy by 2025. This strategy reflects Chinese Taipei's commitment to sustainability and energy transition.

Despite the Chinese Taipei’s government's efforts to promote the development of renewable energy, the economy still faces significant challenges related to its dependence on fossil fuels. In 2022, 35% of primary energy in Chinese Taipei came from coal, while oil accounted for 34%, highlighting the significant weight that these non-renewable energy sources still hold in the economy’s energy matrix (see Figure 79). This situation underscores the critical importance of transitioning to clean energy, not only to meet CO2 emission reduction targets but also to decrease dependence on imported energy resources, which currently dominate Chinese Taipei's energy production.

On the other hand, nuclear energy remains an important source of domestic energy production, accounting for 59% of output in the same year. However, in line with government policies, there has been growth in the production of renewable energy, particularly from wind and solar sources, although these still constitute a relatively small fraction of the total energy supply. The goal of achieving 8% of electricity generation from renewable energies by 2025, as established in the Renewable Energy Development Statute, is a fundamental step toward a more diversified and sustainable energy matrix.

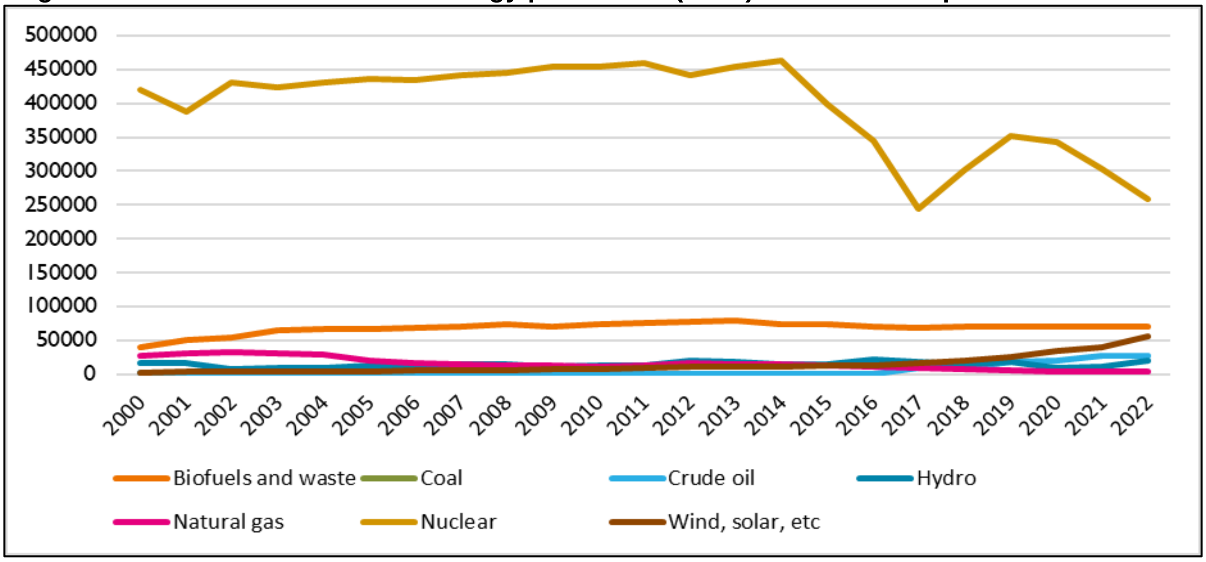
[390] Ministry of Transportation and Communications (MOTC). (2022). **Remote areas are not remote and homes are just steps away**. CommonWealth Magazine. Available at: https://english.cw.com.tw/article/article.action?id=2786
[391] Esta sección se ha elaborado sobre la base del siguiente documento: International Energy Agency (IEA). (n.d.). **Chinese Taipei**. International Energy Agency. Available at: https://www.iea.org/countries/chinese-taipei

Figure 79. Total energy supply, Chinese Taipei, 2022



Source: International Energy Agency (2024)

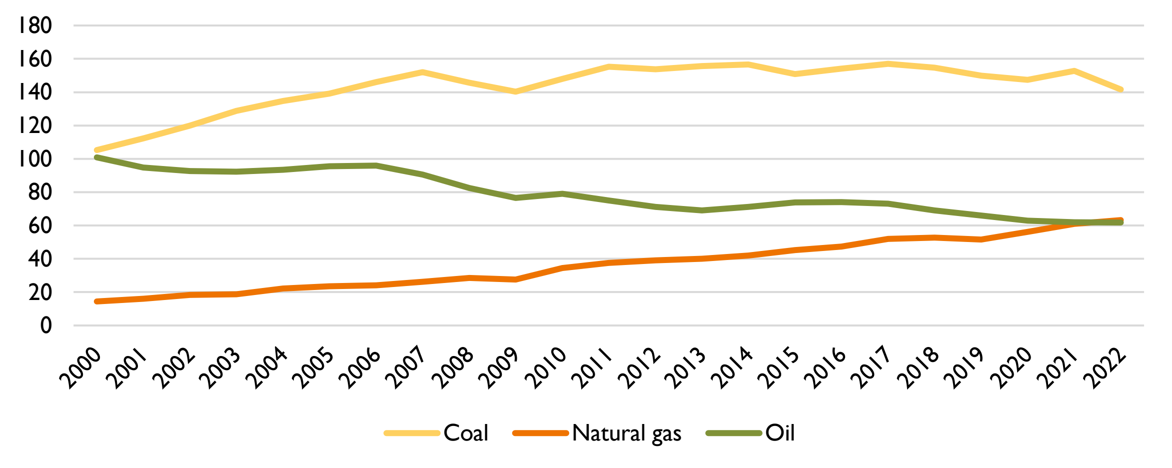
Figure 80. Evolution of domestic energy production (in TJ) in Chinese Taipei since 2000



Source: International Energy Agency (2024)

In 2022, Chinese Taipei's energy sector continued to significantly depend on fossil fuels, especially coal, which accounted for 53.1% of the total CO2 emissions from fuel combustion. This figure reflects the predominant use of coal in electricity and heat production, making it one of the main sources of polluting emissions in the economy. Additionally, oil and natural gas represented 23.2% and 23.5%, respectively, of CO2 emissions, underscoring the importance of accelerating the transition to cleaner and more sustainable energy sources to mitigate environmental impact.

Figure 81. Evolution of CO2 emissions by fuel in Chinese Taipei since 2000



Source: International Energy Agency (2024)

2050 Net zero pathway and strategy[392]

The document titled "Chinese Taipei's Net Zero Emissions Pathway and Strategy for 2050" is a central piece in Chinese Taipei's effort to confront the global challenge of climate change and fulfill international commitments related to carbon emission reduction. Published by the National Development Council in 2022, this document represents a comprehensive plan detailing the strategic pathways that the economy will adopt to achieve carbon neutrality by 2050. With a multidimensional approach, the strategy addresses both the technical and social-economic challenges of the energy transition, presenting a robust and coordinated approach among various government areas and industrial sectors.

The document establishes four fundamental areas of transformation as its core pillars: i) energy, ii) industry, iii) daily life, and iv) society. In the energy sector, it explores pathways for expanding alternative energy sources, such as wind and solar energy, while promoting the electrification of transportation and improving energy storage systems. In the industrial sector, it emphasizes the need to adopt cleaner technologies, promote energy efficiency, and transform production patterns towards a circular economy, where waste is minimized and resources are used more efficiently.

The report also places great emphasis on developing regulatory frameworks that facilitate this transition to a low-carbon future, highlighting the importance of public policies in areas such as technological innovation, scientific research, and investment in green infrastructure. Additionally, it underscores the need to engage society as a whole, from businesses to citizens, to achieve profound changes in consumption patterns and attitudes toward sustainability.

Among the key points, the document recognizes that climate change is not only an environmental issue but also a challenge for economic development and energy security. Therefore, it addresses aspects related to a just transition, ensuring that workers and communities affected by the phase-out of fossil fuels can adapt and thrive in this new green economy.

[392] National Development Council, Environmental Protection Administration, Ministry of Economic Affairs, Ministry of Science and Technology, Ministry of Transportation and Communications, Ministry of the Interior, Council of Agriculture, & Financial Supervisory Commission. (2022). 臺灣2050淨零排放路徑及策略總說明 [Chinese Taipei's 2050 Pathway to Net-Zero Emissions]. National Development Council. Available at:https://www.ndc.gov.tw/Content_List.aspx?n=DEE68AAD8B38BD76

Finally, the document emphasizes the urgency of reducing greenhouse gas emissions, acknowledging the international pressure and commitments made under global agreements like the Paris Agreement. The Chinese Taipeiese government commits to implementing ambitious and coordinated measures to ensure that Chinese Taipei not only achieves carbon neutrality by 2050 but also positions itself as a leader in the innovation and adoption of sustainable technologies, paving the way for a more resilient and sustainable future for its citizens.

- **Alternative Energy**

The Taipei government has set ambitious goals to increase its electricity generation capacity from alternative energy sources such as geothermal, biomass, and tidal energy. Specifically, the economy aims to generate between 8 and 14 GW of electricity from these sources to contribute to energy diversification and carbon emission reduction. To achieve this goal, a specific budget has been allocated to finance the development of new infrastructure that enhances the installed capacity in these areas. This commitment reflects not only Chinese Taipei's interest in reducing its dependence on fossil fuels but also its intention to lead innovation in sustainable and environmentally friendly alternative energy technologies.

The inclusion of these less conventional sources in Chinese Taipei's energy portfolio not only addresses the need to diversify the energy matrix but also takes advantage of the economy´s specific natural resources. Geothermal energy, in particular, has significant potential due to the island's geological location, while tidal energy offers a viable option thanks to Chinese Taipei's extensive coastline. Biomass complements these options by providing an energy solution that utilizes organic waste, contributing to a more efficient circular economy.

- **Solar and Wind Energy**

Wind and solar energy are central to Taipei's energy strategy, and the government has outlined ambitious objectives to increase generation capacity from these renewable sources. In the realm of offshore wind energy, the plan includes the installation of offshore turbines with a total capacity of 13.1 GW by 2030, with the goal of expanding this capacity to between 44 and 55 GW by 2050. This expansion reflects the commitment to harness the vast potential of offshore wind energy, given the island's strategic location and favorable geographic conditions.

On the other hand, the government has also set significant targets for solar energy. By 2030, the additional solar generation capacity is expected to reach 30 GW, with a projected increase ranging from 40 to 80 GW by 2050. These investments aim to solidify a robust renewable energy infrastructure that not only diversifies the energy matrix but also decisively contributes to carbon emission reduction and strengthens Chinese Taipei's energy security. The government is promoting policies that encourage investment in these technologies as well as the development of the necessary infrastructure for their widespread implementation.

- **Power systems and energy storage**

The development of advanced electrical systems and energy storage solutions is a crucial component of Chinese Taipei's strategy to ensure a sustainable and reliable energy supply within its plan for carbon neutrality by 2050. Modern electrical systems, which integrate both renewable and conventional energy sources, require a robust and flexible power grid capable of handling the intermittency of solar and wind energy. To address these challenges, Chinese Taipei is investing in the modernization of its grid infrastructure, adopting smart grids that optimize energy use, enable better demand management, and ensure the stability of the energy system. As part of this modernization, the Taipei government has allocated specific funds to strengthen the operational resilience of the power grid and enhance the system's integration capacity, ensuring greater efficiency in the integration of renewable energies.

Energy storage is equally fundamental to the transition towards a greener energy matrix. Storage technologies, such as large-capacity batteries, allow for the storage of surplus energy generated from renewable sources and its release when demand requires it or when weather conditions are unfavorable for solar or wind energy generation. Chinese Taipei has identified energy storage as a priority in its energy agenda, with pilot projects aimed at assessing the viability of various battery technologies, including lithium-ion technology and other innovative alternatives. By 2030, the government aims to deploy an energy storage capacity of 5.5 GW, with the goal of optimizing supply stability and reducing reliance on real-time energy generation, significantly contributing to the resilience of the economy's energy system.

In addition to batteries, other storage technologies, such as pumped hydro storage, are being explored as part of a comprehensive approach to ensure a more stable energy supply. These innovations not only support the integration of renewable energies but also play a crucial role in reducing carbon emissions by minimizing the need to rely on fossil fuel sources during peak demand periods. Together, the modernization of electrical systems and the expansion of energy storage capacities position the Chinese Taipeiese economy as a key player in the energy transition in the region.

8.8.3. Specific Policies for Electromobility

Net Zero Emissions Route and Strategy for 2050

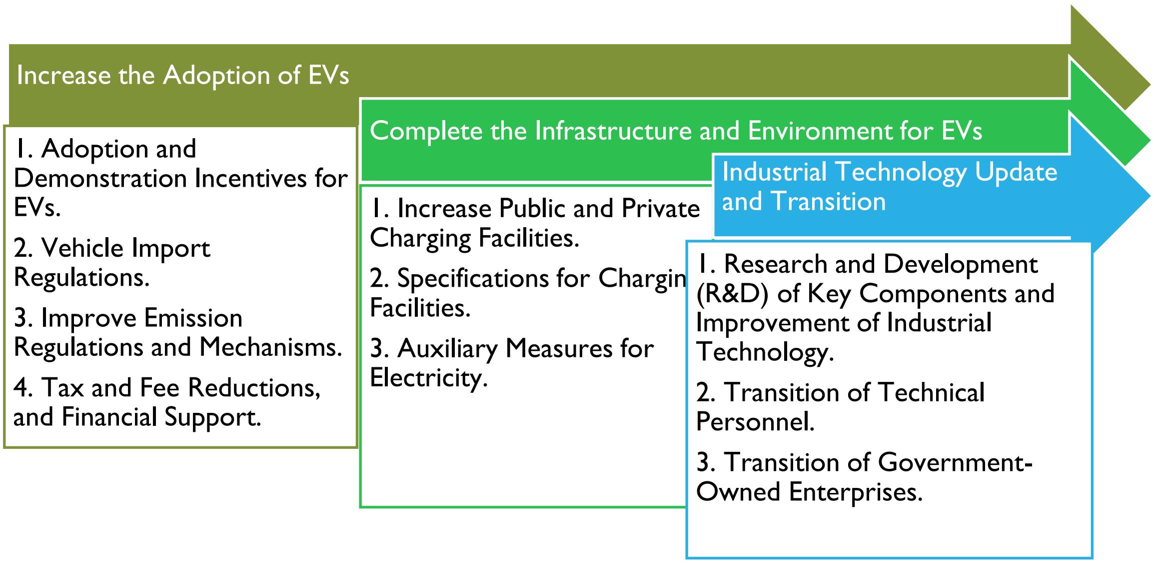
Taipei's approach to decarbonizing public transport is clearly defined in its "Net Zero Emissions Route and Strategy for 2050," announced in March 2022. Within this framework, twelve key strategies are highlighted, one of the most relevant being the electrification of road vehicles. This strategy focuses on the development of EV technology, the promotion of EVs, the improvement of the environment for their use, and the deployment of concrete policies, strategies, and objectives. In this regard, three major goals are outlined[393]:

- Increase the Adoption of EVs
- Complete the Infrastructure and Environment for EVs
- Promote the Update and Transition of Industrial Technology

Each of these objectives follows a series of steps that will ensure their fulfillment (See Figure 82).

[393] Ministry of Environment. Chinese Taipei's 2050 Net Zero Carbon Emission Path and Strategic Planning, ELECTRIC & CARBON-FREE VEHICLES. Available at: https://service.cca.gov.tw/File/Get/climatetalks/zh-tw/YaujFH6FboOTMDG

Figure 82. Steps According to the Net Zero Emissions Route and Strategy Objectives for 2050



Source: Ministry of Environment. Chinese Taipei's 2050 Net Zero Carbon Emission Path and Strategic Planning, ELECTRIC & CARBON-FREE VEHICLES.

The strategy places special emphasis on promoting electric transportation modes, prioritizing mature technologies such as electric buses, electric private vehicles, and scooters. With a view toward 2030, the complete electrification of the bus fleet is projected, along with achieving a 100% share of electric cars and motorcycles in the market by 2024. These ambitious goals reflect the government's strong commitment to transforming its transportation system into a more sustainable model.

Complete Electrification of Buses

The transition to a large-scale fleet of electric buses presents significant challenges. These include efficient energy management, the complexity of supplying and scheduling electric demand, and space limitations for charging infrastructure. The simultaneous rapid charging of a large number of electric vehicles (EVs) adds an additional layer of difficulty to energy planning and the stability of the electrical grid.

To address these challenges, Chinese Taipei's strategy incorporates the integration of advanced technologies such as AI and the Internet of Things (IoT) in transportation management. Additionally, there is an emphasis on the need for smart transportation and effective energy management to optimize existing infrastructure and accelerate the electrification process of buses toward the set goal for 2030. This vision for the complete electrification of buses encompasses not only the electrification of the buses themselves but also the integration of intelligent transportation and energy solutions specifically designed to tackle the inherent challenges of this transition.

The focus is on developing the first integrated transportation and energy solution for smart cities, specially designed for electric bus fleets. This solution is also adaptable to other types of vehicles, such as electric cars and electric logistics vehicles. The vision aims to effectively address the challenges that arise with the mass electrification of vehicles, such as energy management, the complexity of electrical supply, and space limitations for charging infrastructure, by incorporating emerging technologies associated with the Internet of Things. This solution aims to optimize both energy management and demand planning, allowing for a more flexible and efficient infrastructure.

Chinese Taipei's strategy goes beyond the electrification of buses by incorporating VR technology for energy management. This innovative system allows EV fleets, such as buses, to function as "mobile energy storage," returning energy to the grid during peak demand periods. This integration not only enhances urban energy resilience but also opens new revenue opportunities for charging infrastructure developers while optimizing resource and space utilization.

Additionally, Chinese Taipei has implemented an intelligent transportation system that integrates IoT technologies for the management of electric bus fleets. This cloud-based system collects real-time data from both vehicles and charging stations, enabling efficient energy management and dynamic fleet scheduling. The optimization of charging schedules and power through an intelligent charging system maximizes efficiency and reduces operational costs, thereby improving the availability and performance of electric buses.

To tackle the challenges associated with the electrification of the bus fleet, Chinese Taipei has developed a comprehensive strategy based on several key measures. One of the main initiatives is the standardization of charging interfaces, a crucial aspect for interoperability and efficiency in the implementation of charging infrastructure. To achieve this, an interdepartmental coordination mechanism was established to facilitate collaboration between different government agencies and the charging industry. This cooperation was formalized through an alliance with the electric charging industry, allowing for a consensus on the standard interface for electric buses.

The selected standard, CCS1+N, was adopted as the charging interface for all electric buses in Chinese Taipei. This decision was supported by subsidy policies that require the use of this interface for all electric buses purchased under these financial support programs. The implementation of a unified standard not only simplifies the electrification process but also enhances the effectiveness and expansion of electric bus usage by reducing technical and operational barriers, thus facilitating their mass adoption in the public transportation system.

Furthermore, collaboration among various units has been promoted to test and deploy electric bus stations, starting in Taipei City and subsequently expanding to other major cities in Chinese Taipei, with the vision of extending to other APEC economies in later phases.

Electric Vehicles

The vehicle electrification strategy aims to incentivize the use of light electric vehicles (EVs) through subsidies for the purchase of electric taxis and private vehicles. As a result, it is expected that by 2030, electric cars will represent 30% of annual light vehicle sales, a figure that will increase to 60% by 2035. Thus, by 2040, all new cars sold will be electric. A similar goal has been set for electric motorcycles, with a target of 35% by 2030 and 70% by 2035, with the expectation that all new motorcycles sold in 2040 will be electric. This ambitious transportation electrification plan seeks to completely transform the economy's vehicle fleet in the next two decades[394].

