FROST & SULLIVAN

RECOMMENDATIONS FOR A NATIONAL ELECTROMOBILITY POLICY

Mexican Automotive Industry Association (AMIA)

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CONTENTS

1 Executive Summary

Introduction

Toward the end of the 20th century interest in electric mobility and the development of mobility alternatives to internal combustion engines (ICE) saw a resurgence. This renewed interest is associated with the environmental impact of ICE vehicles, the projected shortage of fossil fuel reserves and new progressive regulations aimed at reducing emissions.

Many developed countries, like some developing ones, are implementing stimulus programs for the purchase of hybrid and electric vehicles. These stimuli may be financial in nature, with a direct effect on the vehicle's market price. Other stimuli are indirect or non-financial (non-tax) incentives, such as parking benefits, preferential lanes, access to restricted low-emission vehicle zones, or toll exemptions. This latter set of initiatives has a cultural effect in stimulating the visibility of this type of vehicle and should complement economic stimuli since they play a relevant role in the decision-making process to purchase vehicles with electric technologies.

Market and Manufacturing Analysis of Hybrid and Electric Vehicles in Mexico

As is the case across the globe, the Mexican transportation sector is responsible for about 25% of the total carbon emissions in the country. In this context, the transition to electromobility becomes a viable and efficient alternative for reducing the sector's CO_2 emissions, with the aim of improving air quality and meeting the international CO_2 emissions reduction commitments Mexico has subscribed to. In November 2022, the Mexican government signed a new commitment at the Climate Summit in Egypt (COP27), in which it committed to reducing greenhouse gas (GHG) emissions up to 35 percent by 2030 and becoming a carbon-neutral country by 2050. This means Mexico should stop emitting approximately 297 million tons of carbon by 2030.

The existing legal framework is a set of hardly versatile initiatives, laws, and regulations, which, in isolation and with limited objectives and scope, may at some point support the transition to electromobility in the country. The structure and content of the current regulatory framework do not clearly express the conditions and rules of the game and are generally unfocused. There are still many gaps in regulations and secondary rules for each specific sector, and there is a lack of vision in the medium and long terms. In this context, the development in legal matters is still at different levels of progress. While progress in electricity commercialization is important, the implementation of rules of operation and secondary regulations is still uncertain for domestic and foreign investors.

Similarly, for consumers, incentives and financing are still limited and there is much to do. The same happens in the cultural aspect, where the use of hybrid and electric vehicles still fails to significantly achieve collective interest, mainly due to the consumers' lack of information regarding new technologies and their economic and environmental benefits. It is also essential to develop programs and mechanisms to encourage the fleet renewal of commercial vehicles, substituting ICEs with hybrid and electric ones. As these vehicles penetrate the market, business models for charging infrastructure will also benefit, becoming attractive to public-private associations and companies for investing in the sector.

Regarding hybrid and electric vehicle manufacturing, the ideal regulatory framework should involve a promotion and incentive scheme, and regulations that allow companies to invest in new production plants or in the conversion of current facilities. The availability of basic infrastructure (water, clean energy) is expected to promote the development of industry, satisfying the local market and maintaining (or increasing) Mexico's position as a leading global vehicle manufacturer.

Certain competitive advantages position Mexico in an unbeatable situation with high potential for developing hybrid and electric vehicle manufacturing. However, the magnitude of the changes required for the rapid transformation of the automotive industry requires the impetus and a joint strategy between governments (federal, state and local) and industry to attract large investments that can transform the manufacturing plant. Most global vehicle manufacturers have committed to stopping ICE vehicle production between 2030 and 2050, in a total shift toward clean energy technologies. That is why, if Mexico wants to maintain its lead in the global automotive industry, it must develop a strategy that considers supplying energy coming from renewable sources, since the industry's main global interest is to be carbon neutral throughout its production cycle.

Undoubtedly, the Mexican market for hybrid and electric vehicles has established itself as the largest in Latin America (LATAM). However, it is still far from its full potential because there is still a significant pricing difference when compared to ICE (especially battery electric vehicles [BEVs]).

Charging Infrastructure in Mexico

According to Frost & Sullivan, in Mexico there are currently about 1,336 public or semi-public charging stations, with a total of 3,206 connectors: an average of 2.4 connectors per station. Although Mexico is the country with the highest amount of charging points in Latin America (in 2022), there is still a significant need to increase the number of charging stations to achieve greater electric vehicle adoption.

Most stations have alternating current (AC) connectors, i.e., semi-fast charging stations where, on average, an electric vehicle takes about 4 to 5 hours to reach full charge. This means that consumers have a considerable waiting time to travel more than 360 km, which is the average range of EVs currently available in the Mexican market. This is why it is advisable to encourage the installation of direct current (DC) connectors that reduce vehicle charging times. In terms of coverage, charging infrastructure is well-distributed throughout the national territory but it remains insufficient.

Analysis of Current and Potential Hybrid and Electric Vehicles Customers in Mexico

One of the main obstacles for the EV market in Mexico is the effect known as range anxiety. It should be noted that potential consumers of hybrid and electric vehicles do not yet experience these technologies directly, but they do have a significant degree of knowledge about their behavior. That is, they are unfamiliar with day-to-day operation, but they are aware of important factors that current owners of hybrid and electric vehicles already go through, such as the fact that domestic charging is more important than public charging, or that there is not much availability of public charging stations in Mexico.

On the other hand, by surveying all existing and potential consumers of hybrid and electric vehicles about their purchasing preference if said vehicles were priced the same as ICE vehicles, answers lean completely in favor of hybrid and electrical technologies. Only 6.9% of the sample would continue to prefer an ICE vehicle. This shed some light on the effectiveness that incentive schemes (that directly affect vehicle price) could have in the market. These schemes would increase the penetration of hybrid and electric vehicles in Mexico and would contribute significantly to reducing emissions, mitigating climate change, and complying with the EV penetration agreements for electric vehicles signed in Glasgow by the Mexican government in 2021. In essence, although an incentive scheme represents an investment, the benefit is palpable for both the consumer, the Mexican government, and society as a whole.

Suggested Elements for a National Electromobility Plan in Mexico

1.1.1 Objectives for a National Electromobility Plan

At the recent 27th United Nations Climate Change Conference (COP27), in Egypt in November 2022, the Mexican government intensified previous commitments on its climate change mitigation strategy. The key element of these changes is the increase in the GHG emission reduction target from 22% to 35% by 2030. As part of the announced measures to achieve this objective, the Mexican government had previously signed the Glasgow Pact (the result of the COP26 held in the United Kingdom in 2021) in which—within the framework of mitigation measures—it commits to accelerating the adoption of electric mobility by setting a target for passenger vehicle sales to be 100% zero-emission by 2040.

In conjunction with the US government, the intermediate goal is to achieve 50 percent of sales of this type of vehicle by 2030.

In this context, having a national electromobility adoption plan or strategy becomes a fundamental axis to achieve these commitments. Although there are very important efforts by different entities of the Mexican government to promote hybrid and electric vehicle adoption, a coordinated strategy with the different players in the ecosystem is of utmost importance for these efforts to come together and go in the same direction. An entity to coordinate, monitor and report on the progress and results of this strategy on a regular basis is also desirable to ensure that the efforts help the main objective, which is to significantly contribute to reducing transportation sector emissions in Mexico.

For consumers—individuals and businesses—there are two fundamental factors in their hybrid and electric vehicle purchasing decision processes:

- The extant price differential between hybrid and electric vehicles and ICE vehicles in the Mexican market
- The availability of charging stations throughout Mexico, especially on highways

Some of the main objectives for this strategy should be:

- Reduce GHG emissions from the transportation sector
- Contribute to meeting international climate change targets
- Generate a positive impact on public health and quality of life in the population

A set of associated objectives would also have a positive impact on the economic and social environment in Mexico, which are:

- Maintain the leadership of the Mexican automotive industry locally, regionally, and globally
- Increase the number and quality of jobs that the automotive sector generates in the Mexican economy
- Strengthen regional supply chain by contributing to the substitution of Chinese imports, in support of regional objectives with the United States and Canada
- Enhance the local industry's ability to access US Inflation Reduction Act (IRA) benefits, as well as other benefits associated with the electric vehicle industry in the region

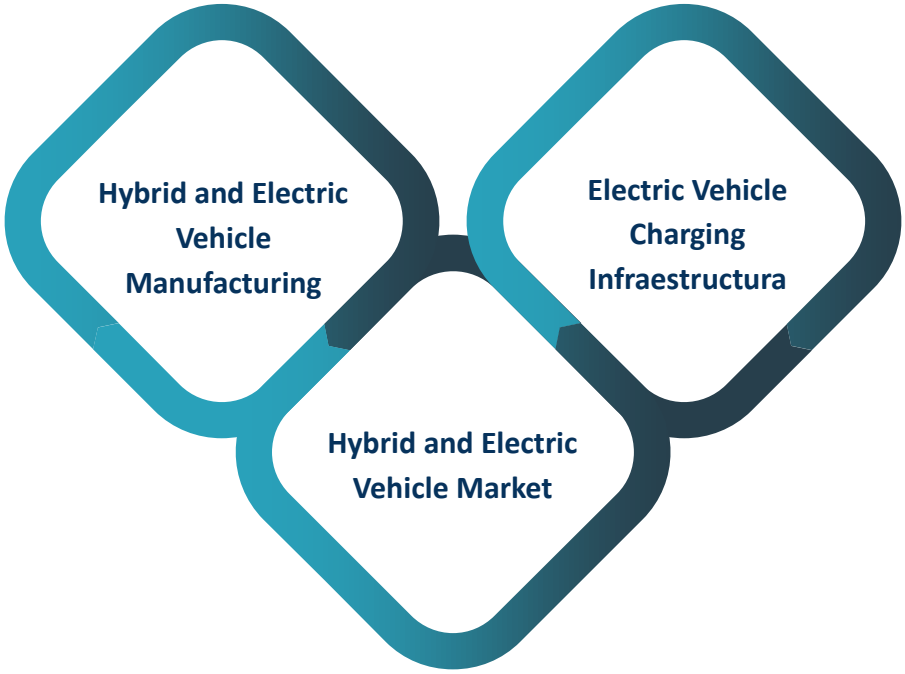
Ideally, this strategy should come from the President of Mexico, so that all entities involved are aligned by the objectives set therein. Electromobility matters in advanced economies have involved commitment and action of different government agencies. Entities involved are related to urban mobility, environment, energy, infrastructure, promotion of industry and investment, employment, and education, to highlight the most relevant.

Furthermore, it is vital that the strategy coordinator have binding powers to regularly monitor and evaluate all entities' efforts and to make sure that each entity involved reports progress and implements actions to achieve the plan's objectives. Otherwise, diverging interests, budgets and objectives can become important but isolated efforts, which could result in bottlenecks limiting or delaying the national strategy's primary objective.

National Electromobility Plan Recommendations

Taking all these factors into consideration, and as shown in Figure 1.6.1, Frost & Sullivan identifies three major areas that the electromobility plan should address:

Figure 1.6.1: Electromobility Plan Recommendations, Mexico, 2023



Source: Frost & Sullivan

Impact of a National Electromobility Plan on the Hybrid and Electric Vehicle Market in Mexico

Incorporating hybrid and electric vehicles to the vehicle fleet in Mexico can result in a 15.8 million ton reduction in CO_2 emissions between 2016 and 2030, considering a penetration under a natural market growth scenario or business as usual (BAU). If a national policy including an incentive scheme was introduced, savings in CO_2 emissions could reach 26.2 million tons. This means an increase of 65.8%, or an additional 10.4 million tons of CO_2. Considering that Mexico's commitment in its updated National Determined Contributions (NDCs) requires reducing about 281 million tons of CO_2, a comprehensive promotion policy for hybrid and light electric vehicles can contribute approximately 9.3% of Mexico's total commitment to reducing CO_2 emissions.

Frost & Sullivan estimates that, by 2030, sales of hybrid and electric vehicles may reach 316,856 units which would represent a penetration of 19.1 percent of total light vehicle sales in Mexico. As mentioned above, this scenario considers that there is no change in the existing incentive scheme, and that the government does not design and successfully implement any policy to promote the adoption of hybrid and electric vehicles. By adopting a comprehensive policy to promote electromobility, the penetration of said vehicles can increase to 38.9% of total light vehicles sales in Mexico by 2030.

However, in the absence of a policy and strategy for the promotion of hybrid and electric vehicles—including an incentive scheme that directly affects vehicle price and manufacturing—it will be difficult to achieve the emission reduction targets and the international commitments the Mexican government has subscribed to. Similarly, there is a risk that the Mexican automotive industry will lose the leadership role it plays in global vehicle manufacturing.

2 Global Electric Vehicle Market Mapping and Trends

Background

Toward the end of the 20th century interest in electric mobility and the development of mobility alternatives to internal combustion engines (ICE) saw a resurgence. This renewed interest is associated with the environmental impact of ICE vehicles, the projected shortage of fossil fuel reserves and new progressive regulations aimed at reducing emissions. In this context, Frost & Sullivan observes an accelerated diversification of technological developments and a redefinition of the ecosystem of companies that mobilize this market.

During the 1990s, major automotive manufacturers developed different electric models such as the Honda EV Plus, GM EV1, Toyota RAV4 EV, Nissan Altra, Chrysler TEVan, or the Ford Ranger EV. However, the star model with alternative fuels during this era, and leader in sales since its launch, was the hybrid Toyota Prius, launched in 1997.

EVs' limited autonomy was still a problem for large-scale deployment. The recession at the end of the first decade of the 21st century prompted a second and definitive wave of EVs equipped with high-performance batteries and an indisputable market settlement. In 2008, Tesla launched the Tesla Roadster, a BEV with a sports design and an autonomy of more than 300 km. Immediately after, GM launched the Chevrolet Volt (or in its European version, the Opel Ampera), with plug-in hybrid (PHEV) technology. Mitsubishi launched the i-MiEV BEV in 2009, with record sales until the launch of the Nissan Leaf the following year.

As research and development in high-performance lithium batteries also progresses, the market expands and supply diversifies rapidly in the early 2010s; the Renault Zoe, the Renault Fluence ZE, BMW ActiveE, BMW i3 EV, Honda Fit EV, Tesla Model S, and the refurbished Toyota Rav4 EV and Toyota Prius PHEV stand out in sales. In this second stage the main Chinese companies launch their own developments and enter the race for electric mobility, dominating the world's largest automotive market with models such as BYD Song PHEV, BJEV EC 180/200EV, Zhi Dou d1/d2 and the Chery eQ EV. Moreover, new power options for electric motors are under development: hydrogen fuel cell electric vehicles (FCEV), such as the Hyundai Nexo, the Honda Clarity FC, and the Toyota Mirai were launched in the early 2010s.

ICE vehicles, both gasoline and diesel, are defined by their storing energy in their fuel tank in chemical form. On the other hand, the essential component of hybrid and electric vehicles are the rechargeable batteries in their different varieties (lead acid, nickel hydroxide, or lithium ion) that store energy for the vehicle to move. For hybrid or full-hybrid (HEV) vehicles, the battery powers the vehicle's movement at low speeds over short distances.

By increasing speed and traveling longer distances, the hybrid technology alternates electric propulsion with ICE propulsion using energy stored as fuel (gasoline or diesel) in a tank. In addition, the accelerating and braking transforms into energy that charges the vehicle battery (regenerative braking).

Plug-in hybrid vehicles (PHEV) are conventional hybrids that incorporate BEVs' external battery power technology, according to different types of engineering. These vehicles can ride in electric mode up to certain speeds (or as the driver chooses), and once the speed threshold is exceeded (depending on the model, this can be up to 80 km/hr) the ICE comes into operation and fuel becomes the main source of energy. If the driver chooses the 100% electric drive mode, the vehicle's range can be up to 90 km, depending on the vehicle model. The battery recharges from an external electrical source, through a charging device. This technology has had much acceptance in different countries because it reduces consumers' "range anxiety," as they feel reassured that they will reach their destination and not become stranded due to lack of battery charge.