In support of these goals, current incentives offer exemptions on the fuel usage tax for cars, as well as on the goods tax and vehicle licensing tax, until 31 December 2025. Additionally, parking facilities managed by local governments provide discounts or partial exemptions on parking and charging fees for electric vehicles (EVs), creating an

[394]National Development Commission, Environmental Protection Administration of the Executive Yuan (2022). Overview of Chinese Taipei's Pathway and Strategy for Carbon Neutrality by 2050. Available at: https://www.ndc.gov.tw/Content_List.aspx?n=DEE68AAD8B38BD76

additional incentive for citizens to choose this mode of transportation[395]. These initiatives represent a crucial step toward fostering the early adoption of electric vehicles (EVs), creating a more accessible and attractive environment for users.

Aligned with these efforts, among other incentives, the installation of charging stations in residential, commercial, and public spaces will be promoted. Additionally, management strategies will be implemented to facilitate the use of EVs, such as issuing exclusive license plates, exempting fuel taxes, and allocating parking spaces dedicated to charging these vehicles. These measures will not only enhance the necessary infrastructure for EVs but also create a more favorable environment for their mass adoption.

Finally, energy efficiency standards for new vehicles produced will be raised, and regulations on carbon dioxide emissions for light-duty vehicles, trucks, and motorcycles will be gradually tightened. This will ensure that, in addition to electrification, vehicles produced in the future are more efficient and generate lower emissions, thus promoting cleaner and more sustainable transportation throughout the economy.

Incentives for the domestic industry

The Chinese Taipei's government is implementing various strategies to promote the development and production of domestic EVs, with a particular focus on the electric bus industry. Through subsidy programs aimed at demonstrating effects, the creation and localization of key components will be incentivized, strengthening local technological capabilities. Additionally, incentives will be proposed for the production of smart EVs, thereby accelerating the growth of this sector. This push aims not only to meet the growing domestic demand for electric transportation but also to position Chinese Taipei in the international market as a leader in EV manufacturing[396].

In line with these efforts, Chinese Taipei's Ministry of Finance has promoted a legislative framework to incentivize the use of electric vehicles (EVs) by reducing the goods tax by 50%. This measure, outlined in Article 12, Paragraph 4 of the Goods Tax Ordinance, aims to encourage the development of the EV industry, reduce energy consumption, and decrease air pollution. Through this, the government seeks to make the acquisition of these vehicles more accessible, aligning fiscal policies with sustainability goals[397].

For electric vehicles (EVs) to benefit from this tax reduction, they must meet a series of specific standards that ensure their efficiency and low environmental impact. These include a taxable value of less than TWD1 million, an engine displacement of less than 3,000 cubic centimeters, a fuel consumption of at least 19 kilometers per liter, and carbon emissions below 120 grams per kilometer. These requirements ensure that only vehicles that truly contribute to emission reduction and energy savings goals can benefit from tax incentives, thereby promoting a transition to cleaner and more efficient transportation.

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[395] International Trade Administration (2023). Chinese Taipei Electric Vehicles. https://www.trade.gov/market-intelligence/Chinese Taipei-electric-vehicle

[396] National Development Commission, Environmental Protection Administration of the Executive Yuan (2022). Overview of Chinese Taipei's Pathway and Strategy for Carbon Neutrality by 2050. Available at: https://www.ndc.gov.tw/Content_List.aspx?n=DEE68AAD8B38BD76

[397] Asociación de Contadores Públicos de Taipéi.
Taipei Association of Certified Public Accountants. Applicable Standards for the Halving of the Commodity Tax on EVs in accordance with Section 4 of Article 12 of the Commodity Tax Act for Gasoline-Electric Hybrid Vehicles. Available at: https://www.taipeicpb.org.tw/news/index.php?id=6035

8.8.4. Sucess Cases

Role of Electromobility in Greenhouse Gas Emission Reduction

The vehicle electrification strategy has played a key role in the success of the sustainable transportation system in New Taipei. In 2020 alone, the Airport Metro Line transported over 18.5 million passengers, solidifying the impact of these actions on emission reduction. Based on traffic data and surveys, initiatives to develop a sustainable urban transportation system led to an estimated annual decrease of 141,648 metric tons of CO2 equivalent, a clear example of success in the transition to green mobility.

In particular, the promotion of electromobility and the encouragement of public bike rentals resulted in a reduction of 6,598 metric tons of CO2 equivalent in 2020, highlighting the fundamental role of electric vehicles (EVs) in this advancement. The adoption of EVs, both public and private, has not only reduced greenhouse gas emissions but also improved air quality in the city, contributing to a decrease in PM2.5 levels from 22.7 µg/m³ in 2014 to 14.2 µg/m³ in 2021. This evolution reinforces the importance of electromobility as a decisive factor in pollution reduction and public health improvement, positioning New Taipei City as a successful example of the transition to a cleaner and more efficient transportation system.[398].

8.8.5. Limitations, Opportunities, and Challenges for the Automotive Industry in the Transition to Electromobility[399]

The automotive industry in Chinese Taipei, faces several limitations, opportunities, and challenges in its transition to electromobility. One of the main limitations is that many of the technologies needed to fully decarbonize vehicles are still in the early stages of development or in demonstration phases. This presents a barrier to the mass adoption of electric vehicles (EVs), as these technological innovations will not be fully ready until after 2030. Additionally, the automotive industry continues to rely on an energy infrastructure that is still being adapted to support the additional load required for the mass electrification of vehicles. Although efforts are being made to reduce dependence on fossil fuels, there remains a significant gap between the supply of clean energy and the needs of the automotive sector.

However, there are also interesting opportunities for the industry. Chinese Taipei is one of the world leaders in the semiconductor and information and communication technology sectors, allowing it to leverage its expertise in these fields to develop advanced components and smart mobility technologies. This context creates a significant opportunity for the local automotive industry to play a key role in the production of electric vehicles (EVs) and related technological solutions. Furthermore, the government has implemented a system of subsidies and financial support to encourage the transition to electromobility, creating a favorable environment for automotive companies to develop and market EVs both locally and internationally.

Despite the above, the industry faces significant challenges. International competition is intense, as other countries are also rapidly advancing in the development of EVs and related technologies. To maintain the competitiveness of its economy, the government of Chinese Taipei plans to accelerate technological innovation and improve its production

[398] https://climatehealthevidence.org/case-studies/developing-sustainable-urban-transport-new-taipei

[399]This section has been prepared based on the document: National Development Council, Environmental Protection Administration, Ministry of Economic Affairs, Ministry of Science and Technology, Ministry of Transportation and Communications, Ministry of the Interior, Council of Agriculture, & Financial Supervisory Commission. (2022). 臺灣2050淨零排放路徑及策略總說明 [Chinese Taipei's 2050 Pathway to Net-Zero Emissions]. National Development Council. Available at: https://www.ndc.gov.tw/Content_List.aspx?n=DEE68AAD8B38BD76

capacity. Additionally, the stability of the electrical system poses a significant challenge for the automotive industry, as the mass electrification of vehicles will increase energy demand and could put pressure on existing infrastructure. Finally, public acceptance and consumer behavior are critical factors for the success of the transition to EVs. Although government policies are favorable, it is essential for the public to be fully committed to this transition for the adoption of EVs to accelerate and sustain.

8.9. The United States

8.9.1. Urban Mobility Policies Related to the Transition to Electromobility

Strategic Plan of the United States Department of Transportation (DOT) (2022-2026): Urban Mobility and Transportation[400]

The United States Department of Transportation's (U.S. DOT) Strategic Plan for fiscal years 2022-2026 provides a comprehensive framework for improving transportation systems across the economy. This document highlights key policies and initiatives aimed at enhancing urban mobility, promoting sustainable transportation, and advancing electromobility.

The plan underscores the importance of safety, equity, economic sustainability, and technological transformation in the transportation system. In particular, it emphasizes the need to modernize transportation infrastructure to support economic growth and create jobs. The plan also promotes the electrification of transportation infrastructure, including the installation of EV charging stations and the electrification of school and public transport buses. These initiatives are crucial for reducing GHG emissions and improving air quality in urban areas.

Additionally, the plan emphasizes the importance of inclusive transportation systems that increase opportunities and advance racial and environmental justice, especially in underserved communities. Expanding affordable access to transportation is a priority, along with developing infrastructure that supports active transportation modes such as walking and cycling. These measures not only improve quality of life but also contribute to environmental sustainability by reducing dependence on internal combustion vehicles.

The document also addresses the need for resilient infrastructure that can adapt to climate change and withstand natural disasters. Investments in resilient infrastructure and updating regulations are fundamental to ensuring transportation systems can meet these challenges. Furthermore, the importance of research and innovation in transportation technologies is highlighted, fostering the adoption of innovative practices that improve the efficiency and sustainability of urban transportation.

A key component of the Plan is the development of a network of EV charging stations, facilitating EV adoption in urban and rural areas. The transition to electric buses in urban public transportation systems is another priority, aimed at reducing emissions and improving air quality. These initiatives are complemented by financial and fiscal incentives for the adoption of EVs and hybrids, as well as the promotion of clean and efficient technologies.

The Plan also promotes infrastructure for active transportation, supporting the construction of safe and accessible bike lanes and pedestrian paths. Integrating these modes of transportation with public transportation systems is crucial for fostering

[400] U.S. Department of Transportation. (2022). *U.S. DOT Strategic Plan FY 2022-2026*. Available at: https://www.transportation.gov/mission/us-dot-strategic-plan-fy-2022-2026

sustainable and equitable urban mobility. Regulations for the energy efficiency and emissions of new vehicles, including mandatory energy labeling, enable consumers to make informed decisions and encourage the adoption of clean technologies.

In conclusion, the U.S. DOT's Strategic Plan for 2022-2026 presents a clear and ambitious vision for transforming urban mobility in the United States. By modernizing infrastructure, developing electromobility, enhancing safety and resilience, and promoting equity and sustainability, the Plan aims to create a transportation system that benefits all citizens. These measures will not only address immediate needs but also establish a solid foundation for future development, improving quality of life and promoting sustainable economic growth.

Guidebook for Deploying Zero-Emission Transit Buses[401]

The "Guidebook for Deploying Zero-Emission Transit Buses" is an essential tool for public transportation agencies seeking to implement ZEBs. This document, supported by research from the Transit Cooperative Research Program (TCRP), offers best practices, case studies, and lessons learned from previous deployments of BEB and fuel cell electric buses (FCEBs), as well as the associated charging and hydrogen refueling infrastructure.

One of the main objectives of this guide is to provide transit agencies with the necessary information to maximize the benefits of their ZEB implementation and mitigate potential risks. Recognizing that each deployment will be guided by the specific needs and priorities of the agency, the guide does not offer prescriptive answers for every decision but provides the context and knowledge needed to understand the complexity of a ZEB deployment. Additionally, it emphasizes the importance of building and maintaining successful relationships with technology providers, utility companies, fuel suppliers, and contractors.

The ZEB market has experienced significant growth in recent years, driven by the benefits of these vehicles in terms of cleanliness, lower noise, and greater efficiency compared to their conventional counterparts. Although capital costs and range remain limiting factors, technological advances and early market adopters have helped increase understanding of the technology's capabilities, demonstrate its utility in transportation applications, and reduce costs. The guide details these benefits, highlighting how ZEBs do not rely on fossil fuels for operation and have zero tailpipe emissions, thus improving local air quality.

The guide is organized into ten key deployment phases, providing information and guidance for assessing needs and requirements, selecting and specifying technology, determining capital costs and financing opportunities, developing and deploying charging infrastructure, accepting and validating buses to ensure they meet specifications, considering training programs, establishing operational and maintenance practices, and monitoring and evaluating deployment performance. Each phase includes a two-page overview and specifies the roles and responsibilities of key actors, followed by examples of ZEB deployments, best practices, key points, and additional resources.

An important section of the document is the "ZEB Technology Overview", which provides an overview of the available BEB and FCEB technologies and associated infrastructure. This section is essential for helping transit agencies identify the most suitable solution for their planned needs. The guide also addresses the specific challenges of ZEB

[401] Linscott, M., & Posner, A. (2021). Guidebook for deploying zero-emission transit buses. National Academies of Sciences, Engineering, and Medicine. Available at: https://nap.nationalacademies.org/catalog/25842/guidebook-for-deploying-zero-emission-transit-buses

implementation, such as range limitations, charging time, high electricity rates in some locations, complicated utility rate structures, and higher capital costs. While some of these challenges can only be minimized or eliminated with market maturity, others can be largely mitigated through careful planning of ZEB deployments.

In conclusion, the "Guidebook for Deploying Zero-Emission Transit Buses" is a comprehensive and vital tool for transit agencies seeking to adopt ZEB technologies. By providing a structured and detailed framework of best practices and lessons learned, the guide supports agencies in making informed decisions and successfully implementing cleaner and more efficient bus fleets.

National EV Infrastructure Formula Program Guidance[402]

The NEVI is an initiative established under the IIJA, signed on 15 November 2021. This program aims to provide funding to states for strategically deploying EV charging infrastructure and establishing an interconnected network to facilitate data collection, access, and reliability. The program guide, updated on 2 June 2023, replaces the initial version issued on 10 February 2022.

The NEVI program consists of two main components: a USD5 billion formula program and a USD2.5 billion discretionary grant program. The former provides dedicated funds to states to deploy EV charging infrastructure in designated alternative fuel corridors (AFC) and eventually on any public road or public access location once the broader network is fully built. The discretionary grant program, divided into corridor and community grants, supports the implementation of EV charging infrastructure in rural areas, underserved communities, and other priority areas.

Each state must annually submit an EV Infrastructure Deployment Plan, which must be approved by the Federal Highway Administration (FHWA) before program funds can be obligated. The plans must comply with EV infrastructure standards and requirements, including technical aspects such as connector types, power levels, minimum number of charging ports per station, payment methods, and network connectivity, among others.

The NEVI program emphasizes equity considerations, ensuring that at least 40% of the benefits from federal investments in climate and clean energy infrastructure are distributed to underserved communities. Additionally, it promotes coordination with state energy and environmental agencies and encourages job creation and the development of a diverse and qualified workforce.

8.9.2. Norms Promoting or Accelerating the Transition to Electromobility

To contextualize the importance of federal policies and plans in promoting electromobility in the United States, it is essential to recognize recent efforts and key initiatives guiding this transition. The Biden-Harris administration has implemented a series of strategic policies and funding programs aimed at accelerating the adoption of EVs and improving charging infrastructure across the economy. These actions not only seek to reduce GHG emissions and combat climate change but also to promote equity and economic development in disadvantaged communities. Below are some of these fundamental initiatives and policies:

Justice40 Initiative[403]

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[402] Federal Highway Administration. (2023). *National EV Infrastructure Formula Program Guidance (Update)*. U.S. Department of Transportation. Available at: https://www.fhwa.dot.gov/bipartisan-infrastructure-law/funding.cfm
[403] White House. (n.d.). *Justice40 Initiative*. Available at: https://www.whitehouse.gov/environmentaljustice/justice40/

The Justice40 Initiative, launched by the Biden-Harris administration, represents a historic commitment to addressing environmental inequalities and promoting social justice in the United States. This initiative is based on the premise that disadvantaged communities, often the most affected by pollution and climate change, should be the primary beneficiaries of federal investments in clean energy, energy efficiency, clean transportation, and climate change mitigation.

One of the most notable features of the Justice40 Initiative is its explicit goal to ensure that 40% of the benefits of federal investments in key environmental sectors reach the most vulnerable communities. These communities often include low-income areas, communities of color, and rural areas that have historically been marginalized and disproportionately impacted by environmental pollution and climate change.

The focus of the Justice40 Initiative is not only on the equitable distribution of benefits but also on the implementation of policies and programs that promote environmental justice. This involves an explicit acknowledgment of existing disparities and a conscious effort to correct them through the design of inclusive and fair policies. For example, clean energy programs funded under this initiative are designed to reduce reliance on fossil fuels and improve air quality in communities suffering from high rates of respiratory diseases due to pollution.

Additionally, the Justice40 Initiative emphasizes the importance of community participation and transparency in decision-making. The recipient communities of these benefits are involved in the planning and execution of projects, ensuring that their needs and priorities are adequately represented. This inclusion is essential for building trust and ensuring that the implemented solutions are sustainable and truly beneficial for the communities.

In terms of implementation, the Justice40 Initiative relies on close collaboration between various federal, state, and local agencies. Interagency coordination is crucial to ensure that resources are used efficiently and that projects have a tangible and lasting impact. Furthermore, innovation and the use of advanced technologies are promoted to maximize the environmental and economic benefits of the investments.

In conclusion, the Justice40 Initiative is a significant step towards building a more equitable and sustainable future in the United States. By focusing the benefits of investments in clean energy and climate change mitigation on the most vulnerable communities, this initiative not only addresses existing inequalities but also lays the foundation for more inclusive and just development. The Biden-Harris administration, through this initiative, demonstrates a firm commitment to environmental justice and equity, recognizing that a sustainable future must be accessible to all, regardless of socioeconomic background or geographic location.

Inflation Reduction Act (IRA)[404]

The IRA, enacted by the Biden-Harris administration, represents a significant milestone in the effort to foster the adoption of EVs and promote a robust and accessible charging infrastructure in the United States. This legislation not only aims to mitigate the effects of climate change but also to revitalize the economy and promote social justice through strategic investments in clean and sustainable technologies.

[404] Atlas EV Hub. (n.d.). *The Inflation Reduction Act EV Provisions*. Available at: https://www.atlasevhub.com/materials/the-inflation-reduction-act-ev-provisions/

One of the most notable components of the IRA is its focus on tax incentives and financing programs designed to facilitate the transition to EVs. The law introduces substantial tax credits for the purchase of EVs, making these vehicles more affordable for a larger portion of the population. These incentives are crucial for reducing the initial economic barrier that often prevents consumers from opting for more sustainable options.

Additionally, the IRA includes specific provisions to expand EV charging infrastructure. With an allocation of billions of USD, the law funds the construction of a network of charging stations to ensure the availability of charging points in urban, rural, and along major transportation routes. This comprehensive approach is essential to fostering confidence among EV users, ensuring that they can conveniently and efficiently charge their vehicles regardless of their location. The following table provides a detailed description of various sections of the Act related to tax incentives and financing programs to promote EV adoption and improve charging infrastructure in the United States.