Installing fast charging public infrastructure networks at key points in cities has also helped consumers overcome range anxiety. In the current stages of electric mobility's mass use, fast-charging infrastructure networks in key regions of the United States (for example, in California), the United Kingdom, Germany, and Norway proved highly important, as well as the recent mass deployment of fast-charging infrastructure (DC) in Japan, currently one of the world's largest.

Battery electric vehicles (BEV) use much larger batteries and superior technology that, with the same principle as hybrids, power the vehicle or electric motors at high speeds and with a range of up to 700 km. The great challenge in developing these vehicles is the mass manufacturing of batteries with high levels of range and autonomy. New lithium-ion batteries (as well as alternative chemicals) have helped overcome range anxiety, and perceptions have changed regarding the maximum speed that these vehicles can reach—which in all market-available models today is comparable to ICE vehicles.

The EV charging infrastructure can be classified into three types:

AC Slow Charging, or Level 1, which consists of charging through an AC standard outlet in homes and offices and does not require any installation. This type of charging does not have a control box as it has a direct connection to the plug. The average charging time ranges between 8 and 10 hours for BEVs (depending on battery size and on the vehicle's on-board charger). Virtually all EVs available in the market include a cable for charging in this manner.

AC Fast Charging, or Level 2, refers to AC charging that requires installing equipment with electrical modifications to access a more powerful current. Level 2 charges through 208V or 240V, depending on electrical outlets. The control box is in a protective device. Normally, this type of charging requires a special installation since the energy demand is higher, and the cable cannot be plugged directly to the outlet. In this case, installation can be both public and at home, with an average charging time between 4 and 7 hours. Connectors used for this type of charging are the J1772 (Type 1), used in the United States and Asia, and the Mennekes (Type 2) mostly used in European markets.

DC fast charging refers to direct-current charging and is the fastest charging model. The charger operates at 480V and the average charging time to fill the battery by 80% ranges from 15 to 20 minutes, depending on battery size. DC charging stations are installed only in public places that have the necessary electricity infrastructure for their operation.

Activities and Commitments of Automotive Companies Regarding Electromobility and Decarbonization Targets

As part of their comprehensive decarbonization targets, as of 2017, major automotive manufacturers—BMW, Volvo, VW Group, General Motors, Renault-Nissan, Toyota, and others—began to announce strategic plans to convert their traditional portfolio of internal combustion products to electric. As a result, production, market size and electric vehicle fleet are expected to grow exponentially from 2025 onward. As shown in Table 2.2.1. the focus is on electric vehicle technologies (PHEV and BEV).

Table 2.2.1: Automotive Companies Electrification and Decarbonization Targets, Global, 2022-2050

Company	Timeframe	Objective
Aston Martin	2030	• 25% of its sales will be BEVs, the rest will be HEV and PHEV
BMW	2023 2025 2030	• At least one BEV circulating in 90% of the segments where BMW operates • 12 BEV and 13 PHEV models • Stop emitting 200 million tons of CO_2 • 50% of vehicle sales to be BEVs
Ford	2024 2026 2030 2035 2050	• 100% of the commercial vehicle portfolio will be zero emissions in Europe • Producing 2,000,000 electric vehicles annually • 100% of the portfolio will be BEVs in Europe, and 50% of sales globally will be EVs • 100% of Lincoln's portfolio will be electric • Reduce greenhouse gas emissions by 50% compared to 2019 • Carbon neutral company
General Motors	2021 2022 2025 2030 2035 2040	• Subscribed to the "Business Ambition for 1.5°C" campaign of the Science-based Goals Initiative (US). • GM joins the "First Movers Coalition" (US) alliance • 30 all-electric models worldwide, and 40% of US models will be electric vehicles • Install 2,700 DC chargers powered by renewable energy in the United States, in collaboration with EVgo • 100% renewable energy in US operations • 1,000,000 EV sales in North America and China. • Between 40% and 50% of total US sales are EV • 100% renewable energy in global operations. • Eliminate exhaust emissions from light vehicles. • Reduce energy intensity in operations by 35% • Carbon neutral company
Honda	2030 2035 2050	• 40% vehicle sales to be electric • 80% vehicle sales to be electric • Carbon neutral company
Hyundai Motor (including KIA)	2023 2030 2035 2040 2045	• 3 FCEV models • 1,870,000 annual EV sales • 100% of its Europe portfolio consisting of EVs • 100% EV sales in South Korea • 100% of the global portfolio of electric vehicles • 100% use of renewable energy in plants in South Korea, Europe, United States, and India

Jaguar Land Rover	2025 2030 2039	• 100% of Jaguar's portfolio consisting of EV • Reduce greenhouse gas emissions by 54% compared to 2010 • Carbon neutral company
Mercedes Benz	2025 2030	• 100% of new platforms to be electric • Reduce GHG emissions by 50% compared to 2020 • Use of 70% renewable energy • 100% of portfolio consisting of EVs • 40% of recycled materials in each vehicle
Nissan	2030 2050	• 23 electric models (15 BEV) globally • 40% electric vehicle sales in the U.S. • Carbon neutral company
Porsche	2023	• 50% of portfolio consisting of EVs
Stellantis	2025 2028 2030 2038	• 4 BEV Jeep models • 100% of US portfolio cosisting of EV • 50% carbon footprint reduction • 100% BEV sales in Europe and 50% in the US • 75 BEV models and sales of 5,000,000 BEVs anually • Carbon neutral company
Toyota	2025 2030 2035 2050	• More than 1,000,000 EV sales globally • 35% emission reduction in new vehicles • Environmental impact evaluation in 22 manufacturing plants in North America, Asia, and Europe • 3,500,000 BEVs manufactured globally • 100% of Lexus portfolio consisting of EVs • Carbon neutral in manufacturing facilities • 90% emission reduction compared to 2010
Volvo	2025 2030	• 1,000,000 EV sales • 50% of global vehicle sales to be BEV • 100% BEV portfolio
VW Group	2025 2026 2030 2050	• More than 50 BEV and 30 PHEV models • More than 2,000,000 EV sales • 50% emission reduction per manufactured vehicle compared to 2015 • Development of the last ICE platform • 100% renewable energy in manufacturing plants in the Americas and Europe • 40% emission reduction per vehicle in Europe compared to 2018 • 70% of sales in Europe and 50% in the United States and China to be BEVs • Carbon neutral company

Source: Frost & Sullivan

Companies are working together with suppliers and partners in electrification and decarbonization targets in vehicle manufacturing and operation, as well as in charging infrastructure, so that the whole value chain contributes to decarbonization and energy for charging stations comes from renewable sources. For example, General Motors has formed a sustainability council with its most important suppliers to share best practices, create new sustainability standards for the industry, and work together towards a future without emissions. The goal is also to find more sustainable materials and jointly advance toward fulfilling zero-emission requirements.

Global Case Studies

Many developed countries, like some developing ones, are implementing stimulus programs for the purchase of hybrid and electric vehicles. These stimuli may be financial in nature, with a direct effect on the vehicle's market price. Other stimuli are indirect or non-financial (non-tax) incentives, such as parking benefits, preferential lanes, access to restricted low-emission vehicle zones, or toll exemptions. This latter set of initiatives has a cultural effect in stimulating the visibility of this type of vehicle and should complement economic stimuli since they play a relevant role in the decision-making process to purchase vehicles with electric technologies.

Germany has long history in the automotive industry, and its electromobility outlook took a turn in the last 5 years. Government incentives to boost technological advances have succeeded in increasing EV performance and reducing costs, driving sales in an increasingly competitive market.

In October 2019, the German government began to promote the use of EVs throughout the country with the "2030 Climate Action Program", which aims to reach 10 million electric vehicles in circulation and 1 million charging stations in the country by 2030. Actions include incentives for owners, manufacturers, and service providers of electric vehicles, charging stations and electricity producers. As part of the process of inclusion of different sectors of the industry, the German government's electromobility program took over the proposal of the German National Electromobility Platform (NEP) to create R&D projects to promote certain areas of cutting-edge technology. The government developed a special implementation concept to ensure that lighthouse projects generate new impetus and incentives, develop existing strengths, and improve the visibility of these strengths for the general public. Electromobility R&D projects will account for an extremely high proportion of all R&D measures that the German government finances.

In South America, Brazil is a pioneer in the use of alternative fuels to conventional gasoline. The configuration of various fuels used for light-vehicle propulsion changed since 1979 with the introduction of ethanol to the market. Later, in the early 2000s, engines with Flex Fuel technology (using gasoline and ethanol interchangeably) burst into the market, gaining ground against ICEs.

In 2018, a slow transition began toward EV use, and since then ICE vehicle (including FlexFuel engines) sales have begun to decrease slightly, giving rise to both hybrid vehicle and BEV sales.

However, Brazil has, currently, no comprehensive legislation specific to EVs that establishes a path toward energy efficiency and emission reduction. Individual states are independently developing partnerships and pilot projects, and the federal government and the business sector—in a more organized effort—launched the Rota 2030 Program in 2018, through Law No. 13,755, with the objective of boosting the national automotive industry through standards and R&D projects for the sector. In terms of incentives, there are a few oriented to EV purchase, especially for investments in charging infrastructure.

In China, the central government has successfully implemented policies for developing the EV industry and its supply chain, motivated mainly by the need to improve air quality, energy independence, and a quest for global leadership in strategic clean technology industries.

China is home to half of the 10 best-selling electric vehicle brands in the world—led by BYD—which is already above Tesla in global market positioning. It is also the world's largest exporter with about 60% of its EV production sold abroad. In this country, EV sales reached a total of 3.3 million units in 2021, and, according to the China Passenger Car Association's estimates, they could reach 8 million units in 2023.

The implementation of central government subsidy policies has been key in the development of the EV market, as well as for the construction and development of charging infrastructure. According to the EV industry development plans, by 2025 China will significantly increase the breadth of its charging infrastructure to meet the needs of more than 20 million cars, even in rural areas.

The new, more structured and comprehensive plan is market-oriented and aims to encourage sustainable development by integrating connected and EV technologies. Its recommendations promote the integral transformation of the industry as part of an interconnected holistic ecosystem that includes transportation, energy, and information technologies, covering the entire value chain and strengthening collaboration between industries.

One of the main objectives of the plan in the medium term (to 2025), is to have a significantly more competitive market of new energy vehicles, with technological advances in batteries, engine operating systems and vehicles, and a general improvement in safety standards. The Chinese government plans to reduce the average EV energy consumption to 12 kWh/100 km, from 15 kWh/100 km, and sales are expected to reach 20% of total vehicle sales (against 5 percent in 2021).

The plan states that, by 2035, the core technology of new energy vehicles in China will be highly competitive and of global quality. Most sales of new energy vehicles will be BEVs; while public fleets will be BEVs in their entirety, the network of charging services and battery exchange will be convenient and efficient, and the construction of the hydrogen fuel supply system will advance steadily.

China is one of the countries with the most severe levels of pollution, which in previous decades even reduced the life expectancy of its population. In this context, one of the main achievements of the EV policies implemented is pollution reduction. Reports from the Ministry of Ecology and Environment indicate a 58% drop in average PM2.5 levels between 2013 and 2021, from 72 micrograms per cubic meter to 30 micrograms per cubic meter. By 2020, China was no longer among the five most polluted countries in the world.

Costa Rica stands out as one of the countries—in Latin America and globally—with the cleanest energy matrix, creating the ideal environment for promoting electric mobility. In 2021, approximately 97% of the country's electricity generation came from renewable sources such as hydroelectric, wind, and geothermal.

Costa Rica was also one of the first countries to sign the Paris Agreement, through Law No. 9405 in 2016, with clear commitments to become a carbon neutral country by 2050. For this commitment, Costa Rica has developed a series of plans and objectives that aim at this decarbonization. For example, the commitment that 100% of its energy matrix will be renewable by 2030, and a National Decarbonization Plan (PND) which is structured in 3 different phases with achievable goals by 2050, and 10 strategic axes. As transportation is the sector that most contributes to the generation of carbon emissions in Costa Rica, 4 of the 10 strategic axes are related to it. The National Decarbonization Plan also recognizes the need to consolidate the national electricity system, with the capacity to supply clean energy at a competitive cost.

Costa Rica was one of the first countries to implement comprehensive legislation promoting zero-emission mobility in Latin America. In 2018, the country presented a comprehensive plan to reduce emissions that will allow it to reach its decarbonization targets by 2050. Among other aspects, the Law on Incentives and Promotion for Electric Transport, better known as Law No. 9518, considers the development of charging infrastructure with specific guidelines and proposes it as a public-private liability. It should be noted that by having a country strategy to combat climate change, different government entities, economic sectors, and civil society achieve coordinated action. This central government launched this effort with defined objectives and a very clear roadmap, including role guidelines for each Ministry to fulfil. EV sales have increased steadily since implementing this comprehensive incentive policy, from 25 EVs (PHEV and BEV) in 2016 to 459 EVs in 2019 (first year with incentives). Just three years after coming into force and amid the COVID-19 pandemic, market penetration of new vehicles reached 7.3% in 2022.

According to Frost & Sullivan estimates, BEV penetration in the new vehicle sales market in Costa Rica will reach 24.2% in 2030, the highest penetration rate in Latin America. By 2035, Costa Rica is expected to achieve its 100% zero-emission vehicle sales target.

The United States is one of the countries with the highest contribution to the global carbon footprint. In 2020, this country generated 5,222 million metric tons of CO_2—10% of global emissions. Although this meant a reduction of approximately 11% compared to 2019 emissions (mainly explained by the reduction in mobility due to the COVID-19 pandemic), there is strong global pressure for the United States to reduce its carbon footprint even more. The transportation sector contributes approximately 27% of emissions, while electricity generation contributes 25%, since the US energy matrix is highly dependent on coal. In 2021, only 12% of electricity generation came from renewable sources such as biomass, wind, and hydropower.

In this context, recent US governments have made different commitments to reduce GHG emissions. The Obama administration adhered to the Paris Agreement that aims to reduce the global average temperature by at least 2° centigrade and preferably by 1.5° centigrade. These commitments have been updated with stricter contributions. In April 2021, the United States committed to reducing between 50% and 52% net GHG emissions by 2030 (compared to GHG emissions in 2005) and becoming an emission-free country by 2050. President Biden designed three programs for promoting electric mobility as a key means to meet climate change goals and promote industrial development in activities where China was taking the lead (like EV battery and EV manufacturing). With a total of $135 billion in resources for market promotion and EV (and their components) manufacturing, these three programs are:

1. Bipartisan Infrastructure Law
2. Chips and Science Act
3. Inflation Reduction Act

In December 2021, the government announced investments of approximately $7.5 billion as part of the Bipartisan Infrastructure Law, of which $5 billion consists of funding for states to build an EV charging network. Ten percent of this amount is reserved each year for the Secretary of Energy to provide funds for states to fill gaps in the network. The remaining $2.5 billion will go to communities and corridors and will be awarded through innovative projects that demonstrate that they meet the objectives of covering rural and/or disadvantaged communities. This investment is the largest in this area in the history of the United States. To achieve these objectives and monitor the efficient deployment of resources and the progress of the network, a dedicated office will be established, comprised of officials from the Energy and Transportation Departments.

The Department of Transportation dictates the rules and standards for the type of chargers that must be installed for the network, ensuring that they function correctly, and that they are safe and accessible. With these investments, the US government hopes to install about 500,000 chargers throughout the country covering both local and interstate travel.

Another key element of the electromobility strategy in the United States is EV battery manufacturing (including its components) at a local level and its recycling. Among the government's priorities is promoting responsible and sustainable mining of the necessary minerals such as nickel, cobalt, and lithium.

The IRA, passed in August 2022, modifies some existing incentives for EVs that had already reached their maximum quota. Previously, EV consumption tax credits had a limit of 200,000 vehicles per company. General Motors, Tesla, and Toyota had reached these limits, which were also for a maximum amount of $7,500.