Table 23. Provisions for EV in IRA

Section Number	Title	Description	Lead Agency	Funding	Funding Type
13401	Clean Vehicle Credit	Amends the tax credit to a USD7,500 tax credit for new EV, half of which if the vehicle is made with domestic battery and half if the vehicle is made with domestic critical minerals. On critical minerals, the requirement is such that the minerals must be extracted in the US or a economy the US has a free trade agreement with or recycled in North America. This is based on a percentage of components that will increase over time, starting with 40 percent in 2024. Beginning in 2024 (battery) and 2025 (critical minerals), no percentage of the material can be extracted or processed in or by an entity of foreign concern (notably China). Capped at USD150,000 for an individual, or up to USD300,000 for a household. There are price caps on vehicles. In the case of a van, USD80,000. In the case of a SUV, USD80,000. In the case of a pickup truck, USD80,000. In the case of any other vehicle, USD55,000. Eliminates the cap on the number of vehicles that can be sold (what was 200,000 per automaker) and the credit will be available at the point of sale.	Department of the Treasury	USD7,541,000,000	Credit
13402	Credit for Previously Owned Clean Vehicles	Creates a used vehicle tax credit of USD4,000 or 30 percent of the vehicle sale price (whichever is lower) limited to USD75,000 for single filer (or USD150,000 for a joint return) income thresholds. The vehicle must be at least two years old and less than 14,000 pounds. The vehicle must cost less than USD25,000, not have previously used the credit (by VIN), and be sold by a dealership. Individuals can only claim the credit once every three years. The credit can be used for FCEV, PHEV and BEVs.	Department of the Treasury	USD1,347,000,000	Credit

Section Number	Title	Description	Lead Agency	Funding	Funding Type
13403	Qualified Commercial Clean Vehicles	Creates a 30% credit for electric and other non gasoline/diesel trucks and 15% for combustion vehicles with at least 15 kWh battery. The credit is capped at USD40,000 or the incremental cost of the vehicle, whichever is lower. The credit is capped at USD7,500 for vehicles under 14,000 pounds. The credit is valid through 2032.	Department of the Treasury	USD3,583,000,000	Credit
13404	Alternative Fuel Refueling Property Credit	The existing tax credit (30C) had expired at the end of 2021. This program extends the credit through 2032 and raises the cap from USD30,000 to USD100,000. For projects that meet the prevailing wage requirement, multiply the credit amount by five. Only available in eligible census tracts – low income urban (the poverty rate for such a tract must be at least 20 percent) and rural communities where the median income is below the statewide median income. Includes 2 and 3 wheelers.	Department of the Treasury	USD1,738,000,000	Credit
13501	Extension of the Advanced Energy Project Credit	Funding for Advanced Energy Project Credit program extended to USD10,000,000,000, with no more than USD6,000,000,000 allocated to qualified investments that are not located within energy communities.	Department of the Treasury	USD6,255,000,000	Credit
13502	Advanced Manufacturing Production Credit	Creates advanced manufacturing production credits including USD35 per kilowatt hour of capacity for battery cells. Meanwhile battery modules could qualify for a credit of USD10 per kilowatt hour of capacity (or USD45 in the case of a battery module which does not use battery cells), and 10 percent of the costs incurred for critical minerals and electrode active materials.	Department of the Treasury	USD30,622,000,000	Credit
30002	Improving Energy Efficiency or Water Efficiency or Climate Resilience of Affordable Housing	Loans for projects that improve energy or water efficiency, indoor air quality or sustainability, implement the use of low-emission technologies, materials, or processes, including zero-emission electricity generation, energy storage, or building electrification, or address climate resilience, of an eligible property. May include EVSE.	Department of Housing and Urban Development	USD1,000,000,000	Loan
50141	Funding for Department of Energy Loan Programs Office	Grants the Department of Energy Loan Programs Office USD40 billion in loan authority and appropriates USD3.6 billion for the cost of guaranteeing those loans and administrative expenses.	Department of Energy	USD3,600,000,000	Loan
50142	Advanced Technology Vehicle Manufacturing	Loan program to support reequipping, expanding, or establishing a manufacturing facility in the United States to produce, or for engineering integration performed in the United States of, advanced technology vehicles only if such advanced technology vehicles emit, under any possible operational mode or condition, low or zero	Department of Energy	USD3,000,000,000	Loan

Section Number	Title	Description	Lead Agency	Funding	Funding Type
		exhaust emissions of greenhouse gases (GHG).			
50143	Domestic Manufacturing Conversion Grants	Provides grants for domestic production of efficient hybrid PHEV, PHEV drive, and hydrogen fuel cell EVs.	Department of Energy	USD2,000,000,000	Grant
60101	Clean Heavy-Duty Vehicles	Funding to replace vehicles with a ZEV, build ZEV charging infrastructure, workforce development and training and planning and technical activities to support adoption of ZEVs.	Environmental Protection Agency	USD1,000,000,000	Grant, Rebate
60102	Grants to Reduce Air Pollution at Ports	Funding split between general assistance (USD2.25 billion) and funding for non-attainment areas (USD750 million) to purchase zero-emission port equipment or develop a climate plan. Equipment refers to human-operated equipment or human-maintained technology that produces zero emissions of any air pollutant that is listed pursuant to section and any greenhouse gas other than water vapor; or captures 100 percent of the emissions that are produced by an ocean-going vessel at berth.	Environmental Protection Agency	USD3,000,000,000	Grant
60103	Greenhouse Gas Reduction Fund	Supports any projects that reduce greenhouse gas emissions and includes USD7 billion for zero emission technologies for low-income and disadvantaged communities and USD8 billion for low income and disadvantaged communities. There will be a further USD11.97 billion for general assistance.	Environmental Protection Agency	USD27,000,000,000	Grant
60104	Diesel Emissions Reductions	Funding to identify and reduce diesel emissions resulting from goods movement facilities, and vehicles servicing goods movement facilities, in low-income and disadvantaged communities to address the health impacts of such emissions on such communities.	Environmental Protection Agency	USD60,000,000	Grant, Rebate, Loan
60105	Funding to Address Air Pollution	Funding includes USD5,000,000 to provide grants to States to adopt and implement greenhouse gas and zero-emission standards for mobile sources pursuant to section 177 of the Clean Air Act. The other funding, largely for monitoring air quality, is not listed here.	Environmental Protection Agency	USD5,000,000	Grant
60106	Funding to Address Air Pollution at Schools	Funding for grants and other activities to monitor and reduce air pollution and greenhouse gas emissions at schools in low-income and disadvantaged communities. Also as part of this, some support for technical assistance.	Environmental Protection Agency	USD50,000,000	Grant
60114	Climate Pollution Reduction Grants	Funding for planning and implementation grants to support programs, policies, measures, and projects that will achieve or facilitate the reduction of greenhouse gas air pollution.	Environmental Protection Agency	USD5,000,000,000	Grant

Section Number	Title	Description	Lead Agency	Funding	Funding Type
60201	Environmental and Climate Justice Block Grants	Funding (including some technical support) for investments in low- and zero-emission technologies and workforce development that help reduce greenhouse gas, among other things.	Environmental Protection Agency	USD3,000,000,000	Grant
60501	Neighborhood Access and Equity Grant Program	Funding is available including to support technologies, infrastructure, and activities to reduce surface transportation-related air pollution, including greenhouse gas emissions.	DOT	USD3,045,100,000	Grant
70002	United States Postal Service Clean Fleets	Funding for USPS vehicles (USD1.29 billion) and charging (USD1.71 billion).	General Services Administration	USD3,000,000,000	Grant

Source: Atlas EV Hub. (n.d.). *The Inflation Reduction Act EV Provisions*.

The law also has a strong environmental justice component, aligning with the Justice40 initiative. It ensures that a significant portion of the benefits from these investments flows to disadvantaged communities that have historically been marginalized and disproportionately affected by environmental pollution. This not only promotes equity but also seeks to correct existing disparities, providing these communities with access to clean technologies and improvements in air quality.

In terms of economic impact, the IRA is designed to stimulate job creation in the clean technology sector. By incentivizing EV production and infrastructure, the law promotes the growth of a new generation of well-paying jobs in the manufacturing, installation, and maintenance of charging stations and EVs. This economic boost is doubly beneficial, as it not only fosters environmental sustainability but also supports economic development and job stability.

Furthermore, the IRA recognizes the importance of research and development in the field of electromobility. The law allocates funds for technological innovation, supporting research projects that enhance EV efficiency, develop new battery technologies, and optimize charging infrastructure. This focus on innovation is essential to keeping the United States at the forefront of the global transition to electric mobility.

In conclusion, the provisions for EV in the IRA mark a significant step toward a more sustainable and equitable future. By combining economic incentives, infrastructure investments, and a commitment to environmental justice, the Biden-Harris administration establishes a solid foundation for the expansion of electromobility in the United States.

EV Charging Action Plan[405]

The Biden-Harris administration has launched an ambitious EV Charging Action Plan, aiming to build a network of 500,000 EV chargers by 2030. This plan is an integral part of the government's broader strategy to promote EV adoption, reduce GHG emissions, and enhance environmental sustainability in the United States. The initiative underscores the federal government's commitment to creating an accessible and equitable charging infrastructure that supports the transition to electric mobility.

[405] White House. (13 December 2021). *Fact Sheet: The Biden-Harris EV Charging Action Plan*. Available at: https://www.whitehouse.gov/briefing-room/statements-releases/2021/12/13/fact-sheet-the-biden-harris-electric-vehicle-charging-action-plan/

One of the key components of the plan is the Bipartisan Infrastructure Law, also known as the Infrastructure Investment and Jobs Act (IIJA), signed by President Biden on 15 November 2021. This legislation allocates up to USD7.5 billion in new funds for EV charging stations, making charging infrastructure eligible for additional federal funding programs. This funding is directed to communities across the economy, providing essential capital for electric mobility infrastructure projects.

The plan also addresses the need for a convenient and accessible charging network for all Americans, regardless of location. This includes the implementation of fast-charging stations in urban and rural areas, ensuring that EV drivers can recharge their vehicles during long trips and that residents of multifamily housing or those without access to private parking have viable charging options. This expansion of infrastructure is vital to overcoming logistical barriers that currently limit the mass adoption of EV.

In addition to environmental benefits, the EV Charging Action Plan aligns with the Biden-Harris administration's Justice40 initiative. This commitment ensures that 40% of the benefits from clean energy and clean transportation investments flow to disadvantaged communities. By focusing on environmental justice, the plan aims to correct existing inequalities and ensure that all communities, especially those historically marginalized, benefit from investments in electric mobility infrastructure.

The implementation of the plan also has a significant economic impact, as it is expected to generate thousands of well-paying jobs in the construction, installation, and maintenance of charging stations. The IIJA not only facilitates job creation but also promotes skill development and workforce training necessary to sustain the long-term expansion of EV infrastructure.

In terms of innovation, the plan encourages the use of advanced technologies and collaboration between the public and private sectors to develop efficient and sustainable charging solutions. The Biden-Harris administration is working closely with EV manufacturers, charging service providers, and other key industry players to ensure that the charging infrastructure evolves in line with the growth of the EV market.

In summary, the Biden-Harris administration's EV Charging Action Plan is a transformative initiative that sets a clear path toward the mass adoption of EVs in the United States. By combining significant funding, a focus on equity and environmental justice, and a commitment to technological innovation, the plan aims not only to reduce GHG emissions but also to revitalize the economy and improve the quality of life for all Americans. This comprehensive effort positions the United States as a leader in the global transition to cleaner and more sustainable mobility.

8.9.3. Energy Policies Related to the Transition to Electromobility

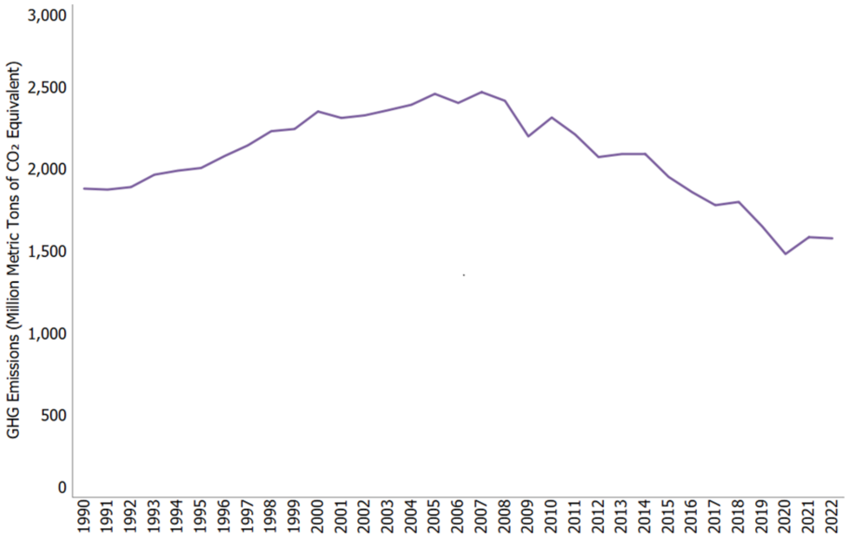
Electricity Production and Emissions

In 2022, electricity production in the United States accounted for approximately 25% of the total GHG emissions, making it the second-largest contributor after the transportation sector (see Figure 83). This figure highlights the importance of the electric sector in the economy's overall emission reduction strategy.

The electric sector is characterized by the generation, transmission, and distribution of electricity. Most emissions come from the combustion of fossil fuels such as coal, oil, and natural gas. In 2022, 60% of the electricity was generated from burning these fossil fuels, with coal representing 20% of the electricity generated but contributing 55% of the sector's CO_2 emissions. Natural gas, on the other hand, generated 39% of the electricity.

Since 1990, GHG emissions from the electric sector have decreased by 15%, reflecting a transition to cleaner energy sources and an increase in energy efficiency (see Figure 83). In 2022, despite a 7% increase in emissions compared to the previous year, clean energy policies and technologies continue to play a crucial role in reducing the sector's carbon footprint.

Figure 83. GHG Emissions from Electricity, 1990-2022



Source: Environmental Protection Agency. (n.d.). Sources of greenhouse gas emissions.

On the other hand, coal, despite its decreased usage, remains a significant source of emissions due to its high carbon intensity. Natural gas, though less carbon-intensive, continues to be a major contributor to total emissions. Non-fossil sources, such as nuclear and renewables (hydroelectric, biomass, wind, and solar), accounted for 40% of electricity generation in 2022 and are essential for decarbonizing the sector.

To reduce emissions in the electric sector, various strategies can be employed:

- **Increase Efficiency of Fossil Fuel Plants and Fuel Switching:** Improving technologies in existing plants and substituting more carbon-intensive fuels with less carbon-intensive alternatives.
- **Renewable Energy:** Increasing the use of renewable energy sources such as wind, solar, hydroelectric, and geothermal.
- **Energy Efficiency in End Use:** Reducing electricity usage through improvements in energy efficiency in homes, businesses, and industries.
- **Nuclear Energy:** Extending the lifespan of existing nuclear plants and constructing new nuclear capacity.
- **Carbon Capture and Storage (CCS):** Capturing CO_2 emitted from fossil fuel combustion and securely storing it underground.

GHG emissions from electricity generation also need to be considered in relation to the sectors using this electricity. It is important to highlight that industrial, commercial, and residential activities show a significant increase in emissions when including the indirect emissions from the electricity used, underscoring the importance of a comprehensive approach to emission reduction.

Annual Energy Outlook (AEO) 2023[406]

The "AEO 2023" explores long-term energy trends in the United States. This report highlights significant changes in the economy's energy policy, particularly due to the passage of the IRA. Projections indicate that U.S. energy-related CO_2 emissions will decrease by 25% to 38% from 2005 levels by 2030, primarily due to increased electrification, equipment efficiencies, and carbon-free electricity generation. However, these reductions are limited by long-term growth in the transportation and industrial sectors.

AEO2023 projects stable growth in electricity demand through 2050, driven by electrification and economic growth. Renewable technologies such as solar and wind are becoming increasingly competitive due to falling costs and government subsidies, increasing their share in electricity generation. Solar generation capacity could grow by up to 1019% and wind capacity by up to 235% by 2050 compared to 2022. Natural gas generation capacity is also expected to increase by 20% to 87% through 2050.

The U.S. electric sector is undergoing significant changes, with increased electrification in end-use sectors such as residential and commercial. A reduction in energy consumption for space heating is expected, while equipment efficiency and stringent building codes will continue to decrease energy intensity. In the transportation sector, energy use from light vehicles is expected to decline until 2045 as EV are deployed and fuel efficiency standards are improved.

The transition to electromobility is crucial for the modernization and decarbonization of the electric system. EVs are projected to be the largest source of growth in electricity demand in the U.S. by 2050, representing more than 25% of total demand. This transition requires effective integration of EVs with the electric system, ensuring that grid planning fully considers the growing electricity demand for transportation. EV charging infrastructure and the operation of flexible electrolyzers for hydrogen production are also essential to support the decarbonization of the electric system.

The U.S. National Blueprint for Transportation Decarbonization[407]

The "National Blueprint for Transportation Decarbonization" of the United States is an ambitious strategy aimed at eliminating GHG emissions from the transportation sector by 2050. This initiative is recognized as a crucial response to the fact that transportation is the largest source of GHG emissions in the United States. The document is a collaboration between the Department of Energy (DOE), the DOT, the Environmental Protection Agency (EPA), and the Department of Housing and Urban Development (HUD).

The plan identifies three critical factors contributing to transportation emissions: i) the design of the transportation system and land use, ii) vehicle and engine efficiency, and iii) dependence on high-GHG-content fuels. Addressing these factors requires a multifaceted approach:

- **Transportation System and Land Use Design:** Improving land use planning to reduce travel distances and enhance accessibility.
- **Vehicle and Engine Efficiency:** Continuing advancements in vehicle technologies to improve fuel efficiency.

[406] U.S. Energy Information Administration. (2023). *Annual Energy Outlook 2023: Narrative*. Available at: https://www.eia.gov/outlooks/aeo/pdf/AEO2023_Narrative.pdf
[407] EIA. (2023). The U.S. National Blueprint for Transportation Decarbonization. Avialable at EIA Website. Available at: https://www.energy.gov/sites/default/files/2023-01/the-us-national-blueprint-for-transportation-decarbonization.pdf

- **High-GHG-Content Fuels:** Reducing oil dependence by adopting cleaner fuels and technologies.

The plan emphasizes the importance of short-term actions and long-term strategies, integrating immediate solutions with ongoing research and development to ensure sustained emission reductions.
Key guiding principles include:

- **Decisive Actions:** Prioritizing rapid and measurable emission reductions.
- **Creative Solutions:** Implementing a wide range of technologies and policies.
- **Safety, Equity, and Access:** Ensuring benefits are distributed equitably, especially in underserved communities.
- **Collaboration:** Engaging federal, regional, state, and local governments, along with the private industry and community stakeholders.
- **Leadership:** Positioning the United States as a leader in global transportation decarbonization efforts.

The plan outlines strategies across different transportation modes, focusing on increasing convenience, improving efficiency, and transitioning to clean options. These strategies include enhancing public transportation, supporting active transportation infrastructure, and deploying zero-emission vehicles and fuels.

Future transportation systems will need to leverage clean and abundant electricity to power EVs and produce hydrogen and sustainable fuels. Integrating EVs into the electrical grid will require significant upgrades to accommodate the increased demand for electric charging, projected to rise by 25% by 2050. Effective grid planning and coordination between the transportation and electricity sectors are crucial. Additionally, the flexible operation of electrolyzers for hydrogen production can support grid stability and resilience, further facilitating the transition to clean transportation.

The document details GHG reduction goals by different transportation modes:

- **Light Vehicles:** Achieve 50% of new vehicle sales being zero-emission by 2030, deploy 500,000 EV chargers by 2030, and ensure 100% of federal vehicle procurement is zero-emission by 2027.
- **Medium- and Heavy-Duty Trucks and Buses:** Achieve 30% of new vehicle sales being zero-emission by 2030 and 100% by 2040, and ensure 100% of federal vehicle procurement is zero-emission by 2035.
- **Other Transportation Modes:** Set specific targets for the maritime, rail, and aviation sectors, and promote the development of sustainable technologies and fuels.

Electromobility is central to the plan's strategy for decarbonizing transportation. The widespread adoption of EVs is expected to be a significant driver of emission reductions, necessitating the modernization of the electrical grid to support increased electricity demand. The transition to EVs will involve not only technological advancements but also comprehensive planning and investment in charging infrastructure. By ensuring the grid can reliably supply clean electricity, the plan aims to create a transportation system that is both environmentally sustainable and economically viable.