The new law includes different aspects— direct credits for the PHEV and BEV purchases and different considerations to promote EV manufacturing in the United States or in countries with that have free trade agreements with the United States. The requirement that vehicles should be manufactured in North America came into effect at the time of signing this Act in August 2022. There are other considerations that came into force on 1 January 2023. Some of these are detailed below:

- Eliminates the cap of 200,000 vehicles per company
- The requirement that the vehicle must be assembled in North America (Canada, United States or Mexico) is maintained

The maximum credit is still $7,500 for new vehicles, however, together with some statewide strategies, the incentive can reach up to $11,000 per vehicle.

While the US government initiatives focus on strengthening local manufacturing along the entire EV value chain, there is a strong interest from US authorities to also strengthen the value chain of its trading partners (to reduce dependence on China imports). For this reason, Mexico is in a privileged situation to benefit from these initiatives and position itself as a manufacturing hub for EVs and their components, consolidating the existing automotive industry.

Sweden is one of the countries with the highest percentage of renewable energies in its energy matrix. According to Sweden's Energy Agency, 90% of energy generation in 2018 was from renewable sources, making it an additional advantage for the adoption of electromobility. In addition, Sweden was one of the first countries to introduce a strong incentive scheme to promote the adoption of electric vehicles in 2012.

The program better known as "Super Green Auto Rebate" was initially designed to cover 5,000 cars with carbon emissions below 60 g per kilometer, and this goal was reached in mid-2014. Vehicles meeting this emission limit received an incentive of around €4,200 ($40,000 SEK) once the vehicle was purchased (i.e., not at the time of purchase, but after). Virtually all BEVs and PHEVs available in the market at the time met this emission limit.

Sweden's regulatory framework, rather than directly incentivize EV purchases, is based on emission levels. The system of malus bonds (higher tax for high-emission vehicles), implemented in 2018, offers refunds for the purchase of low-emission vehicles, and places an additional tax on highly polluting vehicles. This type of policy (similar to France's) allows a balance of resources for the government because revenues from polluting vehicle taxes are used to give incentives to low or zero-emission vehicles.

In April 2018, Sweden inaugurated the first electrified road in the world, where electric cars recharge batteries while passing through a charging rail embedded in the road. Sweden's goal is to have around 2,000 kilometers of electric roads by 2030.

It should be noted that Sweden's main objective is to use EVs as a fundamental tool to combat climate change, achieve greater energy efficiency, and take advantage of the associated benefits that this type of vehicles can bring to the city environment (such as lower noise emission). Given the availability of technology in passenger vehicles, the Swedish government's policy initially focused on promoting adoption in this segment, then moved to passenger buses and cargo vehicles.

Finally, the government of Thailand pledged to achieve carbon neutrality by 2050 and to eliminate greenhouse gas emissions by 2065, at the COP26 in 2021. To achieve these objectives, in 2020 the Thai government created the National Policy Committee for Electric Vehicles as an entity that promotes, coordinates and monitors policies and strategies to achieve said objectives. This Committee consists of the Office of the Prime Minister, in collaboration mainly with the Ministry of Industry, the Ministry of Energy, and the Ministry of Transportation, and it is chaired by the Vice-Prime Minister of Thailand.

This committee's directives include the 30@30 initiative that establishes that at least 30% of vehicles manufactured in the country must be zero-emissions by 2030, which is equivalent to approximately 750,000 vehicles (Thailand produces approximately 2.5 million vehicles annually). This target is mainly focused on BEVs, and to a lesser extent on HEVs and PHEVs, and extends to 2035 when evere EV sold in the country is expected to be locally manufactured. These objectives are unique in that they linke the local market's development with vehicle manufacturing industry's development, which has grown significantly in recent years and represents an important source of employment and income for Thailand.

Decarbonization vision and objectives come with a long-term development policy (within 20 years) known as "Thailand 4.0," which aims to increase the national income of the country and its inhabitants. By 2036, the government intends to compete with knowledge-based economies, adding value to its manufacturing and developing the necessary human capital to achieve these goals. This strategy focuses on 12 sectors including automotive, automation and robotics, digital, aviation and logistics, biofuels and the biochemical industry, among others. To achieve these objectives, there is an important focus on developing the Eastern Economic Corridor, a region that includes 3 provinces in the east of the country that aims to be the gateway between Southeast Asia and the Asia-Pacific region in the short term.

Table 2.3.1 summarizes incentives for EV and EV-component manufacturing in select countries, as well as in Canada, an important trading partner of Mexico.

Table 2.3.1: Incentives Granted to Manufacturing of Electric Vehicles and their Components, Selected Countries, 2023

Main Incentives	New Plant Bonus	Fiscal Manufacturing Incentives	R&D Promotion	Battery Manufacturing Incentives	Clean Energy Availability	Regulatory Incentives (joint-ventures)	EV Material Mining Incentives
Germany	Non exclusive for EVs	Non exclusive for EVs	Non exclusive for EVs	In line with European Union incentives	Non exclusive for EVs		
Brazil		Non exclusive for EVs	Non exclusive for EVs				
Canada							
China						Non exclusive for EVs	
Costa Rica							
United States	Non exclusive for EVs						
Sweden							
Mexico		Non exclusive for EVs					
Thailand		Non exclusive for EVs					

Source: Frost & Sullivan

3 Manufacturing and Market Analysis of Hybrid and Electric Vehicles in Mexico

As is the case across the globe, the Mexican transportation sector is responsible for about 25% of the total carbon emissions in the country. In this context, the transition to electromobility becomes a viable and efficient alternative for reducing the sector's CO2 emissions, with the aim of improving air quality and meeting the international CO2 emissions reduction commitments Mexico has subscribed to. In November 2022, the Mexican government signed a new commitment at the Climate Summit in Egypt (COP27), in which it committed to reducing greenhouse-gas (GHG) emissions up to 35 percent by 2030 and becoming a carbon-neutral country by 2050. This means Mexico should stop emitting approximately 297 million tons of carbon by 2030.

The current government hopes to achieve these goals by increasing the clean energy generation to 40 GW in total, which means adding more than 25 GW of combined wind, solar, geothermal, and hydroelectric capacity to Mexico's energy matrix by 2030. This commitment is expected to reduce 52 million tons of CO_2 by the end of the decade. This objective was established together with the US government and it was announced at COP27 by Mexican Foreign Minister Marcelo Ebrard. According to this official, the government intends to allocate a total of $48 billion to achieve its decarbonization commitments by 2030.

Additionally, at the last Summit of North American Countries (CLAN) in 2021, Mexico and local oil company PEMEX pledged to eliminate the burning and routine venting in oil and gas operations, with an investment of approximately $2 billion and an implementation plan until 2030. Mexico commits to recapture methane gas resulting from oil and gas production and reuse it in the short term (98% reuse by 2024).

Similarly, in November 2022, the Sonora State Energy Plan launched—a project by President Andrés Manuel López Obrador together with the US government—to promote clean energy and the transition to electric mobility, with 3 main axes of action:

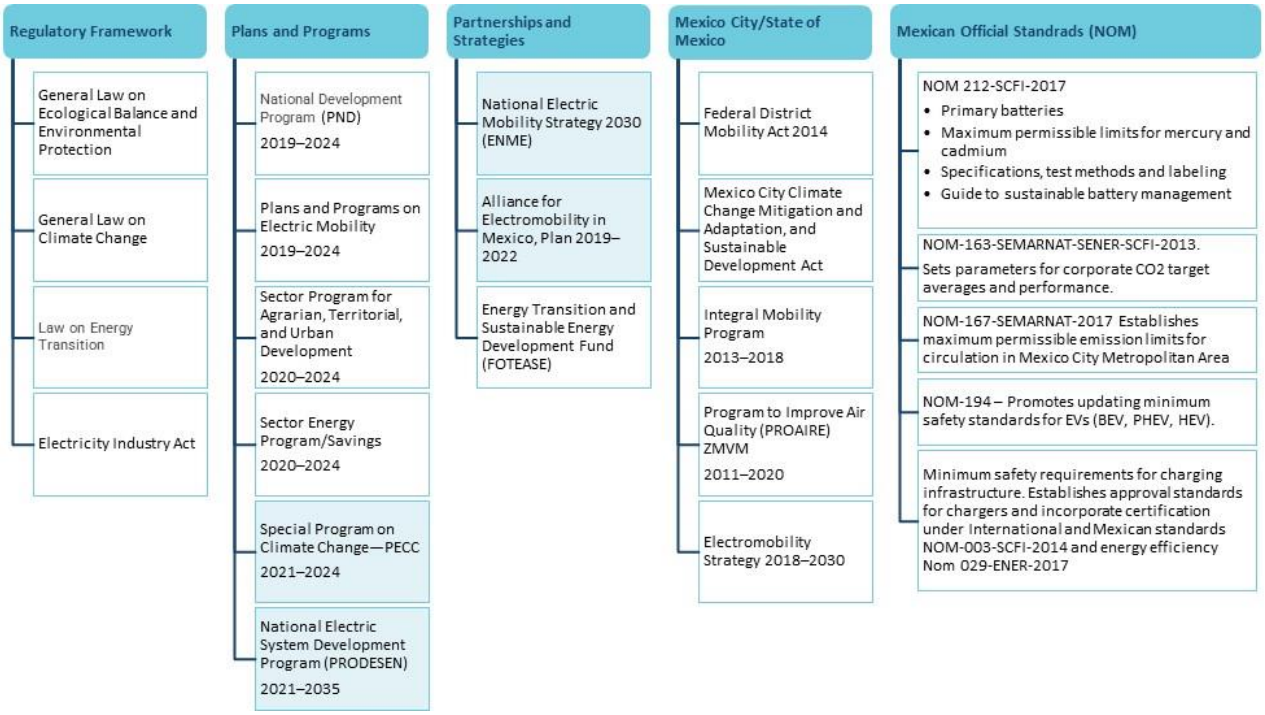
1. **Clean Energy Generation:** The Puerto Peñasco solar power plant is expected to be the largest in Latin America and will be the first of several plants in Sonora to generate a total of 5GW of solar energy over the decade. The solar park in Puerto Peñasco will generate 1GW and will be operational in 2023.
2. **Inserting Mexico into the North American Electric Vehicle Value Chain:** Promoting lithium (through the state-owned company, LitioMX) and graphite extraction from deposits in Sonora, and that of other minerals essential for electronic and semiconductor components, with the aim of inserting Mexico into EV value chains. Together with the national research and development council, CONACYT, the objective is to develop a Mexican network of suppliers that will contribute to the semiconductor hub in Arizona.
3. **Infrastructure Development:** This includes modernizing the Port of Guaymas and the customs facilities in Nogales, Agua Prieta, and San Luis Río Colorado. The project also includes modernizing and expanding roads and railway infrastructure to improve connection with Arizona, in the United States.

"Plan Sonora" is coordinated by the Ministry of Foreign Affairs, the Ministry of Economy, and the Federal Electricity Commission (CFE), while the financing scheme to achieve this is under the Ministry of Finance and Public Credit (SHCP). The US government is expected to provide resources at low interest rates so that the Mexican government can implement the plan.

The existing legal framework is a set of hardly versatile initiatives, laws, and regulations, which, in isolation and with limited objectives and scope, may at some point support the transition to electromobility in the country.

The current regulatory framework for hybrid and electric vehicles starts with the right that all citizens have—at constitutional level—to access mobility in better conditions of road safety, accessibility, efficiency, sustainability, quality, and inclusion; it lays the foundations—together with international commitments—for a national strategy for electromobility and for improving environmental conditions.

Chart 3.1: Regulatory Framework, Main Plans, Programs and Strategies for Electromobility, Mexico, 2022



Source: Frost & Sullivan

These efforts are intended to streamline and direct EV adoption. The aim is to combine all efforts in a coordinated manner generating a single, strong strategy with the best practices available.

In 2017, the Mexican government—with the aim of promoting electromobility in a more organized manner and through the Secretariat of Environment and Natural Resources (SEMARNAT)—partnered with various companies and agencies to work on the National Electric Mobility Strategy Vision 2030 (ENME). The strategy's initial objectives include establishing the incentives schemes and the requirements and technical priorities from the financial, legal, institutional, and administrative systems perspective, that will promote and position electromobility as a viable and sustainable alternative. Although the ENME was expected for publishing by the end of 2022, it has not yet been finalized by June 2023.

Among ENME's main goals there is a 3.3 million to 5 million ton CO_2 emissions reduction through the introduction of 7,000 heavy goods and/or passenger vehicles and 500,000 light vehicles. It also considers establishing zero-emission corridors for public transportation in 10 of the country's main urban areas.

Regarding incentives, EVs are exempted from new vehicle and ownership taxes, environmental verification in some states, and they enjoy income tax deductibility for vehicle acquisition and charging infrastructure installation.

EVs are also exempted from import tariffs, and utilize specific license plates, the EcoTAG. In terms of charging infrastructure, the local electricity company (CFE) install additional meters specific to EVs that enable preferential electricity rates.

Additional support programs vary from state to state. For example, in Mexico City and in the State of Mexico, there are other incentives for hybrid and electric vehicle users, such as the property tax exemption and the "Hologram E" that exempts this type of vehicle from the vehicle restriction program. In Mexico City, the EcoTAG grants a 20% discount on urban toll roads. Figure 3.2 summarizes hybrid and electric vehicle incentives in Mexico.

Figure 3.2: Hybrid and Electric Vehicle Incentives, Mexico, 2023

Source: Frost & Sullivan

In 2012, the federal government eliminated the New Car Tax (ISAN) for hybrid and electric vehicles and this measure will remain in effect in 2023. Mexico has free trade agreements with about 40 countries, so the majority of imported vehicles do not pay the 16% tariff that apply to vehicles from countries without a free trade agreement. In addition the Ministry of Economy announced, in February 2017, that hybrid and electric vehicles are exempt from import duties as long as the importing company manufactures cars in Mexico.

It is worth noting that the majority of plans and incentives expire in 2024, which makes it nearly impossible to lay a long-term foundation for a developing industry and boost the adoption of electric mobility at a larger scale. In this context, developments in the legal field are still at different levels of progress: while progress is relatively high in electricity commercialization, the implementation of rules of operation and regulations are still uncertain for domestic and foreign investors. Similarly, for consumers, incentives and funding remain limited.

It is also essential to develop programs and mechanisms that encourage commercial and government fleet renewal, promoting mandatory replacement for hybrid and electric vehicles. Once the penetration of this type of vehicles increases, business models for charging infrastructure will also benefit, so that investing in this sector becomes attractive for companies and public-private partnerships.

As for hybrid and electric vehicle manufacturing, the ideal regulatory framework should contain a promotion and incentives scheme, as well as regulations allowing companies to invest in new production facilities or in the conversion of existing facilities. Collaboration and the creation of clear rules should replicate the effort made more than three decades ago, when the federal government strongly pushed the automotive industry by encouraging global companies to establish themselves in Mexico along with their supply chains, transforming the industry into automotive clusters.

This coordinated effort should drive all aspects of the industry's transformation, from its current production plant and human capital training, to becoming a global hub for the hybrid and electric vehicle industry. The great challenge is to define and conceptualize the route to follow in each segment of the ecosystem, building on a regulation resilient to politics and business change, which ensures strategy's objectives accomplishment in the long run.

The Hybrid and Electric Vehicle Market in Mexico

The Mexican market for hybrid and electric vehicles has established itself as the largest in Latin America. Similarly to Chile, one of the advantages is the price level for the automotive market in general—thanks to the large number of free trade agreements that Mexico has signed, most vehicles (including hybrids and electric) are duty-free. Additionally, the federal government has implemented financial and non-financial incentives for hybrid and electric vehicles, and there are additional incentives at the city level, especially in Mexico City.

However, the Mexican market is far from attaining its full potential. Even though vehicle prices are lower than in other Latin American countries, there is still a significant difference compared to prices of ICE vehicles. On the supply side, limitations exist in terms of inventories, and not necessarily in the number of available models. In December 2022 there were 21 brands offering at least one hybrid or electric model in the market, there are 18 hybrid models offered by 6 brands, practically in every vehicle segment.