In conclusion, the "National Blueprint for Transportation Decarbonization" underscores the need for coordinated and bold actions to achieve transportation decarbonization. It calls for comprehensive strategies that address current challenges while preparing for future technological advancements. Through government policies, private sector investments, and community engagement, the United States can build a sustainable, equitable, and resilient transportation system.

8.3.2. Specific Electromobility Policies[408]

The transition to electromobility in the United States has been significantly driven in recent years by federal and local initiatives. The Biden-Harris administration has set ambitious goals, such as ensuring that half of all new vehicles sold by 2030 are zero-emission and building an accessible and equitable network of 500,000 charging stations to support both local and long-distance travel.

The IIJA signed in 2021 and the IRA of 2022 represent significant investments in electric mobility infrastructure. These laws not only provide funding for EV charging stations but also establish tax credit programs for EVs and charging infrastructure, thereby supporting a wide range of electric mobility initiatives.

The growth of charging infrastructure has been notable, especially in urban areas and along major highways. In 2019, the 50 most populous metropolitan areas accounted for 80% of new EV registrations in the U.S., despite housing only 55% of the economy's population. Additionally, in 2022, there were over 5,500 zero-emission transit buses in operation and more than 13,000 electric school buses ordered, delivered, or operating, demonstrating a significant commitment to electrifying public transportation[409].

Despite progress, the implementation of charging infrastructure faces challenges, including interoperability issues and the need for equitable planning. Expanding public charging stations is crucial to making electric mobility more accessible to everyone, including underserved communities and residents without access to private parking.

The electrification of transportation has profound implications for energy and electricity systems. The transition to EVs will require increased electricity demand, and EVs are projected to be the largest source of load growth in the U.S. by 2050. This increase in demand underscores the need for coordinated planning and operation between the transportation and electricity sectors. Effective integration of EVs with the electric grid will be crucial to ensuring a reliable supply and supporting the decarbonization of the energy system.

In conclusion, the United States is on a significant path toward the electrification of its transportation system. Federal and local initiatives are laying the groundwork for robust electric mobility infrastructure, though significant challenges remain. Cooperation among government, businesses, and communities will be essential to achieving the ambitious goals set and ensuring that the benefits of electric mobility are distributed equitably.

Charging Forward: A Toolkit for Planning and Funding Urban Electric Mobility Infrastructure[410]

The document provides a comprehensive guide for U.S. cities interested in developing and implementing electric mobility infrastructure. The aim is to foster a transition towards

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[408] This section has been prepared on the basis of the document: Federal Highway Administration. (2023). *Charging Forward: A Toolkit for Planning and Funding Urban Electric Mobility Infrastructure*. U.S. Department of Transportation. Available at: https://www.transportation.gov/sites/dot.gov/files/2023-06/Charging%20Forward-Urban%20Toolkit-June%202023-508%20compliant.pdf

[409] Federal Highway Administration. (2023). *Charging Forward: A Toolkit for Planning and Funding Urban Electric Mobility Infrastructure*. U.S. Department of Transportation. Available at: https://www.transportation.gov/sites/dot.gov/files/2023-06/Charging%20Forward-Urban%20Toolkit-June%202023-508%20compliant.pdf (p.11).

[410] Ibid.

more sustainable transportation systems, improving air quality and reducing GHG emissions.

Electric mobility is a fundamental part of transforming the transportation system in the United States. This shift promises significant benefits for both individuals and entire communities, including economic development, job creation, and public health improvements due to reduced air pollution. The document emphasizes the need for accessible and affordable charging infrastructure as a key component for the success of this transition.

Despite the progress, the implementation of charging infrastructure faces several challenges. These include interoperability issues among different charging systems and the need for equitable planning to ensure that all communities, including underserved ones, have access to charging stations. The document proposes solutions, such as coordination among federal, state, and local agencies, and the use of interoperability standards to ensure an integrated and accessible charging network.

Electrification of transportation has significant implications for energy and electricity systems. The transition to EVs will increase electricity demand, with EVs projected to be the largest source of load growth in the U.S. by 2050. This requires coordinated planning between the transportation and electricity sectors to ensure a reliable and sustainable energy supply. Effective integration of EVs with the electric grid is crucial to support the decarbonization of the energy system and provide additional benefits, such as grid stability and energy storage capacity.

The document also explores the economic benefits of electric mobility, including local economic development and job creation. Charging stations can attract EV drivers to local businesses, generating revenue and promoting economic development. Additionally, the reduction in tailpipe emissions improves air quality, providing public health benefits, especially in densely populated urban areas.

In conclusion, this document is an essential guide for cities looking to implement electric mobility infrastructure. It provides a detailed overview of the policies, funding, and best practices needed to support the transition to a cleaner and more sustainable transportation system. Collaboration among government, businesses, and communities will be fundamental to achieving the ambitious goals set and ensuring that the benefits of electric mobility are distributed equitably.

National EV Infrastructure Standards and Requirements[411]

The law established under the title "National EV Infrastructure Standards and Requirements" by the FHWA of the U.S. DOT represents a significant advancement in the regulation of EV charging infrastructure. This regulation sets minimum standards and requirements for projects funded under the NEVI program and other federally funded EV charging infrastructure projects.

The primary purpose of this law is to ensure an EV charging network that is convenient, affordable, reliable, and equitable across the entire economy. Before this regulation, there were no standardized guidelines for the installation, operation, or maintenance of EV charging stations, leading to significant disparities in key components such as operational practices, payment methods, price display, charger speed and power, and

[411] Federal Highway Administration. (2023). *National EV infrastructure standards and requirements* (FHWA Docket No. FHWA-2022-0015). Federal Register, 88(39), 12435-12454. Available at: https://www.govinfo.gov/content/pkg/FR-2023-02-28/pdf/2023-03500.pdf

the information communicated about the availability and functionality of each charging station.

The law specifies several essential aspects for EV charging infrastructure:

1. **Installation, Operation, and Maintenance:** Requires overall consistency in the installation, operation, and maintenance of EV charging infrastructure, including the qualification of technicians. It mandates that charging stations must include a minimum number of ports, connector types, payment methods, and customer support services. Additionally, technicians installing and maintaining the chargers must meet training and certification standards.

2. **Interoperability:** Establishes requirements for communication between the charger and the vehicle, between chargers and charging networks, and among charging networks, ensuring that chargers can perform smart charging management and the "Plug and Charge" function.

3. **Signage and Traffic Control Devices:** Compliance with the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) and Highway Beautification regulations.

4. **Network Connectivity:** Requirements for network connectivity for the remote communication and management of chargers, addressing cybersecurity concerns and preventing obsolete assets.

5. **Data and Transparency:** Requirements for the reporting of data on the usage, reliability, and costs of charging stations, ensuring that basic station information, real-time status, and pricing are clearly communicated to the public.

6. **Accessibility and Availability:** Charging stations must be available 24/7, especially along designated Alternative Fuel Corridors (AFC). Charging stations not located along these corridors must be publicly accessible at least during the operational hours of the host site.

7. **Payment Methods:** Charging stations must provide contactless payment methods that accept major credit and debit cards and allow payments through a toll-free phone number or a text messaging system.

8. **Data Security and Privacy:** Strategies to protect consumer data and secure the charging infrastructure against potential security risks.

This regulation aims not only to standardize the user experience and improve the reliability of charging stations but also to promote the widespread adoption of EVs. By ensuring an accessible and reliable charging network, it facilitates the transition to electric mobility, significantly contributing to the reduction of GHG emissions and aligning with the climate goals set by the federal administration.

Electrifying Transit: A Guidebook for Implementing BEB[412]

The document "Electrifying Transit: A Guidebook for Implementing BEB" is a comprehensive guide designed to assist decision-makers and stakeholders in the public transportation sector in planning and deploying BEB. Developed by Alana Aamodt,

[412] Aamodt, A., Cory, K., & Coney, K. (2021). *Electrifying Transit: A Guidebook for Implementing Battery Electric Buses*. National Renewable Energy Laboratory. Available at: https://www.nrel.gov/docs/fy21osti/76932.pdf

Karlynn Cory, and Kamyria Coney from the National Renewable Energy Laboratory (NREL), this guide addresses the benefits, challenges, technical components, and strategic considerations necessary for the successful implementation of BEBs in various jurisdictions.

The adoption of BEBs offers numerous significant advantages. Firstly, these buses are more fuel-efficient compared to diesel buses, leading to lower long-term fuel costs. Additionally, BEBs have fewer moving parts, which considerably reduces maintenance costs. Another important benefit is improved performance, providing smoother rides with less vibration and noise, and offering maximum instant torque that facilitates handling heavy loads and inclines. Environmentally, BEBs produce zero tailpipe emissions, significantly reducing local air pollution and GHG emissions. Moreover, using electricity for transportation decreases dependence on imported oil, enhancing energy security. Lastly, BEBs contribute to environmental justice by reducing pollution in urban areas, benefiting disadvantaged communities that are often more exposed to vehicular emissions.

Despite these benefits, implementing BEBs faces several challenges. One major challenge is the high initial cost of BEBs and the need for additional investment in charging infrastructure. The complex planning process, including route analysis, charging infrastructure placement, and transport personnel training, also poses an obstacle. BEBs' range limitations, influenced by factors such as temperature, road grade, and driving style, require careful planning of charging infrastructure. Additionally, as a relatively new technology, BEBs present risks related to component availability and uncertainty about long-term performance.

The technical components of BEBs include the following:

- **Bus:** BEBs operate with electric motors, which offer higher energy conversion efficiency compared to internal combustion engines. They also use regenerative braking to maximize energy efficiency.
- **Battery:** BEBs use lithium-ion batteries due to their high energy density. Considerations for battery implementation include capacity, size, range, and aging. Generally, batteries have a lifespan of around 12 years, although their performance can degrade over time.
- **Charging Infrastructure:** BEBs can be charged either at depots or on-route. Depot charging involves lower-power overnight charging, while on-route charging uses high-power fast chargers. The choice of charging method impacts route planning and operational efficiency.

Implementing BEBs has significant implications for the electrical grid. Careful planning of charging infrastructure is essential to avoid overloading the grid. Collaboration with utility companies is crucial to ensure cost-effective charging strategies and necessary grid upgrades.

Proper training for transport personnel is crucial for successful BEB operation and maintenance. This includes driving practices, maintenance procedures, and safety protocols. Regular evaluation and testing of BEBs help identify performance issues and areas for improvement.

Although BEBs have higher initial costs compared to diesel buses, their lower operational and maintenance costs can lead to long-term savings. Various financing and support options are available to support BEB deployment, including federal grants, state incentives, and innovative financing mechanisms.

Safety is a key consideration in BEB implementation. This includes compliance with codes and standards, managing electrical risks, and emergency preparedness. Adequate safety measures ensure the well-being of both transport personnel and passengers.

Successful BEB implementation requires thorough planning and execution. This involves long-term planning, route analysis, infrastructure development, and continuous evaluation. Engaging all relevant stakeholders and securing necessary funding are critical steps in this process.

NEVI Formula Program[413]

The NEVI Program is an initiative by the U.S. DOT, administered by the FHWA. This program provides funding to states to develop a strategic network of EV charging stations and establish an interconnected network that facilitates data collection, access, and the reliability of EV charging.

The NEVI program funds up to 80% of the costs for eligible projects, including:

- ✓ The acquisition, installation, and networking of EV charging stations.
- ✓ The proper operation and maintenance of charging stations.
- ✓ The long-term collection and sharing of data.

EV charging stations must be publicly accessible or available to multiple authorized vehicle operators and located along corridors designated as Alternative Fuels by the FHWA. If a state does not fully develop all AFCs, it may propose alternative locations and roads for the installation of charging stations.

The FHWA must distribute NEVI Program funds annually through the fiscal year 2026, ensuring that each state receives an amount in accordance with the FHWA funding formula as determined by the U.S. Code. To receive funding, states must submit plans to the FHWA and the Joint Office of Energy and Transportation for annual review and publication. The FHWA announced the approval of all initial state plans in September 2022, and the plans for 2023 were approved in 2023.

Additionally, 10% of the NEVI Formula funds are reserved each fiscal year for the DOT to award grants to states and localities requesting assistance to strategically develop EV charging stations under this program. Additional eligibility criteria and funding considerations will apply.

EV Readiness[414]

The EV readiness program provides guidance to communities in assessing their preparedness and planning for the arrival of EVs and the corresponding charging infrastructure. As local and regional leaders recognize the importance of EV readiness, this program offers a range of topics, questions, and resources to assist communities in planning for EV adoption and readiness.

Planning for EV charging infrastructure involves understanding the basics of charging, engaging stakeholders, setting clear goals, and assessing infrastructure needs. EV charging is more cost-effective compared to gasoline usage, although costs depend on electricity prices, which vary by region and type of generation. Stakeholder involvement

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[413] U.S. Department of Energy. (n.d.). *National EV Infrastructure (NEVI) Formula Program*. Alternative Fuels Data Center. Available at: https://afdc.energy.gov/laws/12744

[414] U.S. Department of Energy. (n.d.). *EV readiness*. Alternative Fuels Data Center. Available at: https://afdc.energy.gov/fuels/electricity-ev-readiness

is crucial, including relevant departments, transportation agencies, utilities, local businesses, and community groups, to ensure balanced and effective planning.

Assessing the needs for charging infrastructure is essential to support EV adoption in the community. This includes the availability of EVs and both public and private charging stations, and the specific charging requirements to meet EV adoption goals. Tools such as state-by-state EV registration and the Station Locator help identify and plan new strategic locations for charging stations.

Utilities play a fundamental role in EV readiness by offering purchase incentives, technical assistance, and demand rates that alleviate the costs associated with EV charging. Collaboration and support from utilities are necessary to ensure that EV charging needs are adequately met within the community.

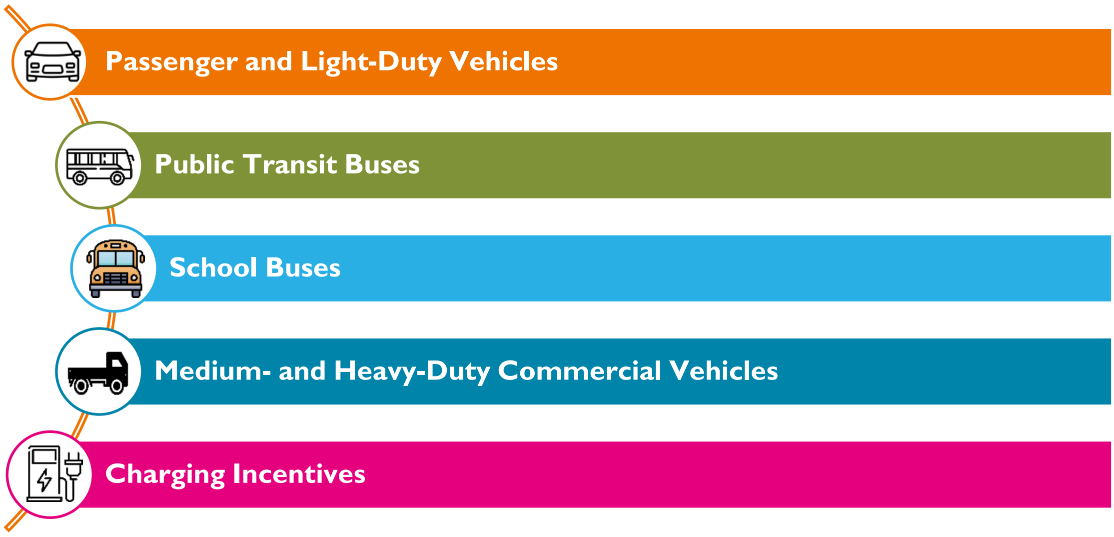
Securing funding is crucial for the successful implementation of EV charging infrastructure. There are federal, state, and local programs that offer incentives and grants to support the adoption and deployment of charging equipment. The NEVI Formula Program and the Charging and Fueling Infrastructure Grant Program provide funds for fast charging stations and other supporting infrastructure.

Selecting appropriate locations for charging stations involves considering proximity to popular destinations, transit routes, local businesses, and multifamily housing. It is essential to prioritize sites in underserved areas and assess installation and maintenance costs. Examples of EV readiness projects in cities like Seattle and Fort Collins offer useful case studies for implementing charging infrastructure.

Once all options have been considered and infrastructure needs assessed, it is crucial to engage the community and begin implementing the plan. ADA guidelines and local regulations are essential to ensure equitable access to EV charging stations. Additionally, examples of EV readiness projects and plans at the municipal, regional, and state levels provide valuable lessons for implementation.

According to Hill, Jason (2024) in his presentation titled "Incentives for Electromobility: The U.S. Approach" delivered during the workshop "Electromobility Towards a Sustainable and Safe Mobility," various programs and incentives have been implemented, which have been grouped into five main categories. This is because the economy seeks to implement mechanisms that address different demands (see Figure 84). For example, the financial incentives and mechanisms needed to motivate a family to acquire an electric vehicle for private use may differ from those that encourage a company to electrify its commercial fleet.

Figure 84. Categories for the Development of Electromobility Programs and Incentives in the United States



Source: Hill, J. (2024). Incentives for Electromobility: The U.S. Approach. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Lima Convention Center, San Borja, Lima, Peru.

Tax Credit Program: Light Duty Vehicle Incentives

The LRI of 2022 introduced a series of tax incentives designed to accelerate the adoption of electric vehicles (EVs) in the United States. These incentives aim to make EVs more accessible to a larger number of people, promoting a faster transition toward more sustainable mobility.

As part of this legislation, starting in 2023, buyers of plug-in electric vehicles can access a tax credit of up to USD7,500 per unit. Additionally, the program includes an extra incentive of up to USD4,000 for the purchase of used EVs, thereby expanding access to cleaner and more affordable mobility options.

These credits are subject to three important conditions. First, proof of income is required, meaning that high-income buyers are not eligible to receive the credits. This measure ensures that the benefits are directed toward segments of the population that need them most.

Second, the vehicle's sale price must align with the manufacturer's suggested price, ensuring that the incentives primarily apply to more accessible EVs and not to luxury models. Furthermore, the program allows the credit to be applied directly at the point of sale, enabling buyers to receive the benefit immediately, without having to wait for their tax return.

Finally, the credit is conditioned on requirements related to the origin of the battery components and critical minerals used in the manufacture of the electric vehicle. This criterion aims to promote domestic production and ensure more sustainable and responsible supply chains.

Low and No Emission Grant Program, known as "Low-No"

The Low and No Emission Grant Program, established by the U.S. government in 2015, is a competitive grant program designed to assist public transit agencies of all sizes and operational patterns in accessing funds for the acquisition or leasing of low or zero-emission buses. Additionally, this program funds the construction of new facilities for the operation of these buses and provides training for workforce development, thereby strengthening the necessary infrastructure for the transition to cleaner transportation.

In July 2024, the Federal Transit Administration announced the latest round of funding for the program, awarding USD1.5 billion to 117 applicants for the purchase of 1,100 buses manufactured in the United States. These funds not only support the acquisition of plug-in electric vehicles (EVs) but also encompass advanced technologies such as hydrogen fuel cells and compressed natural gas, offering a broader spectrum of options for the decarbonization of public transportation.

However, grants represent only a part of the puzzle. To be eligible and access these funds, the Low-No program currently requires agencies to present a Zero Emission Transition Plan, ensuring that investments are aligned with a long-term strategy to reduce emissions. Furthermore, the FTA is committed to providing guidance and education to transit agencies, preparing them for future workforce development needs. This comprehensive approach includes peer knowledge exchange, which is essential for understanding how new buses perform in different operational contexts.

Incentives for School Buses

In the United States, school buses play a crucial role in transporting over 25 million students daily, utilizing a fleet of more than 500,000 vehicles. This system not only constitutes the largest form of public transportation in the economy but also carries more than four times the number of passengers compared to the New York City subway. Despite their size and importance, school buses are generally operated or contracted at the school district level, adding a considerable level of complexity to their management and operation. Currently, there are around 13,500 agencies making operational decisions for their school bus fleets, reflecting the decentralization and variability in local management approaches.

This complexity in managing school buses has led to the need for a specific program and a particular approach to address the challenges and opportunities presented by the transition to a zero-emission fleet. In this context, the Bipartisan Infrastructure Law (BIL) has allocated USD5 billion over five years to fund the replacement of traditional school buses with zero-emission vehicles. This fund, administered by the Environmental Protection Agency, is designed to support local agencies in modernizing their fleets, contributing to the reduction of harmful emissions and the improvement of air quality, especially in communities where school buses are an essential part of daily transportation.

Incentives for Medium and Heavy-Duty Vehicles (MHDV)

Medium and heavy-duty vehicles represent a critical area for the transition to more sustainable transportation in the United States. Although these vehicles make up less than 6% of the vehicle fleet on the economy’s roads, they are responsible for approximately 25% of greenhouse gas emissions from the transportation sector. This disproportionate environmental impact underscores the urgency of implementing specific measures to reduce emissions in this sector.

Given the inherent complexity of transitioning MHDVs to zero-emission technologies, the U.S. strategy adopts a multifaceted approach. It is recognized that many of the technologies for long-range MHDVs are still in pilot and testing phases, which requires a flexible and adaptive approach. While the U.S. is beginning to contemplate incentives for the MHDV sector, a large-scale plan has yet to be developed. To date, funding has primarily been directed towards public sector operators or small-scale pilots testing technologies such as battery electric vehicles and hydrogen-powered vehicles.

One example of these efforts is the "SmartWay" program from the Environmental Protection Agency (EPA), which establishes measures, benchmarks, and improvements in freight transportation efficiency. This program aims not only to reduce emissions but also to optimize performance and operational efficiency in the sector, promoting sustainable practices in logistics and freight transport.

Similarly, the Federal Highway Administration has developed an Economic Zero Emission Transportation Corridor Strategy. This strategy aims to integrate specific routes for zero-emission freight vehicles, providing the necessary infrastructure to support this transition and ensuring that freight transport in the economy can evolve towards a more sustainable model.

Despite these advancements, it is essential to maintain a realistic perspective. The complete transition to clean technologies in the MHDV sector will require time, extensive testing, and significant investment, both in terms of technological development and in building the necessary infrastructure. Nonetheless, current efforts lay the groundwork for broader eventual adoption of zero-emission vehicles in this key sector.

Incentives for Charging Infrastructure

To meet the anticipated growing demand for electric vehicle (EV) charging stations, the U.S. government has allocated funds for the construction of 500,000 public chargers by 2030. This ambitious plan is part of a broader strategy to facilitate the transition to electrified transportation, ensuring that charging infrastructure is widely available and reliable for EV users across the economy.

These chargers are subject to a series of minimum standards that cover various aspects of their installation, operation, and maintenance. These standards include the interoperability of EV charging infrastructure, traffic control signage, and signage at facilities acquired, installed, or managed in conjunction with EV charging infrastructure. Additionally, data collection is required, including the format and schedule for submitting such data, as well as the network connectivity of the charging infrastructure. Information about the location of available public chargers, their prices, real-time availability, and accessibility through mapping applications must also be provided.

U.S. public funding for charging infrastructure is distributed among various beneficiaries. First, state-level transportation authorities have been the primary recipients, having developed and submitted plans for the construction of chargers at the state level. However, financial support also extends to municipal governments, tribal communities, and other local actors such as housing authorities, schools, and libraries. This inclusive approach ensures that charging infrastructure is not limited to urban or state areas but is also available in smaller communities and rural areas.

Moreover, end users can benefit from tax credits for the installation of chargers at their homes or in commercial areas. This not only facilitates access to charging infrastructure but also incentivizes EV owners to install private chargers, complementing the public charging network and contributing to broader and more equitable access to EV charging technology.

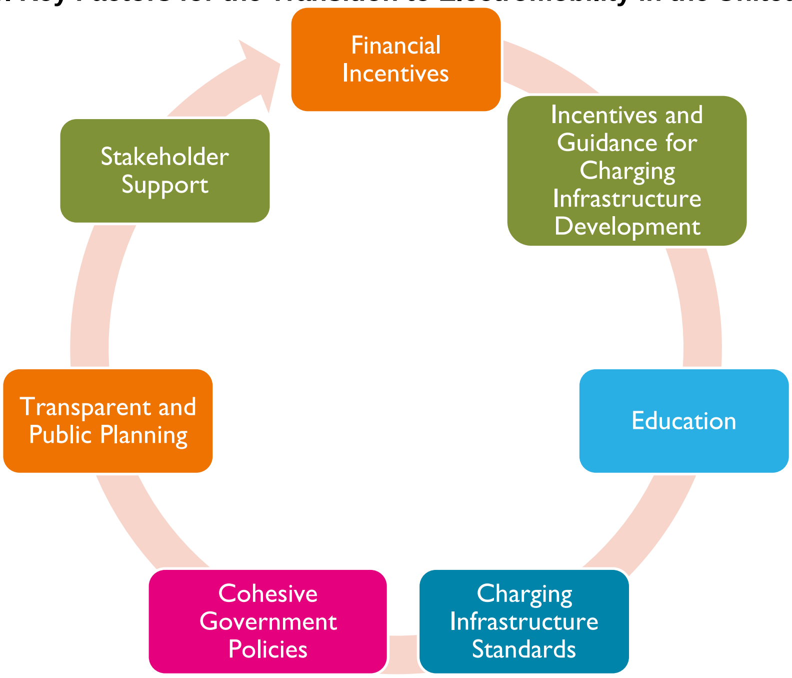
The Bipartisan Infrastructure Law (BIL) represents a fundamental pillar in the U.S. efforts to modernize its infrastructure and move toward a more sustainable future. One of the highlights of this law is the allocation of USD7.5 billion for the creation of the first EV charger network in the United States. This project will facilitate the installation of high-speed chargers, strategically located no more than 50 miles (80 km) apart along major roads and highways, thus ensuring greater accessibility and reliability for EV users.

Additionally, the BIL spurred the creation of the Joint Office of Energy and Transportation, which brings together experts from the Departments of Transportation and Energy. This office has played a crucial role in supporting the U.S. Federal Highway Administration in developing the EV infrastructure standard (NEVI, by its acronym in English) for charging stations. This standard provides confidence to the industry to build according to a specific charging norm and ensures a high-quality experience for users.

In conclusion, based on its experience in the transition to electromobility, the United States has recognized that the success of this process depends on the careful integration of several key factors. For example, financial incentives for drivers and operators are essential to reduce the cost of EV adoption, facilitating access for a broader audience. At the same time, guidance and support in developing reliable and accessible charging infrastructure are crucial to ensure that users feel confident in making the transition without worrying about the availability of charging stations.

Moreover, investment in the education and training of both users and the workforce responsible for operating public transportation EVs and charging infrastructure is of great importance for widespread adoption. The establishment of coherent standards in charging infrastructure, along with cohesive and well-coordinated government policies, is also essential to ensure a regulatory framework that supports the growth of this sector. Finally, transparent and public planning, along with support from all stakeholders, from governments to consumers and manufacturers, is vital to ensuring a smooth and successful transition toward a more sustainable future.

Figure 85. Key Factors for the Transition to Electromobility in the United States



Source: Hill, J. (2024). *Incentives for Electromobility: The U.S. Approach*. Workshop "Electromobility Towards a Sustainable and Safe Mobility," Lima Convention Center, San Borja, Lima, Peru.

8.9.3.1. Bus Procurement Models for Electromobility[415]

Context of Public Transportation in the United States

The Federal Transit Administration (FTA) of the United States, through its "National Transit Database," collected information from nearly 3,000 public transit agencies in the economy in 2022. These figures underscore the magnitude and relevance of the public transportation system in the urban and rural mobility of the nation. Collectively, these transit systems provide approximately 5.9 billion passenger trips annually, covering a total distance of 30 billion miles (equivalent to 48.3 billion kilometers). To operate these systems, there is a fleet of over 171,000 vehicles and a workforce comprising 370,000 individuals.

The reach of public transportation in the United States extends beyond urban areas, also encompassing rural systems and even unconventional modalities operated by other entities. In total, it is estimated that the economy has around 1,295 rural public transportation systems and 927 urban systems, highlighting the diversity and complexity of the public transportation ecosystem in the United States. This data reflects the strategic importance of public transportation in the economy and social well-being, being an essential component for the daily mobility of millions of people across the economy.
The public transportation system in the United States is characterized by its complexity and diversity, reflecting the vast number of transit agencies of varying sizes that serve communities with distinct needs, populations, and demographic characteristics. This diversity implies that there is no standardized approach to public fleet procurement schemes. Each transit agency has the autonomy to make decisions regarding the level of control it exerts in its bus and vehicle fleet acquisition process, in contrast to the option of contracting operators to manage fixed-route services.

This variability in decision-making responds to local realities and the particularities of each community, allowing transit agencies to tailor their strategies to the specific needs of their region. For example, while some agencies may choose to internally manage the acquisition and operation of their fleets, others may prefer to outsource these services to specialized contractors.

A crucial aspect within this context is the requirement imposed by the U.S. government for agencies receiving federal funds intended for the acquisition of new buses. To be eligible, these vehicles must be manufactured in the economy, underscoring the government's commitment to job creation and strengthening the local manufacturing industry.

Contracting Bus Operations for ZEVs

Contracting bus operations to private entities is a strategy that some public transit agencies in the United States are adopting to facilitate the transition to fleets with zero-emission vehicles (ZEVs). This decision has clear advantages, especially for agencies lacking the necessary technical expertise to directly manage these types of fleets. By delegating these operations, agencies can not only achieve their sustainability goals more efficiently but also benefit from the knowledge and best practices that specialized private operators can provide.

However, this strategy also presents significant disadvantages. Outsourcing can increase operational costs and, more concerning, create gaps in the agency's internal

[415] This information has been extracted from the following presentation: Hill, J. (2024). Incentives for Electromobility: The U.S. Approach. Workshop 'Electromobility Towards Sustainable and Safe Mobility,' Lima Convention Center, San Borja, Lima, Peru.

knowledge about the operation and maintenance of ZEVs. This lack of direct experience could limit the agency's ability to adequately oversee operations and make informed decisions in the future. Therefore, while contracting may be a viable short-term solution, it is essential for agencies to carefully consider these potential drawbacks before implementing this approach.

Specific Cases: Washington DC and Los Angeles

Washington DC and Los Angeles have adopted different approaches to the implementation of transit services, reflecting their specific needs and contexts. In Washington DC, the expansion of transit service was a crucial factor leading to the creation of the Circulator, a sub-operation dedicated exclusively to the city. Due to the lack of local operational experience, the decision was made to contract with RATP Dev, a French company with extensive experience in fleet management. This collaboration facilitated the transition to an electric fleet, leveraging the technical and operational expertise that RATP Dev brought to the project.

On the other hand, Los Angeles took a more autonomous approach by internally operating its transit system. LA Metro, the city's transit authority, managed the entire process, from fleet procurement to driver training. This way, for the implementation of electric buses, LA Metro built its own expertise by launching a pilot project on the G Line. This approach allowed the city to address specific challenges and adjust its strategy before expanding electrification to the entire transit network. These contrasting approaches underscore the importance of tailoring implementation strategies to local particularities.

8.3.3. Success Cases

This section will present several success stories in the application of electromobility in the United States. These examples cover both broader and regional initiatives, highlighting the achievements and strategies implemented at different levels of government and by various entities. Through these experiences, it will be illustrated how the adoption of EVs and the expansion of charging infrastructure are progressing in the economy, driving the transition towards a more sustainable and energy-efficient future.

Broader Achievements in Electromobility

IRA

The IRA, enacted in 2022, has been a significant catalyst for the adoption of EVs (EVs) across the United States. This legislation includes a series of tax incentives, such as the "Clean Vehicle Credit," which offers up to USD7,500 in tax credits for the purchase of new EVs and USD4,000 for used EVs. Additionally, the IRA allocates substantial funds for the expansion of charging infrastructure through the "NEVI Formula Program," which aims to ensure an accessible and reliable charging network nationwide[416]. It is projected that the IRA will mitigate a total of 21 billion Mt of CO_2 equivalent from its implementation until 2050. This reduction in emissions is expected to generate global economic benefits exceeding USD5.6 trillion by 2050[417]. Besides the climate benefits, the IRA will also enhance local air quality, resulting in additional benefits valued between USD20 billion and USD49 billion by 2030, derived from the reduction of pollutants such as sulfur dioxide and NOx[418].

[416] https://www.whitehouse.gov/briefing-room/statements-releases/2021/12/13/fact-sheet-the-biden-harris-electric-vehicle-charging-action-plan/
[417] https://home.treasury.gov/news/featured-stories/the-inflation-reduction-acts-benefits-and-costs
[418] Ibid.

National EV Infrastructure Program (NEVI)

The National EV Infrastructure (NEVI) Program, established under the IIJA, allocates USD5 billion to states, D.C., and Puerto Rico from 2022 to 2026 for deploying EV charging infrastructure. The funds, primarily aimed at Alternative Fuel Corridors, enable the installation of fast chargers every 50 miles and require adherence to minimum charging standards. States must submit annual plans to strategically utilize these funds, with grants ranging from USD13.6 million to USD407.8 million, covering up to 80% of project costs.[419]

Regional Success Cases

California's Leadership in Electromobility

California is a pioneer in EV adoption in the United States. The state has implemented aggressive policies and invested significantly in charging infrastructure. The Zero-Emission Vehicle (ZEV) law mandates an increasing proportion of cars sold in California to be electric. Moreover, the state boasts over 30,000 public charging stations, facilitating daily EV use. In 2021, nearly 8% of the light vehicles registered in California were electric[420].

New York's EV Plan

New York has launched several initiatives to promote EV adoption, including the "Drive Clean Rebate" program, which offers financial incentives of up to USD2,000 for the purchase or lease of EVs, stackable with the federal tax credit of up to USD7,500. Additionally, the state reached the milestone of 150,000 EVs in circulation by June 2023 and is investing an additional USD29 million in expanding charging infrastructure under the "Charge Ready NY 2.0" program. This program covers up to 50% of the installation cost for Level 2 chargers at workplaces, multifamily buildings, and public facilities in disadvantaged communities. The state's goal is to have 10,000 charging stations by 2025, supporting the aim to reduce greenhouse gas emissions by 85% by 2050[421].

Texas: Rapid Expansion of Charging Infrastructure

Texas has experienced rapid growth in EV adoption and the expansion of its charging infrastructure. In 2021, the state implemented the Texas Volkswagen Environmental Mitigation Program, allocating USD31 million for installing EV charging stations. This investment has facilitated the installation of over 2,000 public charging stations statewide, improving access for EV drivers. Additionally, Texas received an extra USD408 million from the IIJA to continue expanding the charging network over the next five years[422]. As of April 2023, Texas boasts 2,463 Level 2 and DC fast charging stations with a total of 6,340 ports. This infrastructure is being expanded to include fast chargers every 50 miles along designated Alternative Fuel Corridors, aiming to cover all rural and urban areas in the state[423].

Electric Bus Program in Seattle

[419] https://www.transportation.gov/rural/ev/toolkit/ev-infrastructure-funding-and-financing/federal-funding-programs
[420] https://ww2.arb.ca.gov/es/node/2558
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[423] The White House. (2023). *Texas Fact Sheet*. https://www.whitehouse.gov/wp-content/uploads/2023/04/Texas-Fact-Sheet-042523.pdf

The city of Seattle has adopted an ambitious program to electrify its bus fleet. King County Metro, Seattle's public transportation operator, plans to have a 100% electric fleet by 2040. Currently, the city operates over 200 electric buses, reducing CO_2 emissions and improving urban air quality[424]. The King County Metro Zero Emission Bus Transition Plan[425] aims to transform the public transport system by 2035, offering significant benefits. This plan will reduce greenhouse gas emissions by approximately 100,000 Mt annually, and in 2019, the transit network avoided around 700,000 Mt of emissions, equivalent to removing more than 190,000 cars from daily use. It will improve air quality and public health, especially in South King County, promoting social equity. The charging infrastructure, including new facilities capable of supporting up to 250 electric buses, will generate jobs in construction and maintenance.

8.3.4. Limitations, Opportunities, and Challenges for the Automotive Industry in the Transition to Electromobility

The transition to electromobility in the United States presents a complex landscape with significant limitations but also crucial opportunities and challenges for the automotive industry. Below, these three aspects are analyzed, based on recent data and information on the evolution and projections of the EV sector in the U.S.

One of the main limitations in the transition to electromobility in the United States is the dependence on critical components sourced from abroad, particularly from China. It should be noted that the IRA has implemented strict restrictions to qualify for the tax credit of up to USD7,500, requiring vehicle assembly to occur in North America and battery components to be free from foreign entities of concern. This has reduced the number of eligible EV models for this credit from over 40 in the second half of 2023 to around 27 by early 2024[426].

Despite these limitations, the transition to electromobility also presents numerous opportunities for the U.S. automotive industry. One of the most notable opportunities is the significant investment in battery manufacturing. Since the signing of the IRA, investments of over USD60 billion have been announced to support the EV industry, with about 80% of these investments aimed at battery manufacturing[427]. This focus on battery production not only meets domestic demand but also positions the United States as a leader in battery technology globally.

Another opportunity lies in the tax incentives and government subsidies designed to foster the expansion of the EV industry. The Clean Vehicle Rebate Program, for example, offers up to USD7,500 for vehicles that meet established requirements. Additionally, certain excise taxes on zero-emission trucks have been suspended, further incentivizing the purchase of EVs.[428].

The path to electromobility in this economy is not without challenges. One of the most critical is the need to develop a robust and resilient supply chain for key components, such as semiconductors and battery materials. The recent investment by Micron in a

[424] https://kingcounty.gov/~/media/depts/metro/accountability/reports/2022/zero-emission-bus-fleet-transition-plan-may-2022#:~:text=URL%3A%20https%3A%2F%2Fkingcounty.gov%2F~%2Fmedia%2Fdepts%2Fmetro%2Faccountability%2Freports%2F2022%2Fzero

[425] King County Metro. (2022). *Zero-Emission Bus Fleet Transition Plan*. Seattle: King County Metro. Available at: https://kingcounty.gov/~/media/depts/metro/accountability/reports/2022/zero-emission-bus-fleet-transition-plan-may-2022#:~:text=URL%3A%20https%3A%2F%2Fkingcounty.gov%2F~%2Fmedia%2Fdepts%2Fmetro%2Faccountability%2Freports%2F2022%2Fzero

[426] International Energy Agency. (2024). *Global EV Outlook 2024: Moving towards increased affordability*. Available at: https://iea.blob.core.windows.net/assets/a9e3544b-0b12-4e15-b407-65f5c8ce1b5f/GlobalEVOutlook2024.pdf (p.120).

[427] Ibid.

[428] https://www.csrwire.com/press_releases/794751-electric-vehicle-trends-and-challenges-industrial-real-estate

new semiconductor manufacturing plant in New York, valued at up to USD100 billion, is a step in the right direction but underscores the magnitude of the effort needed to meet demand[429].