The PHEV segment also experienced a launch boom from 2016 onward, and like other countries in the region, vehicle offerings are highly associated with luxury brands such as BMW, Porsche, Volvo and Mercedes Benz, and mainly in the SUV segment. In December 2022, there were 8 brands selling 18 PHEV models.

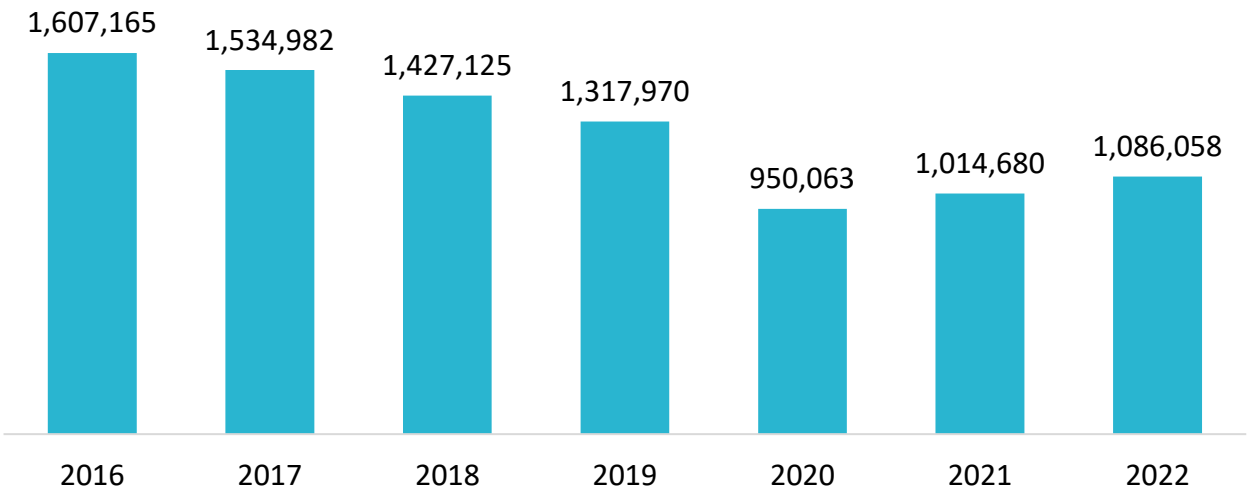
In the case of electric cars, Nissan and BMW started offering the Leaf and i3 models in 2014, and both models remained in the Mexican market until 2021, when the BMW i3 model was removed from offerings. In 2016, Tesla arrived to the Mexican market with its Model S and Model X, and in 2018, it added the Model 3 sedan and the Model Y SUV. The arrival of these brands has given an important impetus to the development of the charging infrastructure in Mexico, a topic that will be explored further later in this document. Since 2020 several brands in the premium segment, such as Jaguar, Porsche and Volvo launched BEV models, and in 2021 brands such as Audi, BMW, and Mercedes Benz added more. In the mass market segment, Chevrolet launched the Bolt EUV version in 2021, and the Chinese brand JAC started to sell 3 electric models in Mexico in the same year. In 2022, US brand Ford launched the crossover Mach E, which is also manufactured in Mexico since 2021.

One of the segments witnessing a boom is that of commercial vehicles, especially in last-mile delivery vans after the growth of e-commerce resulting from the COVID-19 pandemic (due to mobility restrictions). In 2020, Renault launched its Kangoo ZE with a range of up to 200 km with a single battery charge. In 2022, Ford launched the E-Transit electric van and the French brand Peugeot launched its E-Partner. Different fleets of both Mexican and global companies adopt these models to reduce their carbon footprint, such as Mercado Libre, DHL, and Liverpool.

3.1.1 Hybrid and Electric Vehicle Market Size and Forecast in Mexico (2018-2030)

After the 27.9% drop in total light vehicle sales in 2020 due to the COVID-19 pandemic and the 2021 crisis in the sector due to the global semiconductor shortage, the market recovered very slowly. The semiconductor situation improved slightly in 2022 and the market grew around 5.7% to reach 1.09 million units, but it remains far from the peak of the market of about 1.6 million units in 2016, as shown in Chart 3.1.1.1. The semiconductor shortage, disruptions in the value chain, and increasing inflation in Mexico also affected the price of vehicles (growing at a higher rate than overall inflation), negatively impacting sales.

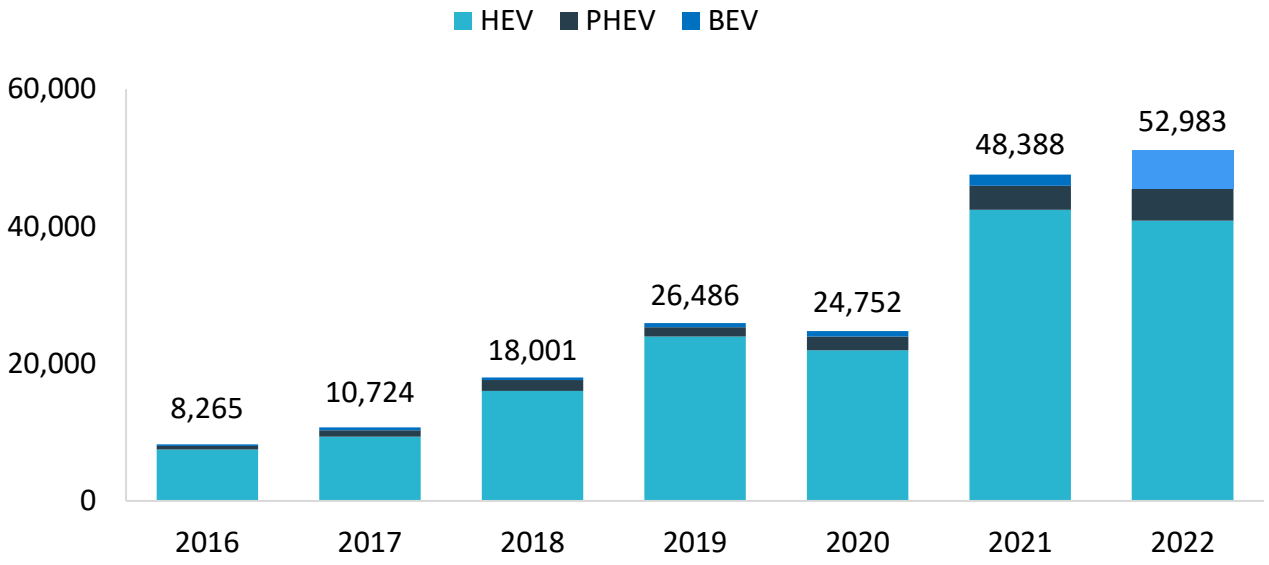
Chart 3.1.1.1: Total Annual Light Vehicle Sales, Mexico, 2016-2022



Source: AMDA; Frost & Sullivan

As shown in Chart 3.1.1.2, most sales in the Mexican market are hybrid vehicles, which represent around 90% of EV sales, mainly due to greater affordability and the fact that the population consider hybrid technology an innovative approach to electric technologies. Hybrid technology has been considered as a transition technology, which helps overcome some of this market's obstacles, such as the range anxiety for plug-in technologies. Sales on this segment are also driven by the environmental contingency that reintroduced vehicle circulation restriction, known as "Hoy No Circula" ("[Your Car] Doesn't Ride Today") for all cars in Mexico City, regardless of a vehicle's age.

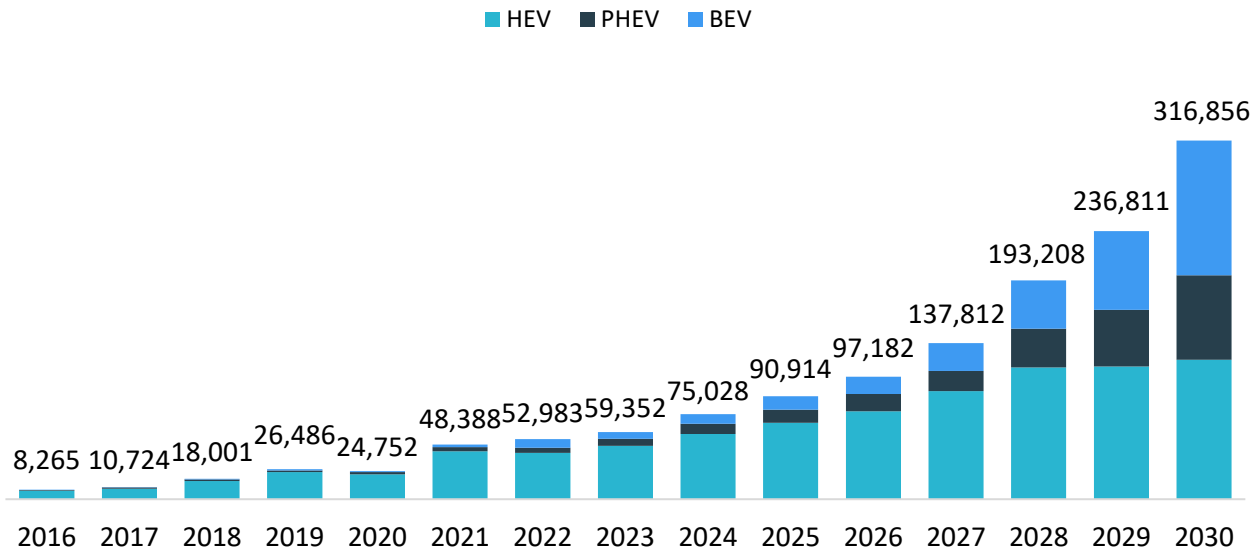
Chart 3.1.1.2: Hybrid and Electric Vehicle Sales, Mexico, 2016-2022



Source: INEGI; Frost & Sullivan

The percentage of hybrid vehicles in total EV sales is decreasing since 2020. First, the semiconductor shortage directly affected the availability of hybrid vehicles in the Mexican market. On the other hand, the increased availability of brands offering plug-in and electric hybrid technology models has resulted in a higher percentage of sales of these specific vehicles. In 2019, sales of vehicles with plug-in technology accounted for 7.6% of total sales of hybrid and electric vehicles, by 2022 this percentage reached 18%. By 2030, that percentage is expected to continue growing, reaching 71.1% hybrid and electric vehicle total sales.

Chart 3.1.1.3: Total Hybrid and Electric Vehicle Sales by Technology, Mexico, 2016-2030



Source: INEGI; Frost & Sullivan

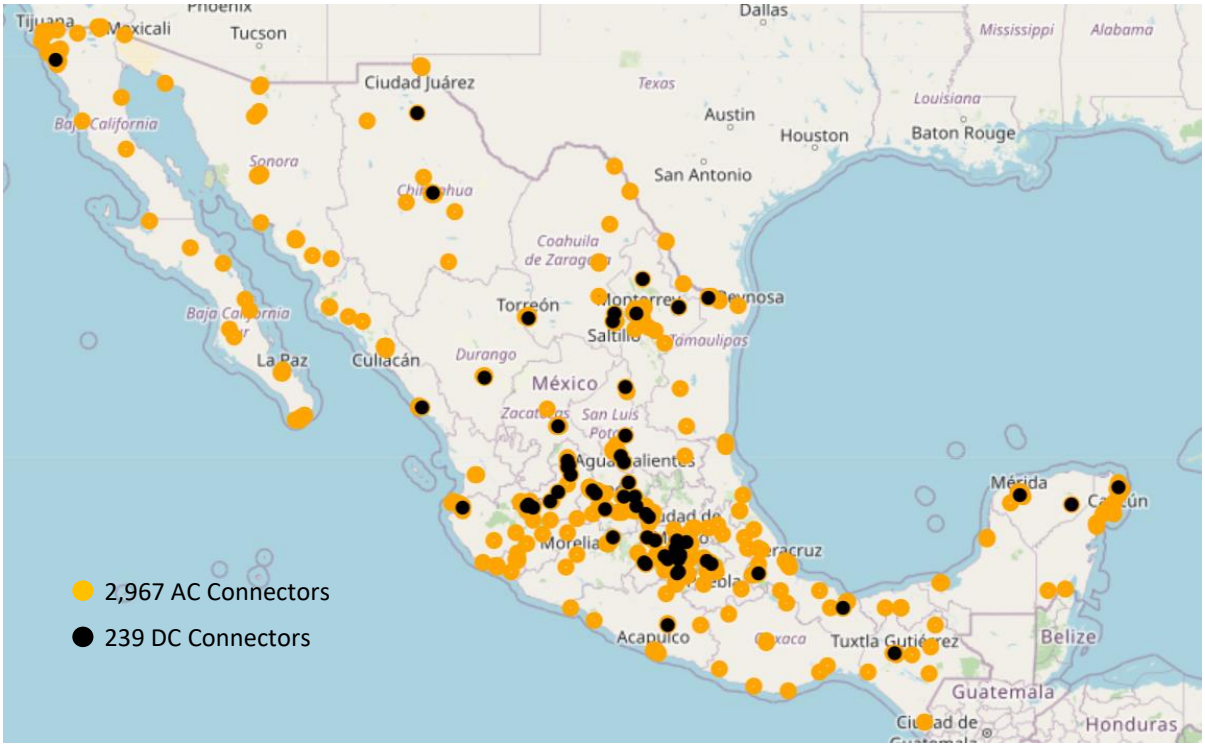
As shown in chart 3.1.1.3, Frost & Sullivan estimates that, by 2023, sales of hybrid and electric vehicles will reach 316,856 units which would represent 19.1% of total vehicle sales in Mexico. This scenario assumes no changes in the current incentive scheme and that the government does not design and successfully implement any additional policies to promote EV adoption. If there incentives change for the better, penetration could increase considerably, and in fact it would be a necessary condition for the Mexican government to reach the intended 50% zero-emission vehicle sales target by 2030.

Typically, the purpose of incentive schemes is to help ensure that EV prices are similar to those of vehicles with ICEs and, therefore, these incentive schemes are usually temporary. In the absence of a policy and strategy for the promotion of hybrid and electric vehicles, including an incentive scheme that directly affects vehicle prices, it is expected that the market will naturally reach this price parity from 2026 onward. Frost & Sullivan estimates that the EV market will grow sustainably throughout this decade.

Current Status and Development of Cargo Infrastructure in Mexico

Currently, according to Frost & Sullivan, there are about 1,336 public or semi-public charging stations in Mexico, with a total of 3,206 connectors, meaning an average of 2.4 connectors per station. Although Mexico is the country with the highest number of charging points in Latin America in 2022, there is a significant need to increase it. Most stations have AC connectors. This means that consumers have a considerable waiting time to travel more than 360 km, which is the average range of electric vehicles currently available in the Mexican market. As seen in Figure 3.2.1, in terms of coverage, the charging infrastructure is distributed throughout the national territory.

Figure 3.2.1: Electric Vehicle Charging Infrastructure Map, Mexico, 2022



Source: Frost & Sullivan

Mexico City has the largest charging infrastructure, with a total 221 stations, followed by Jalisco and Nuevo León with 110 and 100 charging points respectively. Among the 10 regions with the highest number of stations are the State of Mexico, Puebla, Quintana Roo and Guanajuato. It should be noted that in every state of the Mexican territory there is at least one public or semi-public charging station. This can be explained by the fact that a significant number of charging points are installed in dealerships of brands selling EVs in Mexico.

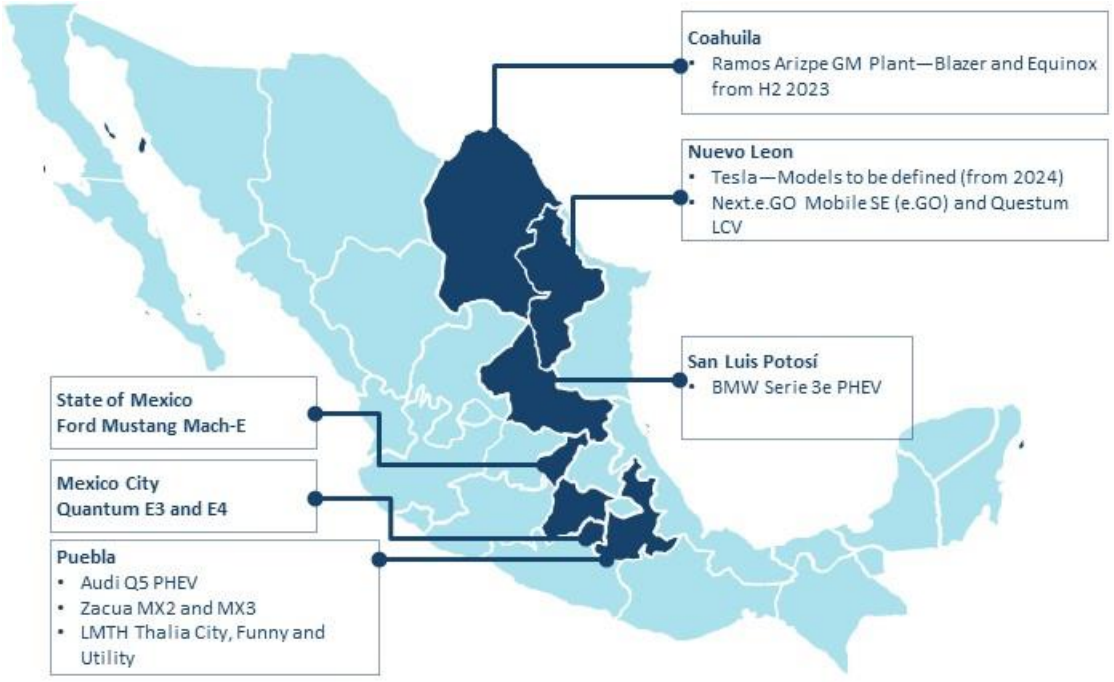
Hybrid and Electric Vehicle Manufacturing in Mexico

The automotive industry in Mexico has been developing for nearly a century. In 1925, Ford installed the first production lines in Mexico City, and since then this industry has gone through various stages and development processes to reach a production of 3.3 million light vehicles in 2022, which makes Mexico the seventh largest global vehicle producer, and the first in Latin America. Mexico has also positioned itself as a major supplier for the international vehicle market, being the fifth largest exporter with 2.9 million light vehicles exported in 2022. Additionally, the national auto-parts industry is the fourth largest producer and exporter globally, and the number one supplier of auto parts to the US market. In total, the automotive industry generates nearly 900,000 formal jobs in Mexico. All of this is largely the result of coordinated efforts between federal, state, and local governments and the automotive industry.

The large number of free trade agreements that Mexico has with more than 40 countries, its proximity to the globally important US market, and the availability, quality and cost of labor in Mexico are the factors behind its current position as an exporter.

As shown in Figure 3.3.1, there are already several plants manufacturing EVs in Mexico. In 2020, Ford began producing the brand's first global BEV, the Mustang MachE, at the Cuautitlán Izcalli plant in the State of Mexico. This was the first Ford plant globally to manufacture EVs. By the end of 2022, more than 150,000 units of this model had been produced, and by 2023 this model's production is meant to be exported to 37 countries (in addition to meeting local market demand). German companies Audi and BMW also began to produce the plug-in hybrid models of the Q5 utility vehicle and the 3e Series sedan respectively. In the case of the Audi Q5, it is manufactured exclusively for export markets, while the Mach E and Serie 3e models are also available in the Mexican market.

Figure 3.3.1: Electric Vehicle Manufacturing Map, Mexico, 2023



Source: Frost & Sullivan

In 2021 General Motors announced an investment of $1 billion dollars for its plant in Ramos Arizpe, Coahuila, to adapt it for producing two BEV models, the Blazer and the Equinox, mainly for export (from the second half of 2023) but that will also meet the Mexican market demand (in the first half of 2024). This plant is expected to manufacture one model for Honda (Honda Prologue) that derived from GM and Honda's collaboration in developing the Ultium platform.

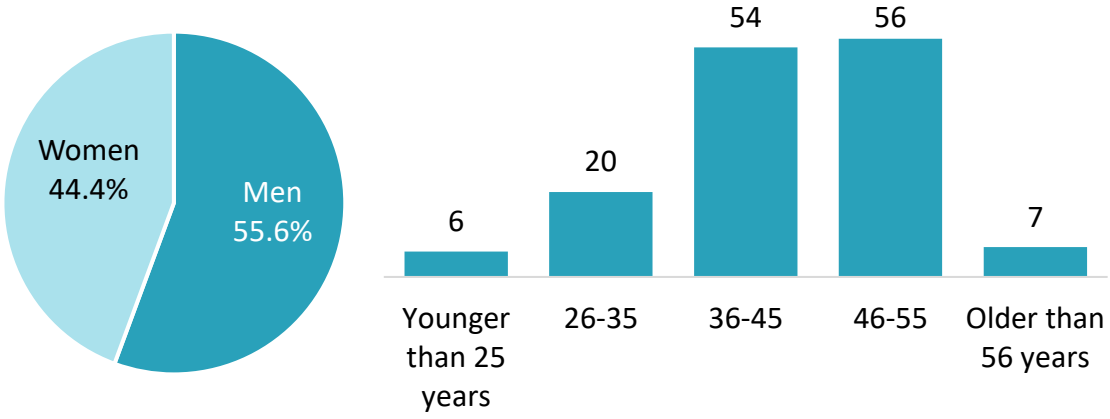
The Volkswagen Group has also announced investments in its plants in Mexico to produce EVs. In 2022, Audi revealed plans to expand its plant in San José de Chiapas, Puebla, to manufacture the Q5 utility vehicle in its BEV version starting in 2027. So far, the announcement refers to a duplicate plant of the current one where the PHEV version is manufactured. Volkswagen brand has announced a similar investment to manufacture BEV vehicles in the state of Puebla starting in 2026.

These are just a few examples of Mexico's readiness to produce EVs. However, the magnitude of the changes required for the rapid transformation that the automotive industry is carrying out at the local level requires impetus and a joint strategy between government (federal, state and local) and the automotive industry to continue attracting large investments. Most global vehicle manufacturers have commitments to stop producing vehicles with ICEs between 2030 and 2050, with a total transformation to clean energy technologies. If Mexico intends to maintain its leadership in the global automotive industry, it would be advisable to also generate a strategy to meet this industry's future demand in terms of energy coming from renewable sources, since its main global interest is to be carbon neutral throughout its production cycle.

Consumer and Potential Customer Analysis of the Hybrid and Electric Vehicle Market in Mexico

A comprehensive analysis of the market for hybrid and electric vehicles in Mexico should also include the consumers' perspective. For this purpose, Frost & Sullivan conducted several surveys, both qualitative and quantitative, to measure the degree of satisfaction of consumers who currently own a hybrid or electric vehicle. This research also analyzes the perspective of consumers who intend to acquire a vehicle featuring these technologies in the next six months. A total 143 online surveys and 6 focus groups were conducted (with a total of 49 participants), for a total contribution of 192 participants from 12 different cities in the country. Chart 3.4.1 specifies some of the sample's characterstics.

Chart 3.4.1: Sample Sociodemographic Characteristics, Mexico, 2022



Source: Frost & Sullivan

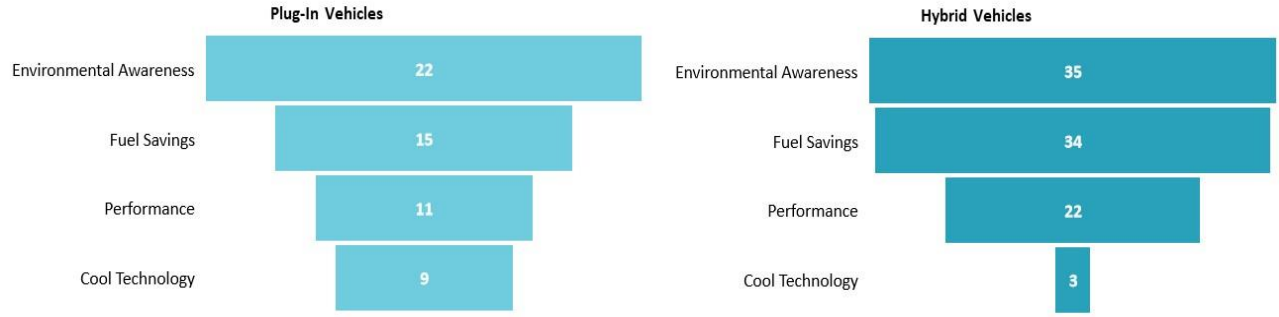
The sample includes users of plug-in vehicles (PHEV and BEV) in 9 cities (CDMX, State of Mexico, Guadalajara, Monterrey, Guanajuato, Hermosillo, Mazatlán, Puebla and Reynosa) which enables a perspective from EV users from the country's main cities and from regions with less charging infrastructure (like Hermosillo, Mazatlán and Reynosa). This indicates that electromobility is garnering greater interest at the national level. For the category of consumers interested in acquiring a vehicle with these technologies, the sample includes the cities of Mérida, Pachuca, and Saltillo.

3.1.2 Analysis of the Experience of Current Owners of Hybrid and Electric Vehicles in Mexico

Among people who have purchased a plug-in vehicle, 87.5% indicate that environmental protection or pollution reduction was the main motivation for their purchase. These consumers also point to fuel savings as an important decision factor. Qualitatively, users comment that electricity spending is much lower than fuel consumption in similarly sized vehicles that they drove in the past, or with automobiles with an ICE belonging to family members. Some owners of plug-in cars that live in single-family homes have installed solar panels to power chargers, which means that their charging expense is practically zero.

Unfortunately, solar panels are not an option for some users who live in condominium buildings—where, in some cases, electrical infrastructure is not in a condition to install a charger, forcing them to install it in their offices or other places. Finally, 9 out of 27 electric car users (33.3%), claim to have purchased these vehicles because they are the latest in technology. This percentage is much lower for hybrid technology (7%). Chart 3.4.1.1 shows the relevant figures.

Chart 3.4.1.1: Main Reasons to Purchase Hybrid and Electric Vehicles, Mexico, 2022 (number of mentions)



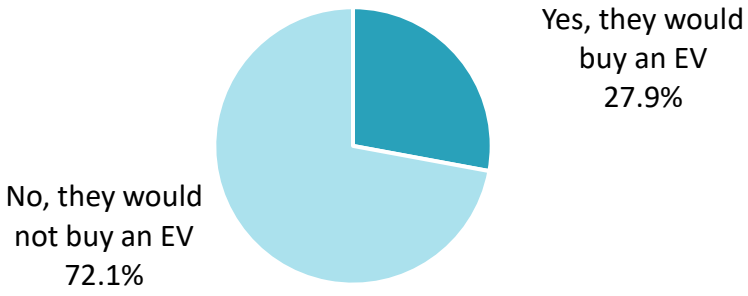
Source: Frost & Sullivan

According to the survey, 81.5% of electric car drivers agree or strongly agree with the claim that long travelling between cities is not feasible in electric cars (due to the lack of charging infrastructure). However, only 4 consumers of the 93 surveyed mentioned that they would not buy a vehicle featuring these technologies—3 plug-in car owners (because of the lack of charging infrastructure) and 1 hybrid car owner who noted that the cost of spare parts (battery) is very high. This means that 95.7% of current owners would buy a hybrid or electric vehicle again.

A highly relevant insight is that users of plug-in vehicles use domestic charging more frequently to meet their daily journey needs. On average, 71.3% of charging happens at home while only 28.7% happens at public charging stations. As a result, given the high levels of investment required to install public charging infrastructure in Mexico, a phased deployment could be designed that gives priority to the installation on main highways, since plug-in vehicle owners pointed to this concern as a limitation.

As mentioned above, vehicles with hybrid technology have had very good acceptance in the Mexican market, accounting for approximately 82% of hybrid and electric vehicles sales in Mexico. In 2022, hybrid and electric vehicles sales accounted for about 4.9% of total light-vehicle sales. This increasing penetration results from the greater availability of models in the Mexican market in most segments, the price (with tax incentives) becoming more affordable—in line with the price of ICE vehicles. Similarly, these models has been a first approach to electric technologies for different consumers, helping them to understand their operation, performance, and ease of use. This is reflected by the fact that 27.9% of owners are considering buying an EV in the short term, mainly to reduce the use of fuels (or non-renewable energies) and thus contribute more significantly to reducing pollution. The technology also reflects the benefits from fuel savings, showing that the cost-benefit ratio of investing in an electric car is positive. Chart 3.4.1.2 shows the relevant figures.

Chart 3.4.1.2: Willingness of Hybrid Vehicle Owners to Acquire an EV in the Short Term, Mexico, 2022



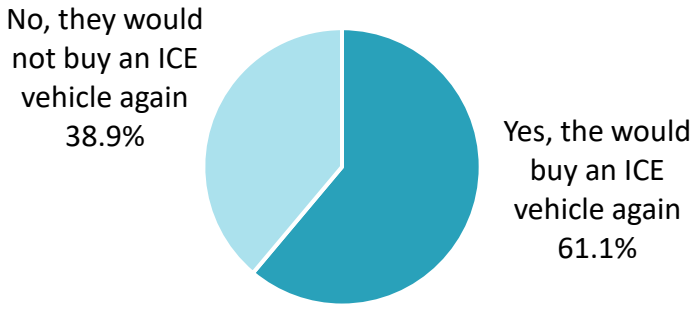
Source: Frost & Sullivan

Of 72.1% of people who are not considering buying an EV in the short term, 35.5% do so because EV prices are very high, which means that an incentive scheme could help more people to access zero-emission technologies. On the other hand, it is of note that 22.6% are comfortable with the hybrid technology vehicle they currently possess. Other answer types relate to the number of charging stations in the country and to existing models' availability and driving range. It should be noted that most of these responses can be solved through an integral promotion strategy for electromobility that attacks most of the consumers' concerns.

3.1.3 Analysis of Potential Customer Needs for Hybrid and Electric Vehicles in Mexico

While the sample does represent potential consumers of hybrid and electric technologies, 61.1% of participants would still buy a vehicle with an ICE as detailed in chart 3.4.2.1, while 39.9% no longer consider buying an ICE vehicle again. Among the reasons to buy an ICE vehicle again participants cite the vehicle's price and the lack of charging infrastructure.

Chart 3.4.2.1: Willingness to Purchase an ICE Vehicle among EV/Hybrid Vehicle Owners, Mexico, 2022

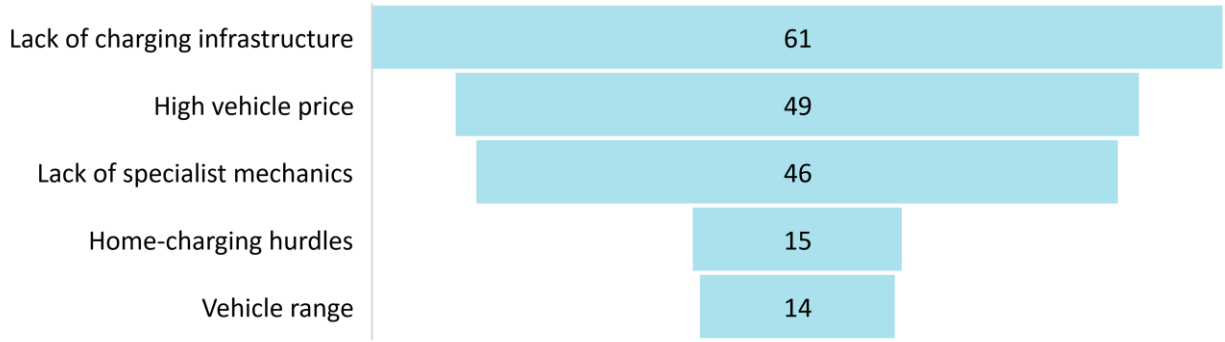


Source: Frost & Sullivan

It should be noted that this survey inquired into the reasons why consumers would buy an ICE vehicle again or not through an open question where responses highlighted the price of gasoline. Yearly fuel savings often appeared as an important decision factor when acquiring these technologies, but now consumers openly state that "gasoline is increasingly expensive." This factor may be relevant at the time of negotiations with the government because the latter allocates a significant amount of resources to subsidizing the Special Tax on Production and Services (IEPS) to maintain fuel prices at a certain level. However, in the minds of consumers, the price continues to rise.