Additionally, the industry faces the challenge of meeting decarbonization commitments amid supply chain tensions. The demand for specialized technicians and the necessary infrastructure to support industry growth will exceed the current supply, creating potential bottlenecks that could slow progress. The growing demand for EVs is fueling the need for more electrical engineers and technicians with specialized training in EVs. These talents are essential to design, develop, and manufacture EVs and their components, such as motors and batteries. Currently, there are approximately 194,000 engineers specializing in EVs, but 200,000 will be needed by 2027. This is the most demanded job in the industry. The total workforce of the industry is expected to grow by more than 27,000 people by 2027[430].

[429] Ibid.
[430] Ibid.

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Source: Elaborated by the author.

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INDrastructure Canada	Zero-Emission Transit Fund	INDrastructure Canada		2023

Author(s)	Title	Publishing Institution	City	Year
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Environment and Climate Change Canada	Clean Electricity Standard Discussion Paper	Environment and Climate Change Canada		2022
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Source: Elaborated by the author.

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Table 39. United States

Author(s)	Title	Publishing Institution	City	Year
Aber, J.	Electric Bus Analysis for New York City Transit	Columbia University	New York	2016
British Petroleum	BP Statistical Review of World Energy	British Petroleum	Houston	2018
British Petroleum	BP Statistical Review of World Energy	British Petroleum	Houston	2019
Bradley, D., Munk, L., Jochens, H., Hynek, S., y Labay, K.	A Preli - minary Deposit Model for Lithium Brines	United States Geological Survey	Virginia	2013
State of California Government	Executive Order B-16-2012 (ZEV Mandate)	State of California Government	California	2012
Hardman, S.	Understanding The Impact of Reoccurring and Non-Financial Incentives on Plug-In Electric Vehicle Adoption – A Review. Transportation Research Part A, 119, 1-14	University of California, Davis	California	2019
Hardman, S., Chandan, A., Tal, G., y Turrentine, T.	The Effectiveness of Financial Purchase Incentives for Battery Electric Vehicles – A Review of the Evidence. Renewable and Sustainable Energy Reviews, 80, 1100-1111	University of California, Davis	California	2017
Nealer, R., Reichmuth, D., y Anair, D.	Cleaner Cars from Cradle to Grave - How Electric Cars Beat Gasoline Cars on Lifetime Global Warming Emissions	Union of Concerned Scientists	Washington D.C.	2015
National Highway Traffic Safety Administration	Critical Reasons for Crashes Investigated in the National Motor Vehicle Crash Causation Survey	United States Department of Transportation	Washington D.C	2015
Nealer, R., Reichmuth, D., y Anair, D.	Cleaner Cars from Cradle to Grave - How Electric Cars Beat Gasoline Cars on Lifetime Global Warming Emissions	Union of Concerned Scientists	Washington D.C.	2015
Plateau Energy Metals	Enabling the New Energy Paradigm	American Lothium	Vancouver	2019

Author(s)	Title	Publishing Institution	City	Year
Slowik, P., Araujo, C., Dallman, T., y Façanha, C.	International Evaluation of Public Policies for Electromobility in Urban Fleets	The International Council on Clean Transportation		2018
Transport & Environment	Electrofuels What Role in EU Transport Decarbonisation?	Transport & Environment		2017
Trip, J. J., Lima, J., y Bakker, S.	Electric Mobility Policies in the North Sea Region Economies	Delft University of Technology	Mekelweg	2012
United States Census Bureau	Annual Estimates of the Resident Population in the United States	United States Census	Suitland	2017
United States Geological Survey	Mineral Commodity Summaries 2001	United States Geological Survey	Virginia	2001
United States Geological Survey	Mineral Commodity Summaries 2011	United States Geological Survey	Virginia	2011
United States Geological Survey	Mineral Commodity Summaries 2019	United States Geological Survey	Virginia	2019
World Economic Forum	Electric Vehicles for Smarter Cities: The Future of Energy and Mobility. World Economic Forum	World Economic Forum	Cologny	2018
Schrank, D., & Lomax, T.	The 2001 Urban Mobility Report. Texas Transportation Institute	The Texas A&M University System.	Texas	2001
World Bank	Global Mobility Report 2022	World Bank	Washington D.C	2023
U.S. Department of the Interior & U.S. Geological Survey	Mineral Commodity Summaries 2024	U.S. Department of the Interior & U.S. Geological Survey	Washington D.C	2024
Palmer, K., Tate, J., Wadud, Z., y Nellthorp, J.	Total Cost of Ownership and Market Share for Hybrid and Electric Vehicles in the UK, US and Japan, Applied Energy 209, 108-119	University of Leeds	Leeds	2018
American Lung Association	The road to clean air: Benefits of a nationwide transition to electric vehicles	American Lung Association		2020
American Lung Association	Driving to clean air: The health and climate benefits of zero-emission cars and electricity	American Lung Association		2022
American Lung Association	Zeroing in on Healthy Air: The health and climate benefits of zero-emission transportation and electricity generation	American Lung Association		2023
International Energy Agency	Global EV Outlook 2024: Moving towards increased affordability	International Energy Agency		2024
Hill, J.	Incentives for Electromobility: The U.S. Approach	APEC	Lima Convention Center,	2024

Author(s)	Title	Publishing Institution	City	Year
			San Borja, Lima, Peru	
Hill, J.	Advancing Electrification Goals through Public Transit Fleets	APEC	Lima Convention Center, San Borja, Lima, Peru	2024

Source: Elaborated by the author.

Table 40. General Bibliography

Author(s)	Title	Publishing Institution	City	Year
World Bank	World Development Report 1997: The State in a Changing World	Oxford University	London	1997
Benavides H. y León G.	Technical INDormation on Climate Change and Greenhouse Gases	Institute of Hydrology, Meteorology and Environmental Studies	Bogota	2007
Edwards G. Viscidi L. y Mojica C.	Loading the Future: The Growth of Electric Car and Bus Markets in Latin American Cities	The Dialogue Leadership for the Americas		2018
Galarza G. y López G.	Electric Mobility: Opportunities for Latin America	United Nations Environment Program	Washington D.C.	2016
Petit Boqué C.	Improving Quality in Public Transport Systems as a Pillar of More Sustainable Mobility	Technical School of Civil Engineering, Canals and Ports of Barcelona, Polytechnic University of Catalonia	Catalonia	2007
Nuclear Energy Agency	Transport Research and Training OGM Oxford University Erasmus University TIS.PT and ISIS	Nuclear Energy Agency	Rijswijk	2003
Rodríguez Porcel M.	Interoperability in Public Transport Fare Collection Systems in Latin America and the Caribbean	Inter-American Development Bank	Asuncion	2018

Author(s)	Title	Publishing Institution	City	Year
International Energy Agency	Energy Efficiency 2023	International Energy Agency		2023
United Nations Economic and Social Commission for Asia and the Pacific	Electric Mobility in Public Transport: A Guidebook for Asia-Pacific Economies	United Nations Economic and Social Commission for Asia and the Pacific		2023
World Health Organization	Ambient Air Pollution: A Global Assessment of Exposure and Burden of Disease. Geneva: WHO Document Production Service	World Health Organization	Geneva	2016

Source: Elaborated by the author.

10. Annex

10.1. Agenda

ELECTROMOBILITY TOWARDS A SUSTAINABLE AND SAFE MOBILITY

FRIDAY, 16 AUGUST– WORKSHOP

08:30-09:00 - Register

Time		Topics/Title	Speaker, Org/Economy
09:00 – 09:20	**1. Opening Session**		
	1.1.	Welcome remarks	▪ Miss TORRES, Claudia ▪ Representative of the Ministry of Transport andCommunications
09:20 – 09:50	2. **Presentation of the partial results of the Background study about strategies to promote sustainable and safe mobility in APEC economies with priority on the transition to electromobility.**		
	2.1	Keynote presentation: Advancing of project (20 minutes)	Mr. Guerra-García
	2.2	Q&A	
9:50 – 11:20	**3. Strategies to promote electromobility in APEC economies:** economies will explain the most effective instruments they have implemented in terms of fiscal incentives, financial incentives and Infrastructure incentives.		
	3.1	Incentives for Electromobility	HERNANDEZ, Marco (Researcher Specialist in Vehicle Dynamics, Mexican Institute of Transportation)- Presentation in Spanish
	3.2	Normative aspects of the implementation of electromobility in Santiago de Chile	STEINMEYER, Alfredo (Legal Manager, Metropolitan Public Transportation Directorate)- Presentation in Spanish
	3.3	Singapore's Vehicular Electrification Journey	NG Emmalene (Assistant Director, Ministry of Transport, Singapore)
	3.4	Incentives for Electromobility: The U.S. Approach	HIIL, Jason (Division Chief – Western Hemisphere of United States)
	3.5	Q&A	
11:00 – 11:15	**Coffee Break**		
11:15 – 13:00	**4. Public fleet tender schemes:** economies will be able to explain the lessons learned from innovations in route tendering processes		
	4.1	Public Fleet Tender Schemes	CASTRO, Maria (Rosario Castro, CEO of Metrobus Mexico City)- Presentation in Spanish
	4.2	Implementation Santiago de Chile of E-buses in Santiago de Chile	TAMBLAY, Sebastian (Planning Manager, Metropolitan Public Transportation Directorate)- Presentation in Spanish
	4.3	Promoting Use of Electric Buses in Singapore	TOH Eu Jin (Assistant Director, Ministry of Transport, Singapore)
	4.4	Advancing Electrification Goals through Public Transit Fleets	HIIL, Jason (Division Chief – Western Hemisphere of United States)
		Chinese Taipei's Innovative E-Bus	CHEN, Jason (Associate Researcher, Institute of

Time		Topics/Title	Speaker, Org/Economy
	4.5	Solution: Facilitating Smart Transformation in Route Tendering	Transportation, Ministry of Transportation and Communication of Chinese Taipei)
	4.6	Q&A	
Time		**Topics/Title**	**Speaker, Org/Economy**
13:00 – 14:30		**Lunch Break**	
14:30 – 15:30	**5. Private sector participation: In this section private firms that explain their perspectives and visions of electromobility.**		
	5.1	Electric Mobility in Peru: Challenges and Opportunities towards a Sustainable Future	GUERRERO, Nestor (Head of Business to Government, Pluz Solucioness-ENEL X)
	5.2	Accelerating sustainable mobility: the METBUS case study in electric bus adoption	VILCHEZ, Andres (Deputy director of studies and strategies -METBUS)
	5.3	Exploring green and sustainable mobility with YUTONG	Lee, Leo (Director of Distribution Channels, America Division -YUTONG)
	5.5	Q&A	
15:30 – 16:10	**6. Participation from the specialist institutions that explain their perspectives and visions of electromobility.**		
	6.1	Role of the SDC Regional International Cooperation Hub in the promotion of Electromobility.	CLOT, Nicole (Regional Deputy Head of Cooperation, COSUDE)
	6.2	Enabling conditions for the introduction of electromobility in Latin American cities: a regional collaborative approach under CALAC+ Program	Montalvo, Adrian (Director CALAC+ Program)
	6.3	Q&A	
16:10 – 16:20	**7. Reflections and conclusions- Representative of the Ministry of Transport and Communications**		
16:20 – 16:30	**8. Closing Remarks**		

10.2. Speaker

Mr. Guerra-García

- Associate consultant at DEE Consultores, specialist in Public Management, investment project formulation and institutional reforms, with more than 20 years of experience in private and public management. He has worked for international organizations such as the WB, IDB, CAF, and others, in other Latin American economies. He held the position of General Director of Intersectoral Coordination of the PCM (2001) and has been Vice Minister of Transport (2001-2002) and Finance (2021-2022). He was director of various public companies and member of the Board of Shareholders of Petroperú. He has led pre-investment studies under the methodologies of the SNIP and Invierte.pe and has served as a professor at universities such as PUCP, UP and Continental.

Hernandez, Marco

- An engineer specializing in Communications and Electronics with a master's degree in Microelectronics and currently a PhD student in Energy, he focuses on Power Electronics and Energy Efficiency in Electric Vehicles. Passionate about IoT technologies, electronic control and hydrogen technologies, he researches electric vehicles, charging infrastructure and regulations at the Mexican Institute of Transport (IMT), where he works in the Vehicle Dynamics area of CIVIE, focusing on electromobility, electric vehicle configuration, energy management, fuel cells and chargers.

Steinmeyer, Alfredo

- Lawyer with more than 10 years of experience in the public sector, specializing in transparency, regulation and administrative law. At the Council for Transparency, he collaborated in the development of statutes, regulations and training. At the Undersecretariat of Transportation, he headed the Regulation Unit, promoting regulatory improvements and leading key bills such as the one on transportation applications.
- Currently, he is head of the legal department of the National Training and Employment Service, where he leads a team of 13 lawyers, advises on legal strategies and optimizes public tender and legality control processes. He has promoted improvements in decrees on training and employment subsidies.

NG Emmalene

- He is currently a Deputy Director at Singapore's Ministry of Transport, focusing on electric vehicles. Previously, he worked at the Ministry of Finance, where he developed decarbonisation and energy security policies, as well as facilitating access to finance for SMEs. He has implemented the carbon tax and zero-emission targets for 2050. He has also collaborated in various government institutions in areas of public policy and strategic planning..

Hiil, Jason

- Regional Manager for Western Hemisphere Affairs at the U.S. Department of Transportation, with more than 10 years of experience in international transportation policy development and management. Currently, he leads the Department's engagement with the Americas, formulating transportation policy and creating programs that support U.S. objectives in the region. He also manages the MOMENTUM program, which provides international technical assistance in transportation systems planning and delivery. Previously, he was Senior Policy Advisor for Asia-Pacific and Chair of the APEC Transportation Working Group.

Castro, Rosario

- CEO of Metrobus, he directs and legally represents an Organization in Mexico City, with broad powers to administer, subscribe to credit instruments, appoint and remove personnel, grant powers, and formulate programs and budgets. He supervises the operation and maintenance of the System, proposes rates and coordinates the implementation of collection mechanisms. In addition, he ensures compliance with the Council's agreements, exercises legal actions and collaborates with other agencies to guarantee efficient operation in accordance with current regulations.

Tamblay, Sebastian

- Planning Manager of the Metropolitan Public Transport Board in Santiago, Chile, a position he has held since March 2022. In this role, he coordinates and supervises strategies for public transport planning in the city. Previously, he was Coordinator of Studies in the same organization, where he led key analyses to improve the transport system for more than three years. In addition, he has experience as a Project Engineer, and has participated as a researcher in the development of transport planning tools, such as the FONDEF project..

Toh Eu Jin

- Professional with more than 10 years of experience in the public sector, currently Deputy Director at the Land Transport Authority (LTA) of Singapore, responsible for designing policies for the financial sustainability of the public bus industry and managing international relations. Previously, he was Senior Assistant Deputy Director at the Ministry of Trade and Industry of Singapore, where he led the development of policies for small and medium-sized enterprises, with a focus on growth, innovation and financing.

Chen, Jason

- Research Associate at the Institute of Transportation of the Ministry of Transport and Communications of Chinese Taipei. He specializes in the innovation and development of sustainable mobility solutions, with a particular focus on the transformation of public transport systems through electrification and the adoption of new technologies.

Guerrero, Nestor

- Industrial Engineer and MBA from the Universidad Peruana de Ciencias Aplicadas, with 16 years of experience in the Business (B2B), Government (B2G) and People (B2C) segments in Business Development, Product, Channels, Sales, Planning and Innovation. Currently, I hold the position of Head of Business to Government at Pluz Energía Perú (formerly Enel Perú). With extensive knowledge of the energy, electric mobility, telecommunications, public and private transportation, and public tenders sectors.

Vilchez, Andres

- He is a Management Control Engineer and currently works as Deputy Manager of Studies at Buses Metropolitana S.A., one of the main public transport operators in Santiago de Chile. Since December 2018, he has led the analysis and development of strategic studies to improve the operation and efficiency of the bus system in the city, contributing to the advancement of electromobility and the optimization of the public transport service in Santiago.

Lee, Leo

- Director of Distribution Channels for the Americas Division of YUTONG, a leading global manufacturer of electric buses. Lee has a distinguished track record in the sustainable mobility industry, leading initiatives to expand YUTONG's presence in the Americas. His work focuses on promoting green transportation solutions and collaborating with governments and companies to implement advanced electric mobility technologies. Under his leadership, YUTONG has consolidated its position in the electric bus market in Latin America and other regions.

Clot, Nicole

- Development specialist with more than 20 years of experience in disaster risk management, climate change adaptation and resilience building in more than 30 economies. Currently working with the Swiss Agency for Development and Cooperation (SDC) in the Andean Region, based in Peru. He has extensive experience in non-profit organizations and is a member of the Swiss Humanitarian Corps, forming part of the group of experts in disaster risk reduction and the environment..

Montalvo, Adrian

- Director of the CALAC+ Program (Clean Air in Latin American Cities), a regional initiative that promotes electromobility and the reduction of emissions in Latin American cities. Montalvo has extensive experience in environmental policies and sustainability, leading regional cooperation efforts to improve air quality and promote the use of clean technologies in transportation. Under his direction, the CALAC+ Program has promoted key projects for the transition to electric mobility in many Latin American economies.

10.3. Survey on Electromobility Towards Sustainable and Safe Mobility in APEC Economies Pre-Workshop Survey

The purpose of the survey is to learn about policies and strategies for the promotion of electromobility as well as to know the environmental and social impact of the measures adopted by APEC economies.
By completing and submitting this form, I consent to the collection, use and disclosure of the personal data provided below to the APEC Secretariat for project administration and evaluation purposes and to be handled in accordance with *APEC Secretariat's Personal Data Protection Policy.*

* Indicates required question

Respondent Information

1. APEC economy *

2. Organization name *

3. Respondent's gender *

4. Respondent's name (optional)

5. Respondent's position (optional)

6. What is your level of knowledge on the topic of electromobility in your economy?

- o No knowledge
- o Some knowledge
- o Neutral
- o Good knowledge
- o Excellent knowledge

Current Situation of Electromobility

1. What is the total number of vehicles on the road in your economy? (Please provide the most recent figure available and indicate the respective year)

2. Could you please specify how many of these vehicles are light cars, buses, vans, or trucks?

3. What is the total number of electric vehicles (EVs) on the road in your economy? (Please provide the most recent figure available)

4. How many electric buses are currently in operation in your economy?

5. What is the ratio of electric vehicles to the total number of vehicles in your economy?

- 0% - 1%
- 1% - 5%
- 5 - 10%
- - 15%
- More than 15%
- Unknown

6. Is there a national strategy or specific action plan to promote electromobility in your economy?

- Yes
- No

7. If the previous answer is yes, could you please provide the names of the strategies or plans and the date of their implementation, as well as the link to the document, if available on the web?

8. Could you provide a brief overview of each of the strategies or plans listed in the previous question?

Policies and Strategies for the Promotion of Electromobility

1. What type of incentives exist in your economy to promote the adoption of electric vehicles? (Select all that apply)

- Tax incentives (tax rebates, subsidies)
- Financial incentives (preferential credits, nancing)
- Infrastructure incentives (deployment of charging stations, subsidies for installation)
- Other:

Additional incentive information

Incentive name: What is the official name of the incentive? *

Year of approval: In which year was the incentive approved or implemented? *

Incentive description: What does the incentive consist of? Provide a brief description of how it works and what benefits it offers.

Beneficiary population: Who are the main beneficiaries of this incentive? (e.g., individual consumers, businesses, fleet operators, etc.)

Estimated fiscal cost: What is the estimated annual fiscal cost of this incentive to the government? Provide approximate figures if available.

2. What public policies are in place to support the transition to electromobility? (Select all that apply)

- Emissions regulations that favor electric vehicles
- Regulations that promote the use of electric vehicles in public eets Public awareness and education programs
- Other:

If in question 2 **"Emissions regulations that favor electric vehicles"** was selected, please answer the following questions.