Consumers are aware of the differences between hybrids, plug-in hybrids and battery electric vehicles, and they identify high prices and low availability of charging points as electric cars' main drawback. As for the three technologies, consumers define the lack of specialized auto mechanics as the main drawback of having a hybrid or electric vehicle, as shown in chart 3.4.2.2. Potential hybrid car customers point to domestic charging and car autonomy as additional EV drawbacks.

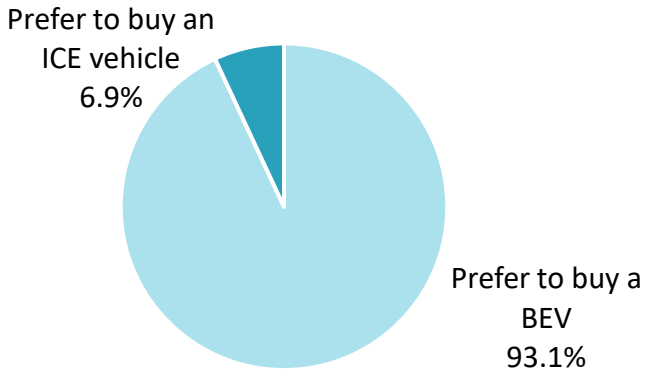
Chart 3.4.2.2: Main Drawbacks of Hybrid and Electric Vehicles, Mexico, 2022



Source: Frost & Sullivan

Finally, by questioning all potential EV consumers on their purchasing preference should EV vehicles be at the same price as ICE vehicles, the response fully favors electric technologies, as shown in chart 3.4.2.3. Only 6.9% of the sample would prefer ICE vehicles, once again highlighting the potential market effectiveness of incentive schemes that directly affect the price of hybrid and electric vehicles. These schemes would increase hybrid and electric vehicle penetration in Mexico, and they would contribute significantly to reducing emissions, mitigating climate change, and complying with the EV penetration agreements signed in Glasgow in 2021.

Chart 3.4.2.3: Purchase Preference between ICE and Electric Vehicles with the Same Price, Mexico, 2022



Source: Frost & Sullivan

4 Impact Analysis of Hybrid and Electric Vehicle Promotion in Mexico

In addition to reducing pollutant and carbon dioxide emissions, EVs provide other social benefits. But these benefits also have a cost, considering that the initial investment is significantly higher than a conventional vehicle's and considering the cost of deploying charging infrastructure.

Table 4.1 summarizes EV benefits and costs in relation to ICE vehicles.

Table 4.1: Examples of Benefits and Costs of Hybrid and Electric Vehicle Adoption, Mexico, 2023

Criteria	Benefits	Costs
Fuel Consumption	Zero or almost-zero fuel cost from well to wheels	The high cost of EVs' propulsion system makes them significantly more expensive to acquire compared to conventional vehicles, in spite of their lower operating costs. Based on the current vehicle tax structure and other costs, the cost of ownership is higher for EVs than for conventional vehicles.
Pollutants	Less particulate pollutants—NMHC, NOx, SOx. Proportional to the fuel consumption reduction.	
GHG Emissions	CO_2 and GHG emission reductions proportionally to fuel consumption reduction.	
Vehicle Noise	EV noise level during idling, partial loading, and full load operation is significantly lower than in conventional vehicles.	
Charging Infrastructure	Vehicle charging mostly occurs at home and at night, so the need for public charging infrastructure may be lower than the current infrastructure for conventional vehicles	Requires investment in charging infrastructure and the related amortization cost.
Government Subsidies	Less fuel subsidies for reduced fuel consumption.	Increase in electricity subsidy Higher cost due to planned tax incentive programs for electric vehicles.
Economic Stimulus	Benefits along the whole value chain and job creation. Economic activity growth related to lithium mining and processing, and recycling/reuse of used batteries.	Reduced economic activity in fuel retail.

Source: Frost & Sullivan

CO_2 Emission Reduction

ICE vehicles generate combustion by-products that contribute to environmental concentrations of ozone, fine particulate matter (PM), NO_2, SO_2, and CO. In addition, combustion processes also produce carbon dioxide (CO_2), a GHG. The regulatory structure associates emissions from most pollutants with how many kilometers a vehicle rides, rather than the amount of fuel consumed. The amount of CO_2 produced, however, depends on the amount of fuel consumed.

EVs' main benefit is that the exhaust emissions are zero or close to zero. While BEVs do not use an ICE, hybrid technologies (HEV and PHEV) do. In a PHEV the ICE comes into operation when the electric propulsion system's available driving range is exhausted, as well as when providing propulsion assistance in high-speed conditions. Assuming that the EV share of the total vehicles in operation will be greater, there would be a reduction in the total exhaust gases emissions from the transport sector and the harmful effects on human health and other economic effects. Table 4.1.1 shows the total savings in CO2 emissions under two scenarios: one without additional EV incentives and one with additional incentives.

Tabla 4.1.1: CO_2 Emissions Avoided by Adopting Hybrid and Electric Vehicles, Mexico, 2016-2023 (in millions of tons)

Period	HEV Emissions	PHEV Emissions	BEV Emissions	ICE Emissions	100% ICE Vehicle Parc Emissions	Total CO_2 Emissions Saved
BAU Scenario	11.6	2.1	1.4	672.8	703.7	15.8
Scenario with Additional EV Incentives	16.2	4.9	3.5	653.8	703.7	26.2

BAU: Business as Usual

Source: Frost & Sullivan

Incorporating hybrid and electric vehicles to the Mexican vehicle fleet at a natural growth rate with the current conditions examined in chapter 2 will result in 15.8 million tons less CO_2 between 2016 and 2030. If a national EV policy was introduced promoting more widespread adoption of this type of vehicle—including an incentive scheme affecting vehicle prices—CO_2 savings could reach 26.2 million tons, which means an increase of 65.8%, or an additional 10.4 million tons of CO_2 saved. Considering that Mexico's commitment in its updated National Determined Contributions (NDCs) requires a reduction of about 281 million tons of CO_2. A comprehensive policy of promoting hybrid and electric passenger vehicles can contribute approximately 9.3% of Mexico's total commitment to reducing CO_2 emissions.

Particulate Matter

PM is a highly complex mixture of solid particles and liquid droplets distributed among numerous atmospheric gases that interact in solid and liquid phases. Particles are emitted directly from sources and form through atmospheric chemical reactions.

Studies show that nitrogen oxides (NOX) and PM in the environment are associated with a wide range of health effects, and they determined that there is a causal relation between short -and long-term exposures to fine particles, such as premature mortality, cardiovascular and respiratory effects, babies' development (e.g., low birth weight, higher infant mortality), and carcinogenic, mutagenic, and genotoxic effects (e.g., higher lung cancer mortality).[1]

Ozone

Ground-level ozone pollution is typically formed through reactions involving volatile organic compounds (VOCs) and NOx in the lower atmosphere in the presence of sunlight. These pollutants, often referred to as "ozone precursors," come from many types of pollution sources, including motor vehicles. Ozone and its precursors can move up to hundreds of kilometers, resulting in high ozone levels even in areas with low VOC or NOX emissions.

Studies have determined that there is a causal relation between short- and long-term ozone exposure and lung issues, including decreased lung function, pulmonary inflammation, onset of or exacerbation of asthma, issues related to the respiratory tract, and even death. Studies also show that cardiovascular effects, including decreased heart function and increased vascular disease, and overall mortality are likely to be causally associated with both gases (VOC and NOX). Finally, evidence suggests a causal relation between short-term exposure to ozone and effects on the central nervous system.[2]

Sulphur Dioxide and Nitrogen Dioxide

Sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) and their gaseous phase oxidation by-products can dissolve in water droplets and further oxidize to form sulphuric and nitric acids which react with ammonia to form sulphates and nitrates, both important components of environmentally polluting particles.

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[1] Pope, C. A., & Dockery, D. W. (2006). Health effects of fine particulate air pollution: Lines that connect. Journal of the Air & Waste Management Association, 56(6), 709–742. doi:10.1080/10473 289.2006.10464485

[2] Turner, M. C., Jerrett, M., Pope III, C. A., Krewski, D., Gapstur, S. M., Diver, W. R., . . . Crouse, D. L. (2016). Long-term ozone exposure and mortality in a large prospective study. American Journal of Respiratory and Critical Care Medicine, 193(10), 1134–1142

Epidemiological studies have found that controlled human exposure and animal toxicology provide evidence of a likely causal relations between short-term exposure to NO_2 and respiratory effects, where evidence includes respiratory disease symptoms, and respiratory issues resulting emergency department visits and hospital admissions. Based on short and long-term exposure studies, children and seniors with pre-existing lung conditions (e.g., asthma or COPD) have a potentially increased risk of NO_2-related respiratory effects.

Greater adoption of hybrid and electric vehicles can lead to lower emissions of these pollutants. Frost & Sullivan's calculations in this regard point to a significant reduction of PM, NOx and non-methane hydrocarbons (NMHC). The choice of these particular measurements for these 3 pollutants is due to the fact that they are normally limited in the emission standards of most countries, including Mexico. Table 4.4.1 shows the emission reductions in these pollutants resulting from greater EV adoption in Mexico by 2030.

Table 4.4.1: NOx, PM and NMHC Emissions Avoided with a Higher Hybrid and Electric Vehicles Adoption, Mexico, 2020-2030 (tons)

Period	Annual NOx Emissions Savings	Annual PM Emissions Savings	Annual NMHC Emissions Savings
BAU Scenario	572.5	35.5	352.3
Scenario with Additional EV Incentives	1,570.4	97.2	966.4

BAU: Business as Usual

Source: Frost & Sullivan

A national policy to increase hybrid and electric vehicle adoption can generate multiple benefits in reducing CO_2 emissions (including those in the government's international commitments to mitigate climate change), and a number of additional pollutants with negative effects on health.

Noise Levels

EVs produce very little audible noise in idling and driving modes. An EVs' noise sources are limited to the electric motor, tire traction against the pavement, and aerodynamic resistance and friction. ICE vehicles typically produce interior noise levels around 40 to 45 db during idling and 70 to 80 db at full throttle. A BEV reaches noise levels of 20 to 25 db during operation, well below the noise levels of an ICE vehicle. Although EVs' low noise level has a positive impact on road noise pollution, it can also be considered a risk to road safety—some countries are considering requiring electric vehicles to emit the sound of an ICE, or other type of noise to make them audible to other vehicles and pedestrians.

Given the small EV share in the current vehicle fleet in Mexico, EVs are not expected to have a significant impact on road noise pollution until 2030. In the long term, noise pollution mitigation in cities through EV adoption will depend on whether EVs will be required to produce ICE noise levels or not.

Health Impact

In a recent study published in the journal Science of the Total Environment[3] there is evidence that increased EV adoption in California has resulted in fewer hospital emergency room visits for asthma. Researchers also observed that an increase in EV penetration of 20 EVs per 1,000 vehicles results in a 0.41% decrease in the average annual NOx levels in the environment. This increase in adoption, while not as significant in absolute numbers, was also associated with a 3.2% reduction in emergency room visits related to asthma.

A study conducted by the International Council of Clean Transport estimates that a reduction in ozone emission levels could prevent around 2,000 premature deaths related to respiratory diseases[4]. Similarly, a reduction in $PM_{2.5}$ particulate matter concentration levels could prevent 7,000 premature deaths each year mainly from cardiovascular disease in adults and from respiratory problems in children under one year of age. More deaths would be avoided in municipalities with a higher population density and higher levels of pollutant concentration. Although this study is not directly related to hybrid and electric vehicle adoption, it does present solid evidence regarding the effect of reducing emissions on health.

As demonstrated above, a greater EV penetration in the Mexican vehicle fleet would result in a reduction in the levels of particulate matter, nitrogen oxides and CO_2, which would have a positive impact on the population's health.

[3] Erika Garcia, Jill Johnston, Rob McConnell, Lawrence Palinkas, Sandrah P. Eckel, California's early transition to electric vehicles: Observed health and air quality co-benefits, Science of The Total Environment, Volume 867,2023. Consultado el 10 de febrero de 2023, https://www.sciencedirect.com/science/article/pii/S0048969723003765

[4] Pineda, Leticia, Blumberg, Kate; Schade Maita & others (2021). Air quality and health benefits by improving emission standards for vehicles and fuels in Mexico. International Council on Clean Transportation, 22-24.

5 Suggested Elements for a National Electromobility Plan in Mexico

Objectives for a National Electromobility Plan

At the recent 27th United Nations Climate Change Conference (COP27), in Egypt in November 2022, the Mexican government intensified previous commitments on its climate change mitigation strategy. The key element of these changes is the increase in the GHG emission reduction target from 22% to 35% by 2030. As part of the announced measures to achieve this objective, the Mexican government had previously signed the Glasgow Pact (the result of the COP26 held in the United Kingdom in 2021) in which—within the framework of mitigation measures—it commits to accelerating the adoption of electric mobility by setting a target for passenger vehicle sales to be 100% zero-emission by 2040. In conjunction with the US government, the intermediate goal is to achieve 50 percent of sales of this type of vehicle by 2030.

In this context, having a national electromobility adoption plan or strategy becomes a fundamental axis to achieve these commitments. Although there are very important efforts by different entities of the Mexican government to promote hybrid and electric vehicle adoption, a coordinated strategy with the different players in the ecosystem is of utmost importance for these efforts to come together and go in the same direction. An entity to coordinate, monitor and report on the progress and results of this strategy on a regular basis is also desirable to ensure that the efforts help the main objective, which is to significantly contribute to reducing transportation sector emissions in Mexico.

The President of Mexico, Andrés Manuel López Obrador, announced that 50% of light vehicles manufactured in Mexico should be zero-emission by 2030, which reinforces the need for a joint strategy with the automotive sector to achieve this objective. Vehicle and autopart manufacturers must transform their current manufacturing plants in the next 7 years to shift 50% of their production lines toward EV manufacturing.

For consumers—individuals and businesses—there are two fundamental factors in their hybrid and electric vehicle purchasing decision processes:

- The extant price differential between hybrid and electric vehicles and ICE vehicles in the Mexican market
- The availability of charging stations throughout Mexico, especially on highways

For this reason, AMIA suggests a comprehensive strategy that addresses the most relevant issues to achieve greater hybrid and electric vehicle adoption and a significant reduction in GHG emissions. This strategy should ideally come from the President of Mexico, with a holistic vision of the benefits and needs to be met for achieving the objectives, of which the most important are:

- Reduce GHG emissions from the transportation sector
- Contribute to meeting international climate change targets
- Generate a positive impact on public health and quality of life in the population

While the primary objective of adopting a policy to promote EVs is the contribution to reducing GHG emissions and creating better living conditions for Mexicans, there is also a set of associated objectives that would have a positive effect on the country's economic and social environment, including:

- Maintaining the leadership of the Mexican automotive industry locally, regionally, and globally
- Increasing the number and quality of jobs that the automotive sector generates in the Mexican economy
- Strengthening regional supply chain by contributing to the substitution of Chinese imports, in support of regional objectives with the United States and Canada
- Enhancing the local industry's ability to access US Inflation Reduction Act (IRA) benefits, as well as other benefits associated with the electric vehicle industry in the region

This proposal's objectives and recommendations agree—in various areas—with the initiatives and strategies on electric mobility that the different entities of the federal government have recently been developing, such as the Ministry of Environment and Natural Resources (SEMARNAT) with its National Electric Mobility Strategy, the Ministry of Economy as part of the industrial promotion strategy, and the Ministry of Foreign Affairs with the Transport Electrification Task Force in partnership with the University of California. The joint work of all these entities, together with the private sector and its member associations, could be the sum of efforts required to achieve the objectives set by this strategy in a coordinated and accelerated manner.

The main objective of the National Electric Mobility Strategy, under development by SEMARNAT, is establishing the incentives schemes and the requirements and technical priorities from the financial, legal, institutional, and administrative systems perspective, that will promote and position electromobility as a viable and sustainable alternative. SEMARNAT expects to mitigate pollution from the transportation sector (NOx, HC, and particles), by adopting zero-emissions forms of transport, improving energy efficiency of transport per km (hence its focus on mass public passenger transport) and GHG emission reduction. The current proposal for a National Electromobility Plan is in line with these objectives, and it recognizes that there is a significant number of passenger vehicles (cars and vans) in circulation and that the benefits will be greater to the extent that these vehicles also use cleaner (hybrid) or zero-emission (electric) technologies.

The Ministry of Economy's activity has focused in recent years on promoting EV industry—through, for example, the Electromobility Forum held in November 2021—both in the development of its value chains and that of charging infrastructure, while contributing to eliminate information asymmetries that could impede market development. Recognizing the importance of the automotive industry in the economy as a significant job creator and source of resources, the Ministry is working to further promote and develop the transition to EVs. Similarly, the current proposal acknowledges that the direction the industry is taking globally (by accelerating the pace of the transition to electric mobility) highlights the need to take immediate action so that the local industry maintains its global leadership position. Mexico's major trading partners, such as the United States, Canada and the European Union, have adopted aggressive EV adoption targets, which is a trigger for the local industry to achieve the transformation process necessary to remain a major global vehicle supplier.

Similarly, the Ministry of Foreign Affairs's initiative—through the Transport Electrification Working Group—together with the United States and the support of the University of California mainly intends to promote and link the various ecosystem stakeholders for electric mobility adoption through five main axes: innovation, human capital, supplier development, charging infrastructure development, and governance structure. Another objective of this working group is to preserve and enhance the role of the automotive industry of both countries in the global industry. In this context, the current proposal recognizes and agrees with the importance of the local automotive industry's transition toward EV manufacturing, considering innovation, supply chain development, and the skills and competences of the human capital necessary for this new industry.

Ideally, this strategy should come from the President of Mexico, so that all entities involved are aligned by the objectives set therein. The issue of electromobility—as seen in countries where implementation is in more advanced stages—involves and requires the commitment and action of different government agencies, but in Mexico the mandate arises from the President. Technically, those entities that have to do with urban and sub-urban mobility, environment, energy, infrastructure, the promotion of industry and investment, employment, and education should be involved at the government level. Table 5.1.1 details some of the entities that must be involved in an electromobility strategy for it to be successful in Mexico.

Figure 5.1.1: Key Entities for the Development and Successful Implementation of a National Electromobility Policy, Mexico, 2023

Entities
Ministry of Economy (SE)
Ministry of Environment and Natural Resources (SEMARNAT)
Ministry of Energy (SENER)
Federal Electricity Commission (CFE)
Energy Regulatory Comission (CRE)
Ministry of Foreign Affairs (SRE)
Ministry of Territorial and Urban Development (SEDATU)
Ministry of Infrastructure, Communication and Transportation (SICT)
Ministry of Public Education (SEP)
Ministry of Labor and Social Security (STPS)
Chamber of Senators, Deputies and Local Congresses
State and Municipal Governments
Associations of Municipalities of Mexico (AMMAC)
Mexican Association of Secretaries of Economic Development (AMSDE)

Source: Frost & Sullivan

For this reason, Frost & Sullivan suggests that a single entity should have complete visibility of action. In addition, it would be important for this body to have binding powers so that the strategy's implementation may be monitored and evaluated periodically, and to which each of the other entities involved should report on progress and actions to be implemented to achieve the set objectives. This body could undoubtedly be the federal government itself (the Office of the President) or a committee or entity that the federal government designates.

For example, in the case of India, the central government appointed the National Institute for the Transformation of India-Aayog (NITI-Aayog), which is the main think tank of the Indian government. In the past, the number of facilitators, actors, and co-ordinations between different levels of government (central and state) resulted in a bottleneck in rapid decision-making regarding the different elements of the EV value chain. To overcome these bottlenecks, key actors meet regularly, coordinated by NITI-Aayog, to review existing policies, remove bottlenecks, and encourage EV investment to drive EV adoption.

In the case of Mexico, a relevant example could be the National System of Mobility and Road Safety, which serves as a coordination mechanism between authorities of the three levels of government and civil society. This system is composed and coordinated by representatives of the Ministry of Territorial and Urban Development (SEDATU), the Ministry of Infrastructure, Communications and Transportation (SICT), the Ministry of Economy (SE), and representatives of the mobility secretariats of the 32 states of the Republic. It aims to promote the principles of the General Law on Mobility and Road Safety, the National Development Plan, and the creation of the National Mobility Strategy. A similar mechanism could be very useful for a National Electromobility Strategy.

The main reason for it to be a committee featuring representatives from different entities—instead of one entity coordinating electromobility efforts—is the fact that the powers of none of the entities involved fully cover the objectives of promoting electromobility. The following points explain why it would not be advisable for the automotive industry to suggest that only one entity coordinate the comprehensive electromobility strategy:

- SEMARNAT: Its functions include the prevention and control of pollution, as well as the fight against climate change, but promoting industry and creating jobs are beyond its sphere of influence. As a result, it could be biased toward promoting EV penetration (mainly in mass public transport), leaving aside hybrid and electric vehicles manufacturing.
- Ministry of Economy: It would be the opposite case to SEMARNAT, i.e., the Ministry prioritizes promoting industry and job creation, but would not necessarily promote incentives to increase hybrid and electric vehicles penetration to reduce GHG emissions.

- Ministry of Foreign Affairs: This entity's main interest in becoming involved in electric mobility is attracting investment to the sector. It aims to be a link between companies of local or foreign capital that want to invest in Mexico and the local government entities required to materialize these investments successfully. Like the Ministry of Economy, it could not necessarily take an approach that aims to reduce GHG emmissions.

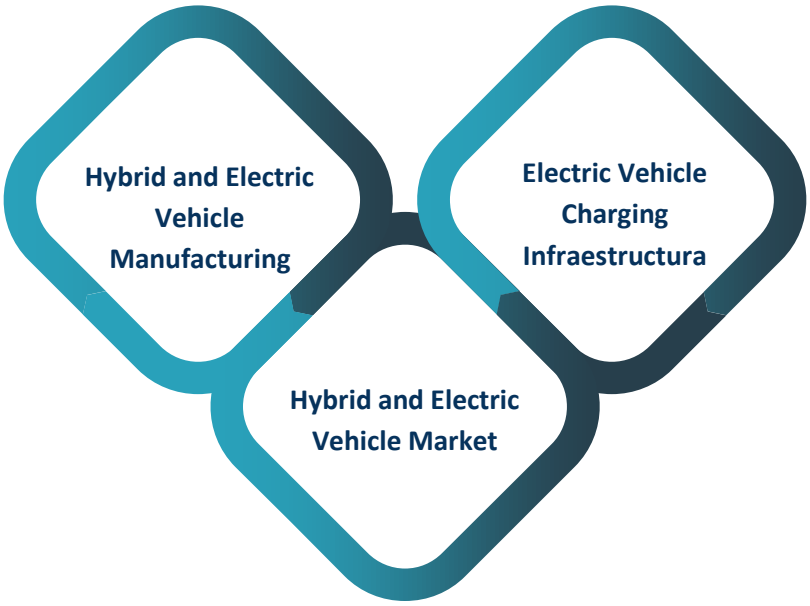
This does not mean that the plan would not function efficiently should the President of the Republic appoint one of these entities and provide it with the necessary powers to have binding action on the others. Such could be the case of SEDATU—designated by the General Law of Mobility and Road Safety to create the National System of Mobility and Road Safety—which has the necessary powers for the system to function and fulfill its objectives efficiently. The better the mandate and coordinated action among the listed entities are, the more successful the strategy will be in the long run.

Likewise, actions undertaken by the Mexican Association of the Automotive Industry should also consider interaction with the Mobility Committee of the Chamber of Deputies of the Congress of the Union, since this entity has the powers to generate initiatives promoting electromobility. Various initiatives on this subject were detailed in chapter 3. In addition, the Chamber of Deputies reviews, modifies, and approves the Federal Budget, which could include the incentives suggested in this proposal and the changes needed in the regulatory framework to move this strategy forward. That is why, both at the federal level and at the local level, it will be important to promote and follow up on proposals regarding development of both the EV industry, market, and charging infrastructure.

Main Recommendations for the National Electromobility Policy

Taking all these factors into consideration, and as shown in Chart 5.2.1, Frost & Sullivan identifies three major areas that the electromobility plan should address:

Chart 5.2.1: Electromobility Plan Recommendations, Mexico, 2023



Source: Frost & Sullivan

Considering that both the hybrid and electric vehicle industry and the market are at a nascent stage, some of these recommendations could enable either the market or the industry, as would various of the incentives suggested and the necessary regulatory framework, while others, such as the clean energy availability, are considered to contribute to emission reduction targets. Table 5.2.1 summarizes the suggested recommendations within each of these strategic axes.

Table 5.2.1: Suggested Recommendations for Each Strategic Axis of the National Electromobility Plan, Mexico, 2023

Manufacturing / Industry	Consumer / Market	Charging Infrastructure
Fiscal incentives for hybrid and electric vehicle manufacturing	Terminology, battery disposal and emissions NOM creation	Joint strategy for planning and installing public charging infrastructure
Administrative incentives for hybrid and electric vehicle manufacturing	ISR temporary deductibility for individuals and higher deductibility for companies	NOM connector standards for public EV charging infrastructure
Clean energy availability for hybrid and electric vehicle manufacturing	Temporary VAT reduction for hybrid and electric vehicles	Census of public charging infrastructure for EVs
Joint work between the industry, the government and academia for developing human capital	Temporary tax credits for companies investing in hybrid and electric vehicles and infrastructure	Administrative and fiscal incentives for installing charging infrastructure
Eliminating bottlenecks and improving logistics	Preferential interest rates and lease schemes for hybrid and electric vehicles	Availability of renewable energy for hybrid and electric vehicle manufacturing
	Toll discounts on federal highways	Guidelines for electricity payments in public charging infrastructure
	Parking meter waiver for hybrid and electric vehicles	Charging infrastructure regulation for new buildings
	Government fleet electrification	Preferential electricity rates for businesses charging EVs

ISR: Revenue Tax

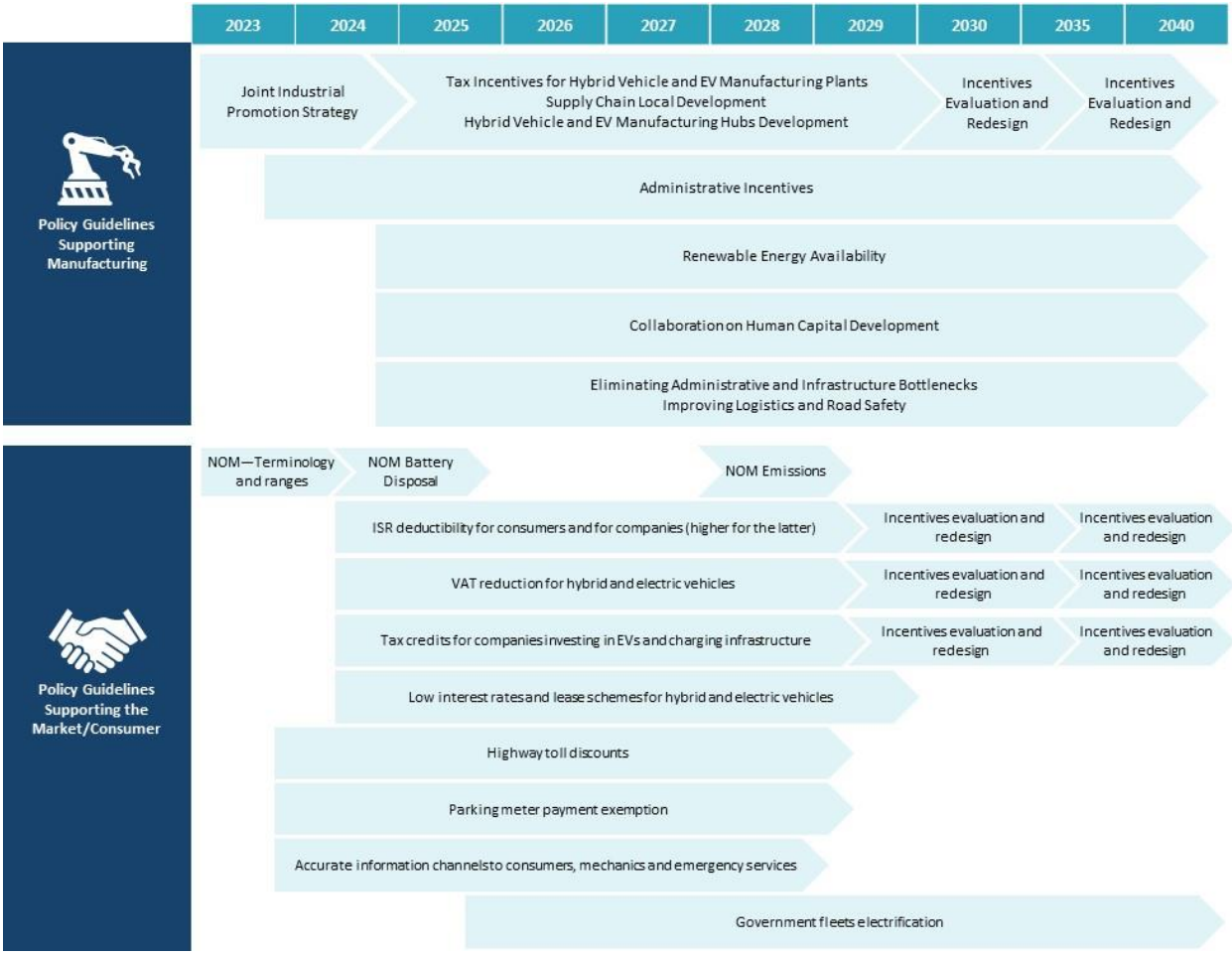
VAT: Value Added Tax

Source: Frost & Sullivan

Suggested Schedule for the Implementation of a National Electromobility Plan

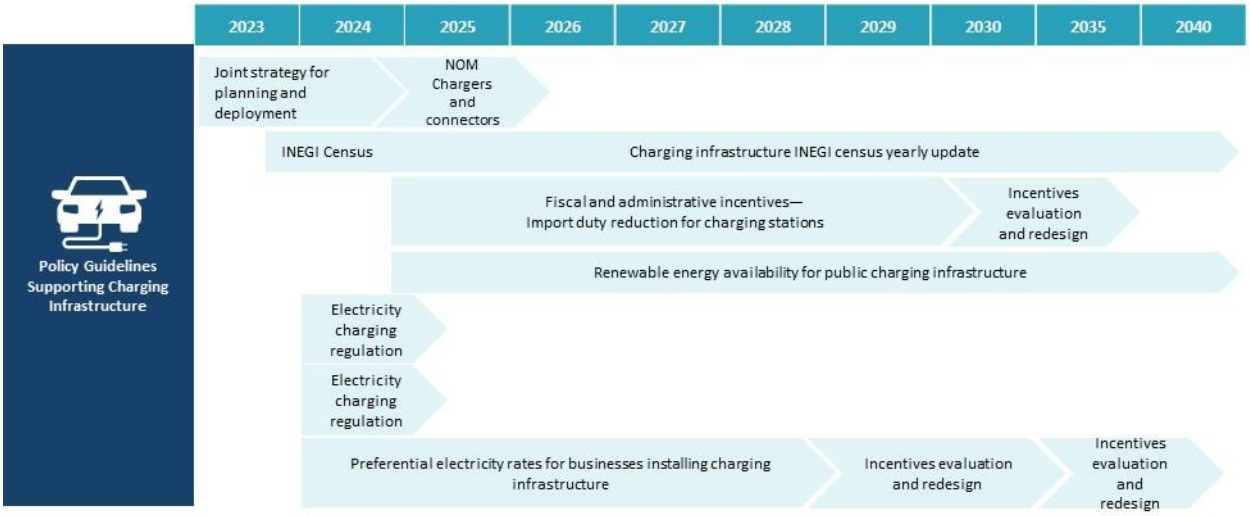
Each of these specific recommendations must be developed and implemented over time between 2023 and 2040. Possibly permanent ones should be differentiated from those that may be temporary, meaning, those that will hold for as long as the necessary conditions exist regarding hybrid and electric vehicle adoption. Frost & Sullivan recommends that these recommendations' costs and benefits be regularly monitored and evaluated to determine the timing or extent of each. Chart 5.3.1. shows the suggested roadmap with the corresponding implementation schedule for these recommendations. The urgent need to take immediate action to achieve emission reduction targets—and the speed of change in the industry—must compel actors to take rapid steps and implement a hybrid and electric vehicle adoption strategy.