Name of regulation:

Year of implementation:

Description of regulation: How does it specifically benefit electric vehicles?

Expected or measured impact: What is the expected or measured impact on emissions reductions due to this regulation?

If in question 2 **"Regulations that promote the use of electric vehicles in public fleets"** was selected, please answer the following questions.

Name of regulation:

Year of implementation:

Description of regulation: What requirements or incentives does it establish for public fleets?

Scope of application: What types of public fleets does it apply to? (e.g., buses, government vehicles, emergency services, etc.)

Expected or measured impact: What is the expected or measured impact on the adoption of electric vehicles in public fleets?

If in question 2 **"Public awareness and education programs"** was selected, please answer the following questions.

Name of program:

Year of launch:

Description of program: What activities or campaigns are conducted to educate and raise public awareness on the benefits of electric vehicles?

Target audience: Who is the target audience for these programs? (e.g., consumers, businesses, youth, etc.)

Expected or measured impact: What is the expected or measured impact on increasing public awareness and adoption of electric vehicles?

If in question 2 **"Other"** was selected, please specify any other public policies that support the transition to electromobility in your economy, providing the following details:

Name of policy:

Year of implementation:

Description of policy: What does it consist of and how does it support the transition to electromobility?

Expected or measured impact: What is the expected or measured impact of this policy on the adoption of electric vehicles?

3. Does your government periodically evaluate the effectiveness of electromobility promotion policies?

- ○ Yes
- ○ No

4. How often are these policies evaluated?

1. What indicators or metrics does your government use to measure the success of electromobility promotion policies? (Select all that apply)

- ○ Number of electric vehicles on the road
- ○ Ratio of electric vehicles to total vehicles
- ○ Reduction in greenhouse gas emissions
- ○ Increase in charging infrastructure for electric vehicles
- ○ Other:

Infrastructure and Technology

1. What is the current state of electric vehicle charging infrastructure in your economy?

- ○ Very poor Poor
- ○ Adequate
- ○ Good

- Very good

2. What is the current number of electric vehicle charging stations in your economy? (Please provide the most recent figure available, as well as the respective year)

3. Are there plans for the expansion of charging infrastructure for the next 5 years?

- Yes
- No

4. If the previous answer is yes, could you please provide details on plans for expansion of the charging infrastructure?

5. If the answer to question 3 is yes, has your economy set a specific target for the optimal ratio of charging infrastructure to the number of electric vehicles? If so, what is that target ratio?

Environmental and Social Impact

1. What environmental benefits have been noted in your economy due to the adoption of electric vehicles? (Select all that apply) *

- Reduction of CO2 emissions
- Improvements in air quality
- Noise reduction
- Other:

If in question 1 **"Reduction of CO2"** was selected, please answer the following questions.

Can you provide specific data or percentages of CO2 emissions reduction since the adoption of electric vehicles?

Are there any targets set for CO2 reduction in the future due to the transition to electric vehicles? *

If in question 1 **"Improvements in air quality"** was selected, please answer the following questions.
What specific changes in air quality have been recorded in areas with high adoption of electric vehicles?

Are there any studies or data showing a direct relationship between the adoption of electric vehicles and the improvement in air quality?

If in question 1 **"Noise reduction"** was selected, please answer the following questions.
In which areas or sectors (urban, rural) has a significant reduction in noise due to electric vehicles been noted?

Are there specific measurements or studies that demonstrate this noise reduction?

2. What social challenges are faced in your economy with regard to the adoption of electric vehicles? (Select all that apply)

- o High initial cost of electric vehicles
- o Lack of public knowledge or acceptance
  Limitations in charging infrastructure
- o Other:

If in question 2 **"High initial cost of electric vehicles"** was selected, please answer the following questions.

What measures or policies are in place to reduce the initial cost of electric vehicles for consumers?

If in question 2 **"Lack of public knowledge or acceptance"** was selected, please answer the following questions.

What strategies have been implemented to educate the public about the benefits and use of electric vehicles?

If in question 2 **"Limitations in charging infrastructure"** was selected, please answer the following questions.

What are the main barriers to the expansion of charging infrastructure in your economy?

Innovation and the Future of Electromobility

1. What emerging technologies are being explored in your economy to support * electromobility? (Select all that apply)

- o Higher capacity, lower cost batteries
- o Fast and ultrafast charging
- o Wireless charging solutions Electric
  autonomous vehicles
- o Other:

2. How does your economy anticipate the evolution of the electric vehicle * market in the next 5 to 10 years?

3. What role will government policies play in the future of electromobility in your * economy?

Improvements and Recommendations

1. What additional measures could your government take to accelerate the * adoption of electromobility?

2. What recommendations would you make to improve current electromobility * policies in your economy?

Best practices to promote electromobility in urban land transportation

1. What is the name of the policy or initiative and when was it launched?

2. Provide a brief description of the policy initiative and/or links to publicly available information. Please consider in your response the purpose, activities, and achievements to date.

3. Who can be contacted for more information? Please provide the name and email address of the contact person.

4. Would your economy be interested in sending a speaker to present the policy initiative noted above at the workshop to be held in Lima, Peru on 16 August 2024? (If so, please provide the name and email address of the contact person).

10.4. Survey Responses

Survey on Electromobility towards sustainable and safe mobility in APEC Economies Pre-Workshop Survey

2 responses

Publish analytics

Respondent Information

1. APEC economy

2 responses

Singapore

Chinese Taipei

2. Organization name

2 responses

Ministry of Transport

Institute of Transportation, MOTC

3. Respondent's gender

2 responses

Female

male

4. Respondent's name (optional)

1 response

5. Respondent's position (optional)

1 response

Researcher

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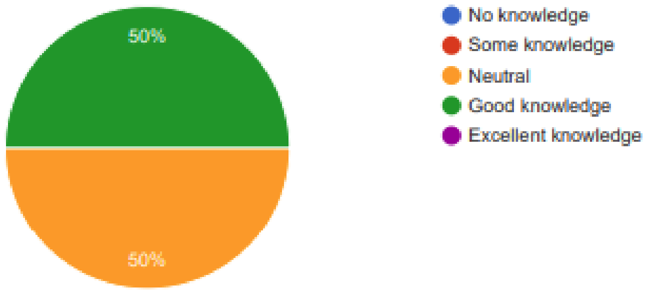
6. What is your level of knowledge on the topic of electromobility in your economy?

2 responses



Current Situation of Electromobility

1. What is the total number of vehicles on the road in your economy? (Please provide the most recent figure available and indicate the respective year)

2 responses

997k (end 2023)

As of June 2024, the total number of registered motor vehicles in our country is 23,245,326.

2. Could you please specify how many of these vehicles are light cars, buses, vans, or trucks?

2 responses

783k (end 2023)

As of June 2024, the total number of vehicles in our country includes 30,172 buses (including those used for commercial purposes), 175,975 heavy trucks (including commercial use), 7,385,394 passenger cars (including commercial use), 978,902 light trucks (including commercial use), and 14,601,975 motorcycles.

3. What is the total number of electric vehicles (EVs) on the road in your economy? (Please provide the most recent figure available)

2 responses

12k electric cars (end 2023)

As of June 2024, the total number of registered electric vehicles in our country is 814,975, including 1,933 electric buses, 4 electric heavy trucks, 78,801 electric passenger cars, 327 electric light trucks, and 733,910 electric scooters.

4. How many electric buses are currently in operation in your economy?

2 responses

64 (end 2023)

As of June 2024, there are 1,933 electric buses in operation.

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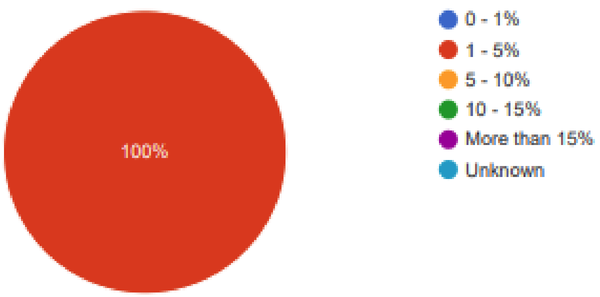
5. What is the ratio of electric vehicles to the total number of vehicles in your economy?

2 responses



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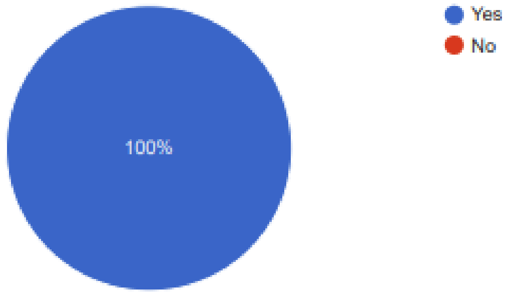
6. Is there a national strategy or specific action plan to promote electromobility in your economy?

2 responses



7. If the previous answer is yes, could you please provide the names of the strategies or plans and the date of their implementation, as well as the link to the document, if available on the web?

2 responses

Singapore Green Plan 2030 (https://www.greenplan.gov.sg/)

(1) name: Carbon Free Electric Vehicles
(2) date: 2023-2040
(3) the link to the document: https://ws.ndc.gov.tw/Download.ashx?u=LzAwMS9hZG1pbmlzdHJhdG9yLzEwL3JlbGZpbGUvMC8xNTQ1Ni81YTVlYTk4NC0zZTJkLTQ5OGItOGE3Zi05ODM3YTJlMjllZGQucGRm&n=MDdf6YGL5YW36Zu75YuV5YyW5Y%2bK54Sh56Kz5YyW6Zec6Y215oiw55Wl6KGM5YuV6Kil55WrKOaguOWumuacrCkucGRm&icon=.pdf

8. Could you provide a brief overview of each of the strategies or plans listed in the previous question?

2 responses

New registrations of diesel cars and taxis to cease from 2025; all Housing Development Board (HDB) towns to be EV-ready and equipped with EV chargers by 2025; all new car and taxi registrations to be of cleaner-energy models from 2030; 60,000 charging points nation-wide, including 40,000 in public carparks and 20,000 in private premises by 2030, in tandem with EV adoption

Key Strategy 7, "Carbon Free Electric Vehicles," is led by the MOTC, the Ministry of Economic Affairs (MOEA), and the Ministry of the Environment (MOENV). It focuses on three main objectives: increasing electric vehicle numbers, enhancing supporting infrastructure, and upgrading industry technology. The strategy includes 10 implementation pathways and 57 action measures. It aims to fully electrify urban buses and official vehicles by 2030 and achieve 100% market share for new electric passenger cars and scooters by 2040. The plan also seeks to create a supportive environment for electric vehicles and advance the transition to electrified and decarbonized transportation.

Policies and Strategies for the Promotion of Electromobility

1. What type of incentives exist in your economy to promote the adoption of electric vehicles? (Select all that apply)

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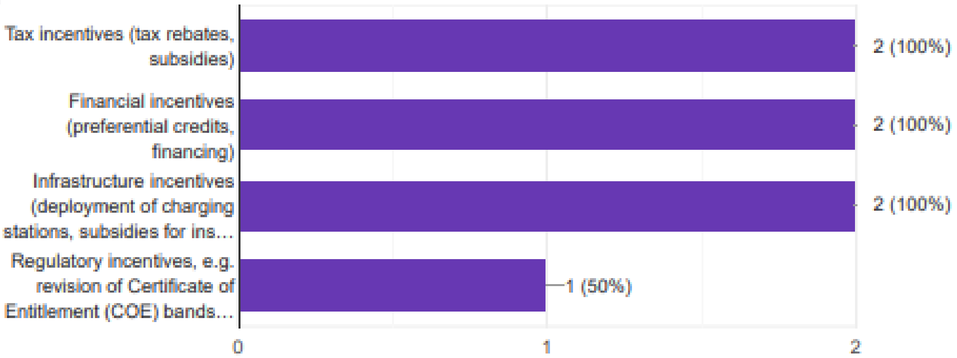
2 responses



Additional incentive information

Incentive name: What is the official name of the incentive?

2 responses

Early EV Adoption Incentive (EEAI)

(1) Electric Vehicles are Exempted from Goods Tax and Use License Tax
(2) Electric Logistics Vehicle Subsidy Plan
(3) Carbon Free Electric Vehicles (includes tax, financial, and infrastructure incentives)

Year of approval: In which year was the incentive approved or implemented?

2 responses

2021

(1) Electric Vehicles are Exempted from Goods Tax and Use License Tax (2022)
(2) Electric Logistics Vehicle Subsidy Plan (2023)
(3) (2023-2040)

Incentive description: What does the incentive consist of? Provide a brief description of how it works and what benefits it offers.

2 responses

45% off Additional Registration Fee (ARF) for electric cars registered between 1 Jan 2021 and 31 Dec 2023, capped at S$20,000. For the period from 1 Jan 2024 to 31 Dec 2024, the 45% off ARF remains, but the cap has been revised downwards to S$15,000.

(1) Electric Vehicles are Exempted from Goods Tax and Use License Tax: Buying and registering an electric vehicle is exempt from commodity tax, up to a taxable price of NT$1.4 million; but, any amount over this is taxed at half the rate. Additionally, local governments may exempt electric vehicles from license plate tax. These measures reduce the cost and encourage the use of low-emission vehicles.
(2) Electric Logistics Vehicle Subsidy Plan: Subsidies support joint proposals for developing electric logistics vehicles, demonstrating fleet operations, and implementing charging infrastructure and management solutions.
(3) To promote the use of electric vehicles, Key Strategy 7, "Carbon Free Electric Vehicles," includes 12 action measures, focusing on tax incentives, loan assistance, financial incentives, and infrastructure support. Regarding benefits, based on the power emission factor of 0.388 kg CO2e per kWh set by the Executive Yuan's "Second Phase (2021-2025) Greenhouse Gas Reduction Promotion Plan" approved on January 10, 2022, it is estimated that vehicle electrification will reduce carbon emissions by 1.728 million tons of CO2e annually by 2030 compared to 2020 levels.

Beneficiary population: Who are the main beneficiaries of this incentive? (e.g., individual consumers, businesses, fleet operators, etc.)

2 responses

Purchasers of electric cars, e.g. individual consumers, businesses, fleet operators

(1) Electric Vehicles are Exempted from Goods Tax and Use License Tax: individual consumers
(2) Electric Logistics Vehicle Subsidy Plan: businesses
(3) Carbon Free Electric Vehicles: individual consumers, businesses, fleet operators

Estimated fiscal cost: What is the estimated annual fiscal cost of this incentive to the government? Provide approximate figures if available.

2 responses

S$71 million for the first three years of the EEAI (1 Jan 2021 to 31 Dec 2023)

Electric Logistics Vehicle Subsidy Plan: NT$245 million
Key Strategy 7, "Carbon Free Electric Vehicles," has a total budget allocation of approximately NT$91.6 billion for the period from 2023 to 2030.

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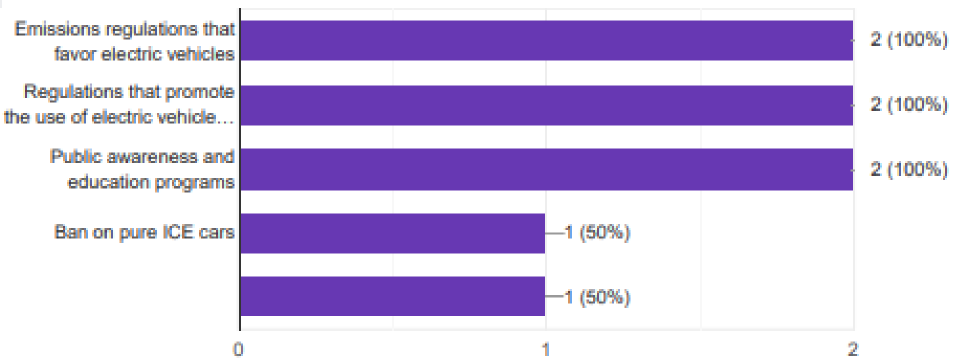
2. What public policies are in place to support the transition to electromobility? (Select all that apply)

2 responses



If in question 2 **"Emissions regulations that favor electric vehicles"** was selected, please answer the following questions.

Name of regulation:

2 responses

Enhanced Vehicle Emissions Scheme (VES)

(1) Vehicle Energy Consumption Standards and Inspection Management Regulations
(2)Greenhouse Gas Performance Standards for New Vehicles

Year of implementation:

2 responses

2021

(1) It is planned to include 2.5-ton and above light trucks in vehicle energy efficiency management by 2025. (2) The establishment of greenhouse gas performance standards for passenger cars is expected to be completed by 2025.

Description of regulation: How does it specifically benefit electric vehicles?

2 responses

Owners of fully electric cars can enjoy a S$25,000 rebate off the ARF, and owners of fully electric taxis a S$37,000 rebate.

(1) Vehicle Energy Consumption Standards and Inspection Management Regulations: These regulations offer multipliers as incentives for electric vehicles within the total energy consumption management of vehicles, encouraging manufacturers to provide more electric vehicles.
(2) Greenhouse Gas Performance Standards for New Vehicles: These standards specify the required greenhouse gas performance criteria that vehicles manufactured or imported for domestic use must meet.

Expected or measured impact: What is the expected or measured impact on emissions reductions due to this regulation?

2 responses

Motorists will prefer to purchase vehicles that produce less emissions to enjoy the cost savings.

Based on the goals for vehicle electrification and the Executive Yuan's "Second Phase (2021-2025) Greenhouse Gas Reduction Promotion Plan," which aims for a power emission factor of 0.388 kg CO2e per kWh by 2025, it is projected that vehicle electrification will cut carbon emissions by 1.728 million tons of CO2e annually by 2030. Specifically, the full electrification of 11,700 urban buses by 2030 is expected to reduce 403,000 tons of CO2e per year. Electric passenger cars, reaching 30% of market sales by 2030, will cut 744,000 tons of CO2e annually. Electric scooters, with a 35% market share by 2030, will result in a reduction of 584,000 tons of CO2e per year.

If in question 2 **"Regulations that promote the use of electric vehicles in public fleets"** was selected, please answer the following questions.

Name of regulation:

2 responses

Pending implementation

(1) Electric Bus Demonstration Project Vehicle Manufacturer Qualification Review Guidelines (2) Subsidy Guidelines for Electric Buses in Public Transportation (3) Electric Bus Demonstration Project Subsidy Guidelines (4) Electric Bus Promotion Plan Vehicle Manufacturer Qualification Review Guidelines (5) Subsidy Guidelines for Electric Buses (6) Central Government Agencies and Schools Procurement and Leasing Guidelines for Official Vehicles (7) Common Cost Budgeting Standards Table (Electric Vehicle Budgeting Standards)

Year of implementation:

2 responses

2025, 2030

(1) 2020-2023 (2) 2011-2022 (3) 2020-2022 (4) 2023 (5) 2023 (6) 2021 (7) yearly

Description of regulation: What requirements or incentives does it establish for public fleets?

2 responses

No new registration of diesel taxis from 2025 onwards. No new registration of internal combustion engine taxis from 2030 onwards.

1. The Electric Bus Demonstration Project and Electric Bus Promotion Plan outline the qualification review process for electric bus manufacturers. Local governments can only receive subsidies for purchasing electric buses from manufacturers who pass this review.
2. The guidelines for subsidizing electric buses in public transport and the subsidy guidelines support local governments in purchasing electric buses for public transportation use.
3. To promote the electrification of official vehicles, the government has increased the purchase subsidy for electric passenger cars (including batteries) for 2025 by 70,000 to 150,000 NTD compared to 2024. The budget for purchasing electric cars will continue to be reviewed and adjusted based on market prices, with government agencies required to budget according to vehicle replacement cycles.

Scope of application: What types of public fleets does it apply to? (e.g., buses, government vehicles, emergency services, etc.)

2 responses

No new registration of diesel taxis from 2025 onwards. No new registration of internal combustion engine taxis from 2030 onwards.

The applicable scope includes urban buses, highway buses, and government vehicles.

Expected or measured impact: What is the expected or measured impact on the adoption of electric vehicles in public fleets?

1 response

The ban on internal combustion engine vehicles will promote the adoption of cleaner energy vehicles, including electric vehicles, within the public taxi fleet.

If in question 2 **"Public awareness and education programs"** was selected, please answer the following questions.

Name of program:

2 responses

Power EVery Move

Key Strategy 7-Carbon Free Electric Vehicles

Year of launch:

2 responses

2022

2023

Description of program: What activities or campaigns are conducted to educate and raise public awareness on the benefits of electric vehicles?

2 responses

The 'Power EVery Move' campaign calls on everyone to participate in the adoption of EVs for a greener and more sustainable future.

Net Zero Cities Expo, Asia-Pacific Sustainable Expo

Target audience: Who is the target audience for these programs? (e.g., consumers, businesses, youth, etc.)

2 responses

All Singaporeans, in particular motorists.

The target audience includes the relate-industry, government, academia, and research sectors, as well as the general public.

Expected or measured impact: What is the expected or measured impact on increasing public awareness and adoption of electric vehicles?

2 responses

Accelerate adoption of electric vehicles.

It is anticipated that public cooperation will help achieve the goal of full electrification of urban buses and official vehicles by 2030, and 100% market share for new electric passenger cars and scooters by 2040.

If in question 2 **"Other"** was selected, please specify any other public policies that support the transition to electromobility in your economy, providing the following details:

Name of policy:

2 responses

Pending implementation

(1) Smart Electric Vehicle Industry Development Plan (2) Smart Electric Bus DMIT (Design and Manufactured in Taiwan) Plan (3) Develop low-cost DC charging equipment

Year of implementation:

2 responses

2025, 2030

(1) Smart Electric Vehicle Industry Development Plan (2023) (2) Smart Electric Bus DMIT (Design and Manufactured in Taiwan) Plan (2023) (3) Develop low-cost DC charging equipment (2022)

Description of policy: What does it consist of and how does it support the transition to electromobility?

2 responses

No new registration of diesel cars from 2025 onwards. No new registration of internal combustion engine cars from 2030 onwards.

(1) Smart Electric Vehicle Industry Development Plan: it promotes domestic production of electric vehicles and components, supports local electric buses and motorcycles, and boosts industry competitiveness through guidance and subsidies.
(2) Smart Electric Bus DMIT (Design and Manufactured in Taiwan) Plan: the plan guides and subsidizes domestic companies to develop electric buses and four key subsystems (vehicle control, smart systems, power systems, drive systems) independently, creating a Taiwan-based electric bus industry chain.
(3) Develop low-cost DC charging equipment: Use project resources to guide companies in developing and producing electric vehicle charging products and assist them in obtaining relevant certifications.

Expected or measured impact: What is the expected or measured impact of this policy on the adoption of electric vehicles?

2 responses

The ban on internal combustion engine vehicles will promote the adoption of cleaner energy vehicles, including electric vehicles, among individual consumers.

Enhance domestic production capabilities for electric vehicles and charging equipment to offer more local EV models and affordable, safe DC chargers, improving the EV charging network and increasing market share.

3. Does your government periodically evaluate the effectiveness of electromobility promotion policies?

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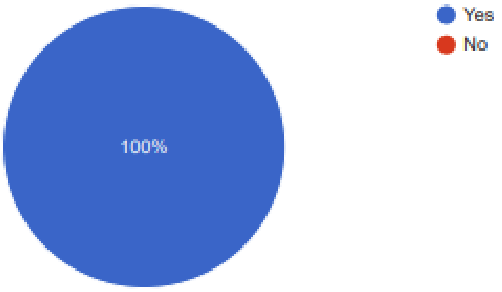
2 responses



4. How often are these policies evaluated?

2 responses

Annually

The above policies will be reviewed and updated occasionally. Such as Key Strategy 7, "Carbon Free Electric Vehicles," involves monthly reporting on progress, biannual submission of written reports, annual public communication and review meetings, and periodic sustainability and net-zero carbon meetings for ongoing assessment.

5. What indicators or metrics does your government use to measure the success of electromobility promotion policies? (Select all that apply)

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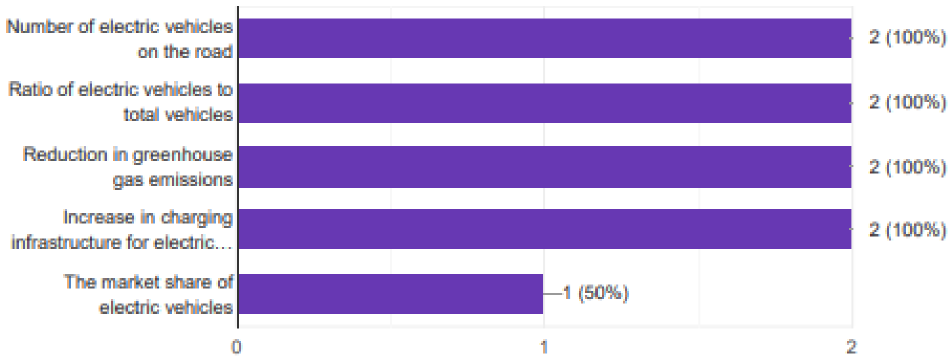
2 responses



Infrastructure and Technology

1. What is the current state of electric vehicle charging infrastructure in your economy?

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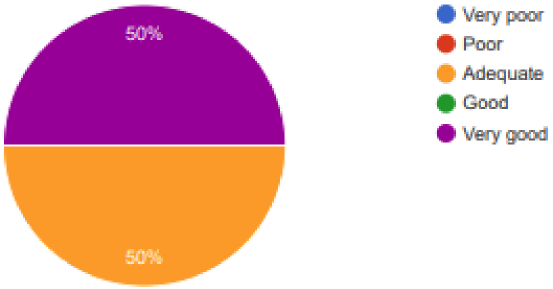
2 responses



2. What is the current number of electric vehicle charging stations in your economy? (Please provide the most recent figure available, as well as the respective year)

2 responses

Around 6,000 (end 2023)

In Chinese Taipei, as of the end of June 2024, a total of 9,564 public charging stations have been installed, including 7,328 slow chargers and 2,236 fast chargers.

3. Are there plans for the expansion of charging infrastructure for the next 5 years?

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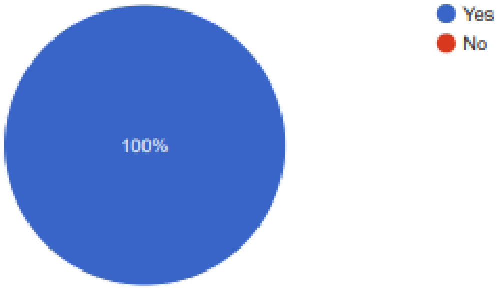
2 responses



4. If the previous answer is yes, could you please provide details on plans for expansion of the charging infrastructure?

2 responses

60,000 EV charging stations will be deployed economy-wide by 2030, in tandem with EV adoption.

The MOTC and the MOENV have allocated approximately NT$1.5 billion from 2023 to 2024 to expand public charging infrastructure. The MOTC is using NT$980 million to subsidize the installation of charging stations at local levels, with revised plans increasing support for tourist sites and raising installation targets. Meanwhile, the MOENV has allocated NT$519 million to improve electricity infrastructure and set up charging facilities at 400 public locations for public use.

5. If the answer to question 3 is yes, has your economy set a specific target for the optimal ratio of charging infrastructure to the number of electric vehicles? If so, what is that target ratio?

2 responses

No

Our overall public charging station installation targets are based on EU recommendations. In the initial phase of promoting electric vehicle use, the planned ratio is 10 electric vehicles to 1 slow charger and 80 electric vehicles to 1 fast charger. Subsequently, with the increase in private charging stations, higher charger power, and improved vehicle range, the target ratio for 2030 is set to 15 electric vehicles to 1 slow charger and 130 electric vehicles to 1 fast charger.

Environmental and Social Impact

1. What environmental benefits have been noted in your economy due to the adoption of electric vehicles? (Select all that apply)

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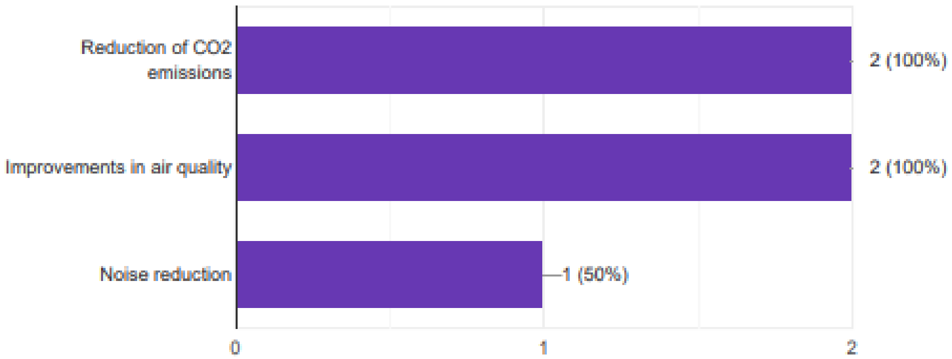
2 responses



If in question 1 **"Reduction of CO2"** was selected, please answer the following questions.

Can you provide specific data or percentages of CO2 emissions reduction since the adoption of electric vehicles?

2 responses

N.A.

From 2013 to 2022, electric vehicles reduced CO2 emissions by approximately 1,005.4 thousand metric tons. According to the MOTC data on electric vehicle registrations have been fully recorded since 2013, with 2023 data yet to be updated. Estimates are based on the assumption that electric vehicles and fuel vehicles have the same annual mileage.

Are there any targets set for CO2 reduction in the future due to the transition to electric vehicles?

2 responses

Net zero by 2050, which is equivalent to a 80% reduction from the peak of 7.7 million tonnes in 2016.

The Executive Yuan's "Carbon Free Electric Vehicles" key strategy (The 7th key strategy) aims for both EV and electric scooter sales to achieve a 100% market share by 2040 and City buses fully electrified by 2030. The transportation sector uses these targets to project future carbon reduction potential.

If in question 1 **"Improvements in air quality"** was selected, please answer the following questions.

What specific changes in air quality have been recorded in areas with high adoption of electric vehicles?

2 responses

Electric vehicles produce no tailpipe emissions.

Improving air quality is the result of multiple measures rather than solely due to the promotion of electric vehicles. According to domestic NO2 concentration data, air quality improved by approximately 24% from 2016 to 2023.

Are there any studies or data showing a direct relationship between the adoption of electric vehicles and the improvement in air quality?

2 responses

No

Based on the Taiwan Emission Data System, TEDS, replacing old vehicles with electric vehicles significantly reduces nitrogen oxides (NOx): the reduction coefficient for old small diesel vehicles is 27,914.65 grams per vehicle per year, while for old small gasoline vehicles, it is 4,161.49 grams per vehicle per year.

If in question 1 **"Noise reduction"** was selected, please answer the following questions.

In which areas or sectors (urban, rural) has a significant reduction in noise due to electric vehicles been noted?

1 response

Urban (Singapore does not have any rural areas).

Are there specific measurements or studies that demonstrate this noise reduction?

1 response

No

2. What social challenges are faced in your economy with regard to the adoption of electric vehicles? (Select all that apply)

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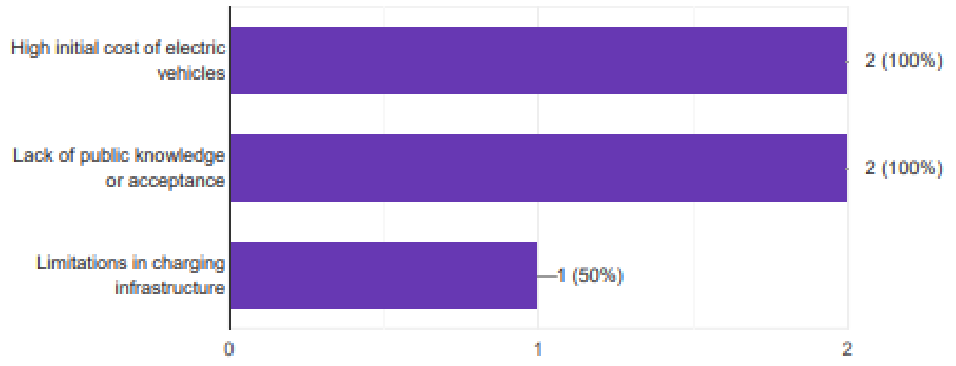
2 responses



If in question 2 **"High initial cost of electric vehicles"** was selected, please answer the following questions.

What measures or policies are in place to reduce the initial cost of electric vehicles for consumers?

2 responses

Tax and financial measures have been introduced to lower the initial cost of electric vehicles (see response to question 3.1)

Key Strategy 7, "Carbon Free Electric Vehicles," focuses on leading the transition to electric vehicles with a public transport-first approach and government-led demonstrations. It prioritizes the electrification of urban buses and official vehicles by 2030. For private vehicles, the strategy emphasizes promoting electric passenger cars and scooters through various incentives. These include subsidies from the MOEA and the MOENV for new purchases and replacements of electric vehicles, fuel usage fee exemptions from the MOCT, and commodity and vehicle license tax exemptions from the Ministry of Finance (MOF). Additionally, local governments offer economic measures tailored to their regional development strategies.

If in question 2 **"Lack of public knowledge or acceptance"** was selected, please answer the following questions.

What strategies have been implemented to educate the public about the benefits and use of electric vehicles?

2 responses

The 'Power EVery Move' campaign seeks to educate the public about the benefits of electric vehicles and to address concerns regarding charger availability and range anxiety.

Key Strategy 7, "Carbon Free Electric Vehicles," continues to hold public communication meetings, bringing together local governments, vehicle industry associations, cargo and passenger transport associations, and other stakeholders from academia, industry, and government. These meetings aim to explain policies and gather feedback. Additionally, the strategy actively promotes policies at cross-ministerial events, such as the annual Net Zero Cities Expo and the Asia-Pacific Sustainable Expo.

If in question 2 **"Limitations in charging infrastructure"** was selected, please answer the following questions.

What are the main barriers to the expansion of charging infrastructure in your economy?

1 response

Some residents still have concerns about the safety and ownership issues related to installing charging stations in apartment buildings.

Innovation and the Future of Electromobility

1. What emerging technologies are being explored in your economy to support electromobility? (Select all that apply)

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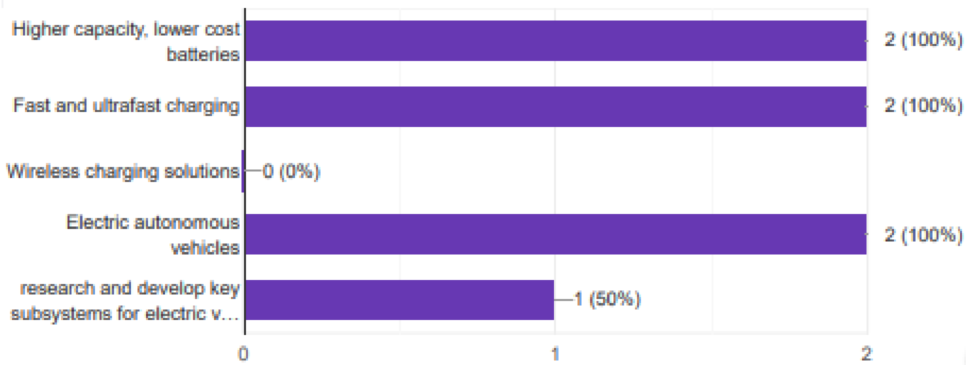
2 responses



2. How does your economy anticipate the evolution of the electric vehicle market in the next 5 to 10 years?

2 responses

There will likely be a shift towards smaller and higher capacity batteries, as well as the maturation of technologies such as battery swapping that will mitigate the current concerns of deploying in a dense urban environment.

1. By 2030, all urban buses and official vehicles, including the heads of departments, will be fully electric, with electric passenger cars making up 30% of sales and electric scooters making up 35% of sales. 2. By 2035, all other official vehicles and passenger cars will be fully electric, with electric passenger cars comprising 60% of sales and electric scooters 70% of sales.

3. What role will government policies play in the future of electromobility in your economy?

2 responses

Government policies will continue to be needed to support the transition to electromobility as Singapore gradually phases out the legacy population of ICE vehicles.

The Executive Yuan has approved Key Strategy 7, "Carbon Free Electric Vehicles." This strategy sets goals and pathways for vehicle electrification, with three main strategic objectives: "Increasing the Number of Electric Vehicles," "Enhancing Supporting Infrastructure," and "Upgrading and Transforming Industry Technologies." The plan includes 10 implementation pathways and 57 specific action measures. It aims to provide clear guidance for government agencies and the public on transitioning to electric vehicles and outlines the following policy roles:
1. Implement economic policies to reduce the barriers for public adoption and lower the investment costs for businesses.
2. Proactively support industry technology transformation to drive the development of electric vehicles.
3. Ensure public transition by continuously assisting all relevant stakeholders, ensuring no one is left behind.

Improvements and Recommendations

1. What additional measures could your government take to accelerate the adoption of electromobility?

2 responses

Additional duties on petrol and diesel to make electric cars more competitive vis-a-vis ICE cars.

Currently, efforts to accelerate vehicle electrification are focused on Key Strategy 7, "Carbon Free Electric Vehicles," specifically the action plan under the strategy of "Increasing the Number of Electric Vehicles."

2. What recommendations would you make to improve current electromobility policies in your economy?

2 responses

Explore alternative EV technologies such as on-road induction charging and battery swapping. Currently battery swapping is only available for electric motorcycles on a trial basis.

None. In the future, relevant actions will be reviewed and adjusted based on international trends to achieve the goals of Carbon Free Electric Vehicles.

Best practices to promote electromobility in urban land transportation

1. What is the name of the policy or initiative and when was it launched?

2 responses

Electrification of half of the public bus fleet by 2030, announced in March 2023

The "Full Electrification of Urban Buses by 2030" was announced on December 21, 2017.

2. Provide a brief description of the policy initiative and/or links to publicly available information. Please consider in your response the purpose, activities, and achievements to date.

2 responses

The Singapore government will be replacing diesel buses that are reaching the end of their statutory lifespan with electric buses, such that half of the public bus fleet will be electric buses by 2030 (https://www.lta.gov.sg/content/ltagov/en/newsroom/2023/3/news-releases/sustaining_the_momentum_of_vehicle_electrification.html)

To achieve urban bus electrification by 2030, the plan of MOTC includes three phases: (https://www.ey.gov.tw/Page/5A8A0CB5B41DA11E/fbaa04ca-a430-48e7-8ba1-0b35d1dc4879) Pilot (2020-2022), Promotion (2023-2026), and Popularization (2027-2030). The Pilot Phase tested electric bus models. From 2023, the focus has shifted to promoting electric buses and ending diesel bus subsidies. By the Popularization Phase, diesel buses will decline as electric buses become more common.

3. Who can be contacted for more information? Please provide the name and email address of the contact person.

2 responses

4. Would your economy be interested in sending a speaker to present the policy initiative noted above at the workshop to be held in Lima, Peru on August 16, 2024? (If so, please provide the name and email address of the contact person).

1 response