Chart 5.3.1: Strategic Axes of the National Electromobility Plan Roadmap, Mexico, 2023



Source: Frost & Sullivan

Chart 5.3.1: Strategic Axes of the National Electromobility Plan Roadmap, Mexico, 2023



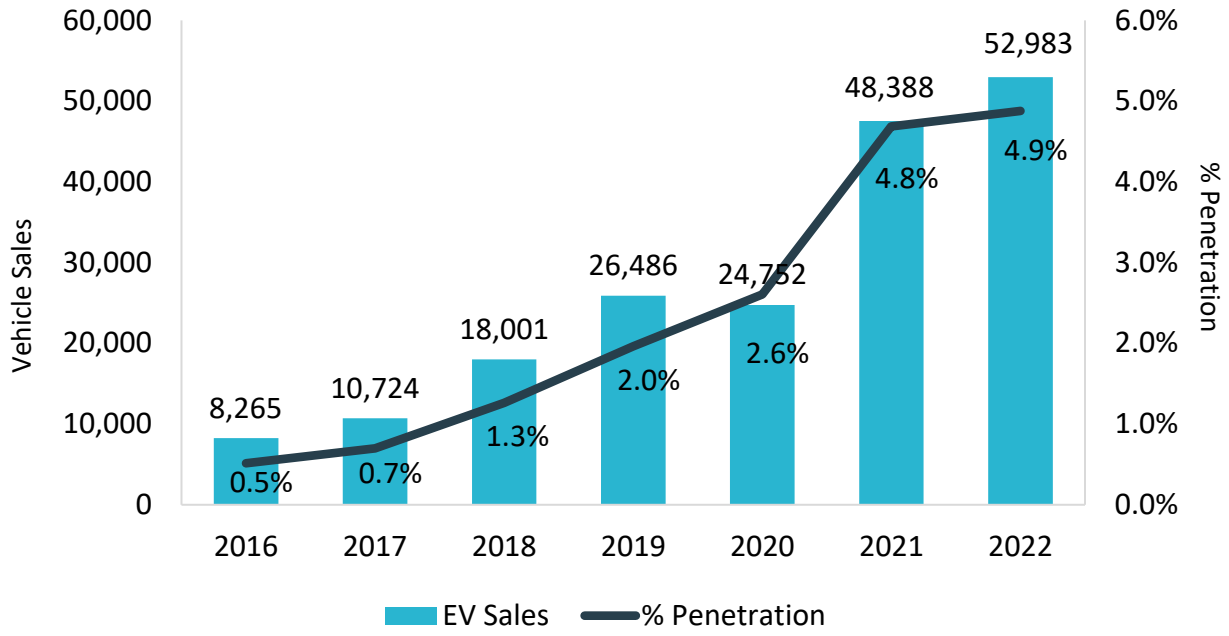
Source: Frost & Sullivan

Impact of a National Electromobility Policy on the Hybrid and Electric Vehicle Market in Mexico

Adopting a comprehensive policy to promote electromobility affects both hybrid and electric vehicle penetration rates. Considering that BEVs are priced higher than hybrids and plug-in hybrids, the impact of an incentive scheme is expected to be greater on BEVs. According to figures from the consulting firm Frost & Sullivan, —which considers the sales reported by INEGI plus the estimated sales of companies like Zacua and Tesla that are not reported—the market for EVs went from 8,265 units in 2016, to 52,983 units in 2022. Even in 2020, when total sales of light vehicles experienced a 27.9% decrease, sales of hybrid and electric vehicles decreased only by 6.5%.

As shown in chart 5.4.1, in terms of penetration, hybrid and electric vehicle sales accounted for 0.5% of total light vehicle sales in 2016, while in 2022 this percentage reached 4.9% of the market.

Chart 5.4.1: Hybrid and Electric Vehicle Sales and Sales Penetration in the Total Market, Mexico, 2016–2022

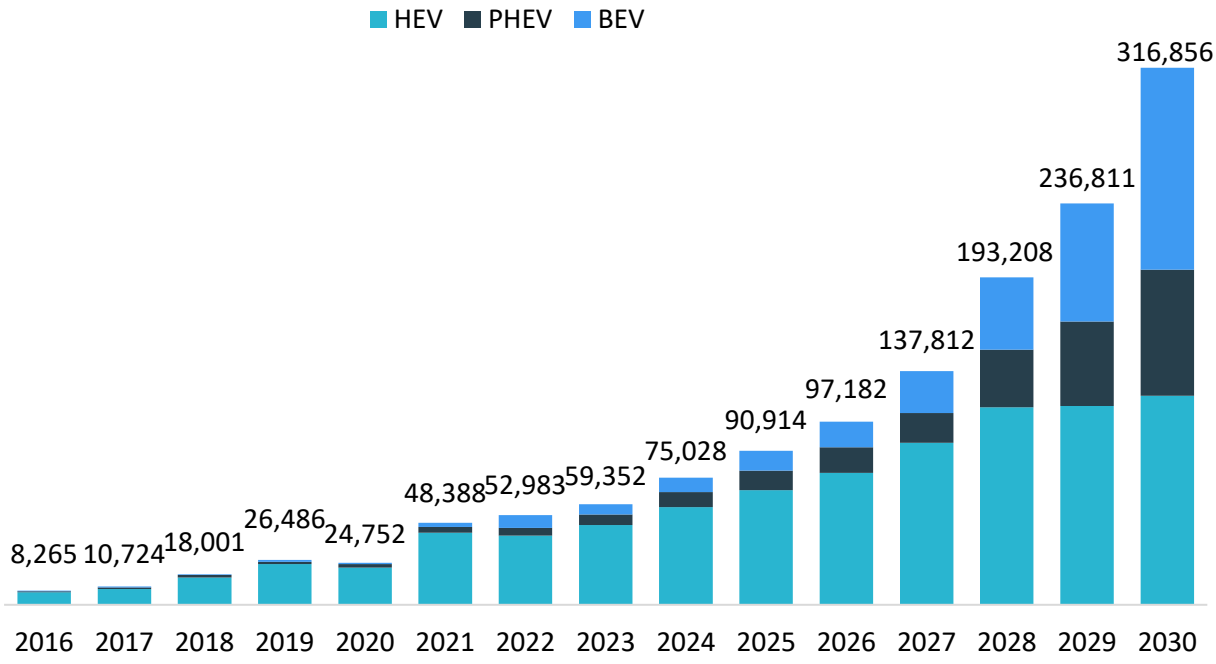


Source: INEGI; Frost & Sullivan

As shown in figure 5.4.2, most sales in the Mexican market are of hybrid vehicles, representing around 90% of sales in the EV segment. This is mainly because the price of hybrid vehicles is more affordable than that of other electric technologies and because, for consumers, hybrid technology represents an initial step toward electrified technologies that are still unknown to the population. In general terms, hybrid technology is regarded as a transition technology that helps overcome some of market's obstacles, like range anxiety for plug-in technologies, considering the existing gap in public charging infrastructure in Mexico.

However, the percentage of hybrid vehicles decreases since 2020. This is due to several factors. First, the lack of semiconductors has directly affected their availability. Consumers are facing long waiting lists (above the average of ICE vehicles) for hybrid vehicles. Second, the increased number of brands offering PHEVs and BEVs has resulted in a diminished preference for HEV technology. In 2019, plug-in vehicle sales accounted for 7.6% of EV sales, by 2022, they reached 14.2%. By 2030, in a business-as-usual scenario (if a more aggressive incentive scheme is not adopted) that percentage will continue to grow, reaching 71.1% of total EV sales. Frost & Sullivan estimates that, by 2030, hybrid and electric vehicle sales will reach 316,856 units, which would represent a penetration of 19.1% into the total vehicle sales in Mexico.

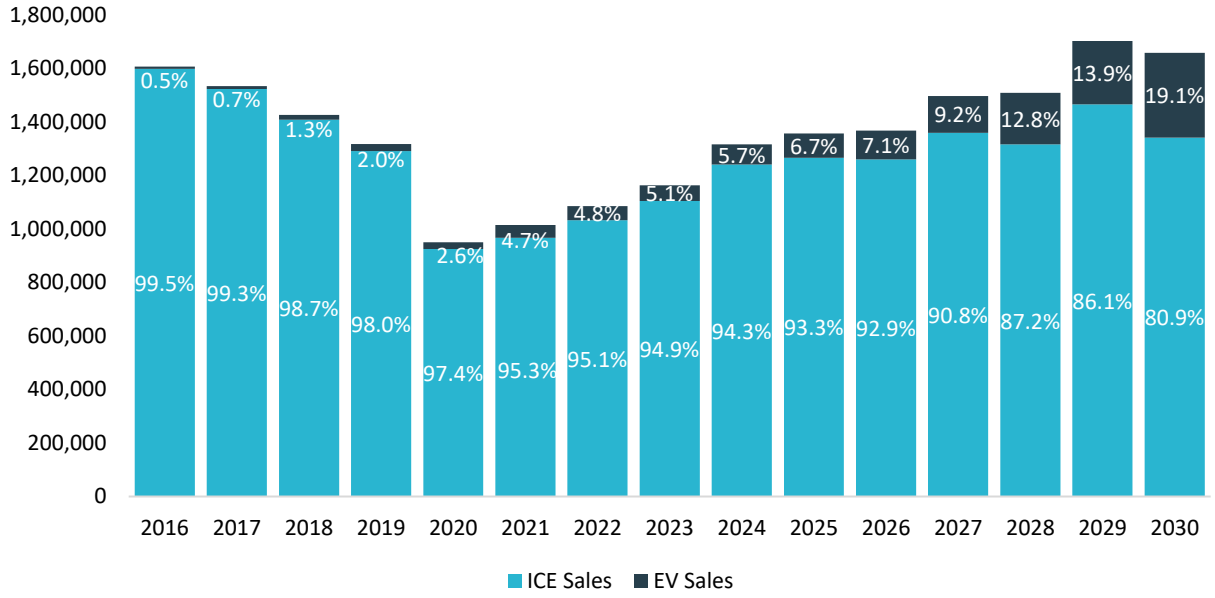
Chart 5.4.2: Total Annual Sales of Hybrid and Electric Vehicles by Technology, Mexico, 2016–2030



Source: Frost & Sullivan, INEGI

As mentioned above, this scenario (business-as-usual) considers that there is no change in the existing incentive scheme in 2023, and that the government does not design nor successfully implements any policy to promote EV adoption. By implementing the comprehensive policy of promoting electromobility developed in this document, EV penetration is highly likely to increase significantly by 2030, as Frost & Sullivan estimates that the penetration of this type of vehicles can increase to 38.9% of total light vehicle sales in 2030, as shown in chart 5.4.3.

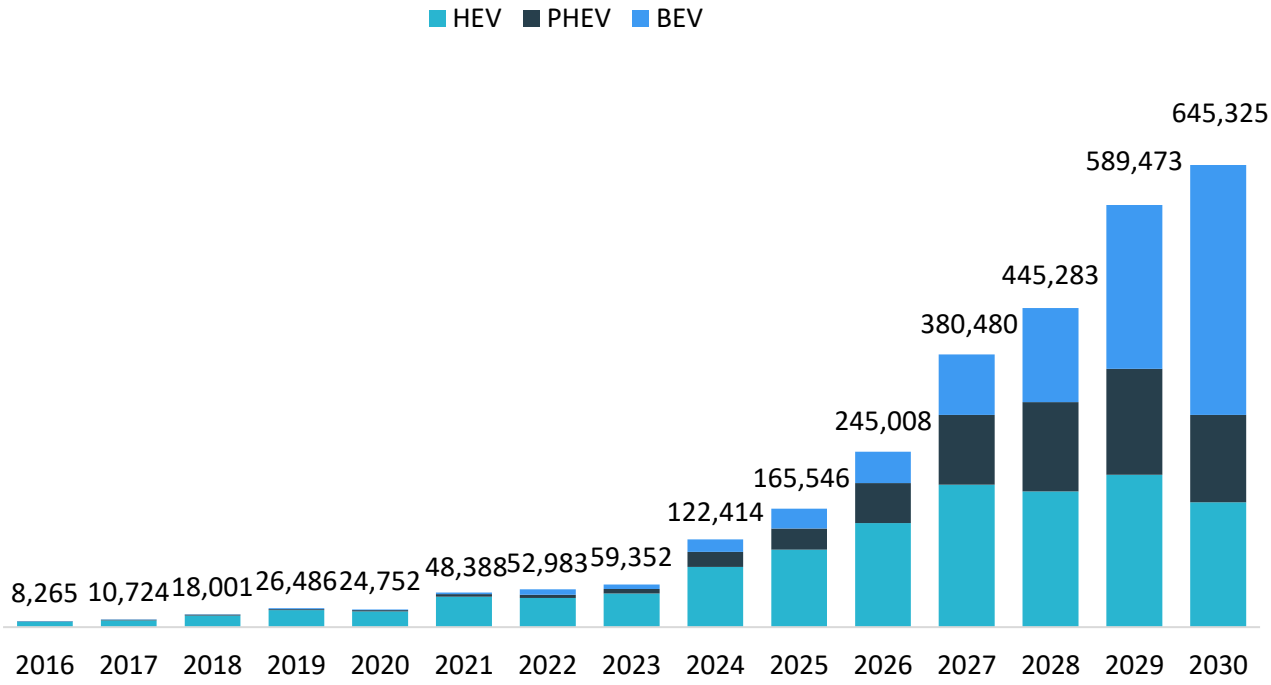
Chart 5.4.3: Hybrid and Electric Vehicle Sales Penetration in Total Sales with a Comprehensive Electromobility Promotion Policy, Mexico, 2016–2030



Source: Frost & Sullivan, INEGI

In terms of technologies, the suggested incentive scheme—and the focus of most car manufacturers on electrical technology towards the end of the decade—generates the expected increase BEV sales. The trend towards lower battery prices and the increased availability of vehicles in all segments would generate more accessible prices for this technology, which, together with the suggested incentive scheme, would significantly increase sales of this type of vehicle. This would be a necessary condition for the Mexican government to reach the announced 50% target for zero-emission vehicle sales by 2030. Chart 5.4.4 shows that HEV sales with a policy for promoting electromobility would reach 17% of total EV sales, while BEV sales would be 44.1%. In the case of the business-as-usual scenario, the BEV percentage represents only 37.6% of sales of vehicles with electrified technologies.

Chart 5.4.4: Total Annual Hybrid and Electric Vehicles Sales by Technology with a Comprehensive Electromobility Promotion Policy, Mexico, 2016–2030



Source: Frost & Sullivan, INEGI

In the absence of a comprehensive policy and strategy for EV promotion, including an incentive scheme that directly affects vehicle prices, it will be very difficult to achieve the emission reduction targets and the international commitments that the Mexican government has undertaken